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Pest Management in Wisconsin Field Crops

A guide to managing weeds, insects, and diseases in corn, soybean, forages, and small grains

UW Extension
Cooperative Extension

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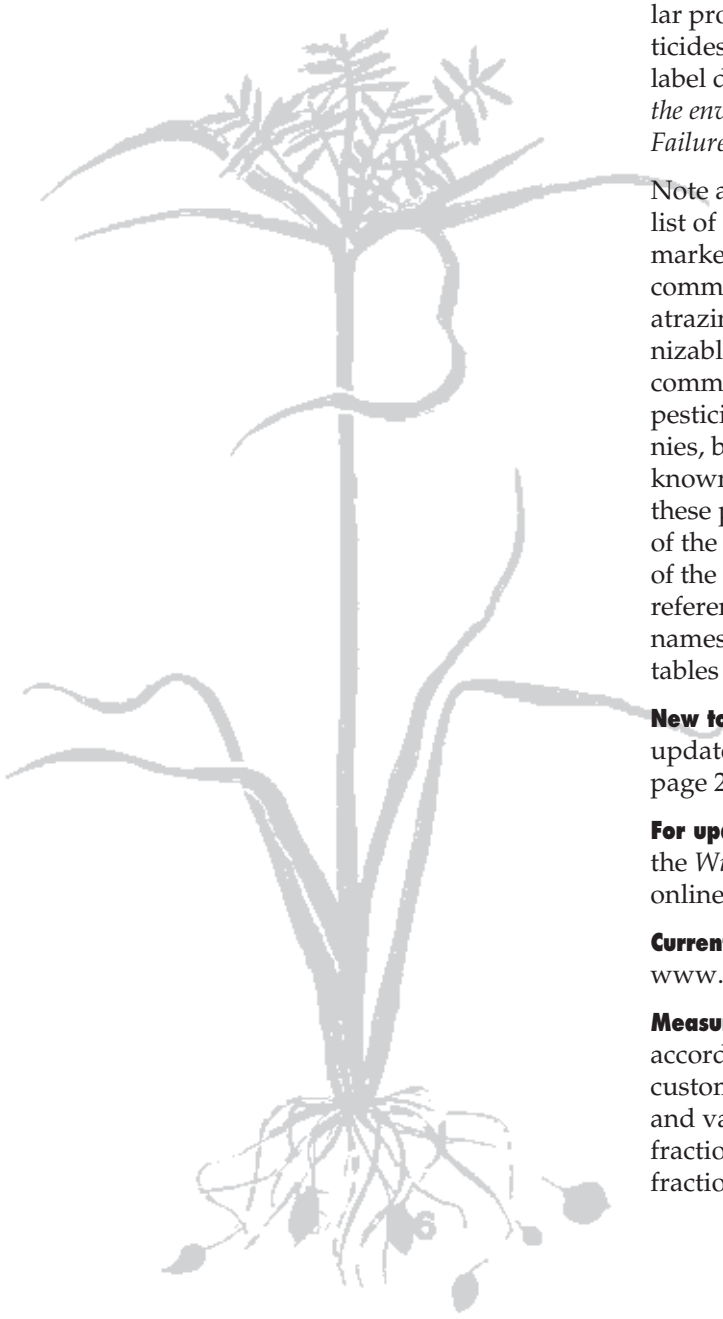

Pesticide references and updates

References to pesticide products in this publication are for your convenience and are not an endorsement or criticism of one product over other similar products. You are responsible for using pesticides according to the manufacturer's current label directions. *Follow directions exactly to protect the environment and people from pesticide exposure. Failure to do so violates the law.*

Note also that this publication is not a complete list of all pesticide labels. Several pesticides are marketed in numerous formulations and the common names of their active ingredients (e.g., atrazine, glyphosate, 2,4-D) are generally recognizable. These pesticides are referenced by their common names. The active ingredients in other pesticides may be marketed by multiple companies, but their common names are not generally known by users. For name recognition purposes, these pesticides are referenced by the trade name of the primary registrant, but the common name of the active ingredient is provided as a cross reference for your use. For a listing of common names of pesticides, please refer to appendix tables 1a–c.

New to this publication: Highlights of this year's updates can be found at the end of the book, on page 267.

For updates throughout the growing season, consult the *Wisconsin Crop Manager* newsletter, available online at ipcm.wisc.edu/wcm.

Current pesticide labels are available online at www.cdms.net/LabelsMsds/LMDefault.aspx?t=

Measurements used in this publication vary according to common usage. In most cases, US customary units (ounces, miles, etc.) are used, and values are expressed in decimals rather than fractions. In a few instances, metric units and/or fractions have been retained to avoid confusion.

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1 PRINCIPLES OF PEST MANAGEMENT

PEST MANAGEMENT AND PESTICIDES

Controlling a pest—be it a weed, insect, or disease—is only part of a total pest management program. Pest control is a corrective measure; you use pesticides or some other control method to reduce a damaging (or potentially damaging) pest population. Pest management, however, includes preventative measures as well.

The primary goal of your pest management program is to maintain pest damage at an acceptable level. Eradication of pests is rarely possible or feasible. In fact, our attempts at eradication may create more problems than they solve (pesticide resistance, secondary pest outbreaks, etc.). Pesticides are vital, effective tools for agriculture and for the production of our nation's food and fiber, but they can no longer be viewed as a cure-all for all of our pest problems. Rather, they must be viewed in the context of a total pest management program.

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is the coordinated use of multiple pest control methods. By becoming familiar with the crop, the pest, and all available control tactics, you can develop and implement a sound IPM program that will help you apply pesticides only when necessary.

To help train growers, field scouts, and consultants, the University of Wisconsin conducts field scout training classes each year in Madison and River Falls and a Wisconsin crop diagnosis training program at the Arlington Agricultural Research Station in Arlington. For more information about the Wisconsin IPM program, contact your county Extension agent or call the state IPM coordinator at 608-263-4073.

FEDERAL PESTICIDE-USE LAW

When Congress amended the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in 1972, it included a mandate for the United States Environmental Protection Agency (EPA) to evaluate all new and existing pesticide products for potential harm they may cause. It also made it illegal to use, except as provided by FIFRA, any pesticide in a manner inconsistent with its labeling. Deviations from the label not recognized by FIFRA are a violation of the law.

The Food Quality Protection Act (FQPA) of 1996 strengthens the system that regulates pesticide residues on food. Recognizing that pesticide residues are present in more sources than just food, the FQPA sets limits on the total exposure from residues found in food, drinking water, and non-dietary sources (such as household, landscape, and pet uses). The more uses a particular pesticide has, the greater the chance its total exposure will be met and, thus, some or all of its uses canceled.

If, during the pesticide registration process, the EPA finds a product to generally cause unreasonable adverse effects on the environment, including injury to the applicator, it will be classified as restricted use. Because restricted-use products can be used only by certified applicators, the FIFRA amendments also call for each state to develop a program for training and certifying pesticide applicators. The certification program is designed to ensure that users of restricted-use products are properly qualified to handle and apply these materials safely and efficiently. A current list of restricted-use pesticides registered for use in Wisconsin may be downloaded from the Pesticide Applicator Training (PAT) website (ipcm.wisc.edu/pat).

WISCONSIN'S TRAINING AND CERTIFICATION PROGRAM

In Wisconsin, responsibility for training lies with the University of Wisconsin-Extension's PAT program, while actual certification is the responsibility of the Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP). The Wisconsin Pesticide Law requires that all commercial applicators for hire participate in the training and certification process if they intend to use any pesticide in the state of Wisconsin, whether or not it is restricted use.

Since 1977, the PAT program has trained over 215,000 Wisconsin applicators in the safe handling of pesticides and prepared them for the written certification exam administered by the WDATCP, which enforces Wisconsin's pesticide regulations.

The selection, use, and potential risks of pesticides vary depending on the method of application and what it is you want to protect from pests. Therefore, there is a separate training manual and certification exam for 21 pest control categories, including categories for agricultural producers, the agricultural industry (10 categories), use in and around commercial and residential buildings (6 categories), use in right-of-way and surface waters (3 categories), and preserving wood. Certification is valid for 5 years, after which you can recertify by passing a new exam that is based on a revised training manual.

The regulated community—including pesticide manufacturers, dealers, and applicators—strongly support training and certification as a way to protect people and the environment while ensuring that pesticides remain an option in pest management. Nearly 75% of applicators surveyed at live training sessions said they had already adopted or plan to adopt all 24 pesticide use practices listed on the survey as a direct result of Wisconsin's training effort; of the remaining applicators, over 90% said they plan to adopt at least one additional use practice. We encourage all applicators to take advantage of the training and certification process, whether or not you use restricted-use pesticides. For more information about the Wisconsin PAT program, contact your county Extension agent or visit ipcm.wisc.edu/pat. For information on Wisconsin's licensing and certification program, visit datcp.wi.gov/Plants/Pesticides/Licenses.

WISCONSIN PESTICIDE LAWS AND REGULATIONS

Operating under the provisions of the Wisconsin Pesticide Law and Administrative Rule, Chapter ATCP 29 (Register, April 2009), the WDATCP has primary responsibility for pesticide use and control in the state. The Wisconsin Department of Natural Resources (WDNR) has responsibility for pesticide use involving "waters of the state," the control of birds and mammals, and pesticide and container disposal. The Wisconsin Division of Emergency Management (WDEM) has responsibility for helping communities evaluate their preparedness for responding to accidental releases of hazardous compounds, including pesticides, under Title III of the EPA's Superfund Amendments and Reauthorization Act (SARA). The Wisconsin Department of Transportation (WisDOT) has responsibility for regulating the transportation of pesticides listed as hazardous materials (shipping papers, vehicle placarding, etc.) and for issuing commercial driver's licenses. It is your responsibility to become familiar with all pertinent laws and regulations affecting pesticide use in Wisconsin.

PESTICIDES AND COMMUNITY RIGHT TO KNOW

To help communities evaluate their preparedness for responding to chemical spills, Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA). This law is part of a much larger legislation called the Superfund Amendments and Reauthorization Act (SARA) and is often referred to as Title III of SARA. Title III sets forth requirements for reporting of hazardous substances stored in the community and for developing an emergency response plan.

The first step in emergency planning is to know which chemicals can cause health problems and environmental damage if accidentally released. The EPA has prepared a list of such chemicals and calls them extremely hazardous substances. These substances are subject to emergency planning and the threshold planning

quantity, the smallest amount of a substance which must be reported. Some of the chemicals listed are commonly used in agricultural production (see table 1-1).

A complete list of EPA's extremely hazardous substances is available from the Local Emergency Planning Committee (LEPC). For a list of county LEPC directors in the state of Wisconsin, visit: emergencymanagement.wi.gov/EPCRA/forms/County_EM_Director_LECP_Listing_wEmail.pdf.

Any facility, including a farm, that produces, uses, or stores any of these substances in a quantity at or greater than their threshold planning quantity must notify the WDEM and their LEPC that it is subject to the emergency planning notification requirements of Title III of SARA.

In addition to emergency planning notification, agricultural service businesses with one or more employees are subject to two community right-to-know reporting requirements: submission of material safety data sheets (MSDS) and submission of Tier II inventory forms. Tier II forms request specific information on each hazardous chemical stored at or above its threshold.

WORKER PROTECTION STANDARD FOR AGRICULTURAL PESTICIDES

The federal Worker Protection Standard (WPS) for Agricultural Pesticides took effect January 1, 1995. Its purpose is to reduce the risk of employee exposure to pesticides. You are subject to the WPS if you have at least one employee who is involved in the production of agricultural plants in a nursery, greenhouse, forest, or farming operation.

The WPS requires employers to do the following:

- Display pesticide safety information in a central location.
- Train uncertified workers and handlers on general pesticide safety principles.
- Provide personal protective clothing and equipment to employees.
- Provide a decontamination site (water, soap, towels, and coveralls).
- Provide transportation to an emergency medical facility for employees who are poisoned or injured by pesticide exposure.
- Provide notification to employees about pesticide applications (see below).

For more information about the WPS and the training requirements for uncertified workers and handlers, download the 2005 edition of the EPA's *How To Comply with the Worker Protection Standard for Agricultural Pesticides, revised 2005* manual (www.epa.gov/agriculture/twor.html).

ORAL NOTIFICATION AND POSTING

The WPS requires employers to give notice of pesticide applications to all workers who will be in a treated area or walk within .25 miles of a treated area during the pesticide application or during the restricted entry interval (described in the next section). Notification may either be oral warnings or posting of warning signs at

Table 1-1. Examples of agricultural chemicals subject to Title III of SARA

Active ingredient	Trade name	Threshold planning quantity (lb or gal of product)
anhydrous ammonia (fertilizer)	—	610 lb
azinphos-methyl	Guthion 50WP	20 lb
dimethoate	Dimethoate 4EC	125 gal
paraquat	Gramoxone Inteon	5 gal
phorate	Thimet 20G	50 lb
phosmet	Imidan 70WP	14.3 lb
terbufos	Counter 15G	667 lb

entrances to treated sites; both are necessary if the label requires dual (oral and posting) notification. A current list of dual-notice pesticides registered for use in Wisconsin is available at ipcm.wisc.edu/pat/download/download/Dual%20Notice_tbl_10.pdf.

Wisconsin's Agriculture, Trade & Consumer Protection (ATCP) 29 posting rule is designed to protect the general public as well as workers. Thus, it requires posting of areas treated with pesticides having a dual notification statement or, for non-agricultural pesticide applications, if the label prescribes a restricted entry interval for that particular application. Refer to *On-Farm Posting of Pesticide-Treated Sites in Wisconsin*, available at ipcm.wisc.edu/pat/download/download/OFPost98.pdf, for a flowchart guiding users through a series of questions to determine when posting of treated sites is needed, what warning sign to use, and where the sign should be located. Also covered are the separate posting requirements for chemigation treatments. This publication is available from your county Extension office or online at ipcm.wisc.edu/pat (search for "On-farm posting").

RESTRICTED ENTRY INTERVAL

A restricted entry interval (REI) is the length of time that must expire after pesticide application before people can safely enter the treated site without using personal protective equipment. Pesticide residues on a treated crop or in a treated area may pose a significant hazard to workers or others who enter the area after treatment. Therefore, nearly all pesticides affected by the WPS (see above) have an REI (see appendix tables 1a–c). Check the Agricultural Use Requirements section on the label for the specific REI for your product. These intervals must be strictly observed.

PESTICIDE TOXICITY

There are four common ways in which pesticides enter the human body: through the skin (dermal), the mouth (oral), the lungs (inhalation), and the eyes. Absorption through the skin is the most common route of poisoning of agricultural workers.

Perhaps the greatest hazard for the applicator is in loading and mixing the pesticide concentrate, which presents a significant risk of exposure to the chemical in its most toxic form. Although hazards associated with the actual application are frequently much less severe, they can still be substantial, especially if there is significant drift or if appropriate precautions are ignored. A pesticide may be toxic as a result of exposure to a single dose (acute toxicity) or as a result of repeated exposures over time (chronic toxicity).

Acute toxicities are normally expressed as the amount of pesticide required to kill 50% of a population of test animals (usually rats or rabbits). For oral and dermal exposure, this is referred to as the LD_{50} or "lethal dose to 50%" in milligrams of toxicant per kilogram of body weight (mg/kg). For inhalation exposure, it is expressed as the LC_{50} or "lethal concentration to 50%" in parts per million (ppm) of toxicant in the total volume of air when the toxicant is a gas or vapor, and in milligrams per liter (mg/l) of air when the toxicant is a dust or mist. ***Pesticides with greater acute toxicities have lower LD_{50} and/or LC_{50} values; that is, it takes less of the chemical to kill 50% of the test population.***

Labels indicate the relative level of acute toxicity through signal words and symbols (see table 1-2). The toxicity category is assigned based on the highest measured toxicity, be it oral, dermal, or inhalation; effects on the eyes and external injury to the skin are also considered.

In the event of human pesticide poisoning, the pesticide label is your first source of first-aid information. Always bear in mind, however, that first-aid response to pesticide exposure is not a substitute for professional medical help. Seek medical attention promptly and always be sure that the label or labeled container is given to the doctor. The product's Material Safety Data Sheet (MSDS) is a more technical document than the label, and it often contains additional treatment instructions for the attending medical professional.

Poison Control Center (1-800-222-1222). You may call the Poison Control Center at any hour for information regarding proper treatment of pesticide poisoning. While hospitals and medical facilities may have some information, the Poison Control

Center has the most complete and current files, and their personnel are specifically trained to deal with poison cases.

Most labels also list a phone number that you (or medical personnel) can call for specific information on poisoning (or other accidents) involving that particular product.

PESTICIDE SAFETY

Before you handle pesticides, ***stop and read the label.*** Labels contain human safety precaution statements and list the specific personal protective clothing and equipment that you need to wear. Some of the following may be label requirements; others are common-sense guidelines that will help minimize pesticide exposure to you, your co-workers, and your family and neighbors.

- Wear a long-sleeved shirt, long pants, shoes, and socks when handling pesticides.
- Wear coveralls (fabric or chemical-resistant) over your work clothes for an added layer of protection.
- Unless the label states otherwise, always wear chemical-resistant gloves whenever you work with pesticides.
- Wear chemical-resistant footwear, gloves, eyewear, and a respirator (if the label requires one) when mixing, loading, or applying pesticides.
- If you wear fabric coveralls, also wear a chemical-resistant apron when mixing and loading pesticides.
- Stand in the crosswind when mixing or loading pesticides.
- Never apply pesticides when there is the likelihood of significant drift.
- Never leave a spray tank containing a pesticide unattended.
- Avoid back siphoning into the water source.
- Never eat, drink, or smoke when handling pesticides.
- Wash hands thoroughly after handling pesticides.
- If you splash pesticide on yourself, remove contaminated clothing immediately and wash yourself thoroughly.
- Wash contaminated clothes separately from other household laundry.
- Keep pesticides in original containers.
- Store and lock pesticides out of the reach of children.
- Observe restricted entry intervals on a treated crop or area.

Table 1-2. Toxicity categories of pesticides

	Toxicity category			
Measure of toxicity	I High toxicity	II Moderate toxicity	III Slight toxicity	IV Low toxicity
Oral LD_{50} (mg/kg)	0–50	50–500	500–5,000	>5,000
Dermal LD_{50} (mg/kg)	0–200	200–2,000	2,000–20,000	>20,000
Inhalation LC_{50}				
gas/vapor (ppm)	0–200	200–2,000	2,000–20,000	>20,000
dust/mist (mg/l)	0–0.2	0.2–2	2–20	>20
Eye effects	corrosive	irritation persists for 7 days	irritation reversible within 7 days	no irritation
Skin effects	corrosive	severe irritation	moderate irritation	mild irritation
Signal word	DANGER[a]	WARNING	CAUTION	CAUTION

Abbreviations: mg/kg = milligrams per kilogram; mg/l = milligrams per liter; ppm = parts per million; < = less than; > = greater than

[a] Products assigned to Category I due to oral, inhalation, or dermal toxicity (as distinct from eye and local skin effects) must also have the word "poison" and the skull and crossbones symbol on the label.

PESTICIDE ACCIDENTS

Pesticide spills. Regardless of the magnitude of a spill, the objectives of a proper response are the same—you must ***control*** the spill, you must ***contain*** it, and you must ***clean it up.*** A thorough knowledge of appropriate procedures will allow you to minimize the potential for adverse effects.

Spills of any compound need to be reported to the WDNR. However, you do ***not*** need to report the spill if it is completely confined within an impervious secondary containment and the spilled amount can be recovered with no discharge to the environment. On the other hand, a spill of any amount is reportable if it occurred outside of secondary containment and it harmed, or threatens to harm, human health or the environment (e.g., back siphoning). The spill is exempt from the WDNR reporting requirements if:

- you deem the spill will not harm, or threaten to harm, human health or the environment AND
- the amount spilled would cover less than 1 acre if applied at labeled rates AND
- if a SARA pesticide, it is less than the reportable quantity.

Reportable spills involving SARA substances (see "Pesticides and Community Right to Know," page 3) are also to be reported to the WDEM and to your LEPC. To simplify emergency notification requirements to state agencies, call the WDEM 24-hour spill hotline (1-800-943-0003) whenever a spill of any compound occurs. Calling this hotline will not, however, remove your responsibility of notifying your LEPC.

Spills of some compounds may require that you notify federal authorities by calling the National Response Center (1-800-424-8802). Your call to the WDEM spill hotline should provide you with assistance in determining whether federal authorities need to be notified.

Pesticide fires. In the event of a fire, isolate the entire area and clear all personnel to a safe distance *upwind* from smoke and fumes. Always inform the fire department of the nature of the pesticides involved and of any specific information that may help them in fighting the fire and protecting themselves and others from injury. For information on cleanup and decontamination, contact the WDEM and the pesticide manufacturer(s).

Livestock poisoning. When you suspect animal poisoning by pesticides, first call your veterinarian. If the cause of poisoning cannot be determined, call the WDATCP's Animal Toxic Response Team Coordinator at 608-224-4500 (during office hours) or the Division of Emergency Government at 1-800-943-0003 (after hours and on weekends).

Wildlife poisoning or water contamination. Contact the WDNR district office. District offices are located in Eau Claire, Fitchburg, Green Bay, Milwaukee, Rhinelander, and Spooner.

PESTICIDES AND ENDANGERED SPECIES

Endangered and threatened species are the most vulnerable plants and animals in our native natural communities. These species are either in danger of extinction or likely to become endangered in the foreseeable future. Starting in 2010, the EPA's Endangered Species Protection Program (ESPP) will implement county-specific bulletins to provide applicators the information they need about pesticide use limitations in their county to better protect listed species and their habitat. The first product to carry a label statement directing users to view a bulletin is methoxyfenozide (Intrepid 2F), to protect the endangered Karner blue butterfly and Hine's emerald dragonfly. Please note that it may take several years for products with the new label to replace existing product in the channel trade. As always, pesticide users are to follow the label on the product they are using.

When using pesticides whose label statements instruct you to follow the measures contained in the ESPP Bulletin, you must either access the EPA's Bulletins Live! website or call their toll-free number (800-447-3813) within 6 months before using the product. The bulletin will show which counties or portions of counties are affected and the use limitations for that particular product. You must use the bulletin that is valid for the month and year in which you will apply the product.

Go to www.epa.gov/espp/ for general information on the ESPP and to access bulletins Live! The WDNR is responsible for implementing ESPP for our state. For more information about protected plants, animals, and natural communities in Wisconsin, see dnr.wi.gov/topic/endangeredresources/biodiversity.html.

PESTICIDE DRIFT

It is impossible to totally eliminate pesticide drift. Drift occurs because of unforeseen wind variations and other factors, many of which are beyond the applicator's control. People living in areas subject to pesticide drift worry about the acute and chronic effects of exposure to pesticides. State rules governing pesticide drift attempt to strike a balance between the intended benefits of pesticide use and the potential risks to those exposed to pesticide drift.

According to state law, people living adjacent to land that is aerially sprayed with pesticides can request to be notified at least 24 hours before application. Beekeepers also are entitled to notification of applications that occur within a 1.5-mile radius of their honeybee colonies. Both ground and aerial pesticide applications are subject to advance notification requirements to beekeepers who request such notification.

For ground applications, you can minimize drift by following these recommendations:

- Follow all label precautions for specific drift-reduction measures.
- Spray when wind speed is low.
- Use the maximum size nozzle orifice without sacrificing pest control activity.
- Keep pressure at the lowest setting possible without distorting spray pattern and distribution.
- Use drift-control agents when permitted by product label.
- Consider using nozzles specifically designed to reduce drift.
- Leave an untreated border strip next to adjacent property.

For more information about drift—what it is, how it occurs, and drift management principles—ask for *Managing Pesticide Drift in Wisconsin: Field Sprayers* from your county Extension office or download it by going to ipcm.wisc.edu/pat/downloads/. This publication also describes the critical role the pesticide applicator plays in deciding whether to spray when arriving at the site.

PESTICIDES AND GROUNDWATER

Trace amounts of pesticides are found in our nation's groundwater. To minimize further contamination, many pesticide labels contain precautionary statements either advising against or prohibiting use in areas vulnerable to groundwater contamination. A summary of these precautionary statements is included under "Remarks" for each pesticide in this publication.

To protect our state's water resources, Wisconsin's groundwater law (Act 310) created two guidelines to limit the presence of fertilizer and pesticides in groundwater: *enforcement standards* are maximum chemical levels allowed in groundwater and *preventive action limits* are set at a percentage of the enforcement standard. When contamination approaches preventive action limits, the responsible party must implement corrective measures to prevent further contamination.

Through groundwater monitoring studies, the most commonly found pesticide is atrazine. Atrazine rate limits and restrictions are explained more fully in the "Corn Weed Management" section of this publication.

Mixing and loading pesticides. Mixing and loading pesticides pose a high risk of point source contamination of ground and surface water because of the concentration, quantity, and type of pesticides that are usually handled at a mixing and loading site. To minimize this risk of environmental contamination, Wisconsin requires that certain mixing and loading sites have secondary containment.

Both private and commercial applicators are required to have a mixing and loading pad if more than 1,500 pounds of pesticide active ingredient are mixed or loaded at any one site in a calendar year or if mixing and loading occurs within 100 feet of a well or surface water. In-field mixing is exempt from the pad requirements provided mixing or loading at the site of application occurs 100 feet or more from a well or surface water.

Agricultural Chemical Cleanup Program. Cleanup of contaminated soil or of contaminated groundwater itself is costly. The Agricultural Chemical Cleanup Program (ACCP) helps ease the financial burden for facilities and farms by reimbursing them for eligible costs associated with the cleanup of sites contaminated with pesticides or fertilizers. For more information, contact the WDATCP at 608-224-4518.

CALIBRATING PESTICIDE EQUIPMENT

Accurate and uniform pesticide application is fundamental to satisfactory pest control. Too frequently a grower does not know exactly how much pesticide has been used until the application is completed. This can lead to substantial monetary losses due to unnecessary pesticide and labor costs, unsatisfactory pest control resulting in reduced yields, and crop damage. Good pesticide application begins with accurate sprayer or granular applicator calibration. One method of calibration is contained in the *Training Manual for the Private Pesticide Applicator*. It also is found in the *Training Manual for the Commercial Pesticide Applicator: Field and Vegetable Crops.* Both of these are available at ipcm.wisc.edu/pat.

CLEANING PESTICIDE SPRAYERS

Thorough sprayer cleaning is necessary when switching from pesticide application on one crop to the application of a different pesticide on another crop. This is especially important when the second crop is quite sensitive to the first pesticide. For example, residue of dicamba left in a sprayer may damage soybeans and other dicamba-sensitive crops during subsequent pesticide applications. No cleaning method is 100% foolproof, however. If you apply significant quantities of different types of pesticides, reserve one sprayer for herbicides only and another for insecticides and fungicides.

Check the label for specific cleaning instructions. If none are listed, follow these guidelines:

1. Park the sprayer on a wash pad, flush the tank, lines, and booms thoroughly with clean water, and apply the pesticide-contaminated rinsate to sites listed on label. Simpler still, mount a clean water source on your sprayer and flush the system while in the field.
2. Select the appropriate cleaning solution for the pesticide used:

   Hormone-type herbicides (e.g., 2,4–D, Banvel). Fill the sprayer with sufficient water to operate, adding 1 quart household ammonia for every 25 gallons of water. Circulate the ammonia solution through the sprayer system for 15 to 20 minutes and then discharge a small amount through the boom and nozzles. Let the solution stand for several hours, preferably overnight. (Please note: household ammonia will corrode aluminum sprayer parts.)

   Other herbicides, insecticides, and fungicides. Fill the sprayer with sufficient water to operate, adding .25 to 2 pounds powder detergent (liquid detergent may be substituted for powder at a rate to make a sudsy solution) for every 25 to 40 gallons of water. Circulate the solution through the sprayer system for 5 to 10 minutes and then discharge a small amount through the boom and nozzles. Let the solution stand for several hours, preferably overnight.
3. Flush the solution out of the spray tank and through the boom.
4. Remove the nozzles, screens, and strainers and flush the system twice with clean water.
5. Scrub all accessible parts with a stiff bristle brush.

PREPARING PESTICIDE SPRAYERS FOR STORAGE

Before storing the sprayer at the end of the season:

1. Clean the sprayer per label instructions or as specified above.
2. Fill the sprayer with sufficient water to operate, adding 1 to 5 gallons of lightweight emulsifiable oil, depending upon the size of the tank. Circulate the oil/water solution through the sprayer system for 5 to 10 minutes.
3. Flush the solution out of the spray tank and through the boom; the oil will leave a protective coating on the inside of the tank, pump, and plumbing.

4. Remove the nozzles, screens, and strainers and place them in diesel fuel or kerosene to prevent corrosion. Cover the nozzle openings in the boom to prevent dirt from entering.
5. As an added precaution to protect pumps, pour 1 tablespoon of radiator rust-inhibitor antifreeze in each of the inlet and outlet ports. Rotate the pump several revolutions to completely coat the interior surfaces.

PESTICIDE DISPOSAL

It is the legal responsibility of all pesticide users to properly dispose of pesticide waste in an environmentally acceptable manner (it is illegal to bury or burn any pesticide containers in Wisconsin).

Some pesticides are considered "hazardous" by the EPA. Disposing waste or excess resulting from use of these pesticides comes under stringent regulations of the Resource Conservation Recovery Act (RCRA). This federal law and the accompanying state law (NR 600) regulate generators of hazardous waste—those who need to dispose of hazardous pesticides.

The simplest way to avoid becoming a hazardous-waste generator is to triple-rinse all pesticide containers and apply rinsates to labeled sites. If you must generate hazardous waste, disposal procedures may differ depending on the volume of waste generated and its characteristics.

You can reduce the amount of pesticide waste (hazardous or not) by following these guidelines:

- Determine whether the pesticide you intend to use is considered hazardous by the EPA. A list of these pesticides is available from your WDNR regional office. If listed, check for alternative pesticides that are not hazardous and will provide equivalent pest control.
- Mix only the amount of pesticide needed and calibrate equipment so all of the solution is applied.
- Attach a clean water supply to the sprayer unit so the tank can be rinsed and the rinsate applied to the labeled site while still in the field.
- Triple-rinse all pesticide containers. Even if the pesticides were hazardous, a triple-rinsed container is not hazardous waste; you can dispose of it in a sanitary landfill.
- Don't mix hazardous waste with other pesticide waste, or the entire mixture will be considered hazardous.

Wisconsin Clean Sweep program. Wisconsin's Clean Sweep program, sponsored by WDATCP and individual counties, offers a way to dispose of most kinds of pesticide waste including liquids, dry formulations, and waste classified as hazardous. For details on when a site will be held in your area, check with your county Extension office or view the WDATCP Clean Sweep interactive map at datcp.wi.gov/environment/clean_sweep/index.aspx. Wisconsin Clean Sweep offers grants for the collection and disposal of agricultural waste, household hazardous waste, and prescription drugs. However, not all municipalities collect all three types of waste at the same time, while some municipalities offer collection sites without use of Wisconsin Clean Sweep funds.

Plastic pesticide container recycling program. The best way to dispose of plastic containers is to recycle them. The Wisconsin Crop Production Association (WCPA) sponsors a recycling program and sets up collection sites at member dealers throughout the state. This program accepts triple-rinsed (dirty containers will not be accepted) plastic pesticide containers of all sizes, including mini-bulk tanks. Farmers must work through their dealer to recycle jugs and mini-bulks. Visit www.wiagribusiness.org/recycling.php for instructions on the proper preparation of containers intended for recycling and for their summer and fall recycling schedules.

Please note that this recycling program is not a Wisconsin Clean Sweep program; waste pesticides will not be accepted at container collection or granulation sites.

Recycling mini-bulk tanks. Although mini-bulk tanks are recycled at the same time as the smaller jugs, dealers must register with WCPA at least 1 week in advance of a scheduled recycling date for all tanks 60 gallons and larger. Visit the Pesticide Containers Recycling Program at www.wiagribusiness.org/recycling.php for details.

WEED MANAGEMENT PRINCIPLES FOR ALL CROPS

The proper combination of cultural, mechanical, and chemical practices can maintain weeds at levels that are not economically damaging. The goal of cultural weed management is to allow a crop to compete vigorously with weeds. Crop competition is one of the most useful and economical methods of weed control. This is achieved by planting adapted varieties at the ideal density into a favorable seedbed that has adequate nutrients. Seeding forage legumes with a small grain companion crop is an excellent example of using crop competition to control weeds. The small grain germinates and grows quickly, preventing most weeds from becoming established.

Rotation to another crop is another essential component of sound weed management programs because certain weeds are more common in some crops than in others. A well-planned cropping system prevents the buildup of weeds associated with monocultures. Mechanical control such as tilling to prepare a weed-free seedbed, rotary hoeing, and row cultivation are effective and important components in many weed management programs.

Herbicides are highly effective chemicals if carefully selected to match the weed spectrum and if application conditions are favorable. Still, the best herbicide and/or tillage program will not be effective without good crop competition.

SELECTING A WEED MANAGEMENT PROGRAM

Plan your weed management program well in advance of the planting season. Base it on thorough knowledge of the weed problem, soil characteristics, and future cropping plans. As crop production practices change, weed problems also change, so a good weed management program must be flexible.

Herbicides vary in the types of plants they control. Some treatments control most broadleaf and grassy weeds, others control primarily annual grasses, and still others control only broadleaf weeds. Soil characteristics may affect herbicide performance and crop safety. Most soil-applied herbicides are less effective on soils high in organic matter and may be ineffective on peat and muck soils. Others should not be used on light-textured sandy soils, since they leach too readily and may damage crop seedlings. Still others interact with organophosphate insecticides to cause serious corn injury. Some herbicides remain in the soil into the next cropping season and injure sensitive crops. Check the rotational crop restrictions for the herbicides that you are considering to prevent injury to next year's crop.

WHEN TO APPLY HERBICIDES

Some herbicides must be soil-incorporated before planting for effective control. Others can be surface-applied before or after planting. Many herbicide treatments are registered for application after crop emergence.

Soil-incorporating herbicides are positioned where weed seeds are germinating and beginning growth. Some herbicides require incorporation to prevent loss through volatility or photo-decomposition. Proper herbicide incorporation is essential; check the herbicide label for recommended tillage/incorporation tools and how deep and fast they should be operated. Although rainfall after preplant-incorporated herbicide application will improve weed control, it isn't essential.

Early preplant- and preemergence-applied herbicides depend on rainfall to move them into the soil. Under Wisconsin conditions, spring rainfall is usually adequate to accomplish this. When rainfall is limited, a shallow tillage tool such as a

rotary hoe or spike-toothed harrow can provide sufficient soil incorporation to activate the herbicide treatment and destroy the first flush of weed seedlings.

Many postemergence-applied herbicide options are available and have increased in use. The effectiveness of these treatments is drastically influenced by weed size as well as temperature, moisture, and other environmental conditions. Proper timing is critical with postemergence applications to optimize weed control and minimize the risk of crop injury.

CAN HERBICIDE RATES BE REDUCED?

Producers are reevaluating their weed management practices and some are using lower herbicide rates than in the past. University of Wisconsin research has shown that application rates as much as 50% lower than the normal rates, combined with cultivation, can give excellent weed control. While the normal rate of a soil-applied herbicide often provides 60 to 90 days of weed control, reducing the rate shortens the length of control; successful full-season weed control with reduced rates often depends on a timely cultivation 30 to 40 days after planting and subsequent crop competition. Reducing rates can be effective with both broadcast applications and banded treatments over the crop row.

If you are considering using reduced rates of herbicides, keep these factors in mind:

- It is legal to use less than the labeled rate of a pesticide. However, the manufacturer and commercial applicator are not liable for the performance under these conditions. You must be ready to cultivate if and when needed to obtain effective full-season control.
- Try reducing the conventional rate 20 to 30% on a few acres the first year. As you gain confidence and experience with the system, you can decide on the direction and pace of future changes.
- Do not consider reduced rates of soil-applied herbicides if you have hard-to-kill weeds like shattercane, wild proso millet, yellow nutsedge, or woolly cupgrass. Also, reduced rates may not give satisfactory performance if your soils have more than 5% organic matter or a high clay content.
- The safest way to cut herbicide use is to make banded applications. If you apply 10-inch bands over corn in 30-inch rows, then you'll apply 67% less herbicide in the field. You'll reduce the rate even more if the rate applied in the band is less than the conventional rate. Two timely cultivations normally give adequate control with banded treatments.

MIXING HERBICIDES

Using mixtures of two or more herbicides for simultaneous application has become popular in recent years. The objective of mixing herbicides is to capitalize on the advantages of all products while diminishing their disadvantages. Many such combinations have been registered for use. Herbicide combinations that are not recommended on the label may cause crop injury or provide ineffective weed control.

When tank mixing wettable powder, liquid flowable, or dry flowable herbicides with emulsifiable concentrate herbicides, mix the wettable powder with the water or liquid fertilizer first. Then add water or liquid fertilizer until you've reached approximately 75% of the total spray volume you'll use. Add the emulsifiable concentrate last; then bring the mixture to final spray volume.

HERBICIDE/FERTILIZER COMBINATIONS

Herbicide application in liquid fertilizer solutions rather than water is popular. While such combination treatments save one trip over the field and enhance the burndown of existing weeds in conservation tillage, emerged corn is usually injured. Many individual herbicides and herbicide combinations are registered with the EPA for simultaneous application with liquid fertilizers. Herbicide labels and accompanying literature provide helpful mixing suggestions to minimize compatibility problems. If you have any doubt about the compatibility of a particular herbicide/fertilizer combination, run a compatibility test first. Adding compatibility agents such as Unite or Compex can reduce mixing problems. Wettable powder, liquid flowable, or dry flowable herbicides not properly mixed will sometimes float when mixed with liquid fertilizers. Emulsifiable concentrates occasionally cause mixing problems.

There also has been a trend toward impregnating herbicides on certain dry fertilizers. Some herbicides and herbicide combinations are registered with the EPA for this type of application. The herbicide manufacturer generally provides detailed directions and guidance for the impregnation process. Herbicide-impregnated fertilizer applications can provide weed control equal to comparable treatments applied as sprays. However, the herbicide/fertilizer blend and its application must be uniform, generally calling for a double spread or an air-flow applicator.

WEATHER AND HERBICIDES

Herbicides applied to the soil are taken up by seeds, roots, and stems of seedling weeds and by established perennial plants. Adequate rainfall is necessary to move surface-applied herbicides into the soil for maximum uptake by developing weed seedlings. Preplant soil-incorporated treatments position herbicide in the soil and minimize the need for rainfall to make them effective. Only certain herbicides can be used in this way; others become too diluted or increase the risk of injuring crops when mixed into the soil.

Adequate soil moisture also helps weed seeds germinate quickly, which is desirable when using soil-applied herbicides. However, excessive rainfall after herbicide application may leach the more soluble herbicides into the vicinity of germinating crop seeds and cause crop damage, especially on light, sandy soils. Chemical and microbial decomposition break down herbicides more slowly in cool, dry soils, thereby increasing the danger that some herbicides may carry over and injure sensitive crops the following year.

Weather conditions also affect post-emergence herbicides. Both weed and crop plant sensitivity generally increase with temperature. Lower herbicide or adjuvant rates are sometimes suggested in hot, humid weather to minimize crop injury. Weeds are more difficult to kill in dry, cool, or cloudy weather. Mature weeds are always more difficult to control than weed seedlings. Rainfall after postemergence application may reduce an herbicide's effectiveness. Check the product label or tables 2-6 (corn) and 3-4 (soybean) for the minimum required rain-free period.

HERBICIDE RESIDUES IN SOIL

Most herbicides control weeds only as long as the herbicides remain in the soil. Full-season weed control is considered desirable for any herbicide treatment. But soil herbicide residue that persists after harvest or into the following growing season and damages the next crop is objectionable.

Following a few simple rules will reduce the risk of herbicide residue damage.

- Follow crop rotation guidelines listed on the herbicide product label. See appendix table 2 for a listing of rotational crop intervals for many common crops. Herbicides that have no carryover risk do not list rotation restrictions.
- Use the minimum recommended rate necessary for adequate weed control and apply the herbicide uniformly.
- Till treated fields before planting a sensitive crop the next year.
- At equal rates of the same herbicide, preplant or preemergence applications generally present less risk of carryover than postemergence applications. The earlier treatment allows more time for breakdown.
- Crops vary in their tolerance to carryover of specific herbicides. Select a crop that has a high degree of tolerance to the previous year's herbicide treatment or select an herbicide that will permit the planting of a rotation crop.

Several years of experience on a particular soil and an appreciation of environmental effects on herbicide carryover are the best guide to which crops you can safely plant the year after applying residual herbicide. Growers are encouraged to run a soil bioassay to determine whether harmful soil residues exist.

HERBICIDES AND CONSERVATION TILLAGE

In conservation tillage systems, crop residue protects the soil surface from excessive raindrop impact and soil erosion. This surface debris can also affect weed seed germination and herbicide distribution. Generally, surface residue of 3,000 pounds per acre or less (30% or less surface cover) does not interfere with herbicide performance. The key consideration of annual weed

management in conservation tillage is that weed control may or may not be more difficult, but it probably will be different than in conventional systems.

HERBICIDE-RESISTANT WEEDS

At least one population of glyphosate-resistant giant ragweed has been confirmed in a production field in Rock County, Wisconsin. Control failures following glyphosate have been anecdotally noted in additional fields in several other counties in the state. Moreover, at least one population of ALS-inhibitor resistant giant ragweed has been confirmed in Columbia County, with anecdotally noted control failures in other areas. If you have heavy infestations of giant ragweed in corn and soybean fields, it is advised to implement a sound herbicide resistance management plan with diverse weed management tactics.

Additionally, biotypes of lambsquarters, smooth pigweed, velvetleaf, and kochia growing in Wisconsin are resistant to atrazine and other triazine herbicides. These problems developed after using triazine herbicides for six or more years without complementary control measures. This allowed the resistant biotype, initially a very small proportion of the total population, to produce seed and become the dominant biotype in many fields. Biotypes of weeds resistant to other herbicides have also been found in Wisconsin: giant foxtail and large crabgrass resistant to lipid synthesis inhibitors like Poast Plus, Select, and Assure; giant foxtail, eastern black nightshade, and kochia resistant to acetolactate synthase (ALS) inhibitors. Careful attention to sound weed management programs is critical if we hope to prevent the appearance of more herbicide-resistant biotypes. Comprehensive lists of herbicide-resistant weeds and other information can be found at weedscience.org/In.asp.

The risk of developing more resistant weed problems is greater if we overuse herbicides that kill weeds by affecting only one physiological process in plants (that is, with a single mode of action). Table 1-3 lists the modes of action of most common herbicides and ranks them according to the risk of developing resistant weeds.

To minimize the risk of developing resistant weeds, a sound herbicide resistance management program uses a combination of these practices:

- Use herbicides only when necessary.
- Rotate herbicides with different modes of action from year to year.
- Use multiple modes of action each year.
- Use broad crop rotations; three or four crops in rotation provide more resistance protection than only two.
- Integrate mechanical control practices (rotary hoeing and cultivation) with herbicide use.
- Scout fields regularly and control escaping weeds as needed.
- Clean tillage and harvest equipment before moving from fields or farms with resistant weeds to other fields.

USING NEW HERBICIDES

The introduction of new herbicides invariably creates a good amount of grower interest. We encourage you to try new products that appear to fit your weed situation and soil condition but suggest you try them on a relatively small scale the first year.

SELECTING HERBICIDES

The herbicide treatments described in the following sections have provided effective weed control under Wisconsin conditions. For corn and soybeans, review tables 2-3 and 3-1 to determine which herbicides will control the weeds in your fields. Then review the remarks in the herbicide entry to select the herbicide that best fits your situation. Tables that summarize rain-free periods and adjuvant requirements for postemergence herbicides, forage and grain harvest intervals, and rotational crop intervals are also included for easy reference.

All herbicide rates are expressed in weight or volume of commercial product as applied on a broadcast basis. See appendix table 1a for a list of herbicide products and related information.

Table 1-3. Listing of herbicides by mode of action and risk of developing resistant biotypes

Mode (site) of action	Group[a]	Herbicide	Ingredient
HIGH RISK of developing resistance			
Amino acid synthesis inhibitors (ALS)	2	Accent Q	nicosulfuron
		Affinity BroadSpec	thifensulfuron + tribenuron
		Ally/Escort	metsulfuron
		Arsenal	imazapyr
		Autumn	iodosulfuron
		Autumn Super	iodosulfuron + thiencarbazone
		Basis Blend	rimsulfuron + thifensulfuron
		Beacon	primisulfuron
		Canopy EX	chlorimuron + tribenuron
		Cimarron	metsulfuron
		Classic	chlorimuron
		Express	tribenuron
		FirstRate	cloransulam
		Harmony Extra SG	thifensulfuron + tribenuron
		Harmony SG	thifensulfuron
		Option	foramsulfuron
		Oust	sulfometuron
		Peak	prosulfuron
		Permit	halosulfuron
		Plateau	imazapic
		Pursuit	imazethapyr
		Python	flumetsulam
		Raptor	imazamox
		Realm Q	rimsulfuron + mesotrione
		Resolve Q	rimsulfuron + thifensulfuron
		Steadfast Q	rimsulfuron + nicosulfuron
		Synchrony XP	chlorimuron + thifensulfuron
		Telar	chlorsulfuron
Lipid synthesis inhibitors (ACCase)	1	Assure II/Targa	quizalofop
		Fusilade DX	fluazifop
		Fusion	fluazifop + fenoxaprop
		Poast Plus	sethoxydim
		Select Max/Arrow	clethodim
MEDIUM RISK of developing resistance			
Amino acid inhibitors (EPSP synthase)	9	Roundup/ Touchdown/etc.	glyphosate
Cell membrane disrupters (PPO)	14	Cadet	fluthiacet
		Cobra/Phoenix	lactofen
		Flexstar/Reflex	fomesafen
		Resource	flumiclorac
		Sharpen	saflufenacil
		Spartan	sulfentrazone
		Starane	fluroxypyr

[a] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action

(continued)

Table 1-3. Listing of herbicides by mode of action and risk of developing resistant biotypes *(continued)*

Mode (site) of action	Group[a]	Herbicide	Ingredient
MEDIUM RISK of developing resistance *(continued)*			
		Ultra Blazer	acifluorfen
		Valor SX	flumioxazin
Cell membrane disrupters (photosystem I)	22	Gramoxone Inteon	paraquat
		Reglone	diquat
Photosynthesis inhibitors —contact (photosystem II)	6	Basagran	bentazon
		Buctril	bromoxynil
Photosynthesis inhibitors —systemic (photosystem II)	5	AAtrex, etc.	atrazine
		Metribuzin, etc.	metribuzin
		Princep	simazine
		Sinbar	terbacil
		Velpar L	hexazinone
	7	Lorox DX	linuron
		Spike	tebuthiuron
Pigment inhibitors (isoprenoid pathway)	27	Callisto	mesotrione
		Impact	topramazone
		Laudis	tembotrione
	13	Command	clomazone
Seedling root growth inhibitors (multiple)	3	Balan	benefin
		Prowl H_2O, etc.	pendimethalin
		Treflan	trifluralin
LOW RISK of developing resistance			
Amino acid inhibitors (Glutamine synthetase)	10	Ignite	glufosinate
Growth regulators (multiple)	4	Banvel/Clarity, etc.	dicamba
		Crossbow	triclopyr + 2,4-D
		Curtail	2,4-D + clopyralid
		Forefront	aminopyralid + 2,4-D
		MCPA	MCPA
		Milestone	aminopyralid
		Starane	fluroxypyr
		Status	diflufenzopyr + dicamba
		Stinger	clopyralid
		Thistrol	MCPB
		Tordon	picloram
		Weedmaster	2,4-D + dicamba
		2,4-D	2,4-D
Seedling shoot growth inhibitors (multiple)	15	Dual II Magnum, etc.	metolachlor
		Harness/Surpass, etc.	acetochlor
		Intrro, etc.	alachlor
		Zidua/Outlook	pyroxasulfone/dimethenamid
	8	Eptam/Eradicane	EPTC
		Ro-Neet	cycloate

[a] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action

FUNGICIDE RESISTANCE MANAGEMENT PRINCIPLES

Fungicides can be an important tool for controlling diseases in corn, soybean, and wheat. However, care must be used when applying fungicides to reduce the risk of resistance. The Fungicide Resistance Action Committee (FRAC) is an organization made up of representatives of the agrochemical industry. FRAC developed a code—known as the FRAC Code and available at www.frac.info—that can be used to classify fungicides into groups based on their modes of action. Fungicides labeled for use in Wisconsin on corn, soybean, and wheat fall into five FRAC Codes: 1, 3, 7, 11, and M.

FRAC Code 1

Methyl benzimidazole carbamate (MBC). This group contains the benzimidazole and thiophanate fungicide families. These fungicides are effective against a broad range of fungi that cause leaf spots, root and crown rots, stem rots, and powdery mildews (but not rusts). MBC fungicides inhibit tubulin production, interfering with normal cell division in sensitive fungi. These fungicides have preventative and early-infection activity. While they have systemic properties, they cannot move down the plant, making canopy penetration and complete plant coverage essential for control. **The MBC fungicide risk of resistance is HIGH.**

FRAC Code 3

Demethylation inhibitors (DMI). This group contains the triazole fungicides. DMI fungicides are highly effective against powdery mildews, rusts, and many leaf-spotting fungi. DMI fungicides inhibit a specific enzyme that plays a role in sterol production in fungi. Sterols are necessary for the development of functional cell walls. Application of a DMI results in abnormal fungal growth and death. However, triazoles have no effect on spore germination; spores contain enough sterol for the formation of germ tubes. Because of this, DMI fungicides must be applied preventatively or at early infection to be effective. DMI fungicides are locally systemic, meaning that they are taken up by the leaves and move within the leaf but not necessarily from one leaf to another. Generally, these fungicides have approximately 14 days of residual activity. **The DMI fungicide risk of resistance is MEDIUM.**

FRAC Code 7

Carboxamides. These fungicides include boscalid, carboxin, and flutolanil. Boscalid is primarily a foliar fungicide used against Botrytis, Sclerotinia, and Alternaria pathogens. These fungicides work by inhibiting the respiration of target fungi, specifically the complex II fungal respiration. Carboxamides have locally systemic to systemic properties and movement is translaminar. **The Carboxamide fungicide risk of resistance is MEDIUM.**

FRAC Code 11

Quinone outside inhibitors (QoI). There are three fungicide families within the QoI fungicide group: strobilurins, imidazoles, and oxazoles. QoI fungicides are effective against a broad range of fungi. The model of action of QoI fungicides is through the inhibition of mitochondrial respiration, which effectively stops energy production of the fungus and results in its death. These fungicides are effective on spore germination and early growth. However, they are not effective against fungi that are growing inside the leaf tissue, so they must be applied preventatively or at early infection. Similar to the DMI fungicides, they are locally systemic and have approximately a 7- to 21-day residual activity. **The QoI fungicide risk of resistance is HIGH.**

FRAC Code M

Multi-site activity fungicides. These include inorganic compounds, dithiocarbamates, and chloronitriles. Multi-site activity fungicides have a broad spectrum of disease control activity. These fungicides are considered protective or preventative fungicides as they are applied to the leaf and stem surfaces prior to pathogen appearance. They have no effect on a fungus once the fungus has infected the plant host. Multi-site activity fungicides affect multiple biochemical sites in fungi, killing fungi by overwhelming them with toxins. These fungicides are sensitive to rainfall and sunlight because they are not absorbed into the plant. Multi-site activity fungicides typically remain active for 7 to 14 days. **The multi-site activity fungicide risk of resistance is LOW.**

Fungicide resistance management

Follow the following guidelines when applying fungicides to reduce the risk of resistance.

- Plant disease-resistant hybrids/varieties whenever possible.
- Scout fields on a regular basis, noting incidence and severity of diseases. Use this information to develop a field history for future disease management decisions.
- Tank-mix high-risk fungicides with fungicides that have different modes of action, are active against the targeted disease(s), and have similar lengths of residual activity.
- Do not use reduced rates of fungicides.
- Alternate or tank-mix fungicides with different modes of action when multiple applications are required.
- Apply fungicides preventatively or early in the disease cycle and when a disease threat is warranted.
- Avoid curative fungicide applications, especially with high-risk fungicides.

Note: *Always read and follow the pesticide label for maximum number of sprays per season, for recommended application rates, and for application timing for both target disease and plant growth stage.*

2

CORN PEST MANAGEMENT

CORN WEED MANAGEMENT

Herbicide treatments are specific as to time and method of application, weeds they control, rates of application to be used on different soils, and crops that may follow in rotation. Failure to apply them according to label directions can result in incomplete weed control, excessive crop injury, or damage to subsequent crops. If you don't get significant rainfall within 5 to 7 days after preemergence herbicide application, use a rotary hoe or spike-toothed harrow to incorporate the herbicide into the soil as well as to destroy many weed seedlings. Whenever possible, use row cultivation to control those weeds that might have escaped earlier weed control treatments.

Many herbicide combinations are registered for use on corn. The use of herbicide combinations that are not registered is discouraged since liability for performance and crop injury lie solely with the user. Similarly, the combination of herbicides with fertilizers or insecticides for simultaneous application is discouraged unless the herbicide label outlines directions for such combination use. Be sure to check the herbicide label or accompanying literature carefully before using herbicides in combination with fertilizers, insecticides, or other herbicides.

ATRAZINE RATE LIMITS AND RESTRICTIONS

Because of concern about groundwater contamination, Wisconsin has enacted atrazine rate restrictions based on surface soil texture, prior atrazine use, and geographic location relative to atrazine detection in groundwater. Wisconsin's Atrazine Rule (ATCP 30) imposes a 0.75 to 1.5 pound/acre (lb/a) rate limit on atrazine use statewide. An exception is allowed for growers who find it necessary to use atrazine postemergence to "rescue" seed or sweet corn from weed competition. This exception applies only to seed corn and sweet corn, and the total amount of atrazine used at planting and postemergence may not exceed 1.5 lb/a on coarse soil and 2 lb/a on medium or fine soil. In addition, atrazine use is prohibited in extensive areas of Dane county and the entire Lower Wisconsin River valley extending downstream from the Highway 60 bridge at Prairie du Sac to the confluence of the Wisconsin and Mississippi Rivers. Localized areas of Adams, Brown, Calumet, Chippewa, Columbia, Dodge, Eau Claire, Grant, Green, Green Lake, Iowa, Jackson, Juneau, Lafayette, Manitowoc, Marathon, Marinette, Marquette, Monroe, Outagamie, Pierce, Portage, Richland, Rock, St. Croix, Sauk, Trempealeau, Vernon, Walworth, Waupaca, Waushara, Winnebago, and Wood counties have a total prohibition on atrazine use. Contact your county Extension office for detailed maps of atrazine prohibition areas or visit the WDATCP website: datcp.wi.gov/Environment/Water_Quality/Atrazine/Atrazine_Prohibition_Areas.

Table 2-1 lists atrazine active ingredient rate limits for various management situations in Wisconsin, and table 2-2 lists the maximum rates of atrazine-containing products according to these rate limits. Be certain to reduce the use rates of atrazine and atrazine-containing products according to the Wisconsin Atrazine Rule.

State and federal rules have also established setbacks for mixing, loading, and applying atrazine and atrazine-containing herbicides. Heed the following guidelines to minimize ground- and surface water contamination by atrazine.

- No mixing or loading within 100 feet of wells, sinkholes, streams, lakes, or reservoirs unless mixing or loading over a spill containment pad constructed in compliance with Wisconsin ATCP 29. (Note: In Wisconsin, this rule applies for all pesticides. Federal rules require a 50-foot setback for atrazine only.)
- No application within 50 feet of a well or sinkhole or within 200 feet of the shoreline of natural or impounded lakes or reservoirs.
- No application within 66 feet of where field runoff enters streams (perennial or intermittent) and rivers.
- No application before April 1 or after July 31.
- Atrazine application records must be kept for 3 years.

Table 2-1. Atrazine active ingredient rate limits

	Statewide atrazine limits	
Surface soil texture	**atrazine used last year**	**no atrazine used last year**
Coarse	0.75 lb/a	0.75 lb/a
Medium and fine	1.0 lb/a	1.5 lb/a

Table 2-2. Wisconsin rate limits for products containing atrazine[a]

	Surface soil texture		
	coarse	medium/fine	
Herbicide	**0.75 lb limit**	**1.0 lb limit**	**1.5 lb limit**
Atrazine 4L	1.5 pt	2.0 pt	3.0 pt
Atrazine 90DF	0.83 lb	1.11 lb	1.67 lb
Bicep II Magnum	0.9 qt	1.3 qt	1.9 qt
Bicep Lite II Magnum	1.1 qt	1.5 qt	2.2 qt
Bullet/Lariat	4.0 pt	5.3 pt	8.0 pt
Degree Xtra	2.2 qt	2.98 qt	3.7 qt
G-Max Lite	2.2 pt	2.9 pt	3.5 pt
Guardsman Max	1.8 pt	2.4 pt	3.6 pt
Harness Xtra	3.5 pt	4.7 pt	5.4 pt
Harness Xtra 5.6L	2.4 pt	3.2 pt	4.8 pt
Keystone	1.3 qt	1.8 qt	2.7 qt
Keystone LA	2.0 qt	2.67 qt	3.0 qt
Lexar	1.7 qt	2.3 qt	3.4 qt
Shotgun	2.7 pt	3.0 pt	3.0 pt

[a] Labeled rate of Lumax EZ does not exceed the atrazine rate limits.

Table 2-3. Weed control ratings of corn herbicides[a]

Herbicides	Mode of action group[b]	Risk of corn injury	Grasses: Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Foxtails	Wild proso millet	Woolly cupgrass	Broadleaves: Cocklebur	Common ragweed	Eastern black nightshade	Giant ragweed	Lambsquarters	Pigweeds	Smartweeds	Velvetleaf	Perennials: Canada thistle	Dandelion	Hemp dogbane	Nutsedge	Quackgrass
Preplant-incorporated																						
Acetanilides + atrazine premixes[c]	5,15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	F/G	**G**	**E**	F/G	**G/E**	**E**	**E**	F	P	—	P	**G**	P
Acetochlor (Harness/Surpass, etc.)	15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	P	F	**G**	P	F/G	**G/E**	F	P	N	—	N	**G**	N
Atrazine	5	N	F	P	P	F	F	P	P	F/G	**G**	**G/E**	F/G	**G/E**	**G/E**	**E**	F	P	—	P	P	P
Dual II Magnum	15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	P	P	**G**	P	F	**G**	P	P	N	—	N	**G**	N
Outlook	15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	P	P	**G**	P	F	**G**	P	P	N	—	N	**G**	N
Zidua	15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	N	P	**G**	N	P	**G**	—	P	N	N	N	**F**	—
Preemergence																						
Acetanilides + atrazine premixes[c]	5,15	VS	**E**	**E**	**E**	**G**	**E**	F	F	F	**G**	**E**	F	**G/E**	**E**	**E**	F/G	P	P	P	F	P
Acetochlor (Harness/Surpass, etc.)	15	VS	**E**	**E**	**E**	F/G	**E**	**G**	F	P	F	**E**	P	F/G	**G/E**	F	P	N	N	N	F	N
Dual II Magnum	15	VS	**E**	**E**	**E**	F	**E**	F	F	P	P	**G/E**	P	F	**G**	P	P	N	N	N	F	N
Outlook	15	VS	**E**	**E**	**E**	F	**E**	F	F	P	P	**G/E**	P	F	**G**	P	P	N	N	N	F	N
Atrazine	5	N	F	P	P	P	F	P	P	F	**G**	**G/E**	F	**G/E**	**G/E**	**E**	F/G	P	P	P	P	P
Callisto	27	VS	P	P/F	P	P	P	P	P	F	F/G	**G/E**	F	**G/E**	**E**	**G/E**	**G/E**	P	P	N	P	N
Dicamba (Banvel/Clarity)	4	S	P	P	P	P	P	P	P	F	**G**	F	F	**G**	**G**	**G**	F	N	F/G	P	N	N
Fierce	14,15	S	**G/E**	**G/E**	**G/E**	P/F	**G/E**	F	F	P	F	**G/E**	P	**G/E**	**G/E**	F	F	P	P	P	F	—
Hornet WDG	2,4	S	N	N	N	N	N	N	N	**G**	**G/E**	**G**	F	**G**	**G**	**G**	**G**	P	P	P	N	N
Lumax EZ	5,15,27	VS	**E**	**E**	**E**	**G**	**E**	F	F	**G**	**G**	**E**	F/G	**E**	**E**	**E**	**G/E**	P	F	P	F	P
Princep	5	N	F	F	P	P	F	P	P	F	**G**	**G/E**	F	**G/E**	**G/E**	**E**	F/G	P	P	P	P	P
Prowl H_2O	3	S	**G**	**E**	**E**	**G**	**E**	F	F	P	N	P	N	**G/E**	**G/E**	P	F/G	N	N	N	N	N
Python	2	S	N	N	N	N	N	N	N	F	F	F	P	**G**	**G**	F/G	**G**	N	P	P	N	N
Resolve	2	S	**G**	P/F	F	P	**G**	P	P	F	P/F	F	P	**G**	**G**	F	F	P	—	P	P	P
Sharpen[d]	14	S	P	P	P	P	P/F	P	P	P	F	**G**	P	**G**	**G**	F	F	P	P/F	P	N	N
SureStart[d]	2,4,15	VS	F	F	F	F	F/G	F	F	F	F	**G**	P	F/G	**G**	F	F	P	P	P	P	N
Valor SX	14	S	P	P	P	P	P/F	P	P	P	F	**G**	P	**G**	**G**	F	F	P	P/F	P	N	N
Verdict[d]	14,15	S	P	P	P	P	F	P	P	P	F	**G**	P	**G**	**G**	F	F	P	P/F	P	P	N
Zemax	15,27	VS	**E**	**E**	**E**	F	**E**	F	F	F	F/G	**E**	F	**G/E**	**E**	**G/E**	**G/E**	P	N	N	F	N
Zidua	15	VS	**E**	**E**	**E**	F	**E**	F	F	N	P/F	**G/E**	N	P/F	**G/E**	—	P/F	N	N	N	P/F	—

(continued)

Abbreviations:

Risk of corn injury: M = moderate; S = slight; VS = very slight; N = none
Control ratings: E = excellent; G = good; F = fair; P = poor; N = none; — = insufficient information
Ratings that are good or excellent are set boldface

[a] These herbicides have been rated for expected weed control, but actual results may vary depending upon rates applied, soil types, weather conditions, and crop management.

[b] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action.

[c] Acetanilide + atrazine premixes include Bicep Lite II Magnum, Bullet, Degree Xtra, G-Max Lite, Harness Xtra, Keystone LA, and Lariat.

[d] Ratings based on full-season control for comparison to other herbicides. SureStart, Verdict, and Sharpen are intended for early-season control and to be followed by glyphosate (Roundup Ready only) or Ignite 280/Liberty (Liberty Link only).

[e] Glyphosate can only be used on Roundup Ready corn hybrids.

[f] Ignite/Liberty can only be used with Liberty Link corn hybrids.

Table 2-3. Weed control ratings of corn herbicides[a] *(continued)*

Herbicides	Mode of action group[b]	Risk of corn injury	Grasses							Broadleaves								Perennials				
			Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Foxtails	Wild proso millet	Woolly cupgrass	Cocklebur	Common ragweed	Eastern black nightshade	Giant ragweed	Lambsquarters	Pigweeds	Smartweeds	Velvetleaf	Canada thistle	Dandelion	Hemp dogbane	Nutsedge	Quackgrass
Postemergence																						
Accent Q	2	S	**G/E**	P	**G**	**G**	**G/E**	**G/E**	**G/E**	P	P	P	P	P	**G**	**G**	F	P	P	P/F	P	**G/E**
Atrazine	5	VS	F	P	P	F	F	P	F	**G/E**	**E**	**E**	**G**	**E**	**E**	**E**	**G/E**	P	F	P	P	F
Basagran	6	VS	N	N	N	N	N	N	N	**E**	F/G	P	F/G	F	P	**E**	**G**	F	P	P	**G**	N
Basis Blend	2	S/M	**G**	P	F/G	P	**G**	P	P	P/F	F	N	P	**G/E**	**G/E**	**G/E**	**G**	P	P	P	—	P
Buctril	6	S	N	N	N	N	N	N	N	**E**	**G/E**	**G**	F	**G/E**	**G**	**G/E**	**G**	P/F	P	P	N	N
Cadet	14	S	N	N	N	N	N	N	N	P	P	P	P	F/G	**G**	P	**E**	—	N	N	N	N
Callisto	27	VS	P	F/G	P	P	P	P	P	**G**	F/G	**E**	**G**	**E**	**E**	**E**	**G/E**	P/F	F	P	F	P
Callisto Xtra	5,27	VS	F	F/G	P	P/F	F	P	P/F	**G/E**	**G/E**	**E**	**G/E**	**E**	**E**	**E**	**E**	P/F	F	P	F	P
Capreno	2,27	VS	**G**	F/G	**G**	F/G	**G**	**G**	**G**	**G/E**	**G/E**	**E**	**G**	**E**	**E**	**E**	**G/E**	F	P	P	—	—
Dicamba (Banvel/Clarity)	4	S/M	N	N	N	N	N	N	N	**G/E**	**G**	F/G	**G**	**G/E**	**G/E**	**E**	**G**	F/G	**G**	F/G	N	N
Glyphosate[e]	9	VS	**G**	**G**	**G**	**G**	**E**	**G/E**	**G/E**	**E**	**G/E**	**G/E**	**G**	**G/E**	**G/E**	**G**	**G**	**G/E**	F	**G**	F	**G/E**
Halex GT	9,15,27	VS	**G/E**	**G/E**	**G/E**	**G/E**	**E**	**G/E**	**G/E**	**E**	**G/E**	**E**	**G/E**	**E**	**E**	**E**	**G/E**	**G**	**G**	**G**	F	**G/E**
Harmony SG	2	S/M	N	N	N	N	N	N	N	F	F	N	P	**G/E**	**E**	**G/E**	**G**	P	P	P	—	N
Hornet WDG	2,4	S	N	N	N	N	N	N	N	**E**	**G**	F	**G**	F	F	**G**	**G/E**	F/G	F/G	P	N	N
Ignite/Liberty[f]	10	VS	F	**G**	**G**	F	**G**	**G**	**G**	**G/E**	**G/E**	**G**	**G**	**G**	**G**	**G/E**	**G**	F	F/G	F	P	F
Impact/Armezon	27	VS	F/G	F/G	P	P	**G**	**G**	F	**G/E**	**G/E**	**E**	**G**	**E**	**E**	**G**	**E**	F	—	P	P	N
Laudis	27	VS	**G**	F/G	P	F	**G**	F/G	F/G	**G/E**	**G/E**	**E**	**G**	**E**	**E**	**E**	**E**	F	P	P	P	N
NorthStar	2,4	S/M	P	P	F/G	F	F	P	P	**E**	**G/E**	**G**	**G/E**	**G/E**	**G/E**	**E**	**G/E**	F/G	F	F/G	F	**G**
Option	2	S	**G/E**	P	**G**	**G**	**G/E**	**G**	**G**	P/F	F/G	**G**	P/F	**G**	**G**	P	**G**	P	F	—	P	**G/E**
Permit	2	VS	N	N	N	N	N	N	N	**E**	**G/E**	N	F	P	**G**	F/G	**E**	P	P	—	**G/E**	N
Priority	2,14	S	N	N	N	N	N	N	N	**E**	**E**	**G**	**G**	**G**	**G/E**	**G**	**E**	P	F	P	**G/E**	N
Rage D-Tech	4,14	S	N	N	N	N	N	N	N	**G**	**G**	**G**	F	**G**	**G**	F	**E**	F	F	F	N	N
Realm Q	2,27	S	**G**	F/G	**G**	P	**G/E**	F	F	**G**	F/G	**E**	F/G	**E**	**E**	**E**	**G/E**	P/F	F	P	F	P/F
Resolve Q	2	S	**G**	P	**G**	P	**G/E**	F	F	F	F	N	P/F	F/G	**G/E**	F/G	**G**	F	F	P	P/F	F
Resource	14	S	N	N	N	N	N	N	N	P/F	F	P	P	F	F	P	**E**	P	N	—	N	N
Status	4,19	S	P	P	P	P	P	P	P	**G/E**	**G**	F/G	**G**	**G/E**	**G/E**	**E**	**G**	F/G	**G/E**	F/G	N	N
Steadfast Q	2	S/M	**G/E**	P	**G**	**G**	**G/E**	**G**	**G**	P/F	P	P	P	P/F	**G**	F	F	P/F	**G**	P	P/F	**G/E**
Stinger	4	VS	N	N	N	N	N	N	N	**G/E**	**G**	F/G	**G**	N	N	F	P	**G/E**	**G**	P	N	N
Yukon	2,4	S	N	N	N	N	N	N	N	**E**	**E**	F	**G**	**G**	**G/E**	**G**	**E**	P	P/F	P	**G/E**	N
2,4–D	4	M	N	N	N	N	N	N	N	**E**	**G**	F	**G**	**G/E**	**G/E**	P	**G**	F	F/G	**G**	N	N

[a] These herbicides have been rated for expected weed control, but actual results may vary depending upon rates applied, soil types, weather conditions, and crop management.

[b] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action.

[c] Acetanilide + atrazine premixes include Bicep Lite II Magnum, Bullet, Degree Xtra, G-Max Lite, Harness Xtra, Keystone LA, and Lariat.

[d] Ratings based on full-season control for comparison to other herbicides. SureStart, Verdict, and Sharpen are intended for early-season control and to be followed by glyphosate (Roundup Ready only) or Ignite 280/Liberty (Liberty Link only).

[e] Glyphosate can only be used on Roundup Ready corn hybrids.

[f] Ignite/Liberty can only be used with Liberty Link corn hybrids.

BURNDOWN HERBICIDES FOR NO-TILL CORN

No-till cropping systems are increasingly being used due to the economic and environmental benefits they offer. Weed management is particularly important in these systems because no tillage is done before planting and few producers cultivate no-till fields after planting. The purpose of a burndown herbicide application is to ensure that the crop is planted into a weed-free setting. Check fields carefully to determine if such a treatment is needed. Give particular attention to perennial weeds like dandelion, white cockle, and quackgrass plus winter annuals like shepherd's purse, chickweeds, buttercups, and pennycress.

Terminating corn stands for replant

Occasionally corn stands are deemed undesirable due to low establishment rates and there is a need to terminate emerged corn seedlings with a herbicide in no-till situations. If the corn hybrid is not glyphosate-resistant (Roundup Ready), then glyphosate can be effectively used by following the burndown recommendations presented in the corn and soybean sections of this book. If the hybrid is glyphosate-resistant (Roundup Ready), then a supplemental label exists for Select Max herbicide to be applied at 6 fl oz/a for corn up to 12 inches and the interval for replanting corn is reduced to 6 days. The replant interval is 30 days for higher rates. Follow adjuvant recommendations noted for Select Max in the Postemergence Herbicides section of the Soybean Pest Management chapter of this book.

Autumn (iodosulfuron) **+ 2,4-D**

Rate: 0.3 oz/a Autumn + 1.0 pt/a 2,4-D ester.

Adjuvants: Add 1% crop oil concentrate and either 1.5 to 2.0 qt/a of 28% nitrogen solution or 1.5 to 3.0 lb/a ammonium sulfate.

Timing: Apply in the fall after harvest or 30 days before corn planting in the spring.

Remarks: Autumn + 2,4-D is intended to provide fall burndown control and limited residual activity on broadleaf weeds including alfalfa, plantain, dandelion, horseweed, and several mustard species. The Autumn label recommends application to annual broadleaf weeds up to 3 inches tall. However, a tank mixture with 2,4-D will increase the size of weeds controlled. Autumn can also be mixed with glyphosate to control grass weeds. The 30-day interval between application and corn planting will primarily limit Autumn's use to fall applications. Autumn is rainfast in 2 hours. Do not apply to frozen soil or soil with a pH greater than 8.0. Autumn can be applied before planting field or silage corn, but not seed or sweet corn.

Rotational restrictions: Field corn can be planted after 30 days; soybeans after 90 days; winter wheat after 4 months; and small grains and sorghum after 8 to 9 months. Other crops cannot be planted for 18 months.

Autumn Super 51 WDG (iodosulfuron + thiencarbazone premix)

Rate: 0.5 oz/a.

Adjuvants: Add 1% crop oil concentrate or methylated seed oil and either 1.5 to 2 qt/a 28% urea ammonium nitrate or 1.5 to 3.0 lb/a ammonium sulfate.

Timing: Apply in the fall after harvest or 30 days before planting corn in the spring.

Remarks: Autumn Super 51 WDG is intended to provide fall burndown control and limited residual activity on broadleaf weeds including alfalfa, plantain, dandelion, horseweed, and several mustard species. The Autumn Super 51 WDG label recommends application to certain broadleaf weeds up to 3 inches and annual grasses no greater than 1 inch in height. However, Autumn Super 51 WDG can be tank mixed with 2,4-D, glyphosate, dicamba, paraquat, or metribuzin for enhanced burndown activity and increased weed spectrum and sizes consistent with the label of the tank-mix partner. The 30-day interval between application and corn planting will primarily limit use to fall applications. Autumn Super 51 WDG is rainfast in 2 hours. Do not apply to frozen soil or soil with pH greater than 8.0.

Rotational restrictions: Field corn can be planted after 1 month; soybeans after 2 months; spring and winter wheat after 3 months; barley, white corn, seed corn, popcorn, and sweet corn after 9 months with a 15-inch minimum rainfall; and all other

crops after 18 months with a 30-inch minimum rainfall. In soils with pH of 7.5 to 8.0, longer rotation intervals are needed; check appendix table 2.

Basis Blend (rimsulfuron + Harmony SG premix)

Rate: 0.825 to 2.5 oz/a.

Adjuvants: Add crop oil concentrate at 1% to the spray mixture plus either 28% nitrogen solution at 2 qt/a or ammonium sulfate at 2 to 4 lb/a.

Timing: Apply in the fall for dandelion control. Apply in the spring within 7 days before planting to preemergence after planting for greatest residual control. Follow the postemergence directions if corn has spiked.

Remarks: Basis Blend is intended to provide weed burndown and early residual control. It will control foxtails up to 2 inches tall; woolly cupgrass up to 1 inch tall; and lambsquarters, pigweed, smartweeds, and velvetleaf up to 3 inches tall. At 1.25 oz/a or more, quackgrass, and common ragweed should be controlled. Basis Blend should control small dandelions. Tank mixing Basis Blend with 2,4-D and atrazine will expand the number of broadleaf weeds controlled. It is labeled for use on soils with 1 to 3.5% organic matter and should not be used on coarse-textured soils with less than 1% organic matter. Do not tank mix with Autumn Super, Capreno, Hornet WDG, or Python. Basis Blend can be applied with water or liquid fertilizer as the carrier. It can be used preemergence on field and silage corn, but not on seed corn or sweet corn.

Rotational restrictions: Field corn and potatoes can be planted any time after Basis Blend application; winter wheat after 3 months; spring cereals after 9 months; snap beans, dry beans, and sweet corn after 10 months; and other crops not listed on the label after 18 months. If tank mixed with 2,4-D and/or atrazine, observe appropriate plant-back restrictions. When Basis Blend is applied at 1.25 oz/a, Optimum GAT soybean can be planted any time after application, STS soybean can be planted after 30 days, and all other soybean can be planted after 10 months. If the rate is 0.825 oz/a, soybean can be planted 15 days after application.

Basis Blend (rimsulfuron + Harmony SG premix) **+ Express** (tribenuron) **+ 2,4-D**

Rate: 0.825 oz/a Basis Blend + 0.25 oz/a Express + 1 pt/a 2,4-D ester.

Adjuvants: Add a crop oil concentrate at 1% to the spray mixture.

Timing: Apply in the fall or at least 14 days before planting in the spring.

Remarks: Basis Blend is a commonly used corn postemergence herbicide. Express is a sulfonylurea herbicide registered for use in small grains. Fall application of Basis Blend, Express, and 2,4-D provides economical and broad-spectrum control of most winter annual and several perennial weeds. This combination needs to be applied after fall harvest but before the ground freezes. Treatments made through corn stalks have performed well in killing dandelions. If possible, wait 10 to 14 days after harvest for the stalks to settle and weeds to be exposed to the spray solution. Basis Blend could also be applied without Express as a burndown treatment prior to planting corn in the spring.

Rotational restrictions: Corn can be planted the spring following a Basis Blend + Express application. Soybean can be planted 15 days after application of Basis Blend at 0.825 oz/a.

Fierce (Valor + Zidua)

Rate: 3.0 to 4.5 oz/a applied in the fall; 3.0 oz/a applied in the spring.

Timing: Fierce may be applied in the fall or in the spring at 3.0 oz/a as an early preplant burndown 7 to 30 days ahead of planting field corn in no-till and minimum till corn systems. If rates higher than 3.0 oz/a are used, or if herbicide is incorporated with tillage, then a minimum of 30 days is required before planting. If Fierce is applied in the fall or winter following crop harvest, do not apply before October 15th and do not apply to frozen or snow-covered ground.

Remarks: Fierce provides selective burndown and residual weed control in minimum and no-till field corn systems. Do not use on popcorn, sweet corn, or seed corn. Fierce is primarily to be used in minimum till and no-till field corn systems. Fields can be cultivated following applications, but

the minimum preplant interval is 30 days if the herbicide is incorporated, and incorporation will reduce residual weed control. Fierce can be tank mixed with several other herbicides, including glyphosate and 2,4-D, to enhance burndown activity. Fierce does not require any spray additives; however, spray adjuvants should be used according to the label of the tank-mix partner. Do not use on soils with less than 1% organic matter unless at least ½ inch of rainfall occurs before planting.

Rotational restrictions: Only field corn can be planted following applications of Fierce. Root crops can be planted 12 months after application. No other crops are currently labeled for rotation.

Glyphosate

Rate: 0.38 to 0.56 lb ae/a for annuals and 0.75 to 1.5 lb ae/a for quackgrass. See labels for specific rate recommendations.

Glyphosate conversion table

Name	Formulation (lb ae/gal)	——Rate for—— 0.38 lb ae/a	0.75 lb ae/a
Many	3.0	16 fl oz	32 fl oz
Durango DMA	4.0	12 fl oz	24 fl oz
Touchdown Total	4.17	12 fl oz	23 fl oz
Roundup PowerMAX	4.5	11 fl oz	21 fl oz
Touchdown HiTech	5.0	10 fl oz	19 fl oz

Adjuvants: Ammonium sulfate at 8.5 to 17.0 lb/100 gal of spray mixture is frequently recommended, especially when tank mixing glyphosate with residual herbicides. Check the label to see if the glyphosate formulation requires additional surfactant.

Timing: *Preplant*—Apply to annual weeds less than 6 inches tall or to quackgrass 6 to 8 inches tall and actively growing. With the exception of Roundup Ready corn, do not include glyphosate in any spray mixture if corn has emerged.

Remarks: Glyphosate can be included as a component of a preplant residual herbicide treatment to provide burndown of existing vegetation. Annual weeds emerging after glyphosate application must be controlled by a residual herbicide or a postemergence herbicide. Where a preplant treatment is made as a split application, include glyphosate with the first application but only if weeds are present at the time of treatment. If quackgrass is present, include glyphosate in the second application instead of the first. Glyphosate can be tank mixed with 2,4-D or dicamba for improved annual broadleaf weed burndown.

To control quackgrass, apply 0.75 lb ae/a of glyphosate to 6- to 10-inch quackgrass if the field will be tilled after application. Delay tillage for 3 days after application. Increase the rate of glyphosate to 1.5 lb ae/a if the field will be no-till planted. Glyphosate can be applied in 28% nitrogen solution rather than in water, but it is not recommended when treating perennials.

Rotational restrictions: Glyphosate formulations have no rotational restrictions for Wisconsin field crops except for a 30-day interval before tobacco.

Gramoxone Inteon (paraquat)

Rate: 2.0 to 2.5 pt/a when weeds are 1 to 3 inches tall, 2.5 to 3.0 pt/a when weeds are 3 to 6 inches tall, and 3.0 to 4.0 pt/a when weeds are taller than 6 inches.

Adjuvants: Include nonionic surfactant at 0.125% or crop oil concentrate at 1% to the spray mixture.

Timing: *Preplant*—Apply preplant or before corn has emerged.

Remarks: Gramoxone can be included with preplant residual herbicides to provide burndown of existing vegetation. Where a preplant treatment is made as a split application, include Gramoxone with the first application, but only if weeds are present at the time of treatment. Annual weeds emerging after Gramoxone application must be controlled by the residual herbicide. Tank mixing Gramoxone with atrazine or Princep can increase burndown activity.

Use a minimum of 10 gal/a of water at 30 to 50 psi pressure with ground applications. Flat fan nozzles are more effective than flood nozzles at delivering the fine spray droplets necessary for thorough spray coverage. If applying less than 20 gal/a of water, only use flat fan nozzles. Do not apply Gramoxone when conditions prevent uniform coverage or when excessive spray drift may occur.

Rotational restrictions: None.

Ignite 280/Liberty (glufosinate)

Rate: 29 to 36 fl oz /a. A maximum of 36 fl oz per application and a maximum of 65 fl oz/a can be used for the entire season in Liberty Link corn.

Adjuvants: Adding 2 lb/a ammonium sulfate will help control weeds under stress.

Timing: Apply to young, actively growing weeds before planting or before corn seedlings emerge.

Remarks: Do not apply with liquid fertilizers as the carrier. Use nozzles that deliver medium-sized droplets for adequate spray coverage with a minimum of 15 gal/a spray solution. Increase spray rate to between 20 and 40 gal/a for dense weed growth.

Rotational restrictions: Corn and soybean may be planted any time after application. Root and tuber vegetables, leafy vegetables, brassica leafy vegetables, and small grains (barley, buckwheat, oats, rye, teosinte, triticale, and wheat) may be planted after 70 days, and all other crops may be planted after 180 days.

Rage D-Tech (Aim + 2,4-D premix)

Rate: Apply 8 fl oz/a for weeds less than 6 inches tall. Increase the rate to 16 fl oz/a for weeds greater than 12 inches tall.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1.5 to 2%. Nitrogen fertilizer may be added if required by a tank-mix partner.

Timing: Apply 3, 7, and 14 days before planting corn when using the 8, 16, and 32 fl oz/a rates, respectively.

Remarks: Rage D-Tech will control many winter and summer annual broadleaf weeds. The Aim component will provide a faster burn of weed foliage than 2,4-D alone. Rage D-Tech can be tank mixed glyphosate or Gramoxone for annual grass control. It can also be tank mixed with preemergence residual herbicides. Do not apply Rage D-Tech on sandy soils or soils with less than 1% organic matter. Do not apply if wind exceeds 15 mph.

Rotational restrictions: Corn or soybeans can be planted after the required interval after burndown treatments. Most other crops can be planted after 30 days.

Vida (pyraflufen)

Rate: 0.5 to 2.0 fl oz/a.

Adjuvants: Add 0.5% nonionic surfactant or 1% crop oil concentrate.

Timing: Apply to emerged broadleaf weeds before they exceed 4 inches in height or 3 inches in rosette diameter and prior to corn planting.

Remarks: Vida is a contact herbicide that will control many emerged annual broadleaf weeds. Only the top growth of perennials will be controlled. Vida can be tank mixed with glyphosate for grass control or added control of larger broadleaf weeds. Vida can also be mixed with 2,4-D or other residual herbicides. Good spray coverage is necessary for good weed control.

Rotational restrictions: Only corn, soybeans, potatoes, or wheat can be planted after a burndown application of Vida. Other crops can be planted after 30 days.

PREPLANT-INCORPORATED & PREEMERGENCE HERBICIDES

Acetochlor + safener

Rate: *Harness*—1.25 to 2.75 pt/a. On soils with 6 to 10% organic matter, use 2.5 to 3.4 pt/a. Apply 3.4 pt/a on soils with greater than 10% organic matter.

Surpass—1.5 to 3 pt/a. Use 2.0 to 3.75 pt/a of Surpass on soils with greater than 7% organic matter.

Timing: *Preplant-incorporated*—Apply and incorporate 1 to 2 inches deep within 14 days before planting.

Preemergence—Apply after planting but before weed emergence.

Postemergence—Acetochlor can be applied to corn from emergence to 11 inches tall for residual grass control. Acetochlor will not control emerged weeds so a tank-mix partner is generally necessary for initial control. Add adjuvants according to requirements of the tank-mix partner. Acetochlor labels vary, but most allow tank mixtures with many postemergence grass and broadleaf herbicides, including glyphosate and Ignite/Liberty, on resistant hybrids. Use water as a carrier when applying these postemergence treatments. Using liquid fertilizer as a carrier may cause severe crop injury. Acetochlor and the tank mixtures may cause temporary leaf burn.

No-till—Harness is recommended at 1.5 to 3 pt/a in no-till. Surpass is recommended at 2 to 3 pt/a in no-till. Surpass or Harness can be applied up to 30 days before planting, but it gives the best control when applied closer to planting and before weeds emerge. Acetochlor can be tank mixed with atrazine, Hornet, Princep, or Python in conservation tillage systems. If weeds are present at treatment, tank mix glyphosate, Gramoxone, or 2,4-D with either formulation for annual weed burndown.

Remarks: Acetochlor provides good to excellent control of foxtails, crabgrass, and fall panicum but has no effect on quackgrass. It controls some small-seeded broadleaf weeds but only suppresses velvetleaf. Acetochlor can be tank mixed with atrazine, dicamba, Hornet, Princep, or Python for improved broadleaf weed control. When preplant-incorporated, a minimum of 2.5 pt/a of Harness or Surpass is required to provide reasonable yellow nutsedge suppression on medium- and fine-textured soils, but preemergence applications only partially control yellow nutsedge. Do not use on sands with less than 3% organic matter, on loamy sands with less than 2% organic matter, or on sandy loams with less than 1% organic matter when depth to groundwater is less than 30 feet. All acetochlor formulations contain a chemical safener to protect corn from herbicide injury. However, acetochlor-treated corn sprouting in cold, wet soils may occasionally leaf out underground. Acetochlor can be mixed with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous application. It may be used on field corn, seed corn, and sweet corn.

Rotational restrictions: Wheat can be planted 4 months after application; alfalfa, barley, potato, and oat can be planted the following year. Snap beans and peas cannot be planted for 2 years.

Acetochlor + atrazine + safener*

Rate: *Degree Xtra*—2.9 to 3.7 qt/a. *Harness Xtra*—1.8 to 2.3 qt/a. *Keystone LA*—1.6 to 3.0 qt/a.

Timing: *Preplant incorporated*—Apply and incorporate 1 to 2 inches deep within 14 days before planting.

Preemergence—Apply after planting and within 5 days of the last tillage.

Postemergence—Acetochlor + atrazine can be applied to corn from emergence to 11 inches tall unless limited by a tank-mix partner. This premix will control small annual broadleaf weeds but generally will not control emerged annual grasses unless they have only one or two leaves. Larger emerged weeds need to be controlled by a tank-mix partner. Acetochlor + atrazine will then provide residual weed control. Include adjuvants according to requirements of the tank-mix partner. Acetochlor + atrazine labels vary, but most allow tank mixtures with many postemergence grass and broadleaf herbicides, including glyphosate and Ignite/Liberty, on resistant hybrids. Use water as a carrier when applying these postemergence treatments. Using liquid fertilizer as a carrier may cause severe crop injury. Acetochlor + atrazine and the tank mixtures may cause temporary leaf burn.

No-till—Preplant surface-applied acetochlor + atrazine can be applied up to 30 days before planting, but it gives the best control when applied closer to planting and before weeds emerge. If weeds are present at the time of treatment, include glyphosate, Gramoxone, or 2,4-D in the spray mixture for annual weed burndown.

Remarks: Several formulations of this premix are marketed. The Harness Xtra 5.6L and Keystone formulations contain a higher concentration of atrazine than Harness Xtra and Keystone LA, respectively. To stay below Wisconsin's atrazine rate limits, the rates of Harness Xtra 5.6L that can be used do not provide the desired amount of acetochlor. The rates of Degree Xtra, Harness Xtra, and Keystone LA closely match our atrazine rate limits with the proper amount of acetochlor for good grass control. Acetochlor + atrazine provides good to excellent control of foxtails, crabgrass, fall panicum, and most annual broadleaf weeds, but will have little effect on quackgrass. Some velvetleaf may escape. Preplant incorporated applications provide reasonable nutsedge control. Preemergence applications provide only partial yellow nutsedge control. Acetochlor + atrazine can be tank mixed with Princep to enhance broadleaf weed control. Degree Xtra also recommends Hornet WDG and Python tank mixtures.

**Contains atrazine.*
See pages 20–21 for rate restrictions.

Do not use on sands with less than 3% organic matter, loamy sands with less than 2% organic matter, or sandy loams with less than 1% organic matter when depth to groundwater is less than 30 feet. All formulations contain a chemical safener to protect corn from herbicide injury. It can be mixed with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous application. Acetochlor + atrazine may be used on field corn, seed corn, and sweet corn.

Rotational restrictions: Corn, sorghum, and soybeans can be planted the year after application. Wheat can be planted 15 months after application of Keystone.

Atrazine*

Rate: *4L formulation*—1.5 to 3.0 pt/a. *90DF formulation*—0.83 to 1.67 lb/a.

Timing: *Preplant-incorporated*—Shallowly incorporate atrazine within 2 weeks before planting.

Preemergence—Apply after planting, but before emergence.

No-till—Because of the 1.5 to 3.0 pt/a (4L formulation) rate limit, soil-applied atrazine treatments are generally inadequate for complete weed control in no-till corn production. However, postemergence-applied atrazine can provide annual broadleaf weed control.

Remarks: These atrazine rates alone are inadequate to control annual grass weeds except on very coarse-textured, low organic matter soils and when combined with rotary hoeing and/or row cultivation. Otherwise, atrazine controls most annual broadleaf weeds. Some velvetleaf and giant ragweed often escape control. These atrazine treatments are ineffective on peat or muck soils. These rates will not control perennial weeds. Many cases of atrazine-(triazine-) resistant common lambsquarters, smooth pigweed, velvetleaf, and kochia have been documented in Wisconsin. Increasing the atrazine rate or altering application timing will not control triazine-resistant weeds.

Atrazine can be mixed with liquid fertilizer for simultaneous preplant-incorporated or preemergence applications. Atrazine may be used on field, silage, seed, and sweet corn.

Rotational restrictions: Atrazine may persist and damage susceptible crops the following growing season. Corn, sorghum, and soybeans may be planted the following year. If atrazine is applied after June 10, the treated area must be planted to corn or sorghum the following year. Do not plant winter wheat or rye after corn silage harvest nor sugar beets, tobacco, vegetables (including dry beans), spring-seeded small grains, or small-seeded legumes and grasses the year following application, or injury may occur.

Banvel

See dicamba (page 31).

Bicep Lite II Magnum*
(Dual II Magnum + atrazine premix)

Rate: 0.9 to 2.2 qt/a.

Timing: *Preplant-incorporated*—For best results, apply and blend into the top 2 inches of soil within 14 days before planting. In dry seasons, preplant-incorporated applications will provide better annual weed control than preemergence applications.

Preemergence—Apply after planting, but before weed emergence.

Postemergence—Bicep Lite II Magnum can be applied to corn up to 5 inches tall or as a directed application to corn 12 inches tall. This premix will control small annual broadleaf weeds but generally will not control emerged annual grasses. Larger emerged weeds need to be controlled by a tank-mix partner. This premix will then provide residual weed control. Include adjuvants according to requirements of the tank-mix partner. Labeled tank-mix partners include glyphosate and Ignite/Liberty on resistant hybrids. Only use water as a carrier when applying these postemergence treatments; liquid fertilizer is not permitted as a carrier because of the risk of crop injury.

No-till—This treatment can be split with one-half of the herbicide applied early and the remainder applied at planting. When corn will be planted in 7 days, make a single application either ahead of or at planting. If weeds are present at the time of treatment, include Gramoxone or glyphosate in the spray mixture for improved

**Contains atrazine. See pages 20–21 for rate restrictions.*

annual weed burndown. It may be tank mixed with Princep as a conservation tillage treatment.

Remarks: This premix contains the correct ratio of atrazine to s-metolachlor to maintain the full rate of s-metolachlor with the maximum allowable rate of atrazine for Wisconsin.

This premix provides good to excellent control of foxtails, crabgrass, fall panicum, and most annual broadleaf weeds, but has little effect on quackgrass. Some velvetleaf and giant ragweed may escape. Preplant-incorporated applications at 2.2 qt/a will generally provide reasonable yellow nutsedge suppression, but preemergence applications only partially control yellow nutsedge. It may be tank mixed with other labeled preemergence herbicides. Bicep Lite II Magnum is ineffective on peat or muck soils.

This formulation contains a chemical safener to protect corn, and injury is unlikely. It can be mixed with liquid fertilizer for simultaneous preplant-incorporated or preemergence applications and can also be impregnated onto certain dry fertilizers. Bicep Lite II Magnum may be used on field corn, silage corn, and sweet corn.

Rotational restrictions: Only corn, sorghum, or soybeans should be planted the year following application.

Bullet/Lariat* (alachlor + atrazine premixes)

Rate: 2.5 to 4.0 qt/a.

Timing: *Preplant-incorporated*—Apply to dry soil within 7 days before planting, blending the herbicide into the top 1 to 2 inches of soil during seedbed preparation. In dry seasons, preplant-incorporated applications will provide better annual weed control than preemergence applications.

Preemergence—Apply after planting but within 5 days after the last tillage for weed control.

Postemergence—Bullet/Lariet can be applied to corn up to 5 inches tall. This premix will control small annual broadleaf weeds, but in general will not control emerged annual grasses.

No-till—Apply 6 to 8 pt/a Bullet/Lariat preemergence. See label for early preplant rates. If weeds are present at the time of treatment, include Gramoxone or glyphosate in the spray mixture for improved annual weed burndown. Bullet/Lariat may be tank mixed with Princep as a conservation tillage treatment.

Remarks: These treatments provide good to excellent control of foxtails, crabgrass, fall panicum, and most broadleaf annual weeds but have little effect on quackgrass. Some velvetleaf may escape. Bullet/Lariat may be tank mixed with other labeled preemergence herbicides. A reduced rate of 2.0 qt/a is labeled if followed by a postemergence application of glyphosate in glyphosate-resistant corn. Bullet/Lariat may also be tank mixed with glyphosate and applied early postemergence. These treatments are ineffective on peat or muck soils. Do not apply if wind exceeds 10 mph.

Bullet/Lariat generally doesn't injure corn. However, under some circumstances, corn injury is possible. Bullet/Lariat can be mixed with liquid fertilizer for simultaneous preplant-incorporated or preemergence application. Preplant-incorporated Bullet/Lariat can also be impregnated onto certain dry fertilizers. Bullet/Lariat may be used on field corn, silage corn, and sweet corn.

Rotational restrictions: Only corn, sorghum, or soybeans should be planted the following year.

Callisto (mesotrione)

Rate: 6.0 to 7.7 fl oz/a or 5 to 6 fl oz/a when tank mixed with an atrazine-containing herbicide.

Timing: *Preemergence*—Apply after planting but before weed emergence.

Remarks: Callisto controls many annual broadleaf weeds including lambsquarters, nightshade, pigweed, common ragweed, and velvetleaf. Callisto can be tank mixed with other preemergence grass herbicides for broad-spectrum weed control. Corn has good tolerance to preemergence applications of Callisto. Do not tank mix Callisto with grass herbicides that have an emulsifiable concentrate formulation and apply after corn has spiked because injury may occur. Callisto drift will bleach the leaves of sensitive plants. Do not apply Callisto if wind speed exceeds 10 mph. Callisto can be applied with water or liquid fertilizer (except suspension fertilizers) as the carrier. Callisto can be applied to field, silage, seed, and sweet corn.

**Contains atrazine. See pages 20–21 for rate restrictions.*

Rotational restrictions: Small grains can be planted 120 days after application. Alfalfa, soybeans, potatoes, and tobacco can be planted after 10 months. Other crops cannot be planted until 18 months after treatment.

Capreno (Laudis + thiencarbazone)

Rate: 3 to 6 fl oz/a.

Adjuvants: No adjuvants are needed if no weeds are present. If weeds are present (for no-till burndown), use 1% crop oil concentrate plus 1.25 pt/a urea ammonium nitrate or 1.5 lb/a ammonium sulfate.

Timing: Apply prior to crop emergence.

Remarks: If Capreno is used preemergence it cannot be applied postemergence as well. Do not use preemergence in coursely textured soils with less than 2% organic matter. Capreno provides control of many broadleaf weeds and several grass weeds but may not provide acceptable season-long residual grass control. The Laudis component of Capreno is synergized by 0.5 lb/a atrazine and improves the consistency of control, which may help burndown activity in no-till applications. Do not use Capreno with Lorsban, Counter, Thimet, or Dyfonate or injury may result. Capreno may be used on field corn, silage corn, and corn grown for seed.

Rotational restrictions: Field corn can be replanted immediately. Wheat can be replanted after 4 months; barley, soybean, and sweet corn after 10 months if 15 inches of rainfall is received. The interval for all other crops is 18 months. If the soil pH is greater than 7.5, consult the label for the extended interval before planting sweet corn, alfalfa, snap and dry beans, oats, and potatoes.

Clarity

See dicamba.

Degree Xtra*

See acetochlor + atrazine + safener (page 28).

Dicamba

Rate: *Banvel or Clarity*—0.5 to 1.0 pt/a.

Adjuvants: Adding a surfactant for improved spray coverage is recommended for burndown treatments.

Timing: *Preemergence*—Apply after planting and before corn emergence. Delay application for 5 to 7 days after planting to reduce risk of corn injury.

No-till—Apply 1 pt/a of dicamba before or immediately after corn planting to control emerged and actively growing annual broadleaf weeds. Use the 0.5 pt/a rate on coarse-textured soils or on medium- or fine-textured soils with less than 2.5% organic matter. When planting into a legume sod, apply dicamba after 4 to 6 inches of regrowth has occurred. For added control of dandelion or plantain, add 0.25 to 0.5 lb/a 2,4-D to the spray mixture. If grass weeds are present at the time of treatment, include Gramoxone or glyphosate in the spray mixture. Dicamba may be tank mixed with acetochlor, atrazine, Dual II, Outlook, or Princep as preplant/preemergence treatments in no-till.

Remarks: Dicamba gives early season residual control of many broadleaf weeds, but some velvetleaf often escapes. Preplant and preemergence applications will not suppress perennials like Canada thistle and hemp dogbane. Dicamba can be tank mixed with acetochlor, atrazine, Dual II Magnum, Outlook, pendimethalin, or Princep as preemergence treatments. Do not apply dicamba preemergence to coarse-textured soils. Do not apply Clarity to soils with less than 2.5% organic matter except if corn was no-till planted. The Banvel label allows use on soils with at least 2% organic matter. Do not apply preemergence if corn is planted less than 1.5 inches deep. Soybeans, tobacco, and most vegetables and flowers are extremely sensitive to dicamba so avoid drift. Two applications of dicamba may be made during a growing season but cannot exceed a total of 1.5 pt/a. Allow at least 2 weeks between applications. Dicamba may be used on field corn and silage corn, but not on sweet corn.

Rotational restrictions: Dicamba will not persist after harvest. Any crop can be planted 120 days after an application of Clarity or Banvel. Soybeans can be replanted 14 days after 8 fl oz/a and 28 days after 16 fl oz/a. Grass crops can be planted 15 and 30 days after 8 and 16 fl oz/a, respectively.

**Contains atrazine. See pages 20–21 for rate restrictions.*

Dual II Magnum (s-metolachlor + safener)

Rate: 1.0 to 2.0 pt/a.

Timing: *Preplant-incorporated*—Apply within 14 days before planting, blending the herbicide into the top 2 inches of soil during seedbed preparation. In dry seasons, preplant-incorporated applications will provide better annual weed control than preemergence applications.

Preemergence—Apply after planting but before corn or weeds emerge.

Postemergence—Dual II Magnum can be applied to corn up to 40 inches tall. Drop nozzles are recommended for applications to corn taller than 5 inches. Dual II Magnum will not control emerged weeds so a tank-mix partner is generally necessary for initial control. Dual II Magnum will then provide residual grass control. Include adjuvants according to requirements of the tank-mix partner. Labeled tank mixes include Accent Q, Ignite/Liberty, and glyphosate on resistant hybrids. Only use water as a carrier when applying Dual II Magnum postemergence; liquid fertilizer is not permitted as a carrier because of the risk of crop injury.

No-till—Apply 1.67 to 2.0 pt/a as a preplant surface treatment. This treatment can be split with one half applied early and the remainder applied at planting. When corn will be planted in 7 days, make a single application either ahead of or at planting. If weeds are present at the time of treatment, include glyphosate, Gramoxone, or 2,4-D in the spray mixture for improved annual weed burndown. On sands, loamy sands, and sandy loams, apply 1.33 pt/a within 14 days before planting.

Remarks: Dual II Magnum provides good to excellent control of foxtails, crabgrass, and fall panicum but has no effect on quackgrass. It fails to control velvetleaf and several other annual broadleaf weeds. It can be tank mixed with atrazine, Hornet, Princep, or Python for added broadleaf weed control. Preplant-incorporated applications at 2 pt/a will generally provide reasonable yellow nutsedge control, but preemergence applications provide only partial yellow nutsedge control. On soils with 6 to 20% organic matter, use up to 2.5 pt/a. It is not labeled for use on peat or muck soils. Both formulations contain a chemical safener to protect corn. However, treated corn sprouting in cold, wet soil may occasionally leaf out underground. It can be mixed with liquid fertilizer for simultaneous application and preplant-incorporated Dual II Magnum can also be impregnated onto certain dry fertilizers. Dual II Magnum may be used on field corn, silage corn, and sweet corn.

Rotational restrictions: Dual II Magnum will not persist into the fall or the following growing season.

G-Max Lite* (Outlook + atrazine premix)

Rate: 2.0 to 3.5 pt/a.

Timing: *Preplant-incorporated*—Apply and incorporate 1 to 2 inches deep within 14 days before planting. In dry seasons, preplant-incorporated treatment provides better annual weed control than preemergence treatment.

Preemergence—Apply after planting and before weed and corn emergence.

Postemergence—G-Max Lite can be applied to corn up to 12 inches tall. Apply before weeds exceed 1.5 inches tall. Since the Outlook in this premix will not control emerged grasses, it is important to treat early while the grasses are small enough to be burned down by the atrazine. Larger emerged weeds need to be controlled by a tank-mix partner. G-Max Lite will then provide residual weed control. Add adjuvants according to requirements of the tank-mix partner. G-Max Lite can be tank mixed with most postemergence grass and broadleaf herbicides, including glyphosate and Ignite/Liberty, on resistant hybrids. Use water as a carrier when applying G-Max Lite postemergence; liquid fertilizer is not recommended as a carrier because of the risk of crop injury.

No-till—Use 3.5 pt/a G-Max Lite to compensate for early preplant treatment and/or heavy crop residue. Usually a split application where one-half of the herbicide is applied early and the remainder applied at planting provides better weed control. When corn will be planted in 7 days, make a single application either ahead of or at planting. If weeds are present at the time of treatment, include Gramoxone or glyphosate in the spray mixture for improved annual weed burndown. Early preplant treatment is not recommended on coarse-textured soils.

**Contains atrazine. See pages 20–21 for rate restrictions.*

Remarks: The G-Max Lite premix contains the correct ratio of atrazine to Outlook to maintain the full rate of both components to fit within Wisconsin's Atrazine Rule. G-Max Lite provides good to excellent control of foxtails, crabgrass, fall panicum, and most annual broadleaf weeds, but has little effect on quackgrass. Some velvetleaf and giant ragweed may escape. The maximum rate applied preplant-incorporated generally provides reasonable yellow nutsedge control, but preemergence-applied treatments only partially control yellow nutsedge. G-Max Lite is not recommended on soils with more than 20% organic matter. It generally does not injure corn, but under some circumstances corn injury is possible. G-Max Lite can be mixed with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous application. It may be used on field corn, silage corn, seed corn, and sweet corn.

Rotational restrictions: Only corn, sorghum, or soybeans should be planted the year following treatment.

Harness

See acetochlor + safener (page 27).

Harness Xtra*
(Harness + atrazine premix)

See acetochlor + atrazine + safener (page 28).

Hornet WDG (Python + Stinger premix)

Rate: 3 to 5 oz/a.

Timing: *Preplant-incorporated*—Apply up to 30 days before planting and incorporate into the top 2 to 3 inches of soil. In dry seasons, preplant-incorporated applications will provide better annual weed control than preemergence applications.

Preemergence—Apply after planting, but before weed emergence.

No-till—Apply as a preplant-surface application up to 30 days before planting. If applying more than 14 days before planting, use the higher rate listed for that soil texture. If weeds are present at time of treatment, include glyphosate, Gramoxone, or 2,4-D for annual weed burndown. Hornet WDG gives partial control of emerged Canada thistle in no-till, but will not affect plants that have not yet emerged.

Remarks: Hornet WDG provides residual control of many annual broadleaf weeds. Because it is a broadleaf herbicide, it will generally be tank mixed with grass herbicides such as acetochlor, Dual II Magnum, or Outlook. Do not use on peat or muck soils or on soils with pH less than 5.9 and organic matter above 5% because of reduced weed control. The flumetsulam component in this premix can cause corn stunting. The injury may be due to corn emerging in cold soils or to other factors. To minimize the risk of injury, plant corn at least 1.5 inches deep and use on soils with at least 1.5% organic matter. Dow does not recommend using Hornet WDG if Counter or Thimet have been applied (but the Counter label allows Hornet use with banded Counter applications). Apply other soil insecticides in a T-band to avoid crop injury. Do not use if soil pH is greater than 7.8 and organic matter is less than 3% to avoid crop injury. Hornet WDG can be applied with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous applications, but the water soluble packages need to be slurried before mixing or impregnation. Hornet WDG may be used on field corn, but not sweet corn or popcorn.

Rotational restrictions: Small grains can be planted 4 months after application; alfalfa, dry beans, forage grasses, popcorn, and soybean after 10.5 months. Sweet corn varieties listed on the supplemental 2ee label can be planted 10.5 months after application, sweet corn varieties not listed after 18 months; peas, snap beans, potatoes, sunflower, and tobacco after 18 months, and all other crops after 26 months.

Keystone LA*

See acetochlor + atrazine + safener (page 28).

Lumax EZ* (Dual II Magnum + atrazine + Callisto premix)

Rate: 2.7 qt/a on soils with less than 3% organic matter; 3.25 qt/a on soils with 3% organic matter or more.

Timing: *Preplant*—Up to 14 days before planting.

**Contains atrazine. See pages 20–21 for rate restrictions.*

Preemergence—Apply after planting but before grass weeds emerge.

Postemergence—Lumax EZ can be applied to corn from emergence to 12 inches tall, but the treatment will not control emerged grasses unless tank mixed with Accent Q, Basis Blend, or Steadfast Q. Broadleaf weeds less than 3 inches tall should be controlled. Add nonionic surfactant or crop oil concentrate when making postemergence applications, but do not add a nitrogen source. The Lumax EZ rate can be reduced to 2 qt/a when mixed with glyphosate or Ignite/Liberty. When tank mixing with Ignite/Liberty, use ammonium sulfate as the only adjuvant. When tank mixing with glyphosate, add a surfactant and ammonium sulfate if the glyphosate formulation requires surfactant. If the glyphosate does not require surfactant, only add ammonium sulfate. Do not apply postemergence if the corn was treated with Counter.

No-till—Lumax EZ can be applied before or after planting and should be tank mixed with glyphosate or Gramoxone to control emerged weeds. It can be tank mixed with 2,4-D to enhance control of broadleaf weeds, but grass weeds would not be controlled with this mixture. Use the adjuvant recommended by the burndown herbicide.

Remarks: Lumax EZ provides good to excellent control of foxtails, crabgrass, fall panicum, and most annual broadleaf weeds, but has little effect on quackgrass. The Callisto in this premix improves velvetleaf control compared to acetamide plus atrazine premixes, but some giant ragweed may still escape control. Yellow nutsedge will be suppressed. Lumax EZ is not recommended on soils with more than 10% organic matter. The amount of atrazine in Lumax EZ will not exceed atrazine rate limits. Additional atrazine or Princep can be tank mixed with Lumax EZ for added broadleaf weed control. Corn has good tolerance to preemergence applications of Lumax EZ. Although it contains a safener to protect corn, corn sprouting in cold, wet soil may occasionally leaf out underground. Lumax EZ applied postemergence after other organophosphate insecticides may cause injury. Lumax EZ drift will bleach the leaves of sensitive plants. Do not apply if wind speed exceeds 10 mph. Lumax EZ can be applied preemergence with water or liquid fertilizer (except suspension fertilizers) as the carrier. Lumax EZ may be applied to field, silage, seed, and sweet corn.

Rotational restrictions: Winter wheat can be planted 4.5 months after a Lumax EZ application and small grains and soybeans can be planted the spring after application. Other crops should not be planted the year after application. Only corn or sorghum can be planted the following year if applied after June 1.

Metribuzin

Rate: 2 to 4 oz/a of metribuzin when applied 9 days preplant to preemergence or 2 to 5.3 oz/a metribuzin when applied 10 to 30 days preplant.

Timing: Apply either preplant or preemergence.

No-till—Metribuzin can be tank mixed with glyphosate, Gramoxone, or 2,4-D LVE, to improve the burndown of many annual broadleaf weeds. Metribuzin will also provide limited early season residual control of broadleaf weeds.

Remarks: Metribuzin can be tank mixed with most residual corn herbicides to assist with the residual control of several annual broadleaf weeds. The amount of residual activity will depend on the rate and time of application. Do not use for residual control on peat or muck soils. Metribuzin has the potential to injure corn if over applied or if cold, wet conditions exist. Observe the following precautions: plant corn at least 1.5 inches deep; do not apply to soils with less than 1.5% organic matter or a pH greater than 7.0; and do not apply more than 4 oz/a metribuzin on soils with less than 2% organic matter. Metribuzin may be used on field corn, silage corn, and seed corn varieties that are known to be tolerant.

Rotational restrictions: Metribuzin will not persist into the following year. Alfalfa and wheat can be planted in the fall.

Outlook (dimethenamid-P)

Rate: 12 to 21 fl oz/a.

Timing: *Preplant-incorporated*—Blend the herbicide into the top 1 to 2 inches of soil within the 14 days before planting. In dry seasons, preplant-incorporated treatment provides better annual weed control than preemergence treatment.

Preemergence—Apply after planting, but before weeds emerge.

Postemergence—Outlook can be applied to corn up to 12 inches tall or as a lay-by application. Outlook will not control emerged weeds so a tank-mix partner is generally necessary for initial control with Outlook providing residual grass control. Include adjuvants according to requirements of the tank-mix partner. Labeled tank mixes include most postemergence grass and broadleaf herbicides, including glyphosate and Ignite/Liberty, on resistant hybrids. Use water as a carrier when applying Outlook postemergence; liquid fertilizer is not recommended as a carrier because of the risk of crop injury.

No-till—Usually a split application where one-half of the herbicide is applied early and the remainder applied at planting provides better weed control. When corn will be planted in 7 days, make a single application either ahead of or at planting. If weeds are present at the time of treatment, include glyphosate, Gramoxone, or 2,4-D in the spray mixture for annual weed burndown. Early preplant treatment is not recommended on coarse-textured soils.

Remarks: Outlook provides good to excellent control of foxtails, crabgrass, and fall panicum, but has no effect on quackgrass. It fails to control velvetleaf and several other annual broadleaf weeds. Preplant-incorporated Outlook at the highest rate for the soil type generally provides reasonable yellow nutsedge suppression, but preemergence-applied Outlook only partially controls yellow nutsedge. Adjust the rate according to either soil cation exchange capacity or soil texture and organic matter content. Use 21 fl oz/a of Outlook on all soils with greater than 8% organic matter. Do not use on sand with less than 3% organic matter when depth to groundwater is less than 30 feet. Outlook generally doesn't injure corn. However, Outlook-treated corn sprouting in cold, wet soil may occasionally leaf out underground. Outlook can be mixed with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous application. It may be used on field corn, silage corn, sweet corn, and seed corn.

Rotational restrictions: Outlook will not persist into the fall or following growing season.

Princep (simazine)

Rate: 2 qt/a of Princep 4L or equivalent.

Timing: *Preplant-incorporated*—Apply and incorporate within 14 days before planting. In dry seasons, preplant-incorporated applications provide better annual weed control than preemergence applications.

Preemergence—Apply before weeds and corn emerge.

No-till—Where corn will be planted directly into a sod, cover crop, or previous crop residue, Princep may be tank mixed with Gramoxone.

Remarks: Atrazine has largely replaced Princep because of its greater water solubility—less rainfall is necessary to make it effective. Nonetheless if rainfall is adequate, Princep will control annual weeds nearly equal to atrazine. Princep can be used as an atrazine substitute in atrazine prohibition areas. Princep can be tank mixed with acetochlor, atrazine, Dual II Magnum, or Outlook. The longer soil residual of Princep may be of value in conservation tillage. Princep will not control triazine-resistant common lambsquarters, smooth pigweed, velvetleaf, or kochia. Princep can be mixed with liquid fertilizer for simultaneous application. Princep may be used on field corn, silage corn, and sweet corn.

Rotational restrictions: The carryover potential of Princep is greater than atrazine. Corn or soybeans can be planted the year after application.

Prowl H_2O (pendimethalin)

Rate: 2 to 4 pt/a.

Timing: *Preemergence*—Apply after planting but before corn and weeds emerge.

Postemergence—Prowl can be applied to corn up to 30 inches tall or until the V8 stage. Prowl will not control emerged weeds so a tank-mix partner is generally necessary for initial control. Prowl will then provide residual grass control. Include adjuvants according to requirements of the tank-mix partner. Prowl can be tank mixed with most labeled postemergence grass and broadleaf herbicides, including glyphosate and Ignite/Liberty, on resistant hybrids. Use water as a carrier when applying these postemergence treatments. Do not use liquid fertilizer as the carrier because severe crop injury may occur.

No-till—Prowl can be used on field corn or silage corn where emerged weeds will be controlled by a tank-mix partner. Apply only after corn planting and be certain that the seed furrow has been thoroughly closed and leveled before treatment. Plant corn at least 1.5 inches deep. Corn seed contact with Prowl will cause stand loss.

Remarks: Prowl provides excellent control of foxtails, crabgrass, and fall panicum, but has no effect on quackgrass, nutsedge, or other perennial weeds. It provides fair control of many annual broadleaf weeds including velvetleaf, but will not control ragweeds or mustards. To improve broadleaf control, Prowl is labeled for tank mixes with atrazine, Banvel, Hornet WDG, and Python. Prowl is ineffective on peat and muck soils. Under cold, wet conditions, Prowl may cause stunting and yellowing of seedling corn. It may also cause root pruning and occasional lodging. Do not soil-incorporate or corn injury will occur. Plant corn at least 1.5 inches deep. Do not apply ahead of planting because the planter shoe may incorporate sufficient Prowl into the seed furrow to damage corn. If post-plant tillage is necessary to break a soil crust or to control weed escapes, use shallow tillage such as a rotary hoe or shallow row cultivation. Preemergence-applied Prowl can be mixed with liquid fertilizer for simultaneous application. Preemergence application may be made to field corn, silage corn, and processing varieties of sweet corn.

Rotational restrictions: Prowl generally doesn't persist into the following season, but winter wheat or winter barley should not be planted within 120 days after application.

Python (flumetsulam)

Rate: 0.8 to 1.33 oz/a.

Timing: *Preplant-incorporated*—Apply and incorporate into the top 2 to 3 inches of soil within 30 days before planting. The lower rates within each soil texture category need to be applied within 14 days of planting.

Preemergence—Apply after planting, but before weeds emerge. Applications to spike stage corn are permitted.

No-till—If weeds are present at the time of treatment, include Gramoxone, glyphosate, or 2,4-D in the spray mixture for annual weed burndown. Do not include Gramoxone or glyphosate if corn has spiked.

Remarks: Python controls lambsquarters, pigweed, and velvetleaf at lower labeled rates. Higher rates are labeled to control smartweed and nightshade. Some common and giant ragweed will escape control, even at higher rates. It can be tank mixed with other grass or broadleaf herbicides to expand the spectrum of weeds controlled. Do not use on peat or muck soils or on soils with pH less than 5.9 and organic matter above 5% because of reduced weed control. Python and Hornet WDG contain flumetsulam. Do not apply more than 0.07 lb/a flumetsulam per year. Python may cause stunting, which may be due to corn emerging in cold soils or other factors. To minimize the risk of injury, plant corn at least 1.5 inches deep and use on soils with at least 1.5% organic matter. Do not use if soil pH is greater than 7.8 and organic matter is less than 3% to avoid crop injury. Do not use if Counter or Thimet have been applied. Apply other soil insecticides in a T-band or surface band to avoid crop injury when using this herbicide. Python can be mixed with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous applications. Python can be applied to field corn, silage corn, or tested seed corn lines.

Rotational restrictions: Field and seed corn can be replanted any time. Do not plant alfalfa, dry or snap beans, small grains, or peas until 4 months after application; tobacco until 9 months after application; or potatoes until 12 months after application. Sweet corn should not be planted until 18 months after application. Specific hybrids listed on the label or supplemental labels may be planted after 10.5 months. Crops not listed on the label require a 26-month rotational interval.

Resolve Q (rimsulfuron)

Rate: 1 oz/a.

Adjuvants: If applied alone, add 1% crop oil concentrate plus either 2 lb/a of ammonium sulfate or 2 qt/a of 28% nitrogen solution. No adjuvant is required if tank mixing with a glyphosate formulation that already contains all the necessary adjuvant (fully loaded).

Timing: *Corn*—Apply preplant or preemergence after planting.

Weeds—Apply before woolly cupgrass exceeds 1 inch and barnyardgrass, foxtails, and fall panicum exceed 2 inches.

Remarks: Resolve will control or suppress many small annual grass and broadleaf weeds and provide some residual control. If tank mixed with glyphosate, it will provide some residual control until postemergence herbicides are applied. If tank mixed with atrazine, it can help control emerged grasses and contribute to residual control until postemergence herbicides are applied. Requires rainfall within several days after application for residual activity. Do not apply Resolve preemergence to coarse-textured soils with less than 1% organic matter. Resolve can be used on field corn but not seed or sweet corn.

Rotational restrictions: Corn and potatoes can be planted any time after application; winter wheat after 3 months; small grains after 9 months; and alfalfa, sweet corn, soybeans, snap beans, and dry beans after 10 months. Any crop not listed on the label cannot be planted for 18 months.

Sharpen (saflufenacil)

Rate: 1 to 3.5 fl oz/a, dependent on soil type. 1 to 2 fl oz/a for seed corn.

Timing: May be applied in the fall prior to first killing frost at 1 to 2 fl oz/a or in the spring, preplant or preemergence.

Preplant-incorporated—Up to 14 days prior to planting. Deep incorporation (greater than 2 inches) may result in decreased weed control. Sharpen should not be preplant-incorporated for seed corn.

Preemergence—Apply after planting but prior to crop emergence. Severe crop injury will occur if applied after crop emergence. Add methylated seed oil (MSO) at 1% v/v plus ammonium sulfate (AMS) or 28% fertilizer solution (UAN) for maximum burndown activity. Decreased activity will occur if a nonionic surfactant (NIS) is substituted for the MSO. Sharpen will not control emerged grasses and requires a tank-mix partner such as Gramoxone, glyphosate, or Ignite 280/Liberty.

No-till—Sharpen can be tank mixed with Gramoxone, glyphosate, or Ignite 280/Liberty to increase burndown activity and to control emerged grasses. 2,4-D LVE can be tank-mixed to improve dandelion control, but planting should be delayed 5 to 7 days to reduce the risk of crop injury from the 2,4-D. Add MSO at 1% v/v plus AMS or UAN at 1 to 2.5% for maximum burndown activity. Decreased activity will occur if a NIS is substituted for the MSO.

Remarks: Sharpen applied at 1 fl oz/a plus either COC or MSO at 1% plus AMS or UAN at 1 to 2.5% will effectively burn down most annual and perennial broadleaf weeds; however, the perennials will recover. Sharpen will not control emerged grasses and will require a tank-mix partner. Early season broadleaf residual control will be obtained with Sharpen applied at the proper rate for the soil type (2 to 3 fl oz/a). Sharpen will require a tank-mix partner to control emerging grasses. A planned sequential herbicide application will be required for season-long broadleaf and grass weed control. Sharpen plus a residual grass herbicide should allow the postemergence application to be delayed without the risk of early season weed competition. Sharpen has good crop tolerance but may cause injury under stressful growing conditions; do not apply to emerged corn or severe injury will occur. Sharpen may be used with Aztec, Fortress, or Force insecticides but cannot be used with Counter or Lorsban insecticides or injury may result. Do not use on sands with less than 3% organic matter and where depth to ground water is 30 feet or less.

Rotational restrictions: None.

SureStart/TripleFLEX (acetochlor + Python + Stinger)

This product is only labeled for use on Roundup Ready and Liberty Link field and silage corn.

Rate: 1.5 to 3.0 pt/a.

Timing: *Preplant incorporated*—Apply and incorporate into the top 2 inches of soil within 14 days before planting.

Preemergence—Apply after planting but before weed emergence.

Postemergence—May be applied to corn postemergence up to 11-inch tall corn for residual grass and broadleaf control. Will not control emerged grass weeds and will only control certain small broadleaf weeds, so tank mixtures with glyphosate or Ignite/Liberty are required to control emerged weeds. Use water as a carrier when making postemergence applications. Do not use liquid fertilizer as a carrier as this may cause

severe injury. Ammonium sulfate may be used in tank mixtures with glyphosate or Ignite/Liberty.

No-till: Apply as a preplant surface application up to 30 days before planting. Should be tank mixed with glyphosate, Gramoxone, or 2,4-D to control emerged weeds.

Remarks: This premix provides approximately half rates of the ingredients in Surpass and Hornet at the 1.5 pt/a rate. A supplemental label allows rates above 2.0 pt/a for greater residual activity. Provides early season preemergence control of many annual grass and broadleaf weeds. Follow with a postemergence application of glyphosate in Roundup Ready corn or Ignite/Liberty in Liberty Link corn. This product should allow these postemergence herbicides to be delayed if needed with less risk of early season weed competition. Do not use on soils with a pH of less than 5.9 and organic matter above 5% because of reduced weed control. To minimize the risk of injury, plant corn at least 1.5 inches deep and use on soils with at least 1.5% organic matter and avoid soils with a pH above 7.8. Soil-applied organophosphate insecticides should be applied in a T-band or banded to avoid injury and Counter and Thimet should not be used. When depth to groundwater is less than 30 feet, do not use on sands with less than 3% organic matter, on loamy sands with less than 2% organic matter, or on sandy loams with less than 1% organic matter. Soil-applied product can be mixed with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous application. It may be used on field corn and seed corn but not sweet corn.

Rotational restrictions: Field corn can be planted any time after application; wheat after 4 months; alfalfa, barley, clover, dry beans, lespedeza, oats, pea, popcorn, rye, soybean, and vetch in the spring in the next year following application; sweet corn varieties listed on the supplemental 2ee label 10.5 months after application; sweet corn varieties not listed, potatoes, sunflower, and tobacco after 18 months, and all other crops after 26 months.

Surpass

See acetochlor + safener (page 27).

Valor SX (flumioxazin)

Rate: 1 to 3 oz/a.

Timing: Apply 7 to 30 days before planting, depending on rate, residue cover, and rainfall.

No-till—Valor can be tank mixed with glyphosate, Gramoxone, 2,4-D, or other burndown herbicides to improve control of emerged broadleaf weeds. Valor SX will also provide residual control of broadleaf weeds depending on rate.

Remarks: Valor SX can only be used in no-till fields where residue has not been incorporated. At a 1 oz/a rate with glyphosate, more rapid control may be observed plus limited residual suppression of annual broadleaf weeds, but this application must be made at least 2 weeks before planting. At rates of 2 to 3 oz/a, residual annual broadleaf weed control should extend past corn planting. Valor SX should not be tank mixed with acetochlor, Dual, Outlook, or products containing these ingredients because of potential injury. Do not irrigate corn from emergence until after the V2 stage. Valor SX can be used on field and silage corn, but not on seed or sweet corn.

Rotational restrictions: At Valor rates up to 3 oz/a, tobacco and wheat can be planted after 2 months; barley, snap and dry beans, and sweet corn can be planted after 4 months; and alfalfa and oats can be planted after 5 months if tilled.

Verdict (Sharpen + Outlook premix)

Rate: 10 to 12 fl oz/a coarse-textured soils; 13 to 15 fl oz/a medium-textured soils; 16 to 18 fl oz/a fine-textured soils. Can be applied at 5 to 10 fl oz/a for seed corn, based on soil type. See supplemental label for details.

Timing: Apply either preplant or preemergence.

Preplant-incorporated—Up to 14 days prior to planting. Deep incorporation (greater than 2 inches) may result in decreased weed control. Verdict should not be preplant-incorporated for seed corn.

Preemergence—Apply after planting but prior to crop emergence. Severe crop injury will occur if applied after crop emergence. Verdict will control many small, emerged broadleaf weeds but requires additional methylated seed oil (MSO) at 1% v/v plus ammonium sulfate (AMS) or 28% fertilizer

solution (UAN) at 1% to 2.5% for maximum burndown activity. Decreased activity will occur if a nonionic surfactant (NIS) is substituted for the MSO. Verdict will not control emerged grasses and requires a tank-mix partner such as Gramoxone, glyphosate, or Ignite 280/Liberty. Verdict can follow burndown application of Sharpen at 1 oz/a; however, do not exceed maximum allowed rate of saflufenacil per season.

No-till—Verdict can be tank mixed with Gramoxone, glyphosate, or Ignite 280/Liberty to increase burndown activity and to control emerged grasses. 2,4-D LVE can be tank mixed to improve dandelion control, but planting should be delayed 5 to 7 days to reduce the risk of crop injury from the 2,4-D. Add MSO at 1% v/v plus AMS or UAN at 1 to 2.5% for maximum burndown activity. Decreased activity will occur if a NIS is substituted for the MSO.

Remarks: Verdict is a premix with both burndown and residual activity. Verdict applied at a labeled rate of 13 fl oz/a on a medium soil will provide the equivalent of 2.6 fl oz/a of Sharpen and 10.8 fl oz/a of Outlook. Labeled rates should give acceptable early-season control of most annual grasses and broadleaf weeds. Verdict will not control perennials weeds. A planned sequential herbicide application will be required for season-long weed control. Verdict should allow the postemergence application to be delayed without the risk of early-season weed competition. Verdict has good crop tolerance but may cause injury under stressful growing conditions. Do not apply to emerged corn or severe injury will occur. Verdict may be used with Aztec, Fortress, or Force insecticides but cannot be used with Counter or Lorsban insecticides or injury may result. Do not use on sands with less than 3% organic matter and where depth to ground water is 30 feet or less. Verdict may be applied impregnated on dry fertilizers.

Rotational Restrictions: Fall-seeded cereal crops may be planted after four months. There are no crop restricts the following spring after a Verdict application.

Zemax (Dual II Magnum + Callisto premix)

Rate: 2 qt/a on soils with less than 3% organic matter and 2.4 qt/a on soils with 3% organic matter or more.

Timing: *Preplant*—Up to 14 days before planting.

Preemergence—Apply after planting, but before grass weed emergence.

Postemergence— Zemax can be applied to corn from emergence to 30 inches tall or the 8-collar (V8) stage, but it will not control emerged grasses unless tank mixed with Accent Q, Basis Blend, or Steadfast Q (drop nozzles should be used if corn is taller than 12 inches). Broadleaf weeds less than 3 inches tall should be controlled. Add nonionic surfactant (preferred) or crop oil concentrate when making postemergence applications, but do not add a nitrogen source. The rate can be reduced to 1.6 qt/a when mixed with glyphosate or Ignite/Liberty. When tank mixing with Ignite/Liberty, use ammonium sulfate as the only adjuvant. When tank mixing with glyphosate, add a surfactant and ammonium sulfate if the glyphosate formulation requires surfactant. If the glyphosate does not require surfactant, only add ammonium sulfate. Do not apply postemergence corn treated with Counter.

No-till—Zemax can be applied before or after no-till planting and should be tank mixed with glyphosate or Gramoxone to control emerged weeds. It can also be tank mixed with 2,4-D to enhance control of broadleaf weeds like dandelion, but grass weeds would not be controlled with this mixture. Use the adjuvant recommended by the burndown herbicide.

Remarks: Zemax provides good to excellent control of foxtails, crabgrass, fall panicum, and most annual broadleaf weeds, but has little effect on quackgrass. The Callisto in this premix improves velvetleaf control compared to Bicep Lite II Magnum or other acetamide plus atrazine premixes, but some giant ragweed may still escape control. Yellow nutsedge will be suppressed. Atrazine or Princep can be tank mixed with Zemax for added broadleaf weed control.

Corn has good tolerance to preemergence applications of Zemax. Although it contains a safener to protect corn, corn sprouting in cold, wet soil may occasionally leaf out underground. Zemax drift will bleach the leaves of sensitive plants. Do not apply Zemax if wind speed exceeds 10 mph. Zemax can be applied preemergence with water or liquid fertilizer (except suspension fertilizers) as the carrier. Zemax can

be applied to field, silage, seed, and sweet corn.

Rotational restrictions: Winter wheat can be planted 4.5 months after a Zemax application; potatoes, small grains, and soybeans can be planted the year after application. Other crops should not be planted for 18 months. Only corn and sorghum can be planted the following year if Zemax is applied after June 1.

Zidua (pyroxasulfone)

Rate: 1.5 to 4.0 oz/a based on soil type and application timing.

Fall—2.5 to 3.5 oz/a on medium soils and 3.5 to 4.0 oz/a on fine soils. Do not apply on course soils in the fall.

Preplant-incorporated, preplant surface, or preemergence—1.5 to 2.75 oz/a for course soils, 2.0 to 3.0 oz/a for medium soils, and 2.5 to 4.0 oz/a for fine soils.

Postemergence—1.0 to 2.75 oz/a for course soils, 1.5 to 3.0 oz/a for medium soils, and 2.0 to 4.0 oz/a for fine soils.

Timing: Zidua may be applied in the fall or in the spring as a preplant-incorporated, preplant surface, preemergence, or early postemergence application up to the V4 growth stage. If applied in the fall or winter following crop harvest, do not apply to frozen or snow-covered ground. Soil can be cultivated before or after application, but if soil is tilled after application, make sure the tillage is uniform and no deeper than 2 inches. Incorporation can occur in the spring up to 14 days prior to planting.

Remarks: Zidua is a selective rate-dependent preemergence herbicide for controlling annual grasses, sedges, and small seeded annual broadleaf weeds. Zidua does not provide postemergence weed control. Zidua can be applied with water or various fertilizer combinations; see label for fertilizer use details. Zidua can be mixed with one or more herbicide products according to both the Zidua and tank-mix partner labels. Zidua does not require any spray additives; however, spray adjuvants may be needed with tank-mix partners and should be added accordingly. You can make sequential applications in one season if the first application is in the previous fall, but do not make more than one application to corn in the spring and do not apply more than 2.75 oz/a per season on course soils or more than 5.0 oz/a per season on other soils. Certain seed corn, popcorn, and sweet corn genetics may be more sensitive to Zidua than others, so check with your seed supplier for additional information. Do not harvest sweet corn ears for human consumption less than 37 days after application.

Rotational restrictions: Corn can be planted following applications of Zidua. Root crops can be planted 12 months after application. No other crops are currently labeled for rotation.

POSTEMERGENCE HERBICIDES

Accent Q (nicosulfuron + safener)

Rate: 0.45 to 1.8 oz/a. If used sequentially, do not exceed 1.8 oz/a per cropping season.

Adjuvants: Add crop oil concentrate at 1% (preferred) or nonionic surfactant at 0.25% to the spray solution. Also add 2 qt/a of 28% nitrogen solution or 2 lb/a of spray-grade ammonium sulfate.

Timing: *Corn*—Apply from emergence through the the 6-collar (V6) stage but before corn is 20 inches tall. Use drop nozzles for 20- to 36-inch-tall corn. Do not apply to corn taller than 36 inches or exhibiting 10 or more collars (V10), whichever comes first. Do not apply Accent Q to seed corn or popcorn that is more than 20 inches tall or exhibits 6 or more collars.

Weeds—Apply to 4-inch foxtails, fall panicum, barnyardgrass, wild proso millet, and woolly cupgrass; 12-inch shattercane; and 10-inch quackgrass. Accent Q also controls pigweed, annual smartweed, and jimsonweed. Weeds that exceed listed weed sizes by up to 50% may be partially controlled with Accent Q rates up to 1.8 oz/a.

Remarks: Accent Q is effective on many annual grasses and quackgrass, but will not control crabgrass. Crabgrass can be controlled if Accent Q is tank mixed with a preemergence grass herbicide and applied before crabgrass emerges. Accent Q lacks residual control, but if a second flush of weeds develops, a second application may be made. The total quantity applied should not exceed 1.8 oz/a. Half-rate applications of Accent Q applied to actively growing quackgrass, followed by a timely cultivation, have consistently given acceptable

control. Accent Q can be tank mixed with atrazine, Buctril, Callisto, dicamba, Impact/Armezon plus atrazine, NorthStar, or Status to provide broadleaf control. Crop oil concentrate is the preferred adjuvant for all these tank mixtures except products containing dicamba, where a nonionic surfactant is preferred. Include a nitrogen additive with all tank mixes. Do not tank mix Accent Q with postemergence herbicides like Basagran or 2,4-D because crop injury or antagonism may occur. Tank mixing Accent Q with dicamba may increase the risk of rat-tailing if applied to small corn.

Do not use Accent Q on fields treated with Counter CR applied in furrow at planting or over the row at cultivation. Accent Q may injure corn treated with Counter CR, Lorsban, or Thimet if soil has less than 4% organic matter. Accent Q may be used on field corn, silage corn, seed corn, popcorn, and on specific sweet corn hybrids approved by DuPont.

Rotational restrictions: Soybeans may be planted 15 days after Accent Q application. Winter wheat may be planted 4 months after application. Barley, oats, or spring wheat can be planted 8 months after application. Alfalfa, dry beans, peas, red clover, and snap beans may be planted 10 months after Accent Q application. Sweet corn can be planted 10 months after Accent Q application, except the varieties Carnival, Merit, and Sweet Success, which should not be planted until 15 months after Accent Q use. Other crops may be planted either 10 or 18 months after Accent Q use depending on soil pH.

Atrazine*

Rate: 1.5 to 3.0 pt/a of the 4L formulation or equivalent.

Adjuvants: Add 1 qt/a of crop oil concentrate.

Timing: *Corn*—Apply before corn exceeds 12 inches tall.

Weeds—Apply before annual broadleaf weeds exceed 4 inches tall. Treat lambsquarters and pigweeds before 6 inches tall.

Remarks: This treatment controls most annual broadleaf weeds but fails to control annual grasses and triazine-resistant weeds. Many cases of triazine-resistant common lambsquarters, smooth pigweed, velvetleaf, and kochia have been documented in Wisconsin. Increasing the atrazine rate or altering time of application will not control triazine-resistant weeds. Wisconsin ATCP 30 allows postemergence rescue treatments to seed and sweet corn only of up to 3 pt/a (coarse soils) or 4 pt/a (medium or fine soils) of the atrazine 4L formulation or equivalent. This rescue treatment cannot be used in atrazine prohibition areas. Oil-based adjuvants speed weed burndown, but can also burn leaf margins and occasionally stunt corn. Injury is increased by cold, wet weather or any other conditions that put corn under stress. Risk of corn injury is greatest with inbred corn lines or breeding stock. Multipurpose surfactants, wetting agents, and soaps are generally less effective than oil-base additives except where weeds are primarily annual broadleaf and relatively small. Atrazine may be used on field corn, silage corn, and sweet corn.

Rotational restrictions: Atrazine may persist and damage susceptible crops the following growing season. Corn, sorghum, and soybeans may be planted the following year. If atrazine is applied after June 10, the treated area must be planted to corn or sorghum the following year. Do not plant sugar beets, tobacco, vegetables (including dry beans), spring-seeded small grains, or small-seeded legumes and grasses the year following application, or injury may occur.

Banvel

See dicamba (page 44).

Basagran (bentazon)

Rate: 1.5 to 2.0 pt/a.

Adjuvants: For common lambsquarters and/or common ragweed, add 1 qt/a of crop oil concentrate in the spray mixture. If velvetleaf is the primary weed problem, add 2 to 4 qt/a of 28% nitrogen solution or 2.5 lb/a of spray grade ammonium sulfate in the spray mixture. If all are present, use crop oil concentrate plus a nitrogen additive.

Timing: *Corn*—Applications generally made to 1- to 5-leaf corn, but all stages are tolerant.

Weeds—The 2 pt/a rate will suppress 2-inch common lambsquarters and control 3-inch common ragweed, 5-inch velvetleaf, and 6-inch giant ragweed, and 10-inch cocklebur. The 2 pt/a Basagran rate plus

**Contains atrazine. See pages 20–21 for rate restrictions.*

crop oil concentrate will suppress 6- to 8-inch yellow nutsedge and Canada thistle from 8 inches to bud stage.

Remarks: Basagran controls several broadleaf weeds, but is weak on pigweeds, lambsquarters, and nightshade. Basagran may be tank mixed with atrazine, Clarity, glyphosate (Roundup Ready only), and Ignite/Liberty (Liberty Link only). Corn is quite tolerant to Basagran, but slight, temporary leaf speckling may occur. Basagran may be used on field corn, silage corn, seed corn, and sweet corn.

Rotational restrictions: None.

Basis Blend (rimsulfuron + Harmony SG premix)

Rate: 0.33 oz/a.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1% to the spray mixture. Also add 2 qt/a 28% nitrogen solution or 2 lb/a ammonium sulfate.

Timing: *Corn*—Apply from emergence to 4-leaf (2-collar) stage.

Weeds—Apply before barnyardgrass, foxtails, or fall panicum exceed 2 inches and before lambsquarters, redroot pigweed, smartweeds, and velvetleaf exceed 3 inches.

Remarks: Basis Blend controls many annual weeds but will not control crabgrass or nightshade, nor will it control quackgrass, wild proso millet, or woolly cupgrass, which emerge after application. Basis Blend can be tank mixed with atrazine, Callisto, or Hornet WDG to improve broadleaf activity. Tank mixing Basis Blend with a preemergence grass herbicide will improve crabgrass control (use nonionic surfactant rather than crop oil concentrate if tank mixing with Prowl). Tank mixing Basis Blend with dicamba may increase the risk of rattailing. Because Basis Blend is applied early and has limited residual activity, a cultivation following treatment is often necessary. Accent Q can be applied 14 days or more after Basis Blend for sequential control of grasses. Injury from Basis Blend has occasionally occurred, especially if applied after the 2-collar stage. Do not apply to hybrids with relative maturities of less than 88 days, or they may be injured. Applying Basis Blend to corn treated with Counter CR, Lorsban, or Thimet may cause injury. Applying Basis Blend after Aztec, Force, or Fortress should not cause injury. Basis Blend may only be used on field corn and silage corn.

Rotational restrictions: Field corn and potatoes can be planted any time after Basis Blend application; soybeans after 15 days; winter wheat after 4 months; spring cereals, peas, snap beans, and dry beans after 8 months; alfalfa, popcorn, sweet corn, and sugar beets after 10 months; and crops not listed on the label after 18 months.

Buctril (bromoxynil)

Rate: 1.0 to 1.5 pt/a. Rates can be increased to 2 pt/a under stress conditions.

Adjuvants: Do not use adjuvants with Buctril unless required for a tank mixture.

Timing: *Corn*—Apply 1 pt/a after emergence or 1.5 pt/a after the 4-leaf stage but before tassel emergence.

Weeds—See label for maximum weed height and rate required for control.

Remarks: Many broadleaf weeds are susceptible to Buctril, but pigweed control requires the maximum rate. When corn is so large that it interferes with the spray pattern, use drop nozzles to direct the herbicide beneath the corn leaves and onto the weeds. To broaden the spectrum of weed control, the labeled rate of Buctril can be tank mixed with 2,4-D or Banvel. However, this tank mixture introduces risk of 2,4-D or Banvel damage. Use application precautions as when applying 2,4-D or Banvel. Buctril can also be tank mixed with atrazine, Accent Q, Permit, or Stinger. Buctril usually causes temporary leaf burn, but injury may be excessive if applied before the 4-leaf stage. Buctril tank mixtures that require a surfactant may increase leaf burn. Buctril is a contact herbicide, so good spray coverage is important. Buctril may be used on field corn and silage corn, but not on sweet corn.

Rotational restrictions: Do not plant rotational crops for 30 days after application.

Cadet (fluthiacet)

Rate: 0.4 to 0.6 fl oz/a in glyphosate mixtures or 0.6 to 0.9 fl oz/a if applied alone or in other tank mixtures.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1 to 2 pt/a to the spray solution. 28% nitrogen solution

at 1 to 2 qt/a or ammonium sulfate at 1 to 2 lb/a may be added. If mixed with a fully loaded glyphosate, only add ammonium sulfate as required for glyphosate.

Timing: *Corn*—Apply from V2 until 48 inches tall or tasseling, whichever occurs first.

Weeds—At the 0.9 fl oz/a rate, apply before lambsquarters and waterhemp exceed 2 inches, before pigweed exceeds 4 inches, and before velvetleaf exceeds 36 inches.

Remarks: Cadet may cause temporary spotting of corn leaves. Cadet has excellent activity on velvetleaf and controls plants up to 36 inches tall at 0.6 fl oz/a or at lower rates in tank mixtures. At the 0.9 fl oz/a rate, it is labeled to control lambsquarters, waterhemp, jimsonweed, and pigweed, but these weeds are only listed as suppressed at lower rates. Cadet has contact activity and requires good spray coverage with a minimum of 15 gal/a spray volume and 20 psi spray pressure. Cadet is an option when targeting velvetleaf alone or to improve the control of other broadleaf herbicides. Cadet is labeled for mixtures with numerous grass or broadleaf weeds. Do not apply if wind speed exceeds 10 mph. Can be used on field, silage, seed, and sweet corn.

Rotational restrictions: Corn or soybeans can be replanted any time if the crop is lost. Any crop can be planted after harvest.

Callisto (mesotrione)

Rate: 3 fl oz/a.

Adjuvants: Add crop oil concentrate at 1% plus either 28% fertilizer at 2.5% or ammonium sulfate at 8.5 lb/100 gal (do not add nitrogen adjuvants when treating sweet corn). Do not use methylated seed oil as an adjuvant because injury may occur.

Timing: *Corn*—Apply from emergence to 30 inches tall or the 8-collar (V8) stage.

Weeds—Apply before lambsquarters, nightshade, pigweed, giant ragweed, smartweed, and velvetleaf exceed 5 inches and before large crabgrass exceeds 2 inches.

Remarks: Callisto controls many annual broadleaf weeds, but will not control most grasses. Callisto can be tank mixed with atrazine at 0.25 to 0.5 lb/a to improve common ragweed control in corn less than 12 inches tall. Buctril is an alternative to atrazine for corn taller than 12 inches. It is also labeled for tank mixtures with Basagran, glyphosate (Roundup Ready only), and Ignite/Liberty (Liberty Link only). Consult the label for adjuvant recommendations for Ignite/Liberty and glyphosate tank mixtures. Syngenta and DuPont have supplemental labels for tank mixing Callisto with Accent Q, Basis Blend, Steadfast Q, and Stout. Syngenta recommends a full Callisto rate while DuPont recommends a reduced rate for many broadleaf weeds. Corn has good tolerance to postemergence applications of Callisto, but occasional yellowing may be seen under stressful conditions. Postemergence tank mixes of Callisto and emulsifiable concentrate formulations of preemergence grass herbicides may cause injury. Consult the label for adjuvant recommendations to reduce this risk. Do not apply Callisto if the corn was treated with Counter because injury may occur. Corn may also be injured if Lorsban was applied. Do not tank mix Callisto with organophosphate or carbamate insecticides or apply these insecticides within 7 days of Callisto because injury may occur. Callisto drift will bleach the leaves of sensitive plants such as peas. Do not apply Callisto if wind speed exceeds 10 mph. Callisto can only be applied to field, silage, seed, and sweet corn.

Rotational restrictions: Small grains can be planted 120 days after application. Alfalfa, soybeans, potatoes, and tobacco can be planted after 10 months. Other crops cannot be planted until 18 months after treatment.

Callisto Xtra* (mesotrione + atrazine)

Rate: 20 to 24 fl oz/a.

Adjuvants: Add crop oil concentrate at 1% plus either 28% fertilizer at 2.5% or ammonium nitrate at 8.7 to 17 lb/100 gallons of spray solution. (Do not use nitrogen fertilizers when treating sweet corn.) Nonionic surfactants may be substituted for crop oil concentrates but weed control may be reduced. Methylated seed oils should not be used due to increased crop injury.

Timing: *Corn*—Apply after emergence but before corn exceeds 12 inches in height.

Weeds—Common lambsquarters, nightshade, pigweeds, smartweed, and velvetleaf less than 5 inches in height will be controlled with 20 fl oz/a. Increasing the

**Contains atrazine. See pages 20–21 for rate restrictions.*

rate to 24 fl oz/a will improve residual activity and control common and giant ragweed up to 5 inches. Treat large crabgrass before it exceeds 2 inches in height.

Remarks: Callisto Xtra controls many annual broadleaf weeds but will require a tank-mix partner for grass control. Callisto Xtra can be tank mixed with numerous herbicides for improved burndown and residual weed control. Consult the label for adjuvant recommendations when tank mixing with glyphosate (Roundup Ready only) or Ignite 280 (Liberty Link only). Corn has good tolerance but bleaching can be observed under certain environmental conditions; the injury is typically transitory and does not affect yields. Do not tank mix with emulsifiable grass herbicides unless specifically addressed in the label or crop injury could occur. Do not apply in liquid fertilizer or to corn treated with Counter or Lorsban or severe crop injury could occur. Do not apply in a tank mix with organophosphate or carbamate insecticides or apply postemergence within 7 days before or after an organophosphate or carbamate insecticide application as crop injury could occur. Only one application per year is allowed, with a maximum use rate of 24 fl oz/a. This premix contains atrazine, so please follow the restrictions in ATCP 30.

Rotational restrictions: The label states that corn (field, pop, seed, and sweet) may be planted immediately after an application in cases of crop failure. Alfalfa, barley, canola, peanuts, soybeans, sunflower, and wheat may be planted the following spring, and all other crops may be planted after 18 months. Caution must be exercised when following Callisto Xtra with sensitive crops such as alfalfa. A quick soil bioassay would be a good insurance policy when in doubt.

Capreno (Laudis + thiencarbazone premix)

Rate: 3 fl oz/a.

Adjuvants: Add 1% crop oil concentrate with a minimum of 1.25 pt/a, plus 1.5 qt/a 28% nitrogen solution or ammonium sulfate at 1.5 lb/a.

Timing: *Corn*—Apply from the 1-collar through 6-collar (V1–V6) stage.

Weeds—Apply before broadleaf weeds exceed 6 inches. Apply before green foxtail exceeds 2 inches, large crabgrass, giant and yellow foxtail, and woolly cupgrass exceed 3 inches, barnyardgrass and fall panicum exceed 5 inches, and wild proso millet exceeds 6 inches.

Remarks: Capreno provides good control of many broadleaf weeds and several grass weeds. The Laudis component of Capreno is synergized by 0.5 lb/a atrazine and improves the consistency of control. Atrazine cannot be used in tank mixture if corn is taller than 12 inches, but Buctril can be used at 6 fl oz/a. In Liberty Link or glyphosate-resistant corn, Laudis could also be mixed at 2 fl oz/a with Ignite/Liberty or at 3 fl oz/a with glyphosate, respectively. Check the herbicide label for specific adjuvant recommendations for Ignite/Liberty or glyphosate mixtures. Do not use Capreno if Lorsban, Counter, Thimet, or Dyfonate was applied or injury may result. Capreno can be used on field corn, silage corn, seed corn, and sweet corn, but sweet corn hybrid tolerance has not been well tested.

Rotational restrictions: Field corn can be replanted immediately. Wheat can be planted after 4 months; barley, soybean, and sweet corn after 10 months if 15 inches of rainfall is received. The interval for all other crops is 18 months. If the soil pH is greater than 7.5, consult the label for the extended interval before planting sweet corn, alfalfa, snap and dry beans, oats, and potatoes.

Clarity

See dicamba.

Dicamba

Rate: *Early postemergence*—0.5 to 1.0 pt/a Banvel or Clarity.

Late postemergence—0.5 pt/a of Banvel or Clarity.

Adjuvants: Adding 2 to 4 qt/a of 28% nitrogen solution or 2.5 lb/a ammonium sulfate to the spray mixture will improve control of wild mustard and velvetleaf that are over 5 inches tall or growing under drought stress.

Timing: *Corn*—Apply early postemergence treatments from emergence through the 5-leaf stage, but before the corn is 8 inches tall. Apply late postemergence treatments when corn is 8 to 36 inches tall and at least 15 days before tasseling. Use drop

nozzles if corn leaves prevent proper spray coverage, sensitive crops are growing nearby, or Banvel is tank mixed with 2,4-D.

Weeds—Annual broadleaf weeds are controlled best when they are less than 3 inches tall. Treat perennials like Canada thistle and hemp dogbane when they are 10 to 18 inches tall.

Remarks: Dicamba controls many annual broadleaf weeds and suppresses perennial broadleaves. Dicamba can be tank mixed with most postemergence herbicides as early postemergence treatments. To lessen the chance of injury, use the 0.5 pt/a rate on loamy sands and sandy loams. Do not use on sand with less than 3% organic matter where ground water depth is shallow. Corn injury from dicamba is only slightly less likely than with 2,4-D. Some stalk brittleness and lodging may occur. Do not cultivate for at least 7 days after treatment or until injury symptoms disappear. Soybeans, tobacco, and most vegetables or gardens are extremely sensitive to dicamba, so avoid drift. Do not apply dicamba when soybeans are nearby if corn is taller than 24 inches, soybeans are taller than 10 inches, or soybeans have begun to blossom. Two applications of dicamba may be made during a growing season, but do not exceed a total of 1.5 pt/a. Allow at least 2 weeks between applications. Dicamba may be used on field corn and silage corn, but not on sweet corn.

Rotational restrictions: Dicamba/Clarity will not persist after harvest. Any crop may be planted 120 days after an application. Soybeans can be replanted 14 days after 8 fl oz/a and 28 days after 16 fl oz/a. Grass crops can be planted 15 and 30 days after 8 and 16 fl oz/a of Clarity, respectively.

Glyphosate

Only use on Roundup Ready corn hybrids.

Rate: 0.56 to 0.75 lb ae/a. A total of 1.5 lb ae/a may be applied in season, but 0.75 lb ae/a is the maximum rate for a single application. Hybrids with the Roundup Ready 2 trait can be treated with a maximum of 1.13 lb ae/a per application and 2.25 lb ae/a per season.

Glyphosate conversion table

Name	Formulation (lb ae/gal)	——Rate for—— 0.56 lb ae/a	0.75 lb ae/a
Many	3.0	24 fl oz	32 fl oz
Durango DMA	4.0	18 fl oz	24 fl oz
Touchdown Total	4.17	17 fl oz	23 fl oz
Roundup PowerMAX	4.5	16 fl oz	21 fl oz
Touchdown HiTech	5.0	14 fl oz	19 fl oz

Adjuvants: Ammonium sulfate at 8.5 to 17 lb/100 gal of spray mixture is frequently recommended, especially when tank mixing glyphosate with residual herbicides. Check the label to see if the glyphosate formulation requires additional surfactant.

Timing: *Corn*—Apply from emergence to the V8 stage (8 collars) or 30 inches, whichever occurs first. Roundup Ready 2 corn hybrids can be sprayed with drop nozzles from 30 to 48 inches tall.

Weeds—Apply the 0.56 lb ae/a rate before crabgrass, foxtails, wild proso millet, and woolly cupgrass exceed 6 inches. Apply before lambsquarters, common ragweed, and giant ragweed exceed 12 inches. Apply the 0.75 lb ae/a rate to 6-inch velvetleaf.

Remarks: Glyphosate provides nonselective control of annual grass and broadleaf weeds and will suppress or control perennial weeds. Unless following a preemergence herbicide, glyphosate applications will need to be made before the weed stages listed above to prevent yield losses from early-season weed competition. Monsanto has recommended reduced rates of preemergence herbicides that should be applied at planting, which will lessen this concern. If applied early in the season, the glyphosate application may be before the optimum timing for control of perennial broadleaf weeds. Glyphosate does not have residual activity, but tank mixtures with acetochlor or atrazine are labeled to improve residual control. When applying glyphosate, be cautious to avoid drift and make sure the spray tank is cleaned before spraying a sensitive crop. Roundup Ready corn hybrids have good tolerance to glyphosate. Roundup Ready corn can be harvested for silage or grain after single or sequential applications of glyphosate.

Rotational restriction: Glyphosate formulations have no rotational restrictions for Wisconsin field crops except for a 30-day interval before tobacco.

Halex GT (Dual Magnum + Callisto + glyphosate premix)

Use only on Roundup Ready hybrids.

Rate: 3.6 to 4 pt/a.

Adjuvants: Add nonionic surfactant at 0.25 to 0.5% and ammonium sulfate at 8.5 to 17 lb/100 gal. Use of 28% nitrogen solution is not recommended because of the risk of injury.

Timing: *Corn*—Apply from emergence to 30 inches tall or the 8-collar (V8) stage.

Weeds—Apply before grass and broadleaf weeds exceed 4 inches tall. Apply before weeds exceed 10 inches when tank mixed with atrazine.

Remarks: Halex GT will provide postemergence control of most annual weeds. The timing may be too early for optimal long-term control of perennials although existing shoots will be killed. The glyphosate rate in this premix will control weeds at the 4-inch stage. The Callisto component provides a second ingredient with postemergence broadleaf activity, which would improve control of glyphosate-resistant weeds. This premix contains about a half rate of Dual and a full rate of Callisto, which will provide residual weed control if rain is received after application. Halex GT can be applied following many preemergence herbicides. Zemax at 1.6 qt/a or Lumex at 2 qt/a are the maximum rates of these herbicides that may be used prior to Halex GT applications because they also contain mesotrione. Halex GT can be tank mixed with atrazine for improved weed control, and 0.25 to 0.5 lb/a are recommended. Drift from Halex GT can injure adjacent crops or vegetation. Thoroughly clean the spray tank after use because residues can injure glyphosate- or Callisto-sensitive crops. Do not tank mix with emulsifiable concentrate grass herbicides because injury may occur. Halex GT may injure corn if the corn was treated with Counter, Lorsban, or other organophosphate soil insecticides or applied within 7 days of a foliar organophosphate insecticide. Halex GT can only be used on glyphosate-resistant field or silage corn.

Rotational restrictions: Field or sweet corn can be replanted any time; barley and wheat can be planted after 120 days; alfalfa, potato, soybeans, and tobacco can be planted after 10 months; and other crops can be planted after 18 months.

Harmony SG (thifensulfuron)

Rate: 0.125 oz (1/8).

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1% plus either 2 to 4 qt/a 28% nitrogen solution or 2 to 4 lb/a of ammonium sulfate. With glyphosate tank mixtures, only ammonium sulfate is needed if the glyphosate is fully loaded with surfactant.

Timing: *Corn*—Apply to 1- to 5-collar (V1 to V5) stages, but before 16 inches tall.

Weeds—Apply before lambsquarters exceeds 4 inches, before smartweeds and velvetleaf exceed 6 inches, and before pigweed exceeds 12 inches.

Remarks: Tank mixing with atrazine or glyphosate (Roundup Ready only) will increase the weed spectrum beyond those weeds listed above. Thifensulfuron has minimal soil activity. Corn has good tolerance to thifensulfuron, but stressed plants may be injured. Do not apply to corn that is less than 88 days of maturity. Applications to corn treated with Counter CR, Lorsban, or Thimet may cause crop injury. Apply to only field or silage corn.

Rotational restrictions: Corn, soybeans, and small grains can be planted any time after application. Any other crop can be planted after 45 days.

Hornet WDG (Python + Stinger premix)

Rate: *Spike stage*—3 to 6 oz/a. *Postemergence*—2 to 5 oz/a.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1% to the spray mixture. When droughty, also add 2.5% of 28% nitrogen solution.

Timing: *Corn*—Spike stage is from emergence to 2 inches, but before the first leaf unfurls. Other postemergence applications can be made to corn through the 6-collar (V6) stage.

Weeds—Apply 2 oz/a when broadleaf weeds are less than 3 inches tall; 3 oz/a when broadleaf weeds are up to 6 inches

tall; and 4 oz/a when broadleaf weeds are up to 8 inches tall.

Remarks: Spike stage applications will control many annual broadleaf weeds if adequate rainfall occurs before weed emergence. When applied at the 2 oz/a postemergence rate, cocklebur and velvetleaf should be controlled but common and giant ragweed, smartweed, and Canada thistle are only suppressed. At higher rates, common and giant ragweed, smartweed, and Canada thistle control improves but black nightshade, common lambsquarters, and pigweed will only be suppressed. Hornet WDG can be tank mixed with other labeled herbicides to improve control, but do not mix with Basagran. Do not apply Hornet if Counter or Thimet were applied.

Hornet WDG at 4 to 5 oz/a will provide reasonable Canada thistle control. The 3 oz/a rate may only control the top growth of Canada thistle. Best results on Canada thistle will be obtained in no-till corn because the weed will be more developed when the treatment is made. Adding 2 to 4 oz/a of Stinger to Hornet WDG will improve long-term control of Canada thistle.

Hornet WDG may be used on field and silage corn.

Rotational restrictions: Small grains can be planted 4 months after application; alfalfa, dry beans, peas, soybeans, and specific sweet corn hybrids listed on the supplemental label can be planted after 10.5 months; and potatoes, non-listed sweet corn hybrids, and tobacco can be planted after 18 months.

Ignite 280/Liberty (glufosinate)

Only use on Liberty Link corn hybrids.

Rate: 29 to 36 fl oz/a. A maximum of 36 fl oz per application and a maximum of 65 fl oz/a can be used for the entire season in Liberty Link corn.

Adjuvants: The Ignite 280/Liberty formulation contains surfactants. Additional surfactants or crop oils are not required. Add 3 lb/a of ammonium sulfate prior to adding Ignite/Liberty to the spray tank. Can reduce to 1.5 lb/a ammonium sulfate above 85˚F to avoid corn injury.

Timing: Apply between dawn and 2 hours before sunset.

Corn—Apply from emergence up to the V7 stage or 24 inches tall.

Weeds—For grasses, apply before barnyardgrass, crabgrass, fall panicum, and yellow foxtail exceed 3 inches and before giant and green foxtail, wild proso millet, and woolly cupgrass exceed 6 inches. For broadleaves, apply before pigweed and velvetleaf exceed 3 inches; before lambsquarters exceeds 4 inches; and before nightshade, common and giant ragweed, and smartweeds exceed 6 inches.

Remarks: Ignite 280/Liberty is a nonselective contact herbicide that controls many annual weeds and will burn the top growth of perennial weeds. Ignite 280/Liberty can be tank mixed with atrazine or most other postemergence herbicides to enhance weed control or provide residual activity. A second application of Ignite 280/Liberty can be made if needed, but use drop nozzles after the V7 stage but before corn exceeds 36 inches. Apply in a minimum of 15 gal/a for good spray coverage. Do not apply if wind speed exceeds 10 mph. Ignite 280/Liberty is rainfast in 4 hours. Glufosinate-resistant hybrids have good tolerance to Ignite 280/Liberty, but conventional hybrids will be severely injured.

Rotational restrictions: Corn and soybean can be replanted at any time. Small grains and root, tuber, and leafy vegetables can be planted 70 days after application and other crops after 180 days.

Impact/Armezon (topramazone)

Rate: 0.75 fl oz/a; use 0.5 fl oz/a if rotating to snap beans. A maximum rate of 1 fl oz/a may be applied sequentially or as a single application to control fall panicum, yellow foxtail, or woolly cupgrass prior to the third leaf. Check the label for rotational restrictions with the 1 fl oz/a rate.

Adjuvants: Add 1.0 to 1.5% methylated seed oil (preferred) or crop oil concentrate. Also add 1.25 to 2.5% of 28% nitrogen solution or 8.5 to 17 lb/100 gal of ammonium sulfate.

Timing: *Corn*—Apply from emergence until 45 days before corn harvest.

Weeds—Apply 0.75 fl oz/a before smartweeds exceed 3 inches; before common lambsquarters, nightshades, common ragweed, and pigweeds exceed 6 inches; and before giant ragweed and velvetleaf exceed 8 inches.

Remarks: Topramazone is effective on many annual broadleaf weeds. Crabgrasses, giant and green foxtail, and wild proso millet are labeled as controlled at the higher rate, but other annual grasses may only be suppressed. A preemergence grass herbicide application or postemergence grass herbicide tank mix may be advised for total grass weed control. Topramazone works synergistically with atrazine, so tank mixtures with 0.25 to 1.0 lb/a atrazine are recommended. It can also be tank mixed with most other postemergence herbicides, including glyphosate and Ignite/Liberty, on resistant hybrids. Corn has good tolerance to topramazone, but under stressful conditions, nonionic surfactant should be used in tank mixtures with 2,4-D or dicamba to reduce the risk of injury. Topramazone has no insecticide use restrictions. Topramazone drift will bleach the leaves of sensitive plants. Do not apply if wind speed exceeds 10 mph. Topramazone is rainfast in 1 hour. Topramazone can be used on field corn (grain, silage, and seed) and sweet corn.

Rotational restrictions: Corn can be planted any time after application; small grains after 3 months; alfalfa, peas, potatoes, sorghum, and soybean after 9 months; and other crops after 18 months. If the 0.5 fl oz/a rate is used, snap beans can be planted after 9 months; otherwise, they cannot be planted for 18 months.

Laudis (tembotrione + safener)

Rate: 3 fl oz/a.

Adjuvants: Add 1% crop oil concentrate or methylated seed oil plus 1.5 qt/a 28% nitrogen solution or ammonium sulfate at 8.5 lb/100 gal. Methylated seed oil is preferred over crop oil concentrate if Laudis is being used as a one-pass postemergence program to maximize the grass weed control.

Timing: *Corn*—Apply from emergence up to the 8-collar (V8) stage.

Weeds—Apply before broadleaf weeds exceed 6 inches tall. Apply before large crabgrass, giant and green foxtail, woolly cupgrass exceed 3 inches; before wild proso millet exceeds 4 inches; before barnyardgrass exceeds 5 inches; and before shattercane exceeds 6 inches.

Remarks: Laudis provides good control of many broadleaf weeds and several grass weeds. Control of broadleaf weeds is generally greater than grass weeds. It is less effective on green foxtail, and fall panicum may not be controlled. Using Laudis in a two-pass program when it is applied after a preemergence grass herbicide may be preferred. If so, crop oil could be used as the adjuvant as broadleaf weeds are the primary target. Laudis is synergized with 0.5 lb/a atrazine, which would be a common tank mixture. If corn is taller than 12 inches tall and atrazine cannot be used, 6 oz/a of Buctril can be used instead of atrazine. Laudis can be tank mixed with Accent Q, Option, Stout, and Steadfast Q for additional grass activity. In resistant corn, Laudis could also be mixed at 2 fl oz/a with Ignite/Liberty or at 3 fl oz/a with glyphosate. With the safener in Laudis, field corn has excellent tolerance to Laudis. Laudis can be applied to field, silage, seed, and sweet corn.

Rotational restrictions: Small grains can be planted after 4 months; soybean can be planted after 8 months; and alfalfa, peas, potato, and snap bean can be planted after 10 months.

Metribuzin

Rate: 2 to 3 oz/a of metribuzin 75DF or equivalent of other metribuzin formulations.

Adjuvants: Never use crop oil concentrate. Do not use adjuvants in 2,4-D or Buctril tank mixes. In tank mixtures with atrazine or dicamba, 1 qt of nonionic surfactant per 100 gal of spray mixture may be added. Surfactant or 28% nitrogen solution may be added to Basagran tank mixtures.

Timing: *Corn*—Metribuzin can be applied from emergence to tasseling, but timing is restricted by the tank-mix partner.

Weeds—Maximum size of broadleaf weeds controlled depends on the tank-mix partner. See label for specifics.

Remarks: Metribuzin has been labeled as a tank-mix partner for atrazine, dicamba, Basagran, Buctril, and 2,4-D to enhance broadleaf weed control. Metribuzin may cause some corn leaf burn, but the effects are generally temporary. Do not apply over coarse-textured soils with less than 0.5% organic matter or to cold-stressed corn. If a preemergence application of metribuzin was applied, do not apply more than a total

of 5.3 oz/a metribuzin. Metribuzin may be applied to field corn and silage corn, but not to sweet corn.

Rotational restrictions: Injury to rotational field crops is not a concern with these low rates of metribuzin.

NorthStar (primisulfuron + dicamba premix)

Rate: 5 oz/a.

Adjuvants: Add nonionic surfactant at 0.25% to the spray solution or 1 to 4 pt/a of crop oil concentrate if corn is less than 12 inches tall. Adding 2 to 4 qt/a of 28% nitrogen solution or 2 to 4 lb/a ammonium sulfate may improve the control of some weeds.

Timing: *Corn*—Apply to 4- to 20-inch corn (applications before 4 inches may cause injury and after the V6 stage may cause pinched ears). Use drop nozzles for corn from 20 inches to 36 inches tall.

Weeds—Apply to 4- to 12-inch shattercane, 4- to 8-inch quackgrass, and 3-inch fall panicum. Apply before lambsquarters, smartweed, and velvetleaf exceed 4 inches; pigweeds exceed 5 inches; cocklebur and nightshade exceed 6 inches; and common and giant ragweed exceed 9 inches.

Remarks: NorthStar controls many annual broadleaves and quackgrass, but will only suppress most annual grasses. NorthStar can be tank mixed with atrazine, dicamba, or Resource to improve broadleaf weed control or tank mixed with Accent Q for added annual grass control. Corn occasionally may show temporary yellowing or leaning/brittleness (from the dicamba component) after application. Delay cultivation until normal growth occurs to prevent stalk breakage. Soybeans, tobacco, and most vegetables are extremely sensitive to the dicamba component in NorthStar, so avoid drift. To prevent residues from injuring other crops like soybeans, use an ammonia solution to clean the sprayer after use. Do not apply NorthStar if Counter CR was applied in furrow. NorthStar applied after surface-banded or T-banded Counter CR may cause injury. NorthStar applications after Dyfonate, Lorsban, and Thimet may also cause temporary injury. NorthStar can be used on IR corn hybrids regardless of insecticide use without increasing risk of injury, but IT corn hybrids should be treated as conventional hybrids. NorthStar can be used on field corn, silage corn, and seed corn. Do not use on sweet corn.

Rotational restrictions: Field corn may be planted 14 days after NorthStar application; winter wheat after 3 months; alfalfa dry and green beans, sweet corn, peas, potatoes, soybeans, small grains, and tobacco after 8 months. Other crops may be planted 18 months after application.

Option (foramsulfuron + safener)

Rate: 1.5 oz/a.

Adjuvants: Add methylated seed oil at 1.5 pt/a plus either 28% fertilizer at 1.5 to 2 qt/a or ammonium sulfate at 1.5 to 3 lb/a.

Timing: *Corn*—Apply from the 1-collar through the 6-collar (V6) stage.

Weeds—Apply before woolly cupgrass exceeds 2 inches; before green and yellow foxtails, wild proso millet, and fall panicum exceed 3 inches; before barnyardgrass exceeds 4 inches; before giant foxtail exceeds 6 inches; and before quackgrass and wirestem muhly exceed 10 inches. Broadleaf weeds should be treated before lambsquarters, common ragweed, and velvetleaf exceed 2 inches; before pigweed exceeds 3 inches; and before nightshade exceeds 4 inches. Weeds beyond these stages may be treated with a 1.75 oz/a rate.

Remarks: Option controls many annual grass weeds and quackgrass, but it will not control smooth crabgrass. Large crabgrass and wirestem muhly may only be suppressed. Grasses like crabgrass and woolly cupgrass that emerge after application will not be controlled adequately because Option has short residual activity. Option is an ALS inhibitor like the Accent Q family of herbicides. As a result, ALS-resistant grasses will likely be cross resistant to Option. Option can be tank mixed with atrazine, Callisto, dicamba, Hornet, NorthStar, Status, or Yukon to improve broadleaf weed control or with acetochlor, Zemax, Lumax EZ, or Prowl for residual activity. Corn is tolerant to Option, which contains a safener to enhance herbicide metabolism, but stressed corn may be temporarily yellowed or stunted. Do not use Option if Counter (in-furrow), Dyfonate, or Thimet was applied because of the risk of injury. Option may cause temporary injury if Lorsban or Counter (T-band) was applied.

Option should not be applied within 7 days of the application of an organophosphate insecticide. Option can be applied to field corn, silage corn, and sweet corn. It is not recommended on seed corn.

Rotational restrictions: Corn can be replanted 7 days after application and soybeans can be planted 14 days after application. All other crops can be planted 60 days after application.

Permit (halosulfuron)

Rate: 0.67 to 1.33 oz/a.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1% to the spray mixture. A 28% nitrogen solution may be added at 2 to 4 qt/a or ammonium sulfate at 2 to 4 lb/a if required by a tank-mix partner.

Timing: *Corn*—Apply from emergence to lay-by stage (about 36 inches tall).

Weeds—At the low rate, apply before smartweed exceeds 2 inches, before pigweed and giant ragweed exceed 3 inches, and before cocklebur, common ragweed, and velvetleaf exceed 9 inches. At 1.0 to 1.33 oz/a, Permit controls 4- to 12-inch yellow nutsedge and larger stages of the previous weeds.

Remarks: Permit controls several broadleaf weeds and nutsedge but it does not control black nightshade and only suppresses common lambsquarters. Permit can be tank mixed with atrazine, Buctril, dicamba, or 2,4-D to broaden the spectrum of broadleaf weed control. Tank mixtures can also be made with Accent Q to control specific grasses. Corn has good tolerance to Permit. Permit can be applied to field corn, silage corn, and seed corn, but not sweet corn.

Rotational restrictions: Field corn can be replanted 1 month after application; small grains can be planted 2 months after application; sweet corn can be planted after 3 months; and alfalfa, dry and snap beans, peas, potatoes, and soybeans can be planted after 9 months.

Priority (Aim EW + Permit premix)

Rate: 1.0 oz/a.

Adjuvants: Add 0.25% nonionic surfactant. Nitrogen additives or crop oil concentrates may be used if required by a tank-mix partner.

Timing: *Corn*—Apply from emergence through the 8-collar (V8) stage.

Weeds—Apply before smartweed exceeds 2 inches, before lambsquarters and giant ragweed exceed 3 inches, before nightshade and pigweed exceed 4 inches, before cocklebur and common ragweed exceed 9 inches, and before velvetleaf exceeds 18 inches.

Remarks: Priority provides the equivalent of 0.5 oz/a of Aim EW and 0.67 oz/a of Permit. It provides excellent velvetleaf control plus good control of several broadleaf weeds and yellow nutsedge. Priority can be tank mixed with postemergence grass herbicides like Accent Q, Basis Blend, and Steadfast Q, or with other postemergence herbicides to control weeds not controlled by Priority. The Aim component will cause some speckling of corn leaves. Avoid spraying within 6 to 8 hours before rain or irrigation or spraying excessive rates in the whorl as excessive leaf burn may occur. Adjust the spray boom to spray at least 18 inches above the corn. Priority may be used on field corn, silage corn, seed corn, and sweet corn, but should only be applied to seed corn using drop nozzles.

Rotational restrictions: Field corn can be replanted 1 month after application; small grains can be planted 2 months after application; sweet corn can be planted after 3 months; soybeans can be planted after 9 months; and alfalfa, dry and snap beans, peas, and potatoes can be planted after 12 months.

Rage D-Tech (Aim + 2,4-D premix)

Rate: 8 fl oz/a.

Adjuvants: Add nonionic surfactant at 0.25%.

Timing: *Corn*—Apply from spike to 8 inches tall. Drop nozzles can be used on corn up to 36 inches tall.

Weeds—Apply before broadleaf weeds exceed 6 inches tall.

Remarks: Rage D-Tech should control lambsquarters, nightshade, pigweed, and velvetleaf. Tank mixtures with atrazine or glyphosate (Roundup Ready corn only) are recommended to broaden the spectrum of weed control. The Aim component will provide a faster burn of weed foliage than 2,4-D alone. Rage D-Tech will cause some temporary speckling of corn leaves and

may cause stalk twisting or brittleness. Avoid spraying within 6 to 8 hours of rain or irrigation or when dew exists because excessive leaf burn may occur. Rage D-Tech can be used on field, silage, and sweet corn.

Rotational restrictions: Corn or soybeans could be replanted after the required interval indicated for burndown treatments. Snap beans, peas, and tobacco can be planted after 12 months. Most other crops can be planted after 30 days.

Realm Q (rimsulfuron + mesotrione premix)

Rate: 4 oz/a.

Adjuvants: Add 1% crop oil concentrate or methylated seed oil plus 2 qt/a 28% nitrogen solution or ammonium sulfate at 2 lb/a. Nonionic surfactant at 0.25% plus 2 qt/a 28% urea ammonium nitrate or ammonium sulfate at 2 lb/a can also be used, but COC is preferred.

Timing: *Postemergence*—Apply to corn up to 20 inches or with seven visible collars (V7), whichever is more restrictive. Apply before 12-inch corn for best performance.

Remarks: Realm Q will control or suppress several small annual grass and broadleaf weeds and provides limited residual control. Realm Q is suggested for use during early postemergence applications as a sequential weed control component following several suggested herbicide programs used prior to corn emergence. Realm Q can be tank mixed with glyphosate products for application on Roundup Ready corn, with glufosinate for application on Liberty Link corn, and with a variety of other postemergence corn herbicides to improve the spectrum of weed control. Do not exceed the total annual limits of rimsulfuron or mesotrione. Rainfall or irrigation is needed within 5–7 days following application to provide residual control. If no rainfall is received in that timeframe, provide row cultivation for soil incorporation or apply another postemergence application as needed. Do not tank mix Realm Q with Basagran because severe crop injury may occur. Do not mix Realm Q with foliar-applied organophosphate insecticides such as Lorsban, malathion, or parathion, as severe crop injury may occur. Do not apply to field corn grown for seed, popcorn, or sweet corn.

Rotational restrictions: Field corn can be planted any time after application; winter wheat after 4 months; small grains after 9 months; and alfalfa, canola, potatoes, flax, sorghum, sweet corn, popcorn, soybeans, and sunflowers after 10 months. Any crop not listed on the label cannot be planted for 18 months.

Resolve Q (rimsulfuron + Harmony SG + safener premix)

Rate: 1.25 oz/a.

Adjuvants: If applied alone, add 0.25% nonionic surfactant plus either 2 lb/a of ammonium sulfate or 2 qt/a of 28% nitrogen solution. Surfactant is not required if tank mixing with a glyphosate formulation that already contains all the necessary surfactant (fully loaded) or with Ignite/Liberty.

Timing: *Corn*—Apply from emergence to 20 inches tall, but before the V7 stage.

Weeds—Apply before barnyardgrass, foxtails, or fall panicum exceed 2 inches and before pigweed and velvetleaf exceed 3 inches.

Remarks: Resolve Q will control or suppress several small annual grass and broadleaf weeds and will provide limited residual control. Resolve Q is being marketed to be mixed with glyphosate or Ignite/Liberty to increase their postemergence activity and provide residual activity. Rainfall or irrigation within several days after application is necessary to obtain residual activity of velvetleaf, pigweed, lambsquarters, and foxtails. Resolve Q may also be tank mixed with preemergence grass herbicides or reduced rates of Lumax EZ for greater residual activity or with Impact/Armezon plus atrazine for greater postemergence activity. Do not tank mix with Basagran because crop injury may occur. Do not use on fields treated with Counter CR applied in furrow or over the row at cultivation. Resolve Q may injure corn treated with Counter CR, Lorsban, or Thimet if soil has less than 4% organic matter. Resolve Q can be used on field corn, but not on seed or sweet corn.

Rotational restrictions: Corn can be planted any time after application; potatoes after 1.5 months; winter wheat after 3 months; small grains after 9 months; and alfalfa, peas, sweet corn, soybeans,

snap beans, and dry beans after 10 months. Any crop not listed on the label cannot be planted for 18 months.

Resource (flumiclorac)

Rate: *Broadcast applications*—4 to fl 6 oz/a. *Drop-nozzle applications*—4 to 8 fl oz/a. *Tank mixtures*—4 fl oz/a.

Adjuvants: Add 1 pt/a crop oil concentrate for broadcast application or 2 pt/a for drop nozzle applications. See label for tank mixture recommendations.

Timing: *Corn*—Apply from V2 to V10 (2- to 10-collar) stage. Tank mix applications can be made from V2 through the maximum stage allowed by the tank-mix partner.

Weeds—Apply broadcast applications of 6 fl oz/a Resource before common ragweed and smooth pigweed exceed 3 leaves and before velvetleaf exceeds 6 leaves. Larger weeds can be controlled with drop-nozzle applications at 8 fl oz/a.

Remarks: Resource may cause temporary spotting of corn leaves. Resource is highly effective on velvetleaf, controlling up to 10-leaf velvetleaf at 8 fl oz/a. It is less effective on other broadleaf weeds and must be applied early for control. Resource can be tank mixed at low rates with numerous broadleaf herbicides to enhance the velvetleaf control of the tank-mix partner. Resource may be used on field corn and silage corn, but not on sweet corn.

Rotational restrictions: Corn and soybeans can be planted any time. Other crops can be planted 30 days after application.

Roundup formulations

See glyphosate (page 45).

Shotgun* (atrazine + 2,4-D ester premix)

Rate: 2 to 3 pt/a; see comments under timing.

Adjuvants: Do not add adjuvants to the spray mix or apply in liquid fertilizer.

Timing: *Corn*—Apply 2 pt/a from emergence to the 4-leaf stage or before 8 inches tall on any soil texture or with drop nozzles to corn up to 5 leaves or 12 inches tall on coarse textured soils. Three pt/a can be applied broadcast to 4-leaf or 8-inch-tall corn or with drop nozzles to 5-leaf or 12-inch corn on medium and fine-textured soils.

Weeds—Annual broadleaf weeds are best controlled if less than 4 inches tall.

Remarks: Shotgun controls many common annual broadleaf weeds. Corn stalks may become brittle during the week following Shotgun application. To minimize the risk of injury, make early applications or use drop nozzles at larger growth stages to avoid spraying excessive rates in the whorl of the corn plant. Later applications also increase the risk of deformed brace roots. Be cautious when applying Shotgun at temperatures above 85˚F because 2,4-D ester vapors may drift to injure nearby sensitive plants. Shotgun may only be used on field corn and silage corn.

Rotational restrictions: Corn, sorghum, and soybeans can be planted the year after application.

Status (dicamba + diflufenzopyr + safener premix)

Rate: 5 to 10 oz/a. Can be tank mixed at 2.5 oz/a with glyphosate or Ignite/Liberty on resistant corn hybrids.

Adjuvants: Add 0.25% nonionic surfactant or 1% crop oil concentrate. Also add either 28% nitrogen solution at 1.25% to the spray mixture or ammonium sulfate at 5 lb/100 gal of spray.

Timing: *Corn*—4 to 36 inches tall or V10.

Weeds—The label does not specify maximum weed sizes for treatment. However, broadleaf weeds should be treated before weed competition occurs and while weeds are still easily controlled. It seems wise to treat before most annual broadleaf weeds exceed 4 inches.

Remarks: Status controls many annual broadleaf weeds and suppresses perennial broadleaves. Status may also suppress growth of annual grasses that escape control after a preemergence grass herbicide application, but do not rely on Status for annual grass control. Status can be tank mixed with other postemergence grass or broadleaf herbicides with the following exceptions: dicamba, Hornet WDG, Northstar, and 2,4-D. Tank mixing with emulsifiable concentrate formulations of preemergence grass herbicides are not recommended because of potential injury.

**Contains atrazine. See pages 20–21 for rate restrictions.*

Corn injury (stalk brittleness or twisting) from Status should be less than injury from other dicamba products because of the safener added to the formulation. Soybeans, tobacco, and most vegetables or gardens are extremely sensitive to Status, so avoid drift. To prevent residues from injuring other crops like soybeans, the sprayer should be cleaned after use with a strong detergent or spray tank cleaner. Do not use Status on soils classified as sand with less than 3% organic matter and where groundwater depth is shallow. Status can be used on field corn, silage corn, and seed corn, but not on sweet corn.

Rotational restrictions: Field corn can be replanted 7 days after application and alfalfa, small grains, and soybeans can be planted 30 days after application if 5 oz/a or less was applied and 1 inch of rain was received. Otherwise, crops should not be planted for 120 days.

Steadfast Q (rimsulfuron + Accent Q + safener premix)

Rate: 1.5 oz/a.

Adjuvants: Add crop oil concentrate at 1% (preferred) or nonionic surfactant at 0.25% to the spray solution. Also add 2 qt/a of 28% nitrogen solution or 2 lb/a ammonium sulfate.

Timing: *Corn*—Apply from emergence to 20 inches, but before the 7-collar (V7) stage. For corn with 77- to 88-day maturities, apply before 12 inches or V6 stage.

Weeds—Apply before large crabgrass exceeds 1 inch; before woolly cupgrass exceeds 3 inches; before foxtails, barnyardgrass, fall panicum, and wild proso millet exceed 4 inches; and before quackgrass exceeds 8 inches.

Remarks: Steadfast Q is effective on many annual grasses and quackgrass. Smooth crabgrass will not be controlled and large crabgrass may only be suppressed. Crabgrass can be controlled if Steadfast Q is tank mixed with a preemergence grass herbicide and applied before the crabgrass emerges. Do not add a nitrogen fertilizer if tank mixing with Lumax EZ. Steadfast Q is labeled for tank mixtures with lower rates of atrazine, Callisto, dicamba, Hornet, Impact/Armezon plus atrazine, or Status to provide broadleaf weed control. Tank mixing with Permit or Yukon will also provide nutsedge control. Tank mixing Steadfast Q with dicamba may increase the risk of rat-tailing when applied to small corn. Do not tank mix Steadfast Q with Basagran, or 2,4-D because crop injury or antagonism may occur. Only tank mix with ALS herbicides when recommended by DuPont. Do not apply to hybrids with relative maturities of less than 77 days or injury may occur. Do not use Steadfast Q on fields treated with Counter CR applied in furrow at planting or over the row at cultivation. Steadfast Q may injure corn treated with Counter CR, Lorsban, or Thimet if soil has less than 4% organic matter. Do not apply organophosphate insecticides within 7 days before or 3 days after Steadfast Q applications. Steadfast Q may only be used on field and silage corn.

Rotational restrictions: Field corn can be planted any time after application; soybeans after 15 days; winter wheat after 4 months; spring cereals after 8 months; and alfalfa, dry beans, snap beans, peas, potatoes, and sweet corn after 10 months.

Stinger (clopyralid)

Rate: 0.25 to 0.5 pt/a for annual weeds and 0.33 to 0.5 pt/a for Canada thistle.

Adjuvants: Not required.

Timing: *Corn*—Apply from emergence through 24 inches tall.

Weeds—Apply before annual broadleaf weeds exceed 5 leaves. Apply to Canada thistle after 6 to 8 inches, but before bud stage.

Remarks: Stinger controls many weeds in the sunflower family including cocklebur, sunflower, common and giant ragweed, Jerusalem artichoke, and Canada thistle plus some weeds in the nightshade, buckwheat, and legume families. For Canada thistle control, do not cultivate before application and delay cultivation 2 to 3 weeks after application for maximum effectiveness. For lighter Canada thistle infestations, the 0.33 pt/a rate is recommended on the label and has been effective in Wisconsin. Stinger may be used on field corn and silage corn, but not sweet corn.

Rotational restrictions: Small grains, field corn, and grasses can be planted any time after a Stinger application. Do not plant alfalfa, dry beans, soybeans, or sweet corn for 10.5 months after application or peas and potatoes for 18 months after application.

Yukon (Permit + dicamba premix)

Rate: 4 to 8 oz/a.

Adjuvants: Add nonionic surfactant at 0.25 to 0.5% (preferred) or crop oil concentrate at 1% to the spray solution. If required by a tank-mix partner, 2 to 4 qt/a of 28% nitrogen solution or 2 to 4 lb/a ammonium sulfate may be added.

Timing: *Corn*—Apply from emergence to 36 inches.

Weeds—At the low rate, apply before smartweed exceeds 3 inches; before lambsquarters, nightshade, and giant ragweed exceed 6 inches; and before nutsedge, pigweed, and common ragweed exceed 12 inches.

Remarks: Yukon at 4 oz/a is equivalent to the standard 0.67 oz/a rate of Permit plus 4 oz/a of dicamba. It controls many annual broadleaf weeds and provides good control of yellow nutsedge. Yukon is labeled for tank mixtures with atrazine, Accent, Callisto, Impact/Armezon, and Steadfast Q. It can be tank mixed with glyphosate or Ignite/Liberty on resistant hybrids. Corn has good tolerance to early postemergence applications, but certain hybrids may have temporary twisting or brittleness because of the dicamba component. Soybeans, tobacco, and most vegetables are extremely sensitive to the dicamba component in Yukon, so avoid drift. To prevent residues from injuring other crops like soybeans, clean the sprayer after use with a detergent solution followed by an ammonia solution. Yukon can be used on field, silage, and seed corn, but not on sweet corn.

Rotational restrictions: Field corn can be planted 1 month after application; small grains can be planted 2 months after application; sweet corn can be planted after 3 months; and alfalfa, dry and snap beans, peas, potatoes, and soybeans can be planted after 9 months.

2,4-D amine or ester

Rate: *Early postemergence*—0.5 to 1.0 pt/a of 2,4-D amine or 0.33 to 0.67 pt/a of 2,4-D low volatile ester, assuming 3.8 lb ae/gal.

Late postemergence—1 pt/a of 2,4-D amine or low volatile ester.

Adjuvants: Do not add crop oil or serious corn injury may occur. Add surfactant if directed by tank-mix partner.

Timing: *Corn*—Apply early postemergence broadcast applications to 4- to 8-inch corn. Make late postemergence drop-nozzle applications to corn between 8 inches tall until 1 week before tassel emergence. Preharvest applications can be made after silks brown.

Weeds—Annual broadleaf weeds are controlled best when less than 3 inches tall. Perennial broadleaves should be 10 inches or more in height when treated.

Remarks: Corn injury is most likely when corn is growing rapidly under high temperature and high soil moisture conditions. Under such circumstances, delay cultivation for 8 to 10 days to allow corn to overcome any temporary stalk brittleness. Corn hybrids vary in their tolerance to 2,4-D. For early postemergence applications, use the lower rate for treatment in hot, humid weather. For late drop-nozzle applications, adjust the application rate in direct proportion to the amount of the field area actually being treated. If the entire row and interrow area is being treated, no rate reduction is necessary. Direct the spray toward the base of the corn row to obtain maximum weed coverage with minimum corn injury. Smartweeds and wild buckwheat are somewhat tolerant of 2,4-D, especially the amine form.

Only certain brands of 2,4-D are registered for preharvest use. The purpose of preharvest treatment is to limit weed seed production and suppress tall growing weeds that might interfere with corn harvest. Apply 1 qt/a by ground or air after corn silks turn brown. Tall pigweed, sunflower, cocklebur, and hemp dogbane are often controlled, but velvetleaf control is usually poor. Some studies have shown substantial reduction in the viability of certain weed seeds, but velvetleaf seed viability was reduced only slightly. Postemergence application of 2,4-D may be used on field corn, silage corn, and sweet corn. Because sweet corn is more susceptible to damage than field corn, 2,4-D is seldom used on sweet corn.

Rotational restrictions: Soil persistence of 2,4-D is short. Rotational restrictions depend on rate and are generally 30 days or less.

Table 2-4. Forage, grazing, and grain harvest intervals for corn herbicides[a]

Product	Forage/grazing interval	Grain harvest interval
Accent Q	30 days	no restrictions
Acetochlor	no restrictions	no restrictions
Acetochlor + atrazine	60 days	no restrictions
Alachlor + atrazine	21 days	no restrictions
Atrazine	60 days	no restrictions
Basagran	12 days	no restrictions
Basis Blend	30 days	30 days
Bicep Lite II Magnum	60 days	no restrictions
Buctril	30 days	apply before tassel emergence
Cadet	30 days	90 days
Callisto	45 days	45 days
Capreno	45 days	no restrictions
Dicamba	delay harvest until milk stage	no restrictions
Dual II Magnum	30 days	no restrictions
Fierce	no restrictions	no restrictions
Glyphosate–broadcast	50 days	7 days
G-Max Lite	60 days	no restrictions
Halex GT	45 days	45 days
Harmony SG	30 days	30 days
Hornet WDG	45 days	85 days
Ignite/Liberty	60 days	70 days
Impact/Armezon	45 days	45 days
Laudis	45 days	no restrictions
Lumax EZ	60 days	45 days
Metribuzin	60 days	60 days
NorthStar	grazing: 30 days; silage: 45 days	60 days
Option	45 days	70 days
Outlook	40 days	no restrictions
Permit	30 days	no restrictions
Princep	60 days	60 days
Priority	30 days	no restrictions
Prowl H2O	21 days	no restrictions
Python	85 days	85 days
Rage D-Tech	7 days	3 days
Realm Q	45 days	70 days
Resolve Q	30 days	30 days
Resource	28 days	28 days
Shotgun	21 days	no restrictions
Status	32 days	72 days
Steadfast Q	30 days	no restrictions
Stinger	40 days	no restrictions
SureStart/TripleFLEX	no restrictions	85 days
Verdict	80 days	no restrictions
Yukon	30 days	no restrictions
Zemax	45 days	45 days
Zidua	no restrictions	no restrictions
2,4-D amine or ester	7 days	no restrictions

[a] Labels may have changed after this table was prepared. Consult current labels to verify the information.

Table 2-5. Rate equivalents of corn herbicide premixes

Herbicide	Rate/a	Provides the equivalent of:
Basis Blend 30DF	0.825 oz	0.66 oz Resolve 25DF + 0.17 oz Harmony SG
Bicep II Magnum 5.5L	1.9 qt	1.2 pt Dual II Magnum 7.64EC + 1.6 lb atrazine 90DF
Bicep Lite II Magnum 6L	1.5 qt	1.3 pt Dual II Magnum 7.64EC + 1.1 lb atrazine 90DF
Bullet 4ME	3 qt	3.75 pt Micro-Tech 4ME + 1.25 lb atrazine 90DF
Callisto Xtra 3.7CS	24 fl oz	3 fl oz Callisto 4L + 0.62 lb atrazine 90DF
Capreno 3.45L	3 fl oz	2.47 fl oz Laudis 3.5L + 0.013 lb thiencarbazone
Degree Xtra 4.04CS	3.7 qt	2.85 pt Harness 7EC + 1.38 lb atrazine 90DF
Fierce WDG	3 oz	2 oz Valor SX 51DF + 1.5 oz Zidua 85WG
G-Max Lite 5L	3 pt	18 fl oz Outlook 6EC + 1.1 lb atrazine 90DF
Guardsman Max 5L	3.6 pt	16 fl oz Outlook 6EC + 1.67 lb atrazine 90DF
Halex GT	3.6 pt	1 pt Dual Magnum 7.64EC + 3 fl oz Callisto 4L + 0.9 lb ae glyphosate
Harness Xtra 5.6L	2.3 qt	2 pt Harness 7.0EC + 1.6 lb atrazine 90DF
Harness Xtra 6L	2 qt	2.46 pt Harness 7.0EC + 0.94 lb atrazine 90DF
Hornet 68.5WDG	4 oz	0.92 oz Python 80WG + 5.3 oz Stinger 3SC
Keystone 5.25L	2.6 qt	2.4 pt Surpass 6.4EC + 1.63 lb atrazine 90DF
Keystone LA 5.5L	2 qt	2.5 pt Surpass 6.4EC + 0.83 lb atrazine 90DF
Lumax EZ 3.95L	3.25 qt	2.1 pt Dual II Magnum 7.64EC + 6.4 fl oz Callisto 4L + 0.83 lb atrazine 90DF
NorthStar 47.4WG	5 oz	0.5 oz Beacon 75WG + 4 oz Clarity 4SC
Priority 62.5DG	1 oz	0.67 oz Permit 75WDG + 0.5 oz Aim EW
Rage D-Tech	8 fl oz	0.5 oz Aim EW + 8.3 oz 2,4-D LV4 (3.8 lb ae/gal)
Realm Q	4 oz	1.2 oz Resolve 25 WDG + 2.5 fl oz Callisto 4L
Resolve Q	1.25 oz	0.9 oz Resolve 25WDG + 0.1 oz Harmony SG
Shotgun 3.25L	2 pt	0.625 lb atrazine 90DF + 8.42 oz Low Vol 4 (3.8 lb ae/gal)
Status	5 oz	0.8 oz ae diflufenzopyr + 4 fl oz Clarity 4S
Steadfast Q 37.7WDG	1.5 oz	0.67 oz Accent Q 54.5WDG + 0.75 oz Resolve 25DF
SureStart/TripleFLEX	1.5 pt	0.88 pt Surpass 6.4EC + 2.3 fl oz Stinger 3SC + 0.45 oz Python 80WG
Verdict 5.57EC	13 fl oz	2.6 fl oz Sharpen 2.86SC + 10.8 fl oz Outlook 6EC
Yukon 67.5WDG	4 oz	0.67 oz Permit 75WDG + 4 oz Clarity 4S
Zemax 3.67L	2.4 qt	2.1 pt Dual II Magnum 7.64EC + 6.3 oz Callisto 4L

Table 2-6. Rainfree period and adjuvants required for postemergence corn herbicides

Herbicide	Hours rainfast	Recommended adjuvants				
		nonionic surfactant		COC		nitrogen additive
Accent Q	4	0.25%	*or*	1%	*plus*	28% N at 2 qt/a *or* AMS at 2 lb/a
Atrazine	6–8			1 qt/a	*or*	28% N at 2–4 qt/a *or* AMS at 2.5 lb/a
Basagran[a]	4			1 qt/a	*or*	28% N at 2–4 qt/a *or* AMS at 2.5 lb/a
Basis Blend	4	0.25%	*or*	1%	*plus*	28% N at 2 qt/a *or* AMS at 2 lb/a
Buctril	1	Add as directed by tank-mix partner.				
Cadet	4	0.25%	*or*	1–2 pt/a	*plus*	28% N at 1–2 qt/a *or* AMS at 1–2 lb/a may be added
Callisto	1			1%	*plus*	28% N at 2.5% *or* AMS at 8.5 lb/100 gal
Callisto Xtra	—	0.25%	*or*	1%	*plus*	28% UAN at 2.5% or AMS at 8.5 lb/100 gal
Capreno	1			1%	*plus*	28% N at 1.5 qt/a *or* AMS at 1.5 lb/a
Dicamba	4					28% N at 2–4 qt/a *or* AMS at 2.5 lb/a may be added for velvetleaf
Glyphosate	2–6	Check label to see if surfactant is needed.				Add AMS at 8.5–17 lb/100 gal
Halex GT	—	0.25–0.5%			*plus*	AMS at 8.5–17 lb/100 gal
Harmony SG	4	0.25%	*or*	1%	*plus*	28% N at 2–4 qt/a *or* AMS at 2–4 lb/a
Hornet WDG	2	0.25%	*or*	1%		Add 28% N at 2.5% if droughty
Ignite/Liberty	4					Add AMS at 3 lb/a
Impact/ Armezon	1			1.0–1.5% (MSO preferred)	*plus*	28% N at 1.25–2.5% *or* AMS at 8.5–17 lb/100 gal
Laudis	1			1% (MSO preferred)	*plus*	28% N at 1.5 qt/a *or* AMS at 8.5 lb/100 gal
NorthStar	4	0.25%	*or*	1–4 pt/a if corn < 12"		28% N at 2–4 qt/a *or* AMS at 2–4 lb/a may be added
Option	2	Add 1.5 pt/a MSO.			*plus*	28% N at 1.5–2.0 qt/a *or* AMS at 1.5–3.0 lb/a
Permit	4	0.25–0.5%	*or*	1%		28% N at 2–4 qt/a *or* AMS at 2–4 lb/a may be added if required by tank-mix partner
Priority	4	0.25%				28% N at 2–4 qt/a *or* AMS at 2–4 lb/a may be added if required by tank-mix partner
Rage D-Tech	—	0.25%				
Realm Q	—	0.25%	*or*	1%	*plus*	28% N at 2 qt/a *or* AMS at 2 lb/a
Resolve Q	4	0.25%			*plus*	28% N at 2 qt/a *or* AMS at 2 lb/a
Resource	1			1 pt/a[b]		
Shotgun	4	Do not add adjuvants.				
Status	4	0.25%	*or*	1%	*plus*	28% N at 1.25% *or* AMS at 5–17 lb/100 gal
Steadfast Q	4	0.25%	*or*	1%	*plus*	28% at 2 qt/a *or* AMS at 2 lb/a
Stinger	6–8	Adjuvants not required.				
Yukon	4	0.25–0.5%	*or*	1%		28% N at 2–4 qt/a *or* AMS at 2–4 lb/a may be added if required by tank-mix partner
2,4-D amine	6–8	Do not add COC; add surfactant if directed by tank-mix partner.				
2,4-D ester	2–3	Do not add COC; add surfactant if directed by tank-mix partner.				

Abbreviations: AMS = ammonium sulfate; COC = crop oil concentrate; MSO = methylated seed oil; N = nitrogen; UAN = urea-ammonium nitrate.

[a] Add COC for lambsquarters and common ragweed control, a nitrogen additive for velvetleaf control, or both if all three weeds are present.

[b] Use 2 pt/a for drop-nozzle applications.

Table 2-7. Application timings for postemergence herbicides (Labeled rates for certain herbicides may be higher or lower than the rate included in this table. At different rates, the maximum weed size labeled for control may change.)

			Broadleaves								Grasses							
Herbicide[a]	Corn stage	Rate/a	Cocklebur	Lambsquarters	Nightshade	Pigweed	Ragweed, common	Ragweed, giant	Smartweed	Velvetleaf	Barnyardgrass	Fall panicum	Foxtail, giant	Foxtail, green	Foxtail, yellow	Large crabgrass	Wild proso millet	Woolly cupgrass
			Maximum size in inches or leaf stage (lf)															
Accent Q[a]	0–20″ or V6	0.9 oz	—	—	—	4	—	—	4	—	4	4	4	4	4	—	4	4
Acetochlor	0–11″	variable	Acetochlor does not control emerged weeds.															
Atrazine 4L	0–12″	1 qt	4	6	4	6	4	4	4	4	—	—	—	1.5	1.5	—	—	—
Basagran	NR	2 pt	10	2	—	—	3	6	10	5	—	—	—	—	—	—	—	—
Basis Blend	0–V2	0.825 oz	—	3	—	3	—	—	3	3	2	2	2	2	2	0.5	—	1
Bicep Lite II Magnum	0–5″	variable	2 lf	2 lf	—	2 lf	2 lf	—	2 lf	2 lf	2 lf	2 lf	2 lf	2 lf	2 lf	2 lf	—	—
Buctril	4 lf–BT	1.5 pt	10	8	6	2	6	6	6	5	—	—	—	—	—	—	—	—
Cadet	V2–48″	0.9 fl oz	—	2	—	4	—	—	—	36	—	—	—	—	—	—	—	—
Callisto	0–30″ or V8	3 fl oz	5	5	5	5	—	5	5	5	—	—	—	—	—	2	—	—
Callisto Xtra	0–12″	24 fl oz	5	5	5	5	5	5	5	5	2	2	2	2	2	—	2	2
Capreno	V1–V6	3 fl oz	6	6	6	6	6	6	6	6	5	5	3	2	3	3	6	3
Dicamba[a]	0–8″ or 5 lf	1 pt	4	4	4	4	4	4	6	4	—	—	—	—	—	—	—	—
Dual II Magnum	0–40″	variable	Dual II Magnum does not control emerged weeds.															
Glyphosate	0–30″ or V8	0.75 lb ae	24	12	6	18	12	12	6	6	6	12	12	12	12	12	12	12
G-Max Lite	0–12″	variable	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	—	—
Halex GT	0–30″ or V8	3.6 pt	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Harmony SG	V1–V5 or 16″	0.083 oz	—	4	—	12	—	—	6	6	—	—	—	—	—	—	—	—
Hornet WDG[a]	0–V6	3 oz	6	—	—	—	6	6	6	6	—	—	—	—	—	—	—	—
Ignite/Liberty[a]	0–24″ or V7	22 fl oz	6	4	6	3	6	6	6	3	3	3	6	6	3	3	6	6
Impact/Armezon	0–45″ BH	0.75 fl oz	8	6	6	6	6	8	3	8	4	—	4	3	—	3	3	—
Laudis	0–V8	3 fl oz	6	6	6	6	6	6	6	6	5	—	3	—	3	3	4	3
Lumax EZ	0–12″	3 qt	3	3	3	3	3	3	3	3	—	—	—	—	—	—	—	—
NorthStar[a]	4–20″ (V2–V6)	5 oz	6	4	6	5	9	9	4	4	—	3	—	—	—	—	—	—
Option[a]	V1–V6	1.5 oz	2	2	4	3	2	—	—	2	4	3	6	3	3	2	3	2
Outlook	0–12″	variable	Outlook does not control emerged weeds.															
Prowl H_2O	0–30″ or V8	variable	Prowl H_2O does not control emerged weeds.															
Permit	0–36″	0.67 oz	9	—	—	3	9	3	2	9	—	—	—	—	—	—	—	—
Priority	0–V8	1 oz	9	3	4	4	9	3	2	18	—	—	—	—	—	—	—	—
Rage D-Tech[a]	0–8″	8 fl oz	6	6	6	6	—	—	6	6	—	—	—	—	—	—	—	—
Realm Q	0–20″ or V7	4 oz	5	5	5	5	5	5	5	5	2	2	2	2	2	0.5	—	1
Resolve Q	0–20″ or V6	1.25 oz	—	—	—	3	—	—	—	3	2	2	2	2	2	0.5	—	1
Resource	V2–V10	6 fl oz	—	3 lf	—	—	3 lf	—	—	6 lf	—	—	—	—	—	—	—	—
Shotgun[a]	0–8″	2 pt	4	4	4	4	4	4	4	4	—	—	—	—	—	—	—	—
Status[a]	4–36″ or V10	5 oz	4	4	4	4	4	4	4	4	—	—	—	—	—	—	—	—
Steadfast Q	0–20″ or V6	0.75 oz	—	—	—	4	—	—	3	—	4	4	4	4	4	1	4	3
Stinger	0–24″	0.25 pt	5 lf	—	—	—	5 lf	5 lf	—	—	—	—	—	—	—	—	—	—
Yukon	0–36″	4 oz	14	6	6	12	12	6	3	12	—	—	—	—	—	—	—	—
Zemax	0–30″ or V8	2.4 qt	3	3	3	3	3	3	3	3	—	—	—	—	—	—	—	—
Zidua	V4	2.5 oz	Zidua does not control emerged weeds.															
2,4-D[a]	4–8″	1 pt	4	4	4	4	4	4	—	2	—	—	—	—	—	—	—	—

Abbreviations: lf = leaf; NR = no restrictions; BH = before harvest; BT = before tasseling; — = not labeled for control.

[a] Drop nozzles allow these herbicides to be applied before stages listed: Shotgun up to 12 inches; Accent Q up to 36 inches or 10 collars; dicamba, Hornet, Ignite/Liberty, NorthStar, Rage D-Tech, and Status up to 36 inches; Option up to V8; 2,4-D before tasseling.

CORN INSECT MANAGEMENT

Insecticides suggested in this section are intended as a guide to assist you in selecting chemical control options. While suggestions provide an overview of product registrations for specific field crop insect pests, this guide is not intended as an exhaustive insecticide label source. Product inclusion or omission does not imply endorsement by the University of Wisconsin-Extension. Keep in mind that certain insecticide active ingredients are produced by more than one manufacturer, and directions for use, rate, and method of application may vary by formulation. Therefore, always read the insecticide label completely before using the material.

A number of the products listed in this section are restricted-use insecticides. We discuss restricted-use pesticides in the beginning of this publication. Refer to appendix table 1b for a list of insecticides that currently require certification to be applied. It is possible that additional insecticides will be classified before the next growing season. Contact your county Extension agent for additional information on insecticide restrictions.

Common and trade names of insecticides are often used interchangeably. Trade names such as Lorsban are capitalized, while common chemical names, chlorpyrifos in this example, are not.

CHEMIGATION

Some insecticides, such as Ambush 2E, Cobalt Advanced, Lorsban Advanced, Pounce 3.2 EC, Penncap-M, Sevin, and Warrior II, can be applied through certain sprinkler irrigation systems, as specified on the label, for control of various aboveground corn insect pests. Consult product labels for specific instructions. Wisconsin has stringent regulations regarding application of pesticides through irrigation water, and an approved anti-siphon system is required. Contact the Wisconsin DATCP for information on legal requirements.

PREDICTING SOIL INSECT CONTROL NEEDS FOR CORN

Crop rotation patterns significantly influence the occurrence and extent of soil insect problems in corn. Awareness of these relationships, along with field scouting information, can help predict the need for a planting-time application of a soil insecticide, a seed-applied insecticide, or selection of a Bt corn hybrid. Exceptions occasionally can occur because of weather fluctuations, abundance or lack of natural enemies, tillage, etc. The following are guidelines for predicting soil insect problems in corn and selecting insect pest management tactics accordingly.

Continuous corn

Corn rootworm is known as a continuous corn pest because it requires corn roots to complete development. Rootworms cause damage beginning the second year when overwintering eggs hatch and larvae feed on corn roots to complete development. (Larvae that emerge in fields planted to nonhost crops such as alfalfa or soybean will not complete development.) A corn rootworm control strategy usually is needed at planting in the rootworm area of the state. A line from Green Bay to Eau Claire typically marks the northern limits of corn rootworm problems during most years. However, along the Mississippi River, relatively high populations extend into St. Croix County. Muck and non-irrigated sandy soils seldom have damaging rootworm populations. For more details about rootworms and control options, see the discussion under “Insect Pests.”

Corn after soybeans

The incidence of soil insect problems in corn following soybeans is typically low, and the use of a planter box or commercial seed treatment for control of soil-dwelling secondary insect pests (e.g., seedcorn maggot, wireworm, white grub) will normally be sufficient. Check seed-applied insecticide labels for pests controlled and/or suppressed. Soil-applied insecticides are seldom necessary.

In most of the state, corn rootworm damage is not a problem when corn is rotated annually with soybeans or other crops, as the adult beetles primarily lay their eggs in corn fields. Larvae that hatch in fields other than corn will starve to death. This makes crop rotation a highly reliable cultural control.

In some cases, not all northern corn rootworm eggs will hatch after the first winter. Some northern corn rootworm eggs remain in a dormant state for two or more winters before hatching. This behavior, known as extended diapause, is more prevalent in states west of Wisconsin. In a 3-year successive rotation of corn/soybean/corn, this can result in economic rootworm injury during the year that corn follows soybean. Therefore, damage to corn that follows soybean in rotation does not necessarily mean that rootworm beetles laid eggs in soybean. Additionally, corn rootworm beetles present in corn fields that follow soybean, alfalfa, or another crop in rotation did not necessarily emerge from the soil in those fields. Rootworm beetles are mobile and are capable of dispersing to new fields very soon after emergence. For areas not affected by the variant western corn rootworm (see next section), if beetles are present in corn fields that follow a crop other than corn, they are likely migrants and did not emerge in such fields.

Although rootworm beetles can be found in "clean" soybean fields, they are especially attracted to weedy fields or those that contain volunteer corn. In these cases, rootworm beetles may deposit enough eggs in soybean fields to cause economic damage when corn is planted the following year. Control of grassy weeds and volunteer corn will help reduce potential problems from corn rootworm as well as larval wireworm, white grub, stalk borer, hop vine borer, and potato stem borer the following year, since the weeds can be attractive to egg-laying adults during the summer.

Corn after soybeans: Variant western corn rootworm

A variant strain of the western corn rootworm has developed a behavioral adaptation to the corn-soybean rotation in some areas of the Midwest, including parts of Wisconsin. This strain no longer requires corn as an egg-laying site. Like normal western corn rootworm beetle populations, this variant moves readily between corn and other crops. Unlike normal rootworm beetles, this variant can lay heavy populations of eggs in soybean fields, resulting in economic injury to corn planted the following year.

The variant western corn rootworm (variant WCR) has been documented in southern Wisconsin, the northern two thirds of Illinois, much of Indiana, southern Michigan, and western Ohio. A team of UW-Extension researchers, corn-soybean growers, and Wisconsin DATCP specialists confirmed its presence in Kenosha, Racine, Walworth, and Rock counties. Contact your UW-Extension agent for the most current information on variant WCR in your area.

In affected areas, producers and consultants should take steps to minimize the risk of corn rootworm damage to first-year corn following soybeans. It's important to scout to determine whether the variant WCR is present in sufficient numbers to cause economic damage. Treating first-year corn without first establishing the need is both costly and environmentally unsound.

Unbaited yellow sticky traps, available from Gempler's and Great Lakes IPM, are used to monitor beetle abundance in soybeans and predict the need for at-planting corn rootworm treatment the following year. For assistance implementing a scouting program, contact your county Extension agent.

If you determine that control is needed, there are several options for reducing damage the following year:

- Use a granular or liquid soil insecticide at planting.
- Plant a Bt rootworm corn hybrid.
- Plant corn treated with a corn rootworm-rate insecticidal seed treatment.

Corn after sod

True grass sod, including grassy legume fields, may harbor pests such as white grubs, wireworms, cutworms, sod webworms, and grasshoppers. Species of wireworms and white grubs that take longer than 1 year to develop also may be a problem the second and third years if not controlled the first year. Seedcorn maggot flies also may be attracted to the increased organic matter of a grass sod broken for corn planting.

Insecticidal seed treatments will control seedcorn maggots, but soil insecticide treatments may be needed for pests like wireworms and white grubs. Several soil insecticides labeled for corn rootworm control are also labeled for control of wireworms and white grubs. In addition, low-rate nicotinoid insecticidal seed treatments are labeled for wireworms and white grubs.

Minimum tillage of true grass sods is favorable to such corn insect pests as cutworms, armyworms, grasshoppers, and stalk borers.

Corn after alfalfa

Rootworms occasionally can be a problem in corn following alfalfa, but this is less common than damage to corn planted after soybean. Adult rootworm beetles attracted to alfalfa or weed blossoms during the summer egg-laying period occasionally have laid enough eggs to cause economic damage the following summer.

There also is a potential for damage from wireworms and white grubs when corn follows grassy alfalfa and clover fields.

Some insecticides (Ambush 2E, Brigade 2EC, Pounce 3.2EC, and Warrior II) are labeled for preventative treatment for occasional pests such as black cutworm, early-season armyworm, and stalk borer, particularly when corn is no-till planted into sod. However, because of the erratic occurrence of these pests, scouting of seedling corn plants combined with timely insecticide application at insect pest thresholds is a more cost-effective and environmentally sound approach. Your county Extension agent can assist you in developing a scouting program.

Corn after sudangrasses

Although corn rootworm beetles can be found in sudangrass, sudex, and other similar grasses, the beetles apparently return to cornfields to lay their eggs, because we have not observed rootworm damage in corn planted after these grasses in rotation.

INSECT PESTS

Armyworm

The true armyworm causes serious damage in some areas of the state almost every year. Armyworms will climb into corn whorls or even attack tasseled corn and "rag" the leaves from the outside edges toward the midrib, sometimes leaving only midribs on the stalk or eventually eating the stalks to the ground. Defoliation below the ear zone is not as detrimental as leaf feeding above the ear.

Armyworm moths will lay eggs on grass in cornfields; thus grass weed control in corn is important. If a cornfield has a heavy infestation of grassy weeds, scout the field carefully. Look on the ground, under debris, and on the weeds.

"Weed-free" fields will not guarantee immunity from armyworm attack. The armyworm can also migrate into corn from nearby harvested alfalfa, pea, or small grain fields or other grassy areas. Monitoring these kinds of fields when they border corn is necessary. When the armyworm migrates into corn from adjoining areas, only a few border rows may need treatment if infestation is detected early enough.

If you find signs of armyworm feeding, check five sets of 20 plants at random. Record the number of damaged plants and the number of worms per plant. Spot treat, if possible, when you find two or more armyworms (.75-inch or smaller) per plant on 25% of the plants or one per plant on 75% of the plants. Finding the worms while they are still small and before damage to corn is severe increases the value of control. Young worms also are easier to control than those nearing maturity.

Corn earworm

Hybrid seed corn production fields occasionally need protection from corn earworm. Moths lay eggs on green and yellow color-stage silks, and larvae crawl down the silk channel and feed on kernels. Corn earworm larvae can be confused with European corn borer—or western bean cutworm—larvae, which also feed within the ears.

Pheromone traps can be used to trap male moths and monitor population trends. Treat with an insecticide (see table 2-12) at 10% silk if traps capture 5 to 10 male moths/night. A second application may be needed 7 to 10 days later if traps continue to catch 5 to 10 moths per night. Moths will not lay eggs on dry silks.

Corn flea beetle

As the name implies, corn flea beetles are small (0.6 inch) and will leap great distances when disturbed. These black beetles overwinter in clumps of grass near cornfields and move to corn seedlings shortly after they emerge in the spring. Feeding damage appears as long, thin, silvery-white streaks. Although heavily injured leaves turn brown and wilt, beetle populations in Wisconsin are rarely large enough to cause this type of damage. The corn flea beetle is more important for its role in transmitting a bacterial disease known as Stewart's wilt or Stewart's disease. This disease is an occasional problem in Wisconsin. Beetles can spread the bacterium, *Erwinia stewartii,* during feeding. The bacterium can overwinter within the beetle, on plant debris, or in the soil. For more information about Stewart's wilt, see the "Corn Diseases" section.

Sweet corn and inbred corn can be highly susceptible to Stewart's wilt and should be scouted from seedling emergence to the V5 stage. An insecticide may be warranted if there are two to three beetles per plant and if 10% of the plants exhibit feeding injury.

Flea beetle survival and Stewart's wilt potential are predicted using the average monthly temperatures for December, January, and February. Typically, Stewart's wilt causes significant losses only one or two years in a 20-year period. For flea beetle predictions, consult early spring issues of the UW-Extension *Wisconsin Crop Manager* newsletter (ipcm.wisc.edu/wcm) or the WDATCP *Wisconsin Pest Bulletin* (pestbulletin.wi.gov).

Corn leaf aphid

Corn leaf aphids are greenish-blue, soft bodied, and about the size of a pinhead. Their sap sucking stresses plants and interferes with ear production. Soil moisture stress reduces the plant's ability to withstand attack. Moisture stress and heavy infestations (tassel and upper leaves plastered with aphids) can result in barren plants.

The most critical period for damage is the late-whorl to pollen-shed stages. If aphid populations are high by the time corn has tasseled and pollinated, major damage will already be done. Because of this, begin scouting fields approximately 2 to 3 weeks before tassel emergence. (You will have to pull and unroll whorl leaves to do this.) Treatment is suggested if 50% of the plants have more than 50 aphids per plant and plants are in the late-whorl to early tassel stages.

Apply sprays before tassels have completely emerged but not before the upper whorl leaves have opened to expose the tassels.

Remember that the presence of predators and adequate soil moisture can influence treatment decisions. However, we are often faced with long summer dry spells during the tassel emergence period.

Corn rootworm

Northern and western corn rootworms overwinter in the egg stage in the soil. Larvae usually can be found feeding on developing corn roots by mid-June, peaking by early July. After completing three larval stages, larvae will leave the roots, form an earthen cell, and pupate. The pupae change into adults, which make their way out of the soil to feed on pollen, silks, and, in the case of the western corn rootworm, even tender corn foliage. At Arlington, Wisconsin, first adults normally begin to appear in mid-July. Because of the prolonged egg hatch, all stages (larvae, pupae, and adults) can be found in July and August. Most of the eggs will be laid from mid- to late August.

The potential for damage and need for a rootworm control strategy in fields of corn that follow corn are based on the number of beetles present in fields during the summer. If beetle numbers averaged 0.75 or more per plant during late July and August, or if lodging or "goosenecking" due to larval feeding were noted during that period, the use of a corn rootworm control tactic (soil insecticide, seed treatment, or Bt corn rootworm hybrid) is recommended if corn is planted again in the field the following year. Consult Extension publication *Corn Rootworms* (A3328)

at learningstore.uwex.edu for information about scouting cornfields for rootworm beetles and about predicting the need for rootworm control.

Rootworm control by crop rotation. Where cropping systems allow and where the variant western corn rootworm is not established, crop rotation is an excellent method of controlling corn rootworm. Larvae will perish soon after hatching if a crop other than corn is planted.

Late-planted corn fields are attractive to rootworm beetles. The corn's green silks and pollen can attract large numbers of beetles from surrounding, more mature fields and result in massive numbers of eggs being deposited in the soil. Since soil insecticides will not control all of the rootworm larvae, an unacceptable amount of root feeding could still occur in fields with heavy egg populations. In these cases, crop rotation is a better alternative when possible.

Resistance to insecticides is possible whenever a population of insects is subjected continually to selection pressure from one insecticide class. Because of this, we strongly encourage the use of crop rotation as a control alternative to insecticide use for corn rootworm control.

Two-year life cycle of the northern corn rootworm. Corn rootworm beetles lay eggs from late July to early September in corn field soil. These eggs will not hatch until the following spring. This is why crop rotation is an effective method of controlling corn rootworms; the larvae will starve if a crop besides corn is planted the following spring.

There are pockets of northern corn rootworms in some areas of the Corn Belt where a large portion of the eggs go through two winters before they hatch. Most of the documented cases of this two-year life cycle (or extended diapause) have occurred in areas of Minnesota, Illinois, and Iowa where they practice extensive annual corn and soybean rotation. Apparently, this annual crop rotation pattern has selected for northern corn rootworms with the extended diapause trait.

So far, we have documented only a few incidences of this extended northern corn rootworm life cycle in Wisconsin, and, based on this evidence, we believe that use of a rootworm insecticide on first-year corn is seldom justified under Wisconsin conditions.

The exception to this guideline for first-year corn is the presence of the variant western corn rootworm affecting corn after soybeans in some fields in southeast Wisconsin. Refer to the earlier section on corn after soybeans for important information (page 60).

Insecticidal control of rootworms. Although a soil insecticide will not kill all corn rootworms in a field, the level of control achieved normally is adequate to prevent economic damage. However, extremely high larval populations, heavy rains, improper calibration and/or incorporation, and other factors can result in poor control.

Following are suggestions for using rootworm insecticides.

- **At planting:** Apply a granular or liquid insecticide labeled for rootworm control as an in-furrow or banded application at the labeled rate (table 2-8). Refer to product label for instructions.
- **At cultivation:** Counter 15G, Force 3G, or Lorsban 15G granules can be applied at the base of stalks with a cultivator applicator at labeled rates and covered lightly with soil. Note that Counter 15G is limited to 8.7 lb/a of product per year. Be aware of the herbicide-use restrictions associated with Counter. For applications made at cultivation, Counter 15G may be applied 7 days AFTER application of ALS-inhibiting herbicides. Chlorpyrifos (e.g., Lorsban Advanced) is also labeled for application at cultivation. Apply the treatment to each side of the row immediately ahead of the cultivator shovels. Refer to the label for complete details and product restrictions. Use extreme caution when using liquid formulations.

  Treatments are most effective when applied close to peak egg hatch, usually between May 25 and June 15. Such applications should be done no later than mid-June; it is suggested only as a rescue treatment because dry weather following application can limit insecticide activation and result in marginal control. Therefore, planting time treatments are preferred.
- **Control of rootworm beetles to prevent egg laying:** Properly timed insecticide applications may reduce beetle populations enough to eliminate the need for

soil insecticides the following year to protect corn roots. Success using this program requires frequent and careful scouting. Scouts must be able to differentiate between the two beetle species (western and northern), determine the sex of the beetles, and tell when the females contain eggs (are gravid).

Treatments include Penncap-M (methyl parathion) and Sevin (carbaryl). These insecticides are hazardous to honeybees. Do not apply or allow product to drift onto blooming crops and/or blooming weeds if bees are foraging the area to be treated. Notify local beekeepers when using such programs.

Single application treatments for beetle control are not always sufficient due to beetle migration and weather conditions. Aerial application is standard in an adult beetle control program.

Corn rootworm beetle resistance has developed to methyl parathion and carbaryl in some areas of the Corn Belt where there has been a history of adult rootworm control.

Slam and Compel are also available for adult rootworm control. Slam contains Sevin (carbaryl) and cucurbitacin, a rootworm feeding stimulant. Compel contains cucurbitacin and a sticking agent; it is combined with a small amount of insecticide, usually carbaryl, just before application. The strategy behind these "bait" compounds is that beetles will feed heavily once they encounter the cucurbitacin, allowing use of very low rates of carbaryl. Although Slam and Compel have been shown to reduce beetle populations, they have provided inconsistent protection of corn roots from feeding by larvae the following year.

- **Alternating the use of insecticide active ingredients:** Avoid using the same insecticide for several consecutive years. Continuous use of the same class of material, uninterrupted by crop rotation or periodic rotation of insecticide class, can lead to development of insect resistance and loss of product efficacy.

Table 2-8. Soil insecticides labeled for rootworm control at planting

Insecticide	Class	oz of product/ 1,000 ft of row	40" rows	38" rows	36" rows	30" rows
Granular formulations		**lb/a of product**				
Aztec 2.1G	organophosphate + synthetic pyrethroid	6.7	5.5	5.8	6.1	7.3
Aztec 4.67G[a]	organophosphate + synthetic pyrethroid	3.0	2.5	2.6	2.7	3.3
Counter 15G[b]	organophosphate	8	6.5	6.9	7.3	8.7
Force 3G	synthetic pyrethroid	4	3.3	3.4	3.6	4.4
Fortress 5G[a]	organophosphate	3.0–4.5	2.5–3.7	2.6–3.9	2.8–4.1	3.3–4.9
Lorsban 15G	organophosphate	8	6.5	6.9	7.3	8.7
Smart Choice 5G	organophosphate + synthetic pyrethroid	4.5–5.0	3.7–4.1	3.9–4.3	4.1–4.5	4.9–5.4
Liquid formulations		**fl oz/a of product**				
Brigade 2EC	synthetic pyrethroid	0.30	3.9	4.1	4.4	5.1
Capture LFR	synthetic pyrethroid	0.49	6.4	6.8	7.1	8.5
Force CS	synthetic pyrethroid	0.46–0.57	6.0–7.5	6.3–7.9	6.7–8.3	8.0–10.0

[a] Aztec 4.67G and Fortress 5G are for use in the SmartBox system only. Smart Choice 5G for use in SmartBox system or Lock 'n Load packaging.

[b] ALS inhibiting herbicides should not be used if Counter 15G has been applied to corn at the time of planting.

- If the material you used last year performed poorly, switch to another insecticide class this year or rotate to a crop other than corn if possible.
- Avoid using the same organophosphate or pyrethroid during several consecutive years.

Insecticidal seed treatment for rootworm control. Seed treatment with insecticides from the nicotinoid class of compounds are labeled for corn rootworm. These compounds are systemic, translocated within the plant as the seed germinates and the plant grows. This is a selective, early-season chemical control tactic as the active ingredient is applied directly to the seed and not the surrounding soil.

Cruiser Extreme 1250 (thiamethoxam) and Poncho 1250 (clothianidin) are labeled at 1.25 mg ai/kernel for corn rootworm. Corn seed is treated by commercial seed treaters in conjunction with seed dealers before it is bagged and sold. Check with your seed dealer to obtain corn seed treated at the rate labeled for corn rootworm (1.25 mg ai/kernel).

Bt corn for corn rootworm control. Transgenic Bt corn contains a gene from the soil bacterium *Bacillus thuringiensis* (Bt) enabling the plant to express Bt toxin active against rootworms. For details, see the section on transgenic Bt corn on page 70.

Cutworm

Although the glassy cutworm can cause serious damage, our most common cutworm pest in corn is the black cutworm. Young cutworms feed upon corn foliage; early detection of this injury allows time to treat before extensive cutting occurs. For this reason, monitor fields carefully as plants emerge. Check for signs of leaf feeding, cut, wilting, or missing plants. Leaf feeding is due to small cutworms (less than .5 inches long); cutworms start to cut plants when they reach the fourth instar.

It is difficult to set a threshold for treatment because several factors influence this decision (stage of plant growth, original plant population, growth stage of cutworms, soil moisture, etc.). The most important aspect of cutworm control is careful field scouting as soon as plants begin to emerge. Remember that there have been instances of cutworms cutting plants as fast as they emerge.

Carefully monitor wet fields, low wet areas within fields, late-planted fields, and fields with low-growing winter annual weeds, where cutworm problems tend to be most common. Marking off defined areas of a field makes it easier to evaluate the cutworm situation. Check these areas every 2 to 3 days for at least 2 to 3 weeks after corn begins to emerge. Keep records of plant stand, number of cut plants, and plants with leaf feeding. This helps evaluate whether populations are increasing or decreasing. If you find occasional cut plants, consider corrective measures. One cutworm is capable of cutting several plants, and the level of damage can increase dramatically from one day to the next. Consult table 2-9 for assistance in determining how long a cutworm will feed and continue to damage corn. For example, a fourth instar (stage) cutworm (larva) will feed for approximately 25 days and will cut off four plants if the plants are in the 1-leaf stage.

Body length is not always an accurate indicator of how "old" a cutworm is. The best technique is to measure the width of the insect's head capsule. Place the head capsule (head) of the cutworm between the shaded areas under the head capsule width column in table 2-9 and match it to one of the size categories available. This will help you determine the age of the cutworm and approximately how long it will continue to feed on corn.

Treatment is suggested when 5% of the plants have been cut. Broadcast spray insecticide when the suggested threshold is reached. Rescue treatments can be very effective if infestations are found soon enough. However, hot, dry weather can reduce the effectiveness of these treatments by causing the black cutworm to spend more time underground, thereby reducing

Table 2-9. Guide to black cutworm development and damage in corn

Larval instar (stage)	Head capsule width	Approximate days left to feed	Potential number of plants that may be cut		
			1-leaf	2-leaf	4-leaf
4	▮	25	4	3	1
5	▲	21	4	3	1
6	▬	14	4	3	1
7	▬	5	1	1	1

exposure to the insecticide. Incorporating Lorsban Advanced spray with shallow cultivation or a rotary hoe during such weather conditions may enhance activity. However, do not incorporate Ambush, Asana, Pounce, or Warrior, as this may reduce their cutworm activity.

If widespread cutworm damage necessitates replanting, you may need to use preemergence rescue treatments. Depending on cutworm size when corn is replanted, feeding injury could occur before, during, and after seedling emergence. In these situations, treating fields after planting but before seedling emergence may be advisable.

Soil insecticides such as Aztec 2.1G, Brigade 2EC, Force 3G and CS, Fortress, and Lorsban 15G are labeled for application at planting time for cutworm control. These products should be applied the same as for rootworm control (refer to table 2-8). Current research suggests that some of these products are relatively effective in controlling light to moderate infestations when applied at planting. However, data for heavy infestations are limited, and reports of unacceptable levels of damage from heavy infestations have occurred. Because of these factors and the difficulty of predicting cutworm outbreaks, the "preventive approach" to black cutworm control is not suggested. Field scouting and rescue treatment is more reliable (table 2-12).

European corn borer

The European corn borer has two generations per year in most of Wisconsin. Borers overwinter as 5th instar larvae in cornstalks, crib corn, and large-stemmed weeds. Moths emerge to begin warm-night egg laying on undersides of leaves about mid-June (in the extreme south of the state). Eggs hatch into very small, black-headed, whitish, smooth larvae (borers) that crawl into the whorl. Early planted corn is most apt to be infested. Late-planted corn usually avoids first-generation borers but is attractive to the second generation. "Early" borer leaf feeding shows as irregular pinhole damage in leaves growing out of the whorl. "Recent" leaf feeding can be found down in the whorl and is evidence of live borers. Once corn reaches 18 inches extended leaf height, examine 10 consecutive plants in 10 areas of the field for leaf feeding. Pull the whorl leaves from two infested plants in each area and unroll the leaves to look for corn borer larvae. Calculate the percentage of plants with recent leaf feeding ("plants infested") and the average number of European corn borer larvae per infested plant. Consult the Management worksheet for first-generation corn borer (see box) to determine whether treatment is necessary.

The best time to control first-generation corn borers is during a 5-day period of accumulated 800 to 1100 modified growing degree days (above 50° F average). In extreme southern Wisconsin this falls around July 1 to 4.

Second-generation European corn borer egg laying occurs over a long period of time, and infestations can go unnoticed until ears begin to drop and stalks begin to break in the fall. Due to the extended egg-laying period, one sampling of a field is not sufficient. Scout fields weekly looking for white egg masses on the undersides of leaves near the midrib. Most of the eggs will be laid on leaves near the ear and above. Use the Management worksheet for second-generation corn borers (see box) to determine whether treatment will be economically worthwhile. If possible, treat when tiny black dots are apparent on most of the egg masses. At this "black-head" stage, the eggs are almost ready to hatch.

Most borers are killed when corn is cut for silage or shredded for fodder if stubble is under 2 inches. Dry-stalk shredding may kill 80% of the borers. Plowing under crop stubble and shredding stalks in the fall to destroy overwintering larve will reduce corn borer populations. However, moldboard plowing is often unacceptable because of the potential for soil erosion.

Bt corn for European corn borer control. Transgenic Bt corn contains a gene from the soil bacterium *Bacillus thuringiensis* (Bt) enabling the plant to express Bt toxin active against European corn borers. For details, see the "Transgenic Bt Corn" section on page 70.

Management worksheet for FIRST-GENERATION European corn borer

_____ % of 100 plants infested x _____ ave. # borers/infested plant[a] = _____ borers/plant

_____ borers/plant x 5% yield loss/borer = _____ % yield loss

_____ % yield loss x _____ expected yield (bu/a) = _____ bu/a loss

_____ bu/a loss x $_____ price/bu = $_____ loss/a

$_____ loss/a x _____ % control[b] = $_____ preventable loss/a

$_____ preventable loss/a – $_____ cost of control/a

= $_____ gain (+) or loss (–) per acre if treatment is applied

[a] Determined by checking whorls from 10 plants.
[b] Assume 80% control for most products; assume 50% control for Asana and Lorsban sprays.

Management worksheet for SECOND-GENERATION European corn borer

_____ number of egg masses/plant[a] x 2 borers/egg mass[b] = _____ borers/plant

_____ borers/plant x 4% loss/borer[c] = _____ % yield loss

_____ % yield loss x _____ expected yield = _____ bu/a loss

_____ bu/a loss x $_____ price/bu = $_____ loss/a

$_____ loss/a x 75% control = $_____ preventable loss/a

$_____ preventable loss/a – $_____ cost of control/a

= $_____ gain (+) or loss (–) per acre if treatment is applied

[a] Use cumulative counts, taken 7 days apart.
[b] Assumes a survival rate of two borers/egg mass.
[c] Use 3% loss/borer if infestation occurs after silks are brown. The potential economic benefits of treatment decline rapidly if infestations occur after corn reaches the blister stage.

Japanese beetle

Japanese beetle adults are about 0.6 inches long and 0.4 inches wide, with metallic copper colored wing covers and a green thorax and head. Adults emerge in late June, feed on a wide range of host plants, and can move to field and sweet corn. The most significant damage comes when Japanese beetles feed on corn silks during pollination.

During July and August, adults move to grass and turf to lay eggs. They can also lay eggs in soybean fields and, to a lesser extent, cornfields. Eggs hatch into small white grubs that feed on grass roots until fall temperatures cool. Third instar grubs move down in the soil profile and are inactive during winter. In early spring, grubs feed, pupate, and then emerge from the soil as adult beetles in late June.

Consider a foliar insecticide treatment during tasseling and silking if there are three or more beetles per ear, silks have been clipped to less than 0.5 inch, and pollination is less than 50% complete.

Obtain a representative field sample to determine whether field border treatment is sufficient or whole field treatment is necessary. Adults are highly mobile during July and August. Beetles present in the field when treated with a foliar insecticide will be killed, but beetles moving into treated fields after application can result in reinfestation. As one of several species of white grubs, Japanese beetle larvae are an occasional pest of corn roots in corn following sod, set-aside, some cover crops, or soybean.

Slugs

Slugs have soft slimy bodies and range in color from light gray to dark brown. They skeletonize leaf tissue with their rasp-like mouths. Cool, damp weather and high crop residue cover can lead to severe outbreaks. Commercially prepared baits containing metaldehyde are fairly effective against moderately heavy infestations. However, prolonged favorable weather conditions will lead to a resurgence of slug populations.

Stalk borer

Stalk borer moths predominately lay their eggs on grass weeds during late summer and fall. In addition, giant ragweed is one of the few broadleaf plants to serve as a preferred egg-laying host. Larvae will hatch from these hosts in the spring and move quickly to corn. The first indication of damage is a series of small pinhole feeding sites running across the leaves of V1 corn. As the larvae grow, the feeding holes will increase in size, and the larvae will tunnel into the plant. This stem boring can be seen in the wilting of the central leaves of the seedling. When this type of injury is widespread it is too late to apply an insecticide. Stalk borers tunnel only in the aboveground portions of the stem, whereas cutworms, hop vine borer, and potato stem borer feed in the underground portion of the stem.

Damage will often be heavy in the four to eight rows that are near fencerows, grass terraces, and waterways. In these cases the larvae are migrating from adjacent vegetation. Patches of injury throughout the field indicate significant levels of host weeds that escaped the weed control program for the previous year. The best insect management tactic is to modify your weed control program using a different herbicide, crop rotation, or increased mechanical cultivation.

Small corn is most susceptible to injury; once plants reach the V7 stage it is unlikely that they will be killed by stalk borers. Research suggests scouting border rows when 1300 to 1400 degree days have occurred. Iowa State University studies indicate that 10% of the larvae will have moved into corn from adjacent bromegrass, quackgrass, ragweed, and other host weeds when 1400 degree days have accumulated, and 50% will have migrated by 1700 degree days. Larvae will start to move when they have outgrown the grass stems in which they have been feeding. However, damage from larvae originating within the field (from last year's weed patches) will start earlier because corn is the only food source. Growers should map these spots during fall harvest and check them the following year, starting at about 900 to 1000 degree days. Treatment thresholds for stalk borer can be found in table 2-10.

Table 2-10. Economic thresholds for stalk borer at three corn prices[a]

	Corn prices ($/bu)		
Leaf stage	**$2.00**	**$3.00**	**$4.00**
	% infested corn		
1	10	7	5
2	12	8	6
3	15	10	7
4	16	11	8
5	17	12	9
6	34	23	17
7	100	100	100

[a] Based on $13.00/acre control costs and 80% control with insecticides.

Source: Iowa State University

Two-spotted spider mite

Spider mites are relatives of insects and are so small that 10X or greater magnification is required for them to be seen distinctly. They damage plants by piercing the cells and sucking sap. Small chlorotic lesions on the leaf surface are the first indications of damage. As mite populations build and damage progresses, the webbing produced by the mites will become apparent, and leaves may die. Plant death is possible if populations are heavy.

Mites are not a problem in Wisconsin unless dry weather persists. Infestations normally start at field edges where mites have migrated from adjacent weeds, alfalfa, or other vegetation. Control is suggested if you find active mite colonies on one-third of the leaves on 50% of the plants or if 15 to 20% of the leaf area is covered with mites or their damage.

Insecticides applied for mite control will not kill eggs, and growers will have to sample the field 4 to 5 days after the initial spray and look for mite adults and nymphs. A second application may be necessary.

Mites are usually on the undersides of plant leaves, making treatment difficult. By air, apply no less than 4 to 5 gallons of finished spray per acre. During periods of extreme heat, try to make applications late in the day to reduce the amount of insecticide lost by volatilization.

Western bean cutworm

Western bean cutworm (WBCW) larvae feed on ears, damaging and consuming kernels. Secondary pathogens and mold are frequently associated with larval feeding in ears. Unlike corn borers, they do not tunnel into stalks. Economic damage potential to corn in Wisconsin has increased since 2005, when WBCW was first detected in the state.

Adult WBCW are brown colored moths .75-inch long with an extended wingspan of 1.5 inches. There are three distinctive markings on each forewing: a white wing bar along the front leading edge, one circular spot approximately in the center, and another boomerang-shaped spot toward the tip of the forewing.

Moths lay white egg masses on the upper surface of corn leaves. These egg masses contain 20 to 200 tightly clustered eggs. As they develop, the eggs change color from creamy white to tan. They remain tan for 2 to 5 days, then turn a deep purple 12 to 24 hours before the larvae emerge.

First instar larvae are dull orange with a black head. Full-grown larvae are 1.5 inches long and tan in color, with two broad brown stripes on the pronotum, or "neck" area behind the head. This insect can be distinguished from the corn earworm by the dark stripes behind the head and the absence of dark spines, tubercles (warts), or stripes on the side of the body.

WBCW has one generation per year and overwinters as a full-grown larva in the ground inside a soil chamber. Spring development begins when temperatures exceed 50 F. Larvae pupate in the soil in May, and moths begin to emerge in late June or early July, depending upon degree day (DD) heat unit accumulation, which varies slightly by area of the state. Half of the season's WBCW moth population will have emerged at 1422 DD, known as the peak flight period.

The female moth is most attracted to corn just before tasseling and lays eggs on the upper leaf surface of the topmost leaf on the plant and on leaves in the ear zone above and below the developing ear. If the tassel has not yet emerged when eggs hatch, larvae crawl into the whorl and feed on pollen. As the tassel emerges, larvae switch to feeding on green silks and enter the developing ear through silk channels or chew directly through the husk to feed anywhere on the ear. Multiple larvae may be found feeding on one ear.

Pheromone traps or degree days can be used to monitor adult emergence, egg-laying, and larval hatch in the field. For details, consult midsummer issues of the UW-Extension Wisconsin Crop Manager newsletter (ipcm.wisc.edu/wcm) and the WDATCP *Wisconsin Pest Bulletin* (pestbulletin.wi.gov).

Once WBCW degree-day accumulations indicate 25% moth emergence or when the first moths are detected in a pheromone trap in your area, examine 20 consecutive corn plants at five locations in the field to obtain a representative field sample. Check the upper three to four leaves of each plant and leaves above and below the ear zone for eggs and small larvae. Scout fields that are tasseling first. When scouting post-whorl corn, also look for small larvae on leave axils, at the intersection of the leaf and stalk, and on silks and husks.

Foliar insecticides effectively suppress larval populations, but only if applied before larvae enter the ear to feed. Once larvae have tunneled into the ear, they're protected from foliar insecticides.

For field corn, insecticide treatment should be considered when 5% of the 100 plants sampled have egg masses and/or small larvae; for processing sweet corn the threshold is lowered to 4% infestation.

Application timing is critical. In fields that have reached or exceeded economic threshold, if eggs have hatched, the insecticide should be applied after 95% tassel emergence, but before larvae enter the silks. If egg hatch has not yet occurred and plants have tasseled, time insecticide application as close to expected egg hatch as possible, when egg masses have reached the dark purple color stage.

Transgenic corn is another option for managing WBCW in field corn. For details, see the "Transgenic Bt Corn" section.

BT SPRAYS AND TRANSGENIC BT CORN FOR INSECT CONTROL

Bacillus thuringiensis (Bt)

The soil bacterium *Bacillus thuringiensis* (Bt) occurs naturally worldwide. Spores produced by the bacterium contain a protein which, when ingested by a susceptible insect, ruptures the insect's midgut membrane, preventing further feeding and killing the insect. There are many different strains of the Bt bacterium, each with specificity toward different groups of insects.

Bt has been commercially available as a microbial foliar insecticide for Lepidoptera (caterpillar) larvae such as European corn borer for decades. Bt spray formulations are applied to leaves and other areas where the insect larvae feed. Bt sprays have a relatively short residual in the field, thus a well-timed single application or, more typically, multiple applications based on pest insect scouting and target pest life stage are necessary to maintain control.

Microbial Bt sprays DiPel, Biobit, and Javelin are listed by the Organic Materials Review Institute (OMRI) for use in USDA-certified organic production. Refer to product labels for Lepidoptera species controlled. Bt sprays are safe for beneficial insects such as parasitic wasps that attack European corn borer eggs and predators such as lady beetles that feed on other pest insect eggs, immatures, and/or adults.

Transgenic Bt corn

Transgenic Bt corn hybrids are genetically modified organisms (GMOs) in which corn has had a gene inserted from an unrelated organism, in this case Bt. The introduced gene produces a Bt protein toxin with insecticidal activity against a particular target insect group. Plants with this trait are commonly referred to as Bt crops.

Unlike Bt microbial spray formulations, which have a field residual measured in days, the Bt toxin in transgenic Bt corn is active for the life of the plant. This leads to more consistent and economic insect control in years when target insect populations reach economic threshold levels.

However, there is a significant risk that with constant exposure of the target insect population to Bt toxins, resistant populations may develop. To help protect against this, the EPA has mandated limits to the percentage of Bt corn that can be grown on each farm and requires an insect resistance management (IRM) plan. The purpose of IRM is to maintain the effectiveness of Bt crops as an insect pest management tool by preventing or delaying development of insect resistance to Bt traits. The IRM plan is implemented by planting refuge corn acres on each farm where a Bt corn hybrid is planted. Refuge corn acres do not contain the Bt insect trait or traits used in the Bt planting.

Depending on Bt corn hybrid, the refuge must be planted to specific percentage of corn acreage on each farm, and there are field configuration and distance requirements to adhere to in placing IRM refuge corn acres within and among fields (see the "Bt Corn Insect Traits and Refuge Requirements" section).

The aim of IRM is to maintain Bt susceptible insect populations by way of the refuge. A refuge provides a corn crop habitat that allows target pest insects to feed, mate, and reproduce without being exposed to the Bt trait. Without a refuge, target insect populations that are exposed to Bt corn each growing season over multiple generations will eventually become resistant to Bt. Mating between Bt-susceptible insects from the refuge and potential resistant insects ensures that susceptibility to the Bt toxin is passed on to the next generation. These Bt-susceptible insects from the refuge decrease the odds that a resistant insect can emerge from a Bt corn field.

Bt corn insect traits and refuge requirements

For growers who incorporate Bt corn trait technology into their insect pest management strategy, Bt insect trait decisions are made during the hybrid selection process. Moreover, all Bt corn hybrids are sold with a low rate neonicotinoid insecticide seed treatment for protection against early season soil insect pests. Seed traits and seed treatment are input costs committed to before planting. This requires a good understanding of these inputs to make sure they are a necessary, effective, and economical fit for insect pest populations and history on a given farm and crop rotation.

This section and table 2-11 provide an overview of the increasing array of Bt corn hybrids available. Some of the single-trait corn borer Bt hybrids have been available for over a decade, while stacked-trait, pyramided-trait, and seed blend "refuge-in-the-bag" Bt trait corn hybrids have been registered more recently by EPA for commercial use.

Single Bt trait hybrids

*Single Bt trait hybrids control **either** caterpillar pests above ground or corn rootworm larvae below ground, but not both.*

European corn borer. Corn with this type of single Bt trait produces the Cry1Ab Bt insecticidal protein effective against larvae (caterpillar stages) of European corn borer (ECB), southwestern corn borer, and sugarcane borer. In Wisconsin and the North Central Region, they are commonly referred to as Bt corn borer hybrids because ECB is the primary target pest in the region. Corn earworm, fall armyworm, and stalk borer are suppressed, but not controlled, by these single-trait Bt hybrids. Suppression implies that feeding damage and yield impact may reach economic injury level under heavy pest pressure.

- **Products:** Agrisure CB/LL, Agrisure GT/CB/LL, YieldGard Corn Borer
- **Bt protein:** Cry1Ab
- **Refuge required:** 20% (with a corn hybrid that does not contain Bt technology for control of corn borers)
- **Refuge structure:** within .5 mile, block, in-field strips at least 4 rows wide, in-field perimeter

European corn borer and western bean cutworm. Another single Bt trait hybrid corn produces the Cry1F insecticidal Bt protein effective against larvae of European corn borer, southwestern corn borer, and sugarcane borer. In addition, the Cry1F single trait controls western bean cutworm. Black cutworm and fall armyworm are also listed as pests controlled by Cry1F, and corn earworm is suppressed.

- **Products:** Herculex I
- **Bt protein:** Cry1F
- **Refuge required:** 20% (with a corn hybrid that does not contain Bt technology for control of corn borers)
- **Refuge structure:** within .5 mile, block, in-field strips at least 4 rows wide, in-field perimeter

Corn rootworm. This type of single Bt trait corn produces one insecticidal Bt protein, either Cry 3Bb1, Cry34/35Ab1 or mCry3A, effective against western and northern corn rootworm (CRW) larvae. Protection does not extend to adult control later in the season, so you can find CRW beetles feeding on silks in a Bt CRW cornfield. These beetles may come from other fields. Additionally, some adult beetles are produced from surviving larvae in the Bt CRW cornfield. Compared to Bt proteins for European corn borer, Bt CRW proteins are expressed at a lower dose in the corn plant.

- **Products:** Agrisure GT/RW, Agrisure RW, Herculex RW, YieldGard RW, YieldGard VTRW
- **Bt protein:** mCry3A (Agrisure GT/RW, Agrisure RW); Cry34/35Ab1 (Herculex RW); Cry3Bb1 (YieldGard RW, YieldGard VTRW)
- **Refuge required:** 20% (with a corn hybrid that does not contain Bt technology for control of corn rootworms)
- **Refuge structure:** within field or directly adjacent, block, in-field strips at least 4 rows wide, in-field perimeter

Stacked Bt trait hybrids

*"Stacked" Bt trait hybrids combine a **single** trait to control caterpillar pests above ground with a single trait to control corn rootworm below ground.*

Caterpillar pests and corn rootworms. A "stacked" Bt trait hybrid contains a single Bt corn rootworm trait and a single Bt corn borer or corn borer/western bean cutworm trait. These traits offer the same spectrum of pest control or suppression as their single trait options explained above, but are combined in one plant. A common refuge must satisfy the 20% refuge requirement for both pest groups: corn borers and corn rootworms. This means growers need to go with the more conservative structure and cannot place the refuge up to .5 mile from the Bt corn field. The refuge must be positioned to best suit corn rootworm.

- **Products:** Agrisure 3000GT, Agrisure CB/LL/RW, Herculex XTRA, YieldGard Plus, YieldGard Plus RR2, YieldGard VT Triple
- **Bt proteins:** Cry1Ab + mCry3A (Agrisure 3000GT, Agrisure CB/LL/RW); Cry1F + Cry34/35Ab1 (Herculex XTRA); Cry1Ab + Cry3Bb1 (YieldGard Plus, YieldGard Plus RR2, YieldGard VT Triple)
- **Refuge required:** 20% (common refuge with a corn hybrid that does not contain Bt trait; separate refuge for each pest group can also be planted. Follow seed dealer instructions)
- **Refuge structure:** within field or directly adjacent, block, in-field strips at least 4 rows wide, in-field perimeter

Pyramided Bt trait hybrids

Pyramided Bt trait hybrids contain multiple Bt traits targeting the same pest complex.

Caterpillar pests and corn rootworms. Agrisure Viptera, Genuity, Genuity SmartStax, Optimum Intrasect, and SmartStax corn hybrids utilize the "pyramid" strategy of a transgenic corn crop, producing multiple Bt toxins targeting the same pests.

Agrisure Viptera 3111 targets caterpillar pests with both Cry1Ab and Vip3A traits, plus corn rootworms with the mCry3A single trait. A 20% adjacent refuge is required based on the single Bt CRW trait.

Genuity Vt Triple Pro targets caterpillar pests with both Cry1A.105 and Cry2Ab2 traits as well as corn rootworms with the Cry3Bb1 single trait. A 20% adjacent refuge is required.

Agrisure Viptera 3110, Agrisure Viptera 3220, Genuity VT Double Pro, and Optimum Intrasect combine two or more above ground traits targeting caterpillar pests, with no belowground corn rootworm activity. **Agrisure Viptera 3110**, with Cry1Ab and Vip3A traits, requires a 20% refuge within 0.5 mile. **Genuity VT Double Pro** (Cry1A.105 and Cry2Ab2), **Agrisure Viptera 3220** (Cry1Ab, Cry1F and Vip3A), and **Optimum Intrasect** (Cry1F and Cry1Ab) all require a 5% refuge within 0.5 mile.

For **Genuity SmartStax** and **SmartStax** corn hybrids, Cry3Bb1 and Cry34/35Ab1 target corn rootworms belowground, while Cry1A.105, Cry2Ab2 and Cry1F target the caterpillar pest complex aboveground. A 5% adjacent refuge is required.

For **Agrisure 3122 Refuge Renew** corn hybrids, mCry3A and Cry34/35Ab1 control corn rootworms belowground, while Cry1Ab and Cry1F target the caterpillar pest complex aboveground. A 5% adjacent refuge is required.

EPA approval of pyramided Bt corn hybrids (two or more aboveground Cry Bt protein traits with no belowground trait; two or more aboveground plus two or more belowground traits) enables growers in the Midwest to reduce structured refuge size from 20 to 5%. According to EPA, multiple modes of action for corn rootworms and multiple modes of action for the caterpillar pest complex are a factor in reduced structured refuge size and long-term durability of Bt corn insect trait technology. This "pyramid" strategy is based in part on the assumption that selection for insect resistance to one toxin does not lead to cross-resistance to the other toxin(s) targeting the same pests.

- **Products:** Agrisure Viptera 3110, Agrisure Viptera 3111, Agrisure Viptera 3220, Genuity VT Double Pro (VT2P), Genuity VT Triple Pro (VT3P), Genuity SmartStax (GENSS), Optimum Intrasect, and SmartStax.
- **Bt proteins:** See table 2-11

- **Refuge required:** See table 2-11
- **Refuge structure:** See table 2-11

Seed blend Bt trait hybrids

Refuge-In-the-Bag products. Current seed blend refuge products include Genuity SmartStax RIB Complete, Optimum AcreMax, Optimum AcreMax1 (AM1), Optimum AcreMax Rootworm (RW), Optimum AcreMax Xtra, and REFUGE ADVANCED (Powered by SmartStax).

Genuity SmartStax RIB Complete and **REFUGE ADVANCED (Powered by SmartStax)** both contain Cry1A.105, Cry2Ab2, and Cry1F for aboveground caterpillar pests as well as Cry3Bb1 and Cry34/35Ab1 for belowground corn rootworms. These two products offer a 5% refuge in the bag. REFUGE ADVANCED (Powered by SmartStax) will also continue to offer a 5% structured refuge (5% refuge within or adjacent to the field).

Optimum AcreMax corn is an integrated seed blend product for aboveground corn insect control (caterpillars). 95% of seed in the bag is a pyramid of Herculex 1 (Cry1F) and YieldGard Corn Borer (Cry1Ab), and 5% is non-Bt seed that serves as the refuge.

Optimum AcreMax1 corn is sold as a seed blend of 90% Herculex XTRA and 10% of a hybrid from the same genetic family with Herculex I trait (Cry1F), which serves as the corn rootworm refuge. Herculex XTRA is a stacked trait corn combining corn borer/western bean cutworm protection aboveground (Cry1F) with corn rootworm protection belowground (Cry34/35Ab1). The 10% Herculex I seed blended in the bag does not contain a Bt corn rootworm trait; thus it can serve as the corn rootworm refuge. According to EPA, the seed blend spatial arrangement in the field is one factor in allowing refuge in the bag at a reduced percentage (10%) for corn rootworm. However, the 20% corn borer refuge requirement still needs to be met and placed within 0.5 mile of the Optimum AcreMax1 Bt cornfield.

Optimum AcreMax RW is an integrated seed blend product for belowground corn rootworm insect control; 90% of seed in the bag contains the Herculex RW trait (Cry34/35Ab1), and 10% is non-Bt seed that serves as the corn rootworm refuge.

Optimum AcreMax Xtra corn is an integrated seed blend product for above- and belowground insect control; 90% of seed in the bag is a pyramid of Herculex XTRA and YieldGard Corn Borer, and 10% is non-Bt refuge seed.

- **Products:** Genuity SmartStax RIB Complete, Optimum AcreMax, Optimum AcreMax1, Optimum AcreMax RW, Optimum AcreMax Xtra, and REFUGE ADVANCED (Powered by SmartStax).
- **Bt proteins:** See table 2-11
- **Refuge required:** See table 2-11
- **Refuge structure:** See table 2-11

Summary

Refuge hybrids should have a relative maturity that is compatible with the Bt corn. Plant the refuge at the same time as the Bt corn and plant it in an area with the same crop rotation history. The non-Bt rootworm refuge may be treated with soil applied or seed-applied insecticides labeled for corn rootworm at planting. The non-Bt corn borer refuge may be treated with conventional foliar insecticides (but not Bt insecticide) only if target pest pressure reaches economic thresholds. It will not be practical to spray the non-Bt corn in a strip configuration within a field.

Crop rotation sequence, insect field scouting records, state pest survey data, and historical insect problems on your farm will help guide your decision when selecting corn hybrids with Bt traits.

When selecting corn hybrids, keep in mind that Bt insect protection is only one of many factors that should go into the decision. Evaluate the cost of added protection with Bt traits and decide if the cost is justified for your situation. Just because you can buy a trait doesn't mean you need that trait. Data from the University of Wisconsin Department of Agronomy corn hybrid yield trials can help you choose the best hybrid for your location. This information is updated annually and is available through your county Extension office or at corn.agronomy.wisc.edu.

Table 2-11. Master list of Bt traits with target pests and refuge requirements for Midwest corn
(By Chris DiFonzo, Michigan State University, and Eileen Cullen, University of Wisconsin–Madison)

Trait group/Name	Bt proteins	Insects controlled (bold) or suppressed (italics)		Herbicide tolerance	Refuge %, location in the Midwest
		aboveground	in soil		
Agrisure products					
Agrisure CB/LL	Cry1Ab	**ECB** *CEW, FAW, SB*	—	LL	20%, .5 mile
Agrisure GT/CB/LL	Cry1Ab	**ECB** *CEW, FAW, SB*	—	GT, LL	20%, .5 mile
Agrisure RW	mCry3A	—	**CRW**	—	20%, adjacent
Agrisure GT/RW	mCry3A	—	**CRW**	GT	20%, adjacent
Agrisure CB/LL/RW	Cry1Ab mCry3A	**ECB** *CEW, FAW, SB*	**CRW**	LL	20%, adjacent
Agrisure 3000GT	Cry1Ab mCry3A	**ECB** *CEW, FAW, SB*	**CRW**	GT, LL	20%, adjacent
Agrisure Viptera 3110	Cry1Ab Vip3A	**BCW, CEW, ECB, FAW, SB, WBC**	—	GT, LL	20%, .5 mile
Agrisure Viptera 3111	Cry1Ab mCry3A Vip3A	**BCW, CEW, ECB, FAW, SB, WBC**	**CRW**	GT, LL	20%, adjacent
Agrisure 3122 E-Z Refuge	Cry1Ab Cry1F mCry3A Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	GT	5% **in the bag**
Agrisure Viptera 3220 E-Z Refuge	Cry1Ab Cry1F Vip3A	**BCW, CEW, ECB, FAW, SB, WBC**	—	GT	5% **in the bag**
Agrisure Artesian 4011	Cry1Ab mCry3A	**ECB** *CEW, FAW, SB*	**CRW**	GT, LL	20%, adjacent
Herculex products					
Herculex I (HX1)	Cry1F	**BCW, ECB, FAW, WBC** *CEW, SB*	—	LL RR2 (some)	20%, .5 mile
Herculex RW (HXRW)	Cry34/35Ab1	—	**CRW**	LL RR2 (some)	20%, adjacent
Herculex XTRA (HXX)	Cry 1F Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	LL RR2 (some)	20%, adjacent
Optimum products					
Optimum AcreMax	Cry1F Cry1Ab	**BCW, ECB, FAW, WBC** *CEW, SB*	—	RR2	5% **in the bag**
Optimum AcreMax 1 (AM1)	Cry1F Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	LL RR2	10% **in the bag** (CRW) & 20%, .5 mile (ECB)
Optimum AcreMax RW	Cry34/35Ab1	—	**CRW**	RR2	10% **in the bag**
Optimum AcreMax Xtra	Cry1F Cry1Ab Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	RR2	10% **in the bag**

(continued)

Table 2-11. Master list of Bt traits with target pests and refuge requirements for Midwest corn *(continued)*

Trait group/Name	Bt proteins	Insects controlled (bold) or suppressed (italics)		Herbicide tolerance	Refuge %, location in the Midwest
		aboveground	in soil		
Optimum AcreMax Xtreme	Cry1F Cry1Ab mCry3A Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	RR2	5% **in the bag**
Optimum Intrasect	Cry1F Cry1Ab	**BCW, ECB, FAW, WBC** *CEW, SB*	—	LL RR2	5%, .5 mile
Optimum Intrasect Xtra	Cry1F Cry1Ab Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	LL RR2	20%, adjacent
Optimum Intrasect Xtreme	Cry1F Cry1Ab mCry3A Cry34/35Ab1	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	LL RR2	5%, adjacent
Optimum Trisect	Cry1F mCry3A	**BCW, ECB, FAW, WBC** *CEW, SB*	**CRW**	LL RR2	20%, adjacent
YieldGard products					
YGCB	Cry1Ab	**ECB** *CEW, FAW, SB*	—	RR2 (some)	20%, .5 mile
YGRW	Cry3Bb1	—	**CRW**	RR2 (some)	20%, adjacent
YieldGard Plus	Cry1Ab Cry3Bb1	**ECB** *CEW, FAW, SB*	**CRW**	RR2 (some)	20%, adjacent
YieldGard VTRW	Cry3Bb1	—	**CRW**	RR2	20%, adjacent
YieldGard VT Triple	Cry1Ab Cry3Bb1	**ECB** *CEW, FAW, SB*	**CRW**	RR2	20%, adjacent
Genuity/SmartStax products					
Genuity VT Double Pro (VT2P)	Cry1A.105 Cry2Ab2	**CEW, ECB, FAW**	—	RR2	5%, .5 mile
Genuity VT Triple Pro (VT3P)	Cry1A.105 Cry2Ab2 Cry3Bb1	**CEW, ECB, FAW**	**CRW**	RR2	20%, adjacent
SmartStax (Dow) or Genuity SmartStax (Monsanto)	Cry1A.105 Cry2Ab2 Cry1F Cry3Bb1 Cry34/35Ab1	**BCW, CEW, ECB, FAW, WBC** *SB*	**CRW**	LL RR2	5%, adjacent
Genuity SmartStax RIB Complete (Monsanto)	Same as Genuity SmartStax	Same as Genuity SmartStax	Same as Genuity SmartStax	LL RR2	5% **in the bag**
Genuity VT Double PRO Complete	Cry1A.105 Cry2Ab2	**CEW, ECB, FAW**	—	RR2	5% **in the bag**
REFUGE ADVANCED Powered by SmartStax (Dow)	Same as Genuity SmartStax	Same as Genuity SmartStax	Same as Genuity SmartStax	LL RR2	5% **in the bag**

Abbreviations: Insects: BCW = black cutworm; CEW = corn earworm; CRW = corn rootworm;
ECB = European corn borer; FAW = fall armyworm; SB = stalk borer; WBC = western bean cutworm.
Herbicide traits: GT = gylphosate tolerant; LL = Liberty Link/glufosinate tolerant; RR2 = Roundup Ready/glyphosate tolerant.

Table 2-12. Insecticide suggestions for corn pests[a]

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Armyworm	**Note:** Treatment is suggested if worms are .75 inch long or less and two or more worms per plant can be found on 25% of the stand; or if one worm per plant can be found on 75% of the stand.			
	Ambush 2E	6.4–12.8 oz	broadcast	Do not apply within 30 days of harvest.
	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Baythroid XL	1.6–2.8 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Belt	2.0–3.0 oz	broadcast	Do not apply more than 3 oz per 3-day interval; no more than 12 oz or 4 times per season.
	Besiege	6.0–9.0 oz	broadcast	Use higher rates within the listed range for large larvae. Do not exceed 31.0 fl oz. of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at-plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	11.0–26.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Declare	1.02–1.54 oz	broadcast	Use higher rates for large larvae. Do not apply within 21 days of harvest. Do not exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19 pt)/a after silk initiation; or 0/015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.5–1.9 oz	broadcast	Do not apply within 21 days of harvest of field corn for grain or fodder, or within 12 days of cutting or grazing field corn for forage or exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	4.0–10.3 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage or exceed 0.4 lb ai/a per season.
	Lorsban Advanced	1.0–2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	3.2–4.0 oz	broadcast	Do not exceed 0.1 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days for forage.
	Penncap-M	2.0–3.0 pt	broadcast	Do not apply within 12 days of harvesting, cutting, or grazing. Do not apply during pollen shed if bees are foraging in the areas to be treated.
	Pounce 3.2EC	4.0–8.0 oz	broadcast	Do not apply within 30 days of harvest for grain or fodder. Do not exceed 0.6 lb ai/a per season.
	Sevin XLR Plus	1.0–2.0 qt	broadcast	Do not apply within 48 days of harvest of grain or fodder or 14 days of harvest or grazing of forage or silage.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Armyworm *(continued)*	Stallion	9.25–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.
	Tracer	2.0–3.0 oz	broadcast	Do not apply more than 6 fl oz (0.188 lb spinosad)/a per year. Do not apply within 28 days of grain or fodder harvest or within 7 days of harvest for forage.
	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	1.28–1.92 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage. Use high rates of Warrior for larger larvae.
Billbug	Avicta Complete Corn	—	seed treatment	Purchase treated seed from seed dealer or seed treatment representative (1.25 mg thiamethoxam ai per kernel).
	Cobalt Advanced	32.0–42.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Counter 15G	8.0 oz/ 1,000 ft row	7-inch band or in furrow	Do not exceed 8.7 lb/a per year. When applied in band, incorporate evenly into top inch of soil.
	Cruiser Extreme 1250		seed treatment	Purchase treated seed from seed dealer or seed treatment representative (1.25 mg ai per kernel).
	Force CS	0.46–0.57 fl oz/ 1,000 ft row	7-inch T-band	Suppression only.
	Lorsban Advanced	2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Poncho 1250	—	seed treatment	Reduces early season feeding damage. Purchase treated seed from seed dealer or seed treatment representative (1.25 mg ai per kernel).
Corn earworm	**Note:** Control occasionally required in hybrid seed production fields. Treat before brown silk stage.			
	Ambush 2E	6.4–12.8 oz	broadcast	Do not apply within 30 days of harvest.
	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Baythroid XL	1.6–2.8 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Belt	2.0–3.0 oz	broadcast	Do not apply more than 3 oz per 3-day interval; no more than 12 oz or 4 times per season.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Corn earworm *(continued)*	Besiege	5.0–9.0 oz	broadcast	For control before larvae enter the ear. Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest or exceed 0.3 lb ai/a per season, including pre and ppi, at plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	16.0–38.0 oz	broadcast	Make direct application to silks for best results. Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Coragen	3.5–5.0 oz	broadcast	Do not apply within 14 days of harvest.
	Declare	0.77–1.28 oz	broadcast	For control before larvae bore into the plant stalk or ear. Do not apply within 21 days of harvest or exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19 pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.5–1.9 oz	broadcast	Do not apply within 21 days of harvest of field corn for grain or fodder, or within 12 days of cutting or grazing field corn for forage or exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	4.0–10.3 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage or exceed 0.4 lb ai/a per season.
	Lorsban Advanced	1.5–2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	1.76–4.0 oz	broadcast	For control before larvae bore into the plant stalk or ear. Do not exceed 0.1 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days of harvest for forage.
	Pounce 3.2EC	4.0–8.0 oz	broadcast	Do not apply within 30 days of harvest for grain or fodder. Do not exceed 0.6 lb ai/a per season
	Stallion	9.25–11.75 oz	Broadcast	For control before larvae bore into ear. Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Corn earworm *(continued)*	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	0.96–1.6 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
Corn leaf aphid	**Note:** Treat if 50% of the plants have more than 50 aphids/plant and plants are in the late whorl to early tassel stages.			
	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Besiege	6.0–9.0 oz	broadcast	Suppression only. Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest or feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	11.0–26.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Delta Gold 1.5EC	1.5–1.9 oz	broadcast	Suppression only. Do not apply within 21 days of harvest for grain or fodder, or within 12 days of cutting or grazing field corn for forage. Do not exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	4.0–10.3 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage or exceed 0.4 lb ai/a per season.
	Lannate LV	0.75–1.50 pt	broadcast	Do not apply within 3 days of harvest for forage. Do not apply within 21 days of harvest for ears or fodder.
	Lannate SP	0.25–0.50 lb	broadcast	Do not apply within 3 days of harvest for forage. Do not apply within 21 days of harvest for ears or fodder.
	Lorsban Advanced	1.0–2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Penncap-M	2.0–3.0 pt	broadcast	Do not apply within 12 days of harvesting, cutting, or grazing. Do not apply during pollen shed if bees are foraging in the areas to be treated.
	Stallion	9.25–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Corn leaf aphid *(continued)*	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
Corn rootworm larvae	Avicta Complete Corn	—	seed treatment	Purchase treated seed from seed dealer or seed treatment representative (1.25 mg thiamethoxam ai per kernel).
	Aztec 2.1G	6.7 oz/ 1,000 ft row	7-inch band, T-band, or in furrow	A maximum of 7.3 lb/a may be applied per season. For applications made within 20 yards of aquatic sites, apply in furrow only.
	Aztec 4.67G	3.0 oz/1,000 ft row	7-inch band, T-band, or in furrow	Must be applied with the SmartBox system. A maximum of 3.27 lb/a may be applied per season.
	Brigade 2EC	0.3 fl oz/1,000 ft row	5- to 7-inch T-band	Do not apply within 30 days of harvest. Do not apply more than 0.10 lb ai/a at planting.
	Capture LFR	6.8–8.5 oz or 0.39–0.49 oz/ 1,000 ft row	5- to 7-inch T-band, or in furrow	Do not exceed 0.1 lb ai/a at planting or 0.3 lb ai/a per season including at-plant plus foliar applications of other bifenthrin products (e.g., Brigade 2EC).
	Counter 15G	8.0 oz/1,000 ft row	7-inch band, in furrow	Do not exceed 8.7 lb/a. When applied in a band, incorporate evenly into top inch of soil.
	Cruiser Extreme 1250	—	seed treatment	To provide corn rootworm protection in light to moderate infestations. Consult your seed dealer and/ or seed treatment representative to obtain treated seed at the 1.25 mg ai/kernel rate for corn rootworm larvae.
	Force 3G	4.0–5.0 oz/ 1,000 ft row	7-inch band, T-band, or in furrow	Do not rotate to other crops within 30 days after application.
	Force CS	0.46–0.57 fl oz/ 1,000 ft row	7-inch T-band or in furrow	T-band applications must be incorporated.
	Fortress 5G	3.0–4.5 oz/ 1,000 ft row	T-band or in furrow	Must be applied with the SmartBox system.
	Lorsban 15G	8.0 oz/ 1,000 ft row	7-inch band, T-band, or in furrow	Do not exceed the equivalent of 16 oz of Lorsban 15G/1,000 ft of row per season.
	Poncho 1250	—	seed treatment	For use by commercial seed treaters only. Consult your seed dealer and/or seed treatment representative to obtain seed treated at the 1.25 mg ai/kernel rate for corn rootworm larvae.
	Smart Choice 5G	4.5–5.0 oz/ 1,000 ft row	in furrow	Do not make more than one application per year.
Corn rootworm beetle	**Note:** Treat before 75% of the plants have silked if you find at least five beetles per plant and silk clipping is observed. For pollination protection only.			
	Ambush 2E	6.4–12.8 oz	broadcast	Do not apply within 30 days of harvest.
	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Corn rootworm beetle *(continued)*	Baythroid XL	1.6–2.8 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Besiege	6.0–9.0 oz	broadcast	Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	11.0–26.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Declare	1.02–1.54 oz	broadcast	Do not apply within 21 days of harvest or exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19 pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.5–1.9 oz	broadcast	Do not apply within 21 days of harvest for grain or fodder or 12 days of cutting or grazing field corn for forage. Do not exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	4.0–10.3 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage or exceed 0.4 lb ai/a per season.
	Lorsban Advanced	1.0–2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	2.72–4.0 oz	broadcast	Do not exceed 0.1 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days of harvest for forage.
	Penncap-M	1.0–2.0 pt	broadcast	Do not apply within 12 days of harvesting, cutting, or grazing. Do not apply during pollen shed if bees are foraging in the areas to be treated.
	Pounce 3.2EC	4.0–8.0 oz	broadcast	Do not apply within 30 days of harvest for grain or fodder. Do not exceed 0.6 lb ai/a per season.
	Sevin XLR Plus	1.0–2.0 qt	broadcast	Do not apply within 48 days of harvest of grain and fodder, or within 14 days of harvest or grazing of forage or silage.
	Stallion	9.25–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Corn rootworm beetle *(continued)*	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	1.28–1.92 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
Cutworm	**Note:** Treat when 5% of the plants show cutting activity.			
	Avicta Complete Corn	—	seed treatment	Purchase treated seed from seed dealer or seed treatment representative (0.45–0.57 mg thiamethoxam ai per kernel).
	Ambush 2E	6.4–12.8 oz	broadcast	Do not apply within 30 days of harvest.
	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Baythroid XL	0.8–1.6 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Belt	2.0–3.0 oz	broadcast	Do not apply more than 3 oz per 3-day interval; no more than 12 oz or 4 times per season.
	Besiege	5.0–9.0 oz	broadcast	Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at-plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	11.0–26.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Cruiser Extreme 250	—	seed treatment	Cutworm suppression. Purchase treated seed from seed dealer or seed treatment representative (0.125–0.80 mg ai/a per kernel).
	Declare	0.77–1.28 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19 pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.0–1.5 oz	broadcast	Do not apply within 21 days of harvest or within 12 days of cutting or grazing for forage. Do not exceed 8.1 oz/a per season.
	Force CS	0.34–0.46 fl oz/ 1,000 ft row	7-inch T-band	*This is the rate if cutworm is the only pest.* If corn rootworm is also targeted, use corn rootworm rate. Must be incorporated (see label).
	Hero	2.6–6.1 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage or exceed 0.4 lb ai/a per season.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Cutworm *(continued)*	Lorsban Advanced	1.0–2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	1.28–2.8 oz	broadcast	Do not exceed 0.1 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days of harvest for forage.
	Penncap-M	4.0 pt	broadcast	For best control of black cutworm, apply when soil is moist. Do not apply or allow product to drift onto blooming crops or weeds if bees are foraging area to be treated. Do not harvest, cut for forage, or graze within 12 days of application. Do not exceed 12 pt/a per year.
	Poncho 250 Poncho 500	0.25 mg ai/ kernel 0.50 mg ai/ kernel	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	Pounce 3.2EC	4.0–8.0 oz	broadcast	Do not apply within 30 days of harvest for grain or fodder. Do not exceed 0.6 lb ai/a per season.
	Stallion	3.75–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.
	Triple Crown	3.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or 60 within days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	0.96–1.6 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
European corn borer	**Note:** See management worksheet in European corn borer description. Application must be made before larvae bore into plant.			
	Ambush 2E	6.4–12.8 oz	broadcast	Do not apply within 30 days of harvest.
	Asana XL	9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Bacillus thuringiensis—BioBit, Dipel, Javelin	*see label*	*see label*	No waiting period to harvest. Apply while larvae are small.
	Baythroid XL	1.6–2.8 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Belt	2.0–3.0 oz	broadcast	Do not apply more than 3 oz per 3-day interval; no more than 12 oz per season and no more than 4 times per season.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
European corn borer *(continued)*	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Besiege	6.0–9.0 oz	broadcast	For control before larvae bore into stalk/ear. Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Cobalt Advanced	16.0–38.0 oz	broadcast	For chemigation applications, may use 19–38 oz/a. Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Coragen	3.5–5.0 oz	broadcast	Do not apply within 14 days of harvest.
	Declare	1.02–1.54 oz	broadcast	For control before larvae bore into the stalk or ear. Do not apply within 21 days of harvest or exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19 pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.5–1.9 oz	broadcast	Do not apply within 21 days of harvest or within 12 days of cutting or grazing for forage. Do not exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	4.0–10.3 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage. Do not apply more than 0.4 lb ai/a per season.
	Lorsban 15G	5.0–6.5 lb	broadcast	Do not apply within 35 days of harvestor exceed 13.0 lb/a of Lorsban 15G per season for foliar insect control.
	Lorsban Advanced	1.0–2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	2.72–4.0 oz	broadcast	Do not exceed 0.1 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days of harvest for forage.
	Penncap-M	2.0–4.0 pt	broadcast	Do not apply within 12 days of harvesting, cutting, or grazing. Do not apply if bees are actively foraging near the area to be treated.
	Pounce 3.2EC	4.0–8.0 oz	broadcast	Do not apply within 30 days of harvest for grain or fodder. Do not exceed 0.6 lb ai/a per season.
	Stallion	9.25–11.75 oz	Broadcast	For control before larvae bore into stalk or ear. Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
European corn borer *(continued)*	Tracer	1.0–3.0 fl oz	broadcast	Do not apply more than 6 fl oz (0.188 lb spinosad)/a per year. Do not apply within 28 days of grain or fodder harvest or within 7 days of harvest for forage.
	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	1.28–1.92 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
Grasshopper	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Baythroid XL	2.1–2.8 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Besiege	6.0–9.0 oz	broadcast	Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at-plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	6.0–13.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Declare	1.02–1.54 oz	broadcast	Do not apply within 21 days of harvest or exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.0–1.5 oz	broadcast	Do not apply within 21 days of harvest or within 12 days of cutting or grazing for forage. Do not exceed 8.1 oz/a (0.095 lb ai/a) per season.
	dimethoate	*see label*	*see label*	—
	Hero	2.6–6.1 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage. Do not apply more than 0.4 lb ai/a per season.
	Lorsban Advanced	0.5–1.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	2.72–4.0 oz	broadcast	Do not exceed 0.1 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days of harvest for silage.
	Penncap-M	2.0–3.0 pt	broadcast	Do not apply during pollen shed if bees are visiting the area to be treated. Do not apply within 12 days of harvesting, cutting, or grazing.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Grasshopper *(continued)*	Sevin XLR Plus	1.0–3.0 pt	broadcast	Do not apply within 48 days of harvest for grain or fodder, or within 14 days of harvest or grazing of forage or silage.
	Stallion	9.25–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.
	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	1.28–1.92 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
Hop vine borer	**Note:** Treatments are most effective if applied when damage is detected in seedling-stage corn. Hop vine borer attacks the plant below the soil surface.			
	Besiege	6.0–9.0 oz	broadcast	For control before larvae bore into plant. Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Cobalt Advanced	16.0–38.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Declare	1.02–1.54 oz	broadcast	For control before larvae bore into stalk. Do not apply within 21 days of harvest. Do not exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Hero	2.6–6.1 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage. Do not apply more than 0.4 lb ai/a per season.
	Mustang Max	2.72–4.0 oz	broadcast	Do not exceed 0.10 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days of harvest for silage.
	Pounce 3.2EC	4.0–8.0 oz	broadcast	Do not apply within 30 days of harvest for grain. Do not exceed 0.6 lb ai/a per season.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Hop vine borer *(continued)*	Stallion	9.25–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.
	Triple Crown	3.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	1.28–1.92 oz	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
Japanese beetle (adult)	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Baythroid XL	1.6–2.8 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Besiege	6.0–9.0 oz	broadcast	Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest or exceed 0.3 lb ai/a per season, including pre and ppi, at plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	32.0–42.0 oz	broadcast	Do not apply within 21 days of harvest for grain, ears, forage, or fodder.
	Declare	1.02–1.54	broadcast	Do not apply within 21 days of harvest or exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19 pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.5–1.9 oz	broadcast	Do not apply within 21 days of harvest of field corn for grain or fodder or within 12 days of cutting or grazing field corn or forage. Do not exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	4.0–10.3 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage. Do not exceed 0.4 lb ai/a per season.
	Mustang Max	2.72–4.0 oz	broadcast	Do not apply within 30 days of harvest for grain or within 60 days of harvest for forage.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Japanese beetle (adult) *(continued)*	Stallion	9.25–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.
	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	1.28–1.92	broadcast	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
Seedcorn beetle, seedcorn maggot	Avicta Complete Corn	—	seed treatment	Purchase treated seed from seed dealer or seed treatment representative (0.45–0.57 mg thiamethoxam ai per kernel).
	Aztec 2.1G	6.7 oz/ 1,000 ft row	7-inch band, in furrow	A maximum of 7.3 lb/a may be applied per season. For applications made within 20 yards of aquatic sites, apply in furrow only.
	Aztec 4.67G	3.0 oz/1,000 ft row	T-band or in furrow	Must be applied with a SmartBox system. Do not exceed 3.27 lb/a per season.
	Brigade 2EC	0.15–0.30 fl oz/ 1,000 ft row	5- to 7-inch T-band	Do not apply within 30 days of harvest. Do not apply more than 0.10 lb ai/a at planting.
	Capture LFR	0.20–0.39 fl oz/ 1,000 ft row	5- to 7-inch T-band or in furrow	Do not exceed 0.1 lb ai/a at planting or 0.3 lb ai/a per season including at-plant plus foliar applications of other bifenthrin products (e.g., Brigade 2EC).
	Counter 15G	8.0 oz/ 1,000 ft row	7-inch band, in furrow	Do not exceed 8.7 lb/a. When applied in a band, incorporate evenly into top inch of soil.
	Cruiser Extreme 250	—	seed treatment	Treat at 0.125–0.80 mg ai/kernel.
	Force 3G	4.0–5.0 oz/ 1,000 ft row	7-inch band, in furrow	Do not rotate to other crops within 30 days after application.
	Force CS	0.46–0.57 fl oz/ 1,000 ft row	T-band or in furrow	T-band applications must be incorporated (see label).
	Fortress 5G	3.0–3.75 oz/ 1,000 ft row	in furrow	Must be applied with a SmartBox system. Labeled for seedcorn maggot, *not* the beetle.
	Kernel Guard Supreme	*see label*	planter-box seed treatment	Contains permethrin as the active ingredient (not lindane).
	Lorsban 15G	8.0 oz/ 1,000 ft row	7-inch band or in furrow	Do not exceed the equivalent of 16 oz of product/ 1,000 ft of row per season.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Seedcorn beetle, seedcorn maggot *(continued)*	Poncho 250 Poncho 500	0.25 mg ai/kernel 0.50 mg ai/kernel	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	Smart Choice 5G	3.0–3.5 oz/1,000 ft row	in furrow	Labeled for seedcorn maggot, not the beetle. Do not make more than one application per year.
	Triple Crown	0.64 oz/1,000 ft row	5- to 7-inch band	Do not apply to soil where there is greater than 30% cover of crop residue remaining. Do not apply within 30 days of harvest. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of treatment. Do not apply more than 0.2 lb ai/a per season as an at-plant application.
Slug	metaldehyde bait	*see label*	broadcast	—
Stalk borer	**Note:** Treatments most effective if applied while larvae are still small and wilting of seedlings is just beginning.			
	Ambush 2E	6.4–12.8 oz	broadcast	Do not apply within 30 days of harvest.
	Asana XL	5.8–9.6 oz	broadcast	Do not apply within 21 days of harvest.
	Baythroid XL	1.6–2.8 oz	broadcast	Preharvest interval for grain and fodder is 21 days. Do not exceed 11.2 oz/a per season.
	Besiege	6.0–9.0 oz	broadcast	For control before larvae bore into the stalk. Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at-plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Cobalt Advanced	16.0–38.0 oz	broadcast	Do not apply within 14 days of harvest for silage or 21 days for grain. Do not exceed 126 oz/a per season.
	Declare	1.02–1.54 oz	broadcast	Do not apply within 21 days of harvest or exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5EC	1.5–1.9 oz	broadcast	Do not apply within 21 days of harvest or within 12 days of cutting or grazing for forage. Do not exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	2.6–6.1 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage. Do not apply more than 0.4 lb ai/a per season.
	Lorsban Advanced	2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	2.72–4.0 oz	broadcast	Do not exceed 0.1 lb ai/a per season. Do not apply within 30 days of harvest for grain or within 60 days of harvest for forage.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Stalk borer *(continued)*	Pounce 3.2EC	4.0–8.0 oz	broadcast	Do not apply within 30 days of harvest for grain or fodder. Do not exceed 0.6 lb ai/a per season.
	Stallion	9.25–11.75 oz	Broadcast	Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.
	Triple Crown	3.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.
	Warrior II	1.28–1.92 oz	over row as spray	Do not apply within 21 days of harvest. Do not exceed 0.12 lb ai/a per season; 0.06 lb ai/a after silk initiation; or 0.03 lb ai/a after corn has reached the milk stage.
Two-spotted spider mite	Brigade 2EC	5.12–6.4 oz	broadcast	Do not apply within 30 days of harvest. Do not exceed 0.3 lb ai/a per season, including pre and ppi, at plant, and foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application.
	Comite	32–48 oz	broadcast	Do not make more than one application per season.
	dimethoate	*see label*	*see label*	—
	Hero	10.3 oz	broadcast	Do not apply within 30 days of harvest for grain stover or 60 days for forage. Do not apply more than 0.4 lb ai/a per season.
	Oberon	2.85–8.0 oz	broadcast	Do not apply more than 8.5 oz/a per 14-day interval; do not apply more than 8.5 oz/a per season.
Western bean cutworm	Ambush 2E	6.4–12.8 oz	broadcast	Do not apply more than 0.6 lb ai/a per season. Do not apply within 30 days of harvest of grain or fodder (stover).
	Asana XL	2.9–5.8 oz	broadcast	Apply before larvae enter the ear. Do not exceed 0.25 lb ai/a per season or apply within 21 days of harvest.
	Baythroid XL	1.6–2.8 oz	broadcast	Do not apply within 21 days of harvest for grain and fodder or exceed 11.2 fl oz/a (0.088 lb ai/a) per season.
	Belt	2.0–3.0 oz	broadcast	Do not apply more than 3 oz per 3-day interval or more than 12 oz or four times per season.
	Besiege	5.0–9.0 oz	broadcast	For control before larvae enter the ear. Do not exceed 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per year. Do not apply within 21 days of harvest. Do not feed treated corn fodder or silage to meat or dairy animals within 21 days after last treatment.
	Brigade 2EC	2.1–6.4 oz	broadcast	Do not apply more than 0.3 lb ai/a per season. Do not apply within 30 days of harvest.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Western bean cutworm *(continued)*	Cobalt Advanced	11.0–26.0 oz	broadcast	Do not exceed 126 oz/a per season. Do not apply within 14 days of harvest for silage or within 21 days for grain.
	Declare	0.77–1.28 oz	broadcast	For control before the larva bores into the ear. Do not apply within 21 days of harvest. Do not exceed 0.06 lb ai (0.38 pt)/a per season; 0.03 lb ai (0.19pt)/a after silk initiation; or 0.015 lb ai (0.096 pt)/a after milk stage.
	Delta Gold 1.5 EC	1.0–1.5 oz	broadcast	Do not apply within 21 day of harvest of field corn for grain or fodder, or within 12 days of cutting or grazing field corn for forage. Do not exceed 8.1 oz/a (0.095 lb ai/a) per season.
	Hero	2.6–6.1 oz	broadcast	Do not apply more than 0.4 lb ai/a per season. Do not apply within 30 days of harvest for grain and stover or within 60 days for forage.
	Lorsban Advanced	1.0–2.0 pt	broadcast	Do not exceed 2 pt/a per application or 6 pt/a per season. Do not apply within 14 days of harvest for silage or 21 days for grain.
	Mustang Max	1.76–4.0 oz	broadcast	For control before the larva bores into the plant stalk or ear. Do not exceed 0.10 lb ai/a per season including at-plant plus foliar applications. Do not apply within 30 days of harvest for grain and stover or within 60 days for forage.
	Penncap-M	2.0–4.0 pt	broadcast	Do not apply during pollen shed if bees are foraging in the areas to be treated. Do not exceed 12 pt/a per year. Do not harvest, cut for forage, or graze within 12 days of application.
	Pounce 3.2 EC	2.0–4.0 oz	broadcast	Up to 0.6 lb ai/a may be used per season. Allow at least 6 days between treatments. Do not apply within 30 days before harvest of grain or fodder.
	Sevin XLR Plus	2.0 qt	broadcast	Treat at economic threshold and at 90–100% tassel emergence. Treatment after 100% silk emergence will reduce effectiveness. Do not apply within 48 days of harvest for grain or fodder or within 14 days of harvest or grazing for forage or silage. Do not exceed 8 qt/a per crop.
	Stallion	5.0–11.75 oz	Broadcast	For control before larvae bore into ear. Do not apply within 30 days of harvest for grain and stover and 60 days of harvest for forage. Do not apply more than 35.25 oz/a per season including at-plant plus foliar applications (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). See label for maximum rates allowed on corn for chlorpyrifos-containing products (granular at-plant and foliar). Do not apply in tank mixes with Steadfast or Lightning herbicides.
	Triple Crown	4.5–10.3 oz	broadcast	Do not apply more than 30.7 oz/a (0.54 lb ai/a) per crop per season. Refer to the maximum usage tables when applying more than one product containing either zeta-cypermethrin or bifenthrin or imidacloprid to this crop. Do not apply within 30 days of grain harvest or within 60 days for forage. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Western bean cutworm *(continued)*	Warrior II	0.96–1.6 oz	broadcast	For control before the larva bores into the plant stalk or ear. Do not apply within 21 day of harvest. Do not exceed 0.12 lb ai/a per season. Do not apply more than 0.06 lb ai/a after silk initiation, or 0.03 lb ai/a after corn has reached the milk stage.
White grub	Avicta Complete Corn	—	seed treatment	Purchase treated seed from seed dealer or seed treatment representative (0.45–0.57 mg thiamethoxam ai per kernel).
	Aztec 2.1G	6.7 oz/ 1,000 ft row	7-inch band or in furrow	A maximum of 7.3 lb/a may be applied per season. For applications made within 20 yards of aquatic sites, apply in furrow only.
	Aztec 4.67G	3.0 oz/ 1,000 ft row	T-band or in furrow	Must be applied with a SmartBox system. Do not exceed 3.27 lb/a per season.
	Brigade 2EC	0.15–0.30 fl oz/ 1,000 ft row	5- to 7-inch T-band	Do not apply within 30 days of harvest. Do not apply more than 0.10 lb ai/a at planting.
	Capture LFR	0.20–0.39 fl oz/ 1,000 ft row	5- to 7-inch T-band or in furrow	Do not exceed 0.1 lb ai/a at planting or 0.3 lb ai/a per season including at-plant plus foliar applications of other bifenthrin products (e.g., Brigade 2EC).
	Cobalt Advanced	2.87 fl oz/ 1,000 ft row	5- to 6-inch T-band	Do not exceed 126 oz/a per season.
	Counter 15G	8.0 oz/ 1,000 ft row	7-inch band or in furrow	Do not exceed 8.7 lb/a. Incorporate evenly into top inch of soil if applied in a band.
	Cruiser Extreme 250	—	seed treatment	Early season seed and seedling protection. Purchase treated seed from seed dealer or seed treatment representative. Do not exceed 0.125–0.80 mg ai/kernel.
	Force 3G	4.0–5.0 oz/ 1,000 ft row	7-inch band or in furrow	Do not rotate to other crops within 30 days after application.
	Force CS	0.46–0.57 fl oz/ 1,000 ft row	T-band or in furrow	Use the higher rate for heavy infestations. For best wireworm and/or white grub control, apply as an in furrow treatment.
	Fortress 5G	3.0–3.75 oz/ 1,000 ft row	in furrow	Must be applied with a SmartBox system.
	Gaucho	—	seed treatment	Early season seed and seedling protection. Purchase treated seed from seed dealer or seed treatment representative (1.34 mg ai/kernel).
	Lorsban 15G	8.0–12.0 oz/ 1,000 ft row	in furrow	Do not exceed the equivalent of 16 oz of product/ 1,000 ft of row per season.
	Poncho 250 Poncho 500	0.25 mg ai/ kernel 0.50 mg ai/ kernel	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	Smart Choice 5G	3.0–3.5 oz/ 1,000 ft row	in furrow	Do not make more than one application per year.
	Triple Crown	0.64 oz/ 1,000 ft row	5- to 7-inch band	Do not apply to soil where there is greater than 30% cover of crop residue remaining. Do not apply within 30 days of harvest. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of treatment. Do not apply more than 0.2 lb ai/a per season as an at-plant application.

[a] This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc. *(continued)*

[b] Multiple trade names listed within a row indicate products with the same active ingredient (ai).

Table 2-12. Insecticide suggestions for corn pests[a] *(continued)*

Insect	Insecticide[b]	Amount of product/a	Placement	Remarks, precautions
Wireworm	Avicta Complete Corn	—	seed treatment	Purchase treated seed from seed dealer or seed treatment representative (0.45–0.57 mg thiamethoxam ai per kernel).
	Aztec 2.1G	6.7 oz/1,000 ft row	7-inch band or in furrow	A maximum of 7.3 lb/a may be applied per season. For applications made within 20 yards of aquatic sites, apply in furrow only.
	Aztec 4.67G	3.0 oz/ 1,000 ft row	T-band or in furrow	Must be applied with a SmartBox system. Do not exceed 3.27 lb/a per season.
	Brigade 2EC	0.15–0.30 fl oz/ 1,000 ft row	5- to 7-inch T-band	Do not apply within 30 days of harvest. Do not apply more than 0.10 lb ai/acre at planting.
	Capture LFR	0.20–0.39 fl oz/ 1,000 ft row	5- to 7-inch T-band or in furrow	Do not exceed 0.1 lb ai/a at planting or 0.3 lb ai/a per season including at-plant plus foliar applications of other bifenthrin products (e.g., Brigade 2EC).
	Cobalt Advanced	2.87 fl oz/ 1,000 ft row	5- to 6-inch T-band	Do not exceed 126 oz/a per season.
	Counter 15G	8.0 oz/ 1,000 ft row	7-inch band or in furrow	Do not exceed 8.7 lb/a. Incorporate evenly into top inch of soil if applied in a band.
	Cruiser Extreme 250	—	seed treatment	Early season seed and seedling protection. Purchase treated seed from seed dealer or seed treatment representative (0.125–0.80 mg ai/kernel).
	Force 3G	4.0–5.0 oz/ 1,000 ft row	7-inch band or in furrow	Do not rotate to other crops within 30 days after application.
	Force CS	0.46–0.57 fl oz/ 1,000 ft row	T-band or in furrow	Use the higher rate for heavy infestations. For best wireworm and/or white grub control, apply as an in-furrow treatment.
	Fortress 5G	3.0–3.75 oz/ 1,000 ft row	in furrow	Must be applied with a SmartBox system.
	Kernel Guard Supreme	*see label*	planter-box seed treatment	Contains permethrin, not lindane, as the active ingredient.
	Lorsban 15G	16.0 oz/ 1,000 ft row	7-inch band or in furrow	Do not exceed the equivalent of 16 oz of product/ 1,000 ft of row per season.
	Poncho 250 Poncho 500	0.25 mg ai/ kernel 0.50 mg ai/ kernel	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	Smart Choice 5G	3.0–3.5 oz/ 1,000 ft row	in furrow	Do not make more than one application per year.
	Triple Crown	0.64 oz/ 1,000 ft row	5- to 7-inch band	Do not apply to soil where there is greater than 30% cover of crop residue remaining. Do not apply within 30 days of harvest. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of treatment. Do not apply more than 0.2 lb ai/a per season as an at-plant application.

[a]This is intended as a guide for corn planted in 30-inch rows. Check labels for use, rates, method of application, etc.

[b]Multiple trade names listed within a row indicate products with the same active ingredient(s).

CORN DISEASE MANAGEMENT

Corn diseases, like those of other crops, vary in severity from year to year and from one locality or field to another. There are many factors that influence disease development, including environmental conditions, the resistance of the corn hybrid, and the population density of the disease organisms that are present. Thus, it is important for growers to distinguish when poor crop development is due to diseases and when insect, nutrient deficiencies, soil conditions, herbicide injury, or weather conditions are the problem.

DISEASE MANAGEMENT STRATEGIES

Corn diseases can be managed by planting resistant or tolerant corn hybrids, rotating crops, using appropriate cultural practices, and applying pesticides. Although a single control procedure can be effective, a sound disease control program integrates all these crop management techniques.

Resistant hybrids

Selecting corn hybrids that are resistant or tolerant to major corn diseases can be an effective and economical method of disease control. Your seed dealer should be a good source of information on specific hybrid reaction to disease. Terms describing hybrid reaction to disease are somewhat confusing. "Disease-resistant hybrids" should be regarded only as a general term that suggests resistance to specific diseases; it cannot be an all-inclusive statement, since no hybrid is resistant to all corn diseases. Also, hybrids are not described as being resistant/tolerant to a specific disease. Rather, leaf health, seedling cold tolerance, root size, and stalk strength are characterized, but each relate to reactions to plant pathogens.

Many hybrids have good resistance to eyespot, Gibberella ear rot, northern corn leaf blight, northern leaf spot, rust, smut, and stalk rot. If you have had a history of problems with one or more of these diseases, ask about hybrid reactions to these specific diseases.

Resistance does not mean immunity—complete freedom from infection or disease development. A resistant hybrid should withstand damage but may show some disease development when conditions favor the disease but not suffer much yield reduction. In other words, there is a gradation among hybrids ranging from susceptible to resistant to highly resistant to disease. Changes in cultural practices, new forms (races) of known pathogens, and new pathogens can result in disease in hybrids that were thought resistant.

Learn to identify the major diseases of corn and evaluate disease reactions of the hybrids you grow. Disease reactions of various hybrids can differ with each farm or locality because of different local weather conditions, tillage operations, soil type, and soil fertility.

Crop rotation and tillage practices

Crop rotation and clean tillage are effective disease control procedures. In many cases, the fungi that cause corn diseases overwinter in stalks, leaves, and roots. Once this corn debris is thoroughly decayed, many corn pathogens perish or are greatly reduced in numbers. Therefore, crop rotation and tillage programs that allow residue decay in a given field before the next corn crop is grown will help reduce diseases, especially leaf and seedling diseases.

We support the concept of no-till or minimum tillage for crop production because of its soil-conserving potential. However, growers using no-till or minimum tillage

should be alert for an increase in crop pest problems; the potential is greater for disease problems with reduced tillage than with conventional tillage systems. The risk of increased corn disease problems is even higher when reduced tillage is associated with continuous corn, planting of susceptible hybrids, and climatic conditions favorable for disease development. Corn hybrids that perform well in conventional tillage systems may decline in performance if grown in no-till systems.

Minimum tillage can affect root rot and stalk rot development in at least two ways: first, the associated pathogens become concentrated in the upper root zone (with conventional plowing they are distributed and thus diluted to a greater depth in the soil), and second, potassium may be less available to plants under a reduced tillage situation. You may need to supplement potassium to prevent a nitrogen–potassium (N:K) imbalance and subsequent stalk-rot problems.

Certain diseases are more prevalent if debris from the previous year's corn crop is left on the surface during wet seasons. Northern leaf spot, eyespot, and Gibberella ear rot are examples.

If you are considering continuous, reduced tillage, or no-till corn production, we suggest the following guidelines to minimize the risk of corn diseases:

- Select corn hybrids with resistance or tolerance to major leaf diseases.
- Select hybrids tolerant to stalk and ear rot.
- Consider chopping stalks in the fall. Many organisms do not survive as well when the debris is close to the soil.
- Examine fields periodically during the growing season to spot any sign of disease development. Early harvest can minimize losses.
- Consider crop rotation to help curb the buildup of corn pathogens that may be developing.
- Select corn hybrids rated superior for seedling cold tolerance.
- Consider planting corn seed treated with a fungicide.

Seed protectants

Chemicals registered for protecting corn seed against seedling rot include captan, fludioxonil (Maxim), mefenoxam (Apron), pentachloronitrobenzene (PCNB), metalaxyl, and mancozeb (check the labels to be sure chemicals include corn seed treatment), but other fungicides can be applied in the planter box. Treatment is especially beneficial when seed vigor is low and during cold, wet spring weather. Virtually all corn seed on the market today is already treated with a fungicide. Many hybrid seed corn companies have changed from captan to Maxim or Maxim-Apron. Some companies take specific requests so you can tailor seed treatments to field conditions. For example, the use of trifloxystrobin (Trilex) in addition to the Maxim-Apron combination offers good protections if planting in cool, wet soils with a high risk of Pythium seed rot.

Leaf disease control with fungicides

Foliar fungicides (table 2-13) can effectively reduce severity of northern corn leaf blight, northern leaf spot, eyespot, gray leaf spot, and rust. It is rarely economical for commercial corn producers to use fungicides for leaf disease control. However, seed corn producers must control these diseases because inbreds can be very susceptible to them.

Should any of these leaf diseases threaten during the period between tasseling and dent (about 35 days), treatment may be economical. Early detection is critical; monitor fields of susceptible hybrids/inbreds weekly.

Check the label for specific limitations on the amount of product that can be used per acre per season, the preharvest interval, growth stage limitations, and feeding restrictions. For example, chlorothalonil (Bravo formulations) is registered for Helminthosporium leaf blights (northern corn leaf blight, northern leaf spot, southern leaf blight) and rust on fresh market sweet corn and corn grown for seed. Bravo is not labeled for use on processing sweet corn. Corn treated with Bravo cannot be fed to livestock, ensiled, or used as livestock forage. Label instructions must be followed carefully for effective use.

(continued on page 98)

Table 2-13. Fungicides labeled for leaf diseases of field corn (hybrid seed production and grain)

Fungicide	Anthracnose	Eyespot	Gray leaf spot	Northern corn leaf blight	Northern corn leaf spot	Rust	Southern rust	Yellow leaf blight	Physoderma brown spot	Active ingredient	Chemical family (FRAC code[a])	Amount/use/a	Preharvest interval (PHI)
Bravo Weather Stik *(corn grown for seed only)*	—	—	—	■	■	■	■	—	—	chlorothalonil	chloronitriles (M5)	0.75–2.0 pt	14 days
Remarks: Use only on corn grown for seed. Consult the label for disease-specific recommendations and rates.													
Bumper 41.8 EC	—	■	■	■	■	■	■	—	—	propiconazole	triazole (3)	2–4 fl oz	30 days for forage, grain, and stover
Remarks: Consult the product label for disease-specific recommendations and rates. Do not apply more than 16 fl oz/a/season. Do not apply more than 8 fl oz/a/season on field corn harvested for forage. Do not apply more than 0.45 lb ai propiconazole/a/season.													
Dithane DF Rainshield	—	—	—	■	■	■	—	—	—	mancozeb	dithiocarbamate (M3)	1.5 lb	40 days (all formulations)
Dithane F-45 Rainshield				■	■	■						1.2 pt	
Dithane M45				■	■	■						1.5 lb	
Remarks: Seasonal use amounts vary according to formulation. Do not feed treated forage to livestock.													
Domark 230 ME	■	■	■	■	■	■	■	—	—	tetraconazole	triazole (3)	4–6 fl oz	Do not apply after R3
Remarks: Do not apply more than one (1) application per year.													
Headline EC Headline SC	■	—	■	■	■	■	■	■	■	pyraclostrobin	QoI (11)	6–12 fl oz	7 days
Remarks: Consult the label for disease-specific recommendations and rates. Do not apply more than two applications per season or more than two sequential applications before alternating to a labeled non-Group 11 fungicide. To limit the potential for resistance, do not apply more than 1.18 lb ai pyraclostrobin/a/season.													
Headline AMP	■	■	■	■	■	■	■	■	■	pyraclostrobin metconazole	QoI (11) triazole (3)	10–14.4 fl oz	20 days for grain and stover; 7 days for forage and silage
Remarks: Consult the label for disease-specific recommendations and rates. Do not make more than four applications per season. Do not apply more than 57.6 fl oz/a/season. Do not make more than two sequential applications before alternating to another fungicide with a different mode of action.													
Manzate ProStick	—	—	■	■	■	■	—	—	—	manganese ethylene-bisdithio-carbamate	dithiocarbamate (M3)	1.5 lb	40 days for both formulations
Manzate Flowable												1.2 lb	
Remarks: Do not feed treated forage to livestock. Seasonal use amounts vary according to formulation.													
Penncozeb 75 DF	—	—	■	■	■	■	—	—	—	manganese ethylene-bisdithio-carbamate	dithiocarbamate (M3)	1.0–1.5 lb	40 days for all formulations
Penncozeb 80 WP			■	■	■	■							
Penncozeb 4 FL			■	■	■	■							
Remarks: Do not apply more than 12 lb ai/a/season.													

[a] Fungicide group numbers indicate the modes of action; multiple applications of fungicides with the same group number increases the chances for disease resistance.

(continued)

Table 2-13. Fungicides labeled for leaf diseases of field corn *(continued)*

Fungicide	Anthracnose	Eyespot	Gray leaf spot	Northern corn leaf blight	Northern corn leaf spot	Rust	Southern rust	Yellow leaf blight	Physoderma brown spot	Active ingredient	Chemical family (FRAC code[a])	Amount/use/a	Preharvest interval (PHI)
Priaxor	■	■	■	■	■	■	■	■	■	fluxapyroxad pyraclostrobin	carboximides (7) QoI (11)	4–8 fl oz	21 days
Remarks: Consult label for disease-specific information. Do not apply more than 16 fl oz/a/season. Do not make more than two (2) consecutive applications of Priaxor before alternating to a labeled fungicide with a different mode of action.													
Propimax EC	—	■	■	■	■	■	■	—	—	propiconazole	triazole (3)	2–4 fl oz	30 days for forage, grain, and stover
Remarks: Consult the label for disease-specific recommendations and rates. Do not apply more than 16 fl oz/a/season. Do not apply more than 8 fl oz/a/season on field corn harvested for forage.													
Proline 480 SC	■	■	■	■	■	■	■	—	—	prothioconazole	triazole (3)	5.7 fl oz	14 days for field corn and field corn seed production; 0 days for forage
Remarks: Do not apply more than 22.8 fl oz per acre per crop.													
Quadris	■	■	■	■	■	■	■	—	—	azoxystrobin	QoI (11)	6.0–15.5 fl oz	7 days
Remarks: Consult the label for disease-specific recommendations and rates. Do not apply more than 123 fl oz of product/a/season. Do not apply more than 2.0 lb ai/a/season of azoxystrobin-containing products.													
Quilt	■	■	■	■	■	■	■	—	—	azoxystrobin propiconazole	QoI (11) triazole (3)	7–14 fl oz	30 days for forage, grain, or stover
Remarks: Consult the label for disease-specific recommendations and rates. Apply no more than two applications of Quilt or any other group-11 fungicides per year or 56 fl oz/a/season. Do not apply more than 28 fl oz for field corn harvested for forage. Do not apply more than 0.45 lb ai of propiconazole-containing products/a/season or more than 2.0 lb ai azoxystrobin-containing products/a/season.													
Quilt Xcel	■	■	■	■	■	■	■	—	—	azoxystrobin propiconazole	QoI (11) triazole (3)	10.5–14 fl oz	30 days for forage, grain, or stover
Remarks: Consult the label for disease-specific recommendations and rates. Do not apply more than 56 fl oz/a/season. Do not apply more than 28 fl oz for field corn harvest for forage. Do not apply more than 0.45 lb ai propiconazole-containing products/a/season or more than 2.0 lb ai azoxystrobin-containing products/a/season.													
Stratego YLD	■	■	■	■	■	■	■	—	—	prothioconazole trifloxystrobin	triazole (3) QoI (11)	4.0–5.0 fl oz	14 days for grain and fodder; forage may be harvested the same day of application
Remarks: Do not apply more than 10 fl oz/a/season. Do not apply more than two sequential applications or any other Group-11 fungicide without alternating with a fungicide from another group.													
Tilt	—	■	■	■	■	■	■	—	—	propiconazole	triazole (3)	2.0–4.0 fl oz	30 days for forage, grain, or stover
Remarks: Consult the label for disease-specific recommendations and rates. Do not apply more than 16 fl oz /a/season Do not apply more than 8 fl oz/a/season on field corn harvested for forage. Do not apply more than 0.45 lb ai propiconazole-containing products/a/season.													

[a] Fungicide group numbers indicate the modes of action; multiple applications of fungicides with the same group number increases the chances for disease resistance.

Consider the following factors before deciding to apply a foliar fungicide:

- The susceptibility of the inbred/hybrid to the disease or diseases that threaten it.
- The anticipated time of disease development and severity. Severe leaf disease development usually occurs post tassel. Consequently, wet weather or continued heavy dews signal possible blight problems on fields already showing modest leaf spotting. If the blight already has invaded much of the leaf surface above the ear, the treatment benefits will be minimal.
- Treatment cost versus expected benefit. Each treatment costs about $20 to $30/a for the chemical, wetting agent, and application.

DISEASE PROBLEMS

Seed rot and seedling blights

Fungicide seed protectants generally control or minimize seed rot and seedling blights of corn. However, seed rot and seedling blight can be expected if corn is planted in wet and cool soils. Hybrids that have good seedling vigor are generally less susceptible to seed rot and seedling blights. Watch for reduced stands and stunted or dying seedlings. Often infected seedlings may develop into a mature plant, but the same disease organisms can cause root rot and stalk rot later on. Because injury from herbicides, insecticides, starter fertilizer, and soil insects can cause similar symptoms and results, accurate diagnosis is important.

Leaf diseases

Leaf diseases vary in prevalence and severity from year to year and from one locality to another, depending largely on environmental conditions. Humid weather, along with heavy dew, favors the spread and development of leaf diseases caused by fungi. Leaf diseases can be found on corn grown in poor and rich soils; soil fertility does not seem to affect these diseases as much as weather conditions, the genetic makeup of a hybrid, and tillage practices. More leaf disease can be expected when no-till or minimum tillage in continuous corn fields is employed. Growers using overhead irrigation should be more watchful for leaf disease development. Leaf diseases are found especially in fields located in valleys and in lowland areas along streams and rivers. These field locations can have prolonged periods of high relative humidity and low or moderate temperatures that favor most leaf diseases of corn. If it is necessary for you to plant hybrids susceptible to leaf diseases, only plant them in upland fields with good air drainage, where corn debris from the previous crop has been thoroughly covered by plowing or where corn does not follow corn in the rotation.

Northern corn leaf blight (NCLB) occurs statewide, but it has historically been more severe in low-lying fields.

Many hybrids have some tolerance to NCLB. In addition to a multiple gene resistance which imparts fair-to-good resistance in some hybrids, the single dominant "Ht1" gene has been introduced into many hybrids to provide an apparent high degree of resistance. The addition of this gene within one parent of a hybrid cross can change a susceptible hybrid to a resistant form but leaves the general agronomic characteristics of the hybrid unaffected. If your seed dealer indicates that a formerly NCLB-susceptible hybrid is now resistant, this may be the reason. Some hybrids may contain both forms of genetic resistance. NCLB resistance is desirable throughout the state.

A strain of the NCLB fungus is common in the Midwest and will infect hybrids or inbreds with the "Ht1" gene. Wisconsin corn growers should be watchful for the occurrence of NCLB in hybrids rated as resistant. An "HtN" gene is being incorporated in some hybrids to control this new race.

Northern corn leaf blight is not affected by tillage or crop rotation.

Northern leaf spot (NLS) can be a problem for some corn hybrids. A new strain of the fungus that causes NLS, *Bipolaris zeicola,* has appeared recently. This pathovar causes considerable damage to certain corn inbreds produced in the upper midwest. Inbreds with B73 background, a popular inbred for the region, appear to be most susceptible. Hybrids from affected crosses show limited foliage symptoms with no apparent effect in yields. Thus, this pathovar is primarily a problem for the seed corn industry. Two sets of symptoms

have occurred in Wisconsin—one affecting foliage, the other affecting root and crown of young plants. Lesions, or leaf spots, develop first on the lower leaves. Given warm, wet conditions, the lesions move rapidly upward. Symptoms are variable depending in part upon the cultivar affected. Most often the lesions are elliptical, or football shaped, .125 to .5 inches long, and have dark margins and light tan centers. There may be some yellowing, or chlorosis, surrounding the spots. On other inbreds, the spots have appeared quite narrow and linear, at least initially.

The seedling blight phase of NLS has been prevalent in susceptible inbreds in some fields. Plants just emerging to 15 inches tall collapsed after showing sudden wilting—symptoms similar to cutworm injury. Root and crown examination revealed extensive dark brown internal and external discoloration beginning in the crown area of the plant.

Crop rotation is not a highly effective control measure, and chemical controls have proven inconsistent to date. If trying fungicides, watch for symptoms on foliage especially after tasseling. Begin treatment if lesions are present and if weather is warm and wet. Continue applications every 7 days during favorable weather up until 10 days before harvest. Seed treatments do not protect seedlings from the root and crown phase of the disease.

Eyespot can be severe when unusually cool, wet weather prevails, when corn is infrequently rotated, and when corn is grown under no-till or minimum tillage. Early-maturing hybrids appear to be more susceptible than full-season hybrids. Eyespot can directly reduce grain yields; severe eyespot may predispose plants to stalk rot and ear rot because of early death and dryness.

Common rust occurs each year but generally develops too late in the season to cause yield losses. The rust fungus does not overwinter in Wisconsin but is carried by winds from the southern states. This factor, along with its sensitivity to weather conditions, makes it a difficult disease to predict. The fungus produces oval or elongated cinnamon-brown blisters (pustules) scattered on both surfaces of the leaves. As the corn matures, the pustules become black. Rust can prematurely kill corn leaves if the disease develops early in the season and wet weather prevails. Most corn hybrids are considered resistant or tolerant.

Gray leaf spot (GLS) is common in southern Wisconsin. GLS is more severe if corn is planted continuously and if corn residue is left on the soil surface. Corn hybrids differ in reaction to GLS.

Corn smut can be recognized by the gray galls that form on all plant parts. When the galls mature, they break open—exposing the black powdery spores of the fungus. Galls that form on the ears and on the stalk above the ear can reduce yield. Most hybrids have good resistance to smut, but this resistance can be altered by hot, dry weather, mechanical injury, hail, and herbicide injury. Excessive application of nitrogen or manure may result in more smut than normal. Smutty corn is not harmful if fed to livestock.

Stewart's bacterial wilt has been documented in seed corn fields over the past few years. Stewart's wilt is caused by a bacterium that is transmitted by the corn flea beetle. The severity of Stewart's bacterial wilt is directly related to beetle population levels.

There are two phases of the disease. One phase affects young plants that are infected by corn flea beetles that survive the winter. Usually infected seedlings rapidly wilt and die. The second and more common phase is a leaf blight that is most apparent after tasseling. Lesions on leaves are gray to green to yellow green and develop as streaks along the veins. Symptoms of Stewart's bacterial wilt may be confused with symptoms associated with northern corn leaf blight caused by a fungus. The use of resistant corn hybrids is the most economical control.

Goss's wilt has recently reemerged in Wisconsin and other areas of the Corn Belt. This bacterial disease has symptoms that can confuse it with other diseases like Stewart's wilt, Northern corn leaf blight, and Diplodia leaf streak, so proper identification is important. Symptoms include distinct light tan or yellow to gray lesions with wavy or irregular margins following the leaf veins. Dark green to black specks or flecks (freckles) are found within the lesions, which often have a shiny appearance due to the bacteria oozing onto the leaf surface. Lesions can coalesce, leading

to whole leaves being blighted. In severely infected plants, wilting and stalk degradation can also occur, causing plant death. Examine stalks for Goss's wilt by splitting the tissue and looking for an orange to brown color with water-soaked and slimy tissue.

Management of this disease is focused on selecting hybrids with good resistance, residue management, and crop rotation. This includes tilling fields immediately after harvest to bury residue and planting a non-host crop like soybean in the subsequent growing season.

Stalk rot

Stalk rot causes substantial losses each year through early plant kill or preharvest stalk lodging. It causes premature death of some plants, fermenting or rotting stalks, and a discolored pith that weakens the stalk. Stalk rot is caused by a complex of fungal organisms that are particularly damaging to plants subjected to stress during the growing season. High soil moisture in August appears to favor root infection of *Pythium* spp. This fungal infection leads to early plant death and subsequent stalk rot. Small ears and lodging often are the result of the early plant kill phase of the stalk rot disease.

Complete control of stalk rot is difficult, but you can take several steps to reduce the problem:

1. Select hybrids that perform best under your system of farming.
2. Maintain a high level of potassium in accordance with soil test recommendations.
3. Control blight diseases, which cause early leaf kill and increase the susceptibility to stalk rot.
4. Grow full-season corn hybrids where possible; early-maturing hybrids generally suffer more from stalk rot.
5. Harvest as early as practical to prevent greater losses from stalk lodging.
6. Minimize plant stresses during the growing season by controlling leaf-feeding insects and borers and irrigating during droughty conditions. Also, avoid unprofitably high plant populations and excessive applications of nitrogen, as both of these stresses increase stalk rot severity.

The nitrogen stabilizer nitrapyrin (N-Serve) reduces soil nitrogen losses from leaching, and it also reduces the incidence and severity of stalk rots in some tests. Less stalk lodging may be another benefit of N-Serve.

Anthracnose symptoms generally appear on the stalk after tasseling as narrow, vertical or oval, water-soaked lesions in the rind. These lesions become tan to reddish brown and eventually dark brown to black late in the season. Black lesions and patches may cover the lower internodes or the entire stalk. Black specks (spore-bearing structures) occasionally are found on the stalk rind. The black external lesions form large, shiny black areas or streaks that may be sunken. Internally, the pith tissues will be decayed and brown to black.

Occasionally, leaves above the ear may die 4 to 6 weeks after pollination while the lower portions of the plant remain green. The upper leaves may turn yellow or red, lodge, and drop off. In some cases, plants may die prematurely and later lodge. Lodging normally is found higher on the stalk when compared to other stalk rot diseases. Anthracnose also can cause a leaf spot phase that usually is not important on field corn but sometimes damages sweet corn.

Control recommendations are resistant hybrids (especially in minimum tillage fields), crop rotation or deep incorporation of corn debris, and balanced fertility.

Root and crown rot

Severe root and crown infections can cause sudden, premature death of plants early in the season or in late August and early September. Affected plants typically develop a uniformly gray to light green appearance a few days before they turn white. Kernels soon shrivel and are somewhat loose on the ears. Stalks are usually firm at this stage, although stalk rot frequently follows.

Symptoms often occur in pockets, although plants can be individually damaged. The primary effect on the crop is a loss from premature plant kill and increased harvesting problems.

Roots usually collapse and appear discolored from their tips toward the base of the stalk. Symptoms progress internally from the crown tissue upward into the stalk. Brace roots are also affected. The base of brace roots appear shriveled, though not necessarily discolored. *Pythium,* a "water

mold" fungus, is believed to be the primary pathogen causing root rot in Wisconsin. Damage may be more severe in low, poorly drained sites and in many sites during years when abundant rains occur in July and August.

No control measures are available, although varieties appear to differ in susceptibility. No relationship to stalk-rot tolerance is believed to exist. The influence of rotations and fertility is not known. Early harvest of severely affected fields should minimize losses.

Nematode diseases

Fields with nematode problems occur in most regions of the state on sandy to clay loam soils. The lesion, lance, and needle nematodes appear to be the most prevalent nematode species associated with corn (table 2-14). In Wisconsin, high populations of nematodes reduce corn yields (table 2-15).

Disease caused by nematodes can be confused with other plant stresses such as low moisture, nutrient deficiencies, and soil compaction. Nematode damage may actually intensify the effects of low soil moisture and low soil fertility. Typical symptoms are small stalks, small ears, and nutrient deficiency symptoms. Nematode problems are diagnosed by examining the soil and roots for these microscopic soil organisms. Do not rely on visual assessments of corn plants to determine if damage is due to nematodes.

Sampling for corn nematodes. A nematode assay can be used to confirm a suspected nematode problem or to eliminate nematodes as one of several possible causes of poor plant growth.

The best results are obtained when soil and root samples are taken 4 to 8 weeks after planting. Nematode populations at this time appear to correlate best with yields obtained in the fall. However, late summer or fall samples also can be useful in predicting next year's problems. Spring samples are less valuable.

Nematode damage to corn often appears in circular or oval pockets in the field. Rarely does an entire field show severe symptoms. Sample the suspected area.

Most laboratories require a fee to process samples for nematode analysis. You may want to contact the laboratory before submission. This is important because some laboratories may require plant or root ball samples in addition to soil samples. Table 2-16 lists laboratories that test for nematodes.

Table 2-14. Nematode genera associated with corn in Wisconsin

Genus, common name	Incidence in Wisconsin	Potential damage	Symptoms	Other hosts
Pratylenchus (root lesion)	very common	moderately damaging	Smaller-than-normal root system. Darkened and discolored roots. Moderate stunting.	Grasses, cereals, legumes, and vegetables. Host range is different for each species of root-lesion nematode.
Longidorus (needle)	common	very damaging in sandy soils	Severe stunting, chlorosis. Severe root pruning. Root system consists mainly of short, stubby, thickened side roots that appear somewhat swollen.	grasses and potatoes
Hoplolaimus (lance)	occasional	moderately damaging	Reduced root system. Darkened and discolored roots. Moderate stunting.	grasses and legumes
Xiphinema (dagger)	occasional	moderately damaging	Severe plant stunting, chlorosis. Few fine feeder roots.	grasses and legumes
Helicotylenchus (spiral)	occasional	damaging only at high populations	Smaller-than-normal root system. Root decay. Mild stunting.	grasses and legumes
Tylenchorhynchus (stunt)	occasional	damaging only at high populations	Smaller-than-normal root system. Moderate stunting, chlorosis.	grasses, cereals, and legumes
Trichodorus (stubby root)	rare	very damaging	Stubby lateral roots, coarse roots, excessive upper roots. Severe stunting, chlorosis.	grasses, legumes, potatoes, cabbages, and beets

There are several ways to take a soil sample for nematode analysis. The following is a general guide:

1. Use a soil probe (preferred) or narrow-bladed trowel or shovel. Take samples close to plants at a depth of 8 to 10 inches. Discard the upper 2 inches of soil, especially if it is dry. Be sure to include plant roots.
2. One sample is adequate for a 10-acre field or for a suspected area within the field. Sample soil and roots from 20 to 25 plants and mix into one sample; 1 to 2 pints of soil is adequate. Sample from plants in the margins of suspected areas and not from their centers. If there is no visible damage, use a zig-zag, W-, or X-shaped pattern to sample the field.
3. Place samples in sturdy plastic bags (do not use paper bags), fasten the open end securely, and accurately label the samples. Use care with the samples as nematodes need to be alive. Do not place samples where they can become dry and overheated. Mail samples early in the week to avoid delays in transit.

Laboratories will report the number of nematodes in nematode per pint (500 cc) of soil, per 100 cc of soil, or per gram of dry root. Each lab may have its own damage thresholds for individual nematode species. However, each lab will give an assessment regarding the possibility of economic damage.

Corn growers can use soil-test reports and strip tests (effective nematicides compared to no treatment) to determine if nematodes are reducing corn yields on their farms. If rootworms are present in a field, the strip test should include an effective insecticide/nematicide rather than a product that gives rootworm control but no nematode control.

If economic populations of nematodes are detected, you can use these control recommendations:

Table 2-15. Corn nematode populations associated with yield loss

Genus and common name	Nematodes/ 100 cc of soil	Nematodes/g of dry root
Pratylenchus (lesion)	100	500
Longidorus (needle)	1	—
Hoplolaimus (lance)	100	300
Xiphinema (dagger)	50	—
Helicotylenchus (spiral)	200	—
Tylenchorhynchus (stunt)	200	—
Trichodorus (stubby root)	50	—

Table 2-16. Directory of nematology laboratories

STATE LABORATORIES

Wisconsin
Plant Disease Diagnostic Clinic
Department of Plant Pathology
UW-Madison
1630 Linden Drive
Madison, Wl 53706-1598
(608) 262-2863
pddc.wisc.edu

Illinois
University of Illinois Plant Clinic
1102 S. Goodman
S-417 Turner Hall
Urbana, IL 61801
(271) 333-0519
plantclinic.cropsci.illinois.edu

Iowa
ISU Plant and Insect Diagnostic Clinic
327 Bessey Hall
lowa State University
Ames, IA 50011
(515) 294-0581
www.ent.iastate.edu/pidc

PRIVATE LABORATORIES

Midwest Laboratories
13611 B Street
Omaha, NE 68144
(402) 334-7770
www.midwestlabs.com

Pest Pros
10086 1st Street
Plainfield, WI 54966
(715) 335-4046
www.pestprosinc.com

- For chemical control, Counter 15G, Mocap 15G, Avicta Complete Corn, and Poncho/VOTiVO are registered nematicides for corn. (Thimet 20G, Lorsban 15G, and all other soil insecticides are not registered as nematicides.) Counter 15G and Mocap 15G are more effective if applied in a 7-inch band at planting rather than in the furrow. Counter 15G is also registered as a corn soil insecticide, such as for corn rootworm control. However, the rates differ for nematode control. See corn rootworm discussion beginning on page 60 for additional information on this chemical. Follow the label directions closely. Avicta Complete Corn and Poncho/VOTiVO are commercially applied seed treatments that are labeled to provide early season protection from plant pathogenic nematodes that attack the root system.
- Maintain high soil fertility. Nutrient-deficient plants are more susceptible to nematode injury.
- Practice good weed control. Many weeds are good hosts and will help maintain or even increase nematode populations.
- Crop rotation may be valuable, but little is known about the susceptibility of other crops to nematodes commonly found on corn.

Ear rot

Corn is susceptible to several ear rot fungi that reduce the yield, quality, and feeding value of the grain. Many of these fungi are capable of producing poisonous metabolites called mycotoxins that affect animal health. Gibberella and Fusarium ear rot are the most common ear rot diseases in Wisconsin. The prevalence and severity of ear rot is associated with above-normal rainfall from July through October, insect feeding on ears, severity of leaf diseases, and hail injury to ears.

Many fungi that cause ear rots also produce mycotoxins that are harmful if fed to livestock. The fungus that causes Gibberella ear rot produces mycotoxins that cause reproductive problems in swine. It also produces a mycotoxin called a refusal factor. If the refusal factor is present, swine will not eat the grain.

The following suggestions may help control corn ear rots.

1. Choose a corn hybrid less susceptible to rot. Ears that are well covered by husks and those that mature in a reclining position have less rot than ears with open husks or those that mature upright. Hybrids that are susceptible to leaf diseases may have more ear rot. Full-season hybrids have fewer ear rot problems than early-maturing hybrids.
2. Control corn earworms and corn borers where practical.
3. Harvest early.

Consider the following strategies when ear rots are prevalent.

- Harvest early; the risk of mycotoxin production increases as the harvest season progresses.
- Harvest as shelled corn or silage. The fungi associated with ear rots will cease activity in corn with less than 20% moisture content and will not survive the activities of fermentation in the silo. Problems may continue if stored as cribbed ear corn.

Corn molds and livestock disorders (mycotoxins)

Moldy grain is not only a grading factor in determining the quality and price of the product, but it can also affect livestock health and milk quality. Some molds under the right environment produce mycotoxins. These may accumulate in the field as corn matures or, more often, during transportation and/or storage.

Several common fungi associated with corn produce many different mycotoxins. Some fungi, such as the *Fusarium* (also called *Gibberella*) fungus that causes pink ear rot, may start in the field. Infection commonly occurs during the silking stage and gradually develops, especially as the grain matures during cool, wet fall periods. This fungus produces several known toxins that actually develop most commonly after fungal growth has occurred, when moderately cool temperatures prevail (50 to 70°F) and kernel moisture is above 20%. These conditions not only exist during many fall seasons, but they can occur when grain sits in bins before grain drying or in feeder

boxes. The *Aspergillus flavus* fungus, which was associated with the aflatoxin problem of the drought season of 1988, can also have its start in the field, but like most other mycotoxin-associated fungi, it is likely to be more damaging as it develops in storage.

Each fungus has its own environmental niche for growth and development. *Cladosporium,* a black fungus found in cold, wet fields, will grow below freezing. Fortunately, it doesn't produce any known toxin. Most *Aspergillus* and *Penicillium* species are "storage" fungi only; they're not found abundantly in field corn, and most are favored by higher temperatures. However, *Aspergillus glaucus* can grow at 13.5% grain moisture (72% relative humidity), and some *Penicillium* species can grow at 35˚F and perhaps around 16% moisture. Growth is slow at first, but heat and moisture migration encourages more rapid mold growth.

Fortunately, the presence of a particular fungus does not mean the poison mycotoxin also is present, but it can be cause for concern. The molds are not always easy to see. Moreover, in most instances, once the poison mycotoxin has been produced it is not readily destroyed, even when the fungus itself is stopped or killed. Consequently the steps outlined to prevent mold buildup—and possibly subsequent mycotoxin development—are important to follow.

Mold control recommendations include prompt drying after harvesting to 13% moisture or below (for longer term storage, especially) or removing oxygen—required for mold growth—by proper ensiling. Feed

Table 2-17. Directory of mycotoxin laboratories

The following laboratories can offer qualitative and quantitative analysis for mycotoxins that include but are not limited to aflatoxins, DAS, fumonisin, ochratoxins, T-2, vomitoxin, and zearalenone. Contact individual laboratories directly for information about prices and services, sample submission, and other details.

AgSource Soil and Forage Laboratory
106 North Cecil Street
Bonduel, WI 54107
agsource.crinet.com
(715) 758-2178

Centralia Animal Disease Laboratory
Illinois Department of Agriculture
9732 Shattuc Road
Centralia, IL 62801-5858
www.agr.state.il.us/AnimalHW/labs/centralialab.html
(618) 532-6701

Covance Laboratories
3305 Kinsman Boulevard
Madison, WI 53707
www.covance.com
(608) 241-4471

Cumberland Valley Analytical Services, Inc.
P.O. Box 669
Maugansville, MD 21767
www.foragelab.com
(800) 282-7522

Dairy One Forage Lab Services
730 Warren Road
Ithaca, NY 14850
www.dairyone.com
(607) 257-1272

Dairyland Laboratories
217 East Main Street
Arcadia, WI 54612
www.dairylandlabs.com
(608) 323-2123

Midwest Laboratories
13611 B Street
Omaha, NE 68144
www.midwestlabs.com
(402) 334-7770

Rock River Laboratory, Inc.
710 Commerce Drive
P.O. Box 169
Watertown, WI 53094-0169
www.rockriverlab.com
(920) 261-0446

Romer Labs, Inc.
Attn: Analytical Services
1301 Stylemaster Drive
Union, MO 63084-1156
www.romerlabs.com
(636) 583-8600

Veterinary Diagnostic Laboratory
North Dakota State University
174 Van ES Hall
Fargo, ND 58105
www.vdl.ndsu.edu
(701) 231-8307

Veterinary Diagnostic Labs
Iowa State University
1600 South 16th Street
Ames, IA 50011
vetmed.iastate.edu/diagnostic-lab
(515) 294-1950

Veterinary Medical Diagnostic Laboratory
1600 East Rollins
Columbia, MO 65211
vmdl.missouri.edu
(573) 882-6811

Woodson-Tenent Laboratories
3507 Delaware Avenue
P.O. Box 1292
Des Moines, IA 50313
www.eurofins.com
(515) 265-1461

corn can also be treated for temporary storage with propionic or other labeled organic acids. None of these destroy toxins, but they prevent accumulated buildup. See comments under "Storage Diseases" on page 106.

Should you suspect a moldy feed problem, stop using that feed and call a veterinarian. Table 2-17 lists several laboratories that will test feed for some of the toxins listed above.

Table 2-18 shows some recognized mycotoxins associated with certain fungi attacking corn and possible animal effects.

Table 2-18. Some mycotoxins and their effects

Toxin or syndrome and (primary) fungal source	Possible animal effects
***Aspergillus* toxins (primarily)**	
Aflatoxins (B1, B2, G1, and G2; B1 is most important)	Liver damage; carcinogenic; reduced growth; hemorrhaging
Ochratoxins	Kidney and liver damage; abortion
Sterigmatocystin	Generally toxic; carcinogenic
Tremorgenic toxin	Tremors and convulsions
***Penicillium* toxins (primarily)**	
Patulin	Lung and brain hemorrhages; edema; kidney damage; possibly carcinogenic
Rubratoxin	Liver damage; hemorrhaging
Citrinin	Kidney damage
***Fusarium* toxins**	
Emetic factor, vomitoxin (deoxynivalenol, DON)	Vomiting; feed refusal by swine, cats, and dogs
Feed refusal factor (may be same as above)	Feed refusal by swine
Other trichothecenes such as T-2, MAS, DAS	Inflammation of gastrointestinal tract; possible hemorrhaging, edema,vomiting, infertility, and other symptoms
Zearalenone and zearalenol (estrogenic syndrome)	Increased estrogenic activity; infertility

Storage diseases

You can store grain for several years with little or no loss of quality if you maintain it at a proper moisture content. For example, corn at a moisture content of 13% or lower can be stored indefinitely regardless of temperature. Note that this is below the 15.5% moisture content required for No. 2 grade corn. Corn at 15.5% moisture content can be safely stored for extended periods of time if the grain temperature is low. However, problems can develop as the grain temperature rises in the spring and during the summer. Table 2-19 charts how long grain can be stored at various temperatures before corn will begin to decay, given the grain's moisture content.

Microbial activity may result in loss of nutrients in the grain; microbes produce heat during growth, and heat damage can occur. Certain microorganisms, mainly fungi, produce toxins (mycotoxins) that can cause illness or even death when consumed by livestock or humans. Since microorganisms affect the value of stored grains in many ways, it is extremely important to minimize this activity.

Storage life of shell corn depends on a combination of factors including moisture content, temperature, degree of invasion by storage fungi, and length of time the corn is to be stored.

Table 2-19. Maximum time for storage of shelled corn at various corn moisture and air temperatures[a]

Storage air temperature	Corn moisture content			
	15%	20%	25%	30%
Fahrenheit	days			
75˚	116	12.1	4.3	2.6
70˚	155	16.1	5.8	3.5
65˚	207	21.5	7.8	4.6
60˚	259	27.0	9.6	5.8
55˚	337	35.0	12.5	7.5
50˚	466	48.0	17.0	10.0
45˚	725	75.0	27.0	16.0
40˚	906	94.0	34.0	20.0
35˚	1,140	118.0	42.0	25.0

[a] The times given above are those in which mold growth will cause enough loss in corn quality to bring about a lowering of grade or permit mold growth that could result in mycotoxin formation. Data are from USDA Farmer's Bulletin No. 2238, *Guidelines for Mold Control in High-Moisture Corn.*

The following suggestions may help control corn storage diseases.

- Clean bins thoroughly before filling.
- Dry shell corn to 12 or 13% moisture content. No damaging invasion by storage fungi will occur below this level.
- Store shelled corn in weathertight bins. Snow and rain are external sources of moisture that can raise the moisture content of stored grain.
- Check stored grain frequently, especially during warm weather. Collect grain samples from several areas in the bin, including the center. A sampling procedure is outlined in table 2-20.

  In circular bins, the grain surface can be divided into "pie sections" for sampling. Make temperature samples by probing the grain 12 to 15 feet with a shielded small-diameter thermometer screwed onto a threaded pipe extension. A good routine to follow is to leave the temperature probe in place while making probes for moisture content. A 6-foot compartmentalized grain trier or implement is best for making probes for moisture content determinations. Do not combine samples when making moisture content determinations. It is important to know the highest moisture content of the bin and where it is located, not an overall bin average. The highest moisture area can serve as a source for moisture migration and is the area where storage fungi will first become active.

Table 2-20. General guide for sampling stored grain

Probe depth	Bin diameter	
	< 24 ft	> 24 ft
Temperature probes	samples/bin	
shallow	1	1[a]
deep	3	5
Moisture probes		
shallow	1[a]	3
deep	5	10

[a] In the bin center

- *Never inspect grain bins alone.* Many people have been covered by grain and suffocated. Work in teams of three, one member wearing a safety line while inside the bin, and the other two handling the line outside. Also, place a sign outside the bin that warns others that people are inside the facility.
- Aeration systems for grain bins can maintain grain quality by reducing the temperature of stored corn and keeping the temperature uniform throughout the bin to prevent moisture migration. You can minimize the problem of moisture migration by keeping the temperatures of the grain in the center of the bin within 10˚F of the average grain temperature near the bin wall. To do this, use aeration fans that pull the air down through the grain at air flow rates of at least .10 cubic foot per minute for each bushel of grain in the bin. Aerate the grain until the temperature of the grain mass is within 10˚F of the average monthly temperature. It is not necessary to lower grain temperatures below 40˚F because most grain storage fungi are not active below this temperature. Also, aeration systems should not be used to raise the temperature above 60˚F because fungi and insects are more active above this temperature.
- Control storage insects; their activities can increase the moisture content of grain. Fumigation may rid grain of insects but not storage fungi.
- Store high-moisture grain in airtight silos or treat grain with organic acids.

When "hot spots" or a crust of moldy corn is found, follow these steps:

1. The decayed and moldy corn should be discarded if mold is severe. Corn with some mold can be dried and fed to livestock, but caution should be exercised. Moldy corn can be fed with less risk if mixed with sound corn but is considered unsafe for all breeding animals.
2. The remaining corn can be turned and thoroughly mixed to redistribute moisture and allow heat to escape. Aeration does this more cheaply and effectively than transferring grain from bin to bin and does not crush and break kernels.

3

SOYBEAN PEST MANAGEMENT

SOYBEAN WEED MANAGEMENT

Herbicide treatments are specific as to time and method of application, weeds they control, rates of application to be used on different soils, and crops that may follow in rotation. Failure to apply them according to label directions can result in incomplete weed control, excessive crop injury, or damage to subsequent crops. Assist your herbicide treatment with a rotary hoe and row cultivation where soybeans are planted in wide rows. For narrow-row soybeans, use a rotary hoe and an increased planting rate to place soybean seedlings in the most competitive position with weeds. Mechanical weed control is seldom an option in no-till soybeans. Check fields regularly to be sure that weeds are being managed on a timely basis.

Many herbicide combinations are registered for use on soybeans (see table 3-1). The use of herbicide combinations that are not registered is discouraged since liability for performance and crop injury lie solely with the user. Similarly, the combination of herbicides with fertilizers or insecticides for simultaneous application is discouraged unless the herbicide label outlines directions for such combination use. Be sure to check the herbicide label or accompanying literature carefully before using herbicides in combination with fertilizers, insecticides, or other herbicides.

BURNDOWN HERBICIDES FOR NO-TILL SOYBEAN

No-till cropping systems are increasingly popular because they offer economic and environmental benefits. Weed management is particularly important in these systems because tillage is not done before planting and few producers cultivate no-till fields after planting. The purpose of a burndown herbicide application is to ensure that the crop is planted into a weed-free setting. No-till soybean fields are more likely to need a burndown application than corn because soybeans are planted later. Check fields carefully to determine if such a treatment is needed. Give particular attention to perennial weeds like dandelion, white cockle, and quackgrass as well as winter annuals like shepherd's purse, chickweeds, buttercups, and pennycress.

Autumn (iodosulfuron) **+ 2,4-D**

Rate: 0.3 oz/a Autumn + 1 pt/a 2,4-D ester.

Adjuvants: Add 1% crop oil concentrate and either 1.5 to 2 qt/a of 28% nitrogen solution or 1.5 to 3 lb/a ammonium sulfate.

Timing: Apply in the fall after harvest or 90 days before soybean planting in the spring.

Remarks: Autumn + 2,4-D is intended to provide fall burndown control and limited residual activity on several broadleaf weeds including alfalfa, plantain, dandelion, horseweed, and several mustard species. The Autumn label recommends application to annual broadleaf weeds up to 3 inches tall. However, a tank mixture with 2,4-D will provide control of larger weeds. Autumn can also be mixed with glyphosate to control grass weeds. The 90-day interval between application and soybean planting limits its use to fall applications. Autumn is rainfast in 2 hours. Do not apply to frozen soil or soil with a pH greater than 8.

Rotational restrictions: Field corn can be planted after 30 days, soybeans after 90 days, winter wheat after 4 months, and spring small grains and sorghum after 8 to 9 months. Other crops cannot be planted for 18 months.

Autumn Super 51 WDG (iodosulfuron + thiencarbazone premix)

Rate: 0.5 oz/a

Adjuvants: Add 1% crop oil concentrate or methylated seed oil and either 1.5 to 2 qt/a 28% urea ammonium nitrate or 1.5 to 3.0 lb/a ammonium sulfate.

Timing: Apply in the fall after harvest or 60 days before planting soybean in the spring.

Remarks: Autumn Super 51 WDG is intended to provide fall burndown control and limited residual activity on broadleaf weeds including alfalfa, plantain, dandelion, horseweed, and several mustard species. The Autumn Super 51 WDG label recommends application to certain broadleaf weeds up to 3 inches and annual grasses no greater than 1 inch in height. However, Autumn Super 51 WDG can be tank mixed with 2,4-D, glyphosate, dicamba, paraquat, or metribuzin for enhanced burndown activity and increased weed spectrum and sizes consistent with the label of the tank-mix partner. The 30-day interval between application and corn planting will primarily limit use to fall applications. Autumn Super 51 WDG is rainfast in 2 hours. Do not apply to frozen soil or soil with pH greater than 8.0.

Rotational restrictions: Field corn can be planted after 1 month; soybeans after 2 months; spring and winter wheat after 3 months; barley, white corn, seed corn, popcorn, and sweet corn after 9 months with a 15 inch-minimum rainfall; and all other crops after 18 months with a 30-inch minimum rainfall. In soils with a pH 7.5 to 8.0, longer rotation intervals are needed; check Appendix Table 2.

Canopy (Classic + Metribuzin premix)

Canopy can be used south of I-90 between La Crosse and Madison and south of I-94 between Madison and Milwaukee.

Rate: 2.25 oz/a.

Adjuvants: Add 1% crop oil concentrate. Add 0.25% nonionic surfactant if tank mixing with glyphosate.

Timing: Apply up to 45 days before planting or preemergence after planting. Annual broadleaf weeds should be less than 3 inches tall and annual grasses should be less than 2 inches tall.

Remarks: Canopy provides burndown control of many no-till weeds such as dandelions, lambsquarters, prickly lettuce, mustard species, common and giant ragweed, and foxtails. Tank mix 1 pt/a of 2,4-D ester for horseweed control. For larger weeds or an expanded spectrum, Canopy can be tank mixed with Assure II, glyphosate, Gramoxone, or 2,4-D. If mixed with 2,4-D, planting must be delayed 7 days after application. Canopy will also provide early season residual control of many annual broadleaf weeds like lambsquarters, pigweed, common ragweed, smartweed, and velvetleaf and suppression of foxtails and crabgrasses. Canopy can be mixed with a preemergence herbicide or followed by a postemergence herbicide for a complete weed control program. About 1 inch of rainfall is needed for full residual activity. Do not use on soils that exceed a soil pH of 7.6. Canopy is rainfast 1 hour after application.

Rotational restrictions: Wheat and barley can be planted 4 months after application; alfalfa, field corn, and tobacco after 10 months; snap beans and peas after 12 months; and sweet corn after 18 months. Oats, potatoes, and crops not listed on the label cannot be planted for 30 months.

Canopy EX (Classic + Express premix) **+ 2,4-D**

Canopy EX can only be applied south of I-90 west of Madison and I-94 east of Madison.

Rate: 1.1 oz/a Canopy EX + 1 pt/a 2,4-D.

Adjuvants: 1% crop oil concentrate (or 0.25% nonionic surfactant if crop oil concentrate is prohibited by a tank-mix partner).

Timing: Apply in the fall or spring at least 7 days before planting soybeans.

Remarks: Canopy EX provides burndown control of dandelions plus several winter annual broadleaves such as mustards (field pennycress, shepherd's purse, etc.), common chickweed, henbit, and horseweed. Canopy EX will provide residual weed control depending on application timing. Other herbicides such as Assure II, glyphosate, Gramoxone, or Metribuzin can be tank mixed to control additional grass or broadleaf weeds. Do not apply to soils with

(Continued on page 114)

Table 3-1. Weed control ratings of soybean herbicides[a]

Herbicides	Mode of action group[b]	Risk of soybean injury	Grasses: Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Foxtails	Wild proso millet	Woolly cupgrass	Broadleaves: Cocklebur	Common ragweed	Eastern black nightshade	Giant ragweed	Lambsquarters	Pigweeds	Smartweeds	Velvetleaf	Perennials: Canada thistle	Dandelion	Hemp dogbane	Nutsedge	Quackgrass
Preplant-incorporated																						
Prowl H_2O	3	VS	**G/E**	**G/E**	**G/E**	**G**	**G/E**	F	F	N	N	P	N	F/G	**G/E**	F	F	N	N	N	N	N
Trifluralin (Treflan)	3	VS	**G/E**	**G/E**	**G/E**	**G**	**G/E**	F	F	N	N	P	N	F/G	**G/E**	P	P	N	N	N	N	N
Preemergence																						
Dual II Magnum	15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	N	F	**G/E**	P	F/G	**G**	P	P	N	N	N	F	N
Intrro	15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	N	F	**E**	P	F	**G**	P	P	N	N	N	F	N
Outlook	15	VS	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	N	F	**G/E**	P	F/G	**G**	P	P	N	N	N	F	N
Warrant	15	S	**G/E**	**G/E**	**G/E**	F/G	**G/E**	F/G	F	P	P/F	**G/E**	P	F/G	**G/E**	F	P	N	N	N	F	N
Authority Assist	2,14	S/M	F/G	F	F	P	**G**	P/F	P	F	F	**E**	F	**G/E**	**E**	**G/E**	**G/E**	P	P	P	F	P
Authority MTZ	5,14	S/M	F	F	F	P	F	P	P	F/G	**G**	**G**	F	**G/E**	**G/E**	**E**	**G/E**	P	P	P	F	P
Boundary	5,15	M	**G**	**G**	**G**	F	**G**	F	F	F/G	**G**	**G**	F	**G**	**G/E**	**E**	**G**	P	P	P	F	P
Enlite	2,14	S/M	P/F	P/F	F	P	F	P	P	P	F/G	**G**	P/F	**G/E**	**G/E**	F	F	P	P/F	P	P	N
Envive	2,14	S	P	P	P	P	P	N	N	F	**G**	**G**	F	**G/E**	**G**	**G**	F/G	P	P/F	P	P	N
FirstRate	2	S	P	P	P	N	P	N	N	**G**	**E**	N	**E**	**G**	**G/E**	**E**	**G**	N	—	—	N	N
Gangster	2,14	S/M	P/F	P/F	P/F	P	P/F	P	P	**G**	**G/E**	**G**	**G/E**	**G/E**	**E**	**E**	**G**	P	F	P	P	N
Lorox	7	M	F	F	F	P	F	P	P	F	**G/E**	F	**G**	**G**	**G/E**	**G/E**	**G**	P	P	N	N	N
Metribuzin	5	M	F	P	F	P	F	P	P	F/G	**G/E**	P	F	**G/E**	**G/E**	**E**	**G/E**	P	P	P	P	P
Optill	2,14	S	F	F	F	P	**G**	P	P	P	F	**G**	F	**G**	**G**	F/G	**G**	P	P/F	P	P	N
OptTILL PRO	2,14,15	S	**G/E**	**G/E**	**G/E**	F	**G/E**	F	F	F	F	**E**	F	**G**	**G/E**	F/G	**G**	P	P/F	P	F	N
Prefix	14,15	S	**G**	**G**	**G**	F	**G**	F	F	P	**G**	**G/E**	F	**G**	**G/E**	**G**	P	P	P	P	P	N
Pursuit	2	VS	F/G	F	F/G	—	F/G	F/P	P	F	F	**E**	F	**G/E**	**E**	**G/E**	**E**	N	P	P	N	P
Python	2	VS	N	N	N	N	N	N	N	F	F/G	F/G	F	**G**	**G**	**G**	**G/E**	N	P	P	N	N
Sharpen	14	S	P/F	P/F	P/F	P	P/F	P	P	P	F	**G**	P	**G**	**G**	F	F	P	P/F	P	P	N
Sulfentrazone + cloransulam (Authority First/Sonic)	2,14	S	P/F	P/F	P/F	N	P/F	N	N	**G**	**E**	**G**	**E**	**E**	**E**	**E**	**G**	P	P	P	F	N
Valor SX	14	S/M	P/F	P/F	P/F	P	P/F	P	P	P	F/G	**G**	P	**G/E**	**G/E**	F	F	P	P/F	P	P	N
Valor XLT	2,14	S	P	P	P	P	P	N	N	F	**G**	**G**	F	**G/E**	**G**	**G**	F/G	P	P/F	P	P	N

Abbreviations:

Risk of soybean injury: H = high; M = moderate; S = slight; VS = very slight; N = none

Control ratings: E = excellent; G = good; F = fair; P = poor; N = none; — = insufficient information

(continued)

Table 3-1. Weed control ratings of soybean herbicides[a] *(continued)*

Herbicides	Mode of action group[b]	Risk of soybean injury	Grasses								Broadleaves								Perennials				
			Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Foxtails	Volunteer Corn	Wild proso millet	Woolly cupgrass	Cocklebur	Common ragweed	Eastern black nightshade	Giant ragweed	Lambsquarters	Pigweeds	Smartweeds	Velvetleaf	Canada thistle	Dandelion	Hemp dogbane	Nutsedge	Quackgrass
Postemergence																							
Basagran	6	S	N	N	N	N	N	N	N	N	**E**	F/G	F	F	P	P/F	**E**	**G/E**	F	P	P	**G**	N
Cadet	14	M	P	P	P	P	P	N	P	P	P	P	F	P	F/G	F/G	P	**E**	P	P	P	N	N
Flexstar	14	M/H	P	P	P	P	P	P	P	P	F/G	**G/E**	**G**	**G**	F	**G/E**	**G**	F	F	P	P	N	N
Lactofen (Cobra/Phoenix)	14	H	P	P	P	P	P	P	P	P	**G/E**	**G/E**	**G**	**G**	F	**G/E**	**G**	F/G	F	P	F	P	N
Resource	14	M	P	P	P	P	P	P	P	P	F	F/G	P	P	F	F	P	**E**	P	P	P	—	P
Ultra Blazer	14	H	P	P	P	P	P	P	P	P	**G**	**G**	**G**	F/G	F	**G/E**	**G/E**	F	P	P	F	P	N
Classic	2	VS	N	N	N	N	N	N	N	N	**E**	**G**	P	F/G	P	**G/E**	**G**	F/G	F	P	P	**G**	N
FirstRate	2	S	N	N	N	N	N	N	N	N	**E**	**E**	N	**E**	P	P	**G**	**G**	F	—	—	F	N
Harmony SG[c]	2	M	N	N	N	N	N	N	N	N	F	F	N	P	**E**	**E**	**G/E**	**G**	P	P	P	—	N
Pursuit	2	S	**G**	F	**G**	F	**G**	P	P	F	**G**	F/G	**E**	F	P	**E**	**G**	**G/E**	F	P	P	N	P/F
Raptor	2	M	**G**	F	**G**	F	**G/E**	**G**	F/G	F	**G/E**	F/G	**E**	**G**	**G**	**E**	**G**	**G/E**	F	—	—	F	F
Synchrony XP[c]	2	M	N	N	N	N	N	N	N	N	**G/E**	**G**	N	F/G	**G**	**E**	**G**	**G**	P	P	P	P	N
Extreme[e]	2,9	S	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G/E**	**G/E**	**E**	**G/E**	**G/E**	**G**	F	**G**	F/G	**G/E**
Flexstar GT 3.5[d,e]	9,14	M	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G/E**	**G/E**	**G/E**	**E**	**G/E**	**G/E**	**E**	F	**G/E**	F/G	**E**
Glyphosate[d,e]	9	N	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G/E**	**G/E**	**G/E**	**E**	**G**	**G/E**	**E**	F	**G/E**	F/G	**E**
Sequence[d,e]	9,15	VS	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G/E**	**G/E**	**G/E**	**E**	**G**	**G/E**	**E**	F	**G/E**	F/G	**E**
Ignite	10	S	F	**G**	**G**	F	**G**	F	**G**	**G**	**G/E**	**G/E**	**G**	**G**	**G**	**G**	**G/E**	**G**	F	F/G	F	P	F
Assure II	1	N	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G**	N	N	N	N	N	N	N	N	N	N	N	N	**G/E**
Fusilade DX	1	N	**E**	**E**	**E**	**E**	**G/E**	**E**	**E**	**G**	N	N	N	N	N	N	N	N	N	N	N	N	**G/E**
Fusion	1	N	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G**	N	N	N	N	N	N	N	N	N	N	N	N	**G**
Poast Plus	1	N	**E**	**E**	**E**	**E**	**E**	**G**	**E**	**G**	N	N	N	N	N	N	N	N	N	N	N	N	F/G
Select Max	1	N	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G**	N	N	N	N	N	N	N	N	N	N	N	N	F/G

[a] These herbicides have been rated for expected weed control, but actual results may vary depending upon rates applied, soil types, weather conditions, and crop management.

[b] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action.

[c] Risk of injury on STS soybeans is very slight.

[d] Only apply to Roundup Ready soybeans or severe injury will occur.

[e] Will not control Roundup Ready volunteer corn.

a pH greater than 7.6 and do not apply any additional Classic or Synchrony if the pH exceeds 7.0. Canopy EX is rainfast in 2 hours.

Rotational restrictions: Begin counting the time interval at soybean planting rather than at application. Small grains can be planted after 3 months; peas, snap beans, and corn can be planted after 9 months; alfalfa can be planted after 12 months; and sweet corn can be planted after 18 months.

Enlite (Valor SX + Classic + Harmony SG premix)

Rate: 2.8 oz/a.

Adjuvants: Add 1% crop oil concentrate (preferred) or 0.25% nonionic surfactant.

Timing: Apply in the fall after soil temperature is less than 50°F or after October 15 or in the spring until planting. Spring applications must be made within 3 days after planting.

Remarks: Enlite will provide burndown and residual control of several broadleaf weeds. Applications in the fall should include 2,4-D or glyphosate for dandelion control. Spring burndown treatments are labeled to control 3-inch-tall weeds like mustards, lambsquarters, pigweed, and smartweed. A tank mix with 2,4-D or glyphosate is recommended to improve control of horseweed and other broadleaf weeds. The residual control from the Valor component fits well in the spring to control lambsquarters, horseweed, nightshade, and pigweeds and to suppress other broadleaf weeds. Annual grasses and giant ragweed will also be suppressed. Burndown treatments should include glyphosate or Assure II to control grasses if present. Either fall or spring applications of Enlite should be followed with a postemergence glyphosate application in Roundup Ready soybean or conventional herbicides for complete weed control. Do not tank mix with Dual, Intrro, or Outlook.

Rotational restrictions: Wheat and barley can be planted 4 months after an Enlite application; field corn, sweet corn, peas, and snap beans after 9 months; alfalfa and oats after 12 months; and potatoes after 30 months.

Envive (Valor SX + Classic + Harmony SG premix)

Envive can only be used south of I-90 between La Crosse and Madison and south of I-94 between Madison and Milwaukee.

Rate: 2.5 oz/a.

Adjuvants: Add 1% crop oil concentrate (preferred) or 0.25% nonionic surfactant.

Timing: Apply in the fall after soil temperature is less than 50°F or after October 15 or in the spring until planting. Spring applications must be made within 3 days after planting.

Remarks: Envive contains a similar ratio of Valor to Classic as Valor XLT. The higher rate of Classic in Envive limits its use to southern Wisconsin because of potential carryover. Enlite contains a lower rate of Classic and will be predominant formulation marketed in Wisconsin. See Valor XLT (page 118) for comments applicable to Envive.

Rotational restrictions: Wheat and barley can be planted 4 months after application; field corn after 10 months; alfalfa, peas, and snap beans after 12 months; sweet corn after 18 months; and potatoes after 30 months.

Extreme (Pursuit + glyphosate premix)

Rate: 3 pt/a.

Adjuvants: Add nonionic surfactant at 0.125% to the spray mixture plus ammonium sulfate at 8.5 to 17 lb/100 gal.

Timing: *Preplant or preemergence*—Apply to annual weeds. Do not apply Extreme if soybeans have emerged unless they are Roundup Ready.

Remarks: Extreme will control emerged weeds and provide residual control of several annual weeds. It can be tank mixed with 2,4-D or pendimethalin if applied before planting.

The Extreme premix provides an economical way to combine the broad-spectrum burndown activity of glyphosate with the residual activity of Pursuit on several broadleaf weeds.

Rotational restrictions: Because this premix contains Pursuit, it can persist and damage certain rotational crops. Do not plant wheat until 3 months after application; alfalfa, edible beans, peas, and rye until 4 months

after application; conventional field and seed corn until 8.5 months after application; barley and tobacco until 9.5 months after application; oats and sweet corn until 18 months after application; and potatoes until 26 months. Allow 40 months before planting all other crops.

Glyphosate

Rate: 0.38 to 0.56 lb ae/a for annuals and 0.75 to 1.5 lb ae/a for quackgrass. See labels for specific rate recommendations.

Glyphosate conversion table

Name	Formulation (lb ae/gal)	Rate for 0.38 lb ae/a	Rate for 0.75 lb ae/a
Many	3.0	16 fl oz	32 fl oz
Durango DMA	4.0	12 fl oz	24 fl oz
Touchdown Total	4.17	12 fl oz	23 fl oz
Roundup PowerMAX	4.5	11 fl oz	21 fl oz
Touchdown HiTech	5.0	10 fl oz	19 fl oz

Adjuvants: Ammonium sulfate at 8.5 to 17 lb/100 gal of spray mixture is frequently recommended, especially when tank mixing glyphosate with residual herbicides. Check the label to see if the glyphosate formulation requires additional surfactant.

Timing: *Preplant*—Apply to annual weeds less than 6 inches tall or to quackgrass that is 6 to 8 inches tall and actively growing. Do not include glyphosate in any spray mixture if soybeans have emerged, unless they are Roundup Ready.

No-till—Glyphosate can be included as a component of a preplant residual herbicide treatment to provide burndown of existing vegetation. Annual weeds emerging after glyphosate application must be controlled by a residual herbicide or a postemergence herbicide. Where a preplant treatment is made as a split application, include glyphosate with the first application, but only if weed growth is present at the time of treatment. If quackgrass is present, include glyphosate in the second application instead of the first. Glyphosate can be tank mixed with 2,4-D ester for improved annual and perennial broadleaf weed burndown, but must be applied at least 7 days before planting.

Remarks: To control quackgrass, apply 0.75 lb ae/a of glyphosate to 6- to 10-inch quackgrass if the field will be tilled after application. Delay tillage for 3 days after application. Increase the rate of glyphosate to 1.5 lb ae/a if the field will be no-till planted. Glyphosate can be applied in 28% nitrogen solution rather than in water, but it is not recommended when treating perennials.

Rotational restrictions: Glyphosate formulations have no rotational restrictions for Wisconsin field crops except for a 30-day interval before tobacco.

Gramoxone Inteon (paraquat)

Rate: Apply 2.0 to 2.5 pt/a when weeds are 1 to 3 inches tall, 2.5 to 3.0 pt/a when weeds are 3 to 6 inches tall, and 3.0 to 4.0 pt/a when weeds are taller than 6 inches.

Adjuvants: Include nonionic surfactant at 0.125% or crop oil concentrate at 1% to the spray mixture.

Timing: *Preplant*—Apply preplant or before soybeans have emerged.

No-till—Gramoxone can be included with preplant residual herbicides to provide burndown of existing vegetation. Where a preplant treatment is made as a split application, include Gramoxone with the first application, but only if weed growth is present at the time of treatment. Annual weeds emerging after application must be controlled by the residual herbicide.

Remarks: Tank mixing Metribuzin or Lorox with Gramoxone usually increases burndown activity. Use a minimum of 10 gal/a of water at 30 to 50 psi pressure with ground applications. Flat fan nozzles are more effective than flood nozzles at delivering the fine spray droplets necessary for thorough spray coverage. If applying less than 20 gal/a of water, only use flat fan nozzles. Do not apply Gramoxone when conditions prevent uniform coverage or when excessive spray drift may occur.

Rotational restrictions: None.

Ignite 280 (glufosinate)

Rate: 29 to 36 fl oz/a. A maximum of 36 fl oz per application and a maximum of 65 fl oz/a can be used for the entire season in Liberty Link soybean.

Adjuvants: Adding 2 lb/a ammonium sulfate will help control weeds under stress.

Timing: Apply to young, actively growing weeds before planting or before soybeans emerge.

Remarks: Do not apply with liquid fertilizers as the carrier. Use nozzles that deliver medium-sized droplets for adequate spray coverage with a minimum of 15 gal/a spray solution. Increase rate to between 20 and 40 gal/a for dense weed growth.

Rotational restrictions: Corn and soybean may be planted any time after application. Root and tuber vegetables, leafy vegetables, brassica leafy vegetables, and small grains (barley, buckwheat, oats, rye, teosinte, triticale, and wheat) may be planted after 70 days, and all other crops may be planted after 180 days.

Optill (Sharpen + Pursuit premix)

Rate: 2 oz/a.

Timing: May be applied in the fall prior to first frost or as a preplant or preemergence in the spring.

Adjuvants: Add 1% methylated seed oil or crop oil concentrate plus 28% nitrogen solution at 2.5% or ammonium sulfate at 8.5 lb/100 gal to maximize burndown activity.

Remarks: Optill can be applied preplant but prior to soybean cracking. Additional adjuvants are required to maximize burndown of existing broadleaf weeds at application. Tank-mix partners such as glyphosate or Ignite 280 may be require to control larger grasses or broadleaf weeds not on the Optill label. Do not apply Optill at cracking or later as severe crop injury will occur. Optill will provide good early-season control of most annual grass and broadleaf weeds but may require a planned sequential application for season-long control. The early-season control will provide greater flexibility with the postemergence timing without the risk of yield loss from weed competition. Planting must be delayed by 30 days if applied to sandy soil with less than 2% organic matter. Tank mixing Authority and Valor are prohibited due to crop injury concerns; wait 30 days before sequential application of either product following Optill. Crop injury may occur if the seed furrows are not properly closed or if the herbicide is washed into the seed furrow.

Rotation restrictions: Alfalfa and wheat can be planted 4 months after an Optill application. Field corn may be planted after 8.5 months; oats, popcorn, sorghum, and sweet corn after 18 months; potatoes after 26 months. All other crops require a 40-month plant-back interval.

OpTILL PRO (OpTILL + Outlook co-pack)

Rate: 2 oz/a OpTILL + 10 fl oz/a Outlook.

Timing: For fall applications, apply prior to first killing frost and do not apply to frozen or snow-covered soil. In the spring apply as a preplant or preemergence application up to soybean emergence in most soils; in coarse soils with ≤ 2.0% organic matter, wait 30 days between application and planting. Do not apply to emerged soybean, as injury will result.

Adjuvants: Add 1% v/v methylated seed oil (MSO) plus either 8.5 to 17 lb/100 g ammonium sulfate (AMS) or 1.25 to 2.5 g/100 g urea ammonium nitrate (UAN). Do not use a nonionic surfactant (NIS) in place of MSO, or poor control of broadleaf weeds will result.

Remarks: OpTILL PRO is a fall- or spring-applied herbicide for selective burndown and residual weed control prior to soybean emergence in minimum and no-till systems. OpTILL PRO may be tank mixed with other burndown herbicides according to the label to increase the spectrum of control. Use of other ALS-inhibiting herbicides, as well as organophosphate or carbamate insecticides, may increase the chance for adverse crop response. Tank mixing with Authority or Valor products are prohibited. Crop injury may occur if the seed furrows are not properly closed or if herbicide is washed into the seed furrow.

Rotational restrictions: Wheat and edible beans and peas can be planted 4 months after an applications; field corn after 8.5 months or 1 month if Clearfield; alfalfa after 9 months; barley after 9.5 months; oats, popcorn, sorghum, and sweet corn after 18 months; potatoes after 26 months. All other crops require a 40-month plant-back interval.

Rage D-Tech (Aim + 2,4-D premix)

Rate: 8 to 16 fl oz/a; the lower rate is recommended for weeds less than 6 inches tall.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1.5 to 2%. Nitrogen fertilizer may be added if required by a tank-mix partner.

Timing: Apply 7 days before planting soybeans when using up to 16 fl oz/a.

Remarks: Rage D-Tech will control many winter and summer annual broadleaf weeds. The Aim component will provide a faster burn of weed foliage than 2,4-D alone. Rage D-Tech can be tank mixed glyphosate or Gramoxone for annual grass control. It can also be tank mixed with preemergence residual herbicides. Do not apply Rage D-Tech on sandy soils or soils with less than 1% organic matter.

Rotational restrictions: Corn or soybeans can be planted after the required interval after burndown treatments. Most other crops can be planted after 30 days.

Sequence (Dual II Magnum + glyphosate premix)

Rate: 2.5 to 4.0 pt/a based on soil texture and weed height.

Adjuvants: Ammonium sulfate may be added at 8.5 to 17.0 lb/100 gal.

Timing: *Preplant or preemergence*—Do not apply if soybeans have emerged unless they are Roundup Ready.

Postemergence—If soybeans are Roundup Ready, applications can be made through the third trifoliate stage.

Remarks: Sequence will control emerged weeds and provide residual control of annual grass weeds. Sequence at 2.5 pt/a provides 0.7 lb ae/a glyphosate; it should be effective on most annual weeds if treated before the 6-inch height. The label has specific rates for individual weed heights. It can be tank mixed with 2,4-D to increase broadleaf burndown activity if applied before planting or other preemergence herbicides. Sequence contains the equivalent of 1.0 to 1.6 pt/a of Dual II Magnum over the labeled rate range and higher rates will provide greater residual grass control.

Rotational restrictions: If the soybean crop is lost, soybeans, corn, peas, or snap beans can be replanted. Alfalfa can be planted 4 months after application and small grains can be planted after 4.5 months. Other crops can be planted the following spring.

Sharpen (saflufenacil)

Rate: 1 oz/a requires 30 days preplant interval on course soils with ≤ 2% organic matter and 0 days preplant on other soils. 1.5 oz/a requires 30 days preplant interval on course soils with ≤ 2% organic matter and 14 days preplant on other soils. 2 oz/a requires 44 days preplant interval on course soils with ≤ 2% organic matter and 30 days preplant on other soils.

Timing: May be applied in the fall prior to first killing frost at 1–2 fl oz/a or in the spring at preplant or preemergence.

Preplant-incorporated—Preplant-incorporated planting based on soil type and rate. Severe crop injury will occur if applied after crop emergence. Sharpen can be tank mixed with Gramoxone, glyphosate, or Ignite 280 to increase burndown activity and to control emerged grasses. 2,4-D LVE can be tank-mixed to improve dandelion control but planting should be delayed 7 to 14 days to reduce the risk of crop injury from the 2,4-D. Add either MSO at 1% plus AMS or UAN at 1 to 2.5% for maximum burndown activity. Decreased activity will occur if a NIS is substituted for the MSO.

Remarks: Sharpen applied at 1 fl oz/a plus MSO at 1% plus AMS or UAN at 1 to 2.5% will effectively burn down most annual and perennial broadleaf weeds; however, the perennials will recover. Sharpen will not control emerged grasses and will require a tank mix partner. Early season broadleaf residual control will be obtained with Sharpen applied at the proper rate for the soil type (up to 2 fl oz/a). Sharpen will require a tank-mix partner to control emerging grasses. A planned sequential herbicide application will be required for season-long broadleaf and grass weed control. Sharpen plus a residual grass herbicide should allow the postemergence application to be delayed without the risk of early-season weed competition. Sharpen has good crop tolerance but may cause injury under stressful growing conditions; do not apply to emerged soybeans or severe injury will

occur. Do not use on sands with less than 3% organic matter and where depth to ground water is 30 feet or less.

Rotational restrictions: None.

Synchrony XP (Classic + Harmony SG permix) **+ Express** (tribenuron) **+ 2,4-D**

Rate: 0.375 oz/a Synchrony + 0.25 oz/a Express + 8 fl oz/a 2,4-D ester.

Adjuvants: Add a crop oil concentrate at 1% to the spray mixture.

Timing: Apply in the fall or in the spring 15 days before planting.

Remarks: Applying Synchrony, Express, and 16 fl oz/a 2,4-D following corn harvest in the fall has given excellent dandelion and winter annual weed control in fields that will be no-till planted to soybeans the next spring. Treatments made through corn stalks have performed well in killing dandelions. If possible, wait 10 to 14 days after harvest for the stalks to settle and weeds to be exposed to the spray solution.

Synchrony plus glyphosate (not 2,4-D or Express) can be applied without delay before soybean planting. Use 0.25% surfactant and ammonium sulfate. This tank mix may increase control of dandelion, horseweed, and some other winter annual weeds compared to glyphosate alone. In addition, if a 0.75 oz/a rate is used in the spring, Synchrony will provide some residual control of lambsquarters, pigweeds, smartweeds, and ragweeds. If mixed with 2,4-D ester, planting must be delayed for 7 days after application.

Rotational restrictions: Only soybeans can be planted the spring following a Synchrony + Express application.

Valor XLT (Valor SX + Classic premix)

Valor XLT can only be applied south of I-90 west of Madison and south of I-94 east of Madison.

Rate: 2.5 oz/a.

Adjuvants: Add 1 to 2 pt/a crop oil concentrate or 0.25% nonionic surfactant. Ammonium sulfate at 8.5 to 17 lb/100 gal may also be added.

Timing: Apply in the fall after soil temperature is below 50°F or October 15 or in the spring either before planting or within 3 days after planting.

Remarks: Valor XLT will provide burndown control of several broadleaf weeds including dandelions in the fall and burndown and limited residual control of lambsquarters, horseweed, pigweed, velvetleaf, and common ragweed in the spring. Annual grasses and giant ragweed will also be suppressed. Burndown treatments should include glyphosate or 2,4-D. Rates higher than 2.5 oz/a and applications north of the interstate may lead to carryover to rotational crops. This rate is intended to be followed by a postemergence glyphosate application in Roundup Ready soybean. Valor XLT can be tank mixed with pendimethalin, Lorox, metribuzin, or additional Valor SX for increased residual activity in the spring. Do not tank mix with Dual, Intrro, or Outlook. Do not use on soil with a pH greater than 7.6.

Rotational restrictions: Barley and wheat can be planted after 4 months; field corn and tobacco after 10 months; alfalfa, snap beans, and peas after 12 months. Oats and potatoes should not be planted for 30 months.

Verdict (Sharpen + Outlook premix)

Rate: 5 to 10 fl oz/a.

Timing: *Preplant (fall applications)*—Apply Verdict at 5 to 10 fl oz/a following crop harvest and prior to the first frost for burndown of broadleaf weeds.

Preplant (spring applications)—Apply Verdict at 5 fl oz/a early preplant through preemergence for burndown of broadleaf weeds. Do not apply to emerged soybean.

Remarks: Verdict is a premix of Sharpen and Outlook herbicides. Verdict can be used as a broadleaf burndown herbicide in no-till or reduced-till soybean systems and will also provide some residual control of some broadleaf and grass weeds but will not provide season-long control. Verdict at the 5 oz/a rate provides the equivalent of 1 oz/a Sharpen and 4.2 oz/a Outlook. Verdict can be used in sequential applications with Sharpen or Optill herbicides, but longer plant-back restrictions are needed for higher rates of saflufenacil, and season limits of saflufenacil cannot be exceeded. Verdict can be tank mixed with Gramoxone, glyphosate, or Ignite 280 to increase burndown activity and control emerged

grass weeds. Verdict can also be mixed with 2,4-D in early preplant applications; however, plant-back restrictions of 2,4-D must be followed. Do not apply Verdict within 30 days of other Group-14 herbicides (sulfentrazone, flumioxazin) as severe crop injury may result. Do not apply to emerged soybean as severe injury may result. Do not use on sands with less than 3% organic matter and where depth to ground water is 30 feet or less. To improve burndown activity, add methylated seed oil at 1% v/v plus ammonium sulfate or urea ammonium nitrate at 1 to 2.5% v/v.

Rotational restrictions: Fall-seeded cereal crops may be planted after 4 months. There are no crop restrictions the following spring after Verdict application. In course soils with 2% organic matter or less, soybean cannot be planted for 1 month following a 5 fl oz/a application.

Vida (pyraflufen)

Rate: 0.5 to 2.0 fl oz/a.

Adjuvants: Add 0.5% nonionic surfactant or 1% crop oil concentrate.

Timing: Apply to emerged broadleaf weeds before they exceed 4 inches in height or 3 inches in rosette diameter and prior to soybean planting.

Remarks: Vida is a contact herbicide that will control many emerged annual broadleaf weeds. Only the top growth of perennials will be controlled. Vida can be tank mixed with glyphosate for grass control or added control of larger broadleaf weeds. Vida can also be mixed with 2,4-D or other residual herbicides. Good spray coverage is necessary for good weed control.

Rotational restrictions: Only corn, soybeans, potatoes, or wheat can be planted after a burndown application of Vida. Other crops can be planted after 30 days.

2,4-D ester

Rate: 1 pt/a of a 3.8 lb/gal 2,4-D ester formulation or equivalent.

Adjuvants: Approved crop oil concentrates, agricultural surfactants and liquid fertilizers may be added to the spray mixture to improve control.

Timing: *Preplant-incorporated*—Apply 2,4-D ester no less than 7 days before planting. Applications of 1 qt/a require a 30-day wait before planting.

No-till—Apply before no-till soybean planting for the suppression or control of small, actively growing broadleaf weeds. This treatment can be used to control broadleaf weeds that aren't effectively controlled by Gramoxone or glyphosate. This treatment may be tank mixed with many conservation-tillage soybean treatments for improved broadleaf weed control.

Remarks: There is some risk of soybean injury, especially if heavy rains occur after application. Do not apply 2,4-D before planting unless you are prepared to accept soybean injury including possible stand loss and/or yield reduction in some years. Plant soybeans 1 to 2 inches deep and make certain the seed is adequately covered. Do not use on sandy soils with less than 1% organic matter. Do not cultivate between herbicide application and soybean planting.

Rotational restrictions: 2,4-D does not persist in the soil for long, but certain labels prohibit replanting other crops in the same season unless 2,4-D is labeled for preplant use on that crop.

PREPLANT-INCORPORATED & PREEMERGENCE HERBICIDES

Authority Assist (Spartan + Pursuit premix)

Rates: 6 to 12 fl oz/a; reduced rates of 4 to 6 fl oz/a are recommended for early-season weed suppression when followed by glyphosate in Roundup Ready soybeans.

Timing: *Preplant-incorporated*—Apply and incorporate into the top 2 inches of soil. In dry seasons, a preplant-incorporated treatment will provide better weed control than preemergence treatment.

Preemergence—Apply between 45 days before planting until within 3 days after planting.

No-till—Authority Assist will provide burndown activity on several annual grass and broadleaf weeds when applied with crop oil, but a tank mix with glyphosate or Gramoxone would typically be required for broad-spectrum burndown of emerged weeds.

Remarks: Authority Assist will control many annual broadleaf weeds and will suppress several annual grass species. Authority Assist can be tank mixed with other preemergence grass herbicides to increase grass control. The length of residual activity will depend on the rate used. At reduced rates, it will provide early-season broadleaf weed control and grass suppression when followed by glyphosate in Roundup Ready soybeans. Heavy rains after application or cold, wet soils may increase the risk of injury. The seed furrow must be closed prior to application or crop injury may result. Do not apply to cracking or emerged soybeans because severe injury will occur. Do not apply to sands with less than 1% organic matter.

Rotational restrictions: Soybeans can be replanted at any time after application; wheat can be planted after 4 months; barley and tobacco can be planted after 9.5 months; field corn, peas, and snap beans can be planted after 10 months; alfalfa can be planted after 12 months; sweet corn and oats can be planted after 18 months; and potato can be planted after 26 months.

Authority First

See sulfentrazone + cloransulam premix (page 125).

Authority MTZ (Spartan + Metribuzin premix)

Rates: 12 to 20 oz/a; reduced rates of 8 to 14 oz/a are recommended for early season weed suppression when followed by glyphosate in Roundup Ready soybeans.

Timing: *Preplant-incorporated*—Apply and incorporate into the top 2 inches of soil. In dry seasons, preplant incorporated treatment will provide better weed control than preemergence treatment.

Preemergence—Apply up to 30 days before or within 3 days after planting.

No-till—Apply up to 30 days before no-till planting or apply preemergence after planting. The addition of 1 qt/a of crop oil concentrate or nonionic surfactant at 0.25% will increase the burndown activity of Authority MTZ. If additional burndown activity is needed, tank mix with glyphosate, Gramoxone, or 2,4-D to control emerged weeds.

Remarks: Authority MTZ will control many annual broadleaf weeds and will suppress several annual grass species. Authority MTZ can be tank mixed with other preemergence grass herbicides to increase grass control. The length of residual activity will depend on the rate used. At the reduced rates, it will provide early season broadleaf weed control when followed by glyphosate in Roundup Ready soybeans. Heavy rains after application, cold, wet soils, or soils with a pH greater than 7.5 may increase the risk of injury. The seed furrow must be closed prior to application or crop injury may result. Do not apply to cracking or emerged soybeans because severe injury will occur. Do not apply to sands with less than 1% organic matter.

Rotational restrictions: Soybeans can be replanted any time after application; wheat and barley can be planted after 4 months; field corn and peas after 10 months; alfalfa, potatoes, and tobacco after 12 months; and snap beans, peas, sweet corn, and oats after 18 months.

Boundary 6.5EC (Dual II Magnum + Metribuzin premix)

Rate: 1.5 to 1.8 pt/a when followed by a postemergence herbicide program or 1.2 to 3 pt/a in a one-pass program.

Timing: *Preplant-incorporated*—Apply and incorporate into the top 2 inches of soil within 14 days before planting.

Preemergence—Apply after planting, but before weeds and crop emerge.

No-till—Boundary can be preplant surface applied up to 30 days before planting or preemergence after planting. Higher rates should be used with early preplant applications. Boundary can be tank mixed with glyphosate, Gramoxone, and 2,4-D to control emerged weeds.

Remarks: Boundary controls many annual grass and broadleaf weeds. When used at lower rates, it will provide early season control; late emerging weeds should be controlled with a sequential postemergence herbicide. Boundary can be tank mixed with Python for added velvetleaf control; with FirstRate for added common and giant ragweed and velvetleaf control; with Command for added common ragweed and velvetleaf control; and with Prowl for aid with

triazine-resistant weeds. Boundary may injure soybeans because of the Metribuzin component. The risk of soybean injury increases when soybeans are planted less than 1.5 inches deep or when heavy rains follow application. Use should be avoided on soils with less than 0.5% organic matter, on soils with a pH of 7.5 or higher, and in fields where residues of atrazine exist. Do not use on sand regardless of organic matter or on loamy sand with less than 2% organic matter. Limit the rate of Boundary to 1.5 pt/a on soils with a pH above 7. Check the label for a list of metribuzin-sensitive soybean varieties. Boundary can be mixed with liquid fertilizer or impregnated onto certain dry fertilizers for simultaneous applications.

Rotational restrictions: Alfalfa and winter wheat can be planted 4.5 months after application; barley, corn, peas, and spring wheat after 8 months. Most other crops can be planted after 12 months, except root crops, which are 18 months.

Dual II Magnum (s-metolachlor + safener)

Rate: 1 to 2 pt/a.

Timing: *Preplant-incorporated*—Apply within 14 days before planting, blending the herbicide into the top 2 inches of soil during seedbed preparation. In dry seasons, preplant-incorporated applications will provide better annual weed control than preemergence applications.

Preemergence—Apply after planting, but before weeds and soybeans emerge.

Postemergence—Apply up to 1.33 pt/a to soybeans that have not exceeded the third trifoliate. Emerged weeds will not be controlled. Do not apply postemergence if a soil-applied application has been made. Apply 90 days prior to harvest and do not graze or feed treated forage.

No-till—Apply 1.67 to 2.0 pt/a of s-metolachlor. This treatment can be split with one-half applied early and the remainder applied at planting. When soybeans will be planted within 7 days, make a single application either ahead of or at planting. If weeds are present at the time of treatment, include Gramoxone or glyphosate in the spray mixture for improved annual weed burndown. On sands, loamy sands, or sandy loams, apply 1.33 pt/a within 14 days before planting.

Remarks: S-metolachlor provides good to excellent control of foxtails and other annual grasses but fails to control velvetleaf and several other annual broadleaf weeds. To broaden the spectrum of weeds controlled, it can be tank mixed with Command, Lorox, Metribuzin, Pursuit, or trifluralin. Preplant-incorporated applications of 2 pt/a s-metolachlor provide reasonable yellow nutsedge control, but preemergence applications provide only limited control. On soils with an organic matter content between 6 and 20%, use up to 2.5 pt/a. It is not labeled for use on peat or muck soils. Soybean injury is not a serious problem. S-metolachlor can be mixed with liquid fertilizer for simultaneous application and preplant-incorporated applications can also be impregnated onto certain dry fertilizers.

Rotational restrictions: S-metolachlor will not persist into the fall or the following growing season.

FirstRate (cloransulam)

Rate: 0.6 oz/a if less than 3% organic matter and 0.75 oz/a if greater than 3% organic matter.

Timing: *Preplant-incorporated*—Apply within 2 weeks before planting for best results and incorporate into the top 1 to 3 inches.

Preemergence—Apply after planting and before weed emergence, within 2 days of planting is best.

No-till—Preplant surface applications can be made within 2 weeks before planting. FirstRate has foliar activity to control certain emerged broadleaf weeds. Add the adjuvants listed for postemergence applications to obtain burndown activity. Gramoxone, glyphosate, and 2,4-D can be tank mixed with FirstRate to enhance burndown. Apply FirstRate within 2 weeks of planting in no-till.

Remarks: FirstRate controls several broadleaf weeds including common and giant ragweed (if not ALS-resistant), velvetleaf, pigweed, lambsquarters, and smartweed. FirstRate will not control black nightshade and will require a tank-mix partner or sequential herbicide treatment for control. Tank mixing FirstRate with Dual II

Magnum, Intrro, or Outlook would provide both grass and black nightshade control. FirstRate's control may be reduced if applied to soil with greater than 5% organic matter. Do not apply if steady wind speed exceeds 10 mph.

Rotational restrictions: Do not plant wheat until 3 months after application; alfalfa, field corn, oats, peas, and snap beans until 9 months after application; and potatoes and sweet corn until 18 months after application. Tobacco can be transplanted 10 months after a 0.3 oz/a rate, but requires 30 months after higher rates. Crops not listed on the label require a 30-month rotational interval.

Gangster (FirstRate + Valor co-pack)

Rate: 1.8 oz/a (0.3 oz/a FirstRate + 1.5 oz/a Valor) to 3.6 oz/a (0.6 oz/a FirstRate + 3.0 oz/a Valor).

Timing: *Preemergence*—Apply from 14 days before planting to 3 days after planting.

Remarks: Gangster will provide preemergence control of many annual broadleaf weeds. The length of residual activity will depend on the rate used. At lower rates, it will provide early season broadleaf control and could be followed with a broad spectrum postemergence herbicide. At higher rates, grasses may be the only weeds that require postemergence treatment. The Gangster co-pack contains Gangster FR, which has a label that is nearly identical to FirstRate, and Gangster V, which has a label that is nearly identical to Valor. Review the information under FirstRate and Valor for details and precautions about these products. Although the Gangster FR label describes postemergence applications, do not apply this co-pack postemergence or serious injury will result.

Rotational restrictions: Each label has rotational restrictions listed. Follow the most restrictive interval. Wheat can be planted at 3 months after application; field corn, oats, peas, and snap beans after 9 months; and sweet corn and potatoes after 18 months. Many other crops require longer intervals.

Intrro (alachlor)

Rate: *Preplant-incorporated*—2.5 to 3 qt/a.

Preemergence—2 to 3 qt/a; 2 qt/a when followed by glyphosate.

Timing: *Preplant-incorporated*—Apply to dry soil within 7 days before planting, blending the herbicide into the top 1 to 2 inches of soil during seedbed preparation. In dry seasons, preplant-incorporated treatment will provide better annual weed control than preemergence treatment.

Preemergence—Apply after planting, but within 5 days of the last tillage for weed control.

No-till—For improved annual weed burndown, tank mix glyphosate or Gramoxone with 2.5 to 3 qt/a.

Remarks: Intrro provides good to excellent control of foxtails and other annual grasses but fails to control velvetleaf and several other annual broadleaf weeds. To broaden the spectrum of weeds controlled, Intrro can be tank mixed with Command, Lorox, Metribuzin, or Pursuit. Preplant-incorporated Intrro at 3 lb/a of active ingredient provides reasonable yellow nutsedge control on mineral soils as well as peat or muck soils. Preemergence-applied Intrro provides only limited control of yellow nutsedge. To control black or hairy nightshade, use a minimum of 2.5 lb/a active Intrro on coarse soils and 3 lb/a active Intrro on medium- and fine-textured soils. Intrro provides better annual weed control on peat or muck soils than other soil-applied herbicides. Soybean injury from Intrro isn't a serious problem. Certain dry fertilizers can be impregnated with Intrro where the herbicide/fertilizer mixture will be incorporated into the soil before planting.

Rotational restrictions: Alfalfa, corn, dry beans, small grains, and soybeans can be planted the following season.

Lorox DF (linuron)

Rate: 1 to 2 lb/a.

Timing: *Preemergence*—Apply after planting but before soybeans emerge.

No-till—Preplant treatments of Lorox DF can be surface-applied where soybeans will be planted into a cover crop or previous crop residue. If small weed seedlings are present, add 1% crop oil concentrate to the spray mixture. For larger weeds, Lorox can be tank mixed with Gramoxone, glyphosate, or 2,4-D for improved annual weed burndown.

Remarks: Lorox provides good control of most annual broadleaf weeds but only partially controls cocklebur and can miss grasses. Lower rates of Lorox can be tank mixed with Dual II Magnum, Intrro, or Outlook to improve grass control. Lorox is ineffective on peat or muck soils. Risk of soybean injury increases markedly on sandy soils. Do not use Lorox on sand, loamy sand, or any soil with less than 1% organic matter. Plant soybeans at least 1.75 inches deep. Even on medium and heavy soils, heavy rainfall following application can leach Lorox to the soybean root zone causing foliar burn and stand reduction. Applications to areas with residual atrazine may cause serious soybean injury.

Rotational restrictions: Crops can be planted 4 months following application.

Metribuzin

Rate: 0.33 to 0.66 lb/a.

Timing: *Preemergence*—Apply after planting, but before soybeans emerge.

No-till—Metribuzin may be tank mixed with either Gramoxone or glyphosate for improved annual weed burndown.

Remarks: Metribuzin provides excellent control of annual broadleaf weeds but only partial control of annual grasses. It can be tank mixed with Command, Dual II Magnum, Intrro, Outlook, or Prowl to broaden the spectrum of control. Metribuzin is ineffective on peat or muck soils. Risk of soybean injury increases markedly on lighter-textured soils and on soils with a pH of 7.5 or higher. Do not use metribuzin on sand regardless of organic matter content, on loamy sand or sandy loam with less than 1% organic matter, or on any soil with less than 0.5% organic matter. Plant soybeans 1.5 inches deep. Even on medium and heavy soils, heavy rainfall following application can leach metribuzin to the soybean root zone causing foliar burn and stand reduction. Applications to areas with residual atrazine may cause serious soybean injury. Additionally, the use of an organophosphate insecticide on the same ground may increase the risk of soybean damage. Certain dry fertilizers may also be impregnated with this herbicide.

Rotational restrictions: Alfalfa, barley, corn, potatoes, and wheat can be planted 4 months after application; peas after 8 months; beans and oats after 12 months.

Outlook (dimethenamid-P)

Rate: 10 to 21 fl oz/a.

Timing: *Preplant-incorporated*—Blend into the top 1 to 2 inches of soil within 14 days before planting. In dry seasons, preplant-incorporated treatment will provide better annual weed control than preemergence treatment. Preplant-incorporated applications are not recommended on coarse soils with less than 1.5% organic matter.

Preemergence—Apply after planting, but before weeds emerge.

Postemergence—Outlook may be applied from the 1 to 5 trifoliate stage.

No-till—Usually a split application where one-half of the herbicide is applied early and the remainder applied at planting provides better weed control. When soybeans will be planted within 7 days, make a single application either ahead of or at planting. If weeds are present at the time of treatment, include Gramoxone or glyphosate in the spray mixture for improved annual weed burndown. Early preplant treatment is not recommended on coarse-textured soils.

Remarks: Outlook provides good to excellent control of foxtails, crabgrass, and fall panicum but has no effect on quackgrass. It fails to control velvetleaf and several other annual broadleaf weeds. To broaden the spectrum of weeds controlled, Outlook can be tank mixed with Command, Lorox, Metribuzin, Prowl, Pursuit, Python, or trifluralin. Preplant-incorporated Outlook at 20 fl oz/a provides reasonable yellow nutsedge control, but preemergence applications provide only limited control. Adjust the rate according to either soil cation exchange capacity or soil texture and organic matter content. Use 21 fl oz/a of Outlook on all soils with greater than 8% organic matter. Outlook generally doesn't injure soybeans, but long periods of saturated soil may suppress early season soybean growth. Outlook can be impregnated onto certain dry fertilizers for simultaneous application.

Rotational restrictions: Small grains can be planted 4 months after application, and there are no restrictions the year after applying Outlook.

Prefix (Dual Magnum + Flexstar premix)

Rates: 2.0 to 2.5 pt/a. In southern Wisconsin (south of Hwy 18 west of Madison and south of I-94 east of Madison), the maximum rate is 2.5 pt/a. The maximum is 2 pt/a in the region south of I-94 and Hwy 29, excluding Adams, Clark, Marathon, Marquette, Portage, Shawano, Waupaca, Waushara, and Wood counties.

Timing: *Preplant-incorporated*—Apply and incorporate into the top 2 inches of soil within 7 days after application. In dry seasons, preplant-incorporated treatment will provide better weed control than preemergence treatment.

Preemergence—Apply after planting, but prior to weed emergence.

Postemergence—Apply from cracking to the third trifoliate stage. Tank mix with glyposate to control emerged weeds in Roundup Ready soybeans. Postemergence applications will speckle and crinkle leaves and may cause stunting.

No-till—Apply up to 15 days before no-till planting or apply preemergence after planting. Tank mix with glyphosate, Gramoxone, or 2,4-D to control emerged weeds.

Remarks: Prefix will control many annual grass and broadleaf weeds. The 2 pt/a rate is intended to provide early season residual control prior to a postemergence glyphosate or conventional herbicide treatment. The length and degree of control will depend on the soil texture and organic matter. Full-season control of many weeds may be possible on coarse-textured soil. If the maximum rate of Prefix was soil-applied, do not apply Flexstar postemergence.

Rotational restrictions: Soybeans and snap or dry beans can be planted anytime after application; small grains can be planted after 4.5 months; field and sweet corn and peas after 10 months; and alfalfa, potatoes, and tobacco after 18 months.

Prowl H_2O (pendimethalin)

Rate: 1.5 to 3.0 pt/a.

Timing: *Preplant-incorporated*—Apply to dry soil within the several weeks before planting. Incorporate into the top 1 to 2 inches of soil within 7 days of application.

Preplant-surface—Apply up to 15 days before planting or 45 days before planting if Pursuit is applied postemergence. Do not apply after planting.

No-till—Pendimethalin can be tank mixed with 2,4-D, glyphosate, or Gramoxone for burndown or with several other residual herbicides to broaden the spectrum of control.

Remarks: Pendimethalin provides good to excellent annual grass control but does not adequately control velvetleaf, wild mustard, common ragweed, smartweed, cocklebur, or black nightshade. To broaden the spectrum of weed control, it can be tank mixed with Command, Dual II Magnum, Intrro, Metribuzin, or Pursuit. Pendimethalin is ineffective on peat or muck soils. Soybean injury doesn't appear to be a problem except when applied to wet soils or in areas subject to prolonged flooding. Injury symptoms are stunted soybean plants with swollen stems and inhibited secondary roots. Pendimethalin can be impregnated onto certain dry fertilizers for simultaneous application.

Rotational restrictions: Pendimethalin generally doesn't persist into the following season, but winter wheat or winter barley should not be planted within 120 days after application.

Pursuit (imazethapyr)

Rate: 4 fl oz/a.

Timing: *Preplant-incorporated*—Apply to dry soil and blend into the top 1 to 2 inches of soil up to 45 days before planting.

Preemergence—Apply after planting, but before soybeans emerge.

No-till—Pursuit may be tank mixed with 2,4-D, Gramoxone, or glyphosate for improved annual weed burndown. For maximum residual grass control, include alachlor, Dual II Magnum, Outlook, or Prowl in the spray mixture.

Remarks: Pursuit controls numerous annual broadleaf weeds and provides some annual grass control. However, it is usually tank mixed with a soil-applied herbicide such as Dual II, Intrro, Outlook, Prowl, or trifluralin to broaden control. Do not tank mix with Command. Do not apply Pursuit more than once per season or the same year as other imazethapyr-containing herbicides. Pursuit is ineffective on peat or muck

soils. Risk of soybean injury from Pursuit is minimal but it occasionally causes internode shortening and a reduction in fine root hairs.

Rotational restrictions: Do not plant wheat until 3 months after application; alfalfa, edible beans, peas, or rye until 4 months after application; conventional field corn or seed corn until 8.5 months after application; barley or tobacco until 9.5 months after application; oats, popcorn, sorghum, or sweet corn until 18 months after application; or potatoes until after 26 months. All other crops should not be planted for 40 months after Pursuit application.

Python (flumetsulam)

Rate: 0.8 to 1.33 oz/a.

Timing: *Preplant-incorporated*—Apply and incorporate in to top 2 to 3 inches of soil within 30 days before planting. The lower rates within each soil texture category need to be applied within 14 days of planting.

Preemergence—Apply after planting, but before soybeans crack or weeds emerge.

No-till—If weeds are present at the time of treatment, include Gramoxone, glyphosate, or 2,4-D in the spray mixture for annual weed burndown.

Remarks: At lower labeled rates Python controls lambsquarters, pigweed, and velvetleaf. Higher labeled rates control smartweed and nightshade. Some common and giant ragweed will escape control, even at higher rates. Python can be used as a preemergence treatment to control broadleaf weeds prior to a glyphosate treatment in Roundup Ready soybeans. Do not use on peat or muck soils. Soybeans have shown good tolerance to Python.

Rotational restrictions: Field and seed corn can be replanted any time. Do not plant alfalfa, dry beans, small grains, or peas for 4 months after application; tobacco until 9 months after application; or potatoes until 12 months after application. Sweet corn should not be planted until 18 months after application, with the exception of the specific hybrids listed on the label or supplements that can be planted after 10.5 months. Crops not listed on the label require a 26-month rotational interval.

Sonic

See sulfentrazone + cloransulam premix.

Sulfentrazone + cloransulam premix

Rate: 6.45 to 8 oz/a; reduced rates of 3 to 4 oz/a are recommended for early-season weed suppression when followed by glyphosate in Roundup Ready soybeans.

Timing: *Preplant-incorporated*—Apply within 14 days and incorporate into the top 1 to 3 inches of soil.

Preemergence—Apply at planting or within 3 days after planting.

No-till—Preplant surface applications can be made before planting and this premix will provide burndown activity on certain broadleaf weeds in addition to residual activity if 0.125 to 0.25% nonionic surfactant and ammonium sulfate at 2.5 lb/a are added. It can be mixed with glyphosate, Gramoxone, or 2,4-D to broaden the spectrum of control.

Remarks: This premix will provide preemergence control of many annual broadleaf weeds. The length of residual activity will depend on the rate used. At lower rates, it will provide early season broadleaf weed control when followed by glyphosate in Roundup Ready soybeans. At full rates, annual grasses will be suppressed, but will likely need to be controlled postemergence. The seed furrow must be closed prior to applying this premix or crop injury may result. Do not apply to cracking or emerged soybeans because severe injury will occur. Do not apply to sands with less than 1% organic matter. Do not apply if steady wind speed exceeds 10 mph.

Rotational restrictions: Wheat can be planted after 4 months; field corn after 10 months (if organic matter is greater than 1.5% and soil pH is less than 7); alfalfa, small grains, and dry beans after 12 months; and sweet corn and potatoes after 18 months. Several other crops cannot be planted for 30 months.

Trifluralin

Rate: 1 to 2 pt/a of 4 lb/gal formulation or equivalent.

Timing: *Preplant-incorporated*—Apply to dry soil within the several weeks before planting. Incorporate into the top 2 to 3 inches of soil within 24 hours after application. Prompt incorporation is important.

Remarks: Trifluralin provides good to excellent annual grass control but does not control black nightshade, cocklebur, wild mustard, common ragweed, smartweed, or velvetleaf. Trifluralin can be tank mixed with Command or metribuzin. It is ineffective on peat or muck soils. Soybean injury doesn't appear to be a problem except when trifluralin is applied to wet soils or in areas subject to prolonged flooding. Trifluralin can cause stunted soybean plants with swollen crowns and inhibited secondary roots. It can be mixed with liquid fertilizers or impregnated onto certain dry fertilizers for simultaneous application.

Rotational restrictions: Rotational grass crops can be planted 12 months following application. There is some danger that trifluralin may persist and damage susceptible crops the following season. Risk of such carryover appears greater when the subsequent sensitive crop is no-till planted.

Valor SX (flumioxazin)

Rate: 2 to 3 oz/a.

Timing: *Preplant or preemergence*—Apply within 3 days after planting. Do not apply preplant incorporated.

No-till—Valor can be tank mixed with glyphosate, Gramoxone, Synchrony, or 2,4-D to increase the speed of burndown or to provide residual annual weed control including seedling dandelion. To obtain the full burndown activity from Valor, include 1 to 2 pt/a crop oil concentrate.

Remarks: Valor controls several small-seeded broadleaf weeds and provides some annual grass suppression. Broadleaf weeds that should be controlled at the 2 oz/a rate include lambsquarters, horseweed, nightshade, and pigweeds. Valor at 2.5 oz/a should control most common ragweed and waterhemp, but the rate should be increased to 3 oz/a on fine-textured soils. Valor is not labeled to control weeds on soils with greater than 5% organic matter. Valor can be tank mixed with FirstRate, Lorox, or Python for additional broadleaf control or Command 3ME or pendimethalin for grass control. Due to the risk of injury, do not use Valor as a tank-mix partner with or apply to fields treated with Dual II Magnum, Intrro, or Outlook. Valor may injure soybeans if soils are cold and wet. To minimize the risk of injury, plant soybeans at least 1.5 inches deep. Do not incorporate Valor or apply if soybeans are cracking. Rain splatter may cause speckling of soybean plants.

Rotational restrictions: At Valor rates up to 3 oz/a, field corn can be planted 1 month after application; tobacco and wheat can be planted after 2 months; barley, snap and dry beans, and sweet corn can be planted after 4 months; and alfalfa and oats can be planted after 5 months if tilled.

Warrant (acetochlor)

Rate: *Preplant or Preemergence*—1.25 to 2.0 qt/a depending on soil conditions. Maximum rate is 1.6, 1.7, and 1.9 qt/a respectively for course-, medium-, and fine-textured soil with less than 1.5% organic matter. Maximum rate is 1.7, 1.9, and 2.0 qt/a respectively for course-, medium-, and fine-textured soil with more than 1.5% organic matter.

Postemergence—1.25 to 2.0 pt/a.

Timing: Warrant can be applied any time preplant, preemergence, or postemergence up to the R2 growth stage at the appropriate rate for the timing. Do not incorporate preplant applications.

Remarks: Warrant is an encapsulated formulation of acetochlor labeled for preplant, at-planting, preemergence, and postemergence use on soybean. It does not include a safener. Warrant will provide residual control of annual grasses and some small-seeded broadleaves but will not control emerged weeds. Warrant is labeled as a tank-mix partner with several other postemergence herbicides including glyphosate on glyphosate-tolerant crops. Follow adjuvant requirements of the tank-mix partner. Up to two applications of Warrant are allowed per season, but do not exceed 4 qt/a total and do not apply past the R2 growth stage. Do not apply postemergence with liquid fertilizer, as severe crop injury may occur. Do not graze or feed treated forage to livestock.

Rotational restrictions: Wheat may be planted 4 months after application, and alfalfa, clover, and birdsfoot trefoil 9 months after. Cover crops can only be planted in the fall following application for non-food or non-feed purposes. All other crops are allowed the following growing season.

POSTEMERGENCE HERBICIDES

Assure II (quizalofop)

Rate: 7 to 10 fl oz/a.

Adjuvants: Add either crop oil concentrate at 1% or nonionic surfactant at 0.25% to the spray mixture.

Timing: *Soybean*—Apply any time after emergence until soybean pod set or up to 80 days before harvest.

Weeds—Apply 7 fl oz/a to 4-inch green foxtail and yellow foxtail and 8-inch giant foxtail. Apply 5 fl oz/a to 6-inch wild proso millet and 12-inch shattercane. Apply 8 fl oz/a to 6-inch crabgrass and 8-inch wirestem muhly; 9 fl oz/a to 4-inch woolly cupgrass; and 10 fl oz/a to 10-inch quackgrass.

Remarks: Assure II controls annual grasses and perennial grasses like quackgrass and wirestem muhly. Control of quackgrass and wirestem muhly is usually evident the season after application. Assure II can be tank mixed with glyphosate to control volunteer Roundup Ready corn. Use 4 fl oz/a for 12-inch tall corn, 5 fl oz/a for 18-inch tall corn, and 8 fl oz/a for 30-inch tall corn. Add 0.125% surfactant if the glyphosate formulation contains an adjuvant. If not, add 0.25% nonionic surfactant. Soybean injury from Assure II is not a problem.

Assure II can be tank mixed with Basagran, Classic, Flexstar, Harmony SG, and Synchrony, but grass control may be reduced. This antagonism can be reduced by increasing the Assure II rate or by applying Assure II in a separate application. In sequential applications, apply Assure II 1 day before or 7 days after the broadleaf herbicide.

Rotational restrictions: Do not rotate to crops other than soybeans, dry and snap beans, peas, and other labeled crops within 120 days after Assure II application.

Basagran (bentazon)

Rate: 1 to 2 pt/a.

Adjuvants: Add 1 qt/a of crop oil concentrate in the final spray mixture. Where velvetleaf is the primary weed problem, 2 to 4 qt/a of 28% nitrogen solution or 2.5 lb/a of spray grade ammonium sulfate may be substituted for crop oil concentrate. If common lambsquarters and/or common ragweed are present with velvetleaf, use crop oil concentrate plus a nitrogen additive. Do not apply Basagran in liquid fertilizer except as specified with 28% nitrogen or ammonium sulfate.

Timing: *Soybean*—Applications are generally made from the unifoliate to second trifoliate leaf stage, but all stages are tolerant.

Weeds—See label for weed size and rate required for control.

Remarks: Basagran provides fair to excellent control of many annual broadleaf weeds. Redroot pigweed and common lambsquarters are only partially controlled, especially when treated late. Velvetleaf and cocklebur control is excellent. Basagran provides good suppression of yellow nutsedge and fair burndown Canada thistle. It can be tank mixed with other postemergence soybean herbicides. Soybeans are quite tolerant of Basagran but slight leaf yellowing, bronzing, speckling, or burn may occur. Soybeans generally outgrow this condition within 10 days. Soybean leaf burn increases when using nitrogen solution, but new soybean growth is normal and crop vigor is not reduced. Because Basagran has contact action, weeds must be thoroughly covered with spray. Do not apply if wind exceeds 10 mph.

Rotational restrictions: None.

Cadet (fluthiacet)

Rate: 0.4 to 0.6 fl oz/a in glyphosate mixtures or 0.6 to 0.9 fl oz/a if applied alone or in other tank mixtures.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1 to 2 pt/a to the spray solution. 28% nitrogen solution at 1 to 2 qt/a or ammonium sulfate at 1 to 2 lb/a may be added. If mixed with a fully loaded glyphosate, only add ammonium sulfate as required for glyphosate.

Timing: *Soybeans*—Apply from first trifoliate to full flower stage.

Weeds—At the 0.9 fl oz/a rate, apply before lambsquarters and waterhemp exceed 2 inches, before pigweed exceeds 4 inches, and before velvetleaf exceeds 36 inches.

Remarks: Cadet may cause temporary speckling of soybean leaves. Cadet has excellent activity on velvetleaf and controls plants up to 36 inches tall at 0.6 fl oz/a or at lower rates in tank mixtures. At the 0.9 fl oz/a rate, it is labeled to control lambsquarters, waterhemp, jimsonweed, and pigweed, but these weeds are only listed as

suppressed at lower rates. Cadet has contact activity and requires good spray coverage with a minimum of 15 gal/a spray volume and 20 psi spray pressure. It is an option when targeting velvetleaf alone or to improve the control of other broadleaf herbicides. Do not apply if wind speed exceeds 10 mph.

Rotational restrictions: Corn or soybeans can be replanted any time if the crop is lost. Any crop can be planted after harvest.

Classic (chlorimuron)

Rate: 0.5 to 0.75 oz/a if soil pH is less than 7.0 or 0.25 to 0.33 oz/a when tank mixed with Harmony SG.

Adjuvants: Add nonionic surfactant at 0.25% to the spray mixture. If droughty, crop oil concentrate at 1.0% (0.5% in Classic + Harmony SG tank mixtures) of spray can be used instead of surfactant. For velvetleaf control, add 2 to 4 qt/a of 28% nitrogen solution or 2 to 4 lb/a of spray grade ammonium sulfate, with surfactant or crop oil concentrate.

Timing: *Soybean*—Apply after the first trifoliate leaf stage, but 60 days before soybean harvest.

Weeds—See label for weed size and rate required for control.

Remarks: Classic controls several annual broadleaf weeds, but lambsquarters and nightshade escape control. Tank mixing Classic at 0.25 to 0.33 oz/a with Harmony SG will control lambsquarters and improve velvetleaf control over that provided by Classic alone. Tank mixing Classic with Flexstar, lactofen, or Ultra Blazer will control nightshade and waterhemp and improve control of common ragweed. Tank mixing Classic with a half rate of Pursuit (use 0.125% surfactant plus nitrogen) will control nightshade. Tank mixing Classic with FirstRate will control common and giant ragweed. Classic can be tank mixed with postemergence grass herbicides. Classic at 0.25 to 0.33 oz/a can also be tank mixed with glyphosate when treating Roundup Ready soybeans to improve yellow nutsedge control. Ammonium sulfate is recommended in all Classic plus glyphosate tank mixtures. Surfactant at 0.25% should be added when the glyphosate formulation allows for this addition.

Temporary yellowing and/or retardation of soybean growth may occur within 5 to 7 days after Classic treatment. Do not apply Classic to soybeans that are under stress from weather extremes or injury from another herbicide. Use Classic spray preparations within 24 hours of mixing or product degradation may occur.

Rotational restrictions: Classic may persist and cause damage to susceptible crops the following growing season especially if the soil pH exceeds 7.0. Small grains can be planted 3 months after treatment; alfalfa, field corn, processing sweet corn, dry beans, and peas can be planted 9 months after treatment.

Cobra

See lactofen (page 133).

Extreme (Pursuit + glyphosate premix)

Use only on Roundup Ready soybean varieties.

Rate: 3 pt/a.

Adjuvants: Add nonionic surfactant at 0.125% to the spray mixture plus ammonium sulfate at 8.5 to 17 lb/100 gal of spray.

Timing: *Soybean*—Apply before bloom and 85 days before harvest.

Weeds—In general, apply before weeds are 8 inches tall. The label lists specific weed heights for control. The maximum size for crabgrass, foxtail, fall panicum, and woolly cupgrass is at least 12 inches tall and barnyardgrass is 6 inches tall. The maximum size for lambsquarters, nightshade, pigweed, common and giant ragweed, smartweed, and waterhemp is at least 6 inches and velvetleaf is 5 inches.

Remarks: Extreme will provide good control of most annual grasses and broadleaf weeds and will suppress perennial weeds. This premix has excellent postemergence activity and will provide residual control of many weeds. The greatest benefit of the residual activity may be in row soybeans where the soybean canopy is slower to close, when Extreme is applied very early in drilled soybean, or when drilled soybeans have a poor stand. Extreme may be tank mixed with Outlook to enhance residual grass control. The risk of injury with Extreme is low, but it may cause stunting. Be cautious to avoid drift onto corn or other

plants during application. Extreme can also be applied before emergence of conventional soybeans as a burndown treatment and can be tank mixed with 2,4-D or Prowl, if applied before planting.

Rotational restrictions: Do not plant wheat until 3 months after application; alfalfa, edible beans, peas, and rye until 4 months after application; conventional field and seed corn until 8.5 months after application; barley and tobacco until 9.5 months after application; oats and sweet corn until 18 months after application; and potatoes until 26 months. Allow 40 months before planting all other crops.

FirstRate (cloransulam)

Rate: 0.3 oz/a.

Adjuvants: Add 0.125 to 0.25% of nonionic surfactant. Ammonium sulfate at 2 lb/a or 2.5% of 28% nitrogen solution or crop oil concentrate at 1.2% may be added to the spray mixture. Always include a nitrogen source when treating velvetleaf. Injury may increase when a nitrogen source is applied with crop oil concentrate.

Timing: *Soybean*—Apply before 50% flowering.

Weeds—Apply before horseweed, smartweed, and velvetleaf exceed 6 inches; before common ragweed exceeds 8 inches; and before cocklebur and giant ragweed exceed 10 inches.

Remarks: FirstRate controls several broadleaf weeds and is excellent on common and giant ragweed (if not ALS-resistant) and cocklebur. To control common lambsquarters and black nightshade, tank mix or follow a preemergence herbicide that controls these weeds. Labeled tank-mix partners include most postemergence broadleaf and grass herbicides. Follow rates and adjuvant recommendations of the tank-mix partner. FirstRate may antagonize Assure II and Fusion's activity, so sequential applications are recommended. Do not apply if steady wind speeds exceed 10 mph. Soybean stunting from FirstRate seems to be minimal or temporary.

Rotational restrictions: Do not plant wheat until 3 months after application; alfalfa, field corn, oats, peas, and snap beans after 9 months; and potatoes and sweet corn after 18 months. Tobacco can be transplanted 10 months after a 0.3 oz/a rate, but requires 30 months after higher rates. Crops not listed on the label require a 30-month rotational interval.

Flexstar (fomesafen)

Rate: 1.0 to 1.3 pt/a. In southern Wisconsin (south of Highway 18 if west of Madison and south of I-94 if east of Madison), the maximum rate is 1.3 pt/a. The maximum rate is 1 pt/a Flexstar in most of the region south of I-94 from Minnesota to Eau Claire and south of Highway 29 from Eau Claire to Green Bay plus Door and Kewaunee counties. Flexstar is not registered for use in Adams, Clark, Marathon, Marquette, Portage, Shawano, Waupaca, Waushara, and Wood counties or in northern Wisconsin.

Adjuvants: Add nonionic surfactant at 0.25 to 0.5% or crop oil concentrate at 0.5 to 1% to the spray mixture. Also add either 1 to 2.5 gal of 28% nitrogen solution or 8.5 lb of ammonium sulfate/100 gal of spray mixture.

Timing: *Soybean*—Apply before bloom. *Weeds*—The maximum leaf stage is 2 to 6 leaves depending on broadleaf species and rate. See label for specific weeds.

Remarks: Flexstar controls many annual broadleaf weeds. Some lambsquarters and velvetleaf may escape control. Tank mixes with Basagran, Classic, FirstRate, glyphosate, Harmony SG, Pursuit, Raptor, Resource, and Synchrony are labeled. Can be tank mixed with all of the postemergence grass herbicides, but it may reduce the activity of the herbicide. Treated soybeans almost always show some leaf speckling, crinkling, and bronzing, especially on the youngest leaves, generally outgrowing this condition without reduced crop vigor. Because Flexstar has contact action, weeds must be thoroughly covered with spray. Use 15 to 20 gal/a of water and 30 to 60 psi pressure through flat fan or hollow cone nozzles.

Rotational restrictions: Soybean and snap and dry beans can be replanted any time. Small grains can be planted 4 months after application, and corn and peas can be planted 10 months after application. Other crops should not be planted until 18 months after treatment. Flexstar can only be used in alternate years.

Flexstar GT 3.5 (glyphosate + Flexstar premix)

Use only on Roundup Ready varieties.

Rate: 3.5 to 4.5 pt/a. In southern Wisconsin (south of Highway 18 west of Madison and south of I-94 east of Madison), the maximum rate is 4.5 pt/a. The maximum rate is 3.5 pt/a in the region south of I-94 from Minnesota to Eau Claire and south of Highway 29 from Eau Claire to Green Bay plus a few counties north of this line. Flexstar GT 3.5 is not registered for use in Adams, Clark, Marathon, Marquette, Portage, Shawano, Waushara, and Wood Counties.

Adjuvants: Add ammonium sulfate at 8.5 to 17.0 lb/100 gal of spray mixture. Flexstar GT 3.5 contains a built-in adjuvant, but crop oil or nonionic surfactant can be added in adverse conditions.

Timing: *Soybean*—Apply up to 45 days before harvest.

Weeds—With 3.5 pt/a, common broadleaf weeds are labeled for control up to 4 inches tall and most annual grasses are labeled for control up to 12 inches tall.

Remarks: Flexstar GT 3.5 will control most annual and perennial grass and broadleaf weeds. It can be tank mixed with postemergence grass herbicides to control glyphosate-resistant corn. This premixture of Flexstar with glyphosate will allow glyphosate-resistant weeds like waterhemp and common and giant ragweed to be controlled. However, resistant weeds will need to be sprayed at a smaller size than typically sprayed with glyphosate in order for them to be controlled by the Flexstar component. The adjuvant system in Flexstar GT 3.5 is designed to reduce speckling and crinkling of soybean leaves, but some symptoms should still be expected. The soybeans should outgrow these symptoms within several days. Because the Flexstar component has contact activity, weeds need thorough spray coverage. Use 15 to 20 gal/a of water and 30 to 60 psi pressure with flat fan nozzles. Do not apply if wind exceeds 15 mph. Flexstar GT 3.5 can only be used in alternate years.

Rotational restrictions: Soybeans and snap and dry beans can be replanted at any time. Small grains can be planted 4 months after application, and corn and peas can be planted 10 months after application. Other crops should not be planted until 18 months after treatment.

Fusilade DX (fluazifop-p)

Rate: Apply 4 to 6 fl oz/a.

Adjuvants: Add 0.25% crop oil concentrate plus any adjuvants required by the glyphosate formulation.

Timing: *Soybean*—Apply from emergence until soybean bloom.

Weeds—Apply before volunteer Roundup Ready corn is 12 inches tall.

Remarks: Fusilade DX has a supplemental label recommending a tank mixture with glyphosate to control volunteer Roundup Ready corn in Roundup Ready soybeans. With favorable soil moisture and weather conditions, the 4 fl oz/a rate can be used. Fusilade DX can be used for annual grass control in conventional soybeans, but other postemergence grass herbicides are recommended. Fusilade DX is rainfast in 1 hour.

Rotational restrictions: Do not replant grass crops like corn or small grains for 60 days.

Fusion (Fusilade + fenoxaprop premix)

Rate: 8 fl oz/a.

Adjuvants: Add crop oil concentrate at 0.5 to 1% or nonionic surfactant at 0.25 to 0.5% to the spray mixture. Use crop oil concentrate at 1% when treating perennial grasses. The Fusion label also permits the addition of 28% nitrogen solution at up to 4% to the spray mixture or up to 4 lb/a ammonium sulfate if required by a tank-mix partner.

Timing: *Soybean*—Apply before bloom.

Weeds—Apply 8 fl oz/a to 2- to 4-inch green and yellow foxtail, field sandbur and woolly cupgrass, 2- to 6-inch fall panicum, 2- to 8-inch giant foxtail, and 1- to 4-inch crabgrass. Fusion at 6 fl oz/a controls 4- to 8-inch wild proso millet, 6- to 12- inch shattercane, and 12- to 24-inch volunteer corn. Apply up to 14 fl oz/a as rescue treatments of giant foxtail, wild proso millet, and woolly cupgrass up to 16 inches tall.

Remarks: Fusion controls annual grasses. Two separate applications of Fusion, timed 2 to 3 weeks apart, control perennial grasses like quackgrass and wirestem muhly. Fusion can be tank mixed with

glyphosate to control volunteer Roundup Ready corn. Use 4 fl oz/a of Fusion plus 0.25% crop oil concentrate if the corn is less than 12 inches tall. If the corn is 12 to 24 inches tall, use 6 fl oz/a. Fusion can be tank mixed with most broadleaf herbicides, but antagonism may reduce grass control. To compensate, the Fusion rate can be increased 4 fl oz/a in tank mixtures. When yellow foxtail, barnyardgrass, woolly cupgrass, sandbur, or crabgrass are problem weeds, applying Fusion sequentially to postemergence broadleaf herbicides is recommended. In sequential applications, apply Fusion 2 or 3 days before the broadleaf herbicide or about 7 days after the broadleaf herbicide, when the grass has grown a new leaf. Do not apply Fusion to grasses that are stressed from weather extremes or injury from another herbicide. Soybean injury from Fusion is not a problem.

Rotational restrictions: Do not plant rotational grass crops such as corn, sorghum, or small grains within 60 days after Fusion application.

Glyphosate

Rate: *Broadcast*—0.75 to 1.5 lb ae/a per application for a total of 2.25 lb ae/a per season in-crop. Use only on Roundup Ready soybean varieties.

Preharvest—Apply 0.75 to 3 lb ae/a according to weed species (Touchdown is limited to 0.78 lb ae/a in Roundup Ready soybeans).

Glyphosate conversion table

Name	Formulation (lb ae/gal)	——Rate for—— 0.56 lb ae/a	0.75 lb ae/a
Many	3.0	24 fl oz	32 fl oz
Durango DMA	4.0	18 fl oz	24 fl oz
Touchdown Total	4.17	17 fl oz	23 fl oz
Roundup PowerMax	4.5	16 fl oz	21 fl oz
Touchdown HiTech	5.0	14 fl oz	19 fl oz

Adjuvants: Ammonium sulfate at 8.5 to 17 lb/100 gal of spray mixture is recommended when treating drought-stressed plants or larger, hard-to-control weeds. Check the label to see if the glyphosate formulation requires additional surfactant.

Timing: *Broadcast*—Apply from soybean emergence to full flower (R2 stage). Treat up to 8-inch annual weeds with 0.75 lb ae/a of glyphosate. Larger weeds and perennials require higher rates.

Preharvest—Apply at least 7 days before normal soybean harvest, but only after soybean pods have lost all their green color. For best dry down of weeds, wait 14 to 21 days after application before harvesting soybeans.

Remarks: *Broadcast*—Roundup Ready soybeans are resistant to postemergence-applied glyphosate, but only use formulations labeled for such use. Glyphosate controls emerged grass and broadleaf weeds, but has no residual control. Glyphosate can be tank mixed with Assure II, Fusilade DX, Fusion, or Select Max to control volunteer Roundup Ready corn. (See the remarks section of those herbicides for adjuvant recommendations.) In drilled soybeans with their earlier canopy closure, a single glyphosate application often provides season-long control. We have had good results treating drilled soybeans at the 2-trifoliate leaf stage (when weeds are 2 to 6 inches) with 0.56 lb ae/a glyphosate. Row soybeans may require a second application. Be very cautious to avoid glyphosate drift onto corn or other plants during application.

Preharvest—Glyphosate can be applied to actively growing weeds as a preharvest cleanup for the control of perennial weeds such as quackgrass (0.75 to 1.5 lb ae/a), Canada thistle (1.5 to 2.25 lb ae/a), bindweeds (2.25 to 3 lb ae/a), and hemp dogbane (3 lb ae/a). Apply in 10 to 20 gal/a of water and adjust nozzle height for good weed coverage. If applying by air, mix up to 0.75 lb ae/a of glyphosate in 3 to 5 gal/a of water. Do not apply if weeds have been damaged by frost. Perennial weeds should only be treated if at least two-thirds of the plants' leaves are green and physiologically active. Touchdown is limited to 1 qt/a as a preharvest treatment on Roundup Ready soybeans, but 6 qt/a can be applied in conventional soybeans.

Rotational restrictions: Glyphosate formulations have no rotational restrictions for Wisconsin field crops except for a 30-day interval before tobacco.

Gramoxone Inteon (paraquat)

Preharvest: Gramoxone is registered as a "harvest aid" or desiccant for soybeans. It is not intended to hasten crop maturity since this would result in immature, low-grade soybeans. The primary purpose of Gramoxone is to dry weed growth that is present in mature soybeans.

Rate: 8 to 16 fl oz/a.

Adjuvants: Add nonionic surfactant at 0.125% or crop oil concentrate at 1% to the spray mixture.

Timing: *Soybean*—Apply when plants are mature, at least 65% of the seed pods have reached a mature brown color, or when seed moisture is 30% or less. Apply at least 15 days before harvest.

Remarks: Paraquat use allows faster combine speed and reduces green weed foliage in the harvested crop. This treatment will desiccate black nightshade leaves but berries will remain on the treated plant. Mature cocklebur is quite tolerant of paraquat. Use a minimum of 20 gal/a of water with ground application and 5 gal/a when paraquat is applied aerially. Avoid paraquat application when uniform coverage cannot be obtained or excessive spray drift may occur.

Rotational restrictions: None.

Harmony SG (thifensulfuron)

Rate: 0.125 oz/a alone or with glyphosate on Roundup Ready soybeans.

Adjuvants: Add nonionic surfactant at 0.125 to 0.25% or crop oil concentrate at 0.5% to the spray mixture. The higher rate of surfactant increases risk of soybean injury, particularly under hot, humid conditions. The oil addition is preferred under dry, cool conditions but also increases the risk of soybean injury. Also include 2 to 4 qt/a of 28% nitrogen solution or 1 to 2 qt/a of 10-34-0 in the spray mixture. Ammonium sulfate at 2 to 4 lb/a may also be used.

With glyphosate tank mixtures on Roundup Ready soybeans, add 4.25 to 17 lb/100 gal of ammonium sulfate. Also add 0.125 to 0.25% nonionic surfactant if the glyphosate formulation is not preloaded.

Timing: *Soybean*—Apply after the first trifoliate leaf, but 60 days before harvest.

Weeds—Harmony SG controls up to 4-inch common lambsquarters, 8-inch pigweeds, and 6-inch smartweeds and velvetleaf.

Remarks: Harmony SG controls several broadleaf weeds but does not control black nightshade. Tank mixing Harmony with a half rate of Pursuit (use 0.125% surfactant plus nitrogen) will control nightshade. Harmony can be tank mixed with postemergence grass herbicides, Basagran, Classic, Flexstar, or lactofen. Harmony can be tank mixed with glyphosate to increase lambsquarters control in Roundup Ready soybeans. Temporary yellowing and/or reduction of soybean growth may occur within 5 to 7 days after Harmony treatment. Such injury occurs most frequently during hot, humid weather. Do not apply Harmony to soybeans that are under stress from weather extremes or injury from another herbicide. Do not tank mix Harmony with organophosphate insecticides or apply Harmony within 14 days before or after such insecticide use.

Rotational restrictions: Any rotational crop can be planted 45 days after treatment.

Ignite 280 (glufosinate)

Only use on Liberty Link soybean varieties.

Rate: 29 to 36 fl oz/a. A maximum of 36 fl oz per application and a maximum of 65 fl oz/a can be used for the entire season in Liberty Link corn.

Adjuvants: Add 2 lb/a ammonium sulfate to help control weeds under stress. The Ignite formulation contains surfactants. Additional surfactants are not required.

Timing: Apply between dawn and 2 hours before sunset.

Soybeans—Apply after emergence but before the bloom stage.

Weeds—Apply before barnyardgrass, crabgrass, fall panicum, and yellow foxtail exceed 3 inches, and before giant and green foxtail, wild proso millet, and woolly cupgrass exceed 6 inches. Apply before pigweed and velvetleaf exceed 3 inches; before lambsquarters exceeds 4 inches; and before nightshade, common and giant ragweed, and smartweeds exceed 6 inches.

Remarks: Ignite is a nonselective contact herbicide that controls many annual weeds and will burn the top growth of perennial weeds. Ignite can be tank mixed with most postemergence herbicides to enhance weed control. Ignite lacks residual activity so a second application can be made if needed. To avoid needing a second application, a preemergence residual herbicide often aids in making a single application of Ignite successful. Liberty Link varieties have good tolerance to Ignite, but slight speckling of leaves may occur. Apply in a minimum of 15 gal/a as thorough spray coverage is required. Do not apply if wind speeds exceed 10 mph. Ignite is rainfast in 4 hours.

Rotational restrictions: Corn and soybeans can be replanted at any time. Small grains and root, tuber, and leafy vegetables can be planted 70 days after application, and other crops can be planted after 180 days.

Lactofen

Rate: 6.0 to 12.5 fl oz/a.

Adjuvants: *Phoenix*—The Phoenix formulation contains a premixed adjuvant. Add 0.125 to 0.25% nonionic surfactant. Use the high concentration when weeds are at their maximum labeled size. Crop oil concentrate can be used at 1 pt/a if droughty.

Cobra—With reduced rates of 6 to 10 fl oz/a, add 1 pt/a crop oil concentrate. With a full rate, add crop oil concentrate at 0.25 to 1% to the spray mixture. Refer to label for recommendations and rates based on relative humidity. Alternatives to crop oil include nonionic surfactant at 0.25% during high humidity or 28% nitrogen solution at 4% plus 0.5% crop oil concentrate during low humidity. Crop oil concentrate is the preferred additive for the control of taller weeds.

Timing: *Soybean*—Apply at the 1- to 2-trifoliate leaf stage to ensure good spray coverage of weeds. Do not apply lactofen within 45 days of soybean harvest or past the R6 stage.

Weeds—The full rate of lactofen controls up to 8-leaf common ragweed and 6-leaf giant ragweed, pigweed, black nightshade, cocklebur, and waterhemp.

Remarks: Lactofen provides good control of black nightshade, pigweeds, ragweeds, and waterhemp, but only suppresses common lambsquarters. Lactofen will burn off aboveground portions of some perennial weeds but since underground portions aren't killed, regrowth will occur. Reduced rates of lactofen are labeled to mix with Classic and Synchrony to control black nightshade and with Classic, Harmony SG, and Pursuit to enhance common ragweed control. Lactofen can also be tank mixed with Assure II, Basagran, FirstRate, glyphosate, Raptor, Resource, or Select Max. Lactofen-treated soybeans almost always show some leaf burning, crinkling, and bronzing, especially on the youngest leaves. Soybeans generally outgrow this condition. Injury is greatest with crop oil concentrate and increases when adding nitrogen solution or ammonium sulfate. New soybean growth is normal, and crop vigor is not reduced. Do not apply lactofen to soybeans that are under stress from weather extremes. Because lactofen has contact action, weeds must be thoroughly covered with spray. Use 20 to 30 gal/a of water with Cobra or 15 to 20 gal/a of water with Phoenix. Apply at 40 to 60 psi pressure through flat fan or hollow cone nozzles spaced 20 inches apart.

Rotational restrictions: None.

Outlook (dimethenamid-P)

Timing: Outlook can be applied from the 1 to 5 trifoliate stage for residual grass control. See Outlook on page 123.

Phoenix

See lactofen (page 133).

Poast Plus (sethoxydim)

Rate: 1.5 pt/a.

Adjuvants: Add 1 qt/a of crop oil concentrate. When controlling volunteer corn or crabgrass, include 2 to 4 qt/a 28% nitrogen solution or 2.5 lb/a ammonium sulfate with crop oil concentrate.

Timing: *Soybean*—Apply any time, but 75 days before harvest.

Weeds—Poast Plus controls up to 8-inch foxtails, fall panicum, barnyardgrass and woolly cupgrass, 6-inch large and smooth crabgrass, 18-inch shattercane, and 20-inch volunteer corn. Poast Plus at 0.75 pt/a controls up to 10-inch wild proso millet.

Remarks: Poast Plus controls annual grasses and perennial grasses like quackgrass and wirestem muhly. Poast Plus can

be tank mixed with most postemergence broadleaf herbicides, but grass control may be reduced. This antagonism can be avoided by applying Poast Plus 1 day before or 7 days after the broadleaf herbicide. Soybean injury is not a problem. Do not apply Poast Plus to grasses that are stressed from weather extremes or injury from another herbicide. Do not apply if wind exceeds 10 mph.

Rotational restrictions: Soybean and alfalfa can be planted any time after application. Other crops can be planted after 30 days.

Pursuit (imazethapyr)

Rate: 4 fl oz/a.

Adjuvants: Add nonionic surfactant at 0.25% to the spray mixture or 1% crop oil concentrate. Also include 1 to 2 qt/a of either 28-0-0, 32-0-0, or 10-34-0 fertilizer solution in the spray mixture. Spray grade ammonium sulfate at 2.5 lb/a may be substituted for liquid fertilizer.

Timing: *Soybean*—Apply before bloom and 85 days before harvest.

Weeds—Apply before weeds are more than 3 inches tall. Cocklebur, pigweeds, and shattercane can be controlled up to 8 inches tall.

Remarks: Pursuit controls many grass and broadleaf weeds. Common lambsquarters usually escapes postemergence treatment, but can be controlled by adding a half rate of Harmony SG (use nonionic surfactant, not crop oil concentrate as the adjuvant). Pursuit can be tank mixed with Basagran, FirstRate, Flexstar, lactofen, or Ultra Blazer to broaden the spectrum of broadleaf weed control. For improved control of volunteer corn and grassy weeds, tank mix with Assure II, Fusion, Poast Plus, or Select Max. However, the effectiveness of the grass herbicide may be reduced due to antagonism from Pursuit. Pursuit can be tank mixed with glyphosate on Roundup Ready soybeans or with Outlook for residual grass control. Risk of soybean injury from Pursuit is minimal but it may shorten internodes.

Rotational restrictions: Do not plant wheat until 3 months after application; alfalfa, edible beans, peas, or rye until 4 months after application; conventional field corn and seed corn until 8.5 months after application; barley or tobacco until 9.5 months after application; oats, popcorn, sorghum, or sweet corn until 18 months after application; or potatoes until 26 months. Allow 40 months after Pursuit application before planting all other crops.

Raptor (imazamox)

Rate: 4 fl oz/a when following a preemergence grass herbicide or 5 fl oz/a when all herbicide applications are postemergence.

Adjuvants: Add nonionic surfactant at 0.25% to the spray mixture, 1% crop oil concentrate, or 1% methylated seed oil. Also include 1 to 2 qt/a of either 28-0-0 or 10-34-0 fertilizer solution in the spray mixture. Spray grade ammonium sulfate at 2.5 lb/a may be substituted for liquid fertilizer.

Timing: *Soybean*—Apply before bloom and 85 days before harvest.

Weeds—Apply before foxtails and fall panicum exceed 6 inches, barnyardgrass exceeds 5 inches, and wild proso millet exceeds 4 inches. Apply to broadleaves before lambsquarters, nightshade, ragweeds, and smartweeds exceed 5 inches and cocklebur, pigweeds, and velvetleaf exceed 8 inches.

Remarks: Raptor controls many annual grasses and broadleaf weeds. Common ragweed may require a tank mix for complete control. Without a prior preemergence grass herbicide treatment, Raptor may not adequately control barnyardgrass, crabgrass, wild proso millet, or woolly cupgrass. If Raptor is tank mixed with a postemergence grass herbicide, grass weed control may be reduced. This antagonism can be avoided by applying the grass herbicide 3 days before or 7 days after the application of Raptor. Raptor may be tank mixed with FirstRate to increase control of common and giant ragweed. Cobra, Flexstar, or Ultra Blazer tank mixtures may increase control of waterhemp and ragweed. Tank mixing broadleaf herbicides with Raptor may also reduce its grass control. Raptor may be tank mixed with Outlook for residual grass control. There is a risk that Raptor may cause temporary chlorosis and shortening of internodes.

Rotational restrictions: Do not plant wheat until 3 months after application; barley until after 4 months; field and sweet corn until after 8.5 months; and alfalfa, oat, pea, and

potato until 9 months after application. Many other vegetable crops are also listed on the label with a 9-month rotational interval.

Resource (flumiclorac)

Rate: 4 to 12 fl oz/a.

Adjuvants: Add 1 qt/a crop oil concentrate when applying Resource alone. Check the Resource label for adjuvant requirements when tank mixing.

Timing: *Soybean*—Do not apply within 60 days of harvest.

Weeds—Apply the following rates for velvetleaf: 4 fl oz/a when 6 leaves or fewer, 6 fl oz/a when 8 leaves, 8 fl oz/a when 10 leaves, and 12 fl oz/a when 30 inches tall.

Remarks: Resource is highly effective on velvetleaf. It is less effective on other broadleaf weeds but will suppress small lambsquarters, cocklebur, common ragweed, and pigweed. Resource can be tank mixed at 2 to 4 fl oz/a with postemergence broadleaf herbicides or glyphosate for added velvetleaf control. Resource may cause temporary speckling of soybean leaves, but plants quickly outgrow this injury.

Rotational restrictions: Corn or soybean can be replanted if crop fails. Other crops can be planted after 30 days.

Roundup formulations

See glyphosate (page 131).

Select Max (clethodim)

Rate: 9 fl oz/a. Use 16 fl oz/a when annual grasses are at the maximum height listed for control. Apply 12 fl oz/a for quackgrass and wirestem muhly.

Adjuvants: Add nonionic surfactant at 0.25% or crop oil concentrate at 1 qt/a to the spray mixture. Also add ammonium sulfate at 2.5 lb/a or 2 qt/a 28% nitrogen solution.

Timing: *Soybean*—Apply 60 days before harvest.

Weeds—Apply to 6-inch crabgrass and field sandbur; 8-inch green foxtail, yellow foxtail, fall panicum, and woolly cupgrass; 12-inch giant foxtail; 10-inch wild proso millet; 8-inch quackgrass and wirestem muhly; and 18-inch shattercane.

Remarks: Select Max controls annual grasses and two separate applications timed 2 to 3 weeks apart will control heavy infestations of quackgrass. Select Max does not injure soybeans. Select Max at 6 fl oz/a can be tank mixed with glyphosate to control Roundup Ready corn up to 12 inches tall. Higher rates can be used to control taller corn. Add nonionic surfactant if the glyphosate formulation is not preloaded with surfactant. Add 8.5 to 17 lb/100 gal ammonium sulfate to all glyphosate tank mixtures.

Select Max can be tank mixed with broadleaf herbicides, but grass control may be reduced. Increased rates should be used with Pursuit and Raptor tank mixtures. This antagonism can be avoided by applying Select Max 1 day before or 7 days after the broadleaf herbicide. When tank mixing, check the label for specific adjuvant options for the mixture. If regrowth of perennial grasses occurs, make a second application of Select Max. Do not apply if wind is greater than 10 mph.

Rotational restrictions: Soybean, alfalfa, potatoes, and other labeled crops can be planted any time. Do not plant other rotational crops until 30 days after application.

Sequence (Dual Magnum + glyphosate premix)

Use only on Roundup Ready varieties.

Rate: 2.5 to 3.5 pt/a.

Adjuvants: Ammonium sulfate may be added at 8.5 to 17 lb/100 gal.

Timing: *Soybean*—Apply from emergence through the third trifoliate stage.

Weeds—Sequence at 2.5 pt/a provides 0.7 lb ae/a glyphosate and is effective on most annual weeds if treated before the 6-inch height. The label has specific rates for individual weed heights.

Remarks: Sequence will provide good control of most annual grasses and broadleaf weeds and many perennial weeds. The s-metolachlor component will provide residual annual grass control, which may be beneficial in row soybeans or when applied early in drilled soybeans. It can be tank mixed with Fusion or Fusilade DX to control volunteer Roundup Ready corn or Classic, FirstRate, or Flexstar for added broadleaf control. Sequence may cause some slight leaf crinkle or leaf spotting, but the soybeans should rapidly outgrow this symptom. Be cautious to avoid drift onto

corn or other plants during application. Do not apply if a preemergence application of metolachlor was previously made.

Rotational restrictions: If the soybean crop is lost, soybeans, corn, peas, or snap beans can be replanted. Alfalfa can be planted 4 months after application and small grains can be planted after 4.5 months. Other crops can be planted the following spring.

Synchrony SG (Harmony SG + Classic premix)

Rate: Apply 0.375 oz/a alone or with glyphosate on Roundup Ready soybeans.

Adjuvants: On conventional varieties, add nonionic surfactant at 0.25% to the spray mixture. In addition, add either 2 to 4 qt/a of 28% nitrogen solution, 1 to 2 qt/a of 10-34-0, or 2 to 4 lb/a of ammonium sulfate. On Roundup Ready soybeans, add 0.25% nonionic surfactant when mixed with glyphosate plus ammonium sulfate at 4.25 to 17 lb/100 gal.

Timing: *Soybean*—Apply after the first trifoliate leaf stage and 60 days before harvest.

Weeds—Apply before pigweed, cocklebur, and other broadleaf weeds exceed 4 inches.

Remarks: At 0.375 oz/a, only pigweed, cocklebur and sunflower are listed as controlled. Lambsquarters, smartweed, and velvetleaf control can be improved with the addition of 0.06 oz/a Harmony SG; common ragweed and velvetleaf control can be improved with 0.15 oz/a FirstRate; and waterhemp, common ragweed, nightshade, and velvetleaf control can be improved with 1 pt/a Flexstar. Synchrony will not control nightshade by itself. Non-STS soybean varieties may be slightly stunted by Synchrony.

Rotational restrictions: Soybeans can be replanted any time after application. Small grains can be planted after 3 months; alfalfa, dry and snap beans, field corn, sweet corn, peas, and tobacco after 9 months; and potatoes after 30 months.

Touchdown

See glyphosate (page 131).

Ultra Blazer (acifluorfen)

Rate: 1.0 to 1.5 pt/a.

Adjuvants: Add nonionic surfactant at 0.125 to 0.25%, crop oil concentrate at 1 to 2 pt/a, 2 to 4 qt/a of 28% nitrogen solution, or 2.5 lb/a ammonium sulfate to the spray mixture.

Table 3-2. Rate equivalents of soybean herbicide premixes

Herbicide	Rate/a	Provides the equivalent of:
Authority Assist	6 fl oz	5 fl oz Spartan 4L + 2 fl oz Pursuit 2S
Authority First/Sonic	3 oz	3.7 fl oz Spartan 4L + 0.28 oz FirstRate 84DF
Authority MTZ	12 oz	4.3 fl oz Spartan 4L + 4.3 oz Metribuzin 75DF
Boundary 6.5EC	1.5 pt	1.03 pt Dual II Magnum 7.64EC + 5 oz Metribuzin 75DF
Canopy EX 29.5DF	1.1 oz	1.0 oz Classic 25DF + 0.15 oz Express 50SG
Canopy 75DF	2.25 oz	1 oz Classic 25DF + 1.9 oz Metribuzin 75DF
Enlite	2.8 oz	2 oz Valor SX + 0.3 oz Classic 25DF + 0.5 oz Harmony SG
Envive	2.5 oz	1.4 oz Valor SX + 0.9 oz Classic 25DF + 0.14 oz Harmony SG
Extreme 2.17SC	3 pt	4 fl oz Pursuit 2S + 0.56 lb ae glyphosate
Flexstar GT	3 pt	1 lb ae glyphosate + 1 pt Flexstar 1.88EC
Fusion 2.56EC	8 fl oz	8 fl oz Fusilade DX 2EC + 6.7 fl oz Option II 0.67EC
Gangster (co-pack)	2.4 oz	2 oz Valor 51DF + 0.4 oz FirstRate 84DF
OpTILL PRO (co-pack)	2 oz + 10 fl oz	2 oz OpTILL + 10 oz Outlook
Prefix	2 pt	1.1 pt Dual II Magnum 7.64EC + 1 pt Flexstar
Sequence 5.25EC	2.67 pt	1 pt Dual II Magnum 7.64EC + 0.75 lb ae glyphosate
Synchrony XP 28.4DF	0.375 oz	0.32 oz Classic 25DF + 0.05 oz Harmony 50SG
Valor XLT	2.5 oz	1.5 oz Valor SX + 1 oz Classic 25DF
Verdict	5 fl oz	1 fl oz Sharpen + 4.2 fl oz Outlook

Timing: *Soybean*—Apply in the 1- to 2-trifoliate leaf stage to ensure good spray coverage of weeds. Apply 50 days before harvest.

Weeds—The maximum leaf stage is 2 or 4 leaves for most weeds listed for control. See label for size and rate required for specific weeds.

Remarks: Ultra Blazer controls pigweed, common ragweed, and black nightshade better than Basagran but is less active on velvetleaf and cocklebur. It will burn the aboveground portions of perennial weeds such as common milkweed, Canada thistle, and field bindweed, but since underground portions are not killed, regrowth will occur. Ultra Blazer can be tank mixed with Basagran, Classic, FirstRate, glyphosate, Harmony SG, Pursuit, Raptor, Resource, and the postemergence grass herbicides. Soybeans treated with Ultra Blazer almost always show some leaf speckling, crinkling, and bronzing, especially on the youngest leaves. Soybeans generally outgrow this condition. Do not apply to soybeans that are under stress from weather extremes or injury from another herbicide. Because Ultra Blazer has contact action, weeds must be thoroughly covered with spray. Use 10 to 20 gal/a of water and a minimum of 40 psi pressure through flat fan or hollow cone nozzles spaced 20 inches apart. Do not apply if wind exceeds 15 mph.

Rotational restrictions: Soybeans can be planted any time, small grains after 40 days, and all other crops after 100 days.

Table 3-3. Forage and grain harvest intervals for soybean herbicides[a]

Herbicide	Forage harvest interval	Grain harvest interval
Assure II	not permitted	80 days
Authority Assist	not permitted	no restrictions
Authority First/Sonic	not permitted	65 days
Authority MTZ	not permitted	no restrictions
Basagran	30 days	30 days
Boundary	40 days	no restrictions
Cadet	not permitted	60 days
Classic	not permitted	60 days
Dual II Magnum	no restrictions	no restrictions
Enlite	not permitted	no restrictions
Envive	not permitted	no restrictions
Extreme	not permitted	85 days
FirstRate	14 days	65 days
Flexstar	not permitted	treat before bloom
Flexstar GT	not permitted	45 days
Fusilade DX	not permitted	treat before bloom
Fusion	not permitted	treat before bloom
Gangster	not permitted	65 days
Glyphosate—broadcast[b]	14 days	14 days
Glyphosate—preharvest	25 days	7 days
Gramoxone Inteon—harvest aid	not permitted	15 days
Harmony SG	not permitted	60 days
Ignite	not permitted	70 days
Intrro	not permitted	no restrictions
Lactofen (Cobra/Phoenix)	not permitted	45 days
Lorox	not permitted	no restrictions
Metribuzin	40 days	no restrictions
OpTILL	not permitted	85 days
OpTILL PRO	not permitted	85 days
Outlook	not permitted	no restrictions
Poast Plus	75 days	75 days
Prefix	not permitted	no restrictions
Prowl H_2O	no restrictions	no restrictions
Pursuit	not permitted	85 days
Python	not permitted	85 days
Raptor	no restrictions	no restrictions
Resource	not permitted	60 days
Select Max	not permitted	60 days
Sequence—preplant	30 days	—
Sequence—postemergence	not permitted	90 days
Synchrony XP	not permitted	60 days
Trifluralin	no restrictions	no restrictions
Ultra Blazer	not permitted	50 days
Valor SX	not permitted	no restrictions
Valor XLT	not permitted	no restrictions
Verdict	80 days	no restrictions
Warrant	not permitted	no restrictions

[a] Labels may have changed after this table was prepared. Consult current labels to verify the information.

[b] For broadcast postemergence applications to Roundup Ready soybeans.

Table 3-4. Rainfree period and adjuvants required for postemergence soybean herbicides

Herbicide	Hours rainfast	Recommended adjuvants				
		NIS		COC		N additive
Assure II	1	0.25%	*or*	1%		
Basagran[a]	4			1 qt/a	*or*	28% N at 2–4 qt/a *or* AMS at 2.5 lb/a
Cadet	4	0.25%	*or*	1–2 pt/a	*plus*	28% N at 1–2 qt/a *or* AMS at 1–2 lb/a may be added
Classic	1	0.25%	*or*	1% if hot, dry		Also add 28% N at 2–4 qt/a *or* AMS at 2–4 lb/a for velvetleaf
Cobra[b]	0.5	0.25% if high RH	*or*	0.25–1.0%	*or*	28% N at 1 gal/a *or* AMS at 2–4 lb/a *plus* NIS *or* COC
Extreme	1	0.125%			*plus*	AMS at 2.5 lb/a *or* 28% N at 1–2 qt/a
FirstRate	2	0.125–0.25%	*or*	1.2%		Add 28% N at 2.5% *or* AMS at 2 lb/a when using nonionic surfactant
Flexstar	1	0.25–0.5%	*or*	0.5–1.0%	*plus*	28% N at 2.5% *or* AMS at 10 lb/100 gal
Flexstar GT	1					AMS at 8.5–17.0 lb/100 gal may be added
Fusilade DX	1			0.25%		
Fusion	1	0.25–0.5%	*or*	0.5–1.0%		28% N at up to 4% may be added
Glyphosate	2–6	Check label to see if surfactant is needed				AMS at 8.5–17 lb/100 gal may be added
Gramoxone Inteon —preharvest	0.5	0.25%	*or*	1%		
Harmony SG	1	0.25–0.5%	*or*	0.5% if cool, dry	*plus*	28% N at 2–4 qt/a *or* 10-34-0 at 1–2 qt/a *or* AMS at 2–4 lb/a
Ignite	4					
Phoenix	1	0.125–0.25%				
Poast Plus	1			1 qt/a		28% N at 2–4 qt/a *or* AMS at 2.5 lb/a[c]
Pursuit	1	0.25%	*or*	1% COC *or* MSO	*plus*	28% N *or* 10-34-0 at 1–2 qt/a *or* AMS at 2.5 lb/a
Raptor	1	0.25%	*or*	1% COC *or* MSO	*plus*	28% N *or* 10-34-0 at 1-2 qt/a *or* AMS at 2.5 lb/a
Resource	1			1 qt/a		
Select Max	1	0.25%	*or*	1 qt/a	*plus*	AMS at 2.5 lb/a
Synchrony XP	1	0.25% if non-STS variety	*or*	1% if STS variety	*plus*	28% N at 2–4 qt/a *or* 10-34-0 at 1–2 qt/a *or* AMS at 2–4 lb/a
Ultra Blazer	4	0.125–0.25%	*or*	1–2 pt/a	*or*	28% N at 2–4 qt/a *or* AMS at 2.5 lb/a

Abbreviations: AMS = ammonium sulfate; COC = crop oil concentrate; MSO = methylated seed oil; N = Nitrogen; NIS = nonionic surfactant; RH = relative humidity; STS = sulfonylurea-tolerant

[a] Add COC for lambsquarters and common ragweed control, add a nitrogen additive for velvetleaf control, or add both if all three weeds are present.

[b] Adjust adjuvant type and rate based on RH. See label for recommendations.

[c] Add a nitrogen additive plus COC when controlling volunteer corn or large crabgrass.

SOYBEAN INSECT MANAGEMENT

Insecticides suggested in this section are intended as a guide to assist you in selecting chemical insect control options. While suggestions provide an overview of product registrations for specific field crop insect pests, this guide is not intended as an exhaustive label source. Product inclusion or omission does not imply endorsement by the Univeristy of Wisconsin-Extension. Proper and safe insecticide use requires great care and strict adherence to the most current label directions. Label changes and occasional-use cancellations may have occurred since the writing of this publication.

A number of the products listed in this section are restricted-use insecticides. We discuss restricted-use pesticides in the beginning of this publication. Refer to appendix table 1b for a list of insecticides that currently require certification to be applied. It is possible that additional insecticides will be classified before the next growing season. Contact your county Extension agent for additional information on insecticide restriction.

Insecticides applied at pest insect economic thresholds help control insect pests, but they also kill beneficial insect predators and parasitoids that are important in biological control. Insecticides such as Penncap-M (methyl parathion) and Sevin (carbaryl) are hazardous to honeybees. For these and all insecticides, follow label directions. Where required by label, notify local beekeepers when using such products and do not apply or allow product to drift onto blooming crops and/or weeds when bees are foraging in the area to be treated.

See the discussion on reducing insecticide hazards to bees in "Forage Insect Management" for more information.

INSECT PESTS

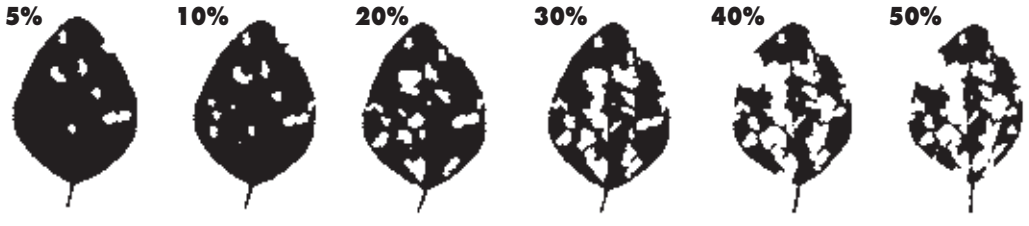
Bean leaf beetle

Bean leaf beetle population densities have increased in the Midwest following recent mild winters. Although pod feeding has been noted as far north as Chippewa county, defoliation and disease transmission (bean pod mottle virus) are of more concern in the southernmost counties.

Adult beetles are .20 inches long, about the size of lady beetles. Wing covers are typically light yellow with a black margin and four black spots. Variations include crimson wing covers with spots or light yellow wing covers with no spots. There is always a black triangle behind the "neck" region (prothorax). Beetles readily drop from the plant if they detect disturbance.

Adults overwinter under leaf debris near soybean fields. Once they become active in the spring, the beetles feed on wild legumes, alfalfa, and clover. As soybeans begin to emerge, beetles leave these

Use this guide to help determine the extent of defoliation by leaf-feeding insects.



alternate hosts and concentrate on soybean seedlings. Thus, the earliest planted fields are at greatest risk from feeding damage and virus transmission. Bean leaf beetles chew round holes between the major leaflet veins. This damage is easily distinguished from that of caterpillars and grasshoppers, which chew ragged, irregular holes.

Adults lay eggs in the soil next to soybean stems. Larvae hatch about 1 week later and feed on roots and stems. Their root feeding is not believed to be of economic importance. First-generation adults appear in July, peaking during the late vegetative and early reproductive stages of soybean growth. Second-generation adults can be found from late August to mid-September, when they feed on leaves and pods. This second generation can cause significant crop damage. Beetles may clip developing pods from the plant or graze on the outer layer of the pod, leaving only a thin layer of tissue. Diseases can enter these damaged areas and the seeds will be discolored, shrunken, and moldy.

Scout for overwintered beetles beginning shortly after soybeans emerge. Count the number of beetles on each plant sampled. Examine 5 feet of row in each of five locations throughout the field. Divide the total number of beetles found by 25 to estimate the number per foot of row. Also estimate the percent of leaf defoliation using the guide on the previous page. Check again when first-crop alfalfa harvest is underway, as the activity may force beetles to move to soybeans. Consult table 3-5 for guidance on when to treat. Before bloom, soybeans can tolerate up to 30% defoliation.

Scout for second-generation bean leaf beetle adults during August and September by walking 100 feet in from the edge of the field. Scout each field and each variety within a field separately as beetles sometimes prefer one variety over another. Scouting is no longer necessary after pods reach the R7 (yellow pod) stage.

In 30-inch row soybeans, place a 3-foot-wide strip of cloth (stapled to two dowel rods) on the ground between the rows. Slide the cloth under the plants, disturbing the plants as little as possible. Shake the plants vigorously over the cloth. Count the beetles on the cloth. Repeat this procedure four times for each 20 acres in the field. Determine the average number of beetles per foot of row.

In narrow-row soybeans, a sweep net will be easier to use than a drop cloth. Take 20 sweeps in each 20 acres across the field.

Consult table 3-6 for guidance on when to treat. Between bloom and pod fill, plants can tolerate 20% defoliation. Be sure to assess defoliation on the entire plant, not just the top leaves. If the average number of bean leaf beetles equals or exceeds the economic threshold, an insecticide application is necessary to prevent economic yield loss.

Pod damage can also be incorporated into second-generation bean leaf beetle thresholds, with 5–10% of the pods showing bean leaf beetle feeding. Pod clipping is typically worse during dry weather as beetles move from feeding on leaves to feeding on pods. Inspect dropped pods for signs of feeding damage (as opposed to abortion caused by drought stress).

If the beetle population is less than the economic threshold, scout the field again 5 days later. Stop scouting when beetle counts start to decline, soybean pods begin to turn yellow, or the field is sprayed.

Treatment thresholds for the prevention of bean pod mottle virus are not available.

(Scouting techniques and treatment timing courtesy of Marlin Rice, Iowa State University.)

Table 3-5. Early-season bean leaf beetle economic thresholds in soybeans

	Treatment cost/a (insecticide plus application)					
Crop value ($/bu)	**$6**	**$7**	**$8**	**$9**	**$10**	**$11**
	beetles/plant[a]					
Growth stage—VC						
$5.00	2.4	2.8	3.2	3.6	4.0	4.4
$6.00	2.0	2.3	2.7	3.0	3.4	3.7
Growth stage—V1						
$5.00	3.7	4.4	5.0	5.6	6.2	6.8
$6.00	3.1	3.6	4.1	4.7	5.2	5.7
Growth stage—V2						
$5.00	5.9	6.8	7.8	8.8	9.8	10.7
$6.00	4.9	5.7	6.5	7.3	8.1	8.9

[a] For beetles per foot of row, multiply number by 7.6.

Source: Marlin Rice, Iowa State University, 2000

Table 3-6. Second-generation bean leaf beetle economic thresholds in reproductive stage soybean[a]

	Treatment cost/a (insecticide plus application)								
Crop value ($/bu)	**$7**	**$8**	**$9**	**$10**	**$11**	**$12**	**$13**	**$14**	**$15**
	beetles/foot of row								
$5.00	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.0	11.8
$6.00	4.6	5.2	5.9	6.5	7.2	7.8	8.5	9.2	9.9
$7.00	3.9	4.4	5.0	5.6	6.1	6.7	7.3	7.8	8.4
$8.00	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5
	beetles/sweep								
$5.00	3.5	4.0	4.5	5.0	6.5	7.2	7.7	8.3	8.7
$6.00	2.9	3.3	3.7	4.1	5.4	6.0	6.4	6.9	7.3
$7.00	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2
$8.00	2.2	2.5	2.8	3.2	4.1	4.5	4.8	5.2	5.5

[a] Economic thresholds are based on a row spacing of 30 inches and a plant population of eight plants per foot of row. For narrow-row soybean (8-inch rows) and a plant population of three plants per foot of row, multiply the above economic thresholds by 0.70.

Source: Marlin Rice, Iowa State University, 2000

Grasshoppers

Grasshoppers could be a problem during dry years. If young hoppers are numerous in grassy areas, such as fencerows and roadsides adjacent to soybeans, spray such areas before grasshoppers spread through the soybean field. If blooming weeds are present, notify nearby beekeepers before using an insecticide and only apply between 4 p.m. and nightfall, when bees are least likely to be foraging and exposed. Insecticidal control is most effective when used before grasshoppers are fully grown.

Green cloverworms

Green cloverworm overwinters in the southern US, migrating north in the spring. Females lay eggs singly on the underside of soybean leaves. There are six larval instars. Fully grown larvae are approximately 1 inch long and pale green with two horizontal stripes along each side of the body. Larvae have three pairs of legs in the middle of the body, three pairs near the head, and one pair at the hind end of the body. Two generations occur in northern states.

Defoliation due to green cloverworm should be considered together with the damage inflicted by other defoliating insects to make a management decision. Management is recommended if defoliation reaches 40% in pre-bloom, 20% during bloom and pod fill, and 35% from pod fill to harvest.

Japanese beetle

Japanese beetle adults are about 0.6 inches long and 0.4 inches wide, with metallic copper colored wing covers and a green thorax and head. Adults emerge in late June, feed on a wide range of host plants, and can move to soybean, where feeding results in leaf defoliation. Japanese beetles do not feed significantly on soybean flowers or clip pods. Soybean leaf defoliation is the main concern.

During July and August, adults lay eggs in grass and turf, soybean fields, and, to a lesser extent, cornfields. Eggs hatch out into small white grubs that feed on grass roots until fall temperatures cool. Third instar grubs move down in the soil profile and are inactive during winter. In early spring, grubs feed, pupate, and then emerge from the soil as adults in late June.

Adults feed on soybean leaf tissue between leaf veins resulting in a skeletonized or lace-like appearance. The treatment threshold for Japanese beetle in soybean is based on the percentage of leaf defoliation, not the number of beetles per plant. Treatment should be considered at 30% leaf defoliation pre-bloom and 20% defoliation bloom to pod fill.

It is easy to overestimate defoliation percentage; it often looks worse than it is. Use the soybean leaf defoliation guide on page 139 to help determine the extent of damage by defoliating insects. Be sure to

assess defoliation on the entire plant, not just the top leaves. Scout leaf defoliation throughout the field, not just at the field edges, where Japanese beetle aggregation and feeding can appear more concentrated. Field edge/border treatment may be sufficient if damage is confined to this area; scout the field to assess whether a whole-field treatment is required. Beetles present in the field when treated with a foliar insecticide will be killed, but beetles moving into treated fields after application can reinfest.

Potato leafhopper

Large populations of potato leafhopper can pose a threat to soybean fields. The soybean's hairy leaves and stems usually protect it from leafhopper damage. But during years with abnormally high leafhopper populations or in fields with varieties that are less hairy, scout field to make sure the crop is not threatened. Damage appears as yellowish patches on the leaves, and leaf crinkling and cupping are usually noted. The crinkling and cupping look similar to herbicide injury. Extensive feeding by potato leafhopper can stunt plants.

Examine the leaves and stems to take whole-plant counts on plants that are 1 foot or less in height. Take samples in several areas of a field. For plants taller than 1 foot, use a 15-inch diameter sweep net to sample the fields. Research indicates this is more accurate than taking whole plant samples. To complete one sweep, move the net in one continuous straight line motion through the top 15 inches of the foliage of the row from one side of your body through the foliage in the row to the other side of your body. Continue this process until 20 sweeps have been taken in an area, and take no less than five sets of 20 sweeps in a field to estimate the population density. For solid-seeded beans, cover the same area that you would for 30-inch rows.

If an average of two leafhoppers are found per plant in fields with fewer than four trifoliate leaves per plant, control may be needed. If there are six leafhoppers per plant on flowering plants, control may be needed. For a pod that is .75 inch long on one of the four uppermost nodes of the main stem, 13 or more leafhoppers per plant may cause economic injury. Examine the leaves carefully to see if the leafhoppers are able to get through the hairs and feed on leaves before deciding to treat.

Leafhopper sampling data indicate that the number of leafhoppers recovered per sweep in soybean represents half the actual number per plant, regardless of row spacing. For example, if you have taken five sets of 20 sweeps and have an average of two per sweep, you should assume an actual average of four leafhoppers per plant. When deciding on treatment, use the estimated actual number of insects per plant.

Seedcorn maggot

The seedcorn maggot overwinters as a pupa. Adult flies emerge in late spring around the time that soybean fields are being planted. Females lay eggs in fields with high levels of organic matter. Decaying weeds and crop residue in freshly tilled fields or application of livestock manure will make a field more attractive to egg-laying flies. Eggs hatch within a week. The white, tapered, legless maggots attack germinating seeds, feeding on the cotyledons.

Seedlings may emerge with brown feeding scars on the cotyledons or they may have no cotyledons (such shoots are called "snakeheads"). Damage typically occurs in fields with an abundance of organic matter (manure or decaying plant matter) and tends to be worse when cold, wet weather slows germination.

There are no economic thresholds for seedcorn maggot. Preventative planter-box seed treatment (e.g., Kernel Guard Supreme) or commercial seed treatments (e.g., Cruiser Maxx, Gaucho 600) are available when planting soybeans to fields with high organic matter.

Soybean aphid

Aphid identification and life cycle. Soybean aphids (*Aphis glycines*) are about .06-inch long and green to yellowish-green in color. They are the only aphid species known to infest and reproduce on soybean in the United States. Early in the growing season, populations are found predominately on the underside of new leaves. As the season progresses, colonies can be found on leaves within the canopy, moving to stems and petioles when populations are high.

The soybean aphid life cycle is complex, with both sexual and asexual phases, depending on the time of year and the host

plant. They overwinter in the egg stage on buckthorn, the aphid's only known overwintering host. From spring to late summer the aphids are all female and give birth to live females, allowing for exponential population growth. In the spring, winged females migrate from buckthorn to soybeans, where multiple generations are produced. During the summer, both winged and wingless forms can be found on soybeans. The winged aphids fly to other soybean fields to colonize. In the fall, male and female winged aphids migrate back to buckthorn where mating and egg-laying occurs.

Aphids use piercing-sucking mouthparts to remove plant sap. Feeding damage results in stunting and yield loss. They can also transmit soybean viruses as they probe and feed between infected and uninfected plants. In addition, they excrete a sugary substance referred to as "honeydew." If aphid populations are high, affected plants may take on a sooty appearance late in the summer as mold grows on the excrement.

Summer migrants (winged females) seem to prefer late-planted soybeans over early-planted soybean fields. Expect higher infestations on soybeans planted after early June compared to soybeans planted between late April and mid-May.

Natural enemies (predators and parasitic wasps) are an important component of soybean aphid management. Predators such as lady beetles (larvae and adults), green lacewings (larvae), and minute pirate bugs (nymphs and adults) consume soybean aphids. Parasitic wasps lay eggs inside aphids. The developing wasp larva kills the host from within. The adult wasp emerges, leaving behind a hollowed-out shell referred to as an aphid "mummy." Parasitized aphids are tan to dark brown and stick to the underside of soybean leaves. Another natural control agent is a fungal pathogen that can cause an epidemic in the soybean aphid population.

Soybean aphid treatment decisions. Results of university field trials and laboratory and greenhouse studies continue to help refine recommendations on soybean aphid economic injury level, treatment threshold, insecticide efficacy, and soybean host plant resistance to the aphid. Treatment decision guidelines are summarized as follows:

- **Avoid treating soybean aphids when they first appear in a field.** Insecticide applications to control low and nondamaging populations will also kill beneficial insects, allowing surviving aphids and migrants to more readily repopulate the field. Soybean aphids reproduce much faster than lady beetles and other beneficial insects. Thus, early-season treatments can lead to higher-populations than if the field had not been sprayed.
- **Scout fields weekly to determine the rate of population increase.** Begin intensive scouting no later than the mid-vegetative stages of soybean growth, typically around mid- to late-June. Count the number of aphids present on 20 to 30 plants per field. Examine the entire plant for aphids, paying close attention to the upper leaves and stems where aphids congregate. Be sure to sample plants from throughout the field to obtain a representative sample. Calculate the average number of aphids per plant based on the total number of plants sampled. The UW Nutrient and Pest Mangement program has developed a handy card to help with scouting and counting. *The Visual Guide for Soybean Aphid Scouting* is available by calling 608-265-2660 or at ipcm.wisc.edu/download/pubsPM/sba2010-web.pdf.

  Continue monitoring throughout pod development as aphids move down stems and colonies become distributed throughout the canopy.

  Regular field visits are critical as populations can increase to economically damaging levels within 7 days. However, keep in mind that the presence of soybean aphids does not mean that populations will necessarily reach damaging levels. A number of factors play a role in regulating populations: natural enemies (predators and parasitic wasps), temperature (aphids reproduce fastest between 68 and 77°F), planting date, aphid fungal disease, soybean growth stage, degree of plant stress (e.g., drought), and, possibly, soybean variety. Regular scouting will help determine how these factors are influencing aphid growth rates under your field conditions. Monitor soybean aphids through the R5 growth stage.

- **Treat when approximately 80% of the field has reached an average of 250 aphids per plant AND the population is actively increasing.** University trials have found that the best control and yield response occurs when plants are treated between beginning bloom (R1) and beginning seed (R5). Once pods have reached full seed (R6), it is too late to protect yield and treatment is not recommended. For pictures and descriptions of soybean growth stages, see *Reproductive Soybean Development Stages and Soybean Aphid Thresholds* (www.plantpath.wisc.edu/soyhealth/pdf/sbrthresholds05.pdf).

  These recommendations build in a 7-day lead time that allows time to schedule treatment, purchase product, or deal with weather delays when soybean aphid populations are actively increasing.

Research and scouting updates are posted regularly during the growing season in the *Wisconsin Crop Manager* newsletter (ipcm.wisc.edu/wcm). For more information about regional aphid population developments, contact your county Extension agent. Other valuable sources of information include the University of Wisconsin Soybean Plant Health website (www.plantpath.wisc.edu/soyhealth) and the North Central Soybean Research Program website (www.ncsrp.com).

Stink bugs

Two species of stink bugs—the green stink bug (*Acrosternum hilare*) and brown stink bug (*Euschistus* spp.)—may be found in Wisconsin soybean fields in August. Stink bugs feed in clusters on plants along field edges, becoming quite noticeable as plant leaves turn yellow. Occasionally populations may be high.

The chief distinction between the two species is their color. Stink bug adults have a shield-shaped body, with pointed "shoulders." Green stink bug adults are bright green with black bands on their antennae; adult brown stink bugs are a speckled brown. Nymphs are rounder than adults, roughly resembling a beetle. Green stink bug nymphs are multicolored (black, green, yellow, and red markings), while brown stink bugs nymphs are copper-brown.

Both nymphs and adults have piercing-sucking mouthparts which they use to penetrate the pod and suck plant fluids. Punctures can be found as small brown or black spots. Young seeds may be deformed, undersized, and possibly aborted under heavy stink bug pressure; older seeds can be discolored or shriveled. Feeding damage may also indirectly delay plant maturity.

In early August, as soybean pods begin to fill, scout five different areas of the field taking 20 samples at each location. Use sweep nets for drilled narrow-row beans. For wide-row plantings, place a light-colored cloth between rows and shake plants to dislodge bugs from the canopy. Count both nymphs and adults in the sample total. Calculate stink bugs per sweep (or per row foot) based on the average of all samples taken throughout the field.

Stink bug thresholds in seed beans are lower than in grain soybeans. In wide-row plantings, thresholds range from 1 to 3 bugs/foot of row. For narrow-row plantings, the threshold is 20 bugs/100 sweeps for seed beans and 40 bugs/100 sweeps for grain soybeans.

Thistle caterpillar (painted lady butterfly)

The painted lady, an orange and brown mottled butterfly, is noted for periods of great abundance followed by periods of great scarcity, probably due to natural control. It is strongly migratory, explaining its appearance in northern areas such as Wisconsin. The butterfly causes no damage to cultivated crops.

The larval stage, called the thistle caterpillar, is usually first noticed feeding on thistles. Subsequent generations occurring in late July and August can be found in soybeans in large enough numbers to cause concern. The spiny caterpillars have a mottled yellowish-green and black body with a yellow stripe running the length. The spines are also yellowish.

Thistle caterpillars form a loose silk webbing in the upper three or four leaves where they feed. The black granular-appearing material found in the webbing is fecal matter (frass). Most defoliation occurs during the last two stages of larval development, when larvae are .75 to 1.25 inches long.

Soybeans are almost always in the reproductive stages of development when populations become damaging. At that stage, plants can withstand 20% defoliation without an economic loss in yield. In the vegetative stage (prebloom), plants can withstand up to 30% defoliation before the yield loss is economically damaging.

Two-spotted spider mite

Two-spotted spider mite can become serious during hot dry weather. Adults are tiny (about 0.016 inch), yellow-green, with eight legs and dark spots on either side of their oval bodies. Magnification (a 10X hand lens) is often necessary to clearly see spider mite adults, nymphs, and eggs on the underside of leaves. Eggs are round, white to light yellow, and laid on the underside of leaves. In northern states populations overwinter as adult females in sheltered field margin areas. Most years, adequate rainfall and a fungal pathogen keep the spider mites in check. During outbreaks, however, spider mites reproduce quickly with multiple overlapping generations. Eggs hatch in 2 to 4 days, nymphs develop in 2 to 4 days, and adults can live up to 21 days. Each generation is completed in 4 to 14 days, with the fastest developmental rates occurring when temperatures exceed 91°F.

Spider mites damage plants by piercing the cells and sucking sap. Mites often go undetected until damage is severe in part because of their tiny size and because plants are drought stressed. Initially, leaves are discolored with tiny white or yellow specks (stippling). Leaves turn from yellow to bronze and may fall off under heavy infestations. Webbing is often found on the undersides of leaves. Damage is often more severe along field edges where mites have migrated from adjacent fields, grasses, and weeds, or in drier areas of the field.

Check the upper, middle, and lower canopy for damage as well as for the presence of live mites and webbing on the undersides of leaves. Estimate the percentage of soybean leaf surface damaged (stippling, discoloration). Tap plants onto a white sheet of paper to dislodge mites from the plant. If present, you will see black specks moving slowly on the surface. If injury is evident within the field, there is a potential for economically damaging populations within 1 to 2 weeks. Monitor the entire field to determine whether spot treatment or whole field treatment is appropriate.

No specific economic threshold has been developed for two-spotted spider mite in soybeans. Treatment may be warranted if:

- mites are present between bloom (R1) and pod fill (R5),
- 15% or more leaf area on plants are discolored and stippled with leaves yellowing,
- live mites are present, and
- hot, dry weather is expected to continue.

Refer to table 3-7 for treatment decision guidelines for the Upper Midwest soybean growing region.

Treatment may be delayed if cooler temperatures and high humidity are expected. Although rainfall reduces the risk of damaging spider mite populations, thunderstorms alone cannot be relied upon to eliminate infestations, particularly if rains arrive after establishment of large mite populations and are followed by continued hot, dry conditions.

The most effective natural enemy of two-spotted spider mite is a fungal pathogen that thrives under relatively cool temperatures (less than 85˚F) with at least 90% relative humidity. At least 12 to 24 hours of such conditions are believed necessary for extensive spread of the disease, and spider mite populations may decline rapidly in response to fungal disease activity. Infected mites have a dark discolored, waxy, or cloudy appearance, and mite death occurs within 1 to 3 days of infection.

Table 3-7. Treatment decision guidelines for two-spotted spider mites

Presence of mites	Damage	Assessment
Barely detected on leaves in dry locations or on edges of fields.	Barely detectable.	Treatment not necessary.
Easily detected on leaves in dry locations or on edges of fields. Difficult to find within field.	Foliage is green, but stippling injury is detectable on undersides of leaves of some plants.	Treatment not necessary, but keep monitoring.
All plants are infested.	All plants exhibit some stippling, even on healthy leaves. Some speckling and discoloration of lower leaves. Field margins and dry areas have most damage.	Rescue treatment is warranted, especially if many immatures and eggs are present.
All plants heavily infested.	Discolored and wilted leaves easily found throughout the field. Severe damage evident.	Effective rescue treatment may save field.
Extremely high numbers present.	Field discolored, leaves drying down. Significant foliage and stand loss.	Rescue treatment may not save field. However, new growth may appear if treated.

Source: Excerpted from Ohio State University and Michigan State University

Table 3-8. Suggestions for insect control in soybeans

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Bean leaf beetle	**Note:** See the economic threshold tables (tables 3-5 and 3-6) for recommendations on treatment timing.		
	Ambush 2E	3.2–6.4 fl oz	Do not apply within 60 days of harvest. Do not exceed 0.4 lb ai/a per season.
	Belay	3–4 oz	Do not apply within 21 days of harvest. Do not make foliar applications of Belay insecticide in fields treated with a neonicotinoid insecticide seed treatment within 45 days after planting. Regardless of formulation or type of application (foliar or seed treatment), do not apply more than 0.2 lb ai of clothianidin/a per season. Do not graze or feed soybean forage and hay to livestock.
	Asana XL	5.8–9.6 oz	Do not apply within 21 days of harvest. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/a per season.
	Baythroid XL	1.6–2.8 oz	Do not apply within 45 days of harvest. Do not exceed 11.2 oz/a per season.
	Cobalt Advanced	16.0–38.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.
	Cruiser 5FS	seed treatment	For use in commercial seed treaters only, or certified retail treatment locations. May be packaged with compatible and registered seed treatment fungicides (e.g., Cruiser Maxx, Cruiser Maxx Plus).
	Declare	0.77–1.28 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Delta Gold 1.5EC	1.5–2.4 oz	Do not apply within 21 days of harvest. Do not exceed 0.1 lb ai/a per season. Do not allow livestock to graze treated forage or feed treated hay to livestock.
	dimethoate	1.0 pt	Do not apply within 21 days of harvest or feed or graze within 5 days of last application.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Bean leaf beetle *(continued)*	Endigo ZC	4.0–4.5 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Gaucho 600	seed treatment	For protection of planted seeds from damage caused by over-wintering bean leaf beetles. For use in commercial seed treaters only (1.6–3.2 oz/100 lb seed).
	Hero	2.6–6.1 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Justice	2.5–3.0 oz	Do not apply less than 30 days before harvest. Do not exceed a total of 0.14 lb total active ingredient (0.081 lb acetamiprid + 0.059 lb bifenthrin) (10.0 oz of Justice insecticide) per acre per growing season. Do not exceed a total of 0.081 lb acetamiprid/a or 0.3 lb bifenthrin/a per growing season. Do not graze or use cut forage or hay as an animal feed.
	Leverage 360	2.8 oz	Do not apply within 45 days of harvest. Do not exceed 9.0 oz/a (0.07 lb ai/a ß-cyfluthrin, 0.14 lb ai imidacloprid) per season.
	Lorsban Advanced	1.0–2.0 pt	Do not apply more than 6 pt/a (3 lb ai/a) per season or within 28 days of harvest.
	Mustang Max	2.8–4.0 oz	Use higher recommended rate for increased pest pressure, increased residual control, or later-season applications. Do not graze or feed treated forage or straw to livestock. Do not exceed 0.15 lb ai/a per season. Do not treat within 21 days of harvest.
	NipsIt INSIDE	seed treatment	For use in commercial seed treaters or certified retail seed treatment locations only (1.28 oz/100 lb seed).
	Penncap-M[b]	2.0–3.0 pt	Do not apply within 30 days of harvest or make more than two applications per season.
	Pounce 3.2 EC	2.0–4.0 oz	Do not apply within 60 days of harvest. Do not exceed 0.4 lb ai/a per season.
	Sevin XLR Plus	0.5–1.0 qt	Do not apply within 21 days of harvest.
	Stallion	5.0–11.75 oz	Use higher recommended dosage for increased pest pressure, increased residual control, or later-season applications. Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.
	Triple Crown	3.5–4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	0.96–1.6 oz	Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.
Cutworms	Asana XL	5.8–9.6 oz	Do not apply within 21 days of harvest. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/a per season.
	Baythroid XL	0.8–1.6 oz	Do not apply within 45 days of harvest. Do not exceed 11.2 oz/a per season.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s).

[b] Do not apply to blossoming soybeans if bees are foraging.

(continued)

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Cutworms *(continued)*	Cobalt Advanced	11.0–26.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.
	Declare	0.77–1.28 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Delta Gold 1.5EC	1.0–1.5 oz	Do not apply within 21 days of harvest. Do not exceed 0.1 lb ai/a per season. Do not allow livestock to graze treated forage or feed treated hay to livestock.
	Endigo ZC	3.5–4.0 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Hero	2.6–6.1 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Leverage 360	2.8 oz	Do not apply within 14 days of harvest. Do not exceed 9.0 oz/a (0.07 lb ai/a ß-cyfluthrin, 0.14 lb ai imidicloprid) per season.
	Lorsban Advanced	1.0–2.0 pt	Do not apply more than 6 pt/a (3 lb ai/a) per season or within 28 days of harvest.
	Mustang Max	1.28–4.0 oz	Do not graze or feed treated forage or straw to livestock. Do not exceed 0.15 lb ai/a per season. Do not treat within 21 days of harvest.
	Pounce 3.2EC	2.0–4.0 fl oz	Do not apply within 60 days of harvest. Do not exceed 0.4 lb ai/a per season.
	Stallion	3.75–11.75 oz	Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.
	Triple Crown	3.5–4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	0.96–1.6 oz	Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.
Grasshoppers	***Treat when migration from adjacent areas begins and populations are heavy (more than 30% defoliation before bloom or 20% between bloom and pod fill).***		
	Asana XL	5.8–9.6 oz	Do not apply within 21 days of harvest. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/a per season.
	Baythroid XL	2.1–2.8 oz	Do not apply within 45 days of harvest. Do not exceed 11.2 oz/a per season.
	Cobalt Advanced	6.0–13.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Grasshoppers *(continued)*	Declare	1.28–1.54 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Delta Gold 1.5EC	1.5–1.9 oz	Do not apply within 21 days of harvest. Do not exceed 0.1 lb ai/a per season. Do not allow livestock to graze treated forage or feed treated hay to livestock.
	dimethoate	*see label*	—
	Endigo ZC	4.0–4.5 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Hero	2.6–6.1 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Leverage 360	2.0 oz	Do not apply within 45 days of harvest. Do not exceed 9 oz/a (0.07 lb ai/a beta-cyfluthrin, 0.14 lb ai/a imidacloprid) per season.
	Lorsban Advanced	1.0–2.0 pt	Use lower rate for young nymphs. Do not apply more than 6 pt/a (3 lb ai/a) per season. Do not apply within 28 days of harvest. Do not graze or feed treated foliage to livestock.
	Mustang Max	3.2–4.0 oz	Do not graze or feed treated forage or straw to livestock. Do not exceed 0.15 lb ai/a per season. Do not treat within 21 days of harvest.
	Orthene 90S	0.28–0.56 lb	Do not apply within 14 days of harvest.
	Penncap-M[b]	2.0–3.0 pt	Do not apply within 11 days of harvest or make more than two applications per season.
	Sevin XLR Plus	1.0–3.0 pt	Do not apply within 21 days of harvest.
	Stallion	5.0–11.75 oz	Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.
	Triple Crown	4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	1.6–1.92 oz	Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.
Green cloverworm	**Note:** Usually requires 12 or more half-grown worms per foot of row and 15% defoliation during pod-set and pod-fill stages to warrant treatment.		
	Ambush 2E	3.2–6.4 fl oz	Do not apply within 60 days of harvest. Do not exceed 0.4 lb ai/a per season.
	Asana XL	2.9–5.8 oz	Do not apply within 21 days of harvest. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/a per season.
	Baythroid XL	1.6–2.8 oz	Do not apply within 45 days of harvest. Do not exceed 11.2 oz/a per season.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Green cloverworm *(continued)*	Cobalt Advanced	6.0–13.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.
	Declare	0.77–1.28 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Delta Gold 1.5EC	1.0–1.5 oz	Do not apply within 21 days of harvest. Do not exceed 0.1 lb ai/a per season. Do not allow livestock to graze treated forage or feed treated hay to livestock.
	Endigo ZC	3.5–4.0 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Hero	2.6–6.1 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Intrepid 2F	4.0–8.0 fl oz	Do not apply within 7 days of harvest for hay or forage, or within 14 days for seed. Do not make more than 4 applications per year or exceed 64 fl oz/a (1 lb ai/a) per season.
	Leverage 360	2.8 oz	Do not apply within 45 days of harvest. Do not exceed 9 oz/a (0.07 lb ai/a beta-cyfluthrin, 0.14 lb ai/a imidacloprid) per season.
	Lorsban Advanced	0.5–1.0 pt	Do not apply more than 6 pt/a (3 lb ai/a) perseason. Do not apply within 28 days of harvest. Do not graze or feed treated forage to livestock.
	Mustang Max	2.8–4.0 oz	Do not graze or feed treated forage or straw to livestock. Do not exceed 0.15 lb ai/a per season. Do not treat within 21 days of harvest.
	Orthene 90S	0.83–1.1 lb	Do not apply within 14 days of harvest.
	Penncap-M[b]	2.0–3.0 pt	Do not apply within 11 days of harvest or make more than two applications per season.
	Pounce 3.2EC	2.0–4.0 fl oz	Do not apply within 60 days of harvest.
	Sevin XLR Plus	1.0–2.0 qt	Do not apply within 21 days of harvest.
	Stallion	5.0–11.75 oz	Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.
	Tracer	1.0–2.0 fl oz	Do not apply within 28 days of harvest. Do not feed treated forage or hay to meat or dairy animals. Do not exceed more than 6 fl oz/a (0.18 lb ai/a) per season.
	Triple Crown	3.5–4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	0.96–1.6 oz	Do not graze or harvest treated soybean forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Japanese beetle (adult)	Ambush 2E	6.4–12.8 oz	Do not apply within 60 days of harvest or exceed 0.4 lb ai/a per season.
	Asana XL	5.8–9.6 oz	Do not apply within 21 days of harvest. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/a per season.
	Baythroid XL	1.6–2.8 oz	Do not apply within 45 days of harvest or exceed 11.2 oz/a per season.
	Belay	3–4 oz	Do not apply within 21 days of harvest. Do not make foliar applications of Belay insecticide in fields treated with a neonicotinoid insecticide seed treatment within 45 days after planting. Regardless of formulation or type of application (foliar or seed treatment), do not apply more than 0.2 lb ai of clothianidin/a per season. Do not graze or feed forage and hay to livestock.
	Cobalt Advanced	16.0–38.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.
	Declare	1.28–1.54 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Delta Gold 1.5EC	1.5–2.4 oz	Do not apply within 21 days of harvest. Do not exceed 0.1 lb ai/a per season. Do not allow livestock to graze treated forage or feed treated hay to livestock.
	Endigo ZC	4.0–4.5 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin-containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Hero	4.0–10.3 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Leverage 360	2.8 oz	Do not apply within 45 days of harvest. Do not exceed 9.0 oz/a (0.07 lb ai/a beta-cyfluthrin, 0.14 lb ai imidacloprid) per season.
	Mustang Max	2.8–4.0 oz	Do not treat within 21 days of harvest. Do not exceed 0.15 lb ai/a per season. Do not graze or feed treated forage or straw to livestock.
	Penncap-M	2.0–3.0 pt	Do not apply within 30 days of harvest or make more than two applications per season.
	Pounce 3.2EC	2.0–4.0 oz	Do not apply within 60 days of harvest or exceed 0.4 lb ai/a per season.
	Sevin XLR Plus	0.5–1.0 qt	Do not apply within 21 days of harvest.
	Stallion	5.0–11.75 oz	Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.
	Triple Crown	4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	1.6–1.92 oz	Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Soybean aphid	Asana XL	5.8–9.6 oz	Do not apply within 21 days of harvest. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/a per season.
	Baythroid XL	2.8 oz	Do not apply within 45 days of harvest or exceed 11.2 oz/a per season.
	Belay	3–4 oz	Do not apply within 21 days of harvest. Do not make foliar applications of Belay insecticide in fields treated with a neonicotinoid insecticide seed treatment within 45 days after planting. Regardless of formulation or type of application (foliar or seed treatment), do not apply more than 0.2 lb ai of clothianidin/a per season. Do not graze or feed soybean forage and hay to livestock.
	Cobalt Advanced	11.0–26.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.
	Cruiser 5FS	seed treatment	For use in commercial seed treaters only, or certified retail treatment locations. May be packaged with compatible and registered seed treatment fungicides (e.g., Cruiser Maxx, Cruiser Maxx Plus).
	Declare	0.77–1.28 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Delta Gold 1.5EC	1.5–1.9 oz	Do not apply within 21 days of harvest. Do not exceed 0.1 lb ai/a per season. Do not allow livestock to graze treated forage or feed treated hay to livestock.
	dimethoate	1.0 pt	Do not apply within 21 days of harvest.
	Endigo ZC	3.5–4.0 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Gaucho 600	seed treatment	For use in commercial seed treaters only (1.6–3.2 oz/100 lb seed).
	Hero	4.0–10.3 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Justice	2.5–3.0 oz	Do not apply less than 30 days before harvest. Do not exceed a total of 0.14 lb total active ingredient (0.081 lb acetamiprid + 0.059 lb bifenthrin) (10.0 oz of Justice insecticide) per acre per growing season. Do not exceed a total of 0.081 lb acetamiprid/a per growing season. Do not exceed a total of 0.3 lb bifenthrin/a per growing season. Do not graze or use cut forage or hay as an animal feed.
	Leverage 360	2.8 oz	Do not apply within 45 days of harvest. Do not exceed 9 oz/a (0.07 lb ai/a beta-cyfluthrin, 0.14 lb ai/a imidacloprid) per season.
	Lorsban Advanced	1.0–2.0 pt	Do not apply more than 6 pt/a (3 lb ai/a) per season or within 28 days of harvest. Do not graze or feed treated forage to livestock.
	Mustang Max	2.8–4.0 oz	Do not graze or feed treated forage or straw to livestock. Do not exceed 0.15 lb ai/a per season or treat within 21 days of harvest.
	NipsIt INSIDE	seed treatment	For use in commercial seed treaters or certified retail seed treatment locations only (1.28 oz/100 lb seed).
	Orthene 90S	0.56–1.1 lb	Do not apply within 14 days of harvest.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Soybean aphid *(continued)*	Penncap-M[b]	1.0–3.0 pt	Do not apply within 11 days of harvest or make more than two applications per season.
	Pounce 3.2 EC	4.0–8.0 oz	Do not exceed 0.4 lb ai/a per season. Do not apply within 60 days of harvest. Do not graze or feed treated forage or hay.
	Stallion	5.0–11.75 oz	Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.
	Triple Crown	3.5–4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	0.96–1.6 oz	Do not graze or harvest treated soybean forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.
Stink bugs	**Note:** Treat when adult bugs or nymphs reach 1–3 bugs/foot of row during pod fill, 40 bugs/100 sweeps for grain soybean, or 20 bugs/100 sweeps for seed beans.		
	Asana XL	5.8–9.6 oz	Do not apply within 21 days of harvest. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/a per season.
	Baythroid XL	1.6–2.8 oz	Do not apply within 45 days of harvest. Do not exceed 11.2 oz/a per season.
	Belay	3–4 oz	Do not apply within 21 days of harvest. Do not make foliar applications of Belay insecticide in fields treated with a neonicotinoid insecticide seed treatment within 45 days after planting. Regardless of formulation or type of application (foliar or seed treatment), do not apply more than 0.2 lb ai of clothianidin/a per season. Do not graze or feed soybean forage and hay to livestock.
	Cobalt Advanced	16.0–38.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.
	Declare	1.28–1.54 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Delta Gold 1.5EC	1.5–1.9 oz	Do not apply within 21 days of harvest. Do not exceed 0.1 lb ai/a per season. Do not allow livestock to graze treated forage or feed treated hay to livestock.
	Endigo ZC	4.0–4.5 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Hero	4.0–10.3 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Stink bugs *(continued)*	Leverage 360	2.8 oz	Do not apply within 45 days of harvest. Do not exceed 9 oz/a (0.07 lb ai/a beta-cyfluthrin, 0.14 lb ai/a imidacloprid) per season.
	Mustang Max	3.2–4.0 oz	Do not graze or feed treated forage or straw to livestock. Do not exceed 0.15 lb ai/a per season or treat within 21 days of harvest.
	Orthene 90S	0.56–1.1 lb	Do not apply within 14 days of harvest.
	Penncap-M[b]	1.0–3.0 pt	Do not apply within 20 days of harvest.
	Stallion	9.25–11.75 oz	Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.
	Triple Crown	4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	1.6–1.92 oz	Do not graze or harvest treated soybean forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.
Thistle caterpillar	**Note:** Treat if defoliation reaches 30% before bloom or 20% between bloom and pod fill.		
	Ambush 2E	3.2–6.4 fl oz	Do not apply within 60 days of harvest. Do not exceed 0.4 lb ai/a per season.
	Asana XL	5.8–9.6 oz	Do not feed or graze livestock on treated field. Do not exceed 0.20 lb ai/a per season. Do not apply within 21 days of harvest.
	Cobalt Advanced	11.0–26.0 oz	Allow at least 14 days before applying a second application of Cobalt Advanced or another product containing chlorpyrifos. Do not apply within 30 days before harvest. Do not graze or feed treated foliage to livestock.
	Declare	0.77–1.28 oz	Do not apply within 45 days of harvest. Do not graze or harvest treated soybeans for forage, straw, or hay for livestock feed. Do not exceed 0.03 lb ai (0.19 pt)/a per season.
	Endigo ZC	3.5–4.0 oz	Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Hero	2.6–6.1 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Mustang Max	1.28–4.0 oz	Do not graze or feed treated forage or straw to livestock. Do not exceed 0.15 lb ai/a per season. or treat within 21 days of harvest.
	Pounce 3.2EC	2.0–4.0 fl oz	Do not apply within 60 days of harvest. Do not exceed 0.4 lb ai/a per season.
	Sevin XLR Plus	1.5 qt	Do not apply within 21 days of harvest.
	Stallion	3.75–11.75 oz	Do not exceed maximum allowable rate: 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not apply within 28 days of harvest. Do not allow meat or dairy animals to graze in treated areas or otherwise feed treated soybean forage, hay, and straw to meat or dairy animals.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s). *(continued)*

[b] Do not apply to blossoming soybeans if bees are foraging.

Table 3-8. Suggestions for insect control in soybeans *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions
Thistle caterpillar *(continued)*	Triple Crown	3.5–4.8 oz	Do not apply within 21 days of harvest. Maximum amount of Triple Crown insecticide allowed per crop per season: 14.2 oz (0.25 lb ai/a). Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Warrior II	0.96–1.6 oz	Do not graze or harvest treated soybean forage, straw, or hay for livestock feed. Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season.
Two-spotted spider mite	**Note:** Treat as needed on field margins or entire field.		
	Brigade 2EC	5.12–6.4 oz	Do not apply within 18 days of harvest. Do not exceed 0.3 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	dimethoate	1.0 pt	Do not apply within 21 days of harvest. Do not feed or graze within 5 days of last application.
	Cobalt Advanced	11.0–26.0 fl oz	Wait at least 14 days before making a second application of Cobalt Advanced or another product containing chlopyrifos. Do not apply within 30 days of harvest. Do not graze or feed treated foliage to livestock.
	Declare	1.54 oz	*For suppression only, not control.* Do not apply within 45 days of harvest. Do not exceed 0.03 lb ai (0.19 pt)/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Endigo ZC	4.5 oz	*For suppression only, not control.* Do not apply within 30 days of harvest. Do not exceed a total of 9.0 fl oz/a of Endigo ZC or 0.06 lb ai of lambda-cyhalothrin–containing products, or 0.125 lb ai of thiamethoxam-containing products per growing season.
	Hero	10.3 oz	Do not apply within 21 days of harvest. Do not exceed 0.4 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	Lorsban Advanced	1.0 pt	Do not apply more than 6 pt/a per season. Do not apply within 28 days of harvest. Do not graze or feed treated forage to livestock. A second application 3–5 days after the initial spray may be needed to control newly hatched nymphs. In this case, alternate to a non-chlorpyrifos product that is effective against mites (e.g., dimethoate).
	Warrior II	1.92 oz	*For suppression only, not control.* Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

[a] Multiple trade names listed within a row indicate products with the same active ingredient(s).

[b] Do not apply to blossoming soybeans if bees are foraging.

SOYBEAN DISEASE MANAGEMENT

Soybeans grown in Wisconsin are subject to attack by several disease-causing organisms. Growers should learn to identify the major soybean diseases in order to distinguish them from poor plant health due to insects, adverse weather and soil conditions, herbicide injury, and nutrient deficiencies. Solutions to disease problems are generally quite different compared with solutions to insects, weeds, and other problems. Soybean diseases can be controlled or reduced by planting resistant or tolerant varieties, using a crop management system that fits your farming operation, and using agricultural chemicals—generally fungicides.

RESISTANT OR TOLERANT VARIETIES

The use of disease-resistant or tolerant varieties is a practical and economical control for soybean diseases in Wisconsin. However, no soybean variety is resistant to all diseases. Carefully evaluate the major diseases on your farm and consider disease reactions when selecting soybean varieties. Disease reaction of soybean varieties can differ from year to year because the microorganisms that cause plant disease can change genetically and attack varieties that were formerly resistant. Soybean varieties also may have different reactions when grown under different cultural practices and weather conditions. Consult the publication *Wisconsin Soybean Variety Tests* at soybean.uwex.edu for information on specific varieties.

CROP MANAGEMENT

The use of crop rotation and clean tillage are very powerful disease-control tools. Many fungal and bacterial pathogens of soybeans survive between cropping seasons in soybean crop debris. Once this crop residue is thoroughly decayed, these disease-causing organisms die out. Therefore, crop rotation and tillage programs that permit residue decomposition before the next crop is planted will help reduce diseases such as brown stem rot, sclerotinia stem rot (white mold), pod and stem blight, anthracnose, stem canker, Septoria brown spot, Cercospora leaf spot (purple seed stain), bacterial blight and several other fungal and bacterial leaf diseases, and the soybean cyst nematode. Soil populations of the soybean cyst nematode can be minimized by crop rotation with nonhost crops.

Very few of the fungi and bacteria that attack soybeans infect other crop plants. Rotations with corn, small grains, or most forages deprive soybean pathogens of a host on which to infect, reproduce, and carry over between soybean crops.

Adequate, balanced soil fertility also can be important in reducing disease losses. Less-than-adequate phosphorus or potash can result in increased losses from Septoria brown spot, soybean cyst nematode, several root rots, and pod and stem blight. Healthy, vigorous plants are more tolerant of diseases and better able to produce a near-normal yield despite diseases.

FUNGICIDES

Fungicidal seed treatment

Treating soybean seeds may be beneficial to protect against certain pathogens (see table 3-9) under the following conditions:

- Early planting in cold, wet soils.
- Reduced till and no-till fields.
- If germination is below 80% or there are other indications of low seed vigor. Seed invaded by disease-producing organisms such as *Phomopsis* (pod and stem blight fungus) is more likely to respond to seed treatment.
- If the field is heavily infested with soybean root-invading fungi such as *Pythium, Rhizoctonia,* or *Phytophthora.*

Select the seed treatment fungicide to match pathogen pressure. Soil type, tillage, soil moisture and temperature, and seed health will influence the degree of pressure.

Follow the label for application rates and instructions. Apply fungicide seed treatments before applying a *Rhizobium*; inoculum and plant seed immediately.

Foliar fungicides

Folar fungicides can be used to lower losses due to leaf diseases and pod and stem blight (see table 3-10). Pod and stem blight may reduce yield, but its major effect is through seed infection (Phomopsis seed decay) that results in reduced seed germination and lower seedling vigor. Evaluations in Wisconsin reveal that foliar-applied fungicides reduce seed infection and improve germination. Foliar-applied fungicides for the control of leaf diseases and pod and stem blight have improved yields in Wisconsin tests, but this result has been very inconsistent.

Soybean seed producers should consider the use of foliar fungicides to improve seed quality (see table 3-12), taking the following factors into account:

- **Potential risk.** The diseases controlled by fungicide sprays are important when warm, wet weather prevails during the pod-fill stage. If, at bloom, the 30-day outlook is for warm, wet weather, these diseases will be active and fungicide sprays will be beneficial. Most product labels suggest two sprays, one at early pod development (upper pods 0.50 to 0.75 inches long) and a second spray 14 to 21 days later. However, if the weather has been dry since the first application and the forecast is for continued dry weather, do not spray a second time.
- **Was the field planted to soybeans the previous year?** If you grow soybeans for two or more consecutive years, disease severity potential will be higher than if you rotate crops.

Table 3-9. Fungicides for treating soybean seeds for protection against Rhizoctonia, Pythium, Phytophthora, and Phomopsis[a]

Fungicide	Sample formulations	Pathogens controlled				Remarks
		Rhiz.	Pyth.	Phyt.	Phom.	
Bacillus pumilus	Yield Shield	■	—	—	—	Can be applied as a water-based slurry either alone or with other insecticides and fungicides.
Bacillus subtilis	HiStick N/T, Vault HP	■	—	—	—	Provides protection against several early-season root diseases. Can be applied with other compatible seed treatments, but follow label directions closely.
captan	many	■	■	■	—	Protects against seed rot.
carboxin + captan	Vitavax-MDC	■	■	—	■	Protects against seed rot; provides systemic protection of seedlings to disease caused by *Rhizoctonia*. Carboxin controls seedborne phase of *Phomopsis* (pod and stem blight). *Phomopsis* can lower germination and seedling vigor.
carboxin + metalaxyl + captan	Bean Guard /Allegiance	■	■	—	—	Combines the systemic action of carboxin and metalaxyl with the contact action of captan. Effective against *Pythium* and *Rhizoctonia* and show good activity against *Fusarium* and *Helminthosporium.*
carboxin + thiram	Vitavax-CT	■	■	—	■	Protects against seed rot; provides systemic protection of seedlings to disease caused by *Rhizoctonia.* Carboxin controls seedborne phase of *Phomopsis* (pod and stem blight). *Phomopsis* can lower germination and seedling vigor.
fludioxonil	Maxim 4FS	■	—	—	■	Protects against *Rhizoctonia* and seed-borne *Phomopsis.* Use with Apron XL for broad-spectrum protection.

Abbreviations: Rhiz. = Rhizoctonia; Pyth. = Pythium; Phyt. = Phytophthora; Phom. = Phomopsis *(continued)*

[a] Follow label instructions for application rates and additional application instructions. Apply fungicide seed treatments before applying a Rhizobium inoculum and plant seed immediately.

Table 3-9. Fungicides for treating soybean seeds for protection against Rhizoctonia, Pythium, Phytophthora, and Phomopsis[a] *(continued)*

Fungicide	Sample formulations	Pathogens controlled				Remarks
		Rhiz.	Pyth.	Phyt.	Phom.	
fludioxonil + mefenoxam	Apron Maxx RFC, Apron Maxx RTA, Apron Max RTA + Moly, Warden RTA	■	■	■	■	Protects against seed rot and seedling death caused by *Phomopsis, Phytophthora, Pythium,* and *Rhizoctonia*.
ipconazole	Rancona Xxtra	■	■	■	■	May be applied with mechanical, slurry, or mist-type seed treating equipment. Seed should be sound and well cured before treatment.
ipconazole + metalaxyl	Inovate	■	■	■	■	Contains clothianidin for control of wireworm, white grub, seedcorn maggot, and bean leaf beetle.
mefenoxam	Apron XL-LS	—	■	■	—	Improves stands by controlling seed rot and seedling death caused by *Phytophthora* and *Pythium*. Has systemic activity. Will enhance performance of varieties with low to moderate resistance (tolerance) to *Phytophthora*.
metalaxyl	many	—	■	■	—	Improves stands by controlling seed rot and seedling death caused by *Phytophthora* and *Pythium*. Has systemic activity. Will enhance performance of varieties with low to moderate resistance (tolerance) to *Phytophthora*.
PCNB + ethazole	Terra-Coat L-205N	■	■	■	—	Protects against seed rot caused by *Pythium* and *Rhizoctonia.*
pyraclostrobin	Acceleron DX-109	■	—	—	—	Provides protection against seed and seedling disease due to *Rhizoctonia* and may provide suppression against *Pythium* spp.
sedaxane	Vibrance	■	—	—	—	For control of seed decay, seedling blight, and damping-off caused by *Rhizoctonia solani.*
Streptomyces lydicus	Actinogrow ST	■	■	■	—	Biological fungicide for suppression of early season root rot and damping-off fungi. Can be combined with other chemical seed treatment fungicides and/or insecticides.
thiabendazole	Mertect 340F	—	—	—	■	Provides protection against pod and stem blight on soybean seed.
thiamethoxam mefenoxam fludioxonil	CruiserMaxx Advanced	■	■	■	■	Mefenoxam is active against *Pythium* and *Phytophthora.* Fludioxonil is active against *Fusarium* and *Rhizoctonia solani* and suppresses seed-borne *Sclerotinia* and *Phomopsis.*
Trichoderma harzianum	T-22 HC	■	■	—	—	Preventative biological fungicide that protects against several root pathogens. Can be used with some other chemical fungicides, but consult compatibility charts for specific information.
thiram	many	■	■	—	■	Protects against seed rot; suppresses seedborne fungi.
trifloxytrobin	Trilex	■	—	—	—	Provides seed and seedling protection against seedborne fungi causing seed decay, soilborne pathogens, and *Rhizoctonia solani* and *Fusarium* spp.
trifloxystrobin + metalaxyl	Trilex 2000, Trilex 6000	■	■	—	—	Provides seed and seedling protection against seedborne fungi causing seed decay and the soilborne pathogens *Rhizoctonia solani* and *Pythium* spp.

Abbreviations: Rhiz. = Rhizoctonia; Pyth. = Pythium; Phyt. = Phytophthora; Phom. = Phomopsis

[a] Follow label instructions for application rates and additional application instructions. Apply fungicide seed treatments before applying a Rhizobium inoculum and plant seed immediately.

- **No-till or minimum tillage.** This will increase the potential of disease if soybeans are planted consecutive years.
- **Early-maturing varieties.** These usually suffer greater losses from diseases controlled by foliar fungicides than full-season varieties.
- **Benefits of improved seed quality.** The benefits from disease control may be an important consideration for applying fungicides to seed-production fields.
- **High yields.** Higher yields, 50 bu/a or more, should be anticipated if fungicide application is to be economical.
- **Treatment cost versus expected benefit.** Each treatment costs about $20 to $30/a for the chemical, wetting agent, and application.
- **A dense canopy of weeds.** This will impede the movement of the fungicide to soybean pods and foliage.

Follow label instructions for application rates and additional application instructions.

Soil-applied fungicides

These can be used for control of Phytophthora root rot (see table 3-10). Ridomil 2EC and Ridomil 5G are the only products registered for this purpose. Consider the following if you are thinking of using Ridomil 2EC or Ridomil 5G:

- **Potential risk.** Ridomil should be considered for fields with a history of frequent Phytophthora root rot. This disease can cause significant yield loss even without extensive plant death. Soils with high water-holding capacity are usually at greatest risk.
- **Soybean variety.** Ridomil performance is greatly affected by a variety's level of resistance or tolerance to Phytophthora root rot. Varieties that are highly tolerant have performed best with Ridomil use in Wisconsin research trials. Varieties with full resistance respond less to Ridomil treatment. Ridomil should not be applied to a fully susceptible or low-tolerant soybean variety.

Table 3-10. Fungicides for foliar and soil application for soybean[a]

Fungicide	Formulation	Group[b]	Cercospora blight & leaf spot	Downy mildew	Frogeye leaf spot	Phytophthora root rot	Pod and stem blight[c]	Powdery mildew	Sclerotinia stem rot (white mold)	Septoria brown spot
azoxystrobin	Quadris	11	■	—	■	—	■	—	—	■
basic copper sulfate	Cuprofix Disperss, Cuprofix Ultra 40	M1	■ ■	■ ■	—	—	■ ■	■ ■	—	■ ■
chlorothalonil	Bravo 500	M5	■	—	■	—	■	■	—	■
mefenoxam	Ridomil Gold GR, Ridomil Gold 4EC	4	—	—	—	■ ■	—	—	—	—
pyraclostrobin	Headline	11	■	—	■	—	■	—	—	■
thiophanate-methyl	Topsin M 4.5FL, Topsin M 70WP, Topsin M WDG	1	—	—	■ ■ ■	—	■ ■ ■	—	■ ■ ■	■ ■ ■

[a] Follow label instructions for application rates, time of application, and additional application instructions.

[b] Group codes indicate modes of action; use fungicides with different group codes to reduce the risk of disease resistance.

[c] Control of seed infection by PSB (pseudomycin B) pathogen.

SOYBEAN DISEASES

Phytophthora root rot

Phytophthora root rot may be found on soybeans grown on any soil type, but soils with poor internal drainage are especially prone to Phytophthora problems. Young plants are very susceptible and die quickly, the resulting gaps in rows are the only evidence the disease is present. Older plants are killed more gradually or plant vigor is reduced throughout the growing season. Initial leaf symptoms are a progressive yellowing and wilting of leaves from the bottom to the top of the plant. The dead leaves generally remain attached for a week or more. Dead or dying plants have a brown discoloration of the stem progressing upward from the soil line.

Variety selection and field monitoring. Planting resistant varieties provides the highest level of protection against individual races of *Phytophthora*. So if the fungus exists in your fields, you'll need to know which races are prevalent. To determine which races are present in a field, plant several varieties that differ in reported resistance. This test is especially important when planting a variety in a specific field for the first time. Races of the pathogen can differ from field to field. Also, new races can become prevalent, and a soybean variety that has shown no Phytophthora root rot in past years can become very diseased. For this reason, it's important to monitor the performance of varieties with race-specific resistance. Be aware that many soybean varieties have the same source of resistance to Phytophthora root rot. Consult the publication *Wisconsin Soybean Variety Tests* at soybean.uwex.edu for information on specific varieties.

Resistant varieties: Soybean varieties contain different genes for resistance. Each gene confers resistance to specific races of *Phytophthora*. No one variety is resistant to all races. This form of resistance results in a very high level of control. Resistant varieties perform well across a wide range of environments; however, the appearance of a new race can result in severe disease.

Tolerant varieties: Many soybean varieties are not highly resistant to specific races of *Phytophthora* but vary in the degree of susceptibility to all races. Varieties with a low level of susceptibility frequently are referred to as tolerant. Highly tolerant varieties can perform very well against Phytophthora root rot. However, performance of tolerant varieties can drop when conditions are highly favorable for this disease. Tolerance can be supplemented by use of appropriate cultural practices, formulations of seed treatment fungicides that contain mefenoxam or metalaxyl, and Ridomil soil treatment.

Cultural practices. Phytophthora root rot is most effectively suppressed by avoiding susceptible varieties. The ability of varieties to resist Phytophthora root rot can be enhanced by the following cultural practices.

- Improve soil drainage.
- Avoid tillage practices or other field activities that enhance soil compaction.
- Ridge soil around the base of plants during cultivation to promote root growth from the lower stem. This may suppress Phytophthora root rot when the root rot phase predominates. The lower soil moisture in the ridges creates a less favorable environment for Phytophthora activity.

Chemical control. For early Phytophthora root rot control, treat seed with a compound that has this disease on the label; treat only varieties with moderate to high tolerance. For longer control, apply Ridomil 2E in the furrow, over the row, or broadcast or apply Ridomil 5G in the furrow or in a band over the row.

Brown stem rot

Brown stem rot (BSR) can reduce grain yield by 10 to 25%. Symptoms do not appear until after pod development has begun. The insides of stems turn brown and leaves gradually yellow, wilt, and die. The symptoms begin in August and early September, depending on the relative maturity of the variety. Due to the timing, BSR is often confused with early maturity. Yield loss due to BSR is greatest when the soybean crop is planted early and in narrow rows. Brown stem rot resistant varieties and/or longer crop rotations may be most critical in this situation.

Crop management. Crop rotation can be used to control BSR. However, if growing susceptible varieties, you should have at least 2 years of a nonhost crop between soybean crops. Rotating soybean and corn on

alternate years can result in yield loss due to BSR. Corn and small grains are excellent nonhost crops. Current research indicates that forage legumes, peas, and snap beans are not associated with increased severity of BSR. The risk of BSR declines as soil pH increases to 7.0 or above.

Resistant varieties. Both public and private soybean varieties are available with moderate to high levels of resistance to BSR. Consult the publication *Wisconsin Soybean Variety Tests* at soybean.uwex.edu for information on specific varieties. Watch for foliar symptoms associated with "resistant" varieties. These symptoms may be caused by a breakdown of resistance by the BSR pathogen or a different pathogen.

Integration of rotation and resistant varieties. The movement to more integrated agricultural systems to reduce production costs makes an alternating soybean and corn rotation a seemingly desirable system. However, only 1 year of corn between soybean crops results in minimal suppression of the BSR fungus. Preliminary results from experiments in Iowa and Wisconsin suggest that varieties that are highly resistant to BSR reduce inoculum in the soil, but to a lesser degree than a year of corn. Thus, use of varieties resistant to BSR may take on added importance as the time interval between soybean crops is shortened. Although planting a variety resistant to BSR would be the most effective management option, another option is to plant resistant and susceptible soybean varieties on an alternating basis each time soybeans are planted in rotating corn or other nonhost of the BSR fungus. Brown stem rot is more severe in no-till fields than in conventional till. Therefore, longer crop rotations and/or resistant varieties should be considered if using no-till systems for soybean production.

Sudden death syndrome

Sudden death syndrome (SDS) is a relatively new disease to Wisconsin but nationally it is one of the top five yield-limiting diseases. Symptoms of SDS include a yellow to brown discoloration of the leaves around the veins, which can be mistaken for brown stem rot (BSR). To differentiate the symptoms in the field, start by noting the growth stage (SDS typically expresses symptoms earlier in reproductive growth than BSR) and then digging plants out with a shovel so that the roots are intact. Split the stem; SDS does not lead to a brown discoloration of the vascular and pith tissue that is typical with BSR. When infection is severe, it is possible to see a blue coloration on the taproot. This is growth of the fungus. Keep in mind that SDS and BSR can occur together in the same plant, so it is important to properly diagnose the disease.

Risk factors. The pathogen that causes SDS overwinters in soybean debris as resistant fungal spores. Disease development is favored by high soil moisture during vegetative growth and wet and cooler conditions around flowering. Low spots or areas prone to water retention or poorly drained areas are more favorable for disease development. It is not uncommon to see very abrupt areas in the field where plants are severely infected while the neighboring plants are healthy.

Dealing with SDS. There is a known association of SDS with the soybean cyst nematode (SCN), although both can occur in the absence of each other. We strongly advise taking a soil sample and submitting for testing for the presence of SCN from any field where SDS was noted. Management of SDS includes the use of resistant cultivars and the monitoring of conditions at planting to avoid cool soil temperatures that are favorable for infection by the pathogen. Very little varietal tolerance information exists in maturity group 2 and earlier soybean cultivars in Wisconsin; consult the Soybean Variety Trial Results at soybean.uwex.edu for ratings for SDS when conditions warrant. Tillage should also be considered to help increase soil temperature and drainage, although crop rotation does not appear to have much of an impact on SDS as outbreaks have been noted after several other crops, including corn.

Leaf diseases

Leaf diseases such as downy mildew, bacterial blight, powdery mildew, and brown spot are present in most soybean fields but generally do not cause significant yield losses. Frogeye leaf spot and Cercospora leaf spot, diseases normally found in the South, are becoming more prevalent in Wisconsin. Hot, humid weather favors development of these diseases.

Yield losses from leaf diseases may occur more frequently if soybeans are planted after June 1, especially if downy mildew or powdery mildew develop. Under certain environmental conditions these diseases can occur early in the growing season and cause premature defoliation and subsequent yield losses. Early development of brown spot may indicate other health problems are present. Crop rotation, fall plowing to bury soybean debris, or application of foliar fungicides at early podding can reduce the incidence of leaf diseases.

Soybean rust

Soybean rust is a rapidly spreading fungal disease that was first detected in the United States in 2004. Soybeans are susceptible to rust infection at all growth stages. Infected plants have fewer pods, fewer seeds per pod, and poorly filled seeds. To date, losses due to soybean rust in the United States have been low, and the disease has not been observed in Wisconsin.

Symptoms. Symptoms first appear in the lower canopy with tiny gray spots forming on the undersides of leaves, often clustered near leaf veins. As the disease progresses, the spots rapidly increase in size and become visible on the upper side of the leaf as well as on petioles, stems, and pods. Spots change color, going from gray to tan to reddish-brown or black. Leaves turn yellow and drop prematurely. Early rust symptoms may be mistaken for downy mildew, brown spot, bacterial pustule, or frogeye leafspot.

There is no evidence that the soybean rust fungus will survive Wisconsin winters. As a result, the pathogen must be blown northward to reinfest fields each year. Disease development is favored by long periods of leaf wetness (at least 8 hours), high relative humidity (75 to 80%), and temperatures between 59 and 86° F. At higher temperatures, disease development slows or stops. Spores can be produced 10 days after infection and are continually released as long as environmental conditions are favorable.

Scouting. Early detection and a rapid response are critical to soybean rust management. To help guide scouting, monitor the soybean rust website on the ipmPIPE: sbr.ipmpipe.org. Scout fields frequently, concentrating on early planted fields and early maturing varieties, and in fields that are subject to prolonged dews. Begin monitoring at soybean emergence and continue on a weekly schedule. Use a hand lens to check lower leaves where rust symptoms are likely to show first.

To confirm diagnosis, select leaves representing the range of symptoms. Place the leaves between layers of cardboard and paper towels and place in a sealable plastic bag. Keep them cool until mailing and record as much field history information as possible. Send to the Plant Disease Diagnostics Clinic, Department of Plant Pathology, University of Wisconsin-Madison, 1630 Linden Drive, Madison, WI 53706-1598.

Rust management. Fungicides are the only in-season control practices that are effective against soybean rust. Method of control is considered either preventive (sometimes called protectant) or curative:

- **Preventive fungicides.** These prevent fungi from infecting and/or penetrating host tissue. These fungicides must be in place before plants are infected, or they will not control the disease. The strobilurin class of fungicides (azoxystrobin, pyraclostrobin, trifloxystrobin, etc) are all preventive fungicides.
- **Curative fungicides (triazoles).** These inhibit or stop the development of infections that are already established. These fungicides are also able to slow disease development by limiting the pathogen's ability to produce new spores. This "post-infection activity" makes triazoles the fungicide of choice if soybean rust is established at low levels in a field. It is important to remember that triazoles do not have unlimited curative activity and are most effective when applied to plants with less than 10% infection in the lower canopy. Triazole fungicides may also be applied as a preventive, before disease infection.

Soybean cyst nematode

The soybean cyst nematode (SCN) was first discovered in southeastern Wisconsin in 1980. Currently, this destructive root-infecting pathogen should be considered a threat in all soybean growing regions of Wisconsin.

Soybean cyst nematodes are microscopic roundworms that reside in the soil and live by extracting nutrients from soybean roots. Common foliar symptoms are yellowing and eventual premature death. Plants damaged by SCN are usually stunted and nodulation is often disrupted. Plant death may occur, but usually does not. Symptoms can be confused with other crop production problems such as nutrient deficiencies, injury from agricultural chemicals, soil compaction, and other soybean disorders. Populations of SCN can also interact with and intensify these disorders, and vice versa.

If high populations of SCN are present, plants show symptoms often before flowering. However, symptoms may not appear until pod set if low soil populations of SCN exist. Infected plants commonly occur in oval-shaped patches that vary in size and increase each year soybeans are planted in an infested field. The affected area generally expands in the direction of tillage.

A laboratory soil analysis usually is necessary to determine the presence of SCN. However, you can diagnose SCN in the field by observing the cysts on the soybean root. Initially, the cysts are white, but they turn brown with time. The cysts are approximately the size of a pin head. Be careful not to confuse them with nodules caused by nitrogen-fixing bacteria.

Sampling for SCN. A soil analysis test can be used to confirm a suspected nematode problem or to eliminate SCN as one of several possible causes of poor plant growth. Soil samples can be taken any time of the year.

There are several ways to take a soil sample; the following is a general guide:

1. Use a soil probe or narrow-bladed trowel or shovel. Take samples close to plants at a depth of 8 to 10 inches. Discard the upper 2 inches of soil, especially if it is dry. Be sure to include plant roots.
2. Submit one sample for a 10-acre field or for a suspected area within the field. Sample soil and roots from 12 to 20 plants and mix into one sample; 1 to 2 pt of soil is adequate. Sample from plants in the margins of suspected areas and not from their centers.
3. Place samples in sturdy plastic bags, fasten the open end securely, and accurately label samples. Keep the samples from becoming dry and overheated. Mail samples early in the week to avoid delays in transit.

Laboratories will report the number of nematodes per unit of soil, usually per 100 cc of soil, or per gram of dry root. Growers and crop consultants may use these lab results to determine SCN damage potential (table 3-11). Nematode analysis laboratories are listed in table 2-16 on page 102.

(continued on page 166)

Table 3-11. Risk assessment of soybean cyst nematode (SCN) by soil population and soil type

Risk	Egg count range/ 100 cc soil	Potential yield loss for SCN susceptible variety
None	0	none
Low	1–500	0–10% silt or clay soil 5–20% sandy soils
Moderate	500–2,000	10–20% silt or clay soils 10–40% sandy soils
High	2,000–5,000	20–50% all soils
Very high	> 5,000	30–70% 10–20% expected yield loss for resistant varieties[a]

[a] Soybean varieties with CystX resistance should be superior to other forms of SCN resistance in fields with very high SCN populations in the soil.

Table 3-12. Fungicides registered for foliar soybean diseases in Wisconsin

Fungicide	Alternaria leaf spot	Anthracnose	Soybean rust	Septoria brown spot	Frogeye leaf spot	Pod and stem blight	Cercospora leaf spot	Powdery mildew	White mold	Active ingredient	Chemical family (FRAC code[a])	Amount/ use/a	Preharvest interval (PHI)
Alto 100 SL	■	■	■	■	■	■	■	—	—	cyproconazole	triazole (3)	2.75–5.5 fl oz	30 days
Remarks: Do not apply more than 11 fl oz/a/season. Do not graze within 14 days of application or apply more than 0.072 lb ai/a/year of cyproconazole-containing products. Do not use soybean forage or hay as livestock feed if making more than one application at 5.5 fl oz/a.													
Bravo Weather Stik	—	■	■[b]	■	■	■	■	—	—	chlorothalonil	chloronitrile (M5)	1.0–2.25 lb	6 weeks
Remarks: Do not apply more than 6 pt/a during each growing season. Do not feed hay or threshings from treated fields to livestock													
Cuprofix Ultra 40 Disperss	■	—	—	■	■	■	■	■	—	copper sulfate	inorganic (M1)	0.75–2.0 fl oz	Not listed
Remarks: Consult the label for disease specific recommendations and rates.													
Domark 230 ME	—	■	■	■	■	—	■	■	■	tetraconazole	triazole (3)	4.0–5.0 fl oz	Do not apply after R5
Remarks: Do not make more than two applications/year. Do not apply more than 10 fl oz/a/season. Do not graze or feed soybean forage or hay to livestock.													
Echo 720 Echo 90 DF Echo ZN	—	■	■	■	■	■	■	—	—	chlorothalonil	chloronitrile (M5)	1.0–2.25 pt .875–2.0 lb 1.5–3.5 pt	42 days
Remarks: Do not feed soybean or threshings from treated fields to livestock.													
Headline EC, Headline SC	■	■	■	■	■	■	■	—	—	pyraclostrobin	Qol (11)	6.0–12.0 fl oz	21 days
Remarks: Apply no more than 24 fl oz/season. Apply no more than two applications/season before alternating with a labeled non-Group 11 fungicide with a different mode of action.													
Priaxor	■	■	■	■	■	■	■	—	■[b]	fluxapyroxad + pyraclostrobin	Carboximides (7) Qol (11)	4–8 fl oz	21 days for grain and hay and 14 days for forage
Remarks: Do not apply more than 16 fl oz/a/season or make more than two consecutive applications before alternating to a labeled fungicide with a different mode of action.													
Proline 480 SC	—	—	■	—	■	—	—	■	■[b]	prothioconazole	triazole (3)	2.5–4.3 fl oz	21 days
Remarks: Do not apply more than three applications per season. Do not apply more than 12.9 fl oz/a/season.													
Quadris	■	■	■	■	■	■	■	—	—	azoxystrobin	Qol (11)	6.0–15.5 fl oz	14 days
Remarks: Do not apply more than 92.3 fl oz of product/a/season or make more than one application at 15.5 fl oz product/a or 0.25 lb ai/a to soybean forage and hay. Do not apply more than 1.5 lbs ai/a/season of azoxystrobin-containing products.													

[a] FRAC codes indicate the modes of action for each fungicide; multiple applications of fungicides from the same group increases the chances for the fungus developing resistance.

(continued)

[b] Supression only.

Table 3-12. Fungicides registered for foliar soybean diseases in Wisconsin *(continued)*

Fungicide	Alternaria leaf spot	Anthracnose	Soybean rust	Septoria brown spot	Frogeye leaf spot	Pod and stem blight	Cercospora leaf spot	Powdery mildew	White mold	Active ingredient	Chemical family (FRAC code[a])	Amount/ use/a	Preharvest interval (PHI)
Quadris Xtra	■	■	■	■	■	■	■	—	—	azoxystrobin + cyproconazole	Qol (11) triazole (3)	4.0–6.8 fl oz	30 days
Remarks: Do not apply more than 13.6 fl oz /a/season. Do not graze forage within 14 days of application. Do not apply more than 0.072 lb ai/a/year of cyproconazole-containing products. Do not apply more than 1.5 lb. ai/a/year of azoxystrobin-containing products. Do not use soybean forage or hay as livestock feed if making more than one application at 6.8 fl oz product/a.													
Quilt	■	■	■	■	■	■	■	—	—	azoxystrobin + propiconazole	Qol (11) triazole (3)	14.0–20.5 fl oz	21 days for seed and 0 days for forage and hay
Remarks: Do not apply more than 42 fl oz/a/season. Do not apply more than 0.34 lb ai of propiconazole-containing products/a/season. Do not apply more than 1.5 lb ai of azoxystrobin-containing products/a/season.													
Quilt Xcel	■	■	■	■	■	■	■	—	—	azoxystrobin + propiconazole	Qol (11) triazole (3)	10.5–21.0 fl oz	Apply up to stage R6
Remarks: Do not apply more than 42 fl oz/a/crop. Do not apply more than 0.34 lb ai of propiconazole-containing products/a/season. Do not apply more than 1.5 lb ai of azoxystrobin-containing products/a/season.													
Stratego YLD	■	■	■	■	■	■	■	■	—	prothioconazole + trifloxystrobin	triazole (3) Qol (11)	4.0–4.65 fl oz	21 days
Remarks: Do not apply more than three applications per season. Do not apply more than 13.95 fl oz/a/season. Do not graze or feed soybean forage or hay. Do not apply more than two sequential applications of Stratego YLD or any other Group 11-fungicide without alternating with a fungicide from another group.													
Tilt	—	■	■	■	■	—	—	—	—	propiconazole	triazole (3)	4.0–6.0 fl oz	Apply up to stage R6
Remarks: Do not apply more than 12 fl oz/a/season. Do not apply more than 0.34 lb ai propiconazole-containing product/a/season.													
Topsin M 70 WP Topsin M WDG Topsin M WSB	—	■	—	■	■	■	—	—	■	thiophanate-methyl	thiophanates (1)	0.5–1.0 lb 0.5–1.0 lb 0.5–1.0 lb	21 days
Remarks: Do not apply more than 2 lb/a/year. Do not graze or feed treated vines or hay to livestock.													
Topguard	—	—	■	■	■	—	■	■	—	flutriafol	triazole (3)	7.0–14.0 fl oz	21 days
Remarks: Do not apply more than 28 fl oz/a/season. Do not apply more than three applications per growing season. No single application may exceed 14 fl oz/a. Only one application at 14 fl oz/a may be made to any one field during a single growing season. Apply only to soybeans harvested for dry seed. DO NOT rotate to any other crop. Only soybeans may be rotated to treated fields. Do not feed forage or hay or permit animals to graze.													

[a] FRAC codes indicate the modes of action for each fungicide; multiple applications of fungicides from the same group increases the chances for the fungus developing resistance.

[b] Supression only.

Crop management. To keep soil populations of SCN at non-damaging levels, rotate soybeans with crops such as small grains, corn, alfalfa, and most vegetables (except peas, snap beans, lima beans, and dry-edible beans). The SCN can increase rapidly if soybeans are frequently planted in the same field.

Two years of field studies indicate that you can expect higher populations of SCN if planting in areas of fields with soil pH levels above 7.0 as compared to areas with pH levels of 5.9 to 6.5. Damage is usually more severe in sandy soils, but will occur in all types of soil.

Resistant varieties. SCN-resistant soybean varieties are becoming available. However, control should start with crop rotation, which delays development of damaging levels of SCN and greatly enhances the performance of resistant soybean varieties. Sample soils to determine population levels of SCN. Resistant varieties should be planted in fields with more than 1,000 SCN eggs/250 cc of soil. Consult the *Wisconsin Soybean Variety Tests* at soybean.uwex.edu for information on specific varieties.

Seed Treatments. Poncho/VOTiVO is registered as a commercially applied soybean seed treatment for early season nematode protection. This product can only be applied using commercial seed treatment equipment. Consider nematode seed treatments methods only in combination with crop rotation and the use of resistant varieties.

Diaporthe pod and stem blight

Pod and stem blight is a conspicuous disease of maturing soybeans. Plants are infected throughout the season, but conspicuous symptoms do not appear until 2 to 3 weeks before maturity. Symptoms are small, black fruiting bodies that look like specks on maturing soybean stems and pods. Severe infection by the Diaporthe fungus does not always mean a reduction in yield, but it generally results in reduced quality of seed for market or future planting. This is the Phomopsis seed decay phase of pod and stem blight. Infected seed may show no detectable symptoms or can be in some stage of decay. Visibly infected seeds are a discolored brown, shriveled, and often covered with white mold. This disease is favored by warm, wet weather during late pod fill.

Control. Diaporthe pod and stem blight can be controlled or reduced by integrating one or more of the following practices: use pathogen-free seed, delay planting, practice crop rotation, deep-plow soybean debris, harvest as early as possible, and apply registered fungicides at early podding (see the section on fungicides). Resistant varieties are not known, but early-maturing varieties generally are more susceptible. Seed treatments are useful when Phomopsis-infected seed must be sown. Plant-disease diagnostic laboratories can examine seed lots to determine approximate amounts of infection that may be present in seed. Narrow-row production does not increase pod and stem blight (Phomopsis seed decay).

Sclerotinia stem rot (white mold)

Sclerotinia stem rot (also called white mold) is characterized by dying plants in which the stems are covered with white mycelium and hard black structures called sclerotia. Sclerotia also form inside infected stems. Sclerotinia stem rot can be confused with Phytophthora root rot. Close inspection of affected plants is very important. Sclerotinia stem rot is favored by cool to moderate temperatures and high humidities in the crop canopy, especially during the flowering phase of crop development.

The risk of Sclerotinia stem rot is greatest when soybeans are grown in high-yield environments. Narrow-row production, early planting, plant populations greater than 200,000 plants per acre, irrigation, and high soil fertility are management practices that increase the risk of Sclerotinia stem rot. *Variety selection is critical under these conditions.*

Control. Sclerotinia stem rot management recommendations are based on the amount of disease that has been present in the field and on the relative resistance or susceptibility of the soybean variety planted. Refer to table 3-13 for specific recommendations.

Soybean varieties differ in susceptibility to Sclerotinia stem rot. Complete resistance to Sclerotinia is not available. Disease reactions of soybean varieties are greatly influenced by environmental conditions. Consult the publication *Wisconsin Soybean Variety Tests* for information on specific varieties.

The Sclerotinia stem rot fungus survives for years in the absence of a favorable host. Two years of a nonhost crop reduces but does not eliminate the risk of Sclerotinia stem rot. Corn and small grains are excellent nonhost crops to rotate with soybean; sunflowers, lima beans, and snap beans are hosts and increase the potential of Sclerotinia stem rot in soybean. Many broadleaf weeds are also hosts. Thus, control of broadleaf weeds in the nonhost crop year is critical.

There are several fungicides labeled for use in soybean for the control of Sclerotinia stem rot. However, most are only moderately effective and need to be applied when flowers are present on the lower half of the stem.

Herbicides containing lactofen (Cobra, Phoenix) will suppress white mold if applied at or before first bloom. Check the label for rates and adjuvant recommendations.

Sclerotia of *Sclerotinia sclerotiorum* are long-lived in soil but are subject to attack by many soil organisms. One commercially available biological control product, Contans WG, is labeled to control Sclerotinia stem rot in agricultural soils. Contans WG is applied in water to the soil surface, usually during preplanting or post-harvest on the stubble of a previously diseased crop. Contans WG can be sprayed just ahead of the tillage equipment. It should be incorporated within 24 hours after spraying, ideally immediately after spraying. Contans WG can be incorporated with irrigation on sandy soils and some peat soils. It may be tank mixed and applied with herbicides such as trifluralin or glyphosate. Do not mix Contans with any other fungicide. Read and follow label directions. The more time between treatment and the typical onset of disease, the better.

Table 3-13. Management recommendations for Sclerotinia stem rot (white mold)

Field history (% disease)	Management recommendations[a,b]
0%	Plant pathogen-free seed. Maintain current row width and plant population. Avoid crops that are susceptible to white mold in the rotation.
< 5%	**If disease is...** —**present in pockets:** Avoid planting susceptible soybean varieties. Maintain current row width and plant population. Rotate out of soybeans for at least 1 year. —**spread throughout field:** Plant partially resistant varieties. Maintain current row width, but reduce plant population if planting less-resistant varieties. Rotate out of soybeans for at least 1 year.
5–25%	**If soybean variety is...** —**partially resistant:** Maintain current row width and plant population. Rotate out of soybeans for at least 1 year. —**moderately susceptible:** Widen row width to 15 to 30 inches and lower seeding rate accordingly. Rotate out of soybeans for at least 1 year. Consider treating seed fields with a fungicide at flowering.
25–50%	Select partially resistant varieties. Maintain current row width but lower the plant population. Rotate 1 to 2 years out of soybeans. Consider treating field with a fungicide at flowering.
> 50%	Plant varieties with as much resistance as possible. Narrow row spacing maybe acceptable for varieties with good resistance. If planting 30-inch rows, plant at 125,000 seeds/a. Rotate 2 to 3 years out of soybeans. Fungicide treatment necessary for susceptible varieties grown for seed—apply when flowers are present on lower half of stems.

[a] Variety resistance rankings: resistant = <5% mortality, high yield; partially resistant = 5–25% mortality, high yield; moderately susceptible = 26–50% mortality, variable yield; susceptible = 26–50% mortality, low yield; highly susceptible = >50% mortality, low yield.

[b] Optimum seeding rates for fields with a high risk for white mold: 180,000 plants/a for 7.5- and 15-inch rows and 125,000 plants/a for 30-inch rows.

Source: Soybean Plant Health, University of Wisconsin; www.plantpath.wisc.edu/soyhealth

Alfalfa mosaic virus

Alfalfa mosaic virus (AMV) was detected in soybean for the first time in 1999. Most AMV inoculum is introduced into soybean fields by aphids that acquire the virus from forage legumes. Transmission occurs throughout the season. Infected leaves may have a bright yellow mosaic or the leaf veins may turn yellow, but the rest of the leaf remains the normal green color.

Control. No genes with resistance have been reported. Soybeans planted early in the season appear to be less affected by the disease.

Bean pod mottle virus

Bean pod mottle virus (BPMV) was first detected in Wisconsin in 1999. Bean leaf beetles feed on infected forage legumes and transmit the virus to soybeans throughout the season. Young leaves in the upper canopy exhibiting light green to yellow mottling. Some leaves become puckered and distorted. Stems remaining green after pods have matured retain petioles after leaf blades drop. The virus survives in insects over the winter.

Control. Tolerant varieties are reported, but varieties are not characterized for reaction to BPMV. Management of bean leaf beetle is key to control of virus (see the insect section for recommendations). Delay planting until mid-May to avoid feeding by overwintered bean leaf beetles.

Soybean mosaic virus

The soybean mosaic virus (SMV) occurs in Wisconsin, but yield loss has not been documented. Infected leaves develop a mosaic of light and dark green areas and chlorosis may develop between the dark green areas. Leaf surfaces become raised or blistered and leaf margins may be wavy or curl downward. Most infected plants are slightly stunted, have fewer pods, and mature later. Infected seed, a major source of inoculum, may be discolored. Aphids feed on infected plants and transmit SMV to healthy plants throughout the season.

Control. Plant virus-free seed. Varieties appear to differ in susceptibility but they are not characterized for reaction to SMV. Soybeans planted early in the season appear to be less affected by the disease.

Tobacco streak virus

Tobacco streak virus (TSV) is widespread in Wisconsin but yield loss is not known. This disease was detected in soybean for the first time in 1999. Infected leaves acquire a mild mosaic coloring of yellow and green. Leaf and flower buds may be excessively proliferous. Maturity is delayed in infected plants and plants remain green. Most TSV inoculum is introduced into soybean fields as infected seed. Thrips transmit TSV to healthy plants throughout the season.

Control. Varieties appear to differ in reaction to TSV although genes with resistance to the virus have not been reported. Soybeans planted early in the season appear to be less affected by the disease.

4 FORAGE & PASTURE PEST MANAGEMENT

FORAGE & PASTURE WEED MANAGEMENT

Wisconsin has millions of acres of harvested forages and pastures that serve as the base of our strong livestock enterprises. Weeds can cause economic losses in forages and pastures unless management practices are in place to contain them. This section will discuss weed management in legume forages and then in grass pastures.

FORAGE LEGUMES

Weed management tools are much more limited in forage crops compared to grain crops. The only opportunities to use mechanical methods of weed management are during seedbed preparation before establishment or when harvesting forage. As a result, growers rely upon herbicides and competition from forage legumes to suppress weeds. After the seeding year, though, weeds are seldom a problem as long as the stand remains vigorous and dense. Weedy fields usually occur when stands decline, a sign that rotation to another crop is required. Weeds can be suppressed with mowing (or grazing); however, weed species can affect feed quality and palatability. Herbicide use is common in newly seeded stands but less common in established stands. Legume establishment with a cover crop is discussed in the "Small Grains" section of this manual.

ESTABLISHING FORAGE LEGUMES WITHOUT A COVER CROP (DIRECT SEEDING)

Historically, small-seeded legumes in Wisconsin have been sown with a small grain cover crop, but today most growers establish forage legumes without a companion crop. (See the "Small Grains" section for details about weed management when legumes are seeded with cereals.) While direct seeding can enhance yields in the establishment year, small-seeded legumes grow slowly, leaving the soil surface exposed and subject to erosion. Therefore, direct seeding on erodable slopes is not recommended. In these cases, consider planting with a no-till drill or using a temporary cover crop as discussed later. Because small-seeded legumes are poor competitors until they are established, adequate weed control in the seeding phase is important to enhance desirable forage quantity and quality.

The postemergence herbicides available in forages make it possible to practice the IPM principle of "treat as needed." If no preplant-incorporated herbicide is used, scout fields weekly after planting. Consider using the appropriate herbicide or herbicide combination if weed pressure is moderate to high. There is no need to treat if weed pressure is low.

The impact of weeds on forage quality varies from field to field, weed to weed, and year to year but is primarily affected by the weeds present and their density and growth stage when harvested. Table 4-1 compares the relative seriousness of common annual and perennial weeds in forages. These rankings are based on laboratory analyses and feeding studies with animals done by several midwestern universities.

Some of these species may not be particularly objectionable in terms of forage value but may present other problems. For example, pigweed and lambsquarters may be nutritious but can also accumulate nitrates, especially in nitrogen-rich soils and when rain follows a prolonged dry period. Cocklebur and nightshade are in the "serious" category because they contain poisonous compounds. Pennycress imparts a garlicky flavor to milk.

The herbicides listed in table 4-2 control many weeds in direct-seeded legume establishment. Most treatments have little effect on perennial weeds, and special control measures for such species should be used while the field is in other crops.

Table 4-1. Impact of common weeds on forage quality

	Relative seriousness		
	high	**moderate**	**slight**
Annual weeds	cocklebur Eastern black nightshade giant foxtail giant ragweed smartweeds yellow foxtail	green foxtail lambsquarters pennycress shepherd's purse velvetleaf wild mustard	common ragweed pigweeds
Perennial weeds	curly dock hoary alyssum yellow rocket	Canada thistle quackgrass and other grasses	dandelion white cockle

Table 4-2. Seedling legume tolerance and herbicide effectiveness on weeds commonly found in establishing legumes seeded without a cover crop[a]

					Grasses			Broadleaves										
Herbicide	**Crop stage for post**	**Mode of action group[d]**	**Labeled crops**	**Legume tolerance**	**Barnyardgrass**	**Foxtails**	**Quackgrass**	**Common chickweed**	**Common lambsquarters**	**Common ragweed**	**Eastern black nightshade**	**Pennycress**	**Pigweeds**	**Shepherd's purse**	**Smartweeds**	**Velvetleaf**	**Wild mustard**	**Wild radish**
Preplant-incorporated																		
Eptam	—	8	al, bf, cl	F/G	**G/E**	**G/E**	P/F	F	F	F	F	P	F/G	P	P	F/G	P/F	P/F
Treflan	—	3	al	**G**	**G/E**	**G/E**	P	P	F/G	P	P	P	**G/E**	P	P	N	P	N
Postemergence																		
Buctril	≥ 4TL	6	al	F/G	P	P	N	P	**G/E**	**G/E**	**G/E**	**G/E**	F	**E**	**G**	**G**	**G**	**G**
Butyrac	AS	4	al, bf	**G**	N	N	N	P	**G/E**	**G/E**	F	F	**G/E**	F/G	P	**G/E**	F/G	F
Extreme[b]	AS[c]	2,9	al	**E**	**E**	**E**	**G/E**	**E**	**G/E**	**E**	**E**	**E**	**E**	**E**	**G/E**	**G/E**	**E**	**E**
Glyphosate[b]	AS[c]	9	al, bf, cl	**E**	**E**	**E**	**G/E**	**E**	**G/E**	**E**	**E**	**E**	**E**	**E**	**G/E**	**G/E**	**E**	**E**
Poast Plus	AS	1	al, bf, cl	**E**	**G/E**	**E**	F/G	N	N	N	N	N	N	N	N	N	N	N
Prowl H_2O	2TL, < 6" in height	3	al	**E**	**G/E**	**G/E**	P	F/G	**G/E**	P	P	P	G/E	G	P	N	N	N
Pursuit	≥ 2TL	2	al, cl	**G**	**G**	**G**	P	**G**	F/G	F	**E**	**G/E**	**E**	**G/E**	**G**	**G/E**	**G/E**	**G**
Raptor	≥ 2TL	2	al, cle	**G**	**G**	**G/E**	P/F	**G**	**G**	F/G	**E**	**G/E**	**E**	**G/E**	**G**	**G/E**	**G/E**	**G**
Select	AS	1	al, bf	**E**	**G/E**	**E**	**G**	N	N	N	N	N	N	N	N	N	N	N

Abbreviations:

Crop stage: TL = trifoliate leaves; AS = any stage
Labeled crops: al = alfalfa; bf = birdsfoot trefoil; cl = clover
Legume tolerance and control ratings: E = excellent; G = good; F = fair; P = poor; N = none

[a] Adapted from Extension publication *Alfalfa Management Guide* (NCR547), 2011.

[b] If broadcast spraying, apply only to Roundup Ready alfalfa or severe crop injury will occur.

[c] Labels recommend application when alfalfa has 3-4 TL to remove non-transgenic alfalfa seedling.

[d] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action.

[e] Only labeled for clover grown for seed.

Buctril (bromoxynil)

Rate: *Buctril*—1.0 to 1.5 pt/a.
Buctril 4EC—0.5 to 0.75 pt/a.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence, forages*—Treat when alfalfa has at least 4 trifoliate leaves.

Weeds—Treat when annual broadleaves are 2 inches or less in height or 1 inch in diameter and have no more than 4 leaves.

Remarks: Buctril is a postemergence, contact herbicide that controls many common broadleaf weeds in alfalfa in either direct seeding or with a companion crop. Use the lower rate to control Eastern black nightshade, lambsquarters, pennycress, and shepherd's purse, and the higher rate to control wild mustard, pigweed, wild radish, ragweed, and velvetleaf. Buctril may not adequately control overwintered weeds.

Significant alfalfa injury may occur if the temperature exceeds 70°F within 3 days after application. Several factors influence the injury potential of Buctril. The most important seem to be stage of alfalfa growth (seedlings with less than four trifoliate leaves are very sensitive), presence of atrazine and/or Eptam residues (they enhance Buctril injury), temperature and relative humidity (hot, humid conditions present a greater risk than dry conditions), and other causes of stress.

Do not treat alfalfa stressed by moisture shortage or excess, insect injury, or other causes. Use spray volumes of at least 20 gal/a, flat fan nozzles, and 30 psi pressure. Do not add surfactant or other additives to the spray mixture.

Buctril can be tank mixed with Pursuit to improve control of pigweed, chickweed, and nightshade, and alfalfa can be treated at the 2 trifoliate leaf stage if reduced rates of Buctril (0.5 to 0.75 pt/a) are used. Fields treated with Buctril alone may be harvested 30 days after application and the forage used for any purpose. Fall-treated alfalfa cannot be harvested until 60 days after application. Buctril can be applied to seedling alfalfa that has been underseeded with small grains as long as grains are not past the boot stage.

Rotational restrictions: Any crop can be planted 30 days after application.

Butyrac 200 (2,4-DB)

Rate: 1 to 3 qt/a. Check the label for rates according to weed species and size.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence, forages*—Treat any time after legume emergence.

Weeds—Treat when annual broadleaf weeds are 3 inches or less in height.

Remarks: Butyrac 200 is a water-soluble amine liquid that contains 2 lb ae/gal. It controls many annual broadleaf weeds, but is weak on smartweed and mustards and does not control grasses. Some suppression of perennial broadleaf weeds can be expected at 2 to 3 qt/a.

Butyrac 200 can be applied to spring and summer-seeded alfalfa or birdsfoot trefoil. Do not apply Butyrac after the first cutting.

The legume should be actively growing and free of stress, and no rainfall should occur within 7 to 10 days to reduce risk of crop injury. Legume seedlings may show temporary stunting, particularly if higher rates are applied during hot, humid conditions. Treated seedling forage cannot be harvested or grazed for 60 days after application.

Butyrac can be tank mixed with Buctril, Poast Plus, Pursuit, Raptor, or Select Max.

Rotational restrictions: The label gives no information on planting rotational crops.

Eptam (EPTC)

Rate: *Eptam 7-E*—2.25 to 4.5 pt/a.
Eptam 20-G—15 lb/a.

Timing: *Preplant-incorporated*—Apply Eptam to a smooth, dry seedbed just before planting and immediately incorporate to a depth of 2 to 3 inches to prevent herbicide loss through evaporation. Where possible, simultaneously apply and incorporate Eptam in one operation.

Remarks: Eptam provides good control of annual grasses and many annual broadleaf weeds. Eptam may be used to establish alfalfa, birdsfoot trefoil, and clovers. Use the lower rate on coarse-textured soils. Eptam is ineffective on peat or muck soils. To control only annual grasses, 2.25 pt/a is sufficient. The high rate partially suppresses yellow nutsedge and quackgrass, but complete control of any perennial weed should not be expected. Eptam does not

control smartweed, black nightshade, or perennials such as Canada thistle and bindweeds.

Incorporate by working the field in two different directions. Weed control is dependent upon thorough and immediate incorporation. Much of the herbicide will evaporate if it is not incorporated within minutes after application.

Temporary stunting of the small-seeded legume and sealing of the first leaves may occur. Injury is likely if Eptam is applied during cool wet weather, at high rates, or if it is poorly incorporated. Do not seed bromegrass, fescue, ryegrass, orchardgrass, timothy, or small grain since these will be killed. Do not apply Eptam if atrazine has been applied within 12 months as severe injury may result. Eptam can be mixed with liquid fertilizer solution or impregnated onto dry fertilizer for simultaneous application. Fields treated with Eptam cannot be harvested for 14 days.

Rotational restrictions: Other crops can be planted any time after the first harvest.

Extreme (imazethapyr + glyphosate)

If broadcasted, use only on Roundup Ready alfalfa varieties.

Rate: Apply 2.2 to 4.4 pt/a of Extreme. See label for maximum weed heights.

Adjuvants: Add 1 pt of nonionic surfactant + 8.5 to 17 lb/100 gal of ammonium sulfate.

Timing: *Postemergence, forages*—Treat when alfalfa has at least two fully expanded trifoliate leaves.

Weeds—Treat when annual weeds are 1to 3 inches tall or rosettes are 1 to 3 inches wide.

Remarks: The combination of glyphosate and imazethapyr are effective at controlling most weed species encountered in seedlings alfalfa in Wisconsin. The addition of the imazethapyr will provide some residual control that glyphosate does not. Treated fields cannot be harvested for 30 days after application. A maximum of 4.4 pt/a per year can be applied to a field, with only 3.0 pt/a in the last year of the stand. Sequential applications must be applied at least 7 days apart. Apply a minimum of 1 hour before rainfall. Temperatures below 50°F can reduce effectiveness. Following application, plants may be temporarily stunted. Do not harvest alfalfa treated with Extreme until 30 days after application. Adding other adjuvants (e.g. methylated seed oil) has the potential to increase crop injury and is not recommended.

Up to 10% of the purchased seed may not have the Roundup Ready gene; therefore, applying glyphosate when alfalfa has 3 to 4 trifoliate leaves is recommended to eliminate susceptible plants, regardless of weed populations.

Rotational restrictions: If an Extreme-treated field needs to be replanted, do not plant the field to alfalfa for 4 months following application. Soybeans and imidazolinone-resistant/tolerant corn (Clearfield corn) can be replanted anytime after an Extreme application in alfalfa. See appendix table 2 for additional plant-back information.

Glyphosate

If broadcasted, use only on Roundup Ready alfalfa varieties.

Rate: Apply 0.75 to 1.0 lb ae/a following planting for annual and perennial weed control. For established stands with large perennial weeds, rates up to 1.5 lb ae/a can be effective. Currently, several products containing glyphosate have the supplemental label to be applied in Roundup Ready alfalfa.

Adjuvants: Ammonium sulfate at 8.5 to 17 lb/100 gal of spray mixture is recommended if using hard water. Additional surfactant is rarely needed.

Timing: Apply glyphosate when weeds are at the proper height (check the label: generally 4 to 6 inches tall for annuals and just prior to flowering for perennials). Glyphosate can be applied after any cutting if needed.

Remarks: Glyphosate kills a wide range of grass and broadleaf weeds. Roundup Ready alfalfa has excellent tolerance to glyphosate. In Roundup Ready alfalfa, apply glyphosate when the weed population justifies treatment. In direct seedings, this occurs typically 30 to 40 days after seeding. If oats are planted as a temporary cover crop, apply glyphosate when oats are 4 to 6 inches tall to kill oats and weeds. Treated fields can be harvested 5 days after application. A maximum of 6.0 lb ae/a (170 fl oz/a of Roundup PowerMAX) can be applied in the seeding year (including burndown application). In subsequent

years, a maximum of 4.64 lb ae/a (132 fl oz/a of Roundup PowerMAX) can be applied per year. No more than 1.5 lb ae/a is allowed per application. Sequential applications of glyphosate should be at least 7 days apart.

Up to 10% of the purchased seed may not have the Roundup Ready gene; therefore, applying glyphosate when alfalfa has 3 to 4 trifoliate leaves is recommended, to eliminate susceptible plants, regardless of weed populations.

Rotational restrictions: None.

Poast Plus (sethoxydim)

Rate: Apply 18 to 24 fl oz/a of Poast Plus to control annual grass weeds. Use 36 fl oz/a of Poast Plus to kill volunteer grains that emerge following harvest.

Adjuvants: Add 1 qt/a of a crop oil concentrate or 1 pt/a of Dash HC or Sundance HC for all Poast Plus applications. If quackgrass or wirestem muhly is present, also add 2 to 4 qt/a of 28% liquid nitrogen or 2.5 lb/a of ammonium sulfate.

Timing: *Postemergence, forages*—Treat at any stage of alfalfa, clover, or trefoil growth.

Weeds—Treat when annual grasses are 4 to 8 inches tall and actively growing and before the alfalfa gets large enough to reduce interception of the spray solution.

Remarks: Poast Plus gives excellent control of annual grasses in newly seeded alfalfa, clover, and birdsfoot trefoil. For best control, treat before the first mowing. Apply Poast Plus in 5 to 20 gal/a of spray solution using 40 to 60 psi pressure. Do not use flood jet nozzle tips. Treat volunteer winter cereals when they are 4 to 6 inches tall and before tillering has started; treat in the fall as control will be unacceptable with spring applications. Poast Plus is rainfast within 1 hour after application. Alfalfa and birdsfoot trefoil can be harvested 7 days after treatment if the forage is green chopped or ensiled and 14 days after treatment if harvested as dry hay. For clover, dried forage cannot be harvested for 20 days. In alfalfa only, Poast Plus can be tank mixed with Pursuit or Raptor to broaden the spectrum of weeds controlled.

Poast Plus can also be applied to kill oats used as a *temporary companion crop* by an application when the oats are 4 to 6 inches tall.

Rotational restrictions: Do not plant other crops to be harvested for 30 days after application unless Poast Plus is registered for use on that crop.

Prowl H_2O (pendimethalin)

Rate: 1.1 to 2.1 pt/a prior to weed emergence.

Timing: Apply Prowl H_2O to seedlings when alfalfa has two or more trifoliate leaves but is less than 6 inches in height. Note that it will only control weeds that have not emerged.

Remarks: Prowl H_2O is effective at preventing the emergence of many small seeded grasses and broadleaf weeds, but used alone, this product has limited value in weed control for alfalfa seedling establishment in Wisconsin as many weeds have emerged by this time frame. Fields cannot be harvested for 28 days after applications.

Rotational restrictions: Do not plant winter wheat or barley within 120 days after application and avoid planting grass crops for 10 months after a spring application and 12 months after a fall application.

Pursuit (imazethapyr)

Rate: 3 to 6 fl oz/a of Pursuit. See label for rates needed for specific weed species.

Adjuvants: In most situations the addition of a nonionic surfactant to the spray solution (1 qt/100 gal) is recommended. If weeds are large and growing conditions are dry, consider using a crop oil concentrate (5 qt/100 gal) or a methylated seed oil (4 qt/100 gal) instead of a surfactant. For all applications, also add 28% liquid nitrogen (1.25 to 2.5 gal/100 gal) or ammonium sulfate (12 to 15 lb/100 gal) to the spray solution.

Timing: *Postemergence, forages*—Treat when alfalfa or clover has at least two fully expanded trifoliate leaves.

Weeds—Treat when annual weeds are 1 to 3 inches tall or rosettes are 1 to 3 inches wide.

Remarks: Pursuit controls many annual broadleaf and several annual grass weeds. Unlike other postemergence treatments in alfalfa or clover, Pursuit continues controlling weeds as they germinate for several weeks to a month after application if a timely rain places the active ingredient in the zone of weed seed germination. To

increase the spectrum of weeds controlled, Pursuit may be tank mixed with Buctril, Butyrac, Poast Plus, or Select Max.

Pursuit will be safer to alfalfa and more effective on weeds if environmental conditions favor plant growth. Thus if air temperatures stay at or below 40°F for 10 or more hours, delay Pursuit application until at least 48 hours after the temperature rises above 40°F or until weeds are actively growing. Following application, alfalfa may be temporarily stunted.

Do not harvest alfalfa treated with Pursuit until 30 days after application.

Several weed species in Wisconsin have documented resistance to imidazolinone herbicides such as Pursuit. If applications appear to have not worked, please consult your local county Extension agent for assistance in determining if you have a resistant population in your field.

Rotational restrictions: If a Pursuit-treated field needs to be replanted, do not plant the field to alfalfa for 4 months following application. Soybeans and imidazolinone-resistant/tolerant corn (Clearfield corn) can be replanted anytime after a Pursuit application in alfalfa. See appendix table 2 for additional plant-back information.

Raptor (imazamox)

Rate: Apply 4 to 6 fl oz/a. Adjust the rate according to the specific weeds present and their size as indicated on the label. In general, the 4 fl oz/a rate controls sensitive annual grass and broadleaf species.

Timing: Apply Raptor to new alfalfa seedings with two or more trifoliate leaves.

Adjuvants: In most situations the addition of a nonionic surfactant to the spray solution (1 qt/100 gal) is recommended. If weeds are large and growing conditions are dry, consider using a crop oil concentrate (1 to 2 gal/100 gal) or a methylated seed oil (1 to 2 gal/100 gal) instead of a surfactant. For all applications, also add 28% liquid nitrogen (2.5 gal/100 gal) or ammonium sulfate (12 to 15 lb/100 gal) to the spray solution.

Remarks: Raptor can be used as a postemergence herbicide in newly seeded or established alfalfa. The general use guidelines and performance are similar to those of the closely related herbicide Pursuit. The primary differences between Raptor and Pursuit is that Raptor is more effective on common lambsquarters and annual grasses, has no preharvest interval, and has a shorter rotational interval for most vegetable crops. Both provide excellent control of pigweed and mustard species and very good control of chickweeds, foxtails, barnyardgrass, nightshades, and smartweeds. Raptor is weak on ragweeds, but at the maximum labeled rate of 6 fl oz/a, it suppresses common and giant ragweed as well as dandelion, Canada thistle, and quackgrass.

As with Pursuit, there is a risk of alfalfa injury from Raptor. Raptor persists after application and will control sensitive weeds that germinate for several weeks after application if a timely rain places the active ingredient in the zone of weed seed germination. Raptor can be tank mixed with Buctril, Butyrac, Poast Plus, or Select Max. Several weed species in Wisconsin have documented resistance to imidazolinone herbicides such as Raptor. If applications appear to have not worked, please consult your local county Extension agent for assistance in determining if you have a resistant population in your field.

Rotational restrictions: Following a Raptor application, soybeans can be planted any time. Wait 3 months before planting alfalfa and wheat, 8.5 months for corn, and 9 months for most vegetable crops.

Select (clethodim)

Rate: *Select Max* (12.6% ai)—Apply 9 to 16 fl oz/a for annual grass control and 12 to 32 fl oz/a for perennial grass control.

Select 2EC (26.4% ai)—Apply 6 to 8 fl oz/a for annual grass control and 10 to 16 fl oz/a for perennial grass control.

Adjuvants: In most situations the addition of a nonionic surfactant to the spray solution (1 qt/100 gal) is recommended. If weeds are large and growing conditions dry, consider using a crop oil concentrate or methylated seed oil at 0.25% vol/vol. If difficult-to-control grass species are present, consider adding 2.5 to 4.0 lb/a of ammonium sulfate to improve control.

Timing: *Postemergence, forages*—Treat at any stage of alfalfa growth.

Weeds—Treat when annual grasses are 2 to 6 inches tall and actively growing.

Remarks: Select can be used to control grasses during the establishment of alfalfa and birdsfoot trefoil grown for hay, silage, green chop, or direct grazing. Apply Select

in 5 to 20 gal/a of spray solution using 30 to 60 psi pressure. Do not use flood nozzle tips. To control volunteer cereals in summer-seeded alfalfa, treat in the late summer or early fall when the cereals are 4 to 6 inches tall.

Select can also be used to kill oats planted as a *temporary companion crop* by an application when the oats are 4 to 6 inches tall.

Forage treated with Select can be harvested, fed, or grazed 15 days after application. Select can be tank mixed with Pursuit or Butyrac in new seedings for broadleaf weed control, but do not do so unless the feeding, grazing, and harvesting restriction on these labels can be observed. Read the label carefully as restrictions can vary between companies.

Rotational restrictions: Do not plant rotational crops until 30 days after application.

Treflan (trifluralin)

Rate: 1 pt/a on coarse-, 1 to 1.5 pt/a on medium-, and 1.5 pt/a on fine-textured soils.

Timing: *Preplant-incorporated*—Apply Treflan prior to planting and incorporate within 24 hours to a depth of 2 to 3 inches.

Remarks: Trifluralin gives excellent control of annual grasses and pigweed, but has little effect on ragweed, velvetleaf, and weeds in the mustard family. Because it is active on grasses arising from seed, do not seed forage grasses such as orchardgrass or bromegrass with the alfalfa. Treflan will not control quackgrass or wirestem muhly emerging from rhizomes. Treflan can be simultaneously applied with liquid fertilizer or impregnated onto dry fertilizer. It kills weeds by stopping cell division and has a low risk of allowing resistant weeds to develop. Fields treated with trifluralin cannot be harvested or grazed for 21 days.

Rotational restrictions: Peas, potatoes, and soybeans can be planted any time after a Treflan application. Corn, sorghum, oats, and any other grass crop mixtures can be planted 1 year after a spring application or 14 months after a fall application.

SUMMER SEEDINGS

Most growers who seed alfalfa in the summer find that fewer weeds germinate at this time of the year and therefore preplant-incorporated herbicides are not needed. Summer annuals that germinate in late summer (velvetleaf, pigweed, crabgrass, and wild proso millet) typically do not grow very tall and die with the first frost. If ample soil moisture is present, treatment of these weeds is not needed; if dry conditions occur, treatment can improve stand establishment. However, winter annuals like shepherd's purse, chickweed, and pennycress need careful monitoring. They develop into the rosette stage in late summer and early fall and then are quick to flower the following spring. These weeds may reduce forage quality in the second year but rarely impact yield. If concerned about forage quality the spring after a summer seeding, we recommend scouting fields routinely every other week into the early fall to see if a postemergence treatment is needed.

When summer seedings follow wheat, volunteer wheat is often a serious weed problem. This is less likely if fields are moldboard plowed before seeding alfalfa. When fields are disked, chisel plowed, or no-till seeded, winter wheat often germinates and competes vigorously with the alfalfa, especially the following spring. Data from Wisconsin indicate that volunteer wheat densities ≥7 plants/sq ft can reduce alfalfa densities. If volunteer wheat threatens alfalfa establishment, apply Poast Plus, Select, glyphosate (Roundup Ready alfalfa only), or Raptor with an appropriate additive when wheat is 4 to 6 inches tall and actively growing. Delaying applications until wheat is at this height will ensure control of multiple flushes of volunteer wheat seedlings and result in close to 100% control the following spring. Do not wait until the spring or early summer to treat as control will be much more difficult. Poast Plus and Select also kill volunteer oats, but these will die during the winter and seldom require treatment.

WEED MANAGEMENT IN ESTABLISHED FORAGE LEGUMES

Removing weeds from forage crops seldom increases total yield because the weeds are harvested along with the crop. However, since weeds are often less palatable, lower in protein, and less digestibile than forages, controlling weeds can improve forage quality.

Some believe that weed control may prolong the productive life of forage stands by preventing competitive weeds such as quackgrass and dandelions from crowding out the forage. However, if weeds are the only stress present, they seldom affect forage stand density in Wisconsin after establishment. Other factors have been found to play a more important role in determining stand life. These include cold winter temperatures, cutting schedule, and disease and insect problems.

Established stands of forage legumes compete effectively with many annual and perennial weeds. If weeds appear, inadequate soil fertility, low soil pH, poor soil drainage, plant diseases, or other factors hampering legume growth may be the cause. Winter annual weeds such as shepherd's purse, chickweed, and pennycress may become a problem if conditions the previous fall were suitable for their establishment. Some perennial weeds, such as white cockle, yellow rocket, dandelions, hoary alyssum, and quackgrass, persist

Table 4-3. Legume tolerance and herbicide effectiveness on weeds commonly found in established legume stands

				Annual weeds				Perennial weeds											
Herbicide	**Mode of action group[b]**	**Labeled crops**	**Legume tolerance**	**Common chickweed**	**Field pennycress**	**Foxtail species**	**Shepherd's purse**	**Broadleaf plantain**	**Canada thistle**	**Common dandelion**	**Curly dock**	**Hemp dogbane**	**Hoary alyssum**	**Perennial sowthistle**	**Quackgrass**	**White cockle**	**Wirestem muhly**	**Yellow nutsedge**	**Yellow rocket**
Butyrac	4	al	**G**	P	F/G	N	F/G	F/G	N	P	P/F	N	F	N	N	P	N	N	P
Chateau	14	al	**G/E**	**E**	**E**	**G/E**	**E**	—	P	P	P	—	P[e]	—	P	P[e]	—	P	P[e]
Extreme[a]	2,9	al	**G**	**E**	**E**	**E**	**E**	**G/E**	P	P	P/F	P	F	**G**	P	P	P	P/F	F/G
Glyphosate[a]	9	al, bf, cl	**E**	**E**	**E**	**E**	**E**	**G/E**	**G**	**G**	—	**E**	—	**E**	**G/E**	F/G	**E**	F	**G/E**
Metribuzin	5	al	F/G	**E**	**G/E**	F	E	P	P	**G/E**	F	P	F/G	P	F/G	**G**	P	F	**G**
Poast Plus	1	al, bf	**E**	N	N	E	N	N	N	N	N	N	N	N	F/G	N	F/G	N	N
Prowl HO	3	al	**E**	P	P	**G/E**	F/G	P	P	P	P	P	P	—	P	P	—	P	P
Pursuit	2	al, bf,[c] cl	**G**	**G**	**E**	F/G	**G/E**	F	P	P	P/F	P	F	**G**	P	P	P	P/F	F/G
Raptor	2	al, cl[d]	**G**	**G**	**E**	**G/E**	**G/E**	F	P/F	P/F	P/F	—	F	**G**	P/F	P	P	F	F/G
Select	1	al, bf	**E**	N	N	**E**	N	N	N	N	N	N	N	N	G	N	F/G	N	N
Velpar	5	al	**G**	**E**	**G/E**	F	**E**	F/G	N	**G/E**	F	N	**G**	P	F/G	F	F	F	**G/E**

Abbreviations:

Labeled crops: al = alfalfa; bf = birdsfoot trefoil; cl = clover

Legume tolerance and control ratings: E = excellent; G = good; F = fair; P = poor; N = none

[a] If broadcast spraying, apply only to Roundup Ready alfalfa or severe injury will occur.

[b] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action.

[c] Labeled for use only when these species are used as a cover crop.

[d] Labeled only for clover grown for seed.

despite legume competition. These weeds can be kept from spreading by harvesting the infested legume before weed seeds are produced. If seed does mature before the legume is ready for harvest, the forage should be ensiled as this will kill nearly all weed seeds.

Base herbicide selection decisions in established legumes on the weed species to be controlled and forage stand density. *For alfalfa, treat only if the field has an average of 55 stems or a minimum of 4 to 5 crowns per square foot*. For stands with fewer stems or crowns present, we recommend rotating to another crop. Use table 4-3 to help select the appropriate treatment for the weed complex found in each field.

Butyrac 200 (2,4-DB)

Rate: Apply 1 to 3 qt/a to seedling weeds. The lower rate is effective on small pigweed, pennycress, lambsquarters, and wild mustard. Smartweed and curly dock are suppressed at the 3 qt/a rate.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Treat when weeds are actively growing and less than 3 inches tall or wide. Winter annuals like pennycress should be treated in the fall.

Remarks: Alfalfa should be healthy and actively growing for greatest selectivity. Do not apply if temperatures will exceed 90˚F up to 3 days after application. Some stem twisting and leaf malformation may occur, but plants usually outgrow these symptoms. Forage can be harvested 30 days after application in established stands.

Rotational restrictions: The label gives no information on plant-back intervals.

Chateau (flumioxazin)

Rate: 4 oz/a.

Timing: Chateau can be applied to established alfalfa (previously harvested) any time alfalfa is less than 6 inches tall.

Remarks: Make applications before emergence of target weed species as Chateau has only preemergence activity on annuals and germinating perennial weeds that are historically difficult to control once established. Fields cannot be harvested or grazed within 25 days of applications. Sequential applications can be made 60 days after the initial application, but no more than 8 oz/a can be applied per season. Chateau can be impregnated onto dry fertilizer for simultaneous application. Do not add any adjuvant or product formulated as an emulsified concentrate (EC). Addition of adjuvant or tank mixing with an EC product will cause Chateau to also exhibit postemergence activity similar to a contact herbicide. While control of emerged annual weeds can result, damage will occur to alfalfa if it has resumed growth.

Rotational restrictions: Field corn, soybeans, sunflowers, sorghum, and wheat cannot be planted for 4 months after treatment. All other common Wisconsin crops, including alfalfa, cannot be planted for 12 months after treatment.

Extreme (imazethapyr + glyphosate)

If broadcasted, use only on Roundup Ready alfalfa varieties.

Rate: Apply 2.2 to 4.4 pt/a of Extreme. See label for maximum weed heights.

Adjuvants: Add 1 pt of nonionic surfactant + 8.5 to 17 lbs/100 gal of ammonium sulfate.

Timing: *Postemergence, forages*—Treat when alfalfa has 3 inches or less of growth (regrowth). For best results, also treat when weeds are 1 to 3 inches in height or diameter.

Remarks: The combination of glyphosate and imazethapyr is effective at controlling most weed species encountered in seedling alfalfa in Wisconsin. The addition of the imazethapyr will provide some residual control that glyphosate does not. A maximum of 4.4 pt/a per year can be applied to a field, with only 3.0 pt/a in the last year of the stand. Sequential applications must be applied at least 7 days apart. Apply a minimum of 1 hour before rainfall. Temperatures below 50°F can reduce effectiveness. Following application, plants may be temporarily stunted. Do not harvest alfalfa treated with Extreme until 30 days after application. Adding other adjuvants (e.g. methylated seed oil) has the potential to increase crop injury and is not recommended.

Up to 10% of the purchased seed may not have the Roundup Ready gene; therefore, applying glyphosate when alfalfa has 3 to 4 trifoliate leaves is recommended to eliminate susceptible plants, regardless of weed populations.

Rotational restrictions: If an Extreme-treated field needs to be replanted, do not plant the field to alfalfa for 4 months following application. Soybeans and imidazolinone-resistant/tolerant corn (Clearfield corn) can be replanted any time after an Extreme application in alfalfa. See appendix table 2 for additional plant-back information.

Glyphosate

Rate: *Roundup Ready alfalfa*—Apply 0.75 to 1.0 lb ae/a for annual and perennial weed control in the spring. For established stands with large perennial weeds, rates up to 1.5 lb ae/a may be warranted. Several products containing glyphosate have the supplemental label to be applied in Roundup Ready alfalfa.

Adjuvants: Ammonium sulfate at 8.5 to 17 lb/100 gal of spray mixture is recommended if using hard water. Additional surfactant is rarely needed.

Timing: Only broadcast treatments to Roundup Ready alfalfa. Apply glyphosate when weeds are at the proper height or growth stage. Fall applications will give the best results for perennial broadleaf weeds such as curly dock, dandelion, white cockle, and yellow rocket. Quackgrass can be controlled with either spring or fall applications. If annual weeds appear and are dense enough to warrant treatment, apply when they are 4 to 6 inches tall. Glyphosate can be applied after any cutting if needed.

Remarks: Glyphosate provides good-to-excellent control of most grass and broadleaf weeds commonly found in established alfalfa fields in Wisconsin, and Roundup Ready alfalfa has excellent tolerance to glyphosate. While applications can be applied any time except within 5 days before harvest, fall and spring applications to control winter annual or perennial weeds will be most common. A maximum of 4.64 lb ae/a per year (132 fl oz Roundup Weather Max) may be applied, with no more than 1.5 lb ae/a allowed per application. Applications are required to be at least 7 days apart. For removal of Roundup Ready alfalfa, use at least 1.0 lb ae/a of either 2,4-D or dicamba or a combination of both in the fall prior to a hard frost. Also scout and plan for management of volunteer plants in the crop the following year if in a no-till field. In non-Roundup Ready alfalfa fields, glyphosate can be applied to terminate the stand before harvesting the final crop as long as 36 hours elapse between application and harvest/grazing.

Rotational restrictions: None.

Metribuzin

Rate: Metribuzin rates are based upon the weeds to be controlled and if used in pure alfalfa stands (0.33–1.33 lb/a) or mixes of alfalfa and forage grasses (0.67–1.0 lb/a). For chickweed apply 0.33 lb/a of metribuzin. For pennycress, shepherd's purse, and downy brome, apply 0.5 to 0.67 lb/a of metribuzin. For white cockle, yellow rocket, and tansy mustard, use 0.67 to 1.33 lb/a. For dandelion and quackgrass suppression, use 1.33 lb/a of metribuzin. This rate reduces competition from curly dock but will seriously injure most forage grasses. Use the lower rates on sandy loam and loamy sand soils but do not apply on sandy soils or soils with a pH > 7.5.

Timing: *Pre-green-up*—Metribuzin can be early spring-applied to alfalfa established for more than 1 year. Do not apply metribuzin during the seeding year nor the year after seeding. It must be applied to dormant alfalfa any time in early spring after the snow has melted, when the ground is not frozen and when alfalfa is less than 3 inches tall. If green forage shoots are present, injury will occur. It can control weeds that have not yet emerged as well as weeds that are less than 2 inches tall or 2 inches in diameter.

Remarks: Metribuzin controls many annual and several perennial weeds. Metribuzin may be applied to alfalfa mixed with forage grasses, but some injury to the grasses should be expected. Stresses such as drought, disease, low fertility, overcutting, or insects may increase the likelihood of crop injury. Alfalfa may not be harvested or grazed for 28 days after application.

Metribuzin can be impregnated onto dry fertilizer for simultaneous application.

Metribuzin gives good-to-excellent control of dandelions. Do not apply metribuzin if the alfalfa stand is not sufficient to fill the voids left by the controlled weeds.

Rotational restrictions: If cropping plans change after metribuzin application, soybeans, corn, alfalfa, potatoes, and forage grasses may be planted in treated fields 4 months after application. Barley and wheat

may be planted 8 months after metribuzin application. Do not apply additional metribuzin to any of these rotational crops during the same year. Other crops can be planted 12 months after the initial application except root crops like beets and onions, which require an 18-month waiting period.

Poast Plus (sethoxydim)

Rate: To control annual grasses in the summer, use 18 to 24 fl oz/a of Poast Plus. For quackgrass suppression, apply 36 fl oz/a of Poast Plus.

Adjuvants: Add 1 qt/a of a crop oil concentrate or 1 pt/a of Dash HC or Sundance HC for all Poast Plus applications. If quackgrass or wirestem muhly is present, also add 2 to 4 qt/a of 28% liquid nitrogen or 2.5 lb/a of ammonium sulfate.

Timing: *Postemergence*—Treat when annual grasses are 4 to 8 inches tall and actively growing. Treat when quackgrass and wirestem muhly are 6 to 8 inches tall and actively growing.

Remarks: Poast Plus can be spring-applied to suppress quackgrass and wirestem muhly before first cutting or used in the summer to control grasses that appear following the second or third cutting in older (thinner) established alfalfa, clover, and birdsfoot trefoil stands. Forage grasses will be stunted or killed. Poast Plus gives less control if grassy weeds are under stress, especially from drought, or if they have been previously mowed. Forage can be harvested 7 days after Poast Plus application if it is green chopped or ensiled, and 14 days after application if harvested as dry hay. Use 40 to 60 psi pressure, 5 to 20 gal/a spray solution, and flat fan or hollow cone nozzles to apply Poast Plus.

Rotational restrictions: Do not plant other crops to be harvested for 30 days after application unless Poast Plus is registered for use on that crop.

Prowl H_20 (pendimethalin)

Rate: 1.1 to 4.2 qt/a. For foxtail control use 2 qt/a, but higher rates are often required to control common winter annuals like chickweed and shepherd's purse.

Timing: Apply to established fields before weed emergence. Alfalfa must be less than 6 inches tall.

Remarks: Prowl H_20 is effective at preventing the emergence of many small seeded grasses and broadleaf weeds and would be a good fit for thinning stands with many annuals weeds. Its effectiveness on winter annuals is variable unless rates greater than 2 qt/a are utilized. Fields treated with less than 2.1 qt/a of Prowl H_20 cannot be harvested for 28 days after application, while fields treated with more than 2.1 qt/a cannot be harvested for 50 days.

Rotational restrictions: For applications less than 2 qt/a, do not plant winter wheat or barley within 120 days and do not plant annual or perennial grass crops or mixtures 10 months after a spring application or 12 months after a fall application. For applications greater than 2 qt/a, only plant crops for which Prowl H_20 is labeled for preplant-incorporated treatments. Do not plant other crops for 24 months.

Pursuit (imazethapyr)

Rate: 3 to 6 fl oz/a of Pursuit or equivalent. See label for rates for specific weed species.

Adjuvants: Add a crop oil concentrate (5 qt/100 gal) or, under dry conditions, use a methylated seed oil (MSO, 4 qt/100 gal) in the spray solution. For all applications, also add 28% liquid nitrogen (1.25 to 2.5 gal/100 gal) or ammonium sulfate (12 to 15 lb/100 gal) to the spray solution.

Timing: Apply in the spring or fall to established dormant or semi-dormant alfalfa or clover (less than 3 inches in growth) or after a cutting, but before regrowth exceeds 3 inches.

Remarks: Use in established alfalfa/clover will be limited as most common weeds are perennials. Where annuals like shepherd's purse, pennycress, chickweed, eastern black nightshade, or giant or green foxtail appear in established stands, Pursuit could be an appropriate choice. If perennial forage grasses like orchardgrass, tall fescue, or smooth brome are present, Pursuit can be used, but it can reduce growth and competitive effect of forage grasses.

Good herbicide coverage is essential for adequate weed control; weeds treated after a recent harvest may be inadequately controlled. Up to 6 fl oz/a of Pursuit could be applied in established alfalfa and these rates would be necessary to suppress perennial weeds like dandelion or quackgrass. There is a 30-day restriction on harvesting

or grazing alfalfa or clover after applying Pursuit. No more than 4 fl oz/a of Pursuit can be applied during the last year of the stand. Several weed species in Wisconsin have documented resistance to imidazolinone herbicides such as Pursuit. If applications appear to have not worked, please consult your local county Extension agent for assistance in determining if you have a resistant population in your field.

Rotational restrictions: Alfalfa and clovers can be planted 4 months after a Pursuit application. Soybeans and imidazolinone-resistant/tolerant corn (Clearfield corn) can be planted any time after a Pursuit application. See appendix table 2 for additional plant-back information.

Raptor (imazamox)

Rate: Apply 4 to 6 fl oz/a. Adjust the rate according to the specific weeds present and their size as indicated on the label. In general, the 4 fl oz/a rate controls sensitive annual grass and broadleaf species that are no taller or wider than 3 inches.

Timing: Apply Raptor in the spring or fall to established dormant or semi-dormant alfalfa (less than 3 inches growth) or after any cutting before alfalfa regrowth has exceeded 3 inches.

Adjuvants: In most situations when applying Raptor to established alfalfa, add a crop oil concentrate (4 qt/100 gal) or under dry conditions, use a methylated seed oil (4 qt/100 gal) in the spray solution. For all applications, also add 28% liquid nitrogen (2.5 gal/100 gal) or ammonium sulfate (12 to 15 lb/100 gal) to the spray solution.

Remarks: Raptor can be used as a post-emergence herbicide in established alfalfa. Most weeds in established stands are perennials. Raptor is weak on such species, but it will suppress yellow rocket, dandelion, Canada thistle, and quackgrass. Raptor will not control white cockle. Older alfalfa stands sometimes have shepherd's purse, pennycress, or foxtails for which Raptor will be effective. Raptor has no preharvest interval (PHI). Several weed species in Wisconsin have documented resistance to imidazolinone herbicides such as Raptor. If applications appear to have not worked, please consult your local county Extension agent for assistance in determining if you have a resistant population in your field.

Rotational restrictions: Following a Raptor application, soybeans can be planted any time. Wait 3 months before planting alfalfa and wheat, 8.5 months for corn, 9 months for most vegetable crops, and 26 months for red beets and sugar beets.

Select (clethodim)

Rate: *Select Max* (12.6% ai)—Apply 12 to 16 fl oz/a for annual grass control and 16 to 32 fl oz/a for perennial grass control.

Select 2EC (26.4% ai)—Apply 10 to 16 fl oz/a.

Adjuvants: In most situations the addition of a nonionic surfactant to the spray solution (1 qt/100 gal) is recommended. If weeds are large and growing conditions dry, consider using a crop oil concentrate or methylated seed oil at 0.25% vol/vol. If difficult-to-control grass species are present, the label suggests adding ammonium sulfate at 2.5 to 4.0 lb/a to improve control.

Timing: *Postemergence*—Treat when annual grasses are 2 to 6 inches tall and when perennials are 4 to 8 inches tall.

Remarks: Select can be spring-applied to suppress quackgrass or wirestem muhly before first cutting or used in the summer to control annual grasses that appear following the second or third cutting in older (thinner) established alfalfa or birdsfoot trefoil grown for hay, silage, green chop, or direct grazing. A single application usually results in a nearly quackgrass-free first cutting, but some quackgrass regrowth often appears later in the season. Forage grasses in treated fields will be stunted or killed by Select. Forage treated with Select can be harvested, fed, or grazed after 15 days.

See previous section on Select on page 175 for additional comments about its use.

Rotational restrictions: Do not plant other crops for 30 days after application.

Velpar DF (hexazinone)

Rate: Use 0.67 to 1.0 lb/a of Velpar DF on coarse to medium soils with 1% or less organic matter. Use 1 to 2 lb/a on medium-to-heavy soils with 1 to 5% organic matter. The lower rates control weeds such as chickweed, buttercup, shepherd's purse, pennycress, and yellow rocket. Apply 1.33 to 2.0 lb/a to soils with more than 5% organic matter. Usually 1.33 lb/a is needed to suppress dandelions, quackgrass, and

white cockle but lower rates have given acceptable suppression, especially on medium- and light-textured soils.

Timing: *Pre-green-up*—Apply to established alfalfa that is dormant or semi-dormant before growth exceeds 2 inches. Treating taller alfalfa will result in crop injury. Do not treat if ground is snow-covered or frozen.

Remarks: Velpar can be used in alfalfa fields beginning the year after establishment. However, the weed infestation the year after seeding seldom justifies such applications. If such a treatment is needed, Velpar can only be used when the root system is well established. This usually means that the alfalfa was direct seeded (without a companion crop) and grew vigorously in the seeding year. Use no more than 1 lb/a of Velpar in stands less than 12 months old.

Do not treat stressed stands or alfalfa–grass mixtures. Do not use in sandy soils, poorly drained soils, or exposed subsoil areas. Velpar may be mixed with dry bulk fertilizer for simultaneous application.

Add Velpar to a water-filled tank and mix thoroughly. Use at least 20 gal/a of spray solution to apply. Do not overlap, and turn off sprayer when starting, turning, or stopping to avoid crop injury. Do not graze or feed treated forage or hay for 30 days after application. Velpar is also available in a soluble liquid formulation. Velpar AlfaMax and AlfaMax Gold are products that combine hexazinone with diuron to provide burndown and residual control of weeds.

Rotational restrictions: Corn may be planted 12 months after treatment provided the field is deep disked or plowed before planting; other crops can be planted 2 years after Velpar application.

WEED AND BRUSH CONTROL IN GRASS PASTURES

Proper fertilization, grazing, and weed management all play an important role in good pasture management. Low soil fertility or excessive grazing weakens productive forage species and allow weeds to invade. Several management options exist in pastures, although initially producers should ensure pasture management is being conducted properly.

Most producers rely on mowing, grazing, or herbicides. Mowing and grazing can be effective management strategies at preventing further spread of perennial weeds and reducing populations of annual and biennial weeds. Success is dependant on mowing at the correct stage of development to maximize injury to the weed species and to release the forage(s) present. Timings for mowing and grazing are species-specific, but typically plants should be mowed just as the flowers begin to open. Annuals and biennial weeds usually don't die, but they don't regrow enough to produce viable seed. If this practice can be repeated for 3 to 5 years at the correct stage of development, weed populations can be dramatically reduced. Perennial plants have enough energy to regrow and produce viable seed and often need to be mowed multiple times to prevent seed production. Similar results can be obtained with grazing, but the palatability of weeds, especially at the appropriate stage of development, may reduce feeding and result in reduced control.

While mowing and grazing are effective management strategies, herbicides are usually more effective and less expensive. In addition, several herbicides or herbicide combinations can be used to control unwanted brush in pastures. Which herbicide to use will depend upon the susceptibility of the most prevalent weeds in the pasture (see table 4-4). Recommended rates of herbicides typically do not damage forage grasses but will injure or kill existing forage legumes such as clovers and birdsfoot trefoil. If these legumes are desirable, avoid using herbicides or spot treat to minimize herbicide contact with these plants.

Herbicides labeled for pastures are not harmful to livestock when properly applied. However, treatment of poisonous weeds may make these species more palatable to grazing livestock or cause accumulation of toxic substances in poisonous weeds. As a general recommendation, do not graze treated pastures for 1 to 2 weeks after application. Otherwise follow the grazing restrictions as described on the herbicide label. We also suggest a 1- to 2-week interval without grazing before applying herbicides in pastures. This will help ensure that the weeds are not stressed from grazing and trampling when treated.

For details about the effectiveness of herbicides registered for use on invasive weeds growing in CRP fields, refer to appendix table 4 at the end of this book.

Banvel/Clarity

See dicamba (page 185).

Chaparral (aminopyralid + metsulfuron)

Rate: 1.0 to 2.0 oz/a for annual and biennial weeds and 2.5 to 3.3 oz/a for difficult-to-control perennials and brush species. Consult the label for rates for specific weed species.

Timing: *Postemergence*—although Chaparral is effective when applied across a range of plant stages, best results are observed if annual weeds are treated when they are small, biennial weeds as rosettes, and perennials at the flower bud to flowering stages. If perennial plants are mowed in the summer, resprouting plants can be treated in the fall as long as leaves are green. Brush can be treated from the spring through the fall as long as it has leaves present that are green and growing.

Adjuvants: Add either a nonionic surfactant at 0.25 to 0.50% vol/vol, a crop oil concentrate at 1 to 2% vol/vol, or a methylated seed oil at 0.50% vol/vol.

Remarks: The combination of aminopyralid and metsulfuron make this a very active herbicide on nearly all broadleaf weeds and brush species found in Wisconsin pastures. This herbicide is active on legumes and can suppress any growing legume for one or more years. Soil activity of both aminopyralid and metsulfuron can last for months to years depending on the rate applied and environmental conditions. Research in Wisconsin has shown successful establishment of legumes one year after application, but the label recommends conducting a soil bioassay before planting. Since this product contains aminopyralid, users must ensure that manure created from animals that feed on treated hay is not put onto a field that will be planted to any

Table 4-4. Herbicide effectiveness on weeds commonly found in pastures[a]

	Biennials						Perennials												
Herbicide	**Burdock**	**Carrot, wild**	**Parsnip, wild**	**Thistle, bull**	**Thistle, musk**	**Thistle, plumeless**	**Blackberry spp.**	**Buttercup spp.**	**Chickweed, giant**	**Chicory**	**Dock spp.**	**Goldenrod spp.**	**Horsenettle**	**Knapweed, spotted**	**Milkweed, common**	**Nettle, stinging**	**Rose, multiflora**	**Sowthistle, perennial**	**Thistle, Canada**
Chaparral	**G/E**	**E**	**E**	**E**	**E**	**E**	**G**	**E**	**G/E**	**E**	**G/E**	**G/E**	**G**	**E**	P	**G**	**G/E**	**G/E**	**E**
Crossbow	**G/E**	**G**	**G**	**G/E**	**G/E**	**G/E**	**G**	**G/E**	**G**	F/G	**G/E**	F/G	**G**	**G**	F	**G/E**	**G**	F/G	F
Curtail	**G**	**G**	**G**	**G/E**	**G**	**G/E**	—	—	—	**G**	F	F	—	**G**	P	F	—	**G**	**G**
Dicamba	**G**	**G**	F	**G/E**	**G/E**	**G/E**	F	**G**	F/G	F/G	F/G	F/G	F	**G**	F	F	F/G	F/G	F
Escort	**G/E**	**E**	**E**	**G**	**G/E**	**G/E**	**G**	**E**	**G/E**	**E**	**G/E**	**G/E**	**G**	F	N	—	**G/E**	F	F/G
ForeFront	**G/E**	**G**	**G**	**G/E**	**E**	**G/E**	F	**E**	—	—	**G/E**	F/G	**E**	**E**	—	**G**	F/G	**G/E**	**G/E**
Glyphosate	**G**	**G/E**	**G/E**	**G/E**	**G/E**	**G/E**	**G**	**G/E**	**G/E**	**G/E**	**G/E**	**G**	**G**	**G/E**	**G**	**G/E**	**G**	**G**	**G/E**
Milestone	**G/E**	F	F	**E**	**E**	**E**	F	**E**	—	—	**G**	P/F	**E**	**E**	—	**G**	F	**G/E**	**E**
Stinger	**G/E**	P	F	**G/E**	**G/E**	**G/E**	P	—	—	**G/E**	**G**	P	N	**G/E**	P	P	P	F	**G/E**
Weedmaster	**G**	**G/E**	**G/E**	**G/E**	**G/E**	**G/E**	F/G	**G**	F/G	**G/E**	**G/E**	**G**	**G**	**G/E**	F/G	**G**	F	F/G	F/G
2,4-D	**G/E**	**G/E**	**G/E**	**G/E**	**G/E**	**G/E**	F	F	P	**G/E**	F/G	F/G	P	F	P	F/G	P/F	P	F

Abbreviations: E = excellent; G = good; F = fair; P = poor; N = none; — = no information

[a] This summary table is based on observations in Wisconsin and other North Central states.

broadleaf crop (see label for more information). Animals should be fed aminopyralid-free forage for at least 3 days before they are transferred to a field with sensitive plants (such as clovers). Treated areas can be harvested or grazed any time after application, but it is recommended to wait 14 days after treatment. If treated pastures are hayed, forage cannot be sold for 18 months after treatments, but must be used on-farm.

Rotational restrictions: Do not rotate to any crop for one year after treatment. Corn and small grains can be planted 1 year after treatment. Broadleaf crops are more sensitive and can require more than 5 years, depending on the crop and environmental conditions. A soil bioassay is required before planting broadleaf crops.

Crossbow (triclopyr + 2,4-D ester)

Rate: For most brush species use 1.5 gal/a when broadcast spraying, or 1.0 to 1.5% (vol/vol) mixture for foliar applications to single plants or small areas. The broadcast rate varies from 1 to 4 qt/a for herbaceous broadleaf weeds. Check the label for the rate to use on specific weeds.

Timing: *Postemergence*—Plants must be fully leafed out and actively growing when treated with foliar applications. Crossbow can also be applied as a cut stump treatment.

Remarks: Crossbow is a prepackaged mix of triclopyr and 2,4-D ester that controls many herbaceous and brush weeds including alder, ash, burdock, wild carrot, cherry, goldenrod, multiflora rose, sumac, and willow. It can be applied with conventional boom sprayers as a broadcast treatment, as a foliar spray to individual brush plants, or as a cut stump treatment. Crossbow is formulated to have low volatility, but applications should be avoided when temperatures are over 90°F and humidity is low. Follow label precautions to prevent spray or vapor drift to sensitive vegetation.

Do not graze lactating dairy cows in treated pastures until the next growing season. Do not harvest hay for 14 days after treatment. While there is no grazing restriction for other livestock, we recommend a 14-day removal period. If livestock will be slaughtered in the year of treatment, remove the animals from these pastures at least 3 days before Crossbow is used.

If treated pastures are hayed, forage cannot be sold for 18 months after treatment and must be used on-farm.

Curtail (clopyralid + 2,4-D)

Rate: 2 to 6 pt/a. Use lower rates on annual and biennial weeds and higher rates on Canada thistle.

Adjuvants: Adjuvants are not normally needed with Curtail.

Timing: Treat biennial weeds when they are in the rosette growth stage. Treat perennials when the basal leaves are fully developed and up to the bud stage. Later applications to perennials may also be done if soil moisture is adequate and plants are actively growing.

Remarks: Curtail contains 0.38 lb ae of clopyralid and 2.0 lb ae of 2,4-D per gallon. Both active ingredients are formulated as amines. Thus, there is lower risk of vapor drift with Curtail. When applied at 4 to 6 pt/a, Curtail gives the same amount of clopyralid as 8 to 12 fl oz of Stinger and the same amount of 2,4-D as 1.0 to 1.5 qt of 2,4-D (products with 3.8 lb ae per gallon).

The primary use of Curtail in pastures will be to control thistles and spotted knapweed. Curtail is not an effective brush herbicide. The label recommends the 4 pt/a rate for light to moderate Canada thistle and knapweed infestations when plants are actively growing and 6 pt/a for dense infestations or when dry weather or other stresses have reduced the growth of Canada thistles. For biennial thistles, use 2 pt/a when plants are in the rosette stage and 3 pt/a if bolting has occurred but before plants reach the bud stage.

For best results, treat when weeds are actively growing. Drought, heat, and cold stress may reduce weed control and increase crop injury. The grazing restriction for lactating dairy cattle is 14 days. Animals must be removed from treated pastures before being slaughtered unless 2 weeks has passed since treatment. If animals are to be moved into areas with sensitive broadleaf plants, feed animals untreated forage for at least 7 days before moving them. While there is no grazing restriction for other livestock, we suggest a 14-day interval for all animals. Grass hay cannot be harvested for 14 days after application. Curtail is rainfast within 6 hours after application.

Dicamba

Rate: Apply 0.5 to 1.0 pt/a Banvel or Clarity to control weeds such as wild buckwheat, chickweed, chicory, curly dock, common ragweed, giant ragweed, redroot pigweed, shepherd's purse, and velvetleaf. The 1 pt/a rate burns down the topgrowth of field bindweed, Canada thistle, perennial sowthistle, and leafy spurge. Rates of 1 qt/a will control weeds such as wild carrot, goldenrod, knapweed, and yarrow. Broadcast applications cannot exceed 1 qt/a.

Adjuvants: Including a nonionic surfactant at 0.25 to 0.50% (vol/vol) of spray solution can provide additional control, particularly for difficult-to-control weeds.

Timing: *Postemergence*—Apply dicamba to young, actively growing weeds before they blossom. If perennials regrow, treat as needed. In newly seeded grass pastures, do not apply dicamba until the grasses have three to five leaves.

Remarks: Dicamba controls many hard-to-kill broadleaf weeds and several brush species. Follow label directions and adjust application rates according to the weeds that need to be controlled. High rates of dicamba may cause temporary injury to sensitive pasture grasses. Avoid drift of dicamba onto desirable plants or crop injury will occur. *Soybeans, tobacco, vegetable crops, and many ornamentals are particularly sensitive to dicamba*.

Pastures treated with up to 1 pt/a of dicamba should not be grazed by dairy animals for 7 days or harvested for hay for 37 days after treatment. Pastures treated with up to 1 qt/a should not be grazed by dairy animals for 21 days or harvested for hay for 51 days after treatment. Pastures treated with up to 2 qt/a of dicamba should not be grazed by dairy animals for 40 days or harvested for hay for 70 days after treatment. There is no waiting period between treatment and grazing for non-lactating animals, but a 10- to 14-day period is suggested. Meat animals should not graze in treated pastures 30 days before slaughter.

Escort (metsulfuron)

Rate: Rates vary between 0.1 and 1.0 oz/a depending upon targeted weed species. Apply 0.3 oz/a as a broadcast treatment to control multiflora rose. Rates of 0.1 to 0.2 oz/a control wild carrot, musk thistle, buttercup, and curly dock. For spot treatments, mix 1 oz of product/100 gal of water (plus surfactant) and wet foliage to the point just before runoff. Higher rates (0.5 to 1.0 oz/a) are recommended to control difficult weed species. (Please consult the label.)

Adjuvants: Add a nonionic surfactant at 0.5 to 1.0 qt/100 gal of spray solution.

Timing: *Postemergence*—Treat multiflora rose soon after the bushes are fully leafed out and other weeds when they are in the rosette to bud growth stages and actively growing, or in the fall to resprouting green tissue.

Remarks: Escort controls blackberries, bull and plumeless thistles, burdock, chickweed, dandelion, horsenettle, mullein, multiflora rose, plantain, wild parsnip, and yarrow. Thorough coverage of leaves and stems assures best results, but avoid over-application or grass injury will occur. Symptoms in treated weeds begin to appear 2 to 3 weeks after application. If desired, this product can be tank mixed with 2,4-D, Banvel, or Weedmaster.

Apply Escort in 10 gal/a or more of water within 24 hours of preparation or product degradation may occur. Do not use more than 40 psi when applying and do not use hollow cone nozzles. Make only one application per year. Follow all label directions to avoid spray drift and for sprayer cleanup after application.

There is no grazing restriction following application, even for lactating dairy animals. Nevertheless, a 14-day removal period is suggested.

Smooth brome, bluegrass, orchardgrass, and timothy are tolerant of Escort if they have been established for 6 months or more. Fescue should be established for at least 24 months before applications, and seedhead suppression may occur if applied in spring. Do not use these products in pastures containing meadow fescue or perennial ryegrass. Forage legumes are sensitive to metsulfuron and are usually killed in treated areas; therefore, avoid broadcasting treatments if these legumes are desired.

Rotational restrictions: Escort residues persist in the soil for several months to years after application. Do not rotate or overseed any crop or forage into treated areas within 34 months unless a field bioassay test as described on the label has been conducted.

ForeFront (aminopyralid + 2,4-D)

Rate: *ForeFront HL:* 19 to 34 fl oz/a. If spot treating, up to 67 fl oz/a may be applied IF no more than half the acre is sprayed.

Adjuvants: A nonionic surfactant is recommended at 0.25 to 0.5% (vol/vol).

Timing: *Postemergence*—Best results are observed if annual weeds are treated when they are small, biennial weeds as rosettes, and perennials at the flower bud to flowering stages. If perennial plants are mowed in the summer, resprouting plants can be treated in the fall as long as leaves are green.

Remarks: Aminopyralid in combination with 2,4-D results in effective control of most broadleaf weeds found in Wisconsin. Soil activity of aminopyralid lasts for several months; if applied in the fall, it can persist into the next year. Research in Wisconsin has shown successful establishment of legumes one year after application, but the label recommends conducting a soil bioassay before planting. Users must ensure that manure created from animals that feed on treated hay is not put onto a field that will be planted to any broadleaf crop (see label for more information). Animals should be fed aminopyralid-free forage for three days before they are transferred to a field with sensitive plants (such as clovers). Treated areas should not be harvested for 7 days after application. If treated pastures are hayed, forage cannot be sold for 18 months after treatments, but must be used on-farm.

Rotational restrictions: Do not rotate to any crop for one year after treatment. Corn and small grains can be planted 1 year after treatment. Broadleaf crops are more sensitive and can require more than 5 years, depending on the crop and environmental conditions. A soil bioassay is required before planting broadleaf crops.

Glyphosate

Rate: Varies with species and method of application. See label for details.

Adjuvants: Ammonium sulfate at 8.5 to 17 lb/100 gal of spray mixture is recommended if using hard water. Additional surfactant is rarely needed.

Timing: *Postemergence*—Treat perennial broadleaves in the late bud to early flower stage or treat regrowth following mowing or grazing. Treat brush species when leaves are fully expanded and plants are actively growing. Biennial and annual weeds can be treated any time, but best results are seen when they are small.

Remarks: Glyphosate is available in various brand names. Not all products are labeled for use in pastures; check the label before using. Products may also vary in glyphosate concentration, type and amount of surfactants, and approved use rates.

Spot application of glyphosate in pastures is appropriate for treating localized weed problems such as Canada thistle or multiflora rose, which often occur in patches. No more than 10% of any acre should be spot-treated at one time. Additional applications can be made in the same pasture at 30-day intervals. *Glyphosate is nonselective and will kill all treated vegetation;* reseed the area with a desirable mixture of forage species. Foliar sprays of glyphosate control these brush species: alder, elms, honeysuckle, multiflora rose, oaks, poison ivy, sumac, and willow. Symptoms of injury may not appear for several weeks.

Glyphosate can also be used in pastures in wiper applicators. An 8- to 12-inch height difference between the weeds and pasture species is required. This approach is useful to suppress tall herbaceous broadleaf weeds such as chicory, goldenrod, giant ragweed, bull thistle, and plumeless thistle in pastures with birdsfoot trefoil or clover.

For best results, remove domestic livestock before treating and do not graze or harvest for 14 days after treatment.

Milestone (aminopyralid)

Rate: 3 to 7 fl oz/a. Use lower rates for biennial thistles and higher rates for perennials like Canada thistle. If spot treating, up to 14 fl oz/a may be applied IF less than 50% of the area is treated.

Adjuvants: For postemergence applications, a nonionic surfactant should be added at 0.25 to 0.5% (vol/vol).

Timing: *Postemergence*—Best results are observed if annual weeds are treated when they are small, biennial weeds as rosettes, and perennials at the flower bud to flowering stages. If perennial plants are mowed in the summer, resprouting plants can be treated in the fall as long as leaves are green.

Remarks: This herbicide is particularly active on plants in the sunflower (thistles, knapweeds) and bean (legumes) families, but many broadleaf plants appear to be fairly tolerant, and established grasses are very tolerant. This herbicide will surpress legumes for over a year. Soil activity lasts for several months and, if applied in the fall, can persist into the next year. Research in Wisconsin has shown successful establishment of legumes one year after application, but the label recommends conducting a soil bioassay before planting. Users must ensure that manure created from animals that feed on treated hay is not put onto a field that will be planted to any broadleaf crop (see label for more information). Animals should be fed aminopyralid-free forage for three days before they are transferred to a field with sensitive plants (e.g., clovers). Treated areas should not be harvested for 7 days after application. If treated pastures are hayed, forage cannot be sold for 18 months after treatments, but must be used on-farm.

Rotational restrictions: Do not rotate to any crop for one year after treatment. Corn and small grains can be planted 1 year after treatment. Broadleaf crops are more sensitive and can require more than 5 years, depending on the crop and environmental conditions. A soil bioassay is required before planting broadleaf crops.

Overdrive (dicamba + diflufenzopyr)

Rate: 4 to 8 oz/a.

Adjuvants: Use a nonionic surfactant at 1 qt/100 gal of spray solution (0.125%, vol/vol) or methylated seed oil at 1.5 to 2 pt/a.

Remarks: The product contains diflufenzopyr and dicamba. The Overdrive label lists many weeds common in pastures and noncrop areas, including biennial thistles, bindweeds, burdock, buttercups, Canada thistle, curly dock, goldenrod, horsenettle, spotted knapweed, white cockle, wild carrot, and wild parsnip.

The recommended rates of Overdrive in pastures are 4 to 8 oz/a. Annual broadleaf weeds and biennials in the rosette stage will be controlled at lower rates than perennials. Overdrive must be applied with a nonionic surfactant or methylated seed oil (MSO). Consider using MSO when treating hard-to-kill weeds or when plants are under moisture or temperature stress. This product has no harvesting or grazing restrictions.

Rotational restrictions: Do not rotate to any crop within 30 days after application.

Spike (tebuthiuron)

Rate: 0.75 oz of Spike pellets in 100 sq ft (equivalent to 20 lb/a).

Timing: Any time except when the soil is frozen or saturated with moisture.

Remarks: Spike is a persistent, nonselective herbicide registered for brush control in pastures and non-cropland areas. The Spike 20P formulation is the only formulation clearly registered for use in pastures. Spike 20P is a pelleted formulation with 20% active ingredient. The label recommends controlling individual plants by spreading pellets evenly over the area under the target plant. However, the most logical way to distribute the pellets is at the base of individual plants. This approach gives excellent control of multiflora rose when 0.25 oz of Spike pellets are distributed around three to six bushes. All vegetation in the treated area will be suppressed for one to two years. Treated brush will die over a period of several weeks to months. Use great care to avoid injury to nearby sensitive vegetation and to prevent movement into surface or groundwater. Do not apply Spike to areas where soils are sandy to loamy sand and/or the water table is less than or equal to 5 ft deep. Susceptible brush species include black locust, boxelder, maple, mulberry, multiflora rose, oak, willow, and many more. There is no grazing restriction following application, but hay cannot be harvested from treated pastures for 12 months.

Stinger (clopyralid)

Rate: Apply 0.5 to 1.33 pt/a.

Adjuvants: Surfactants and other additives are not normally added to the spray mixture.

Timing: *Postemergence*—Best results are observed if annual weeds are treated when they are small, biennial weeds as rosettes, and perennials at the flower bud to flowering stages. If perennial plants are mowed in the summer, resprouting plants can be treated in the fall as long as leaves are green.

Remarks: Stinger is particularly active on plants in the sunflower family such as thistles and knapweeds. A single application of Stinger may not eradicate Canada thistle, but it often reduces the infestation for several years. Stinger can be tank mixed with 2,4-D or dicamba for a more economical treatment. Stinger will injure or even kill treated forage legumes such as trefoil and clovers.

While there is no grazing restriction for pastures, we recommend a 14-day restriction be followed for pastures. Do not move livestock from treated areas onto sensitive broadleaf crop areas until they have grazed for 7 days on an untreated pasture. Otherwise urine and manure may contain sufficient Stinger to injure sensitive broadleaf crops. Users cannot spread manure created from animals fed treated hay onto any field that will be planted to a broadleaf crop.

Stinger cannot be used in sites vulnerable to groundwater contamination. Follow label guidelines for sprayer cleanup and drift prevention.

Rotational restrictions: Grasses, small grains, and corn can be planted any time after an application, but wait 10.5 months before planting alfalfa, grain sorghum, or soybeans. An 18-month restriction is in place for potatoes A soil bioassay is recommended before planting broadleaf crops.

Weedmaster (dicamba + 2,4-D)

Rate: 1 to 2 pt/a for annual, biennial, and perennial weeds and 2 qt/a for difficult-to-control perennials and brush species.

Adjuvants: The label recommends the addition of NIS (0.25–0.5% vol/vol) or a COC (0.25% vol/vol).

Timing: *Postemergence*—Best results are observed if annual weeds are treated when they are small, biennial weeds as rosettes, and perennials at the flower bud to flowering stages. If perennial plants are mowed in the summer, resprouting plants can be treated in the fall as long as leaves are green.

Remarks: Weedmaster is a prepackaged formulation of dicamba + 2,4-D for use in pastures. Apply 1 pt/a of Weedmaster to control buttercup, lambsquarters, pigweed, and smartweed. Use 2 pt/a to control burdock, chicory, curly dock, dandelions, goldenrod, mustards, bull thistle, musk thistle, and plumeless thistle. Apply 2 qt/a to control elderberry, honeysuckle, nettle, nightshade, poison ivy, and tansy ragwort and to suppress field bindweed, Canada thistle, perennial sowthistle, and leafy spurge. Use appropriate precautions to avoid drift to nearby sensitive vegetation. This product will injure or even kill forage legumes such as clover and trefoil. Wait three weeks per quart of Weedmaster per acre before reseeding pasture species or injury may occur. No grazing restrictions exist for nonlactating animals, but lactating dairy cattle cannot graze treated fields for 7 days after treatment or meat animals within 30 days of slaughter. Treated grass may be harvested for hay 37 days after application.

Rotational restrictions: For small grains, the interval between application and planting is 10 days per pint applied per acre. Any crop can be planted 120 days after an application of Weedmaster.

2,4-D for herbaceous weed control

Rate: Apply 2 pt/a of 2,4-D amine or ester (forms containing 3.8 lb ae/gal) to control annual broadleaf weeds, 2 to 4 pt/a to control biennials and perennial broadleaves.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Treat annual broadleaves when they are seedlings; biennials like bull, musk, and plumeless thistles in the rosette stage; and actively growing perennial broadleaf weeds in the bud stage.

Remarks: Repeated application of 2,4-D amine or ester for 2 or 3 years will effectively control most nonwoody broadleaf weed populations in grass pastures. Either fall or spring applications control biennial thistles in the rosette stage if they are actively growing when sprayed. After the biennials have formed a flower stalk, they are more tolerant to these herbicides. Several years of treatment may be necessary to satisfactorily control hard-to-kill perennial weeds.

The 2,4-D amines are water-soluble liquids and 2,4-D esters are emulsifiable concentrates. Both formulations are sold under various trade names and at various concentrations of ae/gal. Ester formulations have greater potential to volatilize and drift than amine formulations. Read the label carefully to avoid application during conditions that will promote vapor drift. Formulations

of 2,4-D ester are also available in low-volatile forms that reduce the potential for vapor drift.

Most labels state that pastures treated with 2,4-D should not be grazed by dairy cattle for 7 days after treatment and that meat animals must be removed from treated areas 3 days before slaughter unless more than 2 weeks have elapsed since treatment. Do not cut treated grass for hay within 30 days after application. Read the label carefully for specific rates, grazing restrictions, and application precautions.

2,4-D ester for brush control

Rate: Varies with brush species and method of application. See label for details.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Apply 2,4-D ester in late spring or early summer when brush is in full leaf and actively growing.

Remarks: With foliar sprays, wet foliage to the point of runoff. Low volatile esters are preferred, especially near susceptible crops. Esters of 2,4-D alone are not effective on all brush species. Some retreatment is usually required for complete kill. Cut brush that is more than 6 to 8 feet tall and treat the cut surface or regrowth the following year. This product will injure or even kill forage legumes such as clover and trefoil. Wait 2 weeks per pint of 2,4-D applied per acre before reseeding pasture species or injury may occur. Use appropriate precautions to avoid drift or volatilization to nearby sensitive vegetation (see remarks in herbaceous weed control section). Keep dairy cattle off treated pastures for at least 7 days.

PASTURE RENOVATION

No-till pasture renovation with herbicides is attracting interest in several areas of Wisconsin. It is best suited to fields on hillsides where tilling the soil may allow excessive erosion to occur. Success depends on timely rains to stimulate the germination of the forage seeds. The following herbicides aid in no-till pasture renovation. Be sure broadleaf weeds have been controlled before interseeding legumes into pastures. After the legume is established, there are no selective herbicides available for broadleaf weed control. Where biennial thistles are present, treat for at least 2 years before renovation to reduce their abundance.

See table 4-5 for a summary of harvest and grazing intervals following herbicide use in pastures.

Glyphosate

Rate: Varies with species and method of application, but typically ranges from 0.5 to 1.5 lb ae/a. See the label for details.

Adjuvants: See page 186.

Timing: *Preplant*—Apply to actively growing vegetation before planting desirable species.

Remarks: Several brands of glyphosate are registered for pasture renovation and can be used to control Canada thistle, quackgrass, and other perennial weeds before reseeding forages, grasses, and legumes. Treated areas can be tilled before seeding or planted with no-till seeders. Erosion on hillsides may occur as glyphosate kills all treated vegetation. No grazing or harvesting restrictions exist unless more than 2.25 lb ae/a is applied. If this rate is exceeded, wait 8 weeks following treatment before grazing or harvesting hay.

Gramoxone (paraquat)

Rate: Apply 0.7 to 1.3 pt/a Gramoxone Max or 1 to 2 pt/a Gramoxone Inteon. Use the high rate to suppress smooth brome and orchardgrass. Increase both the Gramoxone rate and the volume of water as the density and size of vegetation to be treated increases.

Adjuvants: Add nonionic surfactant at 1 to 2 pt/100 gal of spray solution.

Timing: *Preplant*—Apply preplant or at the time of seeding in spring or early summer.

Remarks: Gramoxone suppresses the competition of existing sod and emerged broadleaf weeds and grasses to facilitate seeding grasses and/or forage legumes such as alfalfa, clovers, and birdsfoot trefoil into existing pastures without tillage. Apply in at least 20 gal/a of water and treat only closely grazed or mowed pastures that are no more than 2 to 3 inches tall at the time of spraying.

The burndown action of Gramoxone facilitates the no-till seeding (pasture seeding) of more desirable forage legumes and grasses. No-till seeding with Gramoxone is more successful in bluegrass pastures than in pastures containing large amounts of quackgrass. Quackgrass recovers more rapidly after treatment than bluegrass and may compete vigorously with legume seedlings. Gramoxone will not kill perennial weeds such as dandelions. In fields infested with broadleaf weeds, use 2,4-D or dicamba in the fall before spring renovation. Allow at least 42 days between treatment and first grazing.

Table 4-5. Harvest and/or grazing restrictions for herbicides registered for use in forages and pastures[a]

Herbicide	Use(s)	Type of animal	Interval between application and grazing or harvest	Comments
Buctril	alfalfa	all	30 days	Do not harvest fall-treated alfalfa until 60 days following application.
Butyrac 200	alfalfa, trefoil	all	60 days: new seedings 30 days: established stands	—
Chaparral	pastures	all	0 days	Before transferring animals from treated areas to areas planted with sensitive broadleaf crops, graze them for 3 days on untreated forage.
Chateau	alfalfa	all	25 days	—
Crossbow	pastures	lactating dairy other	next season 0 days 14 days: harvested areas	Remove livestock from treated areas at least 3 days before slaughter during year of treatment.
Curtail	pastures	lactating dairy other	14 days 0 days	Do not harvest hay for 7 days after application. Remove meat animals 7 days before slaughter unless 2 weeks have elapsed since application.
Dicamba	pastures	lactating dairy	7 days: <1 pt/a 21 days: 1–2 pt/a 40 days: 2–4 pt/a	No waiting period between treatment and grazing for non-lactating animals. Remove meat animals from treated areas 30 days before slaughter. 30–70 days must elapse if hay is to be harvested and fed to dairy animals. See label for restrictions.
Eptam	alfalfa, clovers, trefoil	all	14 days	—
Escort	pastures	all	0 days	No grazing restrictions.
Extreme	alfalfa	all	30 days	—
Forefront	pastures	all	7 days: harvested areas 0 days: grazed areas	Before transferring animals from treated areas to areas planted with sensitive broadleaf crops, graze them for 3 days on untreated forage.

[a] Labels may have changed after this table was prepared. Consult current labels to verify the information. *(continued)*

[b] Differences in restrictions exist on some brands. Verify what restrictions apply to your brand before using it.

Table 4-5. Harvest and/or grazing restrictions for herbicides registered for use in forages and pastures[a] *(continued)*

Herbicide	Use(s)	Type of animal	Interval between application and grazing or harvest	Comments
Glyphosate[b]	spot treatment or selective equipment in forage grasses and legumes	all	0 days: <2 qt/a 7 days: >2 qt/a	If more than 2 qt/a is applied with spot treatments, do not treat more than .10 of any acre.
	pasture renovation	all	0 days: <2 qt/a 8 weeks: >2 qt/a	—
	alfalfa, preharvest	all	36 hours	Only for fields being rotated to another crop.
Gramoxone Inteon	pasture renovation	all	0–60 days	Only apply to pastures ≤3 inches tall. Consult the label for specific grazing restrictions.
Metribuzin	alfalfa	all	28 days	—
Milestone	pastures	all	0 days	Before transferring animals from treated areas to areas planted with sensitive broadleaf crops, graze them for 3 days on untreated forage.
Overdrive	pastures	all	0 days	No grazing restrictions.
Poast Plus	alfalfa, clovers, trefoil	all	7 days: undried forage 14 days: dry hay 20 days: dried clover	Grazing restrictions same as undried forage.
Prowl H_2O	alfalfa	all	28 days ≤ 2.1 qt/a 50 days > 2.1 qt/a	—
Pursuit	alfalfa, clover	all	30 days	—
Raptor	alfalfa	all	0 days	—
Select Max	alfalfa, trefoil	all	15 days	—
Spike	pastures	all	0 days	No grazing restrictions on the label; do not harvest hay from treated pastures for 12 months.
Stinger	pastures	all	0 days	No grazing restrictions on the label. Do not use hay or straw for composting or mulch on broadleaf crops.
Treflan	alfalfa	all	21 days	—
Velpar	alfalfa	all	30 days	—
Weedmaster[b]	pastures	lactating dairy	7 days 0 days	Allow 37 days between application and hay harvest. Remove meat animals from treated areas 30 days before slaughter.
2,4-D[b]	pastures	dairy other	7 days 3–7 days	2,4-D labels vary. See specific product label. Do not harvest grass for hay within 30 days of use.

[a] Labels may have changed after this table was prepared. Consult current labels to verify the information.

[b] Differences in restrictions exist on some brands. Verify what restrictions apply to your brand before using it.

FORAGE & PASTURE INSECT MANAGEMENT

Insecticides suggested in this section are intended as a guide to assist you in selecting chemical insect control options during the season. This book provides an overview of product registrations for specific field crop insect pests; it is not intended as an exhaustive insecticide label source. Product inclusion or omission does not imply endorsement by University of Wisconsin-Extension. Remember, certain insecticides are produced by different manufacturers and directions for use, rate, and method of application may vary by formulation. Therefore, always read the insecticide label completely before using the material.

Insecticides are often interchangeably referred to by their common and trade names. Trade names such as Mustang Max are capitalized, while common chemical names—zeta-cypermethrin in this example—are not.

A number of the products listed in this section are restricted-use insecticides. We discuss restricted-use pesticides in the beginning of this publication. Refer to appendix table 1b for a list of insecticides that currently require certification to be applied. It is possible that additional insecticides will be classified before the next growing season. Contact your county Extension agent for additional information on insecticide restriction.

REDUCING INSECTICIDE HAZARDS TO BEES

Insecticides help control insect pests, but they also can kill beneficial insects such as honeybees. Notify beekeepers before using insecticides and apply only between 4 p.m. and nightfall, when bees are least likely to be actively foraging. ***Never spray alfalfa or clover when in blossom.*** Some insecticides, such as Penncap-M (micro-encapsulated methyl parathion) and dimethoate, state that applications should not be made during bloom. Failure to heed this warning is a use inconsistent with the label and, therefore, a violation of the law.

Insecticides in table 4-6 can be applied to non-blooming alfalfa with minimal bee hazard, provided there are no blooming clover or weeds in the alfalfa field. These insecticides must not be allowed to drift into beeyards or onto adjacent weeds or domestic crops that are in bloom; otherwise substantial bee losses could occur.

Do not spray blooming alfalfa. If insects are damaging blooming alfalfa, harvest the alfalfa and, if necessary, spray the new growth to control the insects. However, before spraying the stubble, check for the presence of blossoming plants. During some years, heavy populations of blossoming white clover appear in alfalfa stubble shortly after harvest of the first crop. Bees foraging on these blossoms will be killed if stubble is sprayed for alfalfa weevils in such fields. Select an effective insecticide that is the least toxic to bees.

Avoid spraying ditch banks, fencerows, and roadsides when plants are in bloom.

Table 4-6. Timing of insecticide applications to avoid bee deaths[a]

Do not apply on blooming crops or weeds
Dimethoate
Imidan
Sevin
Apply only during late evening
Lannate
Malathion

[a] If temperatures are unusually low following treatment, residues on the crop may remain toxic to bees up to 20 times as long as during reasonably warm weather. If abnormally high temperatures occur during late evening or early morning, bees may actively forage on the treated crop during these times.

Advance notification. Wisconsin beekeepers may request a 24-hour advance notice of applications of certain pesticides made within a 1.5-mile radius of their beeyards. The insecticides involved are those which are labeled "Highly Toxic to Bees" or which contain the active ingredient methomyl (e.g., Lannate). Beekeepers desiring advance notification must provide their request in writing to the landowner or person controlling the use of the land on which pesticides may be applied either by ground or aerially. All requests expire at the end of each calendar year.

ALFALFA INSECTS

Alfalfa blotch leafminer

The alfalfa blotch leafminer, native to Europe, was first reported in the Midwestern US in 1996.

Description of life stages. Adults are small, black, humpbacked flies that emerge from overwintering pupae located on the surface of the soil. The first indication of their presence is the appearance of numerous pinholes (from a few to over 100) in the leaflets. These holes are mostly signs of adult feeding but can also serve as egg-laying sites. Females lay one to three eggs per alfalfa leaflet. Small yellow maggots hatch within the leaf and feed between the upper and lower leaf surfaces. The resulting tunnel usually starts at the base of the leaflet and widens with movement toward the tip of the leaf, resulting in the "blotch" appearance. When fully grown they crawl out of the leaves, drop to the ground, and pupate. A second generation of flies emerge in about 1 week (mid-July), and is followed by a third generation in late August.

Damage. Punctures and blotches result in leaf deterioration and possible defoliation. Leaf damage lessens quality while leafdrop reduces yield. Significant yield loss should only occur if damaged leaves drop from the plant or are shaken from the hay during harvesting.

Control. In the upper Midwest, harvest of the first crop normally controls the first generation. Development of the second and third generations, however, may not correspond as closely with cutting schedules, and this could lead to more extensive injury in those cuttings. As is true for the alfalfa weevil, cooler weather favors alfalfa development over that of the insect.

Insecticidal control can be effective if applied during the "pinhole" stage, but treatment will not pay unless leaf drop is extensive. Treatment may be justified when 30 to 40% of the leaflets exhibit pinhole feeding injury. Because the eggs hatch over an extended period, the adults are mobile, and maggots are protected within the leaflet, insecticide trials have had marginal control results.

Biological control of this pest is well established in the northeastern US. Biological control is also a major control factor in the Midwest since parasitized larvae were detected in Wisconsin in 1998.

Table 4-7. Periods to scout for insect pests of forages

Insect pest	Spring growth	Second growth	Third growth	New seeding
Alfalfa blotch leafminer	yes	yes	yes	yes
Alfalfa caterpillar	no	yes	yes	no
Alfalfa weevil	yes	new growth only	no	seldom
Aphids	yes	yes	yes	yes
Blister beetles[a]	no	yes[b]	yes[b]	yes[b]
Cutworms	yes	yes	yes	yes
Grasshoppers	seldom	seldom	seldom	seldom
Plant bugs	no	yes	yes	yes
Potato leafhopper	no	yes	yes	yes
Spittlebug nymphs	yes	no	no	yes

[a] Blister beetles in hay can be toxic to horses.

[b] When abundant, blister beetles make fresh-cut forage distasteful.

Alfalfa caterpillar

Larvae are dark green with a narrow white stripe along each side of the body through which runs a thin red line. When fully grown they are 1.5 inches long. This insect is seldom of concern to alfalfa produced in the Midwest, and treatment is not suggested unless populations reach 10 or more per sweep.

The adult stage attracts the most attention because swarms of these sulfur-yellow butterflies can be seen flying over alfalfa fields during mid- to late summer.

Alfalfa weevil

Alfalfa weevil larvae are slate-colored when small, but bright green when fully grown (.40 inch). There is a white stripe down the back, and the head is black. They chew and skeletonize leaves. If larval populations are large, the entire plant may be defoliated, giving the field a grayish cast. Although larvae are present from May well into the summer, peak feeding activity falls off by mid-June.

When full grown, the larvae spin silken cocoons on the plants, within the curl of fallen dead leaves, or within litter on the ground. They change into adults in 1 to 2 weeks. The adults are dark gray to brown snout beetles measuring about .18 inch in length. There is a distinct dark shield-like mark on the back. After feeding a short time, most adults leave the field and enter a resting period that lasts until fall. Adults then return to the alfalfa field and lay a few eggs before the onset of cold temperatures. This egg laying is insignificant; most eggs are laid during the following spring.

Although most of the feeding damage is done by larvae, at times adult damage is significant. Larvae and adults can continue to feed on new growth of the second crop. Populations can be great enough to kill plants and, as a result, fields can be lost.

Begin checking alfalfa fields for signs of weevil feeding in mid-May. This usually gives sufficient warning of developing problems. Since peak larval activity typically occurs from mid-May to early June, check fields every few days. However, population peaks vary from year to year, making it difficult to predict the extent of activity and exact time when peak populations will occur. Therefore, it is important to periodically check with your county Extension office for updates on the alfalfa weevil situation.

Control measures should be implemented when 40% of the plant tips of the first crop show obvious signs of damage. This does not mean 40% defoliation, but that 40% of the plants are beginning to show signs of feeding activity. If this occurs within 7 to 10 days of the suggested harvest date for your area, harvest the hay as soon as possible and watch the stubble for signs of weevil damage to new growth of the second crop. Early cutting will save the cost of an insecticide application. If you cannot harvest, spray as soon as possible. If 40% tip damage is found more than 10 days ahead of the suggested harvest date, the field should be sprayed as soon as possible. Harvesting too early could be detrimental to alfalfa stands. Growers may not be able to harvest fast enough to stay ahead of the weevil in years of high alfalfa weevil abundance. In these cases, growers may have to spray the most heavily infested fields and harvest those with lighter infestations.

If a field is harvested early because of alfalfa weevil problems, or if substantial damage has occurred with a standard harvesting schedule, the stubble must be checked carefully for signs of damage to new growth of the second crop. Some fields may fail to green up because adults and larvae are consuming new crown buds as fast as they are formed. Check the stubble, the soil surface around alfalfa plants, and under leaf litter for larvae and adults. If you find them and if there is no sign of regrowth in 3 or 4 days after harvest, spray the stubble as soon as possible. Treatment is also suggested if feeding damage is apparent on 50% of the new growth.

If you find no larvae or adults, lack of regrowth is due to other factors. Remember that dry weather will often delay growth of the new crop.

Economic treatment threshold populations which include the presence of adult weevils require an insecticide that is labeled for control of both adult weevils and larvae. Check product labels to select an insecticide that is effective on both stages or does not distinguish between the two.

Aphids

Two types of aphids can be found on alfalfa: the soft, green pea aphids and the spotted alfalfa aphids, which are yellow and faintly dark spotted. Aphids congregate on stems and leaves and suck plant sap. This causes stunting and yellowing of alfalfa. If aphids are abundant, treat before these symptoms occur. Pea aphids can cause significant damage when numbers exceed 100 per sweep, particularly if soil moisture is below plant requirements.

Grasshoppers

Occasionally, grasshoppers are abundant enough to concern farmers. No treatment is suggested until populations reach 20 per square yard in field margins or 8 per square yard within alfalfa fields. Treat while grasshoppers are still small.

Plant bugs

Plant bugs that are particularly important to alfalfa production are the tarnished plant bug, the rapid plant bug, and the alfalfa plant bug. The adult tarnished plant bug is .25 inch long and brown. Nymphs are green with black spots on the back. Adult alfalfa plant bugs are .40 inch long and are light green. Nymphs are green with red eyes. Rapid plant bug adults resemble the alfalfa plant bugs but are dark brown with yellow margins. Nymphs are red-tinged.

Plant bugs extract plant sap with their tubelike mouthparts. In high populations, this can result in stunted alfalfa growth or crinkled, puckered leaves. On alfalfa less than 3 inches tall, treat if there are three plant bug adults and/or nymphs per sweep; on taller alfalfa, treat when there are five or more adults and/or nymphs per sweep.

Insecticide applied within 7 to 10 days of harvest is unlikely to increase alfalfa yield and quality. In addition, preharvest intervals restrict insecticide use during this time. The best solution for such fields is to harvest early.

Note that while plant bug feeding can stunt plants and cause crinkling and puckering of leaves, these alfalfa growth aberrations also have been found in the absence of plant bugs.

Potato leafhopper

Potato leafhoppers are small (.13 inch), green, wedge-shaped insects. Adults and nymphs look similar except that adults have wings and nymphs are wingless. Leafhopper nymphs can be distinguished from other small green insects by their sideways movement when disturbed. Potato leafhoppers feed on alfalfa by inserting their beaklike mouthparts (proboscis) into leaves and tapping into the food-conducting tissue (phloem) to extract plant sugars, minerals, and other compounds. As they feed, they inject a toxin into the plant to inhibit water and nutrient transport. Feeding damage results in plant stunting, and the yellowing of the leaves in a telltale V-shaped pattern starting at the leaf tip. Serious infestations of leafhoppers will also reduce the yield and protein content of the plants.

Potato leafhoppers are mid- to late-season alfalfa pests that migrate to Wisconsin from southern areas. First-crop alfalfa harvested at the proper time escapes damage. However, monitor subsequent crops for leafhoppers. New seedings must also be monitored carefully and sprayed at threshold. Failure to do so can reduce yield throughout the life of the stand due to stress caused by leafhoppers during establishment.

Because potato leafhopper populations vary from year to year, populations within a given year cannot be predicted, and fields must be monitored weekly to accurately determine damage potential. Both nymhs and adults feed on alfalfa and should be counted together when scouting fields. Use a 15-inch diameter insect sweep net to take samples. A total of 100 sweeps should be taken throughout the field. Walk an M-shape through the field, taking 20 consecutive sweeps in each of five randomly selected areas. To obtain an accurate population estimate, sample when plants are dry and avoid field edges. Cold, wet, or windy conditions may temporarily knock adults and nymphs from plants, resulting in an inaccurate sweep count. As you sample, keep a running total of the number of leafhoppers caught at each location and divide the total by 100. Refer to table 4-8 for treatment thresholds.

Economic thresholds are based on the average number of leafhoppers per sweep and on plant height. Taller plants have higher treatment thresholds because they can withstand more damage and will be harvested sooner than shorter plants.

Spittlebugs

Spittlebug nymphs appear in early May in extreme southern Wisconsin. These soft, orange or green bugs can be found in white spittle masses in leaf axils, and later in the clumps of new growth at tips of stems. They suck plant sap and stunt but do not yellow the alfalfa. Treat if there is an average of at least one spittlebug per stem.

Table 4-8. Treatment thresholds for potato leafhoppers on alfalfa[a]

Alfalfa stem height (inches)	Leafhoppers/ net sweep (average)
3	0.2
6	0.5
8–11	1.0
12–14	2.0

[a] Treat when leafhopper densities reach these thresholds.

INSECT PESTS OF BIRDSFOOT TREFOIL, CLOVER, AND PASTURE

Grasshoppers and spittlebugs occasionally cause problems in clover fields.

Grasshoppers are occasionally a problem in pastures. Treat when nymphs are abundant and before migration into row crops is extensive. Apply sprays while grasshoppers are small. Notify nearby beekeepers at least 48 hours before you use an insecticide if blossoming weeds or other plants are present. Do not allow sprays to drift into beeyards or onto blooming crops or weeds.

Use the insecticides listed in table 4-9 to control insect pests of birdsfoot trefoil, clover, and pastures.

Table 4-9. Insecticide suggestions for birdsfoot trefoil, clover, and pasture

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
BIRDSFOOT TREFOIL INSECTS			
Alfalfa plant bug Tarnished plant bug *Plagiognathus* plant bug	Mustang Max	2.8–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting, with up to 0.075 lb ai/a applied per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
Grasshoppers	Mustang Max	2.8–4.0 oz	See remarks for Mustang Max above.
Potato leafhoppers	Sevin XLR Plus	2 pt	Do not apply within 7 days of harvest or grazing.
	Mustang Max	2.24–4.0 oz	See remarks for Mustang Max above
CLOVER INSECTS			
Grasshoppers	malathion	1–2 pt	Refer to label for preharvest interval information. Use only when air temperature is above 60°F.
	Mustang Max	2.8–4.0 oz	See remarks for Mustang Max above.
Potato leafhoppers	Mustang Max	2.24–4.0 oz	See remarks for Mustang Max above.
	Sevin XLR Plus	2 pt	Do not apply within 7 days of harvest or grazing.
PASTURE INSECTS			
Armyworms (pasture)	Besiege	6.0–9.0 oz	Pasture and rangeland grass may be used for grazing or cut for forage 0 days after application. Do not cut grass to be dried and harvested for hay until 7 days after the last application.
	Mustang Max	2.8–4.0 oz	A maximum of 0.025 lb. ai/a may be applied per cutting. For hay, a maximum of 0.10 lb ai/a per season may be applied. For forage and hay, allow at least 7 days between treatments. For straw and seed screenings, wait at least 17 days between treatments and do not apply within 7 days of harvest.
	Sevin XLR Plus	1.0–1.5 pt	Do not apply within 14 days of harvest or grazing.
	Tracer	1.0–2.0 fl oz	No preharvest interval restrictions for forage. Do not harvest hay or fodder for 3 days. Do not allow cattle to graze treated area until spray has dried. Do not apply more than 6 fl oz/a (0.186 lb ai/a) per season.
	Warrior II	1.28–1.92 oz	Do not cut grass to be dried and harvested for hay until 7 days after last application or exceed 0.09 lb ai/a per season.
Grasshoppers (rangeland)	Besiege	6.0–9.0 oz	Pasture and rangeland grass may be used for grazing or cut for forage 0 days after application. Do not cut grass to be dried and harvested for hay until 7 days after the last application.
	Mustang Max	2.8–4.0 oz	See remarks for Mustang Max in pasture armyworms.
	Sevin XLR Plus	0.5–1.0 pt	May be harvested or grazed the same day as treatment. Do not apply more than 2 pt/a per year.
	Warrior II	1.28–1.92 oz	Do not cut grass to be dried and harvested for hay until 7 days after last application or exceed 0.09 lb ai/a per season.

[a] All insecticides in this table are to be applied to the plant foliage.

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall, when bees are least likely to be exposed. Do not treat clover during bloom. Treatment of clover fields that contain blossoming weeds or other plants can result in severe bee losses.

Table 4-10. Insecticide suggestions for alfalfa

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Alfalfa blotch leafminer	Besiege	9.0 oz	Refer to resistance management section on label. Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications during early morning or evening hours when bees are not actively foraging.
	Baythroid XL	2.0–2.8 oz	Do not apply within 7 days of harvest.
	Cobalt Advanced	16.0–38.0 fl oz	Do not graze or cut within 14 days at 19–26 oz/a rate or within 21 days at higher rates. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hayor apply more than 0.06 lb ai (0.38 pt)/a per season.
	Imidan 70WP	1.0–1.33 lb	Do not apply within 7 days of harvest. Apply only once per cutting.
	Lorsban Advanced	2.0 pt	Do not cut or graze within 21 days application. No more than four applications per year or more than one application per cutting.
	Warrior II	1.92 oz	Do not apply more than 0.12 lb ai/a per seasonor within 1 day of harvest for forage or within 7 days of harvest for hay. See label for resistance statement.
Alfalfa caterpillar	Ambush 2E	3.2–12.8 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	1.6–2.8 oz	Do not apply within 7 days of harvest.
	Besiege	5.0–8.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or during evening hours.
	Cobalt Advanced	11.0–26.0 fl oz	Do not graze or cut within 7 days at 13 oz/a rate or within 14 days at rates up to 26 oz/a. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	0.77–1.28 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay. Do not apply more than 0.06 lb ai (0.38 pt)/a per season.
	Mustang Max	2.24–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Pounce 3.2EC	2.0–8.0 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Sevin XLR Plus	2.0 pt	Do not apply within 7 days of harvest.
	Stallion	5.0–11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Warrior II	0.96–1.6 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.

[a] All insecticides in this table are to be applied to the plant foliage.

(continued)

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall when bees are least likely to be exposed. Do not treat alfalfa during bloom. Treatment of fields that contain blossoming weeds or other plants can also result in severe bee losses.

Table 4-10. Insecticide suggestions for alfalfa *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Alfalfa weevil	**Note:** If adult weevils are also causing economic damage, select an insecticide labeled for control of adults. The label for Lorsban lists adults as well as larvae. Technically, Ambush, Imidan, Penncap-M, and Pounce could be used at rates suggested below for control of adults since they list alfalfa weevil.		
	Ambush 2E	6.4–12.8 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	1.6–2.8 oz	Do not apply within 7 days of harvest.
	Besiege	6.0–9.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or during evening hours.
	Cobalt Advanced	16.0–38.0 fl oz	Do not graze or cut within 14 days at 19–26 oz/a rate or within 21 days at higher rates. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	1.02–1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay. Do not apply more than 0.06 lb ai (0.38 pt)/a per season.
	dimethoate	0.5–1.0 pt	Do not apply within 10 days of harvest.
	Imidan 70WP	1.0–1.33 lb	Do not apply within 7 days of harvest. Apply only once per cutting.
	Lorsban Advanced	1.0–2.0 pt	Do not cut or graze treated alfalfa within 14 days after application at rate of 1 pt/a; or within 21 days at higher rates. No more than four applications per year or more than one application per cutting.
	Mustang Max	2.24–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Pounce 3.2EC	4.0–8.0 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Stallion	9.25–11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Warrior II	1.28–1.92 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.
Aphids	Ambush 2E	3.2–12.8 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	2.8 oz	Do not apply within 7 days of harvest.
	Besiege	6.0–9.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or during evening hours.

[a] All insecticides in this table are to be applied to the plant foliage. *(continued)*

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall when bees are least likely to be exposed. Do not treat alfalfa during bloom. Treatment of fields that contain blossoming weeds or other plants can also result in severe bee losses.

Table 4-10. Insecticide suggestions for alfalfa *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Aphids *(continued)*	Cobalt Advanced	11.0–26.0 fl oz	Do not graze or cut within 7 days at 13 oz/a rate or within 14 days at rates up to 26 oz/a. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	1.02–1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay. Do not apply more than 0.06 lb ai (0.38 pt)/a per season.
	dimethoate	0.5–1.0 pt	Do not apply within 10 days of harvest.
	Lorsban Advanced	0.5 pt	Do not cut or graze within 7 days application at 0.5 lb ai/a. No more than four applications per year or more than one per cutting.
	Mustang Max	2.24–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Stallion	9.25–11.75 oz	Aphid control may be variable depending on species present and host-plant relationships. Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging.
	Warrior II	1.28–1.92 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.
Army-worms	Ambush 2E	3.2–12.8 oz	Do no apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	1.6–2.8 oz	Do not apply within 7 days of harvest.
	Besiege	6.0–9.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or during evening hours.
	Cobalt Advanced	16.0–38.0 fl oz	Do not graze or cut within 14 days at 19–26 oz/a rate or within 21 days at higher rates. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	1.02–1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay. Do not apply more than 0.06 lb ai (0.38 pt)/a per season.
	Lorsban Advanced	1.0–2.0 pt	Do not cut or graze within 14 days of application at 1.0 lb ai/or within 21 days of application at higher rates. No more than four applications per year or more than one per cutting.
	Mustang Max	2.8–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Pounce 3.2EC	2.0–8.0 oz	Do no apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Sevin XLR Plus	2.0–3.0 pt	Do not apply within 7 days of harvest.

[a] All insecticides in this table are to be applied to the plant foliage. *(continued)*

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall when bees are least likely to be exposed. Do not treat alfalfa during bloom. Treatment of fields that contain blossoming weeds or other plants can also result in severe bee losses.

Table 4-10. Insecticide suggestions for alfalfa *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Armyworms *(continued)*	Stallion	9.25–11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Tracer	1.0–2.0 fl oz	No preharvest interval restrictions for forage. Do not harvest hay or fodder for 3 days or allow cattle to graze treated area until spray has dried. Do not apply more than 6 fl oz (0.186 lb ai)/a per season.
	Warrior II	1.28–1.92 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.
Cutworms	Ambush 2E	3.2–12.8 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	0.8–1.6 oz	Do not apply within 7 days of harvest.
	Besiege	5.0–8.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or during evening hours.
	Cobalt Advanced	11.0–26.0 fl oz	Do not graze or cut within 14 days at 19–26 oz/a rate or within 21 days at higher rates. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	0.77–1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay. Do not apply more than 0.06 lb ai (0.38 pt)/a per season.
	Lorsban Advanced	1.0–2.0 pt	Do not cut or graze within 14 days of application at 1.0 lb ai/a or within 21 days of application at higher rates. No more than four applications per year or more than one per cutting.
	Mustang Max	2.24–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Pounce 3.2EC	2.0–8.0 oz	Do no apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Stallion	2.5–11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Warrior II	0.96–1.6 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.
Grasshoppers	Baythroid XL	2.0–2.8 oz	Do not apply within 7 days of harvest.
	Besiege	6.0–9.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or during evening hours.

[a] All insecticides in this table are to be applied to the plant foliage. *(continued)*

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall when bees are least likely to be exposed. Do not treat alfalfa during bloom. Treatment of fields that contain blossoming weeds or other plants can also result in severe bee losses.

Table 4-10. Insecticide suggestions for alfalfa *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Grasshoppers *(continued)*	Cobalt Advanced	6.0–13.0 fl oz	Do not graze or cut within 7 days. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or within 10 days of last treatment.
	Declare	1.02–1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay or apply more than 0.06 lb ai (0.38 pt)/a per season.
	dimethoate	0.5–1.0 pt	Do not apply within 10 days of harvest.
	Lorsban Advanced	0.5–1.0 pt	Do not cut or graze within 7 days of application at 0.5 lb ai/a or within 14 days of application at higher rates. No more than four applications per year or more than one per cutting.
	Mustang Max	2.8–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Sevin XLR Plus	1.0–3.0 pt	Do not apply within 7 days of harvest.
	Stallion	9.25–11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Warrior II	1.28–1.92 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.
Plant bugs	Ambush 2E	6.4–12.8 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	1.6–2.8 oz	Do not apply within 7 days of harvest.
	Besiege	6.0–9.0 oz	Refer to resistance management section on label. Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications during early morning or evening hours when bees are not actively foraging.
	Cobalt Advanced	16.0–38.0 fl oz	Do not graze or cut within 14 days at 19–26 oz/a rate or within 21 days at higher rates. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	1.02–1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay or more than 0.06 lb ai (0.38 pt)/a per season.
	dimethoate	0.5–1.0 pt	Do not apply within 10 days of harvest.
	Lorsban Advanced	1.0–2.0 pt	Do not cut or graze within 14 days of application at 1.0 lb ai/a or within 21 days of application at higher rates. No more than four applications per year or more than one per cutting.
	Mustang Max	2.8–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Pounce 3.2EC	4.0–8.0 oz	Do no apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Sevin XLR Plus	2.0–3.0 pt	Do not apply within 7 days of harvest.

[a] All insecticides in this table are to be applied to the plant foliage. *(continued)*

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall when bees are least likely to be exposed. Do not treat alfalfa during bloom. Treatment of fields that contain blossoming weeds or other plants can also result in severe bee losses.

Table 4-10. Insecticide suggestions for alfalfa *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Plant bugs *(continued)*	Stallion	11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Warrior II	1.28–1.92 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.
Potato leafhopper	Ambush 2E	3.2–12.8 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	0.8–1.6 oz	Do not apply within 7 days of harvest.
	Besiege	5.0–8.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or evening hours.
	Cobalt Advanced	6.0–13.0 fl oz	Do not graze or cut within 7 days. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or within 10 days of last treatment.
	Declare	0.77–1.28 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay or more than 0.06 lb ai (0.38 pt)/a per season.
	dimethoate	0.5–1.0 pt	Do not apply within 10 days of harvest.
	Imidan 70WP	1.0–1.33 lb	Do not apply within 7 days of harvest. Apply only once per cutting.
	Lorsban Advanced	0.5–1.0 pt	Do not cut or graze within 7 days of application at 0.5 lb ai/a or within 14 days of application at higher rates. No more than four applications per year or more than one per cutting.
	Mustang Max	2.24–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting, with up to 0.075 lb ai/a applied per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Pounce 3.2EC	4.0–8.0 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Sevin XLR Plus	2.0 pt	Do not apply within 7 days of harvest.
	Stallion	5.0–11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or apply any product containing chlorpyrifos more than once per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Warrior II	0.96–1.6 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.

[a] All insecticides in this table are to be applied to the plant foliage. *(continued)*

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall when bees are least likely to be exposed. Do not treat alfalfa during bloom. Treatment of fields that contain blossoming weeds or other plants can also result in severe bee losses.

Table 4-10. Insecticide suggestions for alfalfa *(continued)*

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Spittlebugs	Ambush 2E	6.4–12.8 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a or less. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Baythroid XL	0.8–1.6 oz	Do not apply within 7 days of harvest.
	Besiege	6.0–9.0 oz	Do not exceed a total of 31.0 oz of Besiege or 0.12 lb ai of lambda-cyhalothrin–containing products or 0.2 lb ai of chlorantraniliprole-containing products/a per growing season. Do not apply within 1 day for forage or 7 days for hay harvest. Make applications when bees are not actively foraging by applying during early morning or during evening hours.
	Cobalt Advanced	16.0–38.0 fl oz	Do not graze or cut within 14 days at 19–26 oz/a rate or within 21 days at higher rates. Do not exceed four applications per season of Cobalt Advanced or other chlorpyrifos-containing products or apply more than once per cutting or apply within 10 days of last treatment.
	Declare	1.02–1.54 oz	Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay. Do not apply more than 0.06 lb ai (0.38 pt)/a per season.
	Imidan 70WP	1.33 lb	Do not apply within 7 days of harvest. Apply only once per cutting.
	Lorsban Advanced	1.0 pt	Do not cut or graze within 14 days of application at 1.0 pt ai/a. No more than four applications per year or more than one per cutting.
	Mustang Max	2.24–4.0 oz	A maximum of 0.025 lb ai/a may be applied per cutting; up to 0.075 lb ai/a per season. Applications may be made up to 3 days before cutting or grazing and up to 7 days before harvesting seed. Allow at least 7 days between applications.
	Pounce 3.2EC	4.0–8.0 oz	Do not apply more than 0.2 lb ai/a per cutting. No waiting period to harvest if application rate is 0.1 lb ai/a. For rates greater than 0.1 lb ai/a, do not apply within 14 days of harvest.
	Stallion	9.25–11.75 oz	Applications may be made up to 7 days of cutting, grazing, or harvesting seed. Do not apply more than 35.25 oz of product/a per season (0.075 lb/a zeta-cypermethrin + 0.75 lb/a chlorpyrifos). Do not make more than four applications of Stallion or other products containing chlorpyrifos per season or more than one per alfalfa cutting. This product is highly toxic to bees exposed to direct treatment on alfalfa. Do not apply if bees are actively foraging in the treated area.
	Warrior II	1.28–1.92 oz	Do not apply more than 0.12 lb ai/a per season. Do not apply within 1 day of harvest for forage or within 7 days of harvest for hay.

[a] All insecticides in this table are to be applied to the plant foliage.

[b] Notify nearby beekeepers before you use insecticides and apply only between 4 p.m. and nightfall when bees are least likely to be exposed. Do not treat alfalfa during bloom. Treatment of fields that contain blossoming weeds or other plants can also result in severe bee losses.

FORAGE DISEASE MANAGEMENT

Many disease-causing organisms attack forages in Wisconsin. Any approach to plant disease control requires identification and knowledge of the cause and its life cycle, the effect of environment on disease development, and the potential control procedures available. Economic and environmental factors often determine the control procedures employed for these various diseases. Control strategies can be an integration of the following methods: planting resistant or tolerant varieties, proper crop management, and agricultural chemicals. There are a few foliar fungicides currently labeled for use in alfalfa, including Headline, Kocide 3000, and Quadris. Note, however, that all of these products have very specific labels regarding use. In particular, pay close attention to the diseases that are controlled, the pre-harvest intervals within a cutting, the total number of allowed applications within a cutting period and across the whole growing season, and the application amounts allowed. We recommend consulting specific labels prior to using a product in alfalfa.

Variety selection is key to disease management in forages and small grains. Refer to Extension publication *Forage Variety Update for Wisconsin* (A1525) for specific disease resistance ratings. This publication is updated each year with new test data for each variety.

The forage diseases section focuses on alfalfa (table 4-11), followed by brief sections on red clover and forage grasses.

ALFALFA LEAF AND STEM DISEASES

Although leaf and stem diseases occur in almost every alfalfa field, their severity is dependent on periods of wet weather and/or heavy dews. While leaf and stem diseases may reduce alfalfa yields, their main effect is reducing the nutritional value of the forage, because severe leaf disease can

Table 4-11. Probability and occurrence of alfalfa diseases in stands of different ages

	Harvest (established stand)				Year				
Disease	**1st**	**2nd**	**3rd**	**4th**	**seeding**	**1st**	**2nd**	**3rd**	**4th**
Anthracnose	—[a]	++	+++	++	++	+++	+++	+++	+++
Aphanomyces root rot	++	+++	+++	+++	+++	++	++	++	++
Bacterial wilt	+	+	+++	+++	—	+	++	+++	+++
Common leaf spot	++	+++	+++	+++	+++	+++	+++	+++	+++
Downy mildew	+++	+	+	+++	+++	++	++	++	++
Fusarium crown root rot	+++	+++	+++	+++	—	+	++	++	+++
Fusarium wilt	+	++	+++	+++	—	+	++	+++	+++
Phytophthora root rot	++	+++	+++	+++	+++	++	++	++	++
Pythium root rot	—	—	—	—	+++	+	+	+	+
Spring black stem	+++	++	—	+++	++	+++	+++	+++	+++
Summer black stem	—	++	+++	+	+++	+++	+++	+++	+++
Verticillium wilt	+++	+	++	+++	—	+	++	+++	+++

[a] Probability of occurrence and/or severity: — = none, + = low, ++ = moderate, +++ = high

cause excessive leaf drop, and the leaves of alfalfa plants contain much more protein and are more digestible than the stems.

Except for anthracnose, alfalfa varieties have not been characterized for reaction to leaf and stem diseases. While there are no alfalfa varieties available with documented resistance, observations indicate that varieties differ in reaction to leaf-infecting pathogens. An important cultural practice that can minimize losses due to leaf and stem diseases is harvesting the crop at the bud stage or no later than 10% flower. Many leaf diseases increase dramatically after the first flower stage. Also, leaf and stem diseases can be more severe when alfalfa is seeded with a companion crop. Leaf diseases common to Wisconsin are common leaf spot, downy mildew, Stemphylium leaf spot and Lepto leaf spot. Spring black stem and summer black stem result in leaf loss but, as their names imply, are diseases of stems and crowns. Anthracnose is also a disease of stems and crowns.

ALFALFA SEEDLING DISEASES

Stand establishment failure due to seedling diseases has become more common in Wisconsin. *Aphanomyces, Pythium, Phytophthora*, and *Rhizoctonia* are the soil fungi considered to be major causes. Seeding failures are more commonly reported in fields with soils that become waterlogged for 7 to 14 days. In addition, many reports are associated with direct seeding. However, this may be because the development of plants established by direct seeding are more easily monitored than plants seeded with a companion crop such as oat. Often seeding failures are blamed on the companion crop from such factors as lodging.

Phytophthora/Aphanomyces-resistant alfalfa varieties are available and should be planted in fields that periodically have waterlogged soils. Alfalfa varieties range from highly susceptible to highly resistant to Phytophthora and Aphanomyces. No information is available on variety reactions to Pythium and Rhizoctonia. Fungicides offer some control in the early seedling phase (see appendix table 1c for more information on alfalfa seed treatments Apron XL and Ridomil Gold Bravo SC).

ALFALFA ROOT AND CROWN DISEASES

Root and crown diseases play a major role in establishment and stand longevity problems in Wisconsin. Often, low soil fertility, winter injury, and soil insects work together with disease organisms to reduce alfalfa stands. Stand losses can be minimized by planting varieties that are resistant to several diseases and using crop management practices that minimize stress on stands. Crop rotation is of little value for control of most alfalfa diseases because most pathogens survive indefinitely in the soil or are introduced with forage debris in seed. However, good management practices can prolong the productivity and life of plants that survive the initial infection.

- **Select disease-resistant varieties.** Consult Extension publication *Forage Variety Update for Wisconsin* (A1525) at learningstore.uwex.edu for ratings.
- **Maintain good soil fertility.** This promotes extensive lateral root development above the diseased region of the root and extends the life of the plant.
- **Avoid untimely cuttings.** This might stress the plants. Heavy rains immediately after cutting often result in severe Phytophthora root rot infections. Do not cut, for example, between September 1 and October 15.
- **Control leaf-feeding insects.** These can stress plants by making them more susceptible to root and crown diseases.
- **Improve surface and subsurface drainage.** Till and land-level, if practical, to reduce root and crown diseases.

Bacterial wilt

Bacterial wilt often appears in the second or third year of the stand and can reduce stands considerably if susceptible varieties are grown. Fortunately, most alfalfa varieties have good resistance to bacterial wilt, but this can differ greatly among varieties.

Fusarium wilt

Fusarium wilt, caused by the fungus *Fusarium oxysporum* f. sp. *medicaginis,* is economically damaging throughout Wisconsin, but is especially a problem in sandy loam soils.

Because the pathogen survives indefinitely in the soil, crop rotation is not an effective control. Planting resistant alfalfa varieties is the only practical control. Many varieties have resistance to Fusarium wilt.

Verticillium wilt

The Verticillium wilt fungus invades the plant's vascular system and reduces the flow of water and nutrients to stems and leaves. Infected alfalfa plants may be killed during the growing season or over winter. Verticillium wilt becomes more apparent after the second year of a stand. It is important for growers and agricultural consultants to be able to recognize Verticillium wilt and to use methods to limit its spread.

The following measures minimize the chances of introducing the fungus to an area and spreading the disease between and within fields.

- **Resistant varieties.** Alfalfa varieties differ in reaction to Verticillium wilt. Carefully select alfalfa varieties with resistance to the prevalent diseases in your area.
- **Harvesting suggestions.** Harvest recent seedings first and harvest fields at the hard-bud or early flower stage. Early harvest can limit some yield and quality losses caused by Verticillium wilt and can slow the spread of the wilt fungus in a field.

Phytophthora root rot

Phytophthora root rot (PRR) is a major cause of alfalfa stand depletion. PRR can kill individual plants scattered throughout the field, all plants in irregularly shaped patches, or entire fields. The disease is most severe in fields with poor internal drainage or fields where soils become saturated by excessive rainfall or irrigation.

Alfalfa varieties with high levels of PRR resistance are available to Wisconsin growers. Growers should be aware that alfalfa varieties rated PRR resistant vary greatly in extent of resistance.

PRR is often most severe in the seeding year. Seeding failures often occur if such fields are immediately replanted; occasionally alfalfa varieties with some level of resistance can fail in the seedling stage of growth. Apron (fungicide) seed treatment supplements inherent resistance to PRR.

Aphanomyces/Phytophthora root rot complex

Aphanomyces is an important water mold fungus contributing to poor alfalfa establishment and growth in wet soils. *Aphanomyces* interacts with *Phytophthora* to cause a destructive disease complex. Resistance to both pathogens is needed to improve alfalfa production in many wet soils in Wisconsin.

Aphanomyces causes poor plant growth, stunting and yellowing but seldom kills plants. Roots may be somewhat yellow and lack laterals and nodules, but the fungus does not cause distinct root lesions like *Phytophthora* does. When diagnosing, check cultural practices such as seed bed preparation, *Rhizobium* inoculum, and planting depth. If you've eliminated cultural practices and you answer yes to these questions, then *Aphanomyces* may be the cause.

1. Have you eliminated a possible atrazine or other herbicide carryover?
2. Does red clover or trefoil grow well in the site?
3. Did you plant a variety with a high level of resistance to *Phytophthora*, and was it treated with mefenoxam (Apron) fungicide?

Soils may be tested for *Aphanomyces* potential through your county Extension agent or by the Plant Disease Diagnostic Clinic (PDDC), Room 183, Russell Labs, University of Wisconsin-Madison, Madison, WI 53706.

There are two types of tests offered by the PDDC. One is a non-specific soil analysis for *Aphanomyces, Pythium,* or *Phytophthora* that costs $35 per sample. The second is a race-specific bioassay for *Apahanomyces* that costs $150 per sample. Tests may take from 2 to 4 weeks to complete. Contact the PDDC (608-262-2863) for specific information about the desired sample amount to conduct either test.

Alfalfa varieties are available with combined resistance to Aphanomyces and Phytophthora root rots. Consult Extension publication *Forage Variety Update for Wisconsin* (A1525) at learningstore.uwex.edu for resistance of alfalfa varieties to Aphanomyces and Phytophthora root rots. Currently, there are several varieties that are resistant to race 2 of *Aphanomyces,* in addition to race

1 resistance. Use results from soil tests to select the variety with the most appropriate resistance for your field conditions.

General root and crown rot

A general root and crown rot is caused by a complex of fungi that persist in the soil; infection results in slow regrowth and stand decline. The disease is very common in older stands but can occur in poorly managed younger stands. Although the outside of infected roots may not exhibit much rot, the core of the root and crown tissues will be rotted and have a brown-black discoloration. Infected plants are more susceptible to attack by other diseases and winter injury. Alfalfa varieties that are rated to have good winterhardiness generally show less root and crown rot. Crown and root rot can be reduced in all alfalfa varieties by maintaining high soil fertility (especially potassium) and a soil pH of 6.8 to 7.0, controlling leaf diseases, and not overgrazing or cutting stands between September 1 and October 15.

RED CLOVER DISEASES

Red clover, like alfalfa, has diseases that attack leaves, stems, and roots, reducing yield, quality, and stand life. The prevalent leaf and stem diseases can be controlled by planting resistant or tolerant varieties. Cutting the crop at late bud or early bloom also can help minimize leaf and stem diseases. Root rots of red clover cause depletions of stands. Stand decline can be reduced by planting varieties with good winterhardiness and maintaining high soil fertility (especially potassium).

Crown and root rots

Crown and root rots can cause serious stand decline in red clover. Several soil fungi can be the cause of this problem. Infected plants often are stunted or wilted. The roots of these plants are rotted (dark brown-black) on the outside and in the central core of the plants. The disease is most damaging when the rot progresses into the crown. Infected plants are prone to winterkill. Winter injury in turn can lead to severe root and crown rot. Varieties such as Arlington or Marathon that have good resistance to northern anthracnose and powdery mildew are strongly recommended. Such resistance also increases winter survival, making them better able to combat the effects of root and crown rot. Root and crown rot also can be reduced by maintaining good soil fertility (especially potassium).

Northern anthracnose

Northern anthracnose can reduce yields and quality of red clover in stands of all ages. Resistant varieties are available.

Powdery mildew

Powdery mildew forms a white powdery mass of mold on the upper surface of the leaves. Most newer varieties are resistant to powdery mildew.

Viruses

Viruses in red clover are recognized by a green-and-yellow mosaic pattern that develops on leaves. Viral symptoms can be confused with symptoms of nutrient deficiencies. Red clover varieties differ in reaction to bean yellow mosaic virus. Reaction to other viruses is not known.

DISEASES OF FORAGE GRASSES

Common diseases of forage grasses are leaf rust, stem rust, leaf spot, and root rot. Rusts are recognized by round, bright orange pustules that rupture the leaf tissues (leaf rust) or oblong, reddish-brown pustules that rupture stem tissues (stem rust). Leaf spot diseases differ from the rusts in that they do not rupture the plant tissues. Most leaf spots are characterized by brown-to-black spots that are bordered by a yellow halo. Root rots cause brown-to-black roots that are reduced in number and size. A disease called ergot can develop in the heads of forage grasses. Long, hard, black fungal structures are scattered in the heads and replace the grain where they form. These ergot bodies can cause health problems if consumed by livestock.

Ergot can be reduced by cutting forage grasses early and clipping wild grasses along the edges of fields. Rust and leaf spot diseases can be reduced by harvesting the crop as early as possible and planting resistant or tolerant varieties. Consult Extension publication *Forage Variety Update for Wisconsin* (A1525) at learningstore.uwex.edu for variety reactions to diseases.

5

SMALL GRAINS PEST MANAGEMENT

SMALL GRAINS WEED MANAGEMENT

A sound weed management program often uses supplementary mechanical weeding to maximize the effectiveness of an herbicide treatment. However, small grains are sown in narrow rows, making cultivation after planting impossible. Consequently, cultural practices such as crop rotation, adapted varieties, adequate fertilization, crop competition, and clean seed will maximize weed control. Fewer herbicide alternatives are available for weed control in small grains than for most other crops (see table 5-1 on page 212). Therefore, the small grain producer must use all possibilities in an integrated approach for effective weed management.

Fall-seeded small grains are very competitive with weeds. Winter wheat, for example, seldom needs an herbicide treatment. The exception is with winter annual weeds like shepherd's purse and pennycress that emerge with wheat in the fall. Check fields regularly after seeding and be ready to treat if and when needed.

Many producers apply nitrogen to winter wheat and often ask about using liquid fertilizer as the carrier to simultaneously apply the herbicide. This "weed and feed" approach would save a trip over the field, but has two serious limitations. First, nitrogen is most effective when applied early in the spring, often before green-up, while most herbicides are applied between Feekes stages 4 and 8. Postponing the fertilizer application creates a major delay that will reduce small grain yield. The other concern is that liquid fertilizers applied at these growth stages may result in leaf burn to the cereal, especially if applied under hot, humid conditions. This risk is particularly high for herbicides like Harmony SG that require a surfactant in the spray solution. Thus, we discourage applying herbicides in liquid fertilizer in small grains.

It's important to measure the growth stage of cereals before using postemergence herbicides. Figure 5-1 shows this relationship using the Feekes scale, which gives a numerical value to 11 developmental stages.

For a summary of harvest and grazing intervals following herbicide use in small grains, refer to table 5-2 on page 219.

SMALL GRAINS WITH A LEGUME SEEDING

Spring-seeded small grains often have alfalfa seeded with them. This greatly limits the use of herbicides. If weeds are abundant, harvesting the small grain as silage is an excellent practice because it kills weeds before they produce seeds, harvests weeds while they still have relatively good feed value, and greatly increases the likelihood of successfully establishing the legume. Interest in frost-seeding red clover into winter wheat is growing in Wisconsin. As with alfalfa seeded into oats, weeds are usually not an important factor after frost seeding, but in situations where broadleaf weeds are abundant, two herbicide options are available.

Buctril (bromoxynil)

Rate: 1.0 to 1.5 pt/a (consult the label to determine rate for specific weed species).

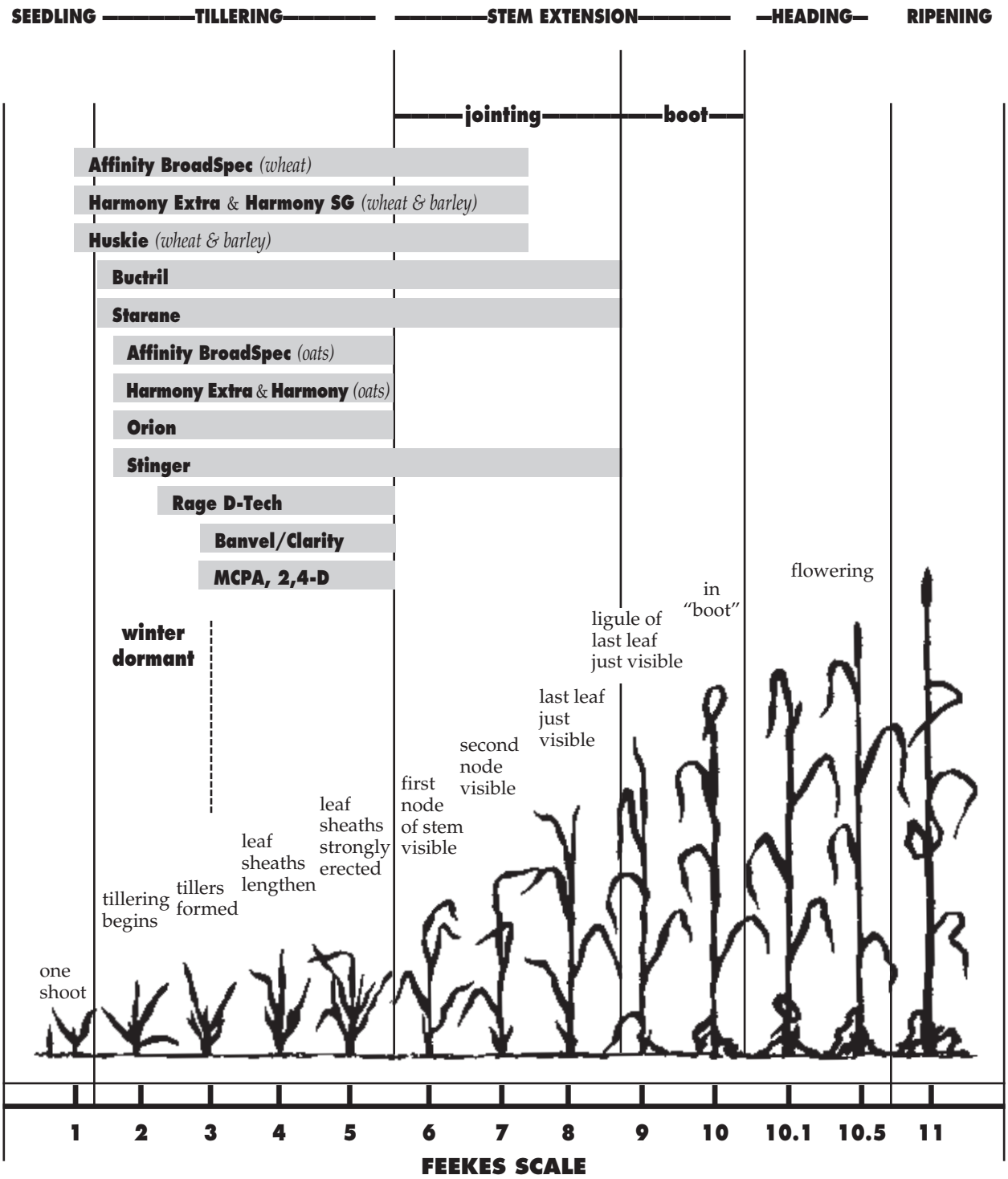
Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Treat when small grains have several leaves and up to the boot stage, when alfalfa has at least four trifoliate leaves, and when weeds are small.

Remarks: This product can be used in small grains alone or with an underseeding of alfalfa but not on red clover or any other legume. Buctril controls many broadleaf weeds that may occur in companion crop

(continued on page 212)

Figure 5-1. Herbicide application periods at various growth stages of small grains (using Feekes scale)



Source: Adapted and used with permission from Michigan State University Extension publication Weed Control Guide for Field Crops (E-434)

seedings, particularly shepherd's purse, pennycress, wild mustard, and wild radish. Apply Buctril in at least 20 gal/a of water. Applications of Buctril to underseeded oats may result in serious alfalfa injury if the temperature on the day of application or in the 3 days after application exceeds 70°F. Temperatures above this limit will be more likely to cause serious injury if the relative humidities are high on the day of treatment. See additional comments on Buctril use on page 214.

MCPA

Rate: Apply 0.33 to 0.5 pt/a of MCPA amine (forms containing 4 lb ae/gal). When using products containing other than 4 lb ae/gal, adjust rates accordingly to apply 0.17 to 0.25 lb ae/a.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Treat when small grain is tillered and has four or more leaves but before the jointing stage. The legume should be 2 to 3 inches tall.

Remarks: Never use the ester formulations of MCPA in companion crop seedings as the legume will be killed. Legume stands of alfalfa; trefoil; or red, alsike, white, or

Table 5-1. Crop registration, tolerance, and herbicide effectiveness on weeds commonly found in small grains

						Annual broadleaves												Perennial broadleaves		
Herbicide	Cereals registered	Mode of action group[a]	Can be underseeded?	Cereal crop tolerance	Annual grass weeds	Common chickweed	Common ragweed	Giant ragweed	Lambsquarters	Pennycress	Pigweed	Prickly lettuce	Shepherd's purse	Smartweeds	Wild buckwheat	Wild mustard	Wild radish	Canada thistle	Field bindweed	Perennial sow thistle
Affinity BroadSpec	B,W	2	no	**G/E**	N	**G**	**G**	P	**G/E**	**E**	**E**	**G**	**E**	**G**	**G**	**E**	F/G	**G**	P	F
Banvel/Clarity	B,O,W	4	no	F/G	N	**G**	**G**	**G**	**G/E**	F	**G/E**	**G**	F	**G/E**	**G/E**	F	F	F	F	F/G
Buctril	all	6	A	**G**	N	P	**G**	F/G	**G/E**	**G**	F/G	F	**E**	**G**	**G/E**	**G**	**G**	P	P	N
Callisto	O	27	no	**G/E**	N	**G**	F/G	F/G	**E**	**E**	**E**	—	**E**	**E**	P	**G**	—	P	P	—
Harmony Extra	B,O,W	2	no	**G/E**	N	**G**	**G**	P	**G/E**	**E**	**E**	**G**	**E**	**G**	**G**	**E**	F/G	**G**	P	F
Harmony SG	B,O,W	2	no	**G/E**	N	F	F	P	**E**	**E**	**E**	F	**E**	**G**	F	**E**	F	P	P	P
Huskie	B,W	6, 27	no	**G/E**	N	**G/E**	**G**	**G**	**E**	**E**	**G/E**	**G/E**	**G/E**	**G/E**	**G/E**	**G/E**	**G/E**	F	F	**G**
MCPA amine	all	4	A, RC	**G**	N	F	**G**	**G**	**G**	**E**	**G**	**G/E**	**E**	P	F	**G/E**	**G/E**	F	F	F
Orion	B,O,W	2, 4	no	**G**	N	**G**	**G**	F	**G**	**G**	**G**	F	**G**	**G**	**G**	**G**	—	P	P	F
Rage D-Tech	all	4, 14	no	**G**	N	P	F	F	**G/E**	**E**	**E**	**G**	**G**	F	F	**G**	**G**	P	F	F
Starane	B,O,W	4	no	**G/E**	N	**G**	**G/E**	—	P	F/G	P	**G**	—	—	F/G	F/G	—	P	F/G	P
Stinger	all	4	no	**E**	N	P	**G/E**	**G/E**	N	P	N	**G/E**	P	F	F/G	N	N	**G/E**	P	F
2,4-D amine	all	4	no/yes[b]	**G**	N	F	**G/E**	**G**	**E**	**E**	**E**	**G/E**	**E**	P	F	**G/E**	**G/E**	F	F	F

Abbreviations:

Grains: A = alfalfa; B = barley; O = oats; RC = red clover; W = wheat
Control ratings: E = excellent, G = good, F = fair, P = poor, N = none, — = no information

[a] Weed Science Society of America-approved group numbers for the corresponding herbicide mode of action.

[b] Some brands of 2,4-D amine allow application in underseeded small grains. We do not recommend it because the risk of legume injury is very high.

ladino clover are usually not severely injured at this rate or time of application. MCPA amine labels caution that the product should not be used unless some legume injury can be tolerated. Some brands of MCPA do not carry label directions for use on small grain undersown with a small seeded legume. Using brands without label directions for this use is illegal.

A well-developed small grain and weed canopy of leaves is necessary to provide a protective "umbrella" over the legume seedlings to minimize herbicide contact with the legume. Sometimes, under ideal growing conditions, legume seedlings grow almost as rapidly as the small grain and such a protective canopy never develops. Do not apply MCPA when legume seedlings are as tall or nearly as tall as the small grain or when the oat and weed canopy does not cover the alfalfa seedlings. Excessive exposure to the herbicide treatment will almost certainly result in severe legume damage. Use less than 6 gal/a of water and low pressure when applying MCPA to reduce risk of legume injury. Broadleaf weeds are more easily controlled as seedlings than when they begin to flower.

Choosing between Buctril and MCPA

The factors to consider in choosing between these two products are temperature and relative humidity at and after time of treatment, degree of protection to the legume by the small grain and weed canopy, the specific weed species present, and the growth stage of the alfalfa and cereal. For example, Buctril is most indicated when lambsquarters, smartweeds, or wild buckwheat are present, temperatures are 70°F or less, and alfalfa has four or more trifoliate leaves. MCPA is the better choice if pigweed is the dominant weed, temperatures exceed 70°F, humidities are high, and the oats and weeds protect the alfalfa seedlings.

SMALL GRAINS WITHOUT A LEGUME SEEDING

Affinity BroadSpec
(Harmony SG + Express premix)

Rate: Use 0.4 to 1.0 oz/a in wheat or barley; 0.4 oz/a in oats. Rates of 0.4 to 0.6 oz/a must be tank mixed with other herbicides.

Adjuvants: Add nonionic surfactant at 0.25% of spray solution. See label for surfactant rates when mixing other herbicides with Affinity BroadSpec. Ammonium sulfate at 2 lb/a or 2 qt/a of nitrogen fertilizer may also be added.

Timing: *Postemergence*—Apply from the 2-leaf stage, but before the flag leaf is visible in wheat and barley. Apply from the 3-leaf stage but before the jointing stage in oats.

Weeds—Treat annual weeds before they are 4 inches tall or wide. Treat 4- to 8-inch Canada thistle in the spring.

Remarks: Affinity BroadSpec is a premix of a 1:1 ratio of Harmony SG and Express, which provides a higher rate of Express than in Harmony Extra. Affinity BroadSpec controls many species of mustards, including wild mustard, shepherd's purse, and pennycress, and also pigweed, lambsquarters, henbit, and smartweeds. Wild buckwheat should be controlled with a 0.8 oz/a rate. Common ragweed control is inconsistent and giant ragweed is not adequately controlled. To ensure adequate control of common ragweed, tank mix with 2,4-D. When treating Canada thistle, tank mix 0.8 oz/a with 2,4-D or dicamba. Buctril and Starane are also labeled for tank mixtures. 2,4-D is a likely partner as Affinity BroadSpec will improve wild buckwheat and smartweed control compared to 2,4-D alone. Affinity BroadSpec can be tank mixed with insecticides or fungicides.

Apply in at least 5 gal/a of water with flat fan nozzle tips and in at least 10 gal/a with flood jet tips. Nitrogen fertilizer may be used as the carrier instead of water. Allow at least 45 days following application before harvest. Straw from treated small grains may be used for bedding or feed.

Rotational restrictions: Wheat and barley can be replanted any time after application, soybeans can be planted after 7 days, and corn can be planted after 14 days. Any

other crop can be planted 45 days after an application of Affinity BroadSpec, except canola or beets, which require a 60-day interval.

Banvel/Clarity

See dicamba.

Buctril (bromoxynil)

Rate: Apply 1.0 to 1.5 pt/a.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Base timing on the stage of weed growth but do not treat small grains in or beyond the boot stage.

Weeds—Apply when weeds in winter wheat have no more than 8 leaves or when weeds in spring-seeded cereals have 4 leaves and when weeds in either seeding time are no more than 2 inches tall.

Remarks: Buctril controls many broadleaves commonly found in small grains, especially shepherd's purse, pennycress, lambsquarters, wild radish, wild mustard, and yellow rocket seedlings. This treatment only controls seedling weeds when spray coverage is thorough and uniform. It will not control perennial weeds like Canada thistle. Apply Buctril with flat fan nozzles using at least 10 gal/a of water and 30 psi pressure.

Buctril can be applied to wheat, barley, rye, and oats and tank mixed with MCPA or 2,4-D for any of these cereals. It can be tank mixed with dicamba, Express, or Harmony Extra only for use in winter and spring wheat. Do not apply if crops are under stress or if the weeds are protected by a crop canopy. Treated areas cannot be grazed for 45 days.

Rotational restrictions: Corn can be planted any time after Buctril application. Other crops can be planted after 30 days.

Callisto (mesotrione)

Rate: 6 fl oz/a preemergence or 3 fl oz/a postemergence.

Adjuvants: For postemergence applications, add crop oil concentrate at 1% or nonionic surfactant at 0.25%. The addition of 28% nitrogen solution at 2.5% or ammonium sulfate at 8.5 lb/100 gal may increase weed control, but may also increase the risk of injury.

Timing: *Preemergence*—Apply after planting oats and before weed emergence.

Postemergence—Apply to oats before weeds exceed 5 inches in height. Do not apply within 50 days of harvest.

Remarks: Callisto has a supplemental label allowing these applications. Callisto controls many annual broadleaf weeds and cannot be used on oats underseeded with alfalfa. A preemergence application should provide greater crop safety than postemergence applications. Tank mixing emulsifiable concentrate formulations of other pesticides with postemergence applications is not recommended because of the risk of injury. Only one Callisto application can be made per year.

Rotational restrictions: Small grains can be planted 120 days after application. Alfalfa, soybeans, potatoes, and tobacco can be planted after 10 months. Other crops cannot be planted until 18 months after treatment.

Dicamba

Rate: Apply 2 to 4 fl oz/a of either Banvel or Clarity in wheat or spring oats; 2 to 3 fl oz/a in spring barley.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Apply to winter wheat in spring after winter dormancy and before joint stage or to spring-sown wheat or oats in the 2- to 5-leaf stage, and to spring-seeded barley in the 2- to 4-leaf stage.

Weeds—Treat when weeds are in the 2- to 3-leaf stage and rosettes are less than 2 inches across.

Remarks: Carefully monitor crop development and treat only at recommended growth stages. Later application may injure small grains and reduce yield. Dicamba controls many broadleaf weeds and is particularly effective on smartweed and wild buckwheat. This herbicide will also kill legumes—never use it on small grain undersown with a legume seeding. Since most of Wisconsin's small grain is grown with an undersown legume, use of dicamba or dicamba combinations in small grain (especially oats) will be very limited.

Dicamba is weak on weeds in the mustard family and very effective on wild buckwheat and smartweed. Dicamba can be tank mixed with 2,4-D, MCPA, Buctril, Express, or Harmony Extra in winter wheat and winter barley to broaden the spectrum of weeds controlled. In spring-seeded barley, Buctril, Express, Harmony Extra, or MCPA can be tank mixed with dicamba; in spring-seeded oats, only MCPA can be tank mixed with dicamba. Oats are more tolerant to dicamba than wheat and barley. Do not treat barley unless some injury is acceptable.

Crop staging and proper application timing are critical to avoid injuring small grains with dicamba. Do not use even low rates of dicamba after the small grain has developed beyond the recommended growth stage. Be particularly cautious with early developing wheat varieties like Madison and Wakefield.

Rotational restrictions: Corn can be planted any time after dicamba application. Other crops can be planted after harvest.

Harmony Extra SG
(Harmony SG + Express premix)

Rate: Use 0.45 to 0.9 oz/a in wheat and barley; 0.45 to 0.6 oz/a in oats. (Rates of new Harmony Extra SG are 50% higher than the original Harmony Extra.)

Adjuvants: Add a nonionic surfactant at 0.25% of spray solution. Ammonium sulfate at 2 lb/a or 2 qt/a of nitrogen fertilizer may also be added. See label for surfactant rates when mixing other herbicides with Harmony Extra.

Timing: *Postemergence*—Apply Harmony Extra to wheat or barley with 2 leaves but before the flag leaf is visible. Treat oats after the crop has 3 leaves but before the jointing stage.

Weeds—Treat annual weeds after emergence and before they are 4 inches tall or wide; treat 4- to 8-inch Canada thistle in the spring.

Remarks: Harmony Extra, a premix of Harmony SG and Express, controls many species of mustards, including wild mustard, shepherd's purse, pennycress, and wild radish, and also pigweed, lambsquarters, henbit, kochia, and smartweed. Common ragweed control is inconsistent and giant ragweed is not adequately controlled. To ensure adequate control of wild radish or common ragweed, mix Buctril MCPA, or 2,4-D with Harmony Extra. When treating Canada thistle, mix 2,4-D with Harmony Extra. If appropriate, dicamba can also be tank mixed with Harmony Extra.

Do not apply more than 0.6 oz/a of Harmony Extra to oats, nor more than 0.9 oz/a to wheat and barley. Small grain varieties vary in tolerance to Harmony Extra. Do not use this product in the oat varieties Ogle, Porter, or Premier.

Apply Harmony Extra in at least 5 gal/a of water with flat fan nozzle tips and in at least 10 gal/a with flood jet tips. Nitrogen fertilizer may be used as the carrier instead of water. Follow label instructions carefully to prevent drift and to properly clean the sprayer after treatment. Tank mixes with dicamba may reduce control of some broadleaf weeds and combinations with Buctril may reduce Canada thistle control. Do not harvest within 45 days of application. Straw from treated small grains may be used for bedding or feed.

Rotational restrictions: Wheat, barley, and oats can be replanted at any time. Any other crop can be planted 45 days after applying Harmony Extra.

Harmony SG (thifensulfuron)

Rate: Use 0.45 to 0.9 oz/a in wheat and barley; 0.45 to 0.6 oz/a in oats.

Adjuvants: Add a nonionic surfactant at 0.25 to 0.5% of spray solution. Ammonium sulfate at 2 lb/a or 2 qt/a of nitrogen fertilizer may also be added. See the label for surfactant rates when tank mixing with other herbicides.

Timing: *Postemergence*—Apply Harmony after wheat or barley is in the 2-leaf stage but before the flag leaf is visible; treat oats when the crop is in the 3-leaf stage but before jointing.

Weeds—Treat when broadleaf weeds are 1 to 4 inches tall.

Remarks: Harmony controls several common annual broadleaves in winter wheat, barley, and oats. These include most weeds in the mustard family, pigweed, lambsquarters, chickweeds, smartweeds, mayweed, pineappleweed, and annual sowthistle. If mixed with other herbicides, it controls prickly lettuce and wild radish.

Harmony can be tank mixed with 2,4-D, dicamba, or Buctril to broaden the spectrum of weeds controlled. Small grain varieties vary in sensitivity to Harmony; do not use this product on the oat varieties Ogle, Porter, or Premier. Harmony SG may be tank mixed with insecticides or fungicides. Do not apply Harmony when the cereals are under environmental stress.

Apply Harmony in 10 to 25 gal/a of water. Nitrogen fertilizer may be used as the carrier instead of water. Straw from treated small grains may be used for bedding or feed.

Rotational restrictions: Wheat, barley, oats, and field corn may be planted any time after applying Harmony. Any other crop may be planted 45 days after application.

Huskie (pyrasulfotole + Buctril + safener premix)

Rate: 11 to 15 fl oz/a (11 fl oz/a is the standard rate).

Adjuvants: Add 0.5 to 1 lb/a ammonium sulfate or 1 to 2 qt/a of 28% nitrogen solution. Nonionic surfactant at 0.25% may be added if required by a tank-mix partner.

Timing: *Postemergence*—Apply from 1-leaf stage up to flag leaf emergence.

Weeds—Treat actively growing weeds before they have more than 4 to 6 leaves or are more than 4 inches in diameter.

Remarks: Huskie controls many annual broadleaf weeds and will suppress some perennial broadleaf weeds in wheat and barley. If needed, Huskie can be tank mixed with other small grain herbicides. Apply Huskie in 10 gal/a of water or more to achieve thorough spray coverage as these ingredients primarily have contact activity. Nitrogen fertilizer may be used as the carrier instead of water when winter wheat is treated. Huskie is rainfast in 1 hour. Do not graze or harvest forage for 25 days after application or harvest grain for 60 days after application.

Rotational restrictions: Small grains can be replanted 7 days after application; soybeans after 4 months; and alfalfa, dry beans, corn, and potato after 9 months. A field bioassay is required before planting crops not listed on the label.

MCPA

Rate: Apply 0.5 to 1.0 pt/a of MCPA amine or MCPA ester (formulations containing 4 lb ae/gal).

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Apply in spring after grain has four leaves and before jointing stage. Do not apply in boot to dough stage.

Remarks: Apply MCPA when small grain is fully tillered (usually 4 to 8 inches tall). The risk of crop injury increases as the rate increases. Apply MCPA with a minimum of 10 gal/a of water. MCPA amine is soluble in water while MCPA ester is an emulsifiable concentrate. MCPA is sold under various trade names and at various concentrations of acid equivalence. Be sure to read and follow the guidelines on the label for your brand of MCPA as there are often labeling differences between manufacturers. Wheat, barley, oats, and rye grain from fields treated with MCPA may be used for any purpose.

Rotational restrictions: The label gives no information on planting rotational crops.

Orion (florasulam + MCPA premix)

Rate: 17 fl oz/a.

Adjuvants: The addition of 0.2% nonionic surfactant is suggested.

Timing: *Postemergence*—Apply from 3-leaf stage up to jointing. Applications from jointing until boot stage may cause injury.

Weeds—Treat actively growing weeds when 1 to 4 inches tall.

Remarks: Orion is labeled to control many mustards such as shepherd's purse, field pennycress, and wild mustard as well as common chickweed, lambsquarters, pigweed, common ragweed, wild buckwheat, and smartweeds. Apply in 8 or more gal/a water. Orion is rainfast in 4 hours. Treated small grains can be grazed in 7 days.

Rotational restrictions: Small grains can be planted 14 days after application; corn can be planted after 3 months; alfalfa, dry beans, potatoes, and soybeans can be planted after 9 months; all other crops can be planted after 12 months.

Rage D-Tech (Aim + 2,4-D premix)

Rate: Apply 8 to 16 fl oz/a.

Adjuvants: Add a nonionic surfactant at 0.25%. Ammonium sulfate at 2 to 4 lb/a or nitrogen fertilizer at 2 to 4 gal/100 gal of spray solution may be added.

Timing: *Postemergence*—Apply to small grains from 3-tillers to before jointing.

Weeds—Treat weeds before they exceed 4 to 6 inches in height.

Remarks: Rage D-Tech controls many annual broadleaf weeds such as lambsquarters, pigweed, and several mustard species like field pennycress, shepherd's purse, and wild mustard and will suppress wild buckwheat. Thorough coverage is important for control. Rage D-Tech may be tank mixed with other herbicides, but tank mixing with Buctril is not recommended. Rage D-Tech contains the ingredient in Aim, which is a contact herbicide and often causes speckling of crop leaves. Do not apply if small grain leaves are wet from dew or rain because injury will be more severe.

Rotational restrictions: Most field crops can be planted after 30 days. Many vegetable crops should not be planted for 12 months.

Starane (fluroxypyr)

Rate: 0.67 pt/a.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Apply Starane to actively growing wheat, oats, or barley from the 2-leaf growth stage up to and including flag leaf emergence. Treat at least 40 days before harvest.

Weeds—Treat actively growing annual weeds before they exceed 8 inches in height; treat hemp dogbane when it is 12 to 18 inches tall.

Remarks: Starane controls several broadleaf weeds in wheat, oats, and barley. Susceptible species include hemp dogbane, chickweed, kochia, common ragweed, and bedstraw. Starane is particularly effective on hemp dogbane; fields with this weed could be rotated to wheat and treated with Starane to reduce the infestation. This product also suppresses pennycress, mustard, wild buckwheat, and field bindweed. Up to 1.33 pt/a of Starane could be applied to these latter weeds but it is probably better to tank mix Starane with other broadleaf herbicides to improve and broaden the spectrum of control to include additional weeds. Control will be reduced if weed foliage is wet at the time of application. Never use Starane in fields underseeded with legumes as they would be killed. Starane is available as an emulsifiable concentrate with 1.5 lb ae fluroxypyr/gal.

Rotational restrictions: Only wheat, barley, and oats can be replanted sooner than 120 days after application. All other crops can be planted after 120 days.

Stinger (clopyralid)

Rate: 0.25 to 0.33 pt/a.

Adjuvants: Do not add surfactants or other additives to the spray mixture.

Timing: *Postemergence*—Apply Stinger to wheat, barley, or oats after the 3-leaf but before the boot stage.

Weeds—Treat Canada thistle in the rosette to early bud stage and annual broadleaves with 2 to 5 leaves.

Remarks: Stinger controls several broadleaf weeds in wheat, barley, and oats. It is weak on smartweed and does not control weeds in the mustard family or lambsquarters. Stinger is labeled for several weeds in the composite family, including giant and common ragweed and Canada thistle. For Canada thistles, use 0.33 pt/a and treat as the cereal reaches the early boot stage. Never use Stinger in fields underseeded with legumes. Weeds should be actively growing when treated; do not add a surfactant or crop oil to the spray solution. Do not use in fields that will be summer seeded to alfalfa. Also avoid using in areas where the groundwater is vulnerable to contamination due to very permeable soils and/or a very shallow water table. Stinger can be tank mixed with Buctril, dicamba, MCPA, or 2,4-D.

Rotational restrictions: Treated fields can be planted to wheat, barley, oats, grasses, or field corn any time after application. Alfalfa, soybeans, dry beans, and sunflowers can be planted 10.5 months after application. Do not plant other crops within 18 months unless risk of some crop injury is acceptable.

2,4-D

Rate: Apply 1.0 pt/a of 2,4-D amine or 0.67 pt/a of 2,4-D ester (forms containing 3.8 lb ae/gal) in wheat, rye, or barley. Apply 0.5 to 1.0 pt/a of 2,4-D amine or 0.5 pt/a of 2,4-D ester in oats.

Adjuvants: Do not add surfactants or other additives to the spray mixture. Nitrogen fertilizer may be used as the carrier instead of water.

Timing: *Postemergence*—Treat when cereals are fully tillered (usually 4 to 8 inches tall) and before the jointing stage; never treat in the boot or dough stages.

Weeds—Treat when annual broadleaves are 4 inches or less in height.

Remarks: When using forms of these herbicides containing other than 3.8 lb ae/gal, adjust rates accordingly. Apply 2,4-D before the small grain reaches the jointing stage of development. Applications after jointing occasionally cause yield loss.

Note: *Do not treat grains in the boot to dough stage because of the risk of severe yield loss.*

Susceptible broadleaf weeds are usually controlled by the lower rates, but less susceptible weeds require full dosage. Smartweed and pennycress are best controlled by 2,4-D ester, but amine is less likely to injure small grains. 2,4-D amines are usually water soluble liquids while 2,4-D esters are emulsifiable concentrates. 2,4-D is sold under various trade names and at various concentrations of acid equivalence. Be sure to read and follow the guidelines on the label for your brand of 2,4-D as there are often labeling differences between manufacturers. Wheat, barley, oats, and rye grain from fields treated with 2,4-D amine or ester may be used for any purpose.

Rotational restrictions: Corn may be planted 7 to 14 days after 2,4-D application; soybeans may be planted after 7 to 30 days; other crops can planted after 3 months.

Table 5-2. Harvest and/or grazing restrictions for herbicides registered for use in small grains[a]

Herbicide	Use(s)	Type of animal	Interval between application and grazing or harvest	Comments
Affinity BroadSpec	wheat, barley	all	7 days for grazing or forage; 45 days before harvest	Allow 30 days between application and hay harvest.
Buctril	small grains	all	45 days	Do not harvest summer-seeded alfalfa treated with Buctril until following spring.
Callisto	oats	all	30 days for grazing or forage; 50 days before harvest	—
Dicamba	small grains	non-lactating lactating	0 days	Do not harvest hay within 37 days after treatment.
Glyphosate[b]	wheat, barley preharvest	—	7 days	Apply only when grain is in hard dough stage (30% moisture or less).
Harmony Extra	wheat, barley	all	7 days for grazing or forage; 45 days before harvests	Allow 30 days between application and hay harvest.
Harmony SG	wheat, barley	all	7 days for grazing or forage; 45 days before harvest	Allow 30 days between application and hay harvest.
Huskie	wheat, barley	all	25 days for grazing or forage; 60 days for grain or straw	—
MCPA	small grains	all	—	Do not allow livestock to graze treated fields within 7 days of slaughter.
Orion	small grains	all	7 days for grazing; 60 days before harvest	—
Rage D-Tech	small grains	dairy or meat	14 days for grazing	Do not feed straw to livestock.
Starane	small grains	all	7 days for grazing; 40 days before harvest	—
Stinger	small grains	all	7 days	Do not harvest hay from treated grain fields.
2,4-D	small grains	all	2-week grazing restriction	—
	small grains, preharvest	all	7 days before harvest	Do not feed straw to livestock.

[a] Labels may have changed after this table was prepared. Consult current labels to verify the information.

[b] These are the restrictions on the Roundup and Touchdown labels and several other glyphosate products. Differences exist on some brands of glyphosate. Verify what restrictions apply to your brand before using it.

SMALL GRAINS INSECT MANAGEMENT

Insecticides suggested in this section are intended as a guide to assist you in selecting chemical insect control options during the season. This book provides an overview of product registrations for specific field crop insect pests; it is not intended as an exhaustive insecticide label source. Product inclusion or omission does not imply endorsement by University of Wisconsin-Extension. Remember, certain insecticides are produced by different manufacturers and directions for use, rate, and method of application may vary by formulation. Therefore, always read the insecticide label completely before using the material.

Insecticides are often interchangeably referred to by their common names and trade names. Trade names such as Warrior are capitalized, while common chemical names—lambda-cyhalothrin in this example—are not.

A number of the products listed in this section are restricted-use insecticides. We discuss restricted-use pesticides in the beginning of this publication. Refer to appendix table 1b for a list of insecticides that currently require certification to be applied. It is possible that additional insecticides will be classified before the next growing season. Contact your county Extension agent for additional information on insecticide restriction.

INSECT PESTS OF SMALL GRAINS

Aphids

Aphids (primarily greenbug, bird cherry-oat, and English grain aphid) damage plants indirectly by transmitting barley yellow dwarf virus (BYDV) and directly by sucking the sap. Light or heavy infestations of these small (less than .062 inch), green, soft-bodied insects may result in severe red-leaf damage of oats, but only heavy infestations cause yellowing and eventual browning. Once the red-leaf damage or yellowing is noticeable, it is usually too late to spray.

These aphids can also infect winter wheat in the fall. Winged, virus-infected aphids fly to the fields and then transmit the virus to the seedlings as they feed on them. The extent of BYDV infection of Wisconsin's winter wheat is related to the number of aphids present during the summer, the percent of the aphid population that carry the virus, and planting date of wheat. The degree of infection and subsequent winterkill and yield reduction can be very high in fields planted during August if the numbers of infected aphids are high. Delaying planting until September 15 will avoid peak fall aphid flights.

Aphids injure small grains by sucking plant sap from leaves, stems, and/or heads and can cause direct yield loss under heavy infestations. When scouting for aphids in winter wheat, take several counts throughout the field prior to heading. Examine 20 stems in each of five areas of the field (100 stems per field). For aphid treatment guidelines in winter wheat and small grains, refer to table 5-3.

Insecticide seed treatments are labeled for early-season control of aphids (including bird cherry-oat, English grain, greenbug, and Russian wheat aphids) and to reduce the potential spread of BYDV. Gaucho XT (3.4 fl oz/hundredweight or cwt of seed) and Gaucho 600 (0.8 fl oz/cwt of seed) are labeled for wheat, oats, rye, and barley. CruiserMaxx Cereals (5.0 fl oz/cwt of seed) and Cruiser 5FS (0.75 to 1.33 fl oz/cwt of seed) are labeled for wheat, barley, and triticale. Small grain seed treatments are applied with fungicide(s) prior to planting as a slurry treatment. Do not graze or feed

livestock on treated areas for 45 days after planting. Treated seed may be obtained from seed dealers and/or seed treatment service providers.

Armyworms

Armyworms can severely damage small grain fields. Larvae, resulting from moth flights in late June and early July, cause the problems. In July, these worms strip leaves and frequently clip off kernels and the head as the crop approaches maturity. By day, they hide on the soil surface and beneath clods. Detecting young larvae requires careful searching.

To guard against severe losses, check several areas of each field carefully. Check thick lodged areas first because armyworms will often be most numerous here. If you do not find worms in these areas, the odds are good that there are no problems in the rest of the field. However, check the field again in several days. If you find armyworms in the lodged areas, check several areas in the rest of the field. Treatment is suggested if populations average three or more per square foot.

Grasshoppers

Occasionally, grasshoppers are abundant enough to concern farmers. Insecticide use is not suggested until populations reach 20 per square yard in field margins or 8 per square yard in small grain fields. Apply treatments while grasshoppers are still small.

Wireworms

Wireworms are small (less than 1.5 inches long), copper-colored larvae that attack underground stems and kill plants in irregular areas in oat fields. They are a problem mainly on Spencer loam soils of central Wisconsin.

Insecticide seed treatments are labeled for early-season suppression and/or control of wireworm in small grains. Gaucho XT (3.4 fl oz/cwt of seed) and Gaucho 600 (0.13 to 0.26 fl oz/cwt of seed) are labeled for wheat, oats, rye, and barley. Cruiser-Maxx Cereals (5.0 fl oz/cwt of seed) and Cruiser 5FS (0.19 to 0.25 fl oz/cwt of seed) are labeled for wheat, barley, and triticale. NipsIt SUITE Cereals (5.0–7.5 fl oz/cwt of seed) is labeled for barley, oats, and wheat. Small grain seed treatments are applied with fungicide(s) prior to planting as a slurry treatment. Do not graze or feed treated livestock on treated areas for 45 days after planting. Treated seed may be obtained from seed dealers and/or seed treatment service providers.

Table 5-3. Treatment thresholds for aphids to prevent direct plant damage (not disease reduction) and subsequent grain yield loss

Growth stage	English grain aphid or oat-bird cherry aphid	Greenbug
Seedling	30 aphids/stem	20 aphids/stem
Boot to heading	50 aphids/stem	30 aphids/stem

Table 5-4. Insecticide suggestions for small grains (check label for registered crops)

Insect	Insecticide[a]	Amount of product/a	Remarks, precautions[b]
Aphids, grasshoppers	Baythroid XL	1.8–2.4 oz	Do not apply within 30 days of harvest. For aphids, use higher rate and increased water volume for applications after damage has occurred.
	Declare	1.02–1.54 oz	Labeled for wheat only. Do not apply more than 0.03 lb ai (0.19 pt)/a per season. Do not apply within 30 days of harvest.
	dimethoate	0.5–0.75 pt	Labeled for control of greenbug aphids and grasshoppers in wheat only.
	malathion 57% EC	1.5–2.0 pt	Do not apply within 7 days of harvest.
	Mustang Max	3.2–4.0 oz	Do not apply more than 0.125 lb ai/a per season.
	Penncap-M[c]	2–3 pt	Labeled for control of aphids (including greenbugs) and grasshoppers in wheat, oat, and barley. Do not apply within 15 days of harvest or grazing.
	Sevin XLR Plus	1–3 pt	Grasshoppers only. Do not apply within 21 days of harvest for grain.
	Stallion	5.0–11.75 oz	Registered for wheat only. Do not apply within 14 days of harvest for forage and hay and within 28 days of harvest for grain and straw. Do not apply more than 23.5 oz of product/a per season (0.05 lb/a zeta-cypermethrin + 0.50 lb/a chlorpyrifos) or make more than two applications of Stallion or other products containing chlorpyrifos per season.
	Warrior II	1.28–1.92 oz	Do not apply within 30 days of harvest. Do not exceed 0.06 lb ai/a per season. Best control obtained before aphids begin to roll leaves. Once crop has started to boot, may provide suppression only. Higher rates and increased coverage will be necessary.
Armyworm	Baythroid XL	1.8–2.4 oz	Do not apply within 30 days of harvest or exceed 4.8 oz/a per season.
	Declare	1.02–1.54 oz	Labeled for wheat only. Do not apply more than 0.03 lb ai (0.19 pt)/a per season. Do not apply within 30 days of harvest.
	Mustang Max	1.76–4.0 oz	Do not apply more than 0.125 lb ai/a per season.
	Penncap-M[c]	2–3 pt	Do not apply within 15 days of harvest or grazing.
	Sevin XLR Plus	2–3 pt	For use on wheat only. Do not apply within 21 days of harvest.
	Stallion	9.25–11.75 oz	Registered for wheat only. Do not apply within 14 days of harvest for forage and hay and within 28 days of harvest for grain and straw. Do not apply more than 23.5 oz of product/a per season (0.05 lb/a zeta-cypermethrin + 0.50 lb/a chlorpyrifos)or make more than two applications of Stallion or other products containing chlorpyrifos per season.
	Tracer	1–3 fl oz	Do not exceed 9 fl oz (0.28 lb spinosad) per acre per year. Do not apply within 21 days of grain or straw harvest, or within 14 days of harvest for forage or hay.
	Warrior II	1.28–1.92 oz	Do not apply within 30 days of harvest or exceed 0.06 lb ai/a per season.

[a] All insecticides in this table are to be applied to the plant foliage.

[b] Do not allow sprays to drift into beeyards or onto adjacent blooming crops or weeds.

[c] Mixing Penncap-M (microencapsulated methyl parathion) with emulsifiable concentrates, organic solvents, or some surfactants may increase the potential hazard to applicators.

SMALL GRAINS DISEASE MANAGEMENT

Many disease-causing organisms attack small grains in Wisconsin. Any approach to plant disease control requires identification and knowledge of the cause and its life cycle, the effect of environment on disease development, and the potential control measures available. Economic and environmental factors often determine the control procedures employed for these various diseases. Control strategies can be an integration of the following methods: planting resistant or tolerant varieties, proper crop management, and agricultural chemicals (mostly fungicides).

Variety selection is key to disease management in small grains. Refer to Extension publications *Wisconsin Oats and Barley Performance Tests* (A3397) and *Wisconsin Winter Wheat Performance Tests* (A3868) at learningstore.uwex.edu for specific disease-resistance ratings. These publications are updated each year with new test data for each variety.

SMALL GRAIN DISEASES

Barley yellow dwarf (red leaf)

Barley yellow dwarf of wheat or barley and red leaf of oat are caused by the same virus—barley yellow dwarf virus (BYDV). Infected wheat or barley plants show yellowed foliage, stunted plants, and underdeveloped heads. Infected oat plants also are stunted and have underdeveloped heads, but the foliage becomes red with slight yellowing—thus, the common name red leaf.

The barley yellow dwarf virus is transmitted by aphids. The virus overwinters in wild grasses and winter wheat; however, inoculum carried in from southern states by aphids appears to be more critical in disease development. Volunteer oat plants, corn, and virus-carrying aphids serve as inoculum for infection of winter wheat in the fall. Corn is another source of inoculum of the BYDV.

To control red leaf, choose resistant varieties of oat. Most wheat varieties are susceptible. Plant oat, barley, and spring wheat early to avoid high populations of virus-laden aphids. Delay planting of winter wheat to avoid high aphid populations in the fall. Generally, winter wheat planted after mid-September is less affected by BYDV. Encourage good vegetative growth by seeding at appropriate rates and by using fertility management techniques.

Ergot

Ergot is an important disease in rye, triticale, wheat, and barley but rare in oats. Some of the grain in an infected head is replaced with a long, purple-black, horn-like fungus structure that may reach 1 inch in length. Ergot causes little or no yield loss but is toxic if fed to livestock. All varieties of rye are susceptible. Information is not available on barley and wheat varieties.

Leaf rust and stem rust

Leaf rust and stem rust occur on all small grains grown in Wisconsin. Disease severity differs each year depending on weather conditions, varieties of small grains grown, and prevalent strain(s) of the rust fungi present. Small grain yields can be greatly reduced as a result of severe rust development. Another rust disease, stripe rust, has been found in Wisconsin. However, this disease occurs with less frequency from season to season.

There are several possible ways to control or reduce rust in small grains. In most years, early planting effectively controls stem rust of oat, and stem rust and leaf rust of spring wheat. Stem rust fungi do not overwinter in Wisconsin, and inoculum must be introduced from states south of Wisconsin. The wheat leaf rust fungus can overwinter on winter wheat if the crop does not freeze, although this situation rarely occurs.

Leaf rust (crown rust) of oat survives on buckthorn bushes; these serve as a source of inoculum each spring. Thus, early planting has less of an impact on leaf rust development on oat. Destruction of buckthorn bushes in the vicinity of oat fields can suppress leaf rust of oat.

Rust diseases of small grains can be effectively controlled by planting rust-resistant varieties. However, new races of the rust fungi frequently develop and infect varieties that were formerly resistant. Beware of rust development in varieties rated as resistant.

Foliar-applied fungicides are registered for rust control in small grains (table 5-5). See product label for registered crops, rates, and timing of applications.

Powdery mildew

Powdery mildew is caused by the fungus *Blumeria graminis.* White to light gray, powdery patches form on the leaves, sheaths, stems, and floral bracts. Black specks (cleistothecia) form in the mildew growth as the crop matures. When mildew growth is severe, infected leaves wither and die early. The fungus overwinters on living and dead plants.

To control powdery mildew, choose resistant varieties of small grains. If the disease is present on lower leaves and the plants are reaching the boot stage, consider the application of foliar fungicides.

Scab

In its most conspicuous form, scab in wheat and barley is a head blight, recognized by the premature ripening or bleaching of one or more spikelets of a grain head any time after heading. The light yellow color of diseased regions of a head show in sharp contrast with the healthy green of the remaining portion of the head. A light pink or salmon color may appear at the base of infected spikelets. Infected kernels are a white, salmon, or reddish color, are badly shrunken and wrinkled, and have a noticeably rough, flaky seed coat. Sometimes the scab fungus girdles the stem below the head, not allowing the head to develop. Stem tissues immediately below the head will turn brown. Scab reduces yield and quality of wheat and barley.

The scab fungus produces mycotoxins that are harmful if scabby grain is fed to swine. In swine, avoid feeding wheat (or barley) with more than 10% scabby kernels as this may cause vomiting, feed refusal, and reproductive problems since there is an increased risk for mycotoxins in these samples.

If seed from scabby fields is planted, seed rot, seedling blight, crown rot, and root rot can cause loss of stand and subsequent yield loss. The most common scab fungus, *Fusarium graminearum,* is the same organism that can cause root rot, stalk rot, and ear rot of corn. Thus, wheat or barley that is planted after corn generally has a higher incidence and severity of scab. If wheat or barley must follow corn, deep incorporation of corn debris should reduce the potential for scab development.

Septoria black stem of oat

Septoria black stem of oat appears as oval, chocolate-brown spots on leaf blades and sheaths. Small, black fruiting bodies of the fungus appear in the center of the spots. Stems under sheath spots are dark brown to black and are rotted. The rotted stems are weakened, and severely infected plants will lodge and make harvesting difficult. Infected kernels are purple to black. Oat varieties differ in susceptibility.

Septoria leaf blotch of wheat

Septoria leaf blotch is caused by the fungus *Septoria tritici.* Small, light green to yellow spots on the leaves and sheaths enlarge and merge to form irregular, tan to reddish brown blotches with gray-brown to ash-colored centers often partly surrounded by a yellow margin. Septoria leaf blotch can be found with another disease caused by the fungus *Stagnonospora nodorum* and therefore may be defined as a complex of the two diseases. Black specks (pycnidia) form in older lesions or at stem nodes. Affected leaves often turn yellow, wither, and die early. The fungus survives in living and dead wheat plants and in seed.

To control Septoria leaf blotch, rotate crops. If planting wheat in fields that were cropped to wheat the previous year, deep incorporation of wheat residues offers some control. Wheat varieties differ in resistance to Septoria leaf blotch. However,

available levels of resistance will not provide adequate control during moderate to severe epidemics of Septoria leaf blotch. Foliar-applied fungicides are necessary if weather and management practices create an environment favorable for severe Septoria leaf blotch development. Apply foliar fungicides at the emergence of the flag leaf into the boot stage to protect the flag leaf of plants.

Smut

Smut in small grains has greatly increased in recent years and has been particularly severe in oat. Plants infected with a smut fungus appear normal until the heads emerge. The grain in infected plants is replaced by the smut fungus and appears as a black powdery mass of spores. The smut fungi are carried with the seed and do not survive in the soil or plant debris. Planting seed from fields with smutted plants the previous year will perpetuate the problem. Do not confuse weathered blackened heads with smut. Heads of small grains are often colonized by non-pathogenic fungi that make the heads black. However, the grain is present, in contrast to smut that replaces the grain with its sooty black spores. Although similar in appearance and biology, smut diseases of small grains are caused by different fungi. These include loose smut of wheat, loose smut of barley, loose smut of oat, covered smut of oat, covered smut of barley and bunt, or stinking smut of wheat.

To control smut diseases of small grains, do not plant seeds from fields heavily infested with smut. You can use seed from fields with less than 1% smutted heads without a significant risk of smut development. Small grain seed certified by the Wisconsin Crop Improvement Association (wcia.wisc.edu) has been grown using procedures that control smut diseases. Plant resistant varieties. Many races of smut fungi of oat are present in Wisconsin and more races may develop that attack oat varieties that are currently resistant.

Certain fungicide seed treatments effectively control smut diseases of small grains (table 5-6). Mechanical seed treatment is recommended but not necessary. Follow the directions on the product label to assure proper treatment, handling, and use of seed treated with fungicide. Fungicide-treated seed cannot be used for food, feed, or oil.

Take-all

Take-all is a root rot disease caused by a soil-inhabiting fungus. Winter wheat is most affected. Spring wheat, barley, and oat are the least susceptible. Symptoms of take-all include stunted plants and bleached-white heads. Lower stems show a black, rotted appearance and the plants present a rotted and sparse root system.

To reduce the incidence and severity of take-all, rotate crops and control wild grasses such as quackgrass. Make sure levels of soil nitrogen are adequate. The NH_3 form of nitrogen suppresses take-all. Consider using nitrapyrin (N-Serve), a nitrogen stabilizer; it improves the effectiveness of nitrogen fertilization. Delay winter wheat planting to escape fall infection. Winter wheat planted after alfalfa may be at risk because of invasion by quackgrass. Take-all is seldom a problem in a rotation sequence of soybean-winter wheat.

Table 5-5. Fungicides for control of foliar diseases of small grains

Fungicide	Fusarium head scab	Rust	Powdery mildew	Septoria leaf blotch	Glume blotch	Tan spot	Active ingredient	Chemical family (FRAC code[a])	Amount/ use/a	Preharvest interval (PHI)
Bumper 41.8 EC	■[b]	■	■	■	■	■	propiconazole	triazole (3)	2–4 fl oz	**Barley, oat, rye, and triticale:** 30 days for forage or hay, 45 days for grain and straw. **Wheat:** do not apply after Feekes 10.5 growth stage.
	Remarks: For use on barley, oats, rye, triticale, and wheat. Consult the label for disease- and crop-specific recommendations and rates.									
Caramba	■	■	■	■	■	■	metconazole	triazole (3)	10–14 fl oz (14–17 fl oz for head scab only)	30 days
	Remarks: For use on barley, oats, rye, triticale, and wheat. Make no more than two applications per season at a maximum product rate of 34 fl oz/a/season.									
Cuprofix Ultra 40 Disperss	—	—	—	■	—	■	basic copper sulfate	inorganic (M1)	1–1.25 lb	Not listed.
	Remarks: For use on barley, oats, and wheat.									
Cuprofix MZ Disperss	—	—	—	■	■	—	mancozeb	dithiocarbamate (M3)	2.5–4.75 lb	26 days. Do not graze livestock in treated areas prior to harvest.
	Remarks: For use on barley, oats and wheat. Do no apply more than 4.8 lbs of mancozeb active ingredient/a/crop.									
Dithane DF Rainshield	—	■	—	■	■	■	mancozeb	dithiocarbamate (M3)	2.0 lb	Do not apply after Feekes growth stage 10.5 or within 26 days of harvest.
Dithane F-45 Rainshield		■		■	■	■			1.6 qt	
Dithane M45		■		■	■	■			2.0 lb	
	Remarks: For use on barley, oats, rye, triticale, and wheat. Refer to label for crop-specific information. Do not make more than three applications during the season. Do not graze livestock in treated areas prior to harvest.									
Folicur 3.6F	■	■	—	—	—	—	tebuconazole	triazole (3)	4 fl oz	Do not apply within 30 days of harvest.
	Remarks: For use on barley and wheat. A maximum of 4 fl oz may be applied/a/season.									
Headline Headline SC	—	■	■	■	■	■	pyraclostrobin	QoI inhibitor (11)	6–9 fl oz	**Barley and rye:** apply no later than 50% head emergence (Feekes 10.3; Zadoks 55). **Oat, wheat, and triticale:** apply no later than the beginning of flowering (Feekes 10.5; Zadoks 55).
	Remarks: For use on barley, oats, rye, triticale, and wheat. Do not make more than two sequential foliar applications. Do not apply more than 18 fl oz/a/season.									

(continued)

Table 5-5. Fungicides for control of foliar diseases of small grains *(continued)*

Trade name	Fusarium head scab	Rust	Powdery mildew	Septoria leaf blotch	Glume blotch	Tan spot	Active ingredient	Chemical family (FRAC code[a])	Amount/ use/a	Preharvest interval (PHI)
Kocide 3000	■	■	■	■	■	—	copper hydroxide	inorganic (M1)	0.50–0.75 lb	None listed.
	Remarks: For use on barley, oats and wheat.									
Manzate ProStick	—	■	—	■	■	■	mancozeb	dithiocarbamate (M3)	2.0 lb	26 days
Manzate Flowable		■		■	■	■			1.6 qt	
	Remarks: For use on barley, oat, rye, triticale, and wheat. Do not make more than three applications per season. Do not apply more than 6 lb Manzate ProStick or 4.8 qt Manzate Flowable/a/crop. Do not graze livestock in treated areas prior to harvest.									
Penncozeb 75 DF	—	■	—	■	■	■	mancozeb	dithiocarbamate (M3)	1.0–2.0 lb	Do not apply after heading or Feekes 10.5 but not less than 26 days before harvest.
Penncozeb 80 WP		■		■	■	■			1.0–2.0 lb	
Penncozeb 4 FL		■		■	■	■			0.8–1.6 qt	
	Remarks: For use on barley, oats, rye, triticale and wheat. Do not make more than three applications per season. Read label for total amount of product to apply/a/season.									
Priaxor	—	■	■	■	■	■	fluxapyroxad pyraclostrobin	Carboximides (7) Qol (11)	4–8 fl oz	**Barley and oat:** apply no later than 50% head emergence (Feekes 10.3, Zadoks 55). **Rye, triticale, wheat:** apply no later than beginning of flowering (Feekes 10.5, Zadoks 59).
	Remarks: Do not apply more than 16 fl oz/a/season or make more than 2 consecutive applications before switching to a labeled fungicide with a different mode of action.									
Proline 480 SC	■	■	■	■	■	■	prothioconazole	triazole (3)	2.8–5.7 fl oz	**Barley:** 32 days. **Oat, rye, triticale, and wheat:** 30 days.
	Remarks: For use on barley, oats, rye, triticale and wheat. Consult the label for crop and disease specific recommendations and rates.									
Propimax EC	■	■	■	■	■	■	propiconazole	triazole (3)	2–4 fl oz.	**Wheat:** Do not apply after Feekes 10.5. **Barley, oat, rye, and triticale:** 30 days for forage or hay, 45 days for grain and straw.
	Remarks: For use on barley, oats, rye, triticale, and wheat. Do not apply more than 8 fl oz/a/season. Do not apply more than 4 fl oz/a/season if forge or hay will be harvested.									
Prosaro 421 SC	■[b]	■	■	■	■	■	prothioconazole tebuconazole	triazole (3) triazole (3)	6.5–8.2 fl oz	30 days
	Remarks: For use on barley and wheat. A maximum of 8.2 fl oz may be applied/a/crop year. Straw may be fed or used for bedding. Grazing permitted 6 or more days after last application.									

(continued)

[a] Fungicide group numbers indicate the modes of action: multiple applications of fungicides with same group number increases the chances for resistance.
[b] Suppression only.

Table 5-5. Fungicides for control of foliar diseases of small grains *(continued)*

Trade name	Fusarium head scab	Rust	Powdery mildew	Septoria leaf blotch	Glume blotch	Tan spot	Active ingredient	Chemical family (FRAC code[a])	Amount/ use/a	Preharvest interval (PHI)
Quadris	—	■	■	■	■	■	azoxystrobin	Qol inhibitor (11)	4.0–12.0 fl oz	**Wheat:** Do not apply later than Feekes growth stage 10.5. **Barley, triticale:** do not apply within 45 days of harvest for grain and straw or within 14 days of harvest for forage and hay.
	Remarks: For use on barley, triticale, and wheat. Do not apply more than 0.40 lb. ai/a/season of azoxystrobin-containing products. Do not apply more than two sequential applications of Quadris or other group-11 fungicides before alternating with a fungicide that is not in Group 11.									
Quilt	—	■	■	■	■	■	propiconazole azoxystrobin	triazole (3) Qol inhibitor (11)	7–14 fl oz	**Wheat:** do not apply after Feekes growth stage 10.5 or within 30 days for forage or hay. **Barley and triticale:** 45 days for grain, 30 days for forage or hay.
	Remarks: For use on barley, triticale, and wheat. Do not apply more than two applications/a/season. Do not apply more than 28.0 fl oz/a/season of Quilt. Do not apply more than 0.22 lb ai of propiconazole-containing products/a/season. Do not apply more than 0.40 lb. ai azoxystrobin-containing products/a/season.									
Quilt Xcel	—	■	■	■	■	■	propiconazole azoxystrobin	triazole (3) Qol inhibitor (11)	7–14 fl oz	**Wheat:** do not apply after Feekes growth stage 10.5 or within 30 days for forage or hay. **Barley and triticale:** 45 days for grain, 30 days for forage or hay.
	Remarks: For use on barley, triticale, and wheat. Applications can be made not closer than a 14-day interval. Do not apply more than two applications/a/season. Do not apply more than 28.0 fl oz/a of Quilt Xcel or more than 0.22 lb ai of propiconazole-containing products/a/season. Do not apply more than 0.40 lb ai azoxystrobin-containing products/a/season. Under certain environmental conditions, tank mixes of Quilt Xcel plus herbicides and/or fertilizers may cause crop injury.									
Stratego	—	■	■	■	■	■	propiconazole trifloxystrobin	triazole (3) Qol inhibitor (11)	7–10 fl oz	**Barley and oat:** Do not apply after Feekes growth stage 8 or within 40 days of harvest. **Wheat and triticale:** do not apply after Feekes 10.5 growth stage or within 35 days of harvest.
	Remarks: For use in barley, oats, triticale, and wheat. Consult label for crop- and disease-specific information.									

(continued)

Table 5-5. Fungicides for control of foliar diseases of small grains *(continued)*

Trade name	Fusarium head scab	Rust	Powdery mildew	Septoria leaf blotch	Glume blotch	Tan spot	Active ingredient	Chemical family (FRAC code[a])	Amount/ use/a	Preharvest interval (PHI)
Stratego YLD	—	■	■	■	■	■	prothioconazole trifloxystrobin	triazole (3) QoI inhibitor (11)	2.3–4.0 fl oz	**Barley:** do not apply after Feekes growth stage 8 or within 40 days of harvest. **Wheat:** do not apply after Feekes growth stage 10.5 or within 35 days of harvest.
	Remarks: For use in barley and wheat. Do not apply more than two applications of Stratego YLD or other Group 11-containing fungicide/a/season. Consult label for further rate restrictions.									
Tilt	■	■	■	■	■	■	propiconazole	triazole (3)	2–4 fl oz	**Barley, oat, rye, and triticale:** do not apply within 45 days of harvest for grain or straw or 30 days for forage or hay. **Wheat:** do not apply after Feekes growth stage 10.5 or within 30 days of harvest for forage or hay.
	Remarks: For use on barley, rye oats, triticale, and wheat. Do not apply more than 8 fl oz/a/season. Do not apply more than 4 fl oz /a/season of Tilt if forage or hay will be harvested. Do not apply more than 0.22 lb ai propiconazole-containing products/a/season.									
Twinline	—	■	■	■	■	■	pyraclostrobin + metconazole	QoI inhibitor (11) triazole (3)	7–9 fl oz	Apply not later than the beginning of flowering (Zadoks 59 or Feekes 10.5). Do not harvest barley hay within 14 days of last application.
	Remarks: For use in barley, oats, rye, triticale, and wheat. Do not make more than two applications or more than 18 fl oz of Twinline/a/season.									

[a] Fungicide group numbers indicate the modes of action: multiple applications of fungicides with same group number increases the chances for resistance.
[b] Suppression only.

Table 5-6. Seed treatment fungicides for small grains[a]

		Oat	Wheat		Barley		
Fungicide	Active ingredient	all smuts	loose smut	bunt	loose smut	covered smut	Seed/seedling decay
Apron XL	mefenoxam	—	—	—	—	—	**Barley, oat, rye, triticale, wheat.** For protection against seed and seedling rot caused by *Pythium* on grain crops.
Dividend Extreme	difenoconazole	■	■	—	—	—	**Wheat.** Protects against *Fusarium* spp. that are associated with "scabby" seed plus seed and seedling rots caused by *Pythium*.
Dividend XL RTA[b]	+ mefenoxam	■	■	—	—	—	
Enhance	carboxin + captan	■	■	■	■	■	**Barley, oat, wheat.**
Gaucho 600	tebuconazole + metalaxyl + imidacloprid	■	■	■	■	■	**Barley, oat, wheat, triticale.**
Manzate Flowable	mancozeb	■	—	■	—	■	**Barley, oat, rye, wheat.**
Manzate Pro-Stik		■	—	■	■	■	**Barley, oat, wheat, triticale.**
Dithane M-45		■	—	■	■	■	**Barley, oat, rye, wheat.**
Penncozeb 75DF		■	—	■	■	■	**Barley, oat, rye, wheat.**
Maxim 4FS	fludioxonil	■	■	—	—	—	**Barley, oat, rye, wheat.** For control of seed-borne and soil-borne fungi that cause seed decay, damping-off, and seedling blights.
NipsIt SUITE	metalaxyl metconazole	■[c]	■	■	■	■	**Barley, oat, wheat.**
Raxil-thiram	tebuconazole + thiram	—	■	■	—	—	**Wheat.** Protection against *Fusarium* spp. that are associated with "scabby" seed.
Vitavax CT	carboxin + thiram	■	■	■	■	■	**Triticale.**
Vitavax M		■	■	■	■	■	**Triticale.**

[a] This table is intended as a reference guide. Chemicals, combinations, and labels change frequently—check current label for details.

[b] Also labeled for use on triticale.

[c] Loose smut only.

6 PERENNIAL WEED MANAGEMENT

PERENNIAL WEED MANAGEMENT

Perennial weeds are less widespread than annuals but traditionally have been more difficult to manage because they propagate by vegetative means as well as by seeds. Knowing how a plant propagates (tubers, taproots, spreading roots, or rhizomes) is an important first step in designing an appropriate management program. For example, while taprooted weeds like dandelions are eliminated with moldboard plowing, this same tool will not eradicate weeds with spreading roots such as hemp dogbane and Canada thistle or those with rhizomes like quackgrass and wirestem muhly.

This section gives information on common perennial weeds. Table 6-1 (238) provides herbicide considerations on these and other perennial species troublesome in some areas of Wisconsin. Few details regarding herbicide treatments are presented here; consult earlier sections of this bulletin for additional information.

The advent of herbicide-resistant crops opens new avenues for perennial weed management. Herbicides that previously would kill the crop can now be used to tackle difficult-to-control perennials at a more appropriate time of treatment and still have the benefit of crop competition after application. Noticeable long-term reductions in perennial weed infestations have been documented in both University of Wisconsin research trials and by farmers in production fields.

QUACKGRASS

Quackgrass is a persistent perennial weed. Its extensive system of rhizomes (underground stems) and roots represents 60 to 70% of the plant's weight and contains abundant food reserves. Rhizomes enable quackgrass to resprout after mowing or cultivation. Quackgrass is quite sensitive to soil disturbance during the growing season and is most effectively managed by a combination of mechanical, chemical, and cultural control practices. Repeated tillage or herbicide treatment controls quackgrass by depleting food reserves and preventing the production and accumulation of additional reserves. Tillage and cultivation are most effective during periods of warm, dry weather because quackgrass rhizomes brought to the soil surface dry out and die. Late fall cultivation can also be effective as freezing winter temperatures also help kill exposed quackgrass rhizomes. Herbicide recommendations vary according to the season in which control begins, the crop to be planted, and the product(s) to be used.

Accent Q (nicosulfuron) **and Option** (foramsulfuron) *for corn*

Accent Q and Option are postemergence sulfonylurea herbicides that selectively control quackgrass in corn. They are particularly well suited for fields where quackgrass appears in localized areas and where other herbicides are inappropriate or difficult to use in a specific cropping system. These products translocate from the foliage to the rhizomes and do not affect quackgrass through soil uptake. Injury symptoms in quackgrass may appear slowly (7 to 10 days) and action may not be complete until 30 days after application. Quackgrass that emerges after application and any escaping weeds can be controlled with a cultivation 7 or more days after treatment.

Do not cultivate fields before applying Accent Q or Option as this will reduce quackgrass control. Half-rate applications applied to actively growing quackgrass followed by a timely cultivation has consistently given acceptable quackgrass control. We expect similar results with Option. The effects of a single application are usually evident for two or more seasons. The

active ingredient of Accent Q is available in several premixed products and provides acceptable quackgrass control.

Assure II (quizalofop),
Fusion (fluazifop + fenoxaprop),
Poast Plus (sethoxydim),
and Select Max (clethodim)
for soybeans

All of these "graminicides" (grass killers) are labeled for quackgrass control in soybeans. They translocate from the treated foliage into the rhizomes. Assure is generally more active on quackgrass than Fusion, Poast Plus, or Select Max. All of the products reduce quackgrass below the economic threshold and have effects that are evident for more than one season. Do not cultivate 7 days before or after applying any of these products, but cultivating 7 to 14 days later often improves overall weed control. Dry weather or other stress conditions will reduce quackgrass control.

Glyphosate
before planting conventional varieties/ hybrids and on Roundup Ready corn and soybean

Many brands of glyphosate can be applied before planting crops to kill existing vegetation. Glyphosate applied to actively growing quackgrass is rapidly translocated throughout the quackgrass rhizome system. Treat when quackgrass is 6 to 8 inches tall (3- to 4-leaf stage) and actively growing in either the fall or spring. Where possible, treat in the fall rather than in the spring.

The rate to use for quackgrass control depends upon the previous cropping system, level of tillage after application, spray volume, and the concentration of glyphosate in the brand you select. In sites where row crops have been grown and tillage is practiced, 0.75 lb ae/a of glyphosate in 10 gal/a or less of water is usually recommended. For no-till sites and old sods that will not be moldboard plowed, 1.5 lb ae/a is recommended.

Glyphosate can be applied directly to quackgrass in Roundup Ready soybeans and Roundup Ready corn. This method can be used in untreated fields that were tilled before planting. Glyphosate offers little advantage in quackgrass control over selective herbicides in corn and soybeans for the season, but should give better long-term control. When glyphosate is used for annual weed control in Roundup Ready crops, rates of 0.75 lb ae/a usually give excellent quackgrass control as well.

Symptoms of injury to quackgrass may not occur until 7 to 10 days after application. Cool, cloudy weather after treatment slows the appearance of symptoms. The effects of a single glyphosate application are usually evident for several seasons, especially in fields that were tilled before planting and/ or row-cultivated after planting.

Some brands of glyphosate can be applied prior to the final alfalfa harvest in the fall or spring to control quackgrass before rotating to another crop. Apply the recommended rate and wait 36 hours or longer before harvesting. No other product can be tank mixed with glyphosate, and tillage will usually be needed to enhance the control of quackgrass and to kill perennial broadleaf species, including alfalfa, before the next crop is planted.

Poast Plus (sethoxydim)
and Select (clethodim)
for alfalfa and trefoil

These are the only grass-specific herbicides approved for use in alfalfa and trefoil. Symptoms develop slowly on quackgrass, but active growth ceases upon application and within 10 to 21 days the stems are easily pulled from treated plants, indicating they are dying. Poast Plus and Select suppress quackgrass significantly in the first cutting of forages but the long-term effects are less evident in alfalfa than in soybeans followed by tillage.

WIRESTEM MUHLY

Unlike most of our weeds, wirestem muhly is native to North America. It has increased in importance in Wisconsin in recent years. This is due to several factors, including less tillage, enhanced control of other species, loss of diversity in crop rotations (especially fewer forages), and the production and spread of wirestem muhly seeds. Because wirestem muhly is a warm-season species, growth starts later in the spring than for quackgrass and other cool-season plants. Wirestem muhly rhizomes grow

near the surface; therefore, shallow tillage can be effective in suppressing this weed. Vigorous tillage done just as growth begins in the spring has been observed to yield the best results.

Control in soybeans

Wirestem muhly is easily controlled with postemergence applications of Assure II, Fusion, Poast Plus, or Select Max. Use a crop oil concentrate and treat when wirestem is 6 to 8 inches tall and actively growing. Planting Roundup Ready soybean varieties and using glyphosate as a postemergence treatment is another option. This may even be practical in no-till systems because wirestem emerges later and grows more slowly in the spring than quackgrass.

Control in corn

Wirestem muhly control is very challenging in corn. Try to achieve effective suppression before planting corn with appropriate control measures the prior season. Accent and Option applied to wirestem 4 to 8 inches tall gives acceptable wirestem suppression. Planting a Roundup Ready corn hybrid and applying glyphosate as a postemergence treatment is another way to suppress wirestem muhly. Two applications of Liberty in Liberty Link hybrids also show promise on this weed. All treatments will give better control if the field is vigorously cultivated 10 or more days after application.

Control in other crops

Wirestem muhly is often an unnoticed weed in alfalfa fields. Use a fall application of glyphosate the year before rotating from alfalfa to corn or other crops. Planting wheat in fields with wirestem muhly can be as effective as the tillage prior to seeding wheat will reduce the rhizome mass and wheat will compete very effectively with wirestem because it grows vigorously in the spring. After wheat harvest, use a combination of glyphosate and tillage to further reduce the infestation.

YELLOW NUTSEDGE

Yellow nutsedge is a persistent perennial weed that reproduces by seed and tubers (nutlets) produced on its rhizome system. Each nutsedge plant can produce nearly 7,000 tubers in a single season. If not controlled, an acre may contain more than 30,000,000 tubers in the upper 10 inches of the soil. The best control strategy is prevention, early detection, and removal. While most tubers develop into new plants the next year, many can remain dormant in the soil for several years. Yellow nutsedge is usually found as isolated patches, in low wet areas, and in soils with high amounts of organic matter, but populations can also establish in upland mineral soils and infest entire fields.

Yellow nutsedge control is feasible in some crops, difficult in others, and nearly impossible in small grains and established forages. Tillage is an essential part of yellow nutsedge management. While the best combination of tillage and chemical treatment may not always provide full-season control, it can suppress nutsedge during the critical period of competition. Many soil-applied herbicides lose much of their effectiveness when applied to the high organic matter soils where yellow nutsedge is often found. Postemergence treatments are not affected by soil texture or organic matter levels and are especially appropriate when nutsedge occurs in patches of fields. In no-till cropping systems, use postemergence strategies to suppress nutsedge because preplant incorporation cannot be done and preemergence applications give inconsistent control.

The following herbicide treatments provide varying degrees of nutsedge control. Individual treatments may be used only on specific field crops as listed.

Acetochlor, Alachlor, Dual II Magnum (s-metolachlor), **and Outlook** (dimethenamid-P)
for corn and soybeans

These herbicides are chemically related. *Acetochlor can only be used in corn* but the others are registered for use in corn and soybeans. All give adequate nutsedge suppression when applied as preplant-incorporated treatments, but preemergence applications will give adequate suppression only if abundant rainfall occurs within 5 to 8 days of treatment. Dual often provides better late-season control of nutsedge than the other herbicides. Rates of these products will usually be higher than those needed for annual weeds. Alachlor and acetochlor

are more active on yellow nutsedge in muck soils than the other products in this group.

Authority premixes (sulfentrazone)
for soybeans

All three Authority premixes—Authority Assist, Authority First/Sonic, and Authority MTZ—are labeled for nutsedge control. Apply prior to soybean cracking, or significant crop injury will occur.

Basagran (bentazon)
for corn, soybeans, and dry or succulent beans

Basagran applied to actively growing nutsedge that is 6 to 8 inches tall provides good suppression in corn, soybeans, and dry or succulent beans. A repeat application may be made 7 to 10 days after the first application if necessary, or the field may be cultivated 10 to 21 days after the first application. Do not apply when either the crop or nutsedge has been exposed to prolonged drought or during periods of unseasonably cold weather as poor weed control will result. Do not cultivate fields within 5 days before or after Basagran treatment. Basagran can be tank mixed with several herbicides and is sold as a premix with some other products for simultaneous application in corn and soybeans. Nutsedge suppression is not usually affected by these mixtures.

Classic (chlorimuron)
for soybeans

Classic is the only sulfonylurea with significant activity on nutsedge in soybeans. Treat when nutsedge is 2 to 4 inches tall and cultivate 14 or more days after treatment if needed.

Permit (halosulfuron)
for corn

Permit is a sulfonylurea applied to corn as a postemergence treatment that gives good to excellent nutsedge control. Use a crop oil concentrate to assure maximum performance and apply Permit when nutsedge is 4 to 12 inches tall. The label indicates that 1.0 to 1.33 oz/a are needed to control nutsedge and 0.67 oz/a to suppress it. However, our data show excellent control even at the 0.67 oz rate. We suggest using 0.67 to 1.0 oz/a and treating when nutsedge averages 8 to 10 inches tall. By waiting for it to reach this height, few additional plants should appear after application. However, a timely row cultivation is recommended to ensure full-season control. The premixture of halosulfuron and dicamba (Yukon) also controls yellow nutsedge.

PERENNIAL BROADLEAF CONTROL IN GLYPHOSATE-RESISTANT CROPS

The advent of Roundup Ready crops opens a new opportunity to control several perennial broadleaf species selectively in the growing crop. This means we can obtain good to excellent suppression of perennial weeds like hemp dogbane, Canada thistle, milkweed, Jerusalem artichoke, field and hedge bindweed, and perennial sowthistle that can last for several seasons. We seldom expect such results from the alternatives available in conventional varieties or hybrids. Our research on glyphosate-resistant corn and soybeans has led to the following suggestions to manage perennial broadleaf weeds in glyphosate-resistant crops.

- Plant the crop without tillage. Tillage delays the development of perennial weeds, while in a no-till system the weed grows rapidly and reaches the ideal growth stage for treatment sooner than if tillage were done.
- Delay the application until the bud stage on the perennial broadleaf weed or until the weed is 24 to 30 inches tall, whichever occurs first. Apply these guidelines to the most advanced plants in the population.
- The right time to treat perennial broadleaves is often 5 to 7 weeks after planting, when the soybeans are in the V4 to V6 growth stage. This is later than when annual weeds would normally be treated. However, this later timing (bud stage) is often the best time for perennials because herbicide movement from the treated foliage to the roots is maximized.

- To avoid crop yield loss due to uncontrolled annual weeds while waiting to treat perennial broadleaves, apply as a tank mixture with the burndown treatment before planting. Select the preemergence herbicide based on the expected annual weed population.
- In fields with perennial broadleaf weeds where tillage has been done, apply a reduced rate of a preplant incorporated or preemergence herbicide. It may take longer for the perennial species to reach the flowering stage in these fields.
- Application timing is more important than rate. Our research has shown that applying 0.75 to 1.0 pounds of acid equivalent per acre of glyphosate to actively growing perennial weeds in the bud to early flower stage gives excellent control the season of application with greatly reduced weed populations the next year.
- Split applications of glyphosate are not necessary. Control from a single treatment when perennial broadleaves begin to flower is as effective as repeated treatments. This means that no additional trips through fields with perennial broadleaf weeds should be needed.
- Uniform coverage of the weed foliage is as important as it is difficult. As mentioned, weed height is seldom uniform in a population of perennial broadleaves. Select the appropriate nozzles and adjust the boom height to cover the weed foliage as uniformly as possible. Remember that boom height also affects the risk of particle drift from the target area.
- Monitor the population of the perennials in following years and use an appropriate management program if/when perennials again reach threshold levels.

CANADA THISTLE IN CONVENTIONAL GRAIN CROPS AND PASTURES

Canada thistle infests croplands, pastures, fencerows, ditch banks, and roadsides. It has increased noticeably in recent years, particularly on our roadsides and in reduced tillage fields. While infestations can start from seed, most shoots emerge from the extensive horizontal and vertical root system. Roots may penetrate to 10 feet deep and spread horizontally 15 feet or more. Single plants form either male or female flowers, and a patch of Canada thistle plants usually consists of only one flower type. The degree of spininess, the extent of leaf lobing, leaf width, and flower color may differ among Canada thistle plants. For example, in Wisconsin we have both purple- and white-flowered biotypes of Canada thistle.

Repeated mowing should at least prevent Canada thistle from spreading to new areas and will probably reduce the area infested. Tillage is more effective than mowing because it exposes roots to drying or freezing conditions and also prevents the buildup of food reserves in the roots. Realize however that tillage may spread the roots to previously uninfested parts of the field. Combining mechanical and chemical controls often gives the best results.

Dicamba (Banvel/Clarity/ Status) and 2,4-D

for corn and small grains

Even though dicamba and 2,4-D are systemic herbicides, a single application will not kill the entire root system. This is especially true in corn and small grains because the rates that can be safely applied and the time of application will not give long-term control of Canada thistle. Status contains dicamba and diflufenzopyr; it can be used in corn and gives results equivalent to dicamba alone on several perennial broadleaf weeds.

Glyphosate

between crops

An effective time to use glyphosate for Canada thistle control is after harvesting wheat or oats for grain or an early-season vegetable crop like peas or sweet corn. This

allows treatment at an effective rate when the thistles have regrown and are actively translocating food reserves to the root system.

Milestone (aminopyralid)
for pastures

Milestone, a relatively new herbicide, has shown the best results in suppressing Canada thistle in Wisconsin. Apply treatments at the flower bud stage in the spring or in the fall to resprouting rosettes. Research has shown that fall treatments can be applied as long as plants appear to be actively growing and have green leaves. Similar to Stinger, the results of one application are evident for 2 to 3 years.

Follow rotational crop and drift control guidelines carefully as this herbicide can persist in the soil for over a year and inhibit growth of broadleaf plants, especially legumes. Specifically forage clovers are not recommended for 1 year after planting; the label also recommends conducting a soil bioassay prior to establishing. Some broadleaf weeds are fairly tolerant to Milestone (plants in the carrot family). If one wishes to control these weeds, mixing 2,4-D with Milestone (prepackaged and sold as ForeFront) or metsulfuron (prepackaged as Chaparral) are effective options.

Stinger (clopyralid)
for corn, small grains, and pastures

While Stinger can be applied in the same crops as Banvel and 2,4-D and has the same mode of action, only a single application is needed for good to excellent Canada thistle suppression. The effects of a single treatment are usually evident for several years. The rate can be adjusted according to thistle density. Apply higher rates in dense thistle areas because there are more roots with buds than in areas where infestations are light to moderate. Apply Stinger when nearly all plants have emerged and Canada thistle is in the rosette to prebud stage (plants are usually 4 to 18 inches tall).

Stinger persists in the soil several months after application. Follow rotational crop and drift control guidelines carefully. The relatively high price of Stinger compared to other herbicides is often justified because the cost can be spread over several years since annual treatments are not needed and usually only a small proportion of a given field needs treating. Stinger can be tank mixed with 2,4-D or dicamba for a more economical treatment. Other premix herbicides used in corn that contain clopyralid and would aid in thistle control include SureStart, TripleFLEX, and Hornet.

HEMP DOGBANE IN CONVENTIONAL CROPS

Hemp dogbane has both vertical and horizontal roots. Plants often spread within fields and from field to field because farmers inadvertently transport a piece of the perennial root to new locations, producing new dogbane colonies.

Plants may flower but establishment from seed is of minor importance. Studies in Kansas found that plants originating from seeds and grown for 2 years without competition formed vertical roots nearly 14 feet deep and horizontal roots that extended almost 40 feet in diameter. Six to 8 weeks after seed germination, hemp dogbane is considered "established" because it can then reproduce vegetatively from the root. Once established, dogbane grows much more rapidly than corn or soybeans, especially in no-till systems. We can use this to our advantage because most postemergence treatments are more effective on larger rather than smaller plants and in no-till fields the weed develops more rapidly than in plowed fields. Thus plants can be treated sooner in the season before significant crop losses from competition have occurred.

Glyphosate applied at 0.75 to 1.5 lb ae/a in glyphosate-resistant soybean or 0.75 to 1.125 lb ae/a in glyphosate-resistant corn crops should be effective for controlling hemp dogbane. Select rates based on size of dogbane plants, size of dogbane patches, and environmental conditions that may influence glyphosate activity.

Dicamba (Banvel/Clarity) and 2,4-D
for corn and small grains

Dicamba and 2,4-D have very good activity on hemp dogbane. They are more effective on this weed at the rates we can use in corn and small grains than they are on Canada thistle. In a between-crops situation, Iowa State researchers applied 1.0 lb

ai/a of 2,4-D and observed 97% dogbane control 1 year after application. University of Illinois weed scientists observed a 60% reduction in dogbane infestation from a 0.5 lb ai/a application of 2,4-D in corn with seven to eight leaves and dogbane in the early flower stage.

Hemp dogbane is listed on many brands of 2,4-D. However, labels require the use of drop nozzles once corn is more than 8 inches tall. This is a serious problem because it is often too early to treat the dogbane effectively since some plants have not yet emerged and those that have are translocating very little material to the roots. When most hemp dogbane has emerged and plants are in the bud stage, the weed is usually much taller than the crop and drop nozzles will not give effective control. Dogbane is more likely to be at the proper growth stage when no-till corn is 6 to 8 inches tall than when conventional or reduced tillage is used.

Even though these products are systemic herbicides, a single application will not kill the entire root system. Ester formulations of 2,4-D are preferred over amine formulations but both are effective. In most cases, 2,4-D and dicamba give similar results on dogbane but occasionally 2,4-D is more effective. A tank mix of these products can be applied. Status herbicide contains dicamba and diflufenzopyr; it can be used in corn and gives results equivalent to dicamba alone on several perennial broadleaf weeds. Cultivation after treatment in corn will further weaken the plants. Cultivators with sweeps will be more effective than those with points or narrow shovels.

Glyphosate
between crops

As with Canada thistle, a good opportunity to use glyphosate for hemp dogbane control is after harvesting wheat or oats for grain or an early-season vegetable crop like peas or sweet corn. This allows treatment with an effective rate when the dogbane has regrown and is actively translocating food reserves to the root system.

Starane (fluroxypyr)
for small grains and corn (field or sweet)

Starane applied postemergence effectively controls hemp dogbane. The use of Starane in small grains was described previously. In field or sweet corn, apply Starane up to the V5 growth stage. Do not apply Starane once corn has six or more visible leaf collars.

Table 6-1. Summary of herbicides for perennial weed suppression in corn and soybeans

Weed	Time of application	Corn	Soybeans
Bindweeds	post	dicamba	Flexstar
		glyphosate[a]	glyphosate[a]
		Status	Ultra Blazer
		2,4-D	
Canada thistle	between crops	glyphosate	glyphosate
	post	dicamba	Basagran + Ultra Blazer
		glyphosate[a]	glyphosate[a]
		Status	
		Stinger	
		2,4-D	
Dandelion	post	dicamba	Classic
		Ignite[b]	glyphosate[a]
		Status	Synchrony
		Steadfast Q	
		Stinger	
		2,4-D	

(continued)

[a] These applications can only be made to Roundup Ready varieties/hybrids with brands of glyphosate clearly approved for use in these varieties/hybrids.

[b] Apply only in Liberty Link hybrids. A split application will give the best results.

Table 6-1. Summary of herbicides for perennial weed suppression in corn and soybeans *(continued)*

Weed	Time of application	Corn	Soybeans
Hemp dogbane	between crops	glyphosate	glyphosate
	post	dicamba	glyphosate[a]
		glyphosate[a]	
		Starane	
		Status	
		2,4-D	
Milkweed, common	between crops	glyphosate	glyphosate
	post	dicamba + 2,4-D	Cobra/Phoenix
		glyphosate[a]	glyphosate[a]
		Permit/Yukon	Ultra Blazer
		Status	
		2,4-D	
Perennial sowthistle	between crops	glyphosate	glyphosate
	post	dicamba	glyphosate[a]
		dicamba + 2,4-D	
		glyphosate[a]	
		Status	
		Stinger	
Quackgrass	preplow/preplant	glyphosate	glyphosate
	post	Accent Q	Assure II
		glyphosate[a]	Fusion
		Option	glyphosate[a]
			Poast Plus
			Select
Wirestem muhly	preplow/preplant	glyphosate	glyphosate
	post	Accent Q	Assure II
		glyphosate[a]	Fusion
		Ignite[b]	glyphosate[a]
		Option	Poast Plus
		Steadfast Q	Select
Yellow nutsedge	preplant/preemergence	acetochlor	Authority Assist
		alachlor	Authority First/Sonic
		Dual	Authority MTZ
		Outlook	alachlor
			Dual
			Outlook
	post	Basagran	Basagran
		Permit/Yukon	Classic

[a] These applications can only be made to Roundup Ready varieties/hybrids with brands of glyphosate clearly approved for use in these varieties/hybrids.

[b] Apply only in Liberty Link hybrids. A split application will give the best results.

7

STORED GRAIN INSECT MANAGEMENT

STORED GRAIN INSECT MANAGEMENT

On-farm infestations of small grains are due primarily to insect-infested equipment and storage facilities and grain molds that attract fungus-feeding beetles. The best approach to this problem is to start with clean, dry grain and clean equipment and bins.

Grain containing cracked kernels, weed seeds, or other foreign material tends to become infested more readily than sound, clean grain.

BIN PREPARATION

Clean out the bin. Never put new grain on top of old grain. Remove all grain and debris from inside and outside bins well in advance of the harvest. This includes feed sacks, cardboard sheets and boxes, boards, and accumulations of grain, crusted grain, and dust. These products harbor the eggs, larvae, pupae, and adults of "bran bugs" and "grain moths." Use brooms, vacuum cleaners, hoes, or other scrapers to do a thorough job. Make sure you wear an approved dust and mold filtering mask while cleaning bins.

Avoid storing grain near animal feeders, feedrooms, or in livestock dwellings. These areas may harbor stored grain pests. Either feed the first few bushels from the combine to livestock or discard them. The old grain left in the combine could be infested.

Patch all holes in the bin to bar entry by birds and rodents. Make sure the roof does not leak.

RESIDUAL BIN SPRAYS AND EMPTY-BIN FUMIGATION

After bins are emptied and cleaned, spray the inside surfaces to the point of runoff with an insecticide approximately 2 weeks prior to harvest. Apply one of the following insecticides to the walls, ceilings, roof, and floors of all bins that will be used to store small grains for more than a few weeks:

- Bin applications of Storcide (chlorpyrifos-methyl plus cyfluthrin) should be applied only from outside the bin (see product label). Dilute 1.69 fl oz Storcide with water to make a 1 gallon of solution. Apply finished spray at the rate of 1 gallon/1,000 square feet before storing or handling grain.
- 8 ml Tempo SC Ultra (cyfluthrin) per 1,000 square feet in sufficient water (about 1.5 pint/1,000 square feet) to adequately cover the area without causing dripping or runoff (see product label). **Note:** *Never apply Tempo directly to any grain.*
- 1 pound Insecto dust (diatomaceous earth) per 1,000 square feet (see product label).
- Chloropicrin fumigant for subfloor plenum. Use restricted to certified grain fumigators.

Spray all cracks and crevices and around doors. The plenum beneath nonremovable perforated floors can harbor many insects and is difficult to treat. While directing extra spray through the perforations will kill some of the insects in this grain debris, it will not kill enough for satisfactory control. Thus, you will either have to fumigate or remove the subfloor to clean out grain debris. Spray the outside bin walls to a height of 6 feet and spray the ground out to a distance of 6 feet from the bin foundation.

Do not let the insecticide spray mix stand overnight; it may break down and result in poor control.

Spraying or fumigating empty bins is only a part of the program for preparing bins for harvest. Before bins are sprayed, they must be thoroughly cleaned. In addition, money spent spraying empty bins is wasted if the grain placed in the bin is not managed properly and is allowed to go out of condition.

GRAIN PROTECTION WITH INSECTICIDES

In Wisconsin clean, dry grain suffers little, if any, damage on the farm during the first season's storage if (1) the preceding suggestions on bin sanitation and residual sprays are followed, (2) the grain is not stored close to livestock feed or other grains that are contaminated with insects, and (3) aeration is used to cool the grain and prevent insect feeding and reproduction.

A grain protectant should be used if the grain will be held beyond June 1 of the following year. However, a grain protectant will not protect grain from insects that feed on molds, such as the foreign grain beetle. A grain moisture of 14 to 18% is favorable for most stored grain insects. Insects that feed on mold prefer the high moisture ranges. Thus, proper grain drying and bin aeration are integral parts of managing stored grain insects. To help bin aeration, do not overfill bins; it hinders uniform air flow during aeration and makes it harder to inspect and treat the grain. Level the grain and allow at least 8 inches between the grain surface and the tip of the bin wall.

Drying grain to 12 to 13% moisture is unfavorable for most grain insects and allows prolonged persistence of protectant insecticides added while the grain is being binned.

Actellic 5E (pirimiphos-methyl)
for corn and popcorn

Actellic will control malathion-resistant Indian meal moths. It should provide 9 to 18 months residual activity depending upon grain moisture and temperatures. Apply 8.6 to 11.5 fl oz Actellic in 5 gal of water/1,000 bu corn. Do not apply before high-temperature drying. *Do not apply Actellic to barley, oats, rye, wheat, or soybean.*

Liquid protectants can be applied as sprays or with a "drip-on" applicator while grain is being placed in storage.

Diacon II (methoprene)
for barley, corn, oat, and wheat

Diacon is labeled as a stored grain treatment. Unlike traditional insecticides, Diacon II does not kill adult insects. This insect growth regulator interferes with the development of young insects, preventing breeding by adult beetles and moths. Dilute Diacon II with water or FDA-approved food grade oils or soybean oil. For maximum residual and efficacy, apply at 5 ppm. See product label for application methods and finished spray concentrations by grain type.

Storcide (chlorpyrifos-methyl + cyfluthrin)
for barley, oat, and wheat

Dilute Storcide with water or FDA-approved food-grade mineral oil or soybean oil and apply to the moving grain stream as a coarse spray to give a deposit of 3 ppm of chlorpyrifos-methyl and 2 ppm of cyfluthrin on the grain (see product label). Final spray volume with water solutions is 5 gal liquid/1,000 bu of grain. Final spray volume with oil solutions should be applied at rates given by the oil manufacturer.

GRAIN SURFACE SPRAY

Once grain is in the bin, surface treatments only are effective against insects feeding at the grain surface. Malathion is registered for such use, but the major grain surface feeder is the Indian meal moth, a species with widespread resistance to malathion. Because of this, malathion is of questionable value for such applications. The following products are suggested for use as surface treatments.

Actellic 5E (pirimiphos-methyl)
for corn

Actellic 5E may be used as a surface treatment in stored corn and will control Indian meal moths, beetles, and weevils. *Do not apply Actellic to barley, oats, rye, wheat, or soybean. Actellic can be used on corn only once during the entire storage period, regardless of the method of use.*

Diacon II (methoprene)
for barley, corn, oat, and wheat

Diacon is labeled as a surface treatment and as a total grain treatment. This insect growth regulator prevents breeding by beetles and moths; it does not kill adult insects. Dilute with water or food-grade oils or soybean oil.

DiPel (*Bacillus thuringiensis*)
for corn, soybean, and small grains

DiPel is a biological insecticide that contains a naturally occurring bacterial organism that kills moth larvae. It is labeled for surface treatment for control of Indian meal moth. This insecticide will not control beetles, weevils, or bran bugs.

Storcide (chlorpyrifos-methyl + cyfluthrin)
for barley, oat, and wheat

Storcide may be used as a surface treatment on wheat, oat, or barley if the entire grain mass is not treated. Mix 3.13 oz of Storcide for wheat, 1.7 oz for oat, or 2.5 oz for barley with 2 gal water for each 1,000 sq ft of grain surface. Make a split application, spraying half of the mixture to the grain surface and raking it in to a depth of 4 inches. Apply the remaining half of the mixture to the raked, treated surface.
Note: *Storcide can be used on grain only once during the entire storage period, regardless of the method of use.*

INDIAN MEAL MOTH

This insect is a problem in portions of Wisconsin. The adult (moth) does no damage, but the larvae feed in the upper few inches of the grain mass and will web the grain together. If populations are great, the surface will be crusted, protecting the larvae from surface-applied insecticides or fumigants. This pest has developed resistance to malathion in many areas. There are a few alternatives to malathion that are specific to stored grain: dichlorvos; Storcide (small grains); Actellic 5E (corn); and *Bacillus thuringiensis* and diatomaceous earth (corn, soybean, and small grains).

- A preventive treatment is to suspend one dichlorvos (DDVP, Vapona) resin strip per 1,000 cubic feet of space over the stored grain. This technique is effective against adults only. The strip must be hung before moths begin to emerge in early spring and usually must be replaced every 6 weeks. During the first season of storage, the strips should be hung immediately after small grains are binned.
- DiPel is a biological insecticide that contains a naturally occurring bacterial organism (*Bacillus thuringiensis*) that attacks moth larvae. It can be used to control Indian meal moth larvae. It will not control adult moths, nor will it control weevils or beetles. Consult the product label for rates and special application instructions.
- Insecto diatomaceous earth is labeled as a surface treatment for Indian meal moth and may be used on feed grains, wheat, barley, corn, oats, and soybean. Insects that come in contact with the product are scraped by the microscopic particles. They lose their body fluids, become dehydrated, and die. This is a physical control, so insects have difficulty building up resistance.

Before applying a grain surface treatment for Indian meal moth, remove webbing or crusted or spoiled grain. Follow application instructions for insecticides listed in the "Grain Surface Spray" section.

It may take several weeks for grain surface treatments to control an Indian meal moth infestation. You may want to hire a fumigator for faster results. If you'll be keeping the grain in storage, treat the grain surface with an appropriate insecticide listed under the "Grain Surface Spray" section to prevent reinfestation once it is safe to enter the bin after fumigation.

GRAIN INSPECTION

Stored grain must be inspected every 2 to 4 weeks from May through October and at least monthly from November to April. If infestations are detected early, they can be controlled before extensive damage occurs.

Check various areas of the grain mass with a grain probe. Sift the grain samples through a screen (10 to 12 mesh to the inch) to separate the insects from the grain. If insects are found, fumigation may be necessary.

Probe traps and pitfall traps can be used for monitoring the grain mass, and sticky pheromone traps can be used to monitor flying moths. It also is important to probe the grain in several locations to monitor grain temperature and moisture.

SAFETY PRECAUTIONS

Stored grain, especially flowing grain, presents many hazards. Following is a list of important safety precautions (adapted from the University of Illinois *Pesticide Training Manual for Grain Facility Pest Control Applicators*).

- Do not enter a bin of flowing grain.
- Do not enter a bin to break a crust or remove a blockage when unloading equipment is running, whether or not grain is flowing. Restarted flow is a hazard.
- Before entering a bin, lock out the circuit controlling the unloading equipment and post a warning so no one else starts the equipment.
- Do not enter a bin without knowledge of previous grain removal practices, especially if crusting is evident.
- Do not trust a surface crust to remain intact.
- Do not depend on a second person to start or stop equipment according to shouted instructions. Equipment noise can prevent communication. The second person may be unable to complete the task soon enough.
- When entering a bin that contains poor quality grain or when unloading history is unknown, have two workers outside the bin. The person in the bin should wear a safety rope. The companions outside the bin should be able to lift him or her out without entering the bin. One outside companion cannot do this. And having two companions present allows one to administer first aid while the other goes for help.
- Always wear a particle respirator capable of filtering fine dust and mold spores when working inside a bin; grain dust and molds are a health hazard.
- Keep children away from equipment, vehicles, and flowing grain.
- Avoid working in overfilled, peaked bins; crawling about in these bins can cause grain flows that block exits.
- Maintain proper and effective shields and guards on hazardous equipment.

CONTROLLING ESTABLISHED INFESTATIONS

To date, most insect problems in grain stored on Wisconsin farms are the result of improper storage. The development of grain molds makes stored grain attractive to foreign and flat grain beetles.

When insects are found in stored grains, you must first correct storage conditions that allow the grain to deteriorate and then determine whether the infestation warrants control. The importance of an insect infestation is determined not only be the number of insects present, but also by type of grain, insect species, time of year, grain temperature and moisture, the planned length of storage, market potential, and local elevator quality and dockage guidelines. Insect-damaged kernels may result in price discounts. Consider too that insect populations and their damage can increase rapidly. Table 7-1 lists the Federal Grain Inspection Service (FGIS) standards for grain infestation that will be in effect until further notice, but local elevators usually enforce more stringent standards.

If you find insects in stored grain, consider several possible management options. Sometimes the most profitable option may be to clean and sell the grain immediately without any chemical treatment. Immediate sale is especially appropriate where early stages of insect infestations are detected before insect numbers reach elevator dockage or discount levels.

Sometimes insect problems are limited primarily to the surface or central core of stored grain. If Indian meal moth is the only problem, you can control light infestations by using Actellic (corn), Storcide (small grains), or DiPel (corn, soybean, small grains) in conjunction with dichlorvos strips as outlined in the section on the Indian meal moth. Where abundant webbing indicates

Table 7-1. The number of live insects required for FGIS designation as infested

Crop	Insect density/kg of grain
wheat, rye	Two or more live insects that are injurious to stored grain
barley, corn, oats	More than one live weevil, *or* One live weevil plus five or more other live pest insects, *or* No live weevils but 10 or more other live pest insects

a severe infestation, rake webbing from the surface before treatment; fumigation may be necessary in this situation. Where bran bugs are the problem and are confined primarily to a central core of fine material, remove one or two loads of grain to extract that core, allowing safe storage of the remaining grain.

Where infested grain can be moved to a clean bin, transfer and treatment with a protectant insecticide is recommended. If possible, use a grain cleaner during the transfer process. Protectant insecticides will not immediately kill immature insects within grain kernels, but residues eventually provide control and protect against reinfestation for a period dependent upon grain moisture and temperature.

FUMIGATION

Infested grain that cannot be treated successfully in any other way should be fumigated. Fumigation of farm-stored grain is difficult, hazardous, and requires special training and equipment.

You must receive supplemental certification to apply fumigants. If you are a certified private applicator, you must receive additional certification in the Agricultural Fumigation subcategory. Commercial applicators must be certified in the Space and Commodity Fumigation category.

All fumigants are extremely toxic and dangerous if improperly used. Use them in strict accordance with label directions and follow all safety precautions. Failure to follow all label instructions is unsafe and illegal.

Always work in pairs; an observer should be present outside the bin. Labeling requires the use or availability of a self-contained breathing apparatus for respiratory protection during one or more stages of the fumigation process. Fumigators also must measure fumigant gas concentrations to determine that the fumigant has dissipated sufficiently before unprotected persons can enter the fumigated space. Follow specific label directions concerning respiratory protection equipment and gas detection devices. If you are uncertain about the safe use of a fumigant, contact the manufacturer for detailed instructions.

These steps are suggested for fumigation:

1. Level the grain; the grain surface must be 8 inches or more below the bin lip to allow good aeration plus sufficient space for inspection and treatment. Remove or break up any caked or crusted area.
2. Use tape and plastic sheeting to thoroughly seal all cracks and holes in the bin, including eaves, hatches, side doors, unloading auger shaft, and fan openings. Leave only the necessary access openings to seal after fumigant application.
3. Fumigate on a still day when the grain temperature is above 60°F. Wind causes rapid leakage of the gas and will reduce the effectiveness of the fumigation.
4. The method of application will vary with the type of fumigant, commodity, and storage facility. Apply the product at labeled rates and follow all safety precautions.

   Chloropicrin. The primary use of this heavier-than-air fumigant will be to control insects in the subfloor area of empty bins.

   Phosphine. This is available in solid formulations of aluminum or magnesium phosphate and is used for fumigation of insect-infested grain. When exposed to heat and moisture, the formulations release phosphine, a highly toxic gas. Even moisture from hands can activate the pellets, so neoprene or cotton gloves must be used.
5. Seal all access doors to the bin. Place warning signs as directed by the fumigant label.
6. Keep the bin closed for at least 72 hours before airing out bins following aluminum phosphide or chloropicrin fumigation. Do not enter the bin during or after fumigation until gases have been thoroughly removed by aeration.

Fumigated grain must be aerated thoroughly before processing or feeding. Once it is aired out, fumigated grain may become reinfested. Surface application of protectant insecticide and/or placement of dichlorvos resin strips should follow fumigation if storage is to continue. If the infestation was a result of poor grain storage practices, these conditions must be corrected.

APPENDIX

Appendix Table 1a. HERBICIDE products and related information

Commercial name	Formulation[a,b]	Common name	Site of inhibition[c]	Manufacturer	RUP[a]	Signal word	REI[a,d]
Accent Q	54.5DF	nicosulfuron + safener	ALS —	DuPont		caution	4 hr
Affinity BroadSpec	25 + 25SG	thifensulfuron + tribenuron	ALS ALS	DuPont		caution	12 hr
Assure II	0.88EC	quizalofop	ACCase	DuPont		danger	12 hr
Atrazine, others	90DF, 4L	atrazine	photosystem II	several	■	caution	12 hr[d1]
Authority Assist	3.33 + 0.67S	sulfentrazone + imazethapyr	PPO ALS	FMC		caution	12 hr
Authority First	62.1 + 7.9DF	sulfentrazone + cloransulam	PPO ALS	FMC		caution	12 hr
Authority MTZ	0.18 + 0.27DF	sulfentrazone + metribuzin	PPO photosystem II	FMC	■	danger	12 hr
Autumn	10DF	iodosulfuron	ALS	Bayer		caution	12 hr
Autumn Super 51 WDG	0.06 + 0.45DF	iodosulfuron + thiencarbazone	ALS ALS	Bayer		caution	12 hr
Banvel	4S	dicamba	auxin	Arysta		caution	24 hr
Basagran	4S	bentazon	photosystem II	Arysta		caution	48 hr
Basis Blend	20 + 10DF	rimsulfuron + thifensulfuron	ALS ALS	DuPont		caution	4 hr
Bicep II Magnum	2.4 + 3.1L	s-metolachlor + atrazine + safener	seedling shoot photosystem II —	Syngenta	■	caution	24 hr[d1]
Bicep Lite II Magnum	3.33 + 2.67L	s-metolachlor + atrazine + safener	seedling shoot photosystem II —	Syngenta	■	caution	24 hr[d1]
Boundary 6.5	5.25 + 1.25L	s-metolachlor + metribuzin	seedling shoot photosystem II	Syngenta		caution	12 hr[d1]
Buctril	4EC, 2EC	bromoxynil	photosystem II	Bayer		warning	24 hr
Bullet	2.5 + 1.5ME	alachlor + atrazine	seedling shoot photosystem II	Monsanto	■	caution	12 hr[d1]
Butyrac 200	2S	2,4-DB amine	auxin	Albaugh		danger	48 hr
Cadet	0.91EC	fluthiacet	PPO	FMC		warning	12 hr
Callisto	4L	mesotrione	pigment	Syngenta		caution	12 hr[d1]
Callisto Xtra	0.5 + 3.2L	mesotrione + atrazine	pigment photosystem II	Syngenta		caution	12 hr
Canopy	64.3 +10.7DF	metribuzin + chlorimuron	photosystem II ALS	DuPont		caution	12 hr
Canopy EX	22.7 + 6.8DF	chlorimuron + tribenuron	ALS ALS	DuPont		caution	12 hr
Capreno	0.57 + 2.88L	thiencarbazone + tembotrione + safener	ALS pigment —	Bayer		caution	12 hr
Chaparral	62.1 9.5DF	aminopyralid + metsulfuron	auxin ALS	Dow		warning	48 hr
Chateau	51WG	flumioxazin	PPO	Valent		caution	12 hr
Cimarron Max	Part A: 60DF Part B: 1 + 2.87S	metsulfuron dicamba + 2,4-D	ALS auxin	DuPont		danger	48 hr
Cimarron Plus	48 + 15DF	metsulfuron + chlorsulfuron	ALS ALS	DuPont		caution	4 hr
Cimarron X-tra	30 + 37.5DF	metsulfuron + chlorsulfuron	ALS ALS	DuPont		caution	4 hr

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(continued)

Appendix Table 1a. HERBICIDE products and related information *(continued)*

Commercial name	Formulation[a,b]	Common name	Site of inhibition[c]	Manufacturer	RUP[a]	Signal word	REI[a,d]
Clarity	4S	dicamba	auxin	BASF		caution	24 hr
Classic	25DF	chlorimuron	ALS	DuPont		caution	12 hr
Cobra	2EC	lactofen	PPO	Valent		danger	12 hr
Crossbow[e]	1 + 2EC	triclopyr + 2,4-D ester	auxin auxin	Dow		caution	—-
Curtail	0.38S + 2.0S	clopyralid +2,4-D amine	auxin auxin	Dow		danger	48 hr
Degree Xtra	2.7 + 1.34 ME	acetochlor + atrazine + safener	seedling shoot photosystem II —	Monsanto	■	caution	12 hr[d1]
Dual II Magnum	7.64EC	s-metolachlor + safener	seedling shoot —	Syngenta		caution	24 hr[d1]
Enlite	2.85 + 36.21 + 8.8DF	chlorimuron + flumioxazin + thifensulfuron	ALS PPO ALS	DuPont		caution	12 hr
Envive	9.2 + 29.2 + 2.9DF	chlorimuron + flumioxazin + thifensulfuron	ALS PPO ALS	DuPont		caution	12 hr
Eptam	7EC, 20G	EPTC	seedling shoot	Syngenta		caution	12 hr[d1]
Escort	60DF	metsulfuron	ALS	DuPont		caution	4 hr
Express	50DS	tribenuron	ALS	DuPont		caution	12 hr
Extreme	0.17 + 2S	imazethapyr + glyphosate	ALS EPSPS	BASF		warning	48 hr
Fierce	33.5 + 42.5	flumioxazin + pyroxasulfone	PPO seedling shoot	Valent		caution	12 hr
FirstRate	84DF	cloransulam	ALS	Dow		caution	12 hr[d1]
Flexstar	1.88S	fomesafen	PPO	Syngenta		warning	24 hr
Flexstar GT 3.5	0.56 + 2.26EC	fomesafen + glyphosate	PPO EPSPS	Syngenta		caution	24 hr
Forefront HL	0.417 + 3.33	aminopyralid + 2,4-D	auxin auxin	Dow		danger	48 hr
Forefront R&P	0.33 + 2.67S	aminopyralid + 2,4-D amine	auxin auxin	Dow		danger	48 hr
Fusilade DX	2EC	fluazifop	ACCase	Syngenta		caution	12 hr
Fusion	2 + 0.66EC	fluazifop + fenoxaprop	ACCase ACCase	Syngenta		caution	24 hr
Gangster FR	84DF	cloransulam	ALS	Valent		caution	12 hr
Gangster V	51DF	flumioxazin	PPO	Valent		caution	12 hr
G-Max Lite	2.25 + 2.75L	dimethenamid-P + atrazine	seedling shoot photosystem II	BASF	■	caution	12 hr[d1]
Gramoxone Inteon	2S	paraquat	photosystem I	Syngenta	■	danger	12 hr[d2]
Guardsman Max	1.7 + 3.3L	dimethenamid-P + atrazine	seedling shoot photosystem II	BASF	■	caution	12 hr[d1]
Halex GT	2.09 + 2.09 + 0.209L	s-metolachlor + glyphosate + mesotrione	seedling shoot EPSPS pigment	Syngenta		caution	24 hr[d1]
Harmony Extra	16.7 + 33.3SG	tribenuron + thifensulfuron	ALS ALS	DuPont		caution	12 hr
Harmony SG	50SG	thifensulfuron	ALS	DuPont		caution	4 hr
Harness	7EC	acetochlor + safener	seedling shoot —	Monsanto		warning	12 hr[d1]

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(continued)

Appendix Table 1a. HERBICIDE products and related information *(continued)*

Commercial name	Formulation[a,b]	Common name	Site of inhibition[c]	Manufacturer	RUP[a]	Signal word	REI[a,d]
Harness Xtra	4.3 + 1.7L	acetochlor + atrazine + safener	seedling shoot photosystem II —	Monsanto	■	caution	12 hr[d1]
Harness Xtra 5.6L	3.1 + 2.5L	acetochlor + atrazine + safener	seedling shoot photosystem II —	Monsanto	■	caution	12 hr[d1]
Hornet WDG	18.5 + 50WG	flumetsulam + clopyralid	ALS auxin	Dow		warning	48 hr[d1]
Huskie	0.3 + 1.75EC	pyrasulfotole + bromoxynil + safener	pigment photosystem II —	Bayer		warning	12 hr
Ignite	2.34S	glufosinate	GS	Bayer		warning	12 hr
Impact/Armezon	2.8L	topramazone	pigment	Amvac		caution	12 hr
Intrro	4EC	alachlor	seedling shoot	Monsanto	■	danger	12 hr[d1]
Journey	0.75 + 1.5S	imazapic + glyphosate	ALS EPSPS	BASF		caution	12 hr
Keystone	3 + 2.25L	acetochlor + atrazine + safener	seedling shoot photosystem II —	Dow	■	warning	12 hr[d1]
Keystone LA	4 + 1.5L	acetochlor + atrazine + safener	seedling shoot photosystem II —	Dow	■	caution	12 hr[d1]
Lariat	2.5 + 1.5L	alachlor + atrazine	seedling shoot photosystem II	Monsanto	■	warning	12 hr[d1]
Laudis	3.5L	tembotrione + safener	pigment —	Bayer		caution	12 hr
Lexar	1.74 + 1.74 + 0.224L	s-metolachlor + atrazine + mesotrione	seedling shoot photosystem II pigment	Syngenta	■	caution	24 hr[d1]
Lorox	50DF	linuron	photosystem II	Griffin		caution	24 hr
Lumax EZ	2.49 + 0.935 + 0.249L	s-metolachlor + atrazine + mesotrione	seedling shoot photosystem II pigment	Syngenta	■	caution	24 hr[d1]
MCPA Amine	various	MCPA	auxin	several		danger	48 hr
MCPA Ester	various	MCPA	auxin	several		caution	12 hr
Metribuzin	75DF	metribuzin	photosystem II	MANA		caution	12 hr[d1]
Milestone	2.0S	aminopyralid	auxin	Dow		caution	12 hr
NorthStar	7.5 + 39.9DF	primisulfuron + dicamba	ALS auxin	Syngenta		caution	12 hr[d1]
Optill	17.8 + 50.2WG	saflufenacil + imazethapyr	PPO ALS	BASF		caution	12 hr
Option	35DF	foramsulfuron + safener	ALS —	Bayer		caution	12 hr
Orion	0.033 + 2.34S	florasulam + MCPA	ALS auxin	Syngenta		caution	12 hr
Outlook	6EC	dimethenamid-P	seedling shoot	BASF		warning	12 hr[d1]
Overdrive	50 + 20DS	dicamba + diflufenzopyr	auxin auxin synergist	BASF		caution	12 hr
Permit	75DF	halosulfuron	ALS	Gowan		caution	12 hr
Phoenix	2EC	lactofen	PPO	Valent		danger	12 hr
Poast	1.5EC	sethoxydim	ACCase	BASF		warning	12 hr
Poast Plus	1EC	sethoxydim	ACCase	BASF		caution	12 hr

Footnotes on page 256.

(continued)

Appendix Table 1a. HERBICIDE products and related information *(continued)*

Commercial name	Formulation[a,b]	Common name	Site of inhibition[c]	Manu-facturer	RUP[a]	Signal word	REI[a,d]
Prefix	4.34 +0.95EC	s-metolachlor + fomesafen	seedling shoot PPO	Syngenta		warning	24 hr
Princep	90DF, 4L	simazine	photosystem II	Syngenta		caution	12 hr[d1]
Priority	12.5 + 50DF	carfentrazone + halosulfuron	PPO ALS	Tenkoz		caution	12 hr
Prowl H_2O	3.8ME	pendimethalin	seedling root	BASF		caution	24 hr[d1]
Pursuit	2S, 70DF	imazethapyr	ALS	BASF		warning	12 hr[d1]
Python	80DF	flumetsulam	ALS	Dow		caution	12 hr[d1]
Rage D-Tech	0.13 + 3.93EC	carfentrazone + 2,4-D ester	PPO auxin	FMC		caution	12 hr
Raptor	1EC	imazamox	ALS	DuPont		caution	4 hr[d1]
Realm Q	7.5 + 31.25DF	rimsulfuron + mesotrione	ALS pigment	Dupont Syngenta		caution	12 hr
Resolve Q	18.4 + 4DF	rimsulfuron + thifensulfuron + safener	ALS ALS —	DuPont		caution	4 hr
Resource	0.86EC	flumiclorac	PPO	Valent		warning	12 hr
Roundup PowerMAX	4.5S	glyphosate	EPSPS	Monsanto		caution	4 hr
Select	2EC	clethodim	ACCase	Valent		warning	24 hr
Select Max	0.97EC	clethodim	ACCase	Valent		warning	24 hr
Sequence	2.25 +3EC	glyphosate + s-metolachlor	EPSPS seedling shoot	Syngenta		caution	24 hr
Sharpen	2.85SC	saflufenacil	PPO	BASF		caution	12 hr
Shotgun	2.25 + 1L	atrazine + 2,4-D ester	photosystem II auxin	Platte	■	danger	12 hr
Sonic	62.1 + 7.9DF	sulfentrazone + cloransulam	PPO ALS	Dow		caution	12 hr
Spartan	4F	sulfentrazone	PPO	FMC		caution	12 hr[d1]
Spike[e]	20G	tebuthiuron	photosystem II	Dow		caution	—-
Starane	1.5EC	fluroxypyr	auxin	Dow		warning	12 hr
Status	40 + 16DF	dicamba + diflufenzopyr + safener	auxin auxin synergist —	BASF		caution	24 hr
Steadfast Q + safener	25.2 + 12.5DF	nicosulfuron + rimsulfuron	ALS ALS	DuPont		caution	4 hr
Stinger	3S	clopyralid	auxin	Dow		caution	12 hr
SureStart	3.75 + 0.29 + 0.12L	acetochlor + clopyralid + flumetsulam	seedling shoot auxin ALS	Dow		caution	12 hr[d1]
Surpass	6.4EC	acetochlor + safener	seedling shoot —	Dow		warning	12 hr[d1]
Synchrony XP	21.5 + 6.9DF	chlorimuron + thifensulfuron	ALS ALS	DuPont		caution	12 hr
Thistrol	2S	MCPB	auxin	Bayer		caution	12 hr
Touchdown	3, 4.17, 5S	glyphosate	EPSPS	Syngenta		caution	12 hr
Treflan	4EC, 10G	trifluralin	seedling root	Dow		caution	12 hr[d1]
TripleFLEX	3.75 + 0.29 + 0.12L	acetochlor + clopyralid + flumetsulam	seedling shoot auxin ALS	Monsanto		caution	12 hr
Ultra Blazer	2S	acifluorfen	PPO	United Phospho-rus		danger	48 hr

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(continued)

Appendix Table 1a. HERBICIDE products and related information *(continued)*

Commercial name	Formulation[a,b]	Common name	Site of inhibition[c]	Manufacturer	RUP[a]	Signal word	REI[a,d]
Valor SX	51DF	flumioxazin	PPO	Valent		caution	12 hr
Valor XLT	30 +10.3DF	flumioxazin + chlorimuron	PPO ALS	Valent		caution	12 hr
Velpar	75DF	hexazinone	photosystem II	DuPont		danger	24 hr
Verdict	0.57 5EC	salflufenacil dimethenamid-P	PPO seedling shoot	BASF		warning	12 hr
Vida	0.208EC	pyraflufen	PPO	Gowan		danger	12 hr
Warrant	3CS	acetochlor	seedling shoot	Monsanto		caution	12 hr
Weedmaster	2.87 + 1S	2,4-D amine + dicamba	auxin auxin	BASF		danger	48 hr
Yukon	12.5 + 50DF	halosulfuron + dicamba	ALS auxin	Gowan		caution	12 hr
Zemax	3.34 + 0.33L	s-metolachlor + mesotrione	seedling shoot pigment	Syngenta		warning	24 hr[d1]
Zidua	85DF	pyroxasulfate	seedling shoot	BASF		caution	12 hr
2,4-D Amine	various	2,4-D	auxin	several		danger	48 hr
2,4-D Ester	various	2,4-D	auxin	several		caution	12 hr

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Appendix Table 1b. INSECTICIDE products and related information

Commercial name	Formulation[a,b]	Common name	Manufacturer	RUP[a]	Signal word	REI[d]
Actellic[e]	5EC	pirimiphos-methyl	Agriliance		danger	—
Alias	4F	imidacloprid	Makhteshim Agan		caution	12 hr
Ambush	2E	permethrin	Amvac, Syngenta	■	warning	12 hr
Asana XL	0.66EC	esfenvalerate	DuPont	■	warning	12 hr
Avicta Complete Corn	seed treatment (nematicide/ insecticide)	abamectin + thiamethoxam	Syngenta	■	warning	12 hr[d1]
Aztec	4.67G, 2.1G	tebupirimphos + cyfluthrin	Amvac, Bayer	■	warning	48 hr[d1]
Baythroid XL	1EC	beta-cyfluthrin	Bayer	■	warning	12 hr
Belay	2.13 L	clothianidin	Valent		caution	12 hr
Belt	4SC	flubendiamide	Bayer		caution	12 hr
Besiege	0.835 + 0.41L	chlorantraniliprole + lambda cyhalothrin	Syngenta	■	warning	24 hr
Brigade	2EC	bifenthrin	FMC	■	warning	12 hr
Capture	1.5LFR	bifenthrin	FMC	■	warning	12 hr
Cobalt Advanced	2.5 + 0.129EC	chlorpyrifos + lambda-cyhalothrin	Dow	■	warning	24 hr
Comite	6.55EC	propargite	Chemtura	■	danger	13 days
Coragen	1.67SC	chlorantraniliprole	DuPont		—	4 hr
Counter[f]	15G	terbufos	Amvac	■	danger	48 hr[d1]
Cruiser	seed treatment	thiamethoxam	Syngenta		caution	12 hr[d1]
Declare	1.25CS	gamma-cyhalothrin + imidacloprid	Cheminova	■	caution	24 hr
Delta Gold	1.5EC	deltamethrin	Agriliance	■	danger	12 hr

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(continued)

Appendix Table 1b. INSECTICIDE products and related information *(continued)*

Commercial name	Formulation[a,b]	Common name	Manufacturer	RUP[a]	Signal word	REI[d]
Diacon II[e]	2.5EC	methoprene	Wellmark Int'l		caution	—
Dimethoate	4EC, 400	dimethoate	several		warning	48 hr
Dipel	DF, ES	*Bacillus thuringiensis*	Valent		caution	4 hr
Endigo	1.18 + 0.88ZC	thiamethoxam + lambda-cyhalothrin	Syngenta	■	warning	24 hr
Force	3G	tefluthrin	Amvac, Syngenta	■	caution	none
Force	CS	tefluthrin	Syngenta	■	warning	12 hr
Fortress[f]	5G	chlorethoxyfos	Amvac	■	danger	48 hr
Gaucho	seed treatment	imidacloprid	Bayer		caution	12 hr[d1]
Hero	1.24EC	beta-cypermethrin + bifenthrin	FMC	■	caution	12 hr
Imidan	70WP	phosmet	Gowan		warning	24 hr
Insecto[e]	90D	diatomaceous earth	Natural		caution	—
Intrepid	2F	methoxyfenozide	Dow		caution	4 hr
Justice	1.0 + 0.8L	acetamiprid + bifenthrin	Gowan	■	warning	12 hr
Lannate[f]	2.4LV, 90SP	methomyl	DuPont	■	danger	48 hr
Leverage	2.7SE	imidacloprid + cyfluthrin	Bayer	■	warning	12 hr
Lorsban[f]	15G	chlorpyrifos	Amvac, Dow		caution	24 hr[d1]
Lorsban[f]	4E, Advanced	chlorpyrifos	Dow	■	warning	24 hr[d1]
Kernel Guard Supreme	seed treatment	permethrin	Bayer		caution	12 hr[d1]
Malathion	57EC	malathion	several		caution	12 hr
Mustang Max	0.8EC	zeta-cypermethrin	FMC	■	warning	12 hr
NipsIt INSIDE	seed treatment	clothianidin	Valent		caution	—
NipsIt SUITE Cereals	seed treatment	clothianidin + metalaxyl + metconazole	Valent		caution	—
Oberon	4SC	spiromesifen	Bayer		caution	12 hr
Orthene	90S	acephate	Valent		caution	24 hr
Penncap-M	2ME	methyl parathion	United Phosphorous	■	warning	11 days[d7]
Phorate	20G	phosphorodithioate	several	■	danger	48 hr
Poncho	seed treatment	clothianidin	Bayer		caution	12 hr[d1]
Pounce	3.2EC	permethrin	FMC	■	caution	12 hr
Sevin XLR Plus	4F	carbaryl	Bayer		caution	12 hr
SmartChoice	5G	chlorethoxyfos + bifenthrin	Amvac	■	danger	48 hr
Stallion	0.275 + 2.75L	zeta-cypermethrin + chlorpyrifos	FMC	■	warning	24 hr
Storcide II[e]	1.92 + 1.28L	chlorpyrifos-methyl + cyfluthrin	Bayer		danger	—
Tempo SC Ultra[e]	1S	cyfluthrin	Bayer	■	caution	—
Tracer	4L	spinosad	Dow		caution	4 hr
Triple Crown	2.25L	zeta-cypermethrin + bifenthrin + imidacloprid	FMC	■	warning	12 hr
Vapona[e]	industrial strip	dichlorvos	several		caution	—
Warrior II	2CS	lambda-cyhalothrin	Syngenta	■	warning	24 hr

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Appendix Table 1c. FUNGICIDE products and related information

Commercial name	Formulation[a,b]	Common name	Manufacturer	RUP[a]	Signal word	REI[d]
Acceleron DX-109	18.4%	pyraclostrobin	Monsanto		caution	12 hr
Actinogrow ST	0.33%	*Streptomyces lydicus*	SimcamAdvan		caution	1 hr
Allegiance Dry	12.5%	metalaxyl	Chemtura		caution	24 hr
Allegiance FL	2.6 FL	metalaxyl	Bayer Crop Science		warning	24 hr
Alto	100 SL	cyproconazole	Syngenta		caution	12 hr
Apron Maxx RFC	2.31% 3.46%	fludioxonil mefenoxam	Syngenta		caution	48 hr
Apron Maxx RTA	0.73% 0.73%	fludioxonil mefenoxam	Syngenta		caution	48 hr
Apron Maxx RTA + Moly	1.02% 0.68%	mefenoxam fludioxonil	Syngenta		caution	48 hr
Apron XL LS	3.3S	mefenoxam	Syngenta		warning	48 hr[d1]
Avicta Duo Corn	12.4% 28.1%	abametin thiamethoxam	Syngenta		warning	4 hr
Bayleton	50DF	triadimefon	Amvac		caution	12 hr
Bean Guard/ Alliance	12.5% 3.75% 24.45%	carboxin metalaxyl captan	Chemtura		danger	24 hr
Bravo Weather Stik	6F	chlorothalonil	Syngenta		caution	12 hr
Bumper	41.8EC	propiconazole	Makhteshim-Agan		warning	24 hr
Captan	5D, 7.5D, 80WP	captan	several		danger	4 days [d3,5]
Caramba	90 SL	metconazole	BASF		warning	12 hr
CruiserMaxx Advanced	21.50% 3.21% 1.07%	thiamethoxam mefenoxam fludioxonil	Syngenta		caution	48 hr
Cuprofix MZ Disperss	30 + 22DF	mancozeb + copper sulfate	Cerexagri		caution	24 hr
Cuprofix Ultra	40DF	copper sulfate	Cerexagri		caution	12 hr
Dithane	75DF, 45F, 45M	mancozeb	Dow		caution	24 hr
Dividend	0.15S, 0.31S	difenoconazole	Syngenta		caution	12 hr[d1]
Domark 230ME	1.9EW	tetraconazole	Isagro		caution	24 hr
Dynasty	9.6%	axoxystrobin	Syngenta		caution	4 hr
Echo	90DF	chlorothalonil	Sipcam Agro USA		danger	12 hr
Echo Zn	4.17F	chlorothalonil	Sipcam Agro USA		warning	12 hr
Echo 720	6F	chlorothalonil	Sipcam Agro USA		warning	12 hr
Enhance	20 + 20D	carboxin + captan	Trace Chemicals		danger	48 hr[d1]
Folicur	3.6F	tebuconazole	Bayer		caution	12 hr
Headline	2.09EC	pyraclostrobin	BASF		warning	12 hr
Headline AMP	13.64% 5.14%	pyraclostrobin + metconazole	BASF		warning	12 hr
Kocide 3000	46.1 DF	copper hydroxide	DuPont		caution	24 hr
Laredo	2EC	myclobutanil	Dow		danger	24 hr
Manzate	4F	mancozeb	DuPont		caution	24 hr
Manzate Flowable	37 FL	EDBC	DuPont		caution	24 hr

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Appendix Table 1c. FUNGICIDE products and related information *(continued)*

Commercial name	Formulation[a,b]	Common name	Manufacturer	RUP[a]	Signal word	REI[d]
Manzate Pro-Stick	75DF	mancozeb	DuPont		caution	24 hr
Maxim[g]	4S	fludioxonil	Syngenta		caution	—
Maxim Quattro	3.32% 2.65% 1.33% 26.50%	fludioxonil mefenoxam azoxystrobin thabendazole	Syngenta		caution	—
Mertect 340	4.1F	thiabendazole	Syngenta		danger	12 hr
Mertect 340-F	42.3%	thiabendazole	Syngenta		caution	12 hr
NipsIt SUITE	2.93% 0.88% 0.44%	clothianidin metalaxyl metconazole	Valent		caution	24 hr
Penncozeb	75DF	mancozeb		24 hr	caution	24 hr
Priaxor	14.33% 28.58%	fluxapyroxad pyraclostrobin	BASF		caution	12 hr
Proline 480	4SC	prothioconazole	Bayer		caution	48 hr
PropiMax	3.6EC	propiconazole	Dow		warning	24 hr[d1]
Prosaro	421 SC	prothioconazole + tebuconazole	Bayer		caution	48 hr
Quadris	2F	azoxystrobin	Syngenta		caution	4 hr
Quadris Ridomil Gold[h]	2F + 4EC	azoxystrobin + mefenoxam	Syngenta		caution	48 hr[d1]
Quadris Xtra	280 SC	azoxystrobin + cyproconazole	Syngenta		caution	12 hr
Quilt	1.04 + 0.62EC	azoxystrobin + propiconazole	Syngenta		warning	12 hr
Quilt Xcel	1.2L + 1.18L	azoxystrobin + propiconazole	Syngenta		warning	12 hr
Rancona Xxtra	0.0916% 1.64 %	ipconazole + metalaxyl	Chemtura		caution	24 hr
Raxil MD	0.039 + 0.051L	tebuconazole + metalaxyl	Bayer		caution	24 hr[d1]
Raxil XT	15 + 20WP	tebuconazole + metalaxyl	Bayer		caution	24 hr[d1]
Raxil-Thiram	0.055 + 1.84F	tebuconazole + thiram	Bayer		caution	24 hr[d1]
Ridomil Gold	5G, 50WP, 4EC	mefenoxam	Syngenta		caution	48 hr[d1]
Ridomil Gold Bravo SC	0.33 SC + 3.34 SC	mefenoxam + chlorothalonil	Syngenta		warning	48 hr
Ridomil Gold Copper	5 + 60WP	mefenoxam + copper hydroxide	Syngenta		danger	48 hr
Stratego	1.04 + 1.04S	propiconazole + trifloxystrobin	Bayer Crop Science		warning	24 hr
Stratego YLD	1.05LS + 3.13LS	prothioconazole + triflozystrobin	Bayer Crop Science		caution	48 hr
T-22 HC	1.15%	*Trichoderma harzianum*	BioWorks		caution	—
Terraclor	4F, 75WP	PCNB	Uniroyal		caution	12 hr[d1]
Thiram	65WP	thiram	Taminco		caution	24 hr

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(continued)

Appendix Table 1c. FUNGICIDE products and related information *(continued)*

Commercial name	Formulation[a,b]	Common name	Manufacturer	RUP[a]	Signal word	REI[d]
Tilt	3.6EC	propiconazole	Syngenta		warning	24 hr[d1]
Topsin M	4.5F + 70WP	thiophanate + methyl	Cerexagri		caution	12 hr
Trilex	22.0%	trifloxystrobin	Bayer Crop Science		caution	12 hr
Twinline	1.083L + 0.67L	pyraclostrobin + metconazole	BASF		warning	12 hr
Vibrance	45.45%	sedaxane	Syngenta		caution	12 hr
Vitavax CT	5.7% 5.7%	carboxin thiram	Helena Chemical		caution	24 hr
Vitavax MDC	23.9% 12.5%	captan carboxin	Helena Chemical		caution	24 hr
Vitavax-200	1.67 + 1.67F	carboxin + thiram	Crompton		caution	24 hr[d1]

FOOTNOTES *for* Appendix Tables 1a–c

[a] CS = capsule suspension; D = dust; DF = dry flowable; DS = dry soluble; EC = emulsifiable concentrate; ES = emulsifiable suspension; EW = emulsifiable in water; F = flowable; G = granular, L = liquid flowable; LV = liquid volatile; ME = microencapsulated; REI = restricted entry interval; RUP = restricted-use product; S = soluble; SC = suspension concentrate; SE = suspension emulsion; SG = soluble granules; WG = wettable granules; WP = wettable powder; WSP = water-soluble packet; ZC = Zeon Concentrate

[b] Numbers before the dry formulations represent percent active ingredient; numbers before liquids represent pounds of active ingredient or ae/gal of product.

[c] Site of inhibition: ACCase = acetyl CoA carboxylase (lipid synthesis inhibitor); ALS = acetolactate synthase (amino acid synthesis inhibitor); auxin = growth regulator; EPSPS = 5-enolpyruvylshikimate-3-phosphate synthase (amino acid synthesis inhibitor); GS = glutamine synthetase (nitrogen metabolism inhibitor); photosystem I = cell membrane disrupter; photosystem II = photosynthesis inhibitor; pigment inhibitor = isoprenoid pathway; PPO = protoporphyrinogen oxidase (cell membrane disrupter); seedling shoot = seedling shoot growth inhibitor; seedling root = seedling root growth inhibitor

[d] REI as required by the Worker Protection Standard (WPS) to protect agricultural workers and handlers of agricultural pesticides. Labeled nonagricultural uses may have different REIs or worker notification requirements.

[d1] REI EXCEPTION: If the product is soil-injected or soil-incorporated or used for seed treatment, the WPS, under certain circumstances, allows workers to enter the treated area if there will be no contact with anything that has been treated.

[d2] REI EXCEPTION: 24 hours for harvest aid and desiccation applications.

[d3] REI EXCEPTION: After the first 48 hours of the REI, workers may enter the treated area to perform hand labor or other tasks involving contact with anything that has been treated, such as plants, soil, or water, without time limit, if they wear the early-entry personal protective equipment (PPE) listed on the label.

[d4] REI EXCEPTION: 14 days for foliar applications to corn, sunflowers, and sorghum. For the last 12 days of the REI, workers may enter the treated area to perform hand labor or other tasks involving contact with anything that has been treated, such as plants, soil, or water, without time limit, if they wear the early-entry PPE listed on the label.

[d5] REI EXCEPTION: 24 hours for strawberries. After expiration of the 24-hour period, no PPE is required.

[d6] REI EXCEPTION: 24 hours for treating seed, but none once planted.

[d7] REI EXCEPTION: 11 days for soybean, 31 days for corn.

[e] Under the WPS, this is a nonagricultural use product, thus there is no REI requirement.

[f] Under the WPS, this product requires dual notification to workers: verbal AND posted. Wisconsin has additional posting requirements when this product is applied to areas within 300 feet of a residence, migrant labor camp, school, day care facility, health care facility, commercial or industrial facility, public recreation area, or other nonagricultural area where people are likely to be present during the REI.

[g] For use only by commercial seed treaters.

[h] Sold in two containers (co-packs).

Appendix Table 2. Planting interval for rotational crops. See the label for information on crops not listed below.

Herbicide	Alfalfa	Barley	Snap beans	Field corn	Sweet corn	Oats	Peas	Potato	Soybean	Tobacco	Wheat
Accent Q	10M	8M	10M	0	10M[a]	8M	10M	10M[b]	15D	10M[b]	4–8M[c]
Affinity BroadSpec	45D	0	45D	14D	45D	45D	45D	45D	7D	45D	0
Assure II	120D	120D	0	120D	120D	120D	0	120D	0	120D	120D
atrazine	2Y	2Y	2Y	0	0	2Y	2Y	2Y	FY	2Y	2Y
Authority Assist	12M	9.5M	10M	10M	18M	18M	10M	26M	0	9.5M	4M
Authority First/Sonic	12M	12M	30M	10–18M[q]	18M	12M	30M	18M	0	30M	4M
Authority MTZ	12M	4M	18M	10M	18M	18M	18M	12M	0	12M	4M
Autumn	18M	8M	18M	30D	90D	9M	18M	18M	90D	18M+BA	4–8M[c]
Autumn Super 51 WDG[u]	12M	9M[y,v]	18M	30D	9M[y,v]	18M	18M	18M	60D[z]	18M	3M
Banvel[d]	AH	AH	AH	0	AH	AH	AH	AH	AH	AH	AH
Basagran	—	—	—	—	—	—	—	—	—	—	—
Basis Blend[l]	10M	9M	10M	0	10M	9M	10M	1M	10M	10M	3–9M[c]
Bicep Lite II	2Y	2Y	2Y	0	0	2Y	2Y	2Y	FY	2Y	2Y
Boundary 6.5	4.5M	8M	12M	8M	8M	12M	8M	0	0	12M	4.5–8M[c]
Buctril	30D	30D	30D	0	30D	30D	30D	30D	30D	30D	30D
Bullet/Lariat	FY	2Y	2Y	0	0	2Y	2Y	2Y	FY	2Y	2Y
Butyrac 200	—	—	—	—	—	—	—	—	—	—	—
Cadet	AH	AH	AH	0	0	AH	AH	AH	0	AH	AH
Callisto	10M	120D	18M	0	0	0	18M	10M	10M	10M	120D
Canopy	10M	4M	12M	10M	18M	30M	12M	30M	0	10M	4M
Canopy EX	12M	3M	9M	9M	18M	3M	9M	30M	0	9M	3M
Capreno	18M	10M	18M	0	18M[v]	18M	18M	18M	10M	18M	4M
Chaparral	24M+BA	12M	24M+BA	12M	12M	12M	24M+BA	24M+BA	24M+BA	24M+BA	12M
Chateau[w]	6–12M	6–12M	6–18M	4M	6–12M	6–12M	6–18M	6–12M	4M	4M	4M
Cimarron Max/Plus[r]	BA	BA	BA	BA	BA	10M	BA	BA	BA	BA	1M
Cimarron X-tra[s]	BA	24M	BA	BA	BA	16M	BA	BA	BA	BA	4M
Clarity	120D	15–30D	120D	0	120D	15–30D	120D	120D	14–28D	120D	15–30D
Classic	9M	3M	9M	9M	9M	3M	9M	30M	0	15M	3M
Cobra/Phoenix	—	—	—	—	—	—	—	—	—	—	—
Degree Xtra	2Y	2Y	2Y	0	0	2Y	2Y	2Y	FY	2Y	2Y

Abbreviations: 0 = no restriction; M = month; AH = after harvest; D = day; Y = year; NA = not approved; BA = bioassay required; FY = following year; — = no restrictions for rotational crops listed on label

(continued)

[a] The hybrids Merit, Carnival, and Sweet Success require 15M.
[b] If the soil pH is 6.5 or greater, do not plant for 18M.
[c] Use shorter interval for winter wheat, longer interval for spring wheat.
[d] Use shorter interval after 8 oz/a or longer interval after 16 oz/a.
[e] A 12M interval exists following the 2.67 pt/a of Command 3ME.
[f] Imidazolinone tolerant corn hybrids have no restrictions.
[g] If the soil has less than 2% organic matter and less than 15 inches of rain has fallen, do not plant for 18M.
[h] Following application to fallow or crop stubble.
[i] Interval depends on rate and formulation.
[j] 10M interval for transplant tobacco after 0.3 oz/a FirstRate or less.
[k] A 10.5M interval exists for hybrids listed on the supplemental label.
[l] Rotational intervals for 1.25 oz/a rate without Optimum GAT or STS soybean. Lesser soybean rotation restrictions may apply. See label for details.
[m] Only corn or sorghum can be planted FY if applied after June 1.
[n] Wait 9M if using 0.5 oz/a rate.
[o] Interval of 18M if <18 inches of rainfall or if soil pH is <6.2.
[p] For rates over 0.375 oz/a, the interval is 18M.
[q] Interval of 18 months if soil pH is >7 and organic matter is <1.5%.
[r] Rotational intervals are for 0.25 oz/a rate.
[s] Rotational intervals are for 0.5 oz/a rate.
[t] Rotational intervals are for 12 oz/a rate.
[u] Crops with an 18M interval also require 30 inches of rainfall; if soil pH is >7.5, the interval is 24M.
[v] Interval of 18M if soil pH is >7.5.
[w] Intervals for 4 oz/a rate; use 6M interval if soil tilled before planting.
[x] If less than 15 inches of rain has fallen, extend the interval to 18M.
[y] Also requires a minimum of 15 inches of rainfall.
[z] When soil pH is >7.5, soybean rotation interval is 9M, or 4M for sulfonyl-tolerant soybean (STS) varieties.
[aa] Intervals are for 3 fl oz/a rate and may vary for other rates.

Appendix Table 2. Planting interval for rotational crops *(continued)*

Herbicide	Alfalfa	Barley	Snap beans	Field corn	Sweet corn	Oats	Peas	Potato	Soybean	Tobacco	Wheat
Dual II Magnum	4M	4.5M	0	0	0	4.5M	0	0	0	FY	4.5M
Enlite	12M	4M	9M	9M	9M	12M	9M	30M	0	9M	4M
Envive	12M	4M	12M	10M	18M	30M	12M	30M	0	10M	4M
Eptam	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Express	45D	0	45D	14D	14D	45D	45D	45D	45D	45D	0
Extreme	4M	9.5M	4M	8.5M[f]	18M	18M	4M	26M	0	9.5M	3M
Fierce	NA	NA	NA	7–30D	NA	NA	NA	NA	NA	NA	NA
FirstRate	9M	30M+BA	9M	9M	18M	9M	9M	18M	0	10–30M[j]	3M
Flexstar	18M	4M	0	10M	10M	4M	10M	18M	0	18M	4M
Flexstar GT	18M	4M	0	10M	10M	4M	10M	18M	0	18M	4M
ForeFront	24M+BA	12M	24M+BA	12M	12M	12M	24M+BA	24M+BA	24M+BA	24M+BA	12M
Fusilade DX	0	60D	0	60D	60D	60D	0	0	0	0	60D
Fusion	0	60D	0	60D	60D	60D	0	0	0	0	60D
Gangster	30M+BA	30M+BA	9M	9M	18M	9M	9M	18M	0	30M	3M
Glyphosate	0	0	0	0	0	0	0	0	0	30D	0
G-Max Lite	2Y	2Y	2Y	0	0	2Y	2Y	2Y	FY	2Y	2Y
Gramoxone Inteon	0	0	0	0	0	0	0	0	0	0	0
Halex GT	10M	120D	18M	0	0	18M	18M	10M	10M	10M	120D
Harmony Extra	45D	0	45D	45D	45D	0	45D	45D	45D	45D	0
Harmony SG	45D	0	45D	0	45D	0	45D	45D	0	45D	0
Harness	9M	FY	2Y	0	0	FY	2Y	FY	FY	FY	4M
Harness Xtra	2Y	2Y	2Y	0	0	2Y	2Y	2Y	FY	2Y	2Y
Hornet WDG	10.5M	4M	10.5–18M	0	10.5–18M[k]	4M	10.5M	18M	10.5M	18M	4M
Huskie	9M	7D	BA	9M	9M	7D	BA	9M	4M	BA	7D
Ignite	180D	70D	180D	0	180D	70D	180D	70D	0	180D	70D
Impact/Armezon	9M	3M	9–18M[n]	0	0	3M	9M	9M	9M	18M	3M
Intrro	FY	FY	2Y	FY	FY	FY	2Y	2Y	0	2Y	FY
Journey[t]	36M+BA	24M	18M	36M+BA	36M+BA	24M	36M+BA	48M+BA	18M	36M+BA	12M
Keystone LA	15M	15M	2Y	0	0	15M	2Y	15M	FY	15M	15M
Laudis	10M	4M	10M	0	0	4M	10M	10M	8M	18M	4M
Lorox	4M	4M	4M	4M	4M	4M	4M	4M	0	4M	4M
Lumax EZ[m]	18M	FY	18M	0	0	FY	18M	18M	FY	18M	4.5M
Metribuzin	4M	4M	12M	4M	4M	12M	8M	12M	0	12M	4M
Milestone	24M+BA	12M	24M+BA	12M	12M	12M	24M+BA	24M+BA	24M+BA	24M+BA	12M
NorthStar	8M	8M	8M	14D	8M	8M	8M	8M	8M	8M	3–8M[c]
OpTILL	4M	9.5M	4M	8.5M	18M	18M	4M	26M	0–1M	9.5M	4M
OpTILL PRO	9M	9.5M	4M	8.5M	18M	18M	4M	26M	0–1M	9.5M	4M
Option	60D	60D	60D	7D	7D	60D	60D	60D	14D	60D	60D
Orion	9M	14D	12M	3M	3M	14D	12M	9M	9M	12M	14D
Outlook	FY	4M	FY	0	0	4M	FY	FY	0	FY	4M
Permit	9M	2M	9M	1M	3M	2M	9M	9M	9M	2Y	2M
Poast Plus	0	30D	30D	30D	30D	30D	30D	30D	0	30D	30D
Prefix	18M	4.5M	0	10M	10M	4.5M	10M	18M	0	18M	4.5M
Princep	2Y	2Y	2Y	0	0	2Y	2Y	2Y	FY	2Y	2Y

(continued)

Appendix Table 2. Planting interval for rotational crops *(continued)*

Herbicide	Alfalfa	Barley	Snap beans	Field corn	Sweet corn	Oats	Peas	Potato	Soybean	Tobacco	Wheat
Priority	12M	2M	12M	1M	3M	2M	12M	12M	9M	18M	2M
Prowl	FY	FY	0	FY	FY	FY	0	0	0	0	120D–FY[c]
Pursuit	4M	9.5M	4M	8.5M[f]	18M	18M	4M	26M	0	9.5M	3M
Python	4M	4M	4M	0	10.5–18M[k]	4M	4M	12M	0	9M	4M
Rage D-Tech	30D	30D	12M	3D	30D	30D	12M	30D	7D	12M	30D
Raptor	3M	4M	0	8.5M	8.5M	9M	0	9M[o]	0	9M	3M
Realm Q	10M[x]	9M	18M	0	10M	9M	18M	10M	10M	18M	4–9M[c]
Resolve Q	10M	9M	10M	0	10M	9M	10M	1.5M	10M	18M	3–9M[c]
Resource	30D	30D	30D	0	30D	30D	30D	0	0	30D	30D
Select Max	0	30D	0	6–30D	30D	30D	0	30D	0	30D	30D
Sequence	4M	4.5M	0	0	0	4.5M	0	FY	0	FY	4.5M
Sharpen[aa]	6M	0	3M	0	2M	0	3M	6M	2–3M	6M	0
Starane	120D	0	120D	0	0	0	120D	120D	120D	120D	0
Status	30D	30D	120D	7D	120D	30D	120D	120D	30D	120D	30D
Steadfast Q	10M	8M	10M	0	10M[a]	8M	10M	10M[b]	15D	10M[b]	4–8M[c]
Stinger	10.5M	0	18M	0	10.5M	0	18M	18M	10.5M[g]	18M	0
SureStart	FY[g]	FY	2Y	0	10.5–18M	FY	2Y	18M	FY[g]	18M	4M
Surpass	FY	FY	2Y	0	0	FY	2Y	FY	FY	FY	4M
Synchrony XP	9M	3M	9M	9M	9–18M[p]	3M	9M	30M	0	9M	3M
Treflan	5M	12M	0	12M	12M	12M	0	0	0	5M	12M
Ultra Blazer	100D	40D	100D	100D	100D	40D	100D	100D	0	100D	40D
Valor SX	10M	4M	4M	1M	4M	10M	4M	12M+BA	0	2M	2M
Valor XLT	12M	4M	12M	10M	18M	30M	12M	30M	0	10M	4M
Velpar	2Y	2Y	2Y	12M	2Y	2Y	2Y	2Y	2Y	2Y	2Y
Vida	30D	30D	30D	0	0	30D	30D	0	0	30D	0
Yukon	9M	2M	9M	1M	3M	2M	9M	9M	9M	2Y	2M
Zemax[m]	18M	FY	18M	0	0	FY	18M	FY	FY	18M	4.5M–FY[c]
Zidua	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA
2,4-D[h]	3M	3M	3M	7–14D	3M	3M	3M	3M	7–30D[i]	3M	3M

Abbreviations: 0 = no restriction; M = month; AH = after harvest; D = day; Y = year; NA = not approved; BA = bioassay required; FY = following year; — = no restrictions for rotational crops listed on label

[a] The hybrids Merit, Carnival, and Sweet Success require 15M.
[b] If the soil pH is 6.5 or greater, do not plant for 18M.
[c] Use shorter interval for winter wheat, longer interval for spring wheat.
[d] Use shorter interval after 8 oz/a or longer interval after 16 oz/a.
[e] A 12M interval exists following the 2.67 pt/a of Command 3ME.
[f] Imidazolinone tolerant corn hybrids have no restrictions.
[g] If the soil has less than 2% organic matter and less than 15 inches of rain has fallen, do not plant for 18M.
[h] Following application to fallow or crop stubble.
[i] Interval depends on rate and formulation.
[j] 10M interval for transplant tobacco after 0.3 oz/a FirstRate or less.
[k] A 10.5M interval exists for hybrids listed on the supplemental label.
[l] Rotational intervals for 1.25 oz/a rate without Optimum GAT or STS soybean. Lesser soybean rotation restrictions may apply. See label for details.
[m] Only corn or sorghum can be planted FY if applied after June 1.
[n] Wait 9M if using 0.5 oz/a rate.
[o] Interval of 18M if <18 inches of rainfall or if soil pH is <6.2.
[p] For rates over 0.375 oz/a, the interval is 18M.
[q] Interval of 18 months if soil pH is >7 and organic matter is <1.5%.
[r] Rotational intervals are for 0.25 oz/a rate.
[s] Rotational intervals are for 0.5 oz/a rate.
[t] Rotational intervals are for 12 oz/a rate.
[u] Crops with an 18M interval also require 30 inches of rainfall; if soil pH is >7.5, the interval is 24M.
[v] Interval of 18M if soil pH is >7.5.
[w] Intervals for 4 oz/a rate; use 6M interval if soil tilled before planting.
[x] If less than 15 inches of rain has fallen, extend the interval to 18M.
[y] Also requires a minimum of 15 inches of rainfall.
[z] When soil pH is >7.5, soybean rotation interval is 9M, or 4M for sulfonyl-tolerant soybean (STS) varieties.
[aa] Intervals are for 3 fl oz/a rate and may vary for other rates.

Appendix Table 3. Herbicide price list, 2011. Please note that these prices were not updated for 2012.

This table lists many of the common herbicides used in Wisconsin field crops and their approximate costs in 2011. Prices are listed on both a unit basis and for many of the frequently used rates. The unit prices represent the average from several sources. These prices provide a general guide when considering the cost of herbicide programs. Actual prices will vary depending on container size, date of purchase, and changes in manufacturer pricing. The costs of adjuvants or application are not included.

The comments specify whether the rate is for a certain soil type or how the rate compares to the range of rates recommended on the label. These rates are only a guide for comparing herbicide costs. Refer to the label for the exact rate that is required for your situation.

Under the crop heading, abbreviations indicate when only specific herbicide-resistant varieties or hybrids can be treated.

Herbicide	Crop	Timing	Price in $/unit	Price at the following application rates: $/a	rate/a	Comments
Assure II	soybean	post	116.28 gal	3.63	4 fl oz	12-inch volunteer corn rate
atrazine 90DF	corn	pre/post	3.43 lb	2.57	0.75 lb	coarse soil, MR
				5.14	1.5 lb	medium soil, MR
Authority Assist	soybean	pre	329.39 gal	15.44	6 fl oz	sequential rate
Authority First	soybean	pre	73.91 lb	14.78	3.2 oz	LR
				36.96	8 oz	HR
Authority MTZ	soybean	pre	18.83 lb	11.77	10 oz	RR soybean program
				18.83	16 oz	sequential rate
Autumn	corn, soybean	pre	21.90 oz	6.57	0.3 oz	FR
Banvel	corn, small grains,	post	35.70 gal	2.23	0.5 pt	LR
	pasture			4.46	1 pt	SR
				1.12	4 fl oz	FR, small grain
Basagran	corn, soybean	post	97.06 gal	24.26	2 pt	HR
Basis Blend	corn	pre/post	18.86 oz	18.86	1 oz	HR, pre
Bicep Lite II Magnum	corn	PPI/pre	58.91 gal	16.20	1.1 qt	coarse soil
				22.09	1.5 qt	medium soil
Boundary 6.5EC	soybean	PPI/pre	59.12 gal	9.24	1.25 pt	coarse soil
				12.93	1.75 pt	medium soil
Buctril	corn, alfalfa,	post	69.20 gal	8.65	1 pt	LR
	small grains			12.98	1.5 pt	SR
Callisto	corn	post	617.34 gal	14.47	3 fl oz	SR
Capreno	corn	post	5.85 fl oz	17.54	3 fl oz	SR
Chateau	alfalfa	between cuttings	106.06 lb	26.52	4 oz	SR
Clarity	corn, small grains,	post	87.27 gal	5.45	0.5 pt	LR
	pasture			10.90	1 pt	SR
				2.72	4 fl oz	FR, small grain
Classic	soybean	post	15.70 oz	3.92	0.25 oz	reduced rate for tank mix
				7.85	0.5 oz	LR
Cobra	soybean	post	176.23 gal	8.26	6 fl oz	reduced rate for tank mix

(continued)

Abbreviations:

Crop: CRP = Conservation Reserve Program; LL = Liberty Link; RR = Roundup Ready

Timing: EPP = early preplant; pre = preemergence; post = postemergence; PPI = preplant incorporated

Comments: CT = Canada thistle; FR = full rate, rate when a single rate is recommended on the label; HR = high rate, highest rate listed on the label; LR = low rate, lowest rate listed on the label; MR = maximum rate; OM = organic matter; RR = reduced rate; SR = standard rate, the typical rate listed on the label

Appendix Table 3. Herbicide price list, 2011 *(continued)*

Herbicide	Crop	Timing	Price in $/unit	Price at the following application rates: $/a	rate/a	Comments
				17.21	12.5 fl oz	HR
Crossbow	pasture	post	55.50 gal	83.25	1.5 %	cost per 100 gal
Curtail	pasture	post	48.77 gal	24.38	2 qt	light CT infestation
				36.58	3 qt	heavy CT infestation
Degree Xtra	corn	PPI/pre/post	37.19 gal	26.96	2.9 qt	coarse soil
				34.40	3.7 qt	medium soil
Dual II Magnum	corn, soybean	PPI/pre	120.38 gal	15.05	1 pt	coarse soil
				20.01	1.33 pt	medium soil
Durango DMA	many	post	17.41 gal	3.26	24 fl oz	SR
Enlite	soybean	pre	5.65 oz	15.81	2.8 oz	SR
Eptam	alfalfa, birdsfoot trefoil, clovers	PPI	42.60 gal	11.98	2.25 pt	annual grasses
				23.96	4.5 pt	FR
Express TotalSol	wheat, barley	post	18.24 oz	4.57	0.25 oz	SR
Extreme	soybean	pre/post	23.61 gal	8.85	3 pt	FR
FirstRate	soybean	PPI/pre/post	39.14 oz	11.74	0.3 oz	postemergence rate
				29.36	0.75 oz	HR, soil applied
Flexstar	soybean	post	127.89 gal	15.99	1 pt	SR
Flexstar GT 3.5	soybean	post	36.10 gal	15.79	3.5 pt	LR, northern counties
				20.31	4.5 pt	HR, southern counties
ForeFront	pasture, CRP	post	53.70 gal	13.43	2 pt/a	SR
Fusilade DX	soybean	post	148.52 gal	4.64	4 fl oz	12-inch volunteer corn rate
Fusion	soybean	post	200.39 gal	6.26	4 fl oz	12-inch volunteer corn rate
Gangster	soybean	EPP/pre	7.56 oz	13.61	1.8 oz	RR soybean program
				23.44	3.1 oz	conventional soybean program
G-Max Lite	corn	PPI/pre	72.73 gal	22.73	2.5 pt	coarse soil
				27.27	3 pt	medium oil
Gramoxone Inteon	many	post	32.25 gal	8.06	2 pt	low burndown rate
Halex GT	RR corn	post	43.18 gal	19.43	3.6 pt	SR
Harmony SG	small grain, soybean	post	34.45 oz	4.31	0.125 oz	soybean rate
				27.56	0.8 oz	fallow, wheat, and barley rate
Harmony Extra SG	small grain	post	13.05 oz	7.83	0.6 oz	SR
Harness	corn	PPI/pre	94.43 gal	14.75	1.25 pt	coarse soil
				21.25	1.8 pt	medium soil
Harness Xtra	corn	PPI/pre	57.97 gal	26.09	1.8 qt	medium soil
Harness Xtra 5.6L	corn	PPI/pre	45.64 gal	26.24	2.3 qt	medium soil
Hornet WDG	corn	PPI/pre/post	69.83 lb	13.09	3 oz	post, MR

Abbreviations: *(continued)*

Crop: CRP = Conservation Reserve Program; LL = Liberty Link; RR = Roundup Ready

Timing: EPP = early preplant; pre = preemergence; post = postemergence; PPI = preplant incorporated

Comments: CT = Canada thistle; FR = full rate, rate when a single rate is recommended on the label; HR = high rate, highest rate listed on the label; LR = low rate, lowest rate listed on the label; MR = maximum rate; OM = organic matter; RR = reduced rate; SR = standard rate, the typical rate listed on the label

Appendix Table 3. Herbicide price list, 2011 *(continued)*

Herbicide	Crop	Timing	Price in $/unit	Price at the following application rates: $/a	rate/a	Comments
				17.45	4 oz	pre, MR
Ignite 280	many; LL corn/ soybeans	pre/post	54.87 gal	12.43	29 fl oz	SR
Impact	corn	post	20.23 oz	10.12	0.5 oz	LR
				15.17	0.75 oz	HR
Intrro	soybean	PPI/pre	25.77 gal	12.89	2 qt	coarse soil
				16.11	2.5 qt	medium soil
Keystone LA	corn	PPI/pre	58.86 gal	29.43	2 qt	SR
Lariat	corn	PPI/pre	25.24 gal	15.77	2.5 qt	coarse soil
				23.66	3.75 qt	medium soil
Laudis	corn	post	5.02 fl oz	15.07	3 fl oz	SR
Lorox DF	soybean	pre	19.76 lb	19.76	1 lb	coarse soil
Lumax EZ	corn	pre/post	65.46 gal	40.91	2.5 qt	soil OM < 3%
				49.10	3 qt	soil OM = 3%
metribuzin	soybean	pre	14.67 lb	4.89	0.33 lb	coarse soil for soybean
				7.33	0.5 lb	medium soi for soybean
	alfalfa	spring dormant		14.67	1 lb	alfalfa rate
Milestone	pasture	post	346.33 gal	18.94	7 fl oz	CT rate
Northstar	corn	post	2.46 oz	12.28	5 oz	FR
Optill	soybean	pre	6.31 oz	12.62	2 oz	SR
Option	corn	post	10.51 oz	15.77	1.5 oz	SR
Outlook	corn, soybean	PPI/pre	186.70 gal	20.42	14 fl oz	coarse soil
				23.34	16 fl oz	medium soil
Permit	corn	post	19.37 oz	12.97	0.67 oz	SR
Phoenix	soybean	post	176.23 gal	11.01	8 fl oz	SR
Poast Plus	soybean, alfalfa	post	65.16 gal	12.22	1.5 pt	annual grass rate
Prefix	soybean	pre	52.22 gal	13.06	2 pt	SR
Princep Caliber 90	corn	PPI/pre	4.34 lb	11.29	2.6 lb	medium soil
Prowl H20	corn, soybean	pre:corn	43.43 gal	10.86	2 pt	coarse soil for corn
		PPI:soybean		16.28	3 pt	medium soil for corn
Pursuit	soybean	PPI/pre/post	636.65 gal	19.90	4 fl oz	FR
	seedling alfalfa	post		14.92	3 fl oz	SR for alfalfa
Python	corn, soybean	PPI/pre	13.05 oz	13.05	1 oz	medium soil, SR
Rage D-Tech	corn, small grains	pre/post	29.87 gal	1.86	8 fl oz	
	soybean	PPI		2.80	12 fl oz	7-day planting interval
Raptor	soybean	post	576.90 gal	18.03	4 fl oz	SR

Abbreviations: *(continued)*

Crop: CRP = Conservation Reserve Program; LL = Liberty Link; RR = Roundup Ready

Timing: EPP = early preplant; pre = preemergence; post = postemergence; PPI = preplant incorporated

Comments: CT = Canada thistle; FR = full rate, rate when a single rate is recommended on the label; HR = high rate, highest rate listed on the label; LR = low rate, lowest rate listed on the label; MR = maximum rate; OM = organic matter; RR = reduced rate; SR = standard rate, the typical rate listed on the label

Appendix Table 3. Herbicide price list, 2011 *(continued)*

Herbicide	Crop	Timing	Price in $/unit	Price at the following application rates: $/a	rate/a	Comments
Realm Q	corn	post	4.69 oz	18.75	4 oz	SR
Resolve Q	corn	pre	7.85 oz	9.82	1.25 oz	SR
Resource	corn, soybean	post	209.79 gal	6.56	4 fl oz	low tank-mix rate
Roundup PowerMax	many	post	19.71 gal	3.39	22 fl oz	SR
Roundup WeatherMax	many	post	27.32 gal	4.70	22 fl oz	SR
Select Max	soybean	post	99.75 gal	4.68	6 fl oz	12-inch volunteer corn rate
Sequence	corn, soybean	pre/post	41.51 gal	12.97	2.5 pt	SR
Sharpen	corn, soybean	pre	658.81 gal	5.15	1 fl oz	burndown rate
Status	corn	post	3.14 oz	15.73	5 oz	SR
Steadfast Q	corn	post	11.13 oz	8.34	0.75 oz	SR
Stinger	corn, cereals,	post	129.18 qt	16.15	0.25 pt	LR
	pasture			32.30	0.5 pt	pasture, CT rate
SureStart	corn	EPP/pre/post	77.96 gal	17.05	1.75 pt	medium soil, ≥3% OM
Surpass	corn	PPI/pre	95.07 gal	17.82	1.5 pt	coarse soil
				23.77	2 pt	medium soil
Synchrony XP	soybean	post	11.35 oz	4.26	0.375 oz	postemergence rate
Touchdown Total	many	post	19.66 gal	3.67	1.5 pt	SR
Treflan	soybean	PPI	24.89 gal	3.11	1 pt	coarse soil
				4.67	1.5 pt	medium soil
Ultra Blazer	soybean	post	73.14 gal	13.71	1.5 pt	HR
Valor SX	soybean	pre	89.66 lb	11.21	2 oz	SR
Velpar L	alfalfa	pre-greenup	78.65 gal	24.58	2.5 pt	coarse soil
				39.32	4 pt	medium soil
Verdict	corn	pre	209.38 gal	21.27	13 fl oz	medium soil
Warrant	soybean	post	32.76 gal	5.12	1.25 qt	LR
				8.19	2 qt	HR
Weedmaster	pastures	post	22.42 gal	2.80	1 pt	annual weed rate
				5.61	2 pt	perennial rate
WideMatch	small grains, corn, CRP	post	66.69 gal	8.34	1 pt	SR
Yukon	corn		2.91 oz	11.64	4 oz	SR
2,4-D amine (4)	corn, small grains, pastures	post	15.00 gal	1.88	1 pt	SR
2,4-ester (LV 4)	corn, small grains, pastures	post	18.46 gal	2.31	1 pt	SR

Abbreviations:

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Timing: EPP = early preplant; pre = preemergence; post = postemergence; PPI = preplant incorporated

Comments: CT = Canada thistle; FR = full rate, rate when a single rate is recommended on the label; HR = high rate, highest rate listed on the label; LR = low rate, lowest rate listed on the label; MR = maximum rate; OM = organic matter; RR = reduced rate; SR = standard rate, the typical rate listed on the label

Appendix Table 4. Herbicide effectiveness on listed invasive weeds in CRP fields

Commercial name	Common name (active ingredient)	Burdock	Canada goldenrod	Chinese lespedeza	Common tansy	Crown vetch	Curly dock	Dames rocket	Field bindweed	Garlic mustard	Giant hogweed	Giant ragweed	Hawkweeds	Hill mustard	Japanese hedge parsley
Banvel	dicamba	**G**	F/G	P	**G**	**G**	F/G	**G**	F/G	F	P/F	F/G	F/G	—	—
Butyrac	2,4-DB	—	F/G	—	—	—	F	N	N	—	—	—	—	—	—
Chaparral	aminopyralid + metsulfuron	**G/E**	**G/E**	F/G	**G/E**	**G/E**	**G/E**	**G**	—	**G/E**	**G**	**G**	**G/E**	**G**	**G**
Cimarron Max	metsulfuron + 2,4-D + dicamba	**G/E**	**G/E**	**G**	**G**	**G**	**G/E**	—	F/G	—	—	F	—	**G/E**	—
Cimarron Plus	metsulfuron + chlorsulfuron	**G/E**	**G/E**	—	**E**	**G**	—	—	—	—	—	—	—	—	—
Crossbow	2,4-D + triclopyr	**G/E**	F/G	**G**	F/G	**G**	**G/E**	—	F/G	—	—	**G/E**	—	**G**	—
Curtail	2,4-D + clopyralid	**G**	F	—	**G**	**G**	F	—	—	—	—	**G**	F/G	—	—
Escort	metsulfuron	**G/E**	**G/E**	F/G	**G**	**G**	**G/E**	**G**	P/F	**G/E**	**G**	P	—	**E**	**E**
Forefront	2,4-D + aminopyralid	**G/E**	F/G	P	F/G	**E**	**G/E**	—	—	—	—	**E**	**E**	—	—
Fusilade	fluazifop	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Garlon	triclopyr	**G/E**	F/G	**G/E**	P	**G/E**	F/G	**G**	F	**G**	**G**	**G/E**	—	**G**	**G**
Gramoxone[a]	paraquat[a]	P/F	P	P	P	P	P	P	P	P/F	P	P/F	P	P	P/F
Grazon P+D[b]	2,4-D + picloram[b]	**E**	**G**	P	**G**	**E**	**E**	—	**G**	—	—	**E**	**G**	—	—
Habitat[a]	imazapyr[a]	**G**	—	P	**E**	P	**G/E**	—	**G/E**	**G/E**	—	F	—	—	—
Journey[a]	imazapic+glyphosate[a]	—	P	P	F	P	F/G	—	F/G	**G/E**	—	F/G	—	—	—
MCPA	MCPA	—	N	—	P	P	F/G	—	P/F	—	P/F	—	F/G	—	—
Milestone	aminopyralid	**G/E**	P/F	P	P	**E**	**G**	—	—	—	**G**	**G**	**E**	—	—
Oust[a]	sulfometuron[a]	—	**G**	—	—	**G**	F/G	—	—	**G/E**	—	—	—	—	—
Outrider	sulfosulfuron	—	—	—	F	—	—	—	—	**G/E**	—	—	—	—	—
Overdrive	dicamba + diflufenzopyr	**G**	F/G	P	**G**	P	**G/E**	—	**G**	F	—	F/G	—	—	—
Pastureguard	fluroxypyr + triclopyr	F/G	**G/E**	**G/E**	—	**G**	**G/E**	—	P/F	—	—	**G**	—	—	—
Perspective	aminocyclopyrachlor + chlorsulfuron	**G/E**	**G/E**	—	**G**	F/G	**G**	**G**	**G/E**	F/G	—	**G**	**E**	—	—
Plateau	imazapic	—	N	N	P	N	F/G	**G**	F/G	**G/E**	**G**	F	—	**G**	—
Poast	sethoxydim	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pursuit	imazethapyr	—	—	—	—	N	F/G	—	N/P	—	—	F/G	—	—	—
Redeem	clopyralid + triclopyr	**G/E**	**G**	F	F	**G**	**G**	—	**G/E**	—	—	**E**	**G**	—	—
Roundup[a]	glyphosate[a]	**G**	**G**	F	F	F	**G/E**	**G**	F/G	**G/E**	**G/E**	F/G	—	**G/E**	**G**
Starane	fluroxypyr	—	—	**G/E**	—	—	**G**	—	F	—	—	—	—	—	—
Stinger	clopyralid	**G/E**	P	P	**G/E**	**G/E**	**G**	—	P	—	F/G	**G/E**	F/G	—	—
Streamline	aminocyclopyrachlor + metsulfuron	**G/E**	**G/E**	**G**	**G/E**	**G/E**	**G/E**	**G**	**G/E**	**G/E**	—	**G**	**E**	—	—
Telar	chlorsulfuron	**G**	**G**	—	—	—	F/G	**G**	—	—	—	—	—	—	—
Tordon[b]	picloram	**G/E**	**G/E**	F	**G**	**E**	**G/E**	—	F/G	—	—	**E**	F/G	—	—
Weedmaster	2,4-D + dicamba	**G**	**G**	P/F	**G/E**	**G/E**	**G/E**	—	F/G	F	—	**E**	—	F/G	—
2,4-D	2,4-D	**G/E**	F/G	P	**G**	F/G	F/G	**G**	F	F	P/F	**G**	F/G	**G**	—
2,4-D + glyphosate[a]	2,4-D + glyphosate[a]	**G/E**	—	—	**G**	—	—	—	F/G	—	—	F/G	—	—	—

Control ratings: E = excellent (90–100%), G = good (80–90%), F = fair (60–80%), P = poor (<60%), N = none (0%), — = no information

Japanese knotweed	Knapweed spp.	Multiflora rose	Phragmites	Poison hemlock	Purple loosestrife	Queen Anne's lace	Reed canary grass	Spurge, leafy & cypress	Sweet clover, white & yellow	Teasel, cutleaf & common	Thistle, bull	Thistle, Canada	Thistle, marsh	Thistle, musk	Thistle, plumeless	Wild chervil	Wild parsnip	Commercial name
F/G	F/G	F/G	N	**G/E**	—	**G**	N	P/F	F	**G/E**	**G/E**	F	**G/E**	**G/E**	**G/E**	F	F	Banvel
—	—	—	—	—	—	—	N	—	N	—	—	—	—	—	—	—	—	Butyrac
G/E	**E**	**G/E**	N	**G/E**	**G/E**	**E**	N	—	**G/E**	**G/E**	**E**	**E**	**G/E**	**E**	**E**	**G/E**	**G/E**	Chaparral
—	F/G	**G/E**	N	**G/E**	—	**E**	N	F/G	F	**G/E**	**G/E**	F/G	—	**E**	**E**	**G/E**	—	Cimarron Max
—	—	F/G	—	**G/E**	—	**G/E**	N	—	F	**G/E**	**G/E**	**G**	—	**G/E**	—	**G/E**	—	Cimarron Plus
—	F/G	**G**	N	F/G	—	**G**	N	F	F/G	**G/E**	**G/E**	F	**G/E**	**G/E**	**G/E**	P/F	**G**	Crossbow
—	**G**	—	N	F/G	—	**G**	N	P	F/G	F/G	**G/E**	**G**	—	**G**	**G/E**	P/F	**G**	Curtail
—	F	**G**	N	**G/E**	**G**	**E**	N	—	F	**G/E**	**G**	F/G	**G**	**G/E**	**G/E**	**G/E**	**E**	Escort
—	**E**	F/G	N	**G/E**	**G**	**G**	N	P	**G/E**	P	**G/E**	**E**	—	**E**	**G/E**	—	**G**	Forefront
N	N	N	F/G	N	N	N	**G/E**	N	N	N	N	N	N	N	N	N	N	Fusilade
F/G	P/F	F/G	N	**G/E**	F	**G**	N	P/F	F	**G/E**	**G/E**	F	**G/E**	F/G	**G/E**	F	F	Garlon
P	P	P	P	P/F	—	P/F	P	P	P/F	P	P/F	P	P/F	P/F	P/F	P	P	Gramoxone[a]
—	F/G	**G**	N	**G/E**	—	**G**	N	**G/E**	**G/E**	**G/E**	**E**	**G/E**	—	**E**	**E**	—	**G**	Grazon P+D[b]
G	F/G	**G**	**G/E**	**G**	**E**	**G/E**	**G/E**	**G**	P/F	**G/E**	**G**	F	**G**	F/G	**G**	**G/E**	—	Habitat[a]
F	F	P	F	**G**	—	**G/E**	**G/E**	**G/E**	N	**G**	**G/E**	P	—	F/G	—	F/G	F	Journey[a]
—	—	—	N	F/G	—	—	N	—	P/F	—	—	—	—	—	—	—	—	MCPA
G/E	**E**	F	N	P	**G**	F	N	P	**G/E**	**G/E**	**E**	**E**	**E**	**E**	**E**	—	F	Milestone
—	F/G	—	—	**G/E**	—	—	**G/E**	P/F	F	**G/E**	—	**G**	—	**G**	—	—	—	Oust[a]
—	—	—	—	—	—	—	—	—	—	P	—	—	—	—	—	—	—	Outrider
F	**G/E**	—	—	**G/E**	—	**G/E**	—	—	P	**G/E**	**G/E**	**G**	—	**G/E**	**G/E**	—	**G**	Overdrive
—	P	**G**	—	**G/E**	—	F	—	—	F	**G/E**	P	P	—	P	P	—	—	Pastureguard
—	**E**	**G/E**	P	**G**	—	**E**	P	**G/E**	**G/E**	**E**	**E**	**E**	—	**E**	**E**	**G/E**	**E**	Perspective
P	F	N	P	**G**	—	**G/E**	**G/E**	**G**	N	**G**	F	P	—	F	—	F	P	Plateau
N	N	N	P	N	N	N	**G/E**	N	N	N	N	N	N	N	N	N	N	Poast
—	—	—	—	—	—	—	F	—	N	—	—	P	—	—	—	—	—	Pursuit
—	**G/E**	P	N	**G/E**	—	**G/E**	N	P	**G**	**G/E**	**G/E**	F/G	—	**G/E**	**G/E**	—	F	Redeem
F/G	**G/E**	**G**	**G/E**	F/G	F/G	**G/E**	**G/E**	F	P/F	**G/E**	**G/E**	**G**	F/G	**G/E**	**G/E**	**G**	**G/E**	Roundup[a]
—	—	—	—	—	—	—	—	P	F	—	—	—	—	—	—	—	—	Starane
—	**G/E**	P	N	**G/E**	—	P	N	P	**G/E**	**G**	**E**	**G/E**	**G**	**E**	**E**	F	F	Stinger
—	**E**	**G/E**	P	**G/E**	—	**E**	P	**G/E**	**G/E**	**E**	**E**	**E**	—	**E**	**E**	**G/E**	**E**	Streamline
—	—	F/G	—	**G**	—	**G/E**	N	—	F	**G**	**G/E**	F/G	**G/E**	**G/E**	**G/E**	**G**	**G/E**	Telar
G	**G/E**	**G**	N	**G/E**	—	**G**	N	**G**	**G**	**G/E**	**E**	**G**	**E**	**E**	**E**	—	—	Tordon[b]
—	**G/E**	F	N	**G/E**	—	**G/E**	N	P/F	F	**G/E**	**G/E**	F/G	—	**G/E**	**G/E**	—	**G/E**	Weedmaster
F/G	F/G	P/F	N	**G/E**	P	**G/E**	N	P/F	F	**G**	**G/E**	F	**G/E**	**G/E**	**G/E**	F	**G/E**	2,4-D
—	—	—	—	—	—	—	—	F/G	F/G	—	**G/E**	**G**	—	—	—	—	—	2,4-D + glyphosate[a]

[a] Nonselective herbicide: will injure both grasses and broadleaf plants.

[b] Restricted-use product in Wisconsin.

ADDITIONAL RESOURCES

The following publications may be purchased from your county Extension office or from Extension Publications. You can order online at learningstore.uwex.edu or call toll-free 877-WIS-PUBS (947-7827).

Corn and soybean

Corn Earworm (A3655)

Corn Fertilization (A3340)

Corn Replant/Late-Plant Decisions in Wisconsin (A3353)

Corn Rootworms (A3328)

Corn Silage Production, Management, and Feeding (NCR574)

European Corn Borer (A1220)

Herbicide Persistance and Carryover (A3819)

Herbicide Resistance Management in Vegetable Rotations—poster (A3822)

Insect Resistance Management and Refuge Requirements for Bt Corn (A3857)

Moth Identification Guide for Blacklight Trap Catch in Wisconsin (A3855)

Protect Your Corn from Cranes (A3897)

Seed Corn Maggot (A3820)

Two-spotted Spider Mite Management in Soybean and Corn (A3890)

Uneven Emergence in Corn (NCR344)

Western Bean Cutworm: A Pest of Field and Sweet Corn (A3856)

Forages and small grains

Alfalfa Germination and Growth (A3681)

Alfalfa Management Guide (NCR547)

Alfalfa Stand Assessment: Is This Stand Good Enough to Keep? (A3620)

Buying Horse Hay (A3772)

Determining Pasture Condition (A3667)

Forage Variety Update for Wisconsin (A1525)

Identifying Pasture Grasses (A3637)

Identifying Pasture Legumes (A3787)

Pastures for Horses: A Guide to Rotational Grazing—CD (A3764)

Pastures for Profit: A Guide to Rotational Grazing (A3529)

Wisconsin Oats and Barley Performance Tests (A3874)

Weed management

Common Weed Seedlings of the North Central States (NCR607)

Herbicide Effectiveness on Invasive Plants in Wisconsin (A3893)

Invasive Plants of Wisconsin: Perennial Pepperweed (A3832)

Weed Identification and Management—DVD (A3829)

Related UW-Extension websites

Extension Publications: learningstore.uwex.edu

Agronomy: agronomy.wisc.edu

Forages: uwex.edu/ces/crops/teamforage **and** www.uwex.edu/ces/forage

Grains: fyi.uwex.edu/grain

Insects: entomology.wisc.edu/diaglab/entodiag.html **and** labs.russell.wisc.edu/cullenlab

Pesticide Applicator Training: ipcm.wisc.edu/pat

Plant diseases: www.plantpath.wisc.edu/pddc

Soybeans: fyi.uwex.edu/fieldcroppathology/ **and** soybean.uwex.edu

Weed identification: weedid.wisc.edu

Weed science: fyi.uwex.edu/weedsci

Weed identification: weedid.wisc.edu

Wisconsin Crop Manager: ipcm.wisc.edu/wcm

HIGHLIGHTS OF THE UPDATES TO *PEST MANAGEMENT IN WISCONSIN FIELD CROPS—2013*

Herbicide resistance update

The herbicide resistance section has received an update as one population of giant ragweed has been confirmed resistant to glyphosate and one population has been confirmed resistant to the ALS inhibitor, cloransulam. See page 14.

Terminating corn stands for replant

A short paragraph was added in the corn burndown section to address an option for terminating failed glyphosate-resistant corn stands with SelectMax and replanting in 6 days. Please see details regarding this supplemental herbicide use. See page 24.

Corn product updates

Basis herbicide was a premix of rimsulfuron and Harmony SG. It has been replaced in the book with **Basis Blend.** Basis Blend contains the same combination of active ingredients but it is a new formulation with a different concentration of rimsulfuron and thifensulfuron ingredients and therefore it also has different rate recommendations. See page 25.

Fierce herbicide is a newly registered premix herbicide (Valor + Zidua) for early preplant burndown and preemergence control of selective grass and small seeded broadleaf weeds in corn. As an important note, a label for use in soybean is still under review by EPA and has not been approved. At the time of this A3646 update, soybean cannot be rotated following Fierce application. Unless a soybean label has been approved prior to using Fierce, only use Fierce on acres than can be planted to corn again the following year. See page 25.

Zidua herbicide is a newly registered seedling shoot inhibitor for preemergence control of grass and small seeded broadleaf weeds in corn. As an important note, a label for use in soybean is under review by EPA and has not been approved. At the time of this A3646 update, soybean cannot be rotated following Zidua application. Unless a soybean label has been approved prior to using Zidua, only use on acres than can be planted to corn again the following year. See page 40.

Bt corn trait updates are included in table 2-11. This section contains newly registered Bt corn products for European corn borer and other lepidopteran pests above ground and corn rootworm below ground. Bt trait hybrid names, target pests, and refuge requirements (percentage and configuration as structured refuge or seed blend refuge-in-the-bag) are listed. Table is current as of September 8, 2012, at the time of A3646—2013 edition production. See page 74.

Avicta Complete Corn seed treatment replaces Avicta Duo seed treatment by the same manufacturer (Syngenta). This nematicide/insecticide/fungicide seed treatment contains the systemic neonicotinoid insecticide active ingredient thiamethoxam. See table 2-12, page 76.

Besiege insecticide is a newly registered premix foliar insecticide containing one pyrethroid (lambda-cyhalothrin) and one anthranilic diamide (chlorantraniliprole) active ingredient. Besiege replaces Voliam Xpress by the same manufacturer (Syngenta) and contains the same active ingredients and crop-insect pest uses. See table 2-12, page 76.

Stallion insecticide is a newly registered premix foliar insecticide containing one pyrethroid (zeta-cypermethrin) and one organophosphate (chlorpyrifos) active ingredient. See table 2-12, page 76.

Triple Crown insecticide is a newly registered premix foliar insecticide containing two contact activity pyrethroid active ingredients (zeta-cypermethrin + bifenthrin) and one systemic neonicotinoid active ingredient (imidacloprid). See table 2-12, page 76.

Soybean product updates

Optill PRO is a newly registered co-pack of Optill + Outlook herbicides for burndown and preemergence control of selective grass and broadleaf weeds in soybean. See page 116.

Sharpen herbicide should primarily be used as a burndown in soybean, so it has been moved to the burndown section to reflect this. Spray timing and rate recommendations have also been updated. See page 117.

Warrant herbicide is now labeled for preemergence use in soybean. See page 126.

Belay foliar neonicotinoid systemic insecticide (active ingredient clothianidin) is registered on a Supplemental Label for some insect pests on soybean. See table 3-8, page 146.

Justice insecticide is a newly registered premix foliar insecticide containing one systemic neonicotinoid (acetamiprid) and one pyrethroid contact activity (bifenthrin) active ingredient. See table 3-8, pages 146.

NipsIt INSIDE is a newly registered seed treatment insecticide containing the systemic neonicotinoid active ingredient clothianidin. See table 3-8, page 146.

Stallion insecticide is a newly registered premix foliar insecticide containing one pyrethroid (zeta-cypermethrin) and one organophosphate (chlorpyrifos) active ingredient. See table 3-8, page 146.

Triple Crown insecticide is a newly registered premix foliar insecticide containing two contact activity pyrethroid active ingredients (zeta-cypermethrin + bifenthrin) and one systemic neonicotinoid active ingredient (imidacloprid). See table 3-8, page 146.

Alfalfa product updates

Extreme is a newly registered herbicide for use in Roundup Ready alfalfa. It is a mixture of glyphosate and imazethapyr. Extreme is registered for establishing and established stands and has the same preharvest interval (30 days) and rotational restrictions as Pursuit. See page 173.

Besiege insecticide is a newly registered premix foliar insecticide containing one pyrethroid (lambda-cyhalothrin) and one anthranilic diamide (chlorantraniliprole) active ingredient. Besiege replaces Voliam Xpress by the same manufacturer (Syngenta) and contains the same active ingredients and crop-insect pest uses. See table 4-10, page 198.

Pasture product updates

Due to label updates we have emphasized restrictions placed on all products that contain aminopyralid **(Chaparral, Forefront, Milestone).** Each of these products have the following restrictions in Wisconsin:

- Forage from treated pastures cannot be sold for 18 months following an application.
- Animals must be fed aminopyralid-free forage for at least 3 days before being transferred to a field with plants sensitive to aminopyralid.
- Manure from animals that feed on forage treated with aminopyralid cannot be spread onto fields that will be planted to a broadleaf crop.

Besiege insecticide is a newly registered premix foliar insecticide containing one pyrethroid (lambda-cyhalothrin) and one anthranilic diamide (chlorantraniliprole) active ingredient. Besiege replaces Voliam Xpress by the same manufacturer (Syngenta) and contains the same active ingredients and crop-insect pest uses. See table 4-9, page 197.

Small grains product updates

NipsIt SUITE Cereals is a newly registered seed treatment insecticide/fungicide containing the systemic neonicotinoid active ingredient clothianidin for wireworm control on barley, oats, and wheat. See page 221.

Stallion insecticide is a newly registered premix foliar insecticide containing one pyrethroid (zeta-cypermethrin) and one organophosphate (chlorpyrifos) active ingredient. Registered on wheat only. See table 5-4, page 222.

2013: the year of carryover?

2012 is already known for its record drought and heat. That drought has specialists concerned that certain herbicides used for one crop may be likely to persist into the next season and damage a different crop in 2013, a process known as carryover.

The soybean seedling in the photo (right) was taken from a field in southern Wisconsin in the spring of 2012 and has visible damage in the form of chlorosis and bleaching from an HPPD-inhibiting herbicide used in corn the previous growing season.

Many factors affect herbicide persistence, and soil moisture is a major factor. To avoid herbicide carryover damage in your field, follow the crop rotation restrictions found in Planting Intervals for Rotational Crops (appendix table 2) beginning on page 257 of this publication.

Photo courtesy of Dr. Shawn Conley, state soybean specialist.

Pest Management Mobile lets you access key data from A3646 from your smartphone or other mobile device. Visit **pmm.pocketdata.net**.

UW Extension Cooperative Extension

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Photo credits (cover): (Clockwise from upper right) giant ragweed plants from Rock County, Wisconsin in the greenhouse 4 weeks after treatment with 3.0 lb ae/a glyphosate (two susceptible plants on the left and two resistant plants on the right), image courtesy of David Stoltenberg; Canada thistle and dandelions flourishing in a rotationally grazed pasture in southwest Wisconsin, image courtesy of Mark Renz; two-spotted spider mite image courtesy of Eileen Cullen.

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