

2009 Missouri

# **Pest Management Guide:**

**Corn  
Grain sorghum  
Soybean  
Winter wheat**

# Missouri Pest Management Guide

## Preface

This guide is intended to provide current recommendations for control of the most problematic weeds, insects and diseases encountered in Missouri corn, soybean and winter wheat cropping systems. This information can also be accessed on the World Wide Web at [ppp.missouri.edu/pestguide/index.cfm](http://ppp.missouri.edu/pestguide/index.cfm)

The information and recommendations in this publication are based on research conducted at the University of Missouri and elsewhere. This guide is a cooperative publication written by the following faculty members at the University of Missouri-Columbia:

Kevin W. Bradley  
Extension Weed Scientist  
Department of Agronomy  
[bradleyke@missouri.edu](mailto:bradleyke@missouri.edu)

Laura E. Sweets  
Extension Plant Pathologist  
Department of Plant Microbiology and Pathology  
Commercial Agricultural Program  
[sweetsl@missouri.edu](mailto:sweetsl@missouri.edu)

Wayne C. Bailey  
Extension Entomologist  
Department of Entomology  
[baileyw@missouri.edu](mailto:baileyw@missouri.edu)

J. Allen Wrather  
Extension Plant Pathologist  
Delta Research Center  
[wratherj@missouri.edu](mailto:wratherj@missouri.edu)

The trade names within this guide are given with the understanding that no discrimination is intended and no endorsement by the University of Missouri is implied. The pesticides named in this publication are registered by the U.S. Environmental Protection Agency (EPA) and the Missouri Department of Agriculture. These pesticides are designed to be used according to specific label directions pertaining to rates of application, number of applications, intervals between application and harvest, etc. Failure to follow these directions

may result in hazards to humans and/or the environment, unsafe pesticide residues, and fines to the applicator. Any use of a pesticide that is inconsistent with its label is a violation of federal law.

This publication will be revised annually to reflect label updates, name changes and the entry of new herbicide, insecticide, or fungicide active ingredients in the marketplace. The authors welcome reader suggestions to help improve future editions of this publication.

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## Introduction

The information in this guide is based on research conducted at the University of Missouri Agricultural Experiment Station and elsewhere. It addresses crop, soil and weed problems of the state of Missouri. All herbicide information conforms to federal and state regulations at the time of writing. Consult the label attached to the herbicide container for current use precautions and restrictions.

Use this publication as a guide in selecting and comparing herbicides. It is not a substitute for reading product labels. The University of Missouri does not warrant commercial products and regrets any errors or omissions in this guide. Cost of herbicides was not considered in making these recommendations because prices vary with location and time. Herbicides may perform better or worse depending upon weeds infesting the field, rainfall, soil type, temperature and many other environmental factors. Therefore, we have made no effort to list herbicides in order of preference.

Apply herbicides only to labeled crops. Do not exceed the maximum recommended rate for a herbicide. Excessive herbicide application rates are expensive and can result in injury to the crop or make the crop unsafe as food or feed. Apply herbicides only at times specified on the label. Observe label restrictions for required intervals between time of treatment and time of planting, pasturing or harvesting a crop. Guard against injury to nearby, susceptible crops or plants that herbicide drift or volatility could cause.

This publication discusses using herbicides to control weeds. However, good agricultural practices also enhance weed control. You can reduce reliance on herbicides by planting high-quality, weed-free seed. Other practices include proper seedbed preparation, proper planting depths, proper seeding rates, timely cultivation, narrower row widths, maintaining optimum fertility and pH, and crop or tillage rotations.

## Endangered species

The Environmental Protection Agency is planning to restrict the use of certain pesticides that may harm endangered species in some areas of the country. You should check with your local University Outreach and Extension Center, State Game and Fish Office, or your pesticide dealer to determine if the area you are planning to spray with any pesticide is protected for endangered species.

You should request the *Pesticide Use Bulletin for Protection of Endangered Species* for your county. The bulletin indicates which areas are protected for endangered species and lists the pesticides that may and may not be used in that area. In addition, pesticide labels will list counties where endangered species protection zones exist.

## How to use this guide

Farmers frequently ask us, "What herbicides should I use for soybeans (or corn, wheat)?" Unfortunately, there is no simple answer to this question. The herbicide or, more likely, the combination of herbicides you use for producing a crop depends on the weeds you need to control. Herbicide

selection that is not matched to a field's weed problems will probably result in poor weed control and lost profits from lower crop yields. Thus, the first step toward obtaining good weed control is proper identification of the weeds in your field.

Each crop chapter in this book starts with a chart entitled "Guide to Weed Response to Herbicides." You should use this chart to select the herbicide or combination of herbicides that will give good control of the weeds present in your field. In some cases several herbicide choices may do an effective job of controlling the weeds. Other considerations, such as herbicide price, method of application (pre, post), availability of proper equipment, soil type, and tillage practices, should help you narrow your choices. A soil-applied herbicide rate table is also included in most chapters as a guideline to select rates for your field. Be warned that soil-applied herbicide rates are usually dependent on soil texture, percent organic matter, crop and weed species.

All of this information could not be summarized in one table. The herbicide label should always be your final guide to herbicide use.

The largest section of each crop chapter includes specific use rates, timing, application methods and precautions for all of the herbicides and combinations recommended for Missouri. This section is most easily used after you have narrowed your choices by using the herbicide response table. If a herbicide you have heard about is not included in this guide, it could be for the following reasons:

1. The herbicide or herbicide use was not yet registered by the Environmental Protection Agency at this writing (August and September of the year preceding the date of publication).
2. There was insufficient University-generated data to evaluate the herbicides performance and applicability for Missouri crop production (a minimum of three years' data is usually required).
3. The herbicide or herbicide use did not perform well or was not appropriate in Missouri crop production conditions.

At the back of the guide are reference tables giving crop replant and rotational intervals, forage and grazing restrictions, herbicide compatibility with fertilizers, rainfast intervals and preharvest intervals. These tables are designed to answer questions that are encountered during the growing season.

## Herbicide treatment methods and timing

Herbicides are generally applied at the following times:

1. **Early preplant (EPP)** onto the soil and early emerging weeds up to a month before crop planting. Some herbicides are even registered for application in the fall prior to planting the next spring.
2. **Preplant (PPS)** onto the soil or any early emerging weeds before the crop is planted.
3. **Preplant-Incorporated (PPI)** into the soil before crop planting.
4. **Preemergence (PRE)** onto the soil before or after crop

planting, but before weed or crop emergence.

5. **Postemergence-overtop (POST)** onto weeds after the crop and weeds have emerged.
6. **Post-directed (DIR)** onto small weeds in rows of taller crops.

Good coverage of the entire weed is usually necessary to obtain maximum control with postemergence herbicides. Most soil-applied herbicides can be applied in 10 to 20 gallons per acre (gpa) of water. Postemergence herbicides often require a 10 to 20 gpa spray volume using flat fan or hollow cone spray tips. Consult the herbicide label for recommended spray volumes, pressures and application equipment.

### Incorporation

Incorporation of some preplant herbicides is necessary to prevent loss from the soil surface and to place the herbicide in the proper position for weed control. Incorporation may also improve weed control when rainfall is untimely or too low to activate the herbicide.

Allowable waiting periods between herbicide application and incorporation vary. The label gives the maximum acceptable waiting period for the herbicide. However, incorporating as quickly as possible after application will reduce the chances of obtaining poor weed control.

Incorporate herbicides into the top 1.5 to 3 inches of soil. Most weeds germinate within the upper 2 inches of soil. Incorporating a herbicide deeper than recommended on the label "dilutes" the herbicide and gives poor weed control. Incorporating a herbicide too shallow can result in vapor loss from the soil or failure to control weeds germinating below the herbicide zone.

Tandem disks, field cultivators, power-driven cultivation equipment and combination bed conditioners, such as a Do-All or Triple K, all give acceptable herbicide incorporation following seedbed preparation. Set tandem disks to cut to a depth of 4 to 6 inches. Operate them at 4 to 6 mph to obtain adequate incorporation to a depth of 2 to 3 inches. Set field cultivators and bed conditioners to cut 2 to 4 inches deep and operate them at a speed of at least 5 mph. Use field cultivators with three to four rows of sweeps spaced at 7 inches or less. Chisel points are unacceptable for incorporation with a field cultivator.

You need to make two passes for tandem disks, field cultivators and combination bed conditioners. Make the second pass at an angle to the first. You can use power-driven cultivators in a single pass, but don't exceed speeds of 4 mph. The spike-toothed harrow or the rotary hoe alone usually won't give satisfactory herbicide incorporation. Follow the equipment owner's manual and the herbicide label for settings for proper soil incorporation.

### Cultivation

You might want to cultivate shallowly for weed control when rows are spaced far enough apart to allow the use of cultivation equipment. Cultivation can be used to control weeds that escape after herbicide treatment or to control weeds in row middles when applying herbicides in a band. You can save money by banding herbicides over the row and

cultivating the middles. Don't use banding for rows narrower than 20 inches or when spraying perennials such as rhizome johnsongrass where cultivation is ineffective. Set cultivators shallow to prevent crop root pruning and new weeds' seeds from being brought to the soil surface.

A timely rotary hoeing can eliminate the need for postemergence herbicide or at least delay the need for a postemergence herbicide. Rotary hoes are especially useful in narrow-row or broadcast soybeans where you can't use conventional cultivators. You'll get best results with a rotary hoe when the crop has just emerged (just past the crook stage in soybeans, spike to two-leaf stage for corn and grain sorghum). Weeds should be just emerging (within two days). Soil surface should be dry in the top 2 inches for the best hoeing action. Using the hoe properly, you'll destroy less than 5 to 10 percent of a well-established crop stand. Do not use a rotary hoe if stands are already thin.

When following a preplant-incorporated herbicide, cultivate at less than half the depth of incorporation to prevent bringing untreated soil to the surface. Some preemergence herbicides require rainfall for activation to move the chemical into the soil. If it doesn't rain within seven days of application, you might be able to improve weed control with a shallow incorporation with a rotary hoe, harrow or field cultivator.

### Multiple applications

It is usually necessary to make more than one herbicide application to obtain broad spectrum weed control. You might need a preplant incorporated herbicide for grass control, followed by a preemergence treatment for broad-leaf weed control. You might need tank mixtures of two or more herbicides in one application to obtain broad spectrum control. We included only registered **package mixes** (mixtures formulated into one package by a manufacturer) and **tank mixes** (herbicides combined in the spray tank by the grower) in this guide.

### Types of herbicide formulations

This guide lists several herbicide formulations. The abbreviations used are: emulsifiable concentrates (EC), liquids (L), solutions (S), flowables (F), dry flowables (DF), wettable powders (WP) and water dispersible granules (WDG). Most spray mixtures require constant agitation to prevent the herbicide from settling to the bottom of the spray tank. Granular formulations (G) are dry formulations that cannot be mixed with water. Don't mix granular herbicides with other granular pesticides or fertilizers.

### Herbicide additives

Additives are substances added to the spray mixture to enhance effectiveness. Common additives used for weed control are as follows:

**Emulsifiers:** Substances that promote the suspension of one liquid in another (for example, oil into water).

**Surfactants:** Materials that modify wetting, spreading, dispersing, or emulsifying of liquids. Most herbicides that

require surfactants specify *nonionic surfactants*. Most surfactants sold for agricultural use are nonionic. Many surfactants sold for home or industrial use are not nonionic, so don't use them.

**Fertilizers:** Liquid fertilizers such as UAN and 10-34-0 and dry fertilizers such as ammonium sulphate are popular additives for several postemergence herbicides.

**Oil concentrates:** (Also crop oil concentrates). These are normally a mixture of non-phytotoxic oil and 10 to 20 percent surfactant. For herbicides that suggest an "oil concentrate," you can sometimes substitute soybean or vegetable oil concentrates for crop oil concentrates. However, some herbicide labels do not recommend the use of soybean oil. Consult the herbicide label before using a soybean oil.

**Methylated oils:** These can be manufactured from seed oils (such as sunflower) or petroleum oils. Be sure to consult the herbicide label for compatibility with these oils.

**Utility modifiers:** Two types are commonly used with herbicides.

1. Compatibility agents are frequently used to mix herbicides with liquid fertilizers.
2. Anti-foaming agents can be added to the tank or sprayed onto the solution surface to prevent foam or suds from forming when filling the spray tank.

**Spray modifiers:** The most common spray mix modifier used with herbicides is the *thickening agent or drift control agent*. These materials thicken the spray solution to reduce drift problems. These are usually used by aerial applicators.

Be sure you are using the proper additive for the herbicide you are using. Most herbicide labels specify the type and amount of additive to use. Failure to follow the recommendation can result in poor weed control or excessive crop injury. The proper additive is included in this guide when required or suggested by the label. It is also recommended that additives be purchased from reputable sources. Additives are not subject to quality-control regulations. Some herbicides have a list of specifically recommended products.

## Herbicide application

Proper herbicide application is necessary to obtain the best weed control. Check spray equipment frequently for even and proper spray output. Generally you should apply herbicides at pressures ranging from 20 to 40 psi *at the boom*, although some postemergence-contact herbicides require 40 psi or greater for adequate coverage. Most herbicide labels recommend a flat fan or hollow cone spray nozzle. Use stainless steel or nylon tips and 50-mesh screens with wettable powder, flowable or dry flowable formulations. Some herbicide labels state that excess speed with ground equipment (>10 mph) may result in erratic weed control due to poor coverage. Provide adequate agitation to keep herbicides suspended in the tank mix. Wettable powders and flowables are especially susceptible to settling in the tank. Use flat fan, even tips for band applications. All herbicide labels include recommendations for proper spray volume, pressure and nozzle types.

## Spray equipment

Accurate sprayer calibration is essential for proper herbicide application and weed control. Sprayer calibration is not difficult, but most people usually don't calibrate often enough. Screens may become blocked with trash and nozzles wear down, changing delivery patterns and spray rates. Thoroughly inspect and calibrate spray rigs at least once a year.

## Sprayer calibration

It is absolutely essential to know how much spray liquid the sprayer is delivering per acre at the speed and pressure the tractor is operating. Here is a simple method for calibrating a sprayer for broadcast or banding applications.

### Once calibration method

**Step 1.** Measure the specified distance in the field as determined in the following table. Select the distance that matches the nozzle spacing for broadcast or the row spacing for band applications. This table assumes that nozzle spacing equates to the effective band width per nozzle.

Row or nozzle spacing (inches)	Distance to time for calibration (feet)
40	102
38	107
36	113
34	120
32	127
30	136
28	146
26	157
24	170
22	185
20	204
18	227
16	255
14	291

**Step 2.** Drive the measured distance at the desired speed and record in seconds the amount of time it takes. Note: Perform the test in the field in which you will be spraying. Attach and operate any equipment you will be using during spraying (disk, planter).

**Step 3.** Using a measuring cup or baby bottle marked in fluid ounces, catch the discharge from a nozzle for as long as it took to travel your measured distance. If you use more than one nozzle to spray the same band or row (directed banding rigs) catch the spray from each nozzle.

**Step 4.** The total discharge per nozzle or row measured in step 3 in ounces equals the gallons per acre applied. If you used row spacing in step 1, you must measure all nozzles directed on the row to determine gallons per acre.

**Step 5.** Repeat the test for each nozzle to ensure even spray

distribution. Nozzles should vary no more than 5 percent across the boom.

Step 6. Divide tank capacity by gallons per acre determined in step 4 to calculate the number of acres one tankful of spray will cover.

$$\frac{\text{Tank capacity (gals.)}}{\text{GPA}} = \# \text{ of acres covered}$$

Step 7. Multiply the recommended herbicide rate by the number of acres covered per tank. (Measure rate and amount in ounces, pints, quarts, etc.)

$$\text{Rate x acres covered} = \text{Amount to add to tank}$$

Step 8. Band Application. All rates given in this guide are broadcast rates. You must adjust the rate for band applications using the following formula.

$$\frac{\text{Band width x Broadcast rate}}{\text{Row width}} = \text{Band rate}$$

Use the above formula to adjust rates if you have calibrated your sprayer on a row-width basis for band spraying.

## Calibration examples

### Example A. Broadcast.

A grower will apply trifluralin with a broadcast boom having nozzles spaced 18 inches apart while pulling a P.T.O.-driven ROTERRA for incorporation.

Step 1. The distance to travel for an 18-inch nozzle spacing is 227 feet. Measure the distance in the field to be sprayed.

Step 2. Measure the time to drive the distance with the incorporation implement. In this example, it took 39 seconds to cover 227 feet (4 mph).

Step 3. Set the pressure to be used and catch the output of one nozzle for 39 seconds.

Step 4. The output in ounces equals the amount of spray applied in gallons per acre. If the nozzle output was 20 ounces in 39 seconds, then the sprayer is applying 20 gpa.

Step 5. Repeat step 4 for each nozzle.

Step 6. Assume you have two 200-gallon saddle tanks and wish to apply 1.5 pints of trifluralin per acre.

$$\frac{400 \text{ gal per fill}}{20 \text{ gpa}} = 20 \text{ acres covered per fill}$$

Step 7. Since the recommended rate is 1.5 pints per acre, you would use 30 pints of trifluralin per refill (15 pints per 200 gallon tank).

$$1.5 \text{ pt/A} \times 20 \text{ acres} = 30 \text{ pints}$$

$$\frac{30 \text{ pints}}{2 \text{ tanks}} = 15 \text{ pints per tank}$$

### Example B. Band application.

Two nozzles spraying the same band.

A grower will apply Poast plus crop oil concentrate on a 15-inch band with a 30-inch row.

Step 1. The distance to travel for a 30-inch row is 136 feet.

Step 2. Measure the time required to travel 136 feet in the field. Let's say it took 23 seconds (4 mph).

Step 3. Set pressure and catch the output of each of the two nozzles spraying the band for 23 seconds.

Step 4. The output in ounces of the two nozzles combined is equal to the amount in gallons per acre. If the output of the two nozzles combined was 25 ounces, the sprayer is applying 25 gpa.

Step 5. Repeat step 4 for each set of tips.

Step 6. Assume the grower used a 200-gallon tank and a broadcast rate of 1.5 pints per acre of Poast and 1 quart per acre of crop oil concentrate.

$$\frac{200 \text{ gal tank}}{25 \text{ gpa}} = 8 \text{ acres covered per tank}$$

Step 7. Reduce the rates for a 15-inch band.

$$\frac{15 \text{ in. band} \times 1.5 \text{ pt/A broadcast}}{30 \text{ inch row}} = 0.75 \text{ pt/A Poast}$$

$$\frac{15 \text{ in. band} \times 1 \text{ qt/A broadcast}}{30 \text{ inch row (1 pt/A)}} = 0.5 \text{ qt/A crop oil}$$

Step 8.

$$8 \text{ acres} \times 0.75 \text{ pt/A} = 6 \text{ pints of Poast per refill.}$$

$$8 \text{ acres} \times 1 \text{ pt/A} = 8 \text{ pints of crop oil per refill.}$$

## Mixing chemicals in the tank

1. Fill tank 1/4 full with water, liquid nitrogen, or other desired carrier.
2. Start agitation.
3. Add wettable powders or water dispersible granules (WDG) first, than flowables or dry flowables.
4. Add liquids or emulsifiable concentrates next.
5. Add surfactants last when tank is nearly full, to minimize foaming.

## Tank-mix compatibility

Some liquid or dry fertilizers, adjuvants or herbicide combinations may be incompatible. Determine the compatibility of the herbicide with the specific fertilizer to be used. A compatibility agent may be necessary for certain liquid fertilizer/herbicide mixes. Use a jar test if you are uncertain about the compatibility of the mix.

1. Mix an approved compatibility agent and the fertilizer or water to be used in two 1-quart jars.
2. Add the herbicides and adjuvants in both of the jars in the same proportion as that used in the spray tank. Add dry herbicides first, flowables next and emulsifiable concentrates last. The amount and proportion vary with the herbicide. Check the label for each herbicide used. Add compatibility agent to one of the jars.
3. Invert or shake each jar at least 10 times to mix. Let the mixtures stand for 15 minutes.

4. If no separation, large flakes, precipitation, gels or heavy oil films form, you can use the mixture. If the mixture can be remixed after separation, the tank-mix can be used if good agitation is provided.
5. If the mixture is incompatible, try slurring dry herbicides in water before mixing. Also try adding half the compatibility agent to the fertilizer and half the compatibility agent to emulsifiable concentrate or flowable herbicides before mixing. If the mixture still separates the mix cannot be used. Always consult the label for compatibility tests and agents to use for the herbicides involved.

## Cleaning spray equipment

After using a sprayer, you should flush tanks, lines, booms and nozzles with water for a minimum of 5 minutes. After using any herbicide and flushing the sprayer with water, add any of the following plus detergent, surfactant, or spray tank cleaner to the filled tank, then flush the cleaning solution through the boom, hoses and nozzles. Add more water and then clean again by running the pump and agitation for at least 15 minutes. Remove nozzle and screens and clean separately in a bucket of the cleaning agent and water. Add the following in 50 gallons of water to make the cleaning solution:

1. 0.5 gallon of household ammonia (let stand in sprayer overnight for growth regulator type herbicides such as 2, 4-D, Banvel, or Tordon).
2. 4 pounds trisodium phosphate cleaner.
3. 2.5 pounds sal soda.

Some herbicides have specified cleanout procedures. Check label for specific instructions. Consult guidesheet G4852, *Cleaning Field Sprayers to Avoid Crop Injury* for additional information.

## Algae and moss control in tanks

Moss and algae will appear in plastic tanks during warm weather. There are three ways to prevent or eliminate algae and moss:

1. Keep tanks dry when not in use.
2. Paint tanks black to block sunlight. Algae will not grow without sunlight.
3. Use copper sulfate. Measure copper sulfate by dissolving 1 ounce in a pint of water. Then add 7.5 tablespoons of the copper sulfate solution to each 100 gallons of water and mix.

## Pesticide container disposal

Triple rinse all pesticide containers and puncture them before disposing of them in an approved burial site or sanitary landfill. Missouri has a pesticide container recycling program. Contact your dealer or local University of Missouri Extension center for information. Follow local regulations.

## Ground and surface water protection

Contamination of ground and surface water with pesticides has become a growing public concern. Well-water

monitoring of pesticides in Missouri indicates very little pesticide contamination in the state. The levels that have been detected are generally in the parts per billion (ppb) range and are below current health advisory levels considered safe for drinking water. Point-source contamination is usually suspected where levels over a few ppb are detected in water supplies.

Point-source problems are related to a confined area, event or site such as mixing, storage or transport sites. Point-source contamination is probably responsible for a majority of the pesticide detections in wells. These sources of contamination are relatively easy to correct.

The potential for point-source contamination can be reduced by following these suggestions:

1. Mix chemicals in the field away from wells and water sources.
2. If chemicals must be mixed or stored at the well site, use hoses to maintain at least a 150-foot buffer from the well to the spray tank.
3. Keep filling hoses out of the spray tank, maintain an air gap, use check valves and do not leave tanks unattended while filling to avoid back siphoning or overflow.
4. Never dump rinsate or concentrated product in a localized area. Spilling 4 oz. of a chemical in a 100-square-foot area is the equivalent of applying 100 lb per acre! Dispose of rinsate by applying to a labeled crop site.
5. Triple rinse herbicide containers into the spray tank before disposal or return.
6. Properly construct, grout and case new well construction. Properly cap and seal abandoned wells.

Spills or back siphoning of any consequence have the potential to contaminate ground or surface water unless handled properly and promptly. Report spills to the Missouri Department of Natural Resources and local authorities.

**Missouri Department of Natural Resources:  
Environmental Emergency Response  
(573) 634-2436**

Nonpoint water pollution occurs over a broad, generally ill-defined area and the direct cause of contamination may not be readily apparent. Leaching from general field applications within labeled guidelines is often mentioned as a possible cause of nonpoint-source pollution. Field application of herbicides is actually a rare form of water pollution. However, the following steps will further minimize the potential for water contamination.

1. Select herbicides with shorter residual half-lives and strong soil adsorption characteristics, especially for late-season herbicide applications.
2. Leave buffer strips around sinkholes, streams and bodies of water.
3. When possible, banding herbicides, using herbicides with higher unit activity (applied at low lb/A rates), and the use of the reduced-rate herbicide recommendations in this guide can all reduce the overall pesticide load on the environment.
4. Properly calibrate and maintain sprayer equipment to avoid over application.
5. Use practices such as crop rotation, herbicide rota-

tion and cultivation in addition to herbicides for weed control.

6. Use conservation or no-tillage practices on erodible land to reduce off-site herbicide movement that occurs with surface water runoff.
7. See special information for atrazine and cyanazine products.

Good land stewardship dictates that herbicide characteristics be assessed in relation to their ground or surface water pollution potential. Reducing the potential for groundwater pollution (especially point-source contamination) will help ensure the continued availability of agricultural chemicals as an important tool in crop production while protecting our water resources.

**Warning:** The chance of having herbicide crop injury is increased when several herbicides are applied to the same crop. Adherence to labeled rates is especially important when making multiple herbicide applications.

## Weed resistance to herbicides

Weed resistance to many herbicides has been confirmed around the world. The ALS/AHAS inhibiting herbicides (including Accent, Beacon, Classic, Exceed, FirstRate, Harmony Extra, Permit, Pinnacle, Pursuit, Scepter and others) have had numerous cases of herbicide-resistant weeds developing. It is a good general practice to rotate herbicides and herbicide families in a field. Other practices such as cultivation and sequential applications of herbicides from different families can help to reduce the probability of herbicide-resistant weed populations appearing. Herbicide modes of action are given in the table of herbicide name, active ingredients, modes of action and manufacturers found on page 10. Additional information on herbicide family groups, and suggestions for preventing weed resistance problems can be obtained from your county Extension office, your dealer and herbicide manufacturers.

## Special information for atrazine

Atrazine-containing products may not be mixed, loaded or used within 50 feet of any well, including abandoned drainage wells and sinkholes.

In conventional tillage, atrazine may not be surface applied within 66 feet of points where field surface water runoff enters perennial or intermittent streams and rivers or within 200 feet of natural or impounded lakes and reservoirs. On highly erodible land as defined by the USDA Natural Resources Conservation Service (NRCS), the 66-foot buffer for runoff points from fields MUST be planted to crop or seeded with grass.

**Note:** This restriction is voided if (1) the herbicide is applied to fields with heavy plant residues (no-till) or (2) the herbicide is incorporated in conventional tillage crop production.

The maximum annual rate for preemergence application on land designated as having “highly erodible soils” as defined by the NRCS will be 2.0 lb/A active ingredient (a.i.) of atrazine on fields with greater than 30% surface residue and 1.6 lb a.i./A on fields with less than 30% surface residue. The maximum rate on soils not designated as highly

erodible is 2.0 lb a.i./A of atrazine. The maximum annual rate for postemergence applications of atrazine are 2.0 lb a.i./A in fields with no soil-applied atrazine in the same year. The maximum annual amount must not exceed 2.5 lb a.i./A where a soil-applied plus a postemergence application of atrazine is made to a field in the same year.

## Conservation tillage

### Weed control programs

Obtaining good weed control in reduced tillage or no-tillage cropping systems is an important component of successful conservation tillage crop production. Eliminating heavy tillage operations reduces horsepower requirements for farm tractors and reduces the number of trips across the field. Surface mulches from crop residues protect the topsoil from erosion and maintain a higher supply of soil moisture. However, you might need to rely more heavily on herbicides for weed control because you can't till or cultivate.

**Reduced tillage.** There are several reduced tillage systems used for crop production in Missouri. With some systems, primary tillage is completed during dry periods in the fall and winter weeds provide soil protection. A burndown herbicide is then applied before planting. This is sometimes termed *stale seedbed*. In other systems, the soil is worked just enough before planting that winter and annual weeds are controlled; however, residue from the previous year's crop remains to provide ground cover. This system is sometimes termed *stubble* or *mulch tillage*. Perennial weeds are likely to be greatest in this system because tillage is not severe enough to control the deep root systems, and shallow tillage actually spreads these roots.

**Ridge-till** is also practiced in some areas of Missouri. This system provides more winter cover than chisel-disk systems and still allows in-crop cultivation for weed control. This allows herbicide use to be reduced as in conventional tillage systems by banding in the row and cultivating between rows. However, ridge-till is most suited to gently sloping land (less than 2%) and still allows considerable surface water runoff. This can be an advantage on relatively flat, poorly drained fields.

Ridge-till requires frequent trips through the field for cultivation and to maintain the ridges. The ridges are also difficult to maintain during winter small-grain production. Burndown herbicides may also be required as in no-till to control winter weeds before planting. Perennial weeds will also be spread by the shallow tillage as with chisel and disk systems.

**No-till** is rapidly becoming the most important and widely used method of crop production on highly erodible land in Missouri. This system can control erosion and increase water infiltration. Compaction is often lessened in no-till.

You will need herbicide treatments to control winter and early spring weeds, and cover crops that emerge before planting in no tillage (and some ridge-till) fields and to control weeds that emerge later in the season. Winter and early spring weeds, winter cover crops, and sods growing in a no-tillage field can actually deplete soil moisture levels

before planting. This can eliminate the soil-moisture-conserving advantages of the no-tillage mulch. We recommend applying burndown herbicides two weeks before planting for cover crop control. This prevents the cover crop from using available soil moisture in dry years and aids in soil drying and crop seedling establishment in wet years. However, herbicides will be required to kill most cover crops and sods and to reduce the spread of perennial weeds.

Planting crops in narrower rows can enhance weed control in any tillage system by causing the crop canopy to close earlier. Shading the weeds and soil as early as possible makes the crop less susceptible to weed competition and can reduce late-season weed germination or emergence.

Herbicide recommendations made in the no-tillage sections of this guide are designed to control weeds that emerge

before planting and also provide residual weed control. If you apply herbicides preemergence either before or after crop planting, do so at higher spray volumes with contact herbicides such as Gramoxone and atrazine (20 to 40 gpa). This improves herbicide penetration through the mulch cover. The only exception is Roundup and mixtures containing Roundup, which are more effective applied in 10 gpa of water.

Some of the herbicide applied preplant or preemergence will be intercepted by the mulch cover; to compensate for this, you need to use the higher recommended rates for your soil type. Consult the herbicide label for specific directions for no-tillage applications. Postemergence herbicides perform similarly in conventional or reduced tillage systems.

**Herbicide trade and common name, formulation, mode of action, and manufacturer**

Trade name	Common name	Formulation	Mode of action <sup>c</sup>	Manufacturer
AAtrex 4L	atrazine	4 lb/gal	PSE	Syngenta
AAtrex Nine-0	atrazine	90%	PSE	Syngenta
Accent 75DF	nicosulfuron	75%	ALS	DuPont
Achieve	tralkoxydim	50%	ACC	Syngenta
Aim 2EC and 2EW	carfentrazone-ethyl	40%	PPO	FMC
Amplify 84DG	Cloransulam	84%	ALS	Monsanto
Assure II 0.88 EC	quizalofop	0.88 lb/gal	ACC	DuPont
Authority Assist	sulfentrazone + imazethapyr	3.33 lb + 0.67 lb/gal	PPO + ALS	FMC
Authority First	sulfentrazone + cloransulam	62.1% + 7.9%	PPO + ALS	FMC
Authority MTZ	sulfentrazone + metribuzin	18% + 27%	PPO + PSE	FMC
Autumn 10WDG	iodosulfuron	10%	ALS	Bayer
Axial	pinoxaden	0.83 lb/gal	ACC	Syngenta
Axiom 68 DF	flufenacet + metribuzin	54.4 + 13.6%	GGI + PSE	Bayer
Axiom AT	atrazine + flufenacet + metribuzin	50.5 + 19.% + 4.9%	PSE + GGI + PSE	Bayer
Banvel 4E	dicamba	4 lb/gal	GR	MicroFlo
Basagran 4S	bentazon	4 lb/gal	PSE	MicroFlo
Beacon 75DF	primisulfuron	75%	ALS	Syngenta
Balance Flexx	isoxaflutole + safener	2 lb/gal	PI	Bayer
Balance Pro 4L	isoxaflutole	4 lb/gal	PI	Bayer
Basis 75DF	rimsulfuron + thifensulfuron	50 + 25%	ALS + ALS	DuPont
Bicep II Magnum 5.5L	atrazine + S-metolachlor	3.1 + 2.4 lb/gal	PSE + GGI	Syngenta
Bicep Lite II Magnum 6L	S-metolachlor + atrazine	3.33 + 2.67 lb/gal	GGI + PSE	Syngenta
Blazer 2L	acifluorfen	2 lb/gal	PPO	BASF
Boundary 6.5 EC	S-metolachlor + metribuzin	5.25 + 1.25 lb/gal	GGI + PSI	Syngenta
Breakfree	acetochlor + antidote	6.4 lb/gal	GGI	DuPont
Breakfree ATZ	acetochlor + atrazine	3 + 2.5 lb/gal	GGI + PSE	DuPont
Broclean 4L	bromoxynil	2 lb/gal	PSE	Platte Chemical
Bronate 4AS	bromoxynil + MCPA	2 + 2 lb/gal	PSE + GR	Bayer
Buctril 2EC	bromoxynil	2 lb/gal	PSE	Bayer
Buctril 4EC	bromoxynil	4 lb/gal	PSE	Bayer
Buctril + Atrazine 3L	bromoxynil + atrazine	1 + 2 lb/gal	PSE + PSE	Bayer
Bullet 4F	alachlor + atrazine	2.5 + 1.5 lb/gal	GGH + PSI	Monsanto
Butyrac 200	2,4-DB	2 lb/gal	GR	Bayer
Cadet	fluthiacet-methyl	0.91 lb/gal	PPO	FMC
Callisto	mesotrione	4 lb/gal	PI	Syngenta
Camix 3.7L	S-metolachlor + mesotrione	3.34 + 0.33 lb/gal	GGI + PI	Syngenta
Canopy 75 DF	metribuzin + chlorimuron	64.3% + 10.7%	PSE + ALS	DuPont
Canopy EX	chlorimuron + tribenuron	22.7% + 6.8%	ALS + ALS	DuPont
Cinch 7.64EC	S-metolachlor	7.64 lb/gal	GGI	DuPont
Cinch ATZ 5.5L	atrazine + S-metolachlor	3.1 + 2.4 lb/gal	PSE + GGI	DuPont
Cinch Lite ATZ 6L	S-metolachlor + atrazine	3.33 + 2.67 lb/gal	PGE + GGI	DuPont
Clarity 4L	Dicamba	4 lb/gal	GR	BASF
Classic 25DF	chlorimuron	25%	ALS	DuPont
Cobra 2EC	lactofen	2 lb/gal	PPO	Valent
Command 3 ME	clomazone	2 lb/gal	PI	FMC
Conclude Xact B 4L	bentazon + acifluorfen	2.67 + 1.33 lb/gal	PSE + PPO	BASF
Conclude Xact G 2EC	sethoxydim	2 lb/gal	ACC	BASF
Corvus	thiencarbazone + isoxaflutole + safener	2.6 lb/gal	ALS + PI	Bayer
Credit	glyphosate	3 lb/gal	EPSP	Nu-farm
Cornerstone	glyphosate	3 lb/gal	EPSP	Winfield

## Herbicide trade and common name, formulation, mode of action, and manufacturer

Trade name	Common name	Formulation	Mode of action <sup>c</sup>	Manufacturer
Define	flufenacet	4 lb/gal	GGI	Bayer
Degree 3.8L	acetochlor + safener	3.8 lb/gal	GGI	Monsanto
Degree Xtra 4.04L	acetochlor + atrazine	2.7 + 1.34 lb/gal +		Monsanto
Domain 60DF	metribuzin + flufenacet	24 + 36%	PSE + GGI	Bayer
Distinct 70WG	dicamba + diflufenzopyr	55 + 15%	GR	BASF
Dual II Magnum 7.64EC	S-metolachlor	7.64 lb/gal	GGI	DuPont
Duramax	glyphosate (dimethylamine salt)	4 lb acid eq./gal	EPSP	Dow
Durango DMA	glyphosate (dimethylamine salt)	4 lb acid eq./gal	EPSP	Dow
Enlite	flumioxazin + chlorimuron + thifensulfuron	36.2% + 2.9% + 8.8%	PPO + ALS + ALS	DuPont
Envive	flumioxazin + chlorimuron + thifensulfuron	29.2% + 9.2% + 2.9%	PPO + ALS + ALS	DuPont
Epic 58DG	flufenacet + isoxaflutole	58 + 10%	GGI + PI	Bayer
Equip 32DG	foramsulfuron + iodosulfuron	30 + 2%	ALS + ALS	Bayer
Expert 4.9L	atrazine + S-metolachlor + glyphosate	2.14 + 1.74 + 1 lb/gal	PSE + GGI + EPSP	Syngenta
Express TotalSol	tribenuron-methyl	50%	ALS	DuPont
Extreme 1.67L <sup>b</sup>	glyphosate + imazethapyr	1.5 + 0.17 lb/gal	EPSP + ALS	BASF
Fieldmaster 4.25L	acetochlor + atrazine + glyphosate	2 + 1.5 + 0.56 lb/gal	GGI + PSE + EPSP	Monsanto
Finesse	chlorsulfuron + metsulfuron	62.5 + 12.5 WG	ALS	DuPont
Finess Grass + Broadleaf	chlorsulfuron + flucarbazone	25% + 46.7%	ALS + ALS	DuPont
FirstRate 84DG	cloransulam	84%	ALS	Dow
Flexstar 1.88ME	fomesafen + adjuvants	1.88 lb/gal	PPO	Syngenta
Frontrow 80 + 84DG	cloransulam + flumetsulam	80 + 84%	ALS + ALS	Dow
Fultime 4CS	acetochlor + atrazine	2.4 + 1.6 lb/gal	GGI + PSE	Dow
Fusilade DX	fluazifop	2 lb/gal	ACC	Syngenta
Fusion 2.66EC	fluazifop + fenoxaprop	2 + 0.66 lb/gal	ACC + ACC	Syngenta
Gangster (co-pack)	flumioxazin + cloransulam	51% + 84%	PPO + ALS	Valent
Glyfos/Glyfos Xtra	glyphosate	3 lb/gal	EPSP	Chemnova
Glyphosate Original	glyphosate (dimethylamine salt)	3 lb/gal	EPSP	Griffin
Gramoxone Max 3SL	paraquat	3 lb/gal	GMD	Syngenta
Guardzman Max	atrazine + dimethenamid-P	3.3 + 1.7 lb/gal	PSE + GGI	BASF
G-Max Lite	atrazine + dimethenamid-P	2.75 + 2.25 lb/gal	PSE + GGI	BASF
Halex GT	S-metolachlor + glyphosate + mesotrione	2.09 + 2.09 + 0.209 lb/gal	GGI + EPSP + PI	Syngenta
Harmony Extra 75DF	thifensulfuron + tribenuron	50 + 25%	ALS + ALS	DuPont
Harmony Extra TotalSol	thifensulfuron + tribenuron	33.3% + 16.7%	ALS + ALS	DuPont
Harmony SG TotalSol	thifensulfuron	50%	ALS	DuPont
Harmony GT	thifensulfuron	75%	ALS	DuPont
Harness 7EC	acetochlor + antidote	7 lb/gal	GGI	Monsanto
Harness Xtra 5.6L	acetochlor + atrazine	3.1 + 2.5 lb/gal	GGI + PSE	Monsanto
Harness Xtra 6L	acetochlor + atrazine	4.3 + 1.7 lb/gal	GGI + PSE	Monsanto
Hoelon 3EC	diclofop	3 lb/gal	ACC	Bayer
Hornet 78.5 WDG	clopyralid + flumetsulam	60 + 18.5%	GR + ALS	Dow
Ignite	glufosinate	2.3 lb/gal	GS	Bayer
Impact 2.8SC	topramezone	2.8 lb/gal	PI	Amvac
Intrro 4EC	alachlor	4 lb/gal	GGI	Monsanto
Keystone 5.25L	acetochlor + atrazine	3 + 2.5 lb/gal	GGI + PSE	Dow
Laddok S-12	bentazon + atrazine	2.5 + 2.5 lb/gal	PSE + PSE	BASF
Landmaster II 1.7 E	glyphosate + 2,4-D amine	0.9 + 0.8 lb/gal	EPSP + GR	Monsanto
Lasso 4EC	alachlor	4 lb/gal	GGI	Monsanto
Lariat 4F	alachlor + atrazine	2.5 + 1.5 lb/gal	GGI + PSE	Monsanto

**Herbicide trade and common name, formulation, mode of action, and manufacturer**

Trade name	Common name	Formulation	Mode of action <sup>c</sup>	Manufacturer
Laudis	tembotrione + safener	3.5 lb/gal	PI	Bayer
Lexar 3.7L	S-metolachlor + atrazine + mesotrione	1.74 + 1.74 + 0.224 lb/gal	GGI + PSE + PI	Syngenta
Liberty 1.67L	glufosinate	1.67 lb/gal	GS	Bayer
Liberty ATZ 4.3L	atrazine + glufosinate	3.3 + 1 lb/gal	PSE + GS	Bayer
Linex 4L	linuron	4 lb/gal	PSE	DuPont
Lumax 3.948L	S-metolachlor + atrazine + mesotrione	2.68 + 1 + 0.268	GGI + PSE + PI	Syngenta
MCP amine 4L	MCPA	4 lb/gal	GR	Dow, others
Micro-Tech 4L	alachlor	4 lb/gal	GGI	Monsanto
Mirage	glyphosate	3 lb/gal	EPSP	UAP
NorthStar 47.4DG	dicamba + primisulfuron	39.9 + 7.5%	GR + ALS	Syngenta
Olympus 70WDG	propoxycarbazone	70%	ALS	Bayer
Olympus Flex	propoxycarbazone + mesosulfuron	6.75 + 4.5	ALS + ALS	Bayer
Option 35DG	foramsulfuron	35%	ALS	Bayer
Osprey 4.5WDG	Mesosulfuron	4.5%	ALS	Bayer
Outlook	dimethenamid-P	6 lb/gal	GGI	BASF
Paramount	quinclorac	75%	GR	BASF
Partner 65DG	alachlor	65%	GGI	Monsanto
Peak 57DG	prosulfuron	57%	ALS	Syngenta
Permit 75DG	halosulfuron	75%	ALS	Gowan
Phoenix 2EC	lactofen	2 lb/gal	PPO	Valent
Poast 1.5L	sethoxydim	1.5 lb/gal	ACC	MicroFlo
Prefix	S-metolachlor + fomesafen	4.34 lb/gal + 0.95 lb/gal	GGI + PPO	Syngenta
Poast Plus 1E	sethoxydim	1 lb/gal		MicroFlo
Princep 4L	simazine	4 lb/gal	PSI	Syngenta
Princep Caliber 90	simazine	90%	PSI	Syngenta
Propel	dimethenamid-P	6.0 lb/gal	GGI	Rosen's
Propel ATZ	dimethenamid-P + atrazine	1.7 + 3.3 lb/gal	GGI + PSE	Rosen's
Prowl H <sub>2</sub> O 3.8ACS	pendimethalin	3.8 lb/gal	MGI	BASF
Pursuit 2AS	imazethapyr	2 lb/gal	ALS	BASF
Pursuit Plus 2.9E	imazethapyr + pendimethalin	0.2 + 2.7 lb/gal	ALS + MGI	BASF
Python 80WDG	flumetsulam	80%	ALS	Dow
Rage D-Tech	carfentrazone + 2,4-D ester	0.13 lb + 5.9 lb/gal	PPO + GR	FMC
Raptor 1AS	imazamox	1 lb/gal	ALS	BASF
Ready Master ATZ	glyphosate + atrazine	2 + 2 lb/gal	EPSP + MGI	Monsanto
Reflex 2LC	fomesafen	2 lb/gal	PPO	Syngenta
Require Q	rimsulfuron + dicamba	6.3% + 52.9 %	ALS + GR	DuPont
Resolve	rimsulfuron	25%	ALS	DuPont
Resolve Q	rimsulfuron + thifensulfuron	18.4% + 4%	ALS + ALS	DuPont
Resource 0.86EC	flumiclorac-pentyl	0.86 lb/gal	PPO	Valent
Roundup Ultra 3L	glyphosate	3 lb acid eq./gal	EPSP	Monsanto
Roundup PowerMax	Glyphosate (potassium salt)	4.5 lb acid eq./gal	EPSP	Monsanto
Roundup WeatherMax 4.5L	Glyphosate (potassium salt)	4.5 lb acid eq./gal	EPSP	Monsanto
Scepter 70DG	imazaquin	70%	ALS	BASF
Select 2EC	clethodim	2 lb/gal	ACC	Valent
Select Max	clethodim	0.97 lb/gal	ACC	Valent
Sencor 4L	metribuzin	4 lb/gal	PSE	Bayer
Sencor 75DF	metribuzin	75%	PSE	Bayer
Sequence 5.25L	glyphosate + S-metolachlor	2.25 + 3 lb/gal	EPSP + GGI	Syngenta
Shotgun 3.25L	atrazine + 2,4-D	2.25 + 1 lb/gal	PSE + GR	United Ag Products

## Herbicide trade and common name, formulation, mode of action, and manufacturer

Trade name	Common name	Formulation	Mode of action <sup>c</sup>	Manufacturer
Sonalan 3EC	ethalfluralin	3 lb/gal	MGI	Dow
Sonic	sulfentrazone + cloransulam methyl	62.1% + 7.9%	PPO + ALS	Dow
Spartan 4F	sulfentrazone	75%	PPO	FMC
Spirit 57DG	primisulfuron + prosulfuron	42.8 + 14.2%	ALS + ALS	Syngenta
Starane 1.5L	fluroxypyr	1.5 lb/gal	GR	Dow
Status	dicamba + diflufenzopyr + isoxadifen (safener)	16 + 40%	GR	BASF
Steadfast 75DG	nicosulfuron + rimsulfuron	50% + 25%	ALS + ALS	DuPont
Storm 4L	bentazon + acifluorfen	2.67 + 1.33 lb/gal	PSE + PPO	BASF
Stout 72.5 DF	nicosulfuron + thifensulfuron	67.5% + 5%	ALS + ALS	Dow
SureStart 4.25L	acetochlor + flumetsulan + clopyralid	3.75 + 0.12 + 0.38 lb/gal	GGI + ALS + GR	Dow
Surpass 6.4EC	acetochlor + antidote	6.4 lb/gal	GGI	Dow
Synchrony STS XP	chlorimuron + thifensulfuron	21.5 + 6.9%	ALS + ALS	DuPont
TopNotch 3.2 CS	acetochlor	3.2 lb/gal	GGI	Dow
Touchdown HiTech 5L	glyphosate (potassium salt)	5 lb acid eq./gal	EPSP	Syngenta
Touchdown Total	glyphosate (potassium salt)	4.17 lb acid eq./gal	EPSP	Syngenta
Treflan 4HFP	trifluralin	4 lb/gal	MGI	Many
Treflan 10G	trifluralin	10%	MGI	Many
Trific 60DF	trifluralin	60%	MGI	Riverside/Terra
Trilin 4E	trifluralin	4 lb/gal	MGI	Griffin
Trilin 10G	trifluralin	10%	MGI	Tri Corporation
Ultra Blazer	acifluorfen	2 lb/gal	PPO	BASF
Unity 75WDG	thifensulfuron	75%	ALS	Gowan
Valor 51 SX	flumioxazin	51%	PPO	Valent
Valor XLT	flumioxazin + chlorimuron	30% + 10.3	PPO + ALS	Valent
Yukon 67.5 DF	dicamba + halosulfuron	55 + 12.5%	ALS	Monsanto
Zorial 80DF	norflurazon	80%	PI	Syngenta
2,4-D amine or ester	2,4-D	several	GR	Many

<sup>a</sup>The Backdraft label states that the formulation is 1.35 lb/gal with 1.2 lb/gal glyphosate IPA salt. However, in this guide, glyphosate is expressed as the acid form. Backdraft contains 0.9 lb glyphosate acid/gal.

<sup>b</sup>The Extreme label states that the formulation is 2.17 lb/gal with 2lb/gal glyphosate IPA salt. However, in this guide, glyphosate is expressed as the acid form. Backdraft contains 1.5 lb glyphosate acid/gal.

<sup>c</sup>Mode of action abbreviations: ACC: Acetyl Coenzyme A carboxylase, the target enzyme for lipid synthesis by selective grass herbicides; ALS: Acetolactate synthase, the target enzyme for branch-chain amino acid synthesis, numerous herbicides; EPSP: 5-enolpyruvylshikimate-3-phosphate synthase enzyme for aromatic amino acid synthesis; GGI: General inhibitor of root and shoot growth; GMD: General membrane disruptor; GR: Growth regulating, hormone imitating herbicide; GS: Glutamine synthetase inhibitor, which results in the build-up of free ammonia; MGI: Mitotic inhibitor of root growth; MISC: Miscellaneous and unknown mode of action; PPO: Protoporphryn IX inhibitor, which ultimately results in membrane disruption; PI: Pigment inhibitor; PSE: Photosynthetic electron transport inhibitor, which ultimately results in membrane disruption.

**No-tillage burndown**  
Guide to weed response to herbicides

Herbicide	Preplant Interval (days)**						Winter Weeds																					
	Corn	Cotton	Grain sorghum	Rice	Small grain	Soybeans	Annual bluegrass	Little barley	Cheat/downy brome	Annual ryegrass	Bittercress	Buttercup	Chickweed	Curly dock (established)	Cutleaf eveningprimrose	Dandelion	Field pennycress	Geranium species	Henbit	Horseweed (marestail)	Prostrate knotweed	Purslane speedwell	Rough (daisy) fleabane	Shepherdspurse	Vetch	Virginia pepperweed	Prickly lettuce	
2,4-D	**	**	**	**	NL	**	0	0	0	0	9	9	5	4	9	8	8	-	4	8	-	9	6	9	9	9	9	8
Aim	0	0	0	0	0	0	1	1	1	1	-	-	2	1	5	-	-	2	5	3	-	-	-	2	2	2	2	-
Atrazine	0	NL	0	NL	NL	NL	10	10	7	6	9	10	10	4	7	4	8	8	8	8	9	7	10	7	10	9	9	9
Balance Flexx	0	NL	NL	NL	NL	NL	-	-	-	-	-	-	-	-	-	-	8	-	8	-	-	-	-	-	-	-	-	-
Banvel/Clarity	7	NL	15	NL	NL	NL	0	0	0	0	7	7	5	7	5	7	8	-	8	8	-	5	8	8	7	9	7	9
Basis	0	NL	NL	NL	NL	NL	9	-	6	2	7	9	9	3	6	7	9	7	9	6	-	7	8	9	9	5	7	7
Canopy EX	NL	NL	NL	NL	NL	NL	0	0	0	0	10	9	10	5	6	7	9	7	9	6	-	10	8	9	9	-	9	9
Distinct/Status	***	NL	NL	NL	NL	30	1	1	1	1	8	7	6	7	5	7	8	8	8	8	-	-	8	8	9	9	9	-
Glyphosate	0	0	0	0	0	0	10	9	9	9	8	9	10	4	6	5	9	8	9	9	7	9	5	10	6	10	8	8
Gramoxone Max	0	0	0	0	0	0	9	9	8	9	9	9	10	1	8	4	8	9	9	6	6	5	5	10	8	8	7	
Sencor	NL	NL	NL	NL	NL	0	-	10	8	5	10	9	10	-	6	-	-	7	8	6	6	6	-	6	6	6	8	
Scepter	NL	NL	NL	NL	NL	0	-	4	3	5	5	9	9	-	5	-	9	5	7	4	5	-	2	9	-	9	5	
Spartan	NL	NL	NL	NL	NL	0	3	2	3	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	
Valor	30	30	30	30	NL	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Valor XLT	NL	NL	NL	NL	NL	4	-	1	1	1	5	5	6	4	-	8	6	5	8	6	-	6	-	6	7	-	-	5

\* NL = Not labeled  
 \*\* For 2,4-D, see label for details regarding rates and formulations. Be sure to use a 2, 4-D formulation that is labeled for the target crop.  
 \*\*\* Corn can be planted 14 days after a Distinct application of 6 oz or less, 21 days if more than 6 oz is used.

## No-tillage burndown Guide to weed response to herbicides

Herbicide	Summer weeds														Cover crops						Established sods						
	Barnyardgrass	Broadleaf signalgrass	Crabgrass	Giant foxtail	Goosegrass	Rhizome johnsongrass	Red rice	Common cocklebur	Common lambsquarters	Entire/ivyleaf morningglory	Redroot/smooth pigweed	Pitted morningglory	Prickly sida/teaweed	Ragweed, common	Ragweed, giant	Annual smartweed species	Annual rye	Winter wheat	Alfalfa	Crimson clover	Red clover	Hairy vetch	Fescue	Orchardgrass	Timothy	Alfalfa	
2,4-D	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	0	0	7	8	8	9	0	0	0	0	6
Aim	1	1	1	1	1	0	0	6	9	7	9	7	7	7	7	7	1	0	-	-	-	-	-	-	-	-	-
Aatrex	-	-	7	7	0	0	-	9	10	9	9	9	-	9	9	10	6	6	4	3	5	7	2	4	4	4	3
Balance Flexx	-	-	-	9	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barvel/Clarity	0	0	0	0	-	0	0	8	8	8	8	9	8	9	9	7	0	0	9	8	9	9	0	0	0	0	8
Basis	8	-	7	5	-	2	-	5	9	4	7	4	-	7	5	8	-	5	5	5	5	5	-	-	-	3	
Canopy EX	0	-	1	1	1	0	-	5	6	4	7	4	-	8	7	8	-	1	4	5	5	5	-	-	-	4	
Distinct/Status	2	2	1	2	0	0	0	8	9	9	9	8	8	9	9	8	1	1	8	8	8	8	0	1	1	1	8
Glyphosate	8	9	9	9	9	9	7	9	9	7	8	7	7	9	9	8	9	9	4	3	6	6	6	6	6	2	
Gramoxone Max	9	9	8	8	8	3	8	6	8	5	5	6	8	8	8	7	9	6	4	9	4	8	5	3	3	3	
Sencor	-	-	8	-	5	7	8	8	8	7	8	7	8	7	7	7	9	9	4	3	5	5	5	5	5	2	
Scepter	7	2	3	3	7	5	-	10	4	5	10	6	3	6	6	7	4	4	3	2	5	3	-	-	-	3	
Spartan	3	3	7	7	2	0	-	7	8	10	10	9	9	-	-	7	-	-	-	-	-	-	-	-	-	-	
Valor	2	-	1	1	1	0	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	
Valor XLT	5	-	5	5	5	3	1	-	7	8	9	9	9	8	8	8	-	6	4	4	4	4	1	2	2	2	

Weed control: 8 to 10 = good 6 to 7 = Fair\* Less than 6 = poor - = No data available  
 \*A weed control rating of 6 to 7 indicates partial control or suppression.

Use this table as a guide for comparing the relative effectiveness of herbicides on individual weeds. Herbicides may perform better or worse than indicated due to extreme weather conditions and other variables if you are obtaining satisfactory results under your growing conditions, changing products as a result of information in this table is not necessarily recommended.

Due to the overwhelming number of package mixes and tank mixes, it has

become impractical to list and distinguish these combinations. In the interest of fairness, we are therefore listing no package mixes in this table. A reasonably accurate estimate may be obtained by combining the control ratings from the individual package or tank-mix components

## Corn

### Guide to grass and sedge weed response to herbicides

Herbicide	Barnyardgrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Giant foxtail	Goosegrass	Johnsongrass, seedling	Johnsongrass, rhizome	Red rice	Shattercane	Woolly cupgrass	Yellow nutsedge	Crop response***
<b>Preplant or preemergence</b>													
Atrazine	8	6	5	3	7	6	2	0	8	0	4	0	0
Balance Flexx	8	7	8	9	7	-	7	0	5	6	9	4	1
Bicep II Magnum/Cinch ATZ/ Others	9	7	9	8	9	-	5	1	-	5	6	8	1
Callisto	4	6	5	-	2	6	0	0	5	1	-	-	0
Camix	9	-	9	8	9	-	3	1	-	4	6	8	1
Corvus	9	8	9	7	9	8	9	6	-	6	6	4	1
Degree Xtra	9	-	9	8	9	-	5	1	-	4	5	8	1
Dual II Magnum/Cinch	8	7	9	9	9	9	6	0	8	5	7	8	1
Guardsman Max	9	-	8	8	8	-	5	1	-	4	7	8	1
Harness/Breakfree/Degree	8	7	9	9	9	9	6	0	7	6	8	8	1
Harness Xtra/Fultime/Keystone	9	-	9	8	9	-	5	1	-	4	6	8	1
Hornet	0	0	0	0	0	0	0	0	0	0	0	0	2
Lasso/Micro-Tech	8	7	9	9	9	9	6	0	7	5	7	7	1
Lumax/Lexar	8	8	9	8	9	9	6	1	9	5	7	8	1
Outlook	8	7	9	8	9	9	5	0	8	4	7	7	1
Princep	7	6	7	6	7	7	2	0	-	1	2	0	0
Python	6	6	6	7	6	-	7	-	4	6	-	-	2
Resolve	8	7	6	6	8	-	8	4	0	7	6	3	1
Surestart	8	-	8	7	8	-	4	0	-	2	4	6	1
<b>Preemergence</b>													
Prowl H <sub>2</sub> O	9	-	8	8	9	9	7	0	-	7	7	0	1
<b>Postemergence</b>													
Accent	9	8	6	8	8	-	9	9	-	9	7	2	1
Aim	2	1	2	3	3	-	2	1	1	1	-	-	1
Atrazine + oil	8	7	7	5	7	6	3	0	10	2	6	6	1
Banvel/Clarity	0	0	0	0	0	0	0	0	0	0	0	0	1
Basagran	0	0	0	0	0	0	0	0	0	0	0	9	0
Beacon	0	-	0	7	3	-	9	8	-	10	2	2	1
Buctril	0	0	0	0	0	0	0	0	0	0	0	0	1
Callisto	3	1	8	4	6	3	1	1	2	0	0	3	1
Distinct/Status	0	0	0	0	0	0	0	0	0	0	0	0	1
Glyphosate (Roundup Ready corn)	9	10	10	10	10	10	10	10	9	10	9	6	1
Impact	8	3	8	6	8	4	3	1	-	6	4	3	1
Laudis	8	-	8	0	8	-	-	1	-	2	-	4	1
Liberty/Ignite (Liberty Link corn)	8	7	7	7	8	7	8	5	7	8	9	6	0
Option	8	6	7	8	9	8	10	9	-	9	-	2	2
Peak	0	0	0	0	0	0	0	0	0	0	0	0	1
Permit	0	0	0	0	0	0	0	0	0	0	0	9	0
Resource	-	-	-	-	-	-	-	-	0	-	-	-	1
Sencor	-	-	-	-	-	-	-	-	0	0	-	-	1
Starane	0	0	0	0	0	0	0	0	0	0	0	0	1
Steadfast	9	8	8	8	9	8	10	8	-	9	8	4	1
Stout	9	-	6	8	8	-	9	9	-	9	8	2	1
Tough	-	-	2	2	6	-	-	0	0	0	-	-	1
2,4-D	0	0	0	0	0	0	0	0	0	-	-	-	1

Weed control: 8 to 10 = Good 6 to 7 = Fair\*\* Less than 6 = Poor - = No data available

\*\*A weed control rating of 6 to 7 indicates partial control or suppression.

\*\*\*Crop response: A rating of 3 or less will not result in loss of crop yield under normal growing conditions.

Use this table as a guide for comparing the relative effectiveness of herbicides on individual weeds. Herbicides may perform better or worse than indicated due to extreme weather conditions and other variables. If you are obtaining satisfactory results under your growing conditions, changing products as a result of information in this table is not necessarily recommended.

## Corn Guide to broadleaf weed response to herbicides

Herbicide	Black nightshade	Cocklebur	Jimsonweed	Lambsquarters	Morningglory, annual	Pigweed, smooth/redroot	Prickly sida	Ragweed, common	Ragweed, giant	Smartweed, annual	Sunflower	Velvetleaf	Waterhemp**
<b>Preplant or preemergence</b>													
Atrazine	9	9	10	9	9	10	9	9	8	9	7	7	9
Balance Flexx	8	6	6	9	4	8	8	-	-	7	7	8	9
Bicep II Magnum/Cinch ATZ/Others	9	9	8	9	7	9	-	9	8	9	7	8	9
Callisto	8	6	9	-	8	9	9	-	-	-	-	9	-
Camix	9	8	8	9	6	9	-	8	7	8	8	9	9
Corvus	8	8	5	9	6	9	-	8	6	8	6	8	9
Degree Xtra	9	9	7	9	7	9	-	9	8	9	7	8	9
Dual II Magnum/Cinch	9	0	4	6	0	9	3	5	3	5	0	2	9
Guardzman Max	9	9	7	9	7	9	-	9	8	9	6	8	9
Harness/Breakfree/Degree	-	4	-	9	4	10	-	8	5	6	0	4	9
Harness Xtra/Fulltime/Keystone	9	9	8	9	7	9	-	9	8	9	7	8	9
Hornet	8	8	8	9	6	9	-	8	8	8	8	9	9
Lasso/Micro-Tech	9	0	4	6	0	9	4	5	3	5	0	2	9
Lumax/Lexar	9	9	8	9	8	9	8	9	8	9	8	9	9
Outlook	8	2	4	7	2	9	0	5	2	4	0	2	9
Princep	8	8	8	8	8	9	8	8	6	8	6	7	-
Python	7	7	9	9	6	9	9	8	-	9	8	9	7
Resolve	5	6	5	8	6	8	7	6	4	6	5	4	5
Surestart	8	8	8	9	6	9	-	7	6	8	7	8	8
<b>Preemergence</b>													
Prowl H <sub>2</sub> O	0	0	0	7	0	9	-	0	0	3	0	2	7
<b>Postemergence</b>													
Accent	0	2	7	5	5	8	2	2	2	8	5	3	5
Aim	10	6	9	9	7	9	7	7	6	9	7	9	8
Atrazine + oil	9	9	10	10	9	10	9	9	8	9	9	8	10
Banvel/Clarity	9	9	9	9	9	9	8	10	9	9	9	8	8
Basagran	2	9	9	6	5	4	8	8	8	9	8	8	3
Beacon	7	6	8	5	-	8	6	8	8	8	8	6	5
Buctril	9	9	10	9	8	7	4	9	9	9	8	8	6
Callisto	8	8	9	9	7	9	8	7	8	9	8	9	9
Distinct/Status	9	9	9	9	9	9	8	10	9	9	9	8	8
Glyphosate (Roundup Ready corn)	8	9	9	8	6	9	5	9	8	5	8	8	9
Impact	8	9	9	9	6	9	8	8	8	7	8	8	9
Laudis	8	8	9	9	6	9	8	8	8	7	8	8	9
Liberty/Ignite (Liberty Link corn)	8	9	9	8	9	7	7	8	8	9	8	7	7
Option	8	7	8	7	4	8	6	-	4	6	8	8	6
Peak	-	8	8	7	8	9	8	9	7	-	9	9	5
Permit	6	9	8	6	6	9	6	8	8	8	9	8	5
Resource	5	7	7	6	5	7	0	7	7	5	0	9	7
Sencor	3	7	7	4	5	6	5	5	2	6	6	7	6
Starane	6	9	6	6	7	-	-	8	4	4	8	8	6
Steadfast	0	5	9	5	8	9	3	3	3	9	8	4	5
Stout	-	4	8	8	4	8	2	3	2	8	6	6	6
Tough	9	7	7	9	5	9	5	6	7	6	6	6	7
2,4-D	7	9	8	9	9	9	8	9	8	7	9	8	7

Weed control: 8 to 10 = Good 6 to 7 = Fair\* Less than 6 = Poor - = No data available

\*A weed control rating of 6 to 7 indicates partial control or suppression.

\*\*Waterhemp has been observed to routinely escape ALS-herbicide treatments in many areas. Resistance has been formally confirmed in some fields. Control may vary from indicated values on ALS-inhibiting herbicides.

Use this table as a guide for comparing the relative effectiveness of herbicides on individual weeds. Herbicides may perform better or worse than indicated due to extreme weather conditions and other variables. If you are obtaining satisfactory results under your growing conditions, changing products as a result of information in this table is not necessarily recommended.

## Corn

### Soil-applied herbicide rates for corn

Herbicide	Soil texture*		
	Coarse (light, sandy)	Medium (loamy)	Fine (heavy, clay)
	------(Rate per Acre)-----		
Atrazine 4L	3 pt	4 pt	4 pt
Aatrex Nine-0	1.6 lb	2.2 lb	2.2 lb
Axiom 68.8DF	8 to 15 oz	10 to 20 oz	20 to 23 oz
Balance 75WDG	1 to 2 oz	1.5 to 2.5 oz	1.5 to 3 oz
Balance Flexx	3 to 4 fl oz	5 to 6 fl oz	6 fl oz
Bicep II Magnum 5.5L	1.3 to 1.6 qt	1.6 to 2.1 qt	2.1 to 2.6 qt
Bicep Lite II Magnum 6L	0.9 to 1.5 qt	1.1 to 1.5 qt	1.5 to 2.2 qt
Bullet 4F	2.5 to 3 qt	3 to 5 qt	3.75 to 5 qt
Camix 3.7L	2 to 2.4 qt	2 to 2.4 qt	2 to 2.4 qt
Cinch 7.64L	0.8 to 1 pt	1 to 1.33 pt	1.33 to 1.67 pt
Cinch ATZ 5.5L	1.3 to 1.6 qt	1.6 to 2.1 qt	2.1 to 2.6 qt
Cinch Lite ATZ 6L	0.9 to 1.5 qt	1.1 to 1.5 qt	1.5 to 2.2 qt
Callisto	5 to 7.7 fl oz	5 to 7.7 fl oz	5 to 7.7 fl oz
Degree 3.8 L	2.25 to 3.25 pt	3.25 to 4.25 pt	3.25 to 5 pt
Degree Xtra 4.04L	2.9 qt	2.9 to 3.7 qt	3.2 to 3.7 qt
Dual II Magnum 7.64L	0.8 to 1 pt	1 to 1.33 pt	1.33 to 1.67 pt
Epic 58DG	6 to 10 oz	7 to 15 oz	10 to 15 oz
Fieldmaster 4.25L	3.5 to 5 qt	4 to 5 qt	4 to 5 qt
Fultime 4CS	2.5 to 3 qt	2.7 to 3.3 qt	3 to 5 qt
Guardsman 5L	3 to 4.5 pt	3.5 to 5 pt	4.5 to 5 pt
Guardsman Max 5L	2.4 to 3 pt	3 to 4 pt	4 to 4.6 pt
Harness 7E	1.25 to 1.75 pt	1.75 to 2.25 pt	1.75 to 2.75 pt
Harness Xtra 5.6L	1.4 to 1.7 qt	1.7 to 2.6 qt	2.3 to 3 qt
Harness Xtra 6L	1.5 to 1.8 qt	1.8 to 2.3 qt	1.8 to 2.3 qt
Hornet 78.5 WDG	4 to 5 oz	4 to 6 oz	4 to 6 oz
Keystone 5.25L/Breakfree ATZ	2.2 to 2.6 qt	2.4 to 2.8 qt	2.6 to 3.4 qt
Lasso 4EC	2 to 2.5 qt	2 to 4 qt	2 to 4 qt
Lariat 4F	2.5 to 3 qt	3 to 5 qt	3.75 to 5 qt
Lexar 3.7L	3 to 3.5 qt	3 to 3.5 qt	3 to 3.5 qt
Linex 4L	0.67 to 1.5 pt	1 to 1.5 pt	1.33 to 1.5 pt
Lumax 3.95L	2.5 to 3 qt	2.5 to 3 qt	2.5 to 3 qt
Micro-Tech 4EC	2 to 2.5 qt	2 to 4 qt	2 to 4 qt
Outlook 6L	12 to 14 fl oz	14 to 18 fl oz	18 to 21 fl oz
Partner 65G	3 to 3.8 lb	3 to 4.5 lb	3 to 4.5 lb
Princep 90DF		1.1 lb	1.1 lb
Prowl H <sub>2</sub> O 3.8 ACS	2 to 3 pt	3 to 4 pt	3 to 4 pt
Python WDG	0.8 to 1 oz	0.89 to 1.33 oz	0.89 to 1.33 oz
Ramrod 4F	4 to 4.5 qt	4.5 to 5.5 qt	5.25 to 6 qt
Resolve	0.5 to 2 oz	0.5 to 2 oz	0.5 to 2 oz
Surestart	1.5 pt	1.5 to 1.75 pt	2.0 pt
Surpass 6.4EC/Breakfree	1.5 to 2.5 pt	1.5 to 2.5 pt	1.5 to 3 pt
Surpass 100 5SC	2 to 2.4 qt	2.2 to 2.6 qt	2.6 to 4 qt
TopNotch 3.2CS	2 qt	2 to 2.5 qt	2.5 to 3.75 qt

\*Refer to herbicide labels for proper rates for your soil texture and organic matter content and for tank mixes.

## Corn, Burndown

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
The following preemergence corn herbicides may be used for burndown: Atrazine, Balance, Axiom AT, Bicep, Degree Xtra, Epic, Fieldmaster, Guardsman, Harness Xtra and Topnotch. Application information is listed in the preemergence herbicide section. In most cases, a broad-spectrum, foliar burndown herbicide such as Roundup or Gramoxone should be tank mixed with the preemergence herbicide; however, if grass pressure is light and broadleaf weeds are small, the addition of crop oil to an atrazine-containing product may be sufficient.				
2,4-D LV ester or amine (4 lb/gal formulation)	1 to 3 pt/A	2,4-D 0.5 to 1.5 lb/A	Atrazine, Banvel, Bicep, Bronco, Bullet, Callisto, Dual, Glyphosate, Gramoxone, Guardsman, Harness Plus, Lariat, Lasso, Lumax, Outlook, Princep, Python, Surpass	May be applied early preplant (EPP) through planting. Use lower rate for small, susceptible weeds, and higher rates for large or difficult to control weeds.
Aim 2E + Nonionic surfactant	0.25 to 2 fl oz/A + 2 pt/100 gal	carfentrazone 0.004 to 0.031 lb/A	No restrictions listed.	Should be applied with a broad-spectrum burndown herbicide.
Banvel 4E	0.3 to 1 pt/A	dicamba 0.15 to 0.5 lb/A	Atrazine, Bicep, Bronco, Bullet, Dual, Gramoxone, Guardsman, Harness Plus, Lariat, Lasso, Lumax, Outlook, Princep, Glyphosate, Surpass, 2,4-D	May be applied early preplant (EPP) until 7 days before planting (EPP7). See label for specific rates and weed stages for application.
Basis + Nonionic surfactant or Crop oil concentrate + UAN or AMS	0.33 to 0.5 oz/A + 2 pt/100 gal or 1 gal/100 gal + 2 qt/A or 2 lb/A	rimsulfuron + thifensulfuron 0.01 + 0.005 lb to 0.02 + 0.008 lb	Express, Glyphosate, Princep, 2,4-D	May be applied early preplant (EPP) through planting up to the two-collar stage of corn.
Distinct 70WG + Nonionic surfactant	2 to 8 oz/A + 2 pt/100 gal	dicamba + diflufenzopyr 0.06 + 0.025 to 0.25 + 0.1 lb/A	Glyphosate, 2,4-D	Corn can be planted 14 days after application of 6 oz or less, or 21 days if more than 6 oz is used.
Expert 4.9L	2.5 to 3.75 qt/A	glyphosate + S-metotachlor + atrazine 0.6 + 1 + 1.33 to 0.9 + 1.63 + 2 lb/A	Atrazine, Dual, Princep, Glyphosate, Python, Hornet, Prowl, Banvel, Clarity, 2,4-D	May be applied up to 30 days before planting and before emergence of conventional corn hybrids.
Gramoxone Inteon + Nonionic surfactant or Crop oil concentrate	2 to 3.5 pt/A + 1 to 2 pt/100 gal or 1 gal/100 gal	paraquat 0.7 to 1.2 lb/A	Atrazine, Banvel, Bicep, Dual, Bronco, Bullet, Callisto, Dual, Guardsman, Harness Plus, Lariat, Lasso, Lumax, Outlook, Princep, Python, Roundup, Surpass, 2,4-D	May be applied early preplant (EPP) through planting, but before crop emergence. See label for specific rates and weed stages for application. Rate should normally be at least 1.67 pt/A.
Harmony Extra XP	0.3 to 0.6 oz/A	thifensulfuron + tribenuron 0.009 + 0.005 lb/A to 0.018 + 0.01 lb/A	Glyphosate, Gramoxone, 2,4-D	Use for control of smartweed and dock. Tank mix with Gramoxone or Roundup. DO NOT APPLY WITHIN 14 DAYS OF PLANTING.
Roundup brands/ Touchdown brands/ other glyphosates  glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	1 to 3 pt/A or 11 to 32 fl oz/A or 11 to 32 fl oz/A + See label	glyphosate 0.38 to 1.12 lb/A	Atrazine, Banvel, Bicep, Bullet, Callisto, Dual, Guardsman, Harness Plus, Lariat, Lasso, Lumax, Outlook, Princep, Python, Surpass, 2,4-D	May be applied early preplant (EPP) through planting. Use lower rate for small, susceptible weeds and higher rates for large or difficult to control weeds.
Valor 51 WDG + Nonionic surfactant (80%)	2 oz/A + 2 pt/100 gal	flumioxazin 0.064 lb/A	Glyphosate, Gramoxone	Do not apply within 30 days of planting.

## Fall and early preplant applications of preemergence herbicides for reduced tillage

Many preemergence herbicides may be used two or more weeks before planting in an early preplant (EPP) application. Advantages include: Early preplant applications will prevent weed emergence and aid or eliminate a formal burndown application. They may limit weed growth if weather delays planting. Some preemergence herbicides have significant postemergence, burndown activity (adjuvants are sometimes required). Some preemergence herbicides increase the activity or spectrum of burndown herbicides. Finally, combining a preemergence herbicide with a burndown herbicide may simply save time and costs by eliminating a second trip for the traditional preemergence, after-planting application.

Several herbicides are registered for fall application. A fall herbicide application may be beneficial if it eliminates the need for a burndown application in the spring and soil erosion is not a problem. Fall applications could also benefit

drying of the soil in the spring and could reduce the need for tillage before planting.

There are many choices and an option that works well in one field may work poorly in another. For most situations we recommend that growers target early preplant applications 15 or less days before planting. The sooner a herbicide is applied, the sooner it will break down and lose effectiveness. If rain delays planting too long, most advantages of extra-early preplant applications may be lost. Also, after 30 days, there is a much higher probability that a burndown application will be needed and most labels specify that additional preemergence herbicide be applied at planting. Finally, exceptionally long (>30 day) preplant intervals remove winter vegetation and leave the soil vulnerable to erosion and may increase the probability of herbicide contamination of ground and surface water.

### Early preplant (EPP) labels for corn herbicides

Herbicide	Burndown activity	Label allows preplant application		
		45 days	30 days	15 days
Atrazine	Yes	Yes*	Yes*	Yes
Autumn	Yes	Yes	Yes	No
Axiom	No	Yes*	Yes*	Yes
Axiom AT	Yes	Yes*	Yes	Yes
Balance Pro	Yes	No	Yes	Yes
Basis	Yes	Yes	Yes	Yes
Bicep II Magnum	Yes	Yes*	Yes*	Yes
Bicep Lite II Magnum	Yes	Yes*	Yes*	Yes
Bronco	Yes	Yes	Yes	Yes
Bullet	Yes	Yes*	Yes*	Yes
Callisto	Yes	No	No	No
Camix	Yes	No	No	Yes
Cinch	No	Yes*	Yes*	Yes
Cinch ATZ	Yes	Yes*	Yes*	Yes
Cinch Lite ATZ	Yes	Yes*	Yes*	Yes
Degree	Yes	Yes	Yes	Yes
Degree Extra	Yes	Yes	Yes	Yes
Dual II Magnum	No	Yes*	Yes*	Yes
Epic	Yes	No	Yes	Yes
Fieldmaster	Yes	No	Yes	Yes
Fultime	Yes	No***	Yes	Yes
Guardsman Max	Yes	Yes*	Yes*	Yes
Harness	No	Yes*	Yes*	Yes
Harness Xtra	Yes	Yes*	Yes*	Yes
Hornet	Yes	No	Yes	Yes
Keystone/Breakfree ATZ	Yes	No	Yes	Yes
Lariat	Yes	Yes*	Yes*	Yes
Lasso	No	Yes*	Yes*	Yes
Lexar	Yes	No	No	Yes
Lumax	Yes	No	No	Yes
Microtech	No	Yes*	Yes*	Yes
Outlook	No	Yes*	Yes	Yes
Partner	No	Yes*	Yes*	Yes
Princep	Yes	Yes	Yes	Yes
Python	Yes	No	Yes	Yes
Shotgun	Yes	No	No	Yes
Surestart	Yes	No	Yes	Yes
Surpass/Breakfree	No	No	Yes	Yes
Topnotch	No	No***	Yes	Yes

\*Label requires reapplication at the time of planting. (Typically 2/3 applied EPP and 1/3 preemergence at planting.)  
\*\*EPP intervals greater than 15 days are not recommended on coarse-textured (light, sandy) soils.  
\*\*\*EPP treatments are not recommended on coarse-textured (light, sandy) soils where average annual rainfall exceeds 40 inches.

## Corn, Preplant or preemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated or preemergence tank-mix partners	Application method and precautions
Aatrex 4L or Aatrex 90DF	3 to 4 pt/A or 1.6 to 2.2 lb/A	atrazine 1.5 to 2 lb/A	Dual, Guardsman, Harness Plus, Lasso, Micro-Tech, Outlook, Princep, Surpass, Surpass 100	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
Balance Flexx	3 to 6 fl oz/A	isoxaflutole 0.05 to 0.09 lb/A	Aatrex, Axiom, Bicep, Dual, Fultime, Guardsman, Leadoff, Harness, Harness Xtra, Lasso, Outlook, Simazine, Surpass, Surpass 100, Topnotch	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. <b>See label for crop safety restrictions.</b> Plant corn at least 1.5 inches deep and ensure that the seed-furrow is closed. May also be applied early postemergence up to V2 corn. <b>Not registered for use in Butler, Cape Girardeau, Dunklin, Mississippi, New Madrid, Pemiscot, Scott and Stoddard counties.</b>
Callisto 4L	5 to 7.7 fl oz/A	mesotrione 0.16 to 0.24 lb/A	Atrazine, Axiom, Bicep, Degree, Degree Xtra, Doubleplay, Dual, Fultime, Glyphosate, Gramoxone Max, Guardsman/Leadoff, Harness, Harness Xtra, Outlook, Surpass, Prowl, Topnotch, 2,4-D	Callisto primarily controls broadleaf weeds, tank mix with a grass herbicide for broad-spectrum weed control. Tank mixtures with atrazine-containing products are recommended for optimal morningglory control. Use lower rates when tank-mixed with atrazine and higher rates without atrazine. See label for organophosphate and carbamate insecticide restrictions.
Dual II Magnum 7.64E/Cinch 7.64E	0.8 to 1.67 pt/A	S-metolachlor 0.76 to 1.6 lb/A	Atrazine, Princep	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
Harness 7E or Degree 3.8L	1 to 3 pt/A or 2.25 to 5 pt/A	acetochlor + antidote 0.875 to 2.33 lb/A or 1.07 to 2.38 lb/A	Aatrex, Accent, Banvel, Clarity, Glyphosate, Gramoxone Max, Marksman, Permit, Princep, Prowl, Permit, Pursuit,	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Degree is a microencapsulated, slow-release formulation of acetochlor.
Lasso 4EC or Micro-Tech 4L or Partner 65G	2 to 4 qt/A or 2 to 4 qt/A or 3 to 4.5 lb/A	alachlor 2 to 4 lb/A	Atrazine, Princep	Preplant treatment may be shallow incorporated.
Outlook 6E	10 to 21 oz/A	dimethenamid-P 0.47 to 0.98 lb/A	Atrazine, Princep	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
Python 80WDG	0.8 to 1.33 oz/A (5 to 3 A/pkt)	flumetsulam 0.04 to 0.07 lb/A	2,4-D, Dual II Magnum, Flyphosate, Gramoxone Max, Harness, Outlook, Surpass, Touchdown	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. See label for crop injury precautions regarding varieties, soil pH, soybean herbicide carryover, at-planting insecticides and cool weather.
Surpass 6.4EC/ Breakfree	1.5 to 3 pt/A	acetochlor + antidote 0.8 to 2.4 lb/A	Atrazine, Balance Pro, Banvel, Clarity, Glyphosate, Gramoxone Max, Hornet WDG, Marksman, Pendemax/Prowl, Princep, Python, 2,4-D	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
TopNotch 3.2L	2-3.75 qt/A	acetochlor + antidote 1.6 to 3 lb/A	Atrazine, Balance Pro, Banvel, Glyphosate, Gramoxone Max, Hornet, Lorox, Prowl, Pursuit (IMI corn only), Python, Sencor, Touchdown, 2,4-D	Use lower rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Topnotch is a microencapsulated, slow-release formulation of acetochlor.

## Corn, Preplant or preemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated or preemergence tank-mix partners	Application method and precautions
<b>Package mixes - Preplant or preemergence</b>				
Axiom 68DF	8 to 23 oz/A	flufenacet + metribuzin 0.27 + 0.07 to 0.78 + 0.19 lb/A	Atrazine, Balance, Banvel, Clarity, Glyphosate, Gramoxone Max, Hornet, Marksman, Pentagon, Prowl, Python, Sencor, 2,4-D	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Rates are further defined depending upon soil organic matter. Plant corn at least 1.5 inches deep.
Bicep II Magnum 5.5L or Cinch ATZ 5.5L	1.3 to 2.6 qt/A	atrazine + S-metolachlor 1 + 0.78 to 2 + 1.56 lb/A	Atrazine, Dual	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Atrazine and/or Dual may be added to Bicep to improve weed control in heavy infestations or for hard-to-control weeds.
Bicep II Lite Magnum 6L or Cinch ATZ 6L	0.9 to 2.2 qt/A	S-metolachlor + atrazine 0.75 + 0.6 to 1.83 + 1.47 lb/A	Atrazine, Dual	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Atrazine and/or Dual may be added to Bicep to improve weed control in heavy infestations or for hard-to-control weeds.
Bullet 4F	2.5 to 4.5 qt/A	alachlor + atrazine 1.56 + 0.94 to 2.8 + 1.7 lb/A	Atrazine, Micro-Tech	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Atrazine and/or Lasso may be added to Bullet or Lariat to improve weed control in heavy infestations or for hard-to-control weeds.
Epic 58DF	8 to 15 oz/A	flufenacet+ isoxaflutole 0.24 + 0.05 to 0.45 + 0.094 lb/A	Atrazine, Axiom, Axiom AT, Banvel, Clarity, Define, Glyphosate, Gramoxone Max, Hornet, Liberty, Marksman, 2,4-D	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Plant corn at least 1.5 inches deep. <b>See label for crop safety and soil restrictions. Not registered for use in Butler, Cape Girardeau, Dunklin, New Madrid, Mississippi, Pemiscot, Scott and Stoddard counties.</b>
Fieldmaster 4.25L + Ammonium sulphate (optional)	3.5 to 5 qt/A	acetochlor + atrazine + glyphosate 1.75 + 1.31 + 0.49 to 2.5 + 1.88 + 0.7 lb/A + 17 lb/100 gal	Atrazine, Glyphosate, Harness, Princep	No-tillage burndown product. Apply approximately 14 days before planting. Use lower rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
Guardsman Max 5L	2.4 to 3.6 pt/A	atrazine + dimethenamid-P 0.99 + 0.51 to 1.9 + 0.98 lb/A	Atrazine, Balance, Outlook, Princep	Use lower rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Outlook and/or atrazine may be added to Guardsman to improve weed control in heavy infestations or for hard-to-control weeds.
Harness Xtra 5.6L or Harness Xtra 6L or Degree Xtra 4.04 L	1.4 to 3 qt/A or 1.5 to 2.3 qt/A or 2.9 to 3.7 qt/A	acetochlor + atrazine 1.09 + 0.88 to 2.3 + 1.88 lb/A or 1.6 + 0.6 to 2.5 + 1 lb/A or 1.96 + 0.97 to 2.5 + 1.25 lb/A	Aatrex, Accent, Banvel, Clarity, Glyphosate, Gramoxone Max, Harness, Hornet, Marksman, Permit, Princep, Prowl, Pursuit, Python,	Use lower rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Degree Xtra contains microencapsulated, slow-release acetochlor.
Hornet 78.5 WDG	4 to 5 oz/A	clopyralid + flumetsulam 0.125 + 0.46 to 0.188 + 0.06 lb/A	Banvel, Bicep, Buctril, Clarity, Fultime, Glyphosate, Gramoxone Max, Guardsman, Harness Xtra, Keystone, Leadoff, Marksman, Touchdown, 2,4-D	Use lower rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. See label for crop injury precautions regarding varieties, soil pH, soybean herbicide carryover, at-planting insecticides and cool weather.
Lariat 4F	2.5 to 4.5 qt/A	alachlor + atrazine 1.56 + 0.94 to 2.8 + 1.7 lb/A	Atrazine, Lasso	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Atrazine and/or Surpass may be added to Bullet or Lariat to improve weed control in heavy infestations or for hard-to-control weeds.

## Corn, Preplant or preemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated or preemergence tank-mix partners	Application method and precautions
Keystone 5.25L or Fultime 4CS	2.2 to 3.4 qt/A or 2.5 to 5 qt/A	acetochlor + atrazine 1.5 + 1 to 3 + 2 lb/A or 1.7 + 1.3 to 2.6 + 1.9 lb/A or 1.5 + 1 to 3 + 2 lb/A	Atrazine, Balance Pro, Banvel, Clarity, Glyphosate, Gramoxone Max, Hornet WDG, Lasso, Marksman, Pendemax/Prowl, Princep, Python, Surpass, 2,4-D	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Atrazine and/or Surpass may be added to improve control in heavy infestations or for hard-to-control weeds.

## Corn, Preemergence only

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preemergence tank-mix partners	Application method and precautions
Camix 3.7L	2 to 2.4 qt/A	S-metolachlor + mesotrione 1.68 + 0.17 to 2 + 0.2 lb/A	Atrazine, Glyphosate, Gramoxone Max, Touchdown, 2, 4-D	Use low rate when organic matter is less than 3% and high rate when organic matter is more than 3%. <b>See label for insecticide interaction restrictions.</b>
Expert 4.9L	2.5 to 3.75 qt/A	glyphosate + S-metolachlor + atrazine 0.6 + 1 + 1.33 to 0.9 + 1.63 + 2 lb/A	Atrazine, Dual, Princep, Glyphosate, Python, Hornet, Prowl, Banvel, Clarity, 2,4-D	May be applied up to 30 days before planting and before emergence of conventional corn hybrids.
Lexar 3.7L	3 to 3.5 qt/A	S-metolachlor + atrazine + mesotrione 1.3 + 1.3 + 0.17 to 1.5 + 1.5 + 0.2 lb/A	Atrazine, Glyphosate, Gramoxone Max, Princep, Touchdown brands	Use low rate when organic matter is less than 3% and high rate when organic matter is more than 3%. <b>See label for insecticide interaction restrictions.</b>
Lumax 3.95L	2.5 to 3 qt/A	S-metolachlor + atrazine + mesotrione 1.68 + 0.63 + 0.17 to 2 + .75 + 0.2 lb/A	Atrazine, Glyphosate, Gramoxone Max, Princep, 2,4-D	Use low rate when organic matter is less than 3% and high rate when organic matter is above 3%. <b>See label for insecticide interaction restrictions.</b>
Prowl H <sub>2</sub> O 3.8ACS	2 to 4 pt/A	pendimethalin 0.95 to 1.9 lb/A	Aatrex, Balance, Banvel, Bicep, Dual, Guardsman, Hornet, Marksman, Python	<b>DO NOT INCORPORATE</b> or serious crop injury may occur. Plant at least 1.5 inches deep.
Resolve 25DF	0.5 to 2 oz/A	rimsulfuron 0.008 to 0.03 lb/A	Atrazine, Balance, Balance Pro, Bicep, Cich, Dual, Cinch ATZ, Harness, Lumax, Lexar, Outlook	May be applied preemergence or postemergence to corn that is up to 12 inches tall. Postemergence applications require addition of spray adjuvants.

## Corn, Preemergence, Applied postemergence to crop

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preemergence herbicides applied postemergence tank-mix partners	Application method and precautions
AAtrex 4L or AAtrex Nine-0 + Crop oil concentrate	3 to 4 pt or 1.6 to 2.2 lb + See label	atrazine 1.5 to 2 lb/A	Banvel, Basagran, Buctril, Dual	Apply after weed emergence, but before grass weeds reach 1.5 inches and broadleaf weeds reach 4 inches in height and before corn reaches 12 inches tall. The use of crop oil concentrate may injure corn under conditions of stress. Follow mixing procedures and precautions on label to minimize possible injury.
Balance Flexx	3 to 6 fl oz/A	isoxaflutole 0.05 to 0.09 lb/A		May be applied early postemergence up to V2 corn. Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. See label for crop safety restrictions.
Callisto 4L + Crop oil concentrate	5 to 7.7 fl oz/A + 1 gal/100 gal	mesotrione 0.16 to 0.24 lb/A	Do not tank mix with emulsifiable-concentrate (EC) formulations of grass herbicides.	Callisto primarily controls broadleaf weeds, tank mix with a grass herbicide for broad-spectrum weed control. Tank mixtures with atrazine-containing products are recommended for optimal morningglory control. Use lower rates when tank-mixed with atrazine and higher rates without atrazine. See label for organophosphate and carbamate insecticide restrictions. Do not apply with methylated seed oils.

**Corn, Preemergence, Applied postemergence to crop**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preemergence herbicides applied postemergence tank-mix partners	Application method and precautions
Dual II Magnum 7.64E/Cinch 7.64E	0.8 to 1.67 pt/A	S-metolachlor 0.76 to 1.6 lb/A	Atrazine, Banvel, Clarity, Steadfast	<b>Apply before weed emergence or tank mix with a POST-active herbicide.</b> Apply before corn is 5 inches tall.
Harness 7E or Degree 3.8L	1.25 to 2.75 pt/A or 2.25 to 5 pt/A	acetochlor + antidote 1.1 to 2.4 lb/A or 1.07 to 2.38 lb/A	Atrazine, Accent, Banvel, Clarity, Marksman, Permit, Princep, Prowl, Permit, Pursuit, Roundup	<b>Apply before weed emergence or tank mix with a POST-active herbicide.</b> Apply before corn is 11 inches tall. Degree is a microencapsulated, slow-release formulation of acetochlor.
Linex 4L	1 to 1.5 pt/A	linuron 0.5 to 0.75 lb/A	Atrazine, Prowl, Dual II Magnum	Apply after planting but before crop emerges. Plant seed at least 1.75 inches deep.
Outlook 6E	12 to 21 fl oz/A	dimethenamid-P 0.56 to 0.98 lb/A	Atrazine, Accent, Banvel, Clarity, Marksman, Atrazine, Beacon	<b>Apply before weed emergence or tank mix with a POST-active herbicide.</b> Apply before corn is 8 inches tall.
Prowl H <sub>2</sub> O 3.8ACS	2 to 4 pt/A	pendimethalin 0.95 to 1.9 lb/A	Accent, Atrazine, Banvel, Basis Gold, Beacon, Hornet, Marksman	<b>DO NOT INCORPORATE</b> or serious crop injury may occur. This herbicide has no postemergence activity, but may be used to add residual control to other postemergence herbicides. Plant at least 1.5 inches deep. Use lower rates for coarse (light, sandy) soils and higher rates for fine (heavy, clay) soils.
Resolve 25DF	0.5 to 2 oz/A	rimsulfuron 0.008 to 0.03 lb/A	Atrazine, Balance, Balance Pro, Bicep, Cich, Dual, Cinch ATZ, Harness, Lumax, Lexar, Outlook	May be applied preemergence or postemergence to corn that is up to 12 inches tall. Postemergence applications require addition of spray adjuvants.
Surpass 6.4EC	1.5 to 3 pt/A	acetochlor 1.2 to 2.4 lb/A	Aim, Accent, Accent Gold, Atrazine, Banvel, Basis, Basis Gold, Beacon, Buctril, Buctril/Atrazine, Clarity, Distinct, Exceed, Hornet WDG, Liberty, Lightning, Marksman, Peak, Permit, Princep, Prowl, Pursuit, Shotgun, Spirit, Steadfast	<b>Apply before weed emergence or tank mix with a POST-active herbicide.</b> Apply until corn is 11 inches tall.
Topnotch 3.2CS	2 to 3 qt/A	acetochlor 1.6 to 2.4 lb/A	Accent, Banvel, Basis, Basis Gold, Beacon, Buctril, Buctril/Atrazine, Clarity, Distinct, Liberty, Lightning, Marksman, Peak, Pendemax/Prowl, Permit, Prowl, Pursuit, Resource, Shotgun, Spirit, Steadfast, 2,4-D	<b>Apply before weed emergence or tank mix with a POST-active herbicide.</b> Apply until corn is 11 inches tall.
<b>Package mixes - Preemergence applied postemergence</b>				
Bicep II Magnum 5.5L/Cinch ATZ 5.5L	1.3 to 2.6 qt/A	atrazine + S-metolachlor 1 + 0.78 to 2 + 1.56 lb/A		Apply before weeds reach the two-leaf stage and before corn is 5 inches tall.
Bicep Lite II Magnum 6L or Cinch Lite ATZ 6L	0.9 to 2.2 qt/A	S-metolachlor + atrazine 0.75 + 0.6 to 1.83 + 1.47 lb/A	Atrazine, Banvel, Clarity, Lorox	Apply before weeds reach the two-leaf stage and before corn is 5 inches tall.
Camix 3.7L + Nonionic surfactant	2 to 2.4 qt/A + 2 pt/100 gal	S-metolachlor + mesotrione 1.68 + 0.17 to 2 + 0.2 lb/A	Atrazine, Accent, Basis, Steadfast, Steadfast ATZ	Apply before corn exceeds 5 inches in height. Use low rate when organic matter is less than 3% and high rate when organic matter is more than 3%. <b>See label for insecticide interaction restrictions.</b> Do not use crop oils or methylated seed oils or nitrogen additives when applying to corn.
Guardsman Max 5L	2.4 to 3.6 pt/A	atrazine + dimethenamid P 0.99 + 0.51 to 1.9 + 0.98 lb/A	Atrazine, Accent, Banvel, Clarity, Marksman, Pursuit	Apply before weeds are taller than 1.5 inches and before corn is 12 inches tall.

## Corn, Preemergence, Applied postemergence to crop

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preemergence herbicides applied postemergence tank-mix partners	Application method and precautions
Harness Xtra 5.6L or Harness Xtra 6L or Degree Xtra 4.04 L	1.4 to 3 qt/A or 1.5 to 2.3 qt/A or 2.9 to 3.7 qt/A	acetochlor + atrazine 1.09 + 0.88 to 2.3 + 1.88 lb/A or 1.6 + 0.6 to 2.5 + 1 lb/A or 1.96 + 0.97 to 2.5 to 1.25 lb/A	Atrazine, Accent, Banvel, Clarity, Harness, Hornet, Marksman, Permit, Princep, Prowl, Pursuit, Python, Roundup	Apply before weeds reach the two- leaf stage and before corn is 11 inches tall.
Keystone 5.25L or Fultime 4CS or Breakfree ATZ	2.2 to 3.4 qt/A or 2.5 to 5 qt/A or 2.2 to 3.4 qt/A	acetochlor + atrazine 1.7 + 1.3 to 2.6 + 1.9 lb/A or 1.5 + 1 to 3 + 2 lb/A or 1.7 + 1.3 to 2.6 + 1.9 lb/A	Atrazine, Accent, Banvel, Basis, Beacon, Buctril, Buctril/Atrazine, Clarity, Exceed, Marksman, Peak, Permit, Princep, Prowl, Shotgun, Steadfast	Apply before weeds reach the two- leaf stage and before corn is 11 inches tall.
Lexar 3.7L + Nonionic surfactant	3 to 3.5 qt/A + 2 pt/100 gal	S-metolachlor + atrazine + mesotrione 1.3 + 1.3 + 0.17 to 1.5 + 1.5 + 0.2 lb/A	Atrazine, Accent, Basis, Steadfast	Apply before corn exceeds 12 inches in height. Use low rate when organic matter is less than 3% and high rate when organic matter is more than 3%. <b>See label for insecticide interaction restrictions.</b> Do not use methylated seed oils or nitrogen additives when applying to corn.
Lumax 3.95L + Nonionic surfactant	2.5 to 3 qt/A + 2 pt/100 gal	S-metolachlor + atrazine + mesotrione 1.68 + 0.63 + 0.17 to 2 + .75 + 0.2 lb/A	Atrazine, Accent, Basis, Steadfast, Steadfast ATZ	Apply before corn exceeds 5 inches in height. Use low rate when organic matter is less than 3% and high rate when organic matter is more than 3%. <b>See label for insecticide interaction restrictions.</b> Do not use methylated seed oils or nitrogen additives when applying to corn.

## Corn, Postemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Postemergence tank-mix partners	Application method and precautions
AAtrex 4L or AAtrex Nine-0 + crop oil concentrate containing not more than 20% emulsifier or Emulsifiable oil containing 1 to 2% emulsifier	3 to 4 pt or 1.6 to 2.2 lb + 1 qt or 1 gal/A	atrazine 1.5 to 2 lb/A	Banvel, Basagran, Buctril, Steadfast	Apply after weed emergence, but before weeds reach 1.5 inches in height. The use of oil may injure corn under conditions of stress. Follow mixing procedures and precautions on label to minimize possible injury.
Accent SP 75DF + Nonionic surfactant (80%) or crop oil concentrate and 28% or 32% UAN liquid fertilizer (Optional)	0.66 to 1.33 oz/A + 1 to 2 qt/100 gal or 1 gal/100 gal and 2 to 4 qt/100 gal	nicosulfuron 0.031 to 0.062 lb/A	Atrazine, Banvel, Basis, Beacon, Buctril, Buctril + atrazine, Clarity, Exceed, Marksman, Northstar	Apply broadcast to corn up to 20 inches tall (up to 6 collars), or 20 to 36 inches tall (less than 10 collars) with drop nozzles. Do not apply to corn treated with any formulation of Counter insecticide. See label for restrictions with other organophosphate insecticides and postemergence herbicides. Split application may be needed for johnsongrass control.
Aim 2E + Non-ionic surfactant (80%)	0.5 fl oz/A + 2 pt/100 gal	carfentrazone-ethyl 0.008 lb/A	2,4-D, Atrazine, Accent, Banvel, Basis, Basis Gold, Beacon, Clarity, Exceed, Glyphosate, Hornet, Marksman, Permit, Spirit, Liberty	May be applied over-top until corn has 14 collars. See label regarding use of crop oil, EC formulations and crop injury.

**Corn, Postemergence**

<b>Herbicide and formulation</b>	<b>Formulated material per broadcast acre</b>	<b>Herbicide (lb active per acre)</b>	<b>Postemergence tank-mix partners</b>	<b>Application method and precautions</b>
Banvel (4 lb/gal formulation)	1 pt/A  or 0.5 pt/A	dicamba 0.5 lb/A  or 0.25 lb/A	Accent, Atrazine, Beacon, Dual II, Lasso, Outlook, Prowl, 2,4-D	Apply from corn planting until corn is 8 inches tall. For best results, apply after weeds have emerged. Do not apply this rate after corn is taller than 8 inches.  or Apply anytime after weeds have emerged until corn is 36 inches tall or 15 days before corn tassel emergence.
Basagran 4S	1.5 to 2 pt/A	bentazon 0.75 to 1 lb/A	Atrazine	Apply when weeds are small. Add 1 qt/A of crop oil concentrate for yellow nutsedge. Add 2 to 4 qt/A of UAN for velvetleaf.
Beacon 75DF + Non-ionic surfactant (80%) or crop oil concentrate and 28 - 34% UAN liquid fertilizer (Optional)	0.38 to 0.76 oz/A (1 pkt/ 4 to 2 A) + 2 pt/100 gal or 1 to 4 pt/A and 1 to 2 pt/A	primisulfuron 0.018 to 0.036 lb/A	Accent, Atrazine, Banvel, Buctril, Clarity, 2,4-D	Use lower rate in split applications and higher rate in single applications. Apply overtop on 4 to 20 inch tall corn. After 20 inches to tasseling use drop nozzles. Do not apply to corn treated with any formulation of Counter insecticide. See label for restriction with other organophosphate insecticides, and other postemergence herbicides. Some corn hybrids may be susceptible to injury, see your dealer for a list of restricted hybrids. Split application is recommended for johnsongrass control and may be made before tassel emergence.
Buctril 2E or Buctril 4 lb/gal	1 to 1.5 pt/A or 0.5 to 0.75 pt/A	bromoxynil 0.25 to 0.38 lb/A	Accent, Atrazine, Beacon	See label for specific rates, crop stages and weed stages for application.
Callisto 4L + crop oil concentrate + UAN or ammonium sulphate	3 fl oz/A + 1 gal/100 gal + 2.5 gal/100 gal or 8.5 lb/100 gal	mesotrione 0.094 lb/A	Atrazine, Basagran, Liberty, Liberty ATZ. Do not tank mix with emulsifiable-concentrate (EC) formulations of grass herbicides.	Callisto primarily controls broadleaf weeds, tank mix with a grass herbicide for broad-spectrum weed control. Tank mixtures with atrazine-containing products are recommended for optimal morningglory control. Use lower rates when tank-mixed with atrazine and higher rates without atrazine. See label for organophosphate and carbamate insecticide restrictions.
Clarity 4E + 28 - 32% UAN liquid fertilizer (Optional) or Nonionic surfactant (Optional)	16 fl oz/A	diglycolamine salt of dicamba, 0.5 lb/A	Accent, Atrazine, Beacon, Steadfast 2,4-D	May be applied from corn emergence (spike) until corn is 8 inches tall. Addition of UAN is recommended only for velvetleaf control. Nonionic surfactant may be added to improve weed control in dry growing conditions.
Impact 2.8SC + MSO + UAN or AMS	0.5 to 0.75 fl oz/A + 1 gal/100 gal + 1.25 to 2.5 gal/100 gal or 8.5 to 17 lb/100 gal	topramezone 0.01 to 0.016 lb/A	Atrazine, Accent, Glyphosate, Liberty, Steadfast, Status, others. May be tank-mixed with residual herbicides in early post applications to control emerged weeds.	Impact primarily controls broadleaf weeds. Tank mix with a grass herbicide for broad-spectrum weed control. Tank mixtures with atrazine-containing products will enhance weed control significantly. Impact may be applied from anytime after corn emergence up to 45 days before harvest.
Laudis (3.5 lb/gal formulation)	3 oz/A	tembotrione 0.66 lb/A	Atrazine, Liberty, Glyphosate, Accent, Stout, Steadfast, Option	Laudis primarily controls broadleaf weeds. Tank mix with a grass herbicide for broad spectrum weed control. Tank mixtures with atrazine-containing product will enhance weed control significantly.

## Corn, Postemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Postemergence tank-mix partners	Application method and precautions
Option 35DG + MSO + UAN or AMS	1.5 to 1.75 oz/A + 1.5 pt/A + 1.5 - 2 qt/A or 1.5 - 3 lb/A	foramsulfuron 0.03 to 0.04 lb/A	Atrazine, Beacon, Callisto, Degree, Degree Xtra, Banvel, Clarity, Distinct, Exceed, Fulltime, guardsman Max, Harness, Harness Xtra, Hornet, Keystone, Marksman, Northstar, Outlook, Permit, Prowl, Spirit, Surpass, Topnotch, Tough, Volley, Yukon	Broadcast applications must be made when corn is in the V1 to V6 growth stage. Temporary yellowing (flashing), stunting and internode stacking can sometimes occur. See label for insecticide interaction restrictions.
Permit 75DF + Nonionic surfactant (80%) or Crop oil concentrate + UAN or ammonium sulphate (optional)	0.67 to 1.33 oz/A + 1 to 2 qt/A or 1 gal/100gal + 4 gal/100 gal or 2 to 4 lb/A	halosulfuron 0.032 to 0.063 lb/A	Accent, Atrazine, Banvel, Beacon, Buctril, Buctril + Atrazine, Clarity, Marksman, 2,4-D	Do not cultivate for 7 days following application. Apply from spike to lay-by (corn that's approximately 30 inches tall).
Python 80WDG	0.8 to 1.14 oz/A	flumetsulam 0.04 to 0.057 lb/A	No restrictions	Apply before corn reaches 20 inches or 6 collars.
Resolve DF + Nonionic surfactant + UAN or ammonium sulphate	0.50 to 2 oz/A + 1 qt/100 gal + 2 qt/A or 2 lb/A	rimsulfuron 0.012 to 0.03 lb/A	Glyphosate, Cinch, Cinch ATZ, Lumax, Balance PRO, Harness, Outlook, Atrazine, others	May be applied to field corn that is up to 12 inches tall. Do not apply to corn taller than 12 inches or exhibiting 6 or more leaf collars, whichever is more restrictive. Do not tank-mix with Basagran, Laddok, 2,4-D-containing products or foliar applied organophosphate insecticides.
Resource 0.86 EC + Crop oil concentrate	2 to 4 fl oz/A + 1 to 2 pt/A	flumiclorac-pentyl, 0.013 to 0.027 lb/A	2,4-D, Atrazine, Accent, Banvel, Beacon, Buctril, Celebrity, Clarity, Exceed, Glyphosate, Hornet, Laddok, Liberty, Marksman, Northstar, Permit, Spirit, Stinger	Velvetleaf control and lambsquarters suppression only. Higher herbicide and adjuvant rates are for drop-nozzle directed application only.
Sencor 75 DF	2 oz/A	metribuzin 0.094 lb/A	2,4-D, Atrazine, Banvel, Basagran, Buctril, Buctril Gel, Clarity, Laddok, Marksman, Resource, Pursuit, Tough	Must be applied with a tank-mix partner for acceptable weed control. Do not use crop oil. Consult label for tank-mix partners to determine appropriate adjuvant. Do not use on coarse-textured, low organic matter soils.
Starane 1.5L	2/3 pt/A	fluroxypyr 0.125 lb/A	No restrictions	Apply as a broadcast or band treatment to field corn up to and including 5 fully exposed leaf collars (V5 growth stage). Applications to field corn beyond V5 should be made as a directed spray using drop nozzles. Brittleness of corn after application may cause stalk breakage if windstorms or cultivation follow within 8 to 10 days of treatment. Do not use between tasseling and hard dough stage.
2,4-D amine or ester (4 lb/gal formulation)	0.5 to 1 pt/A	2,4-D amine or ester 0.25 to 0.5 lb/A	Banvel, Beacon	May be applied overtop until corn is 8 inches tall. After corn is over 8 inches tall, and until tasseling, use only directed application. Crop injury may occur when using higher rates or if applied during periods of rapid growth. Brittleness of corn after application may cause stalk breakage if windstorms or cultivation follow within 8 to 10 days of treatment. Do not use between tasseling and hard dough stage.

**Corn, Postemergence**

<b>Herbicide and formulation</b>	<b>Formulated material per broadcast acre</b>	<b>Herbicide (lb active per acre)</b>	<b>Postemergence tank-mix partners</b>	<b>Application method and precautions</b>
<b>Package mixes – Postemergence</b>				
Basis 75DG + Crop oil concentrate or Nonionic surfactant + UAN or ammonium sulphate	1/3 oz/A + 1% v/v or 1 qt/100 gal + 2-4 qt/A or 2-4 lb/A	rimsulfuron + thifensulfuron 0.01 + 0.005 lb/A	Atrazine, Callisto, Hornet	Apply broadcast to field corn in the spike through four-leaf (2 collar) stage. Do not apply to corn having 3 fully emerged collars or more than 6 inches tall. See label for restrictions regarding insecticide interactions.
Buctril + Atrazine 3L	1.5 to 3 pt/A	bromoxynil + atrazine 0.19 + 0.38 to 0.38 + 0.75 lb/A	Atrazine, Buctril	See label for specific rates, crop stages and weed stages for application. Buctril and/or atrazine may be added to the package-mix to improve control in heavy infestations or for hard-to-control weeds.
Distinct 70WG + Nonionic surfactant (80%) + UAN	4 to 6 oz/A + 1 qt/100 gal + 2 to 4 qt/A	dicamba + diflufenzopyr 0.138 + 0.053 to 0.206 + 0.079 lb/A	Accent, Steadfast	Apply after corn is 4 inches tall. A 6 oz rate may be used until corn is 10 inches tall and a 4 oz rate may be used until corn is 24 inches tall.
Equip 32 DG	1.5 oz/A	foramsulfuron + iodoflufenuron 0.3 + 0.002 lb/A	Atrazine, Degree, Degree Xtra, Banvel, Clarity, Distinct, Fultime, Guardsman Max, Harness, Harness Xtra, Keystone, Marksman, Outlook, Permit, Prowl, Topnotch, Volley, Yukon	Broadcast applications must be made when corn is in the V1 to V4 growth stage. Temporary yellowing (flashing), stunting and internode stacking can sometimes occur. See label for insecticide interaction restrictions.
Hornet 78.5 WDG + Crop oil concentrate or methylated seed oil or Nonionic surfactant (80%) and UAN or ammonium sulphate (optional)	2 to 5 oz/A + 1 gal/100 gal or 1 gal/100 gal or 1 qt/100 gal and 2.5 gal/A or 2 lb/A	clopyralid + flumetsulam 0.063 + 0.023 to 0.16 + 0.058 lb/A	Accent, Atrazine, Banvel, Basis Gold, Buctril, Callisto Clarity, Distinct, Glyphosate, Option, Steadfast	Apply to actively growing weeds from corn emergence to 20 inches tall over the top or to 20 inches to 36 inches tall with drop nozzles. Do not tank-mix with Basagran, Laddok or Lightning. See label for specific rates and restrictions.
Laddok S-12 5L + Crop oil concentrate	1.3 to 2.3 pt/A + 1 qt/A	bentazon + atrazine 0.52 + 0.52 to 0.73 + 0.73 lb/A	Atrazine, Stinger, 2,4-D	See label for specific rates, crop stages and weed stages for application. Corn is tolerant at all stages of growth. However, best performance is obtained when weeds are small.
NorthStar 47.4DG + Nonionic surfactant (80%) or Crop oil concentrate + UAN or ammonium sulphate (optional)	5 oz/A + 1 qt/100 gal or 1 to 4 pt/A + 2-4 qt/A or 2-4 lb/A	dicamba + primisulfuron 0.125 + 0.023 lb/A	Atrazine, Accent, Banvel, Beacon, Clarity, Marksman, Resource, Tough	Apply over the top when corn is from 4 to 20 inches tall. Applied in a directed or semi-directed spray when corn is from 20 to 36 inches tall. See label comments regarding insecticide interactions. Do not apply to sensitive varieties.
Shotgun 3.25L	1.5 to 3 pt/A	atrazine + 2,4-D 0.24 + 0.19 to 0.84 + 0.38 lb/A	Atrazine, Banvel, Buctril	Do not tank mix with Accent. Apply at least 7 days before or 3 days after Accent applications. See label for rates regarding soil textures. Apply over the top when corn is from the spike to 8-inch (four-leaf) stage or in drop nozzles from 8-inch to 12-inch (five-leaf) stage.

## Corn, Postemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Postemergence tank-mix partners	Application method and precautions
Spirit 57DG + Nonionic surfactant (80%) or Crop oil concentrate + UAN or ammonium sulphate (optional)	1 oz/A + 1 to 2 qt/100 gal or 1 to 4 pt/A + 2 to 4 at/A or 2-4 lb/A	primisulfuron + prosulfuron 0.027 + 0.009 lb/A	2,4-D, Atrazine, Accent, Banvel, Beacon, Bicep, Buctril, Clarity, Dual, Marksman, Tough	See label restrictions regarding insecticide interactions. Apply over the top when corn is 4 to 20 inches tall (or 6 collars). Do not apply to sensitive hybrids. This herbicide is an option for areas with higher pH where Peak and Exceed may present carryover problems.
Status 56WG + Nonionic surfactant (80%) or Crop oil concentrate or MSO	5 oz/A + 2 pt/100 gal or 1 gal/100 gal or 1 gal/100 gal	Dicamba + diflufenzopyr 0.03 + 0.07	Accent, Steadfast	Apply over the top to corn that is 4 to 36 inches tall. Drop nozzles are not required.
Steadfast 75DG + Nonionic surfactant (80%) or Crop oil concentrate + UAN or ammonium sulphate	0.75 oz/A + 2 to 4 pt/100 gal or 1 gal/100gal + 2 qt/A or 2 lb/A	nicosulfuron + rimsulfuron 0.023 + 0.012 lb/A	Atrazine, Callisto, Clarity, Distinct, Marksman, Hornet, Stinger, Tough	May be applied to corn that is up to 20 inches tall and exhibiting up to and including 6 leaf collars. Do not apply to corn taller than 20 inches or exhibiting more than 6 leaf collars, whichever is more restrictive. See label restrictions regarding insecticide interactions.
Stout 72.5 DF + crop oil concentrate or nonionic surfactant + UAN or ammonium sulfate	0.5 to 0.75 oz/A + 1% v/v or 1 qt/100 gal + 2 qt/A or 2 lb/A	nicosulfuron + thifensulfuron 0.02 to 0.0016 to 0.03 + 0.0002 lb/A	Atrazine, Callisto, Distinct, Clarity, Banvel, Dual, Prowl, Cinch, Outlook, others	Apply to field corn that is up to 16 inches tall and is exhibiting up to and including 5 leaf collars. See label for restrictions regarding insecticide interactions.
Yukon 67.5 DF + Nonionic surfactant or Crop oil concentrate + UAN or ammonium sulphate (optional)	4 to 8 oz/A + 2 to 4 pt/100 gal or 1 gal/100 gal + 2 to 4 qt/A or 2 to 4 lb/A	Dicamba + halosulfuron 0.14 + 0.03 to 0.28 + 0.06 lb/A	Accent, Atrazine, Beacon, Bullet, Degree, Degree Xtra, Glyphosate, Partner	Apply over the top to corn from spike to 36 inches.

**Herbicide-resistant corn**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
<b>Liberty Link Corn</b>				
Ignite 28SL + AMS	22 oz/A + 3 lb/A	glufosinate 0.4 lb/A		Applications may be made from emergence through the fifth-leaf collar growth stage. Apply at 22 fl oz/A per application and no more than 44 fl oz/A may be applied per growing season.
Liberty 1.67L + Ammonium sulphate	16 to 34 oz/A + 3 lb/A	glufosinate 0.21 to 0.44 lb/A	Do not tank mix with Aim, Basis, Prowl, Resource, or Sencor.	Use on Liberty Link corn only. Use caution to avoid spraying the wrong field. Consult label to refine rates for particular weed species. Liberty has no residual activity. Apply overtop from emergence to 24-inch tall corn (7 collars) and with drop nozzles from 24 to 36 inches. See label regarding fertilizer additives. Do not apply within two hours of sunset.
Liberty ATZ 4.3SC + Ammonium sulphate	32 to 40 fl oz/A + 3 lb/A	atrazine + glufosinate 0.83 + 0.25 to 1.03 + 0.31 lb/A	Do not tank mix with Basis, Prowl, Resource, or Sencor.	Use on Liberty Link corn only. Use caution to avoid spraying the wrong field. Consult label to refine rates for particular weed species. Apply overtop from emergence to 12-inch tall corn. See label regarding fertilizer additives. Do not apply within two hours of sunset.
Surestart	1.5 to 2 pts/A	acetochlor + flumetsulan + clopyralid 0.7 to 0.02 + 0.07 lb/A to 0.9 + 0.03 + 0.10 lb/A	atrazine, glyphosate, Liberty, 2,4-D	Use only on Roundup Ready or Liberty Link corn. Can be applied preplant preemergence, or early postemergence, to corn up to 11 inches tall. Minimum planting depth should be 1.5 inches.

**Roundup Ready Corn**

**Preemergence or postemergence**

Expert 4.9L	2.5 to 3.75 qt/A	atrazine + S-metolachlor + glyphosate 1.3 + 1 + 0.63 to 2 + 1.6 + 0.9 lb/A	No tank mixes with other products after corn emerges. Before corn emergence, may be tank mixed with Atrazine, Banvel, Clarity, Dual II Magnum, Glyphosate, Hornet, Princep, Prowl, Python, Touchdown, or 2, 4-D	Use on Roundup Ready Corn only. May be applied from 30 days preplant up to 12-inch corn.
Halex GT + Nonionic surfactant + Ammonium sulphate	3.6 to 4 pts/A + 2 pt/100 gal + 8.5 to 17 lb/100 gal	S-metolachlor + glyphosate + mesotrione 0.94 + 0.94 + 0.094 lb/A to 1.05 + 1.05 + 0.105 lb/A	Atrazine	Use on Roundup ready corn only. Can be applied postemergence up to 30-inch or 8-leaf corn.
Roundup brands/ Touchdown brands/ other glyphosates		glyphosate 0.56 to 0.77 lb/A	Bullet, Harness, Harness Xtra, Micro-Tech, Partner, Permit	Use on Roundup Ready corn only. Use caution to avoid spraying the wrong field. Apply overtop from emergence until corn is 30 inches tall (8 collars). Higher rates per application are allowed on Roundup Ready corn 2. Drop nozzles may also be used on Roundup Ready corn 2 for corn 30 to 48 inches in height.
glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	1.5 to 2 pt/A or 16 to 22 fl oz/A or 16 to 32 fl oz/A + See label			
Ready Master ATZ + Ammonium sulphate	1.5 to 2 qt/A + 8.5 to 17 lb/100 gal	atrazine + glyphosate 0.75 + 0.56 to 1 + 0.75 lb/A	Aatrex, Harness, Microtech, Partner	Use on Roundup Ready corn only. Use caution to avoid spraying the wrong field. Apply from emergence until corn reaches 12 inches in height.

## Herbicide-resistant corn

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
<b>Roundup Ready Corn</b>				
<b>Preemergence or postemergence</b>				
Surestart	1.5 to 2 pts/A	acetochlor + flumetsulan + clopyralid 0.7 to 0.02 + 0.07 lb/A to 0.9 + 0.03 + 0.10 lb/A	atrazine, glyphosate, Liberty, 2,4-D	Use only on Roundup Ready or Liberty Link corn. Can be applied preplant preemergence, or early postemergence, to corn up to 11 inches tall. Minimum planting depth should be 1.5 inches.

## Corn, special problems

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
<b>Note:</b> Shattercane and johnsongrass have similar foliar responses to treatments; however, rhizomes of johnsongrass are more difficult to kill and regrowth is possible. Heavy johnsongrass infestations will require split and/or sequential herbicide applications for optimal control. Rhizome johnsongrass should typically be allowed to grow larger than seedling johnsongrass or shattercane so that more leaf area is available to absorb herbicides and translocate them to rhizomes.				
<b>Johnsongrass, Preplant burndown</b>				
Roundup brands/other glyphosates or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	2 to 4 pt/A or 21 to 42 fl oz/A or 21 to 42 fl oz/A + See label	glyphosate 0.75 to 1.5 lb/A	Johnsongrass (seedling and rhizome), shattercane and other annual grass and broadleaf weeds.	Treat with glyphosate before plants are 12 inches tall. Allow 7 or more days after application before tillage. Roundup may be tank-mixed with several preemergence herbicides. Control will be limited if johnsongrass is just emerging.
<b>Johnsongrass, Postemergence</b>				
Accent 75DF + Nonionic surfactant (80%) or Crop oil concentrate and 28 or 32% UAN liquid fertilizer (Optional)	0.67 oz/A + 1 to 2 qt/100gal or 1 gal/100 gal and 2 to 4 qt/100gal	nicosulfuron 0.031 lb/A	Seedling and rhizome johnsongrass, shattercane and other annual grass weeds.	Apply to 4- to 10-inch seedling and 8 to 12 inch rhizome johnsongrass. If regrowth occurs, second application may be made when johnsongrass is 8 to 10 inches tall. May be applied up to 20-inch corn broadcast, and 20- to 36-inch corn with drop nozzles. Do not apply to corn treated with Counter insecticide. See label for restrictions with other organophosphate insecticides, and postemergence herbicides.
Beacon 75DF + Nonionic surfactant (80%) or crop oil concentrate and 28 - 32% UAN liquid fertilizer (Optional)	1 water soluble packet per 2 acres + 2 pt/100 gal or 1 to 4 pt/A and 1 to 2 pt/A	primisulfuron 0.036 lb/A	Seedling and rhizome johnsongrass, shattercane and other annual broadleaf weeds.	Apply to 4- to 12-inch tall seedling and 8- to 16-inch tall rhizome johnsongrass. Another option is a half-rate, split application where a second application is made when regrowth is 8 to 16 inches tall. May be applied over the top to 4- to 20-inch tall corn. Use drop nozzles for 20-inch corn to tasseling. Do not apply to corn treated with Counter insecticide. See label for restrictions with other organophosphate insecticides, and postemergence herbicides. Some corn hybrids may be susceptible to injury, see your dealer for a list of restricted hybrids.

**Corn, special problems**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
Roundup brands/other glyphosates		glyphosate 0.375 to 0.75 lb/A	Johnsongrass (seedling and rhizome), most grass and broadleaf weeds	Roundup Ready corn only. For optimal results, apply to 15- to 20-inch tall rhizome johnsongrass and retreat if new growth reaches 6 to 12 inches tall.
Glyphosate 3L	1 to 2 pt/A			
or	or			
Roundup WeatherMax 4.5L	11 to 21 fl oz/A			
or	or			
Roundup PowerMax 4.5L	11 to 21 fl oz/A			
+	+			
Recommended additives	See label			
Roundup brands/other glyphosates		glyphosate 1% solution	Johnsongrass (seedling and rhizome), and many annual and perennial grass and broadleaf weeds.	Spot spray only, corn plants in treated area will be severely injured or killed. Cover foliage thoroughly. Apply to 12- to 18-inch tall johnsongrass.
Glyphosate 3L				
or				
Roundup WeatherMax 4.5L				
or				
Roundup PowerMax 4.5L				
+	+			
Recommended additives	See label			

**Corn, special problems**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
<b>Harvest aid</b>				
Aim	1 to 2 oz/A	Carfentrazone	—	Allow a minimum of three days between application and harvest.
+		0.015 to 0.031		
Crop oil concentrate				
or				
Nonionic surfactant				
or				
Methylated seed oil				
2,4-D amine	1.5 to 2 pt	2,4-D	Cocklebur, common ragweed, jimsonweed, morningglories, velvetleaf and suppression of vines such as honeyvine milkweed, field bindweed, trumpetcreeper and redvine that interfere with harvesting.	Preharvest treatment: Apply after hard dough or denting stage. Do not forage or feed corn fodder for 7 days following application.
or	or	0.75 to 1 lb		
2,4-D ester	1 to 2 pt/A	0.5 to 1 lb/A		
(4 lb/gal formulation)				
Roundup brands/other glyphosates		glyphosate 0.75 to 2.25 lb/A	Most grass and broadleaf weed species	Preharvest treatment: Apply at 35% moisture or less (black layer). Allow a minimum of 7 days between application and harvest. Do not treat corn grown for seed because reductions in germination or vigor may occur.
Glyphosate 3L	2 to 6 pt/A			
or	or			
Roundup WeatherMax 4.5L	21 to 64 fl oz/A			
or	or			
Roundup PowerMax 4.5L	22 fl oz/A			
+	+			
Recommended additives	See label			

<sup>a</sup> Consider using a tank mixture of two or more of the listed herbicides for optimal perennial vine control.

**Grain sorghum**  
Guide to weed response to herbicides

Herbicide	Barnyardgrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtail	Goosegrass	Seedling johnsongrass	Rhizome johnsongrass	Red rice	Shattercane	Yellow nutsedge	Eastern black nightshade	Cocklebur	Jimsonweed	Common lambsquarters	Entire/Ivyleaf morningglory	Pitted morningglory	Redroot and smooth pigweed	Prickly sida	Common ragweed	Giant ragweed/horseweed	Annual smartweed spp.	Sunflower	Velvetleaf	Common and tall waterhemp	Crop response***	
<b>Preplant incorporated or preemergence</b>																											
Atrazine	8	6	5	3	7	6	2	0	8	0	0	9	9	10	9	9	10	10	9	9	8	9	9	7	8	10	1
Dual II Magnum/Cinch	8	7	9	9	9	9	6	0	9	5	8	9	0	4	6	2	2	2	9	3	5	3	5	0	2	9	1**
Intrro/Lasso/Micro-Tech	8	7	9	9	9	9	6	0	8	5	7	9	0	4	6	2	2	9	4	5	5	3	5	0	2	9	1**
Outlook	8	7	9	9	9	9	6	0	9	4	8	8	2	4	7	2	2	9	0	5	2	4	0	2	9	1**	
<b>Preemergence only</b>																											
<b>Postplant incorporated</b>																											
Treflan	8	-	8	7	8	8	7	0	-	7	0	0	0	0	8	0	0	8	-	0	0	0	3	0	0	7	1
Paramount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prowl/others	9	-	9	8	9	9	7	0	-	7	0	0	0	0	7	0	0	8	-	0	0	3	0	0	7	1	
<b>Postemergence</b>																											
Aim	2	1	2	3	3	-	2	1	1	1	-	10	6	9	9	7	7	9	7	7	6	9	7	9	9	8	1
Atrazine + oil	8	7	7	5	7	6	3	0	10	2	6	9	9	10	10	9	9	10	9	9	8	9	9	9	9	10	1
Banvel/Clarity	0	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	10	9	8	10	9	9	9	9	9	8	1
Basagrán	0	0	0	0	0	0	0	0	0	0	7	2	9	9	6	5	7	4	8	8	8	8	8	8	8	3	0
Buctril	0	0	0	0	0	0	0	0	0	0	0	9	9	10	9	9	8	7	4	9	9	9	8	8	6	1	
Paramount	7	-	2	4	7	-	-	-	-	2	2	5	5	-	5	-	-	5	-	5	-	5	-	-	5	1	
Peak	0	0	0	0	0	0	0	0	0	0	9	6	8	8	7	8	8	8	8	7	8	8	8	8	8	5	1
Permit	0	0	0	0	0	0	0	0	0	0	9	6	9	8	6	6	6	9	7	8	8	8	7	9	9	5	0
Sarane	0	0	0	0	0	0	0	0	0	0	0	7	9	-	9	9	9	8	-	9	-	-	9	9	9	8	1
2,4-D	0	0	0	0	0	0	0	0	0	0	0	7	9	8	9	9	10	9	8	9	8	7	9	9	8	8	1
<b>Post directed</b>																											
Linex	7	-	8	8	8	8	-	7	0	6	-	-	8	-	9	9	8	8	9	9	8	8	9	9	8	-	1
Gramoxone	9	9	9	8	8	8	8	0	9	6	3	-	4	7	9	5	4	9	4	8	-	5	-	6	-	1	

Weed control: 8 to 10 = Good 6 to 7 = Fair\*\*\* Less than 6 = Poor - = No data available

\*Shallow incorporation needed for this level of control.

\*\*Treated seed.

\*\*\*A weed control rating of 6 to 7 indicates partial control or suppression.

Due to the overwhelming number of package mixes and tank mixes, it has become impractical to list and distinguish these combinations. In the interest of fairness, we are therefore listing no package mixes in this table. A reasonably accurate estimate may be obtained by combining the control ratings from the individual package or tank-mix component

## Grain sorghum

### Soil-applied herbicide rates for grain sorghum

Herbicide	Soil texture*		
	Coarse (light, sandy)	Medium (loamy)	Fine (heavy, clay)
----- (Rate per acre) -----			
Atrazine 4L	DO NOT USE	3.2 to 4 pt	4.0 to 4.75 pt
AAtrex Nine-0	DO NOT USE	1.7 to 2.2 lb	2.2 to 2.6 lb
Bicep II Magnum/Cinch ATZ	DO NOT USE	1.6 to 2.1 qt	1.6 to 2.1 qt
Bicep Lite II Magnum/Cinch Lite	DO NOT USE	1.1 to 1.5 qt	1.1 to 1.5 qt
Dual II Magnum/Cinch	1 to 1.33 pt	1.33 to 1.5 pt	1.33 to 1.67 pt
Guardman Max	2.4 to 3 pt	3 to 4 pt	4 to 4.6 pt
G-Max Lite	2 to 3 pt	2.5 to 3.5 pt	2.5 to 3.5 pt
Intro/Lasso/Microtech	1.5 to 2.5 qt	2 to 2.75 qt	2 to 3 qt
Lariat/Bullet	2.5 to 2.75 qt	2.75 to 3.75 qt	3 to 4 qt
Outlook	12 to 18 fl oz	14 to 21 fl oz	14 to 21 fl oz
Paramount 75DF	5.3 to 8 oz	5.3 to 8 oz	5.3 to 8 oz
Partner	2.3 to 3.8	3.1 to 4.2	3.1 to 4.6
Prowl 3.3E/others	DO NOT USE	1.8 pt	2.4 pt

\*Refer to herbicide labels for proper rates for your soil texture and organic matter content and for tank mixes.

### Grain sorghum, Burndown

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
<p>The following preemergence grain sorghum herbicides may be used for burndown: Atrazine, Bicep, Guardsman, Marksman, Ramrod/Atrazine. Application information is listed in the preemergence herbicide section. In most cases, a broad-spectrum, foliar burndown herbicide such as Roundup or Gramoxone should be tank mixed with the preemergence herbicide; however if grass pressure is light and broadleaf weeds are small, the addition of crop oil to an atrazine-containing product may be sufficient.</p>				
Aim 2E + Nonionic surfactant	0.25 to 2 fl oz/A + 2 pt/100 gal	carfentrazone 0.004 to 0.031 lb/A	No restrictions listed.	Should be applied with a broad-spectrum burndown herbicide.
Clarity 4L	8 oz/A	dicamba 0.25 lg/A		Do not apply within 15 days of planting.
Gramoxone Inteon+ Nonionic surfactant or Crop oil concentrate	2 to 3.5 pt/A + 1 to 2 pt/100 gal or 1 gal/100 gal	paraquat 0.7 to 1.2 lb/A	Atrazine, Bicep, Dual, Lasso, Lariat	May be applied early preplant (EPP) through planting, but before crop emergence. See label directions for specific rates, weed stages, and tank-mix instructions. Rate should normally be at least 1.67 pt/A
Roundup brands/ Touchdown brands/ other glyphosates 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	1 to 3 pt/A or 11 to 32 fl oz/A or 11 to 32 fl oz./A + See label	glyphosate 0.38 to 1.12 lb/A	Atrazine, Bicep, Dual, Lasso, Lariat	May be applied early preplant (EPP) through planting, but before crop emergence. See label directions for specific rates, weed stages, and tank-mix instructions.
Starane	0.66 pt/A	fluroxypyr 0.12 lb/A	Atrazine	For burndown applications, apply after planting, but before grain sorghum emergence.
Valor 51 WDG + Nonionic surfactant (80%)	2 to 2.5 oz/A + 1 qt/100 gal	flumioxazin 0.064 to 0.08 lb/A	Roundup, Gramoxone	<b>Do not apply within 30 days of planting.</b>
2,4-D LV ester (4 lb/gal formulation)	1 to 3 pt/A	2,4-D 0.5 to 1.5 lb/A	Atrazine, Lariat, Lasso	
<b>Package mixes - Preplant incorporated or preemergence</b>				
Expert 4.9L	2.5 to 3.75 qts/A	glyphosate + S-metolachlor + atrazine 0.6 + 1 + 1.33 to 0.9 + 1.63 +2 lb/A	Glyphosate, Touchdown	USE SAFENED SEED.
Sequence 5.25L + Ammonium sulfate	2 to 4 pt/A + 8.5 to 17 lb/A	glyphosate + S-metolachlor 0.5 + 0.75 to 1.1 + 1.5 lb/A	Atrazine, Bicep, Dual, Banvel, Claity, Touchdown	USE SAFENED SEED.

## Fall and early preplant applications of preemergence herbicides for reduced tillage

Many preemergence herbicides may be used two or more weeks before planting in an early preplant (EPP) application. Advantages include: Early preplant applications will prevent weed emergence and aid or eliminate a formal burndown application. They may limit weed growth if weather moderately delays planting. Some preemergence herbicides have significant postemergence, burndown activity (adjuvants are sometimes required). Some preemergence herbicides increase the activity or spectrum of burndown herbicides. Finally, combining a preemergence herbicide with a burndown herbicide may simply save time and costs by eliminating a second trip for the traditional preemergence, after-planting application.

Several herbicides are registered for fall application. A fall herbicide application may be beneficial if it eliminates the need for a burndown application in the spring and soil erosion is not a problem. Fall applications could also benefit

drying of the soil in the spring and could reduce the need for tillage before planting.

There are many choices and an option that works well in one field may work poorly in another. For most situations we recommend that growers target early preplant applications 15 days or less before planting. The sooner a herbicide is applied, the sooner it will break down and lose effectiveness. If rain delays planting too long, most advantages of extra-early preplant applications may be lost. Also, after 30 days, there is a much higher probability that a burndown application will be needed and most labels specify that additional preemergence herbicide be applied at planting. Finally, exceptionally long (>30 day) preplant intervals remove winter vegetation and leave the soil vulnerable to erosion and may increase the probability of herbicide contamination of ground and surface water.

### Early preplant (EPP) labels for grain sorghum herbicides

Herbicide	Burndown activity	Label allows preplant application		
		45 days	30 days	15 days
Atrazine	Yes	Yes*	Yes*	Yes
Bicep II/Magnum/Bicep Lite II/Magnum/Cinch	Yes	Yes*	Yes*	Yes
Dual II/ Magnum/Cinch	No	Yes*	Yes*	Yes
Guardsman Max	Yes	Yes*	Yes*	Yes
G-Max Lite	Yes	Yes*	Yes*	Yes
Lariat/Bullet	Yes	Yes*	Yes*	Yes
Intro/Lasso/Microtech	No	Yes*	Yes*	Yes
Outlook	No	Yes*	Yes*	Yes

\*Label recommends reapplication at the time of planting (Typically 2/3 applied EPP and 1/3 preemergence at planting)  
 \*\*EPP intervals greater than 15 days are not recommended on coarse-textured (light, sandy) soils.

### Grain sorghum, Preplant incorporated or preemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
<b>Preplant incorporated or preemergence</b>				
Atrazine, 4L or Aatrex Nine-0	3.2 to 4 pt or 1.7 to 2.2 lb/A	atrazine 1.6 to 2 lb/A	Bicep, Dual, Lariat, Lasso	Do not use on coarse (light, sandy) soils. Do not use on medium (loam) or fine (heavy, clay) soils with less than 1% organic matter.
Dual II Magnum 7.64E/Cinch	1 to 1.67 pt/A	s-metolachlor 1 to 1.6 lb/A	Atrazine, Bicep	USE SAFENED SEED.
IntRRo 4L or Lasso 4EC or Microtech 4L or Partner 65DG	1.5 to 3 qt/A or 1.5 to 3 qt/A or 1.5 to 3 qt/A or 2.3 to 4.5 lb/A	alachlor 1.5 to 3 lb/A	Atrazine, Lariat	USE SAFENED SEED. Preplant treatment should be shallow incorporated. Use higher recommended rate if shallow incorporated.
Paramount 75DF	5.3 to 8 oz/A	quinclorac 0.25 to 0.38 lb/A	Atrazine, Clarity, Roundup, 2,4-D	
<b>Package mixes - Preplant incorporated or preemergence</b>				
Bicep II Magnum 5.5L or Cinch ATZ	1.6 to 2.1 qt/A	atrazine + s-metolachlor 1.24 + 0.96 to 1.63 + 1.26 lb/A	Atrazine, Dual	USE SAFENED SEED. Do not use on coarse (light, sandy) soils. Do not use on medium (loam) soils with less than 1.5% organic matter.
Bicep Lite II Magnum 6L or Cinch Lite ATZ	1.1 to 1.5 qt/A	s-metolachlor + atrazine 0.92 + 0.73 to 1.25 + 1 lb/A	Atrazine, Dual	USE SAFENED SEED. Do not use on coarse (light, sandy) soils. Do not use on medium (loam) soils with less than 1.5% organic matter.

**Grain sorghum, Preplant incorporated or preemergence**

<b>Herbicide and formulation</b>	<b>Formulated material per broadcast acre</b>	<b>Herbicide (lb active per acre)</b>	<b>Labeled tank-mix partners</b>	<b>Application method and precautions</b>
Guardsman Max	2.4 to 4.6 pt/A	atrazine+dimethanamid-P 0.99 + 0.51 to 1.9 + 0.98 lb/A	Atrazine, Gramoxone Max, Glyphosate	USE SAFENED SEED.
G-Max Lite	2 to 3.5 pt/A	atrazine+dimethanamid-P 0.7 + 0.5 to 1.2 + 0.98 lb/A	Atrazine, Banvel, Basagran, Clarity, Gramoxone Max, Glyphosate, Marksman, Outlook, Prowl	USE SAFENED SEED.
Lariat 4F/Bullet	2.5 to 4 qt/A	alachlor + atrazine 1.6 + 0.9 to 2.5 + 1.5 lb/A	Atrazine, Lasso	USE SAFENED SEED. Use lower rates for coarse (light, sandy) soils and higher rates for heavy (fine, clay) soils. Do not use on coarse soils with less than 3% organic matter. Atrazine and/or Lasso may be added to Lariat to improve weed control in heavy infestations or for hard-to-control weeds.
<b>Preemergence only</b>				
Linex 4L	0.625 to 2 pt/A	linuron 0.3 to 1 lb/A		Consult label for specific rated according to soil type. Apply after planting but before crop emergence.
<b>Early postemergence incorporated</b>				
Prowl 3.3EC/others	1.8 to 2.4 pt/A	pendimethalin 0.74 to 1.0 lb/A		BOOTHEEL COUNTIES ONLY. Cultivation with sweeps or a rolling cultivator is required before and after application. Do not use on coarse (light, sandy) soils. Apply after grain sorghum is more than 4 inches tall until last (layby) cultivation.
Prowl H2O 3.8ACS	2 pts/A	pendimethalin 0.74 to 1.0 lb/A		BOOTHEEL COUNTIES ONLY. Cultivation with sweeps or a rolling cultivator set to provide thorough incorporation in the top 1 inch of soil. Do not use on coarse (light, sandy) soils. Apply after grain sorghum is more than 4 inches tall until last (layby) cultivation.
Treflan 4EC/ others	0.75 to 2 pt/A	trifluralin 0.38 to 1 lb/A		Cultivation with sweeps or a rolling cultivator is required before and after application. Apply after grain sorghum is more than 8 inches tall.

**Grain sorghum, Postemergence and directed**

<b>Herbicide and formulation</b>	<b>Formulated material per broadcast acre</b>	<b>Herbicide (lb active per acre)</b>	<b>Labeled tank-mix partners</b>	<b>Application method and precautions</b>
Aim 2E + Nonionic surfactant	0.5 fl oz/A + 2 pt/100 gal	carfentrazone 0.008 lb/A	Atrazine, Banvel, Clarity, Laddok, Peak, Permit	Do not use crop oil concentrate. Leaf speckling is likely. Weeds must be 4 inches or less for adequate control.
Atrazine 4L or AAtrex Nine-0 + Crop oil concentrate (optional)	2 qt/A or 2.2 lb/A	atrazine 2 lb/A	Basagran, Buctril, Laddok	See label precautions for the use of crop oil concentrate. Apply after grain sorghum reaches three-leaf stage but before the 12-inch stage. Apply before weeds exceed 1.5 inches tall. Do not use on sand or loamy sand.
Banvel/Clarity (4 lb/gal formulation)	0.5 pt	dicamba 0.25 lb/A	None	Apply before sorghum is more than 15 inches tall. From 8 to 15 inches, use only directed applications with drop pipes. Apply to weeds less than 3 inches tall for best performance.
Basagran 4S	1.5 to 2 pt/A	bentazon 0.75 to 1 lb/A	None	Apply when weeds are small. May be applied up to and including early boot stage. Add 1 qt/A oil concentrate for use on yellow nutsedge and other hard-to-control weeds listed on the label.
Buctril 2E or Buctril 4 lb/gal	1 to 1.5 pt/A or 0.5 to 0.75 pt/A	bromoxynil 0.25 to 0.38 lb/A	Atrazine	See label for specific rates and weed stages for application. Do not spray when grain sorghum foliage is wet. Application may be made from the three-leaf stage of sorghum up to 14 inches tall.

## Grain sorghum, Postemergence and directed

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
Paramount 75DF + Crop oil concentrate + UAN or ammonium sulfate (optional)	5.3 to 8 oz/A + 1 gal/100 gal + 0.5 to 10 gal/100 gal or 2.5 lb/A	quinclorac 0.25 to 0.38 lb/A	Atrazine, Clarity, Peak, 2,4-D	Apply to grain sorghum up to 12 inches tall. For best annual grass control apply with 0.5 to 1 lb/A atrazine when weeds are less than 2 inches tall. Do not tank mix with fungicides, insecticides or fertilizers.
Peak 57DG + Nonionic surfactant (80%) or Crop oil concentrate + UAN or ammonium sulfate (optional)	0.5 to 1 oz/A (1 pkt/ 6 to 3 A) + 1 gal/100 gal or 4 gal/100 gal + 1 gal or 2 lb/A	prosulfuron 0.018 to 0.036 lb/A	Atrazine, Banvel, Buctril, Marksman, 2,4-D	Apply to actively growing weeds when sorghum is 5 to 30 inches tall.
Permit 75 DF + Nonionic surfactant (80%) or Crop oil concentrate + UAN or ammonium sulfate (optional)	0.67 to 1.33 oz/A + 1 to 2 qt/A or 1 gal/ 100 gal + 4 gal/100 gal or 2 to 4 lb/A	halosulfuron 0.032 to 0.047 lb/A	Atrazine	Do not cultivate for 7 days following application. Do not apply to sorghum treated with an organophosphate insecticide.
Starane	0.66 pt/A	fluroxypyr 0.12 lb/A	Atrazine	May be applied from the 3-leaf growth stage through the 7-leaf stage. Use drop nozzles and directed spray from the 8-leaf stage to the boot stage.
2,4-D amine (4 lb/gal formulation)	1 pt/A	2,4-D 0.5 lb/A	None	Treat only after grain sorghum is over 6 inches tall and before it is 15 inches tall. If crop is over 8 inches tall, use drop nozzles to keep spray off leaves.
2,4-D LV ester	0.5 pt/A	2,4-D 0.25 lb/A	None	Treat only after grain sorghum is more than 5 inches tall and before it is 15 inches tall. If crop is more than 8 inches tall, use drop nozzles to keep spray off of leaves.
<b>Package mixes: Postemergence overtop</b>				
Buctril/ Atrazine 3F	1.5 to 3 pt/A	bromoxynil + atrazine 0.19 + 0.38 to 0.38 + 0.75 lb/A	Buctril, atrazine	See label for specific rates, crop and weed stages for application. Buctril and/or atrazine may be added to the package mix to improve control in heavy infestations or for hard-to-control weeds. Application may be made from the 2-leaf stage (0.19 lb Buctril rate), the 3-leaf stage (0.25 lb rate) or the 4-leaf stage (0.38 lb rate) of sorghum up to 10 inches tall.
Laddok S-12 5L + Crop oil concentrate or 28% UAN	2 to 3.5 pt/A + 1 qt/A or 2 to 4 qt/A	bentazon + atrazine 0.52 + 0.52 0.73 + 0.73 lb/A	None	Apply when weeds are small. May be applied up to and including early boot stage. Use higher rates for yellow nutsedge and other hard-to-control weeds listed on the label.
Shotgun 3.25L	2 pt/A	atrazine + 2,4-D 0.56 + 0.25 lb/A	Atrazine, Banvel, Buctril	Apply to actively growing weeds. Apply over the top from spike- to 8-inch (4-leaf) growth stages and in a directed spray from 8-inch to 12-inch growth stages.
Yukon 67.5 DF + Nonionic surfactant or Crop oil concentrate + UAN or ammonium sulfate (optional)	4 to 6 oz/A + 2 to 4 pt/100 gal or 1 gal/100 gal + 2 to 4 qt/A or 2 to 4 lb/A	dicamba + halosulfuron 0.14 + 0.03 to 0.21 + 0.045 lb/A	Atrazine, Bullet, Partner	Apply over the top to grain sorghum from 2 leaf through 8 inches and with drop nozzles until 15 inches tall.

**Grain sorghum, Postemergence and directed**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
<b>Postemergence directed</b>				
Linex 4L or Lorox 50DF + Surfactant	1 to 2 pt/A or 1 to 2 lbs/A + 2 qt/100 gal	linuron 0.5 to 1 lb/A	None	Keep spray off all but the lower 3 inches of grain sorghum plants. See label directions for application methods, equipment and proper crop and weed heights for application.
Gramoxone Inteon + Nonionic surfactant	1 to 2 pt/A + 8 oz/100 gal	paraquat 0.34 to 0.7 lb/A	None	Apply after grain sorghum is more than 12 inches tall, but before weeds are more than 3 inches tall. Keep spray off all but the lower 3 inches of grain sorghum plants.

**Grain sorghum, Special problems**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
<b>Johnsongrass control</b>				
Roundup Brands/Other glyphosates 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	1 to 3 pt/A or 11 to 32 fl oz/A or 11 to 32 fl oz./A + See label	glyphosate 2% solution	Johnsongrass (seedling and rhizome), shattercane and many annual and perennial grass and broadleaf weeds.	Cover foliage thoroughly. Sorghum plants in treated area will be severely injured or killed.
Roundup Brands/Other glyphosates 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	33% solution + See label	glyphosate 1 gal + 2 gal water	Johnsongrass (rhizome), shattercane and many annual and perennial grass and broadleaf weeds.	
<b>Perennial vine control</b>				

Note: Consider using a tank mixture of two or more of the listed herbicides for optimal perennial vine control.

2,4-D amine (4 lb/gal formulation) or 2,4-D LV ester (4 lb/gal formulation)	1.5 to 2 pt or 0.75 to 1 pt/A	2,4-D 0.75 to 1 lb or 0.38 to 0.5 lb/A	Annual morningglories and suppression of vines such as honeyvine milkweed, field bindweed, trumpetcreeper, and redvine.	These rates are more likely to cause some crop injury than the lower rates in the "post-emergence" section. Treat only after grain sorghum is more than 6 inches tall and before it is 15 inches tall. If crop is more than 8 inches tall, use drop nozzles to keep spray off of grain sorghum leaves.
Banvel (4 lb/gal formulation)	2 to 4 pt/A	dicamba 1 to 2 lb/A	Field bindweed, trumpetcreeper, redvine and many other problem broadleaf weeds.	Between cropping application: Apply as a broadcast or spot treatment to emerged and actively growing weeds after crop harvest but before a killing frost. Majority of weeds should be 8 inches or taller. Avoid disturbing treated areas for at least 7 days. Rates depend on type and density of weeds. Corn, grain sorghum or soybeans may be planted in the spring following application. Wheat may be planted in the fall, but planting must be delayed 45 days for each pint of Banvel applied.

**Grain sorghum, Special problems**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
Roundup Brands/Other glyphosates 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	2 to 4 pt/A or 21 to 42 fl oz/A or 26 to 52 fl oz./A + See label	glyphosate 0.75 to 1.5 lb/A	Field bindweed and other problem grass and broadleaf weeds.	Between cropping applications: Apply as a broadcast or spot treatment to emerged and actively growing weeds, after crop harvest but before a killing frost. Majority of weeds should be 8 inches or taller. Avoid disturbing treated areas for 14 days. See labels for rates on type and density of weeds present. Wheat may be planted in the fall, but planting must be delayed 45 days for each pint of Banvel applied. Corn, sorghum and soybeans may be planted in the spring following application.
<b><i>Hooded sprayer application</i></b>				
Gramoxone Inteon + Nonionic surfactant (80%) or Crop oil concentrate	1 to 2 pt/A + 1 to 2 pt/100 gal or 1 gal/100 gal	paraquat 0.34 to 0.7 lb/A		Gramoxone drift is injurious to grain sorghum. May be applied with a postemergence directed sprayer when corn is 12 inches or taller.
Roundup Brands/Other glyphosates 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	1 to 2 pt/A or 11 to 21 fl oz/A or 13 to 26 fl oz./A + See label	glyphosate 0.375 to 0.75 lb/A	Grass and broadleaf weeds in row middles.	See label for hood specifications and application directions. Avoid drift. Roundup drift is extremely injurious to grain sorghum. Weeds in the drill will not be controlled.
<b><i>Harvest aid</i></b>				
Reglone 2L	1.5 to 2 pt/A	diquat, 0.38 to 0.5 lb/A	Desiccation of green weed foliage.	Make applications at 30% grain moisture or less. Apply 1 to 2 weeks before harvest. Do not use seed from treated plants for food, feed or oil purposes.
Roundup Brands/Other glyphosates 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	2 to 4 pt/A or 21 to 42 fl oz/A or 26 to 52 fl oz./A + See label	glyphosate 0.75 to 1.5 lb/A	Most grass and broadleaf weeds	Make applications at 30% grain moisture and at least 7 days prior to harvest. Do not apply to grain sorghum grown for seed.

**Soybean: Guide to grass and sedge weed response to herbicides**

Herbicide	Barnyardgrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtail, giant	Goosegrass	Johnsongrass, seedling	Johnsongrass, rhizome	Shattercane	Volunteer corn***	Volunteer wheat	Woolly cupgrass	Yellow nutsedge	Crop response**
<b>Preplant incorporated</b>														
Sonalan	9	9	9	9	10	9	8	3	9	7	6	8	0	1
Treflan/others	9	9	9	9	10	9	9	3	9	7	6	9	0	0
<b>Preplant or Preemergence</b>														
Authority Assist	6	5	6	6	7	5	6	4	7	4	3	5	7	1
Authority First/Sonic	2	0	2	2	2	-	0	0	1	1	-	1	8	1
Authority MTZ	5	-	4	4	4	4	2	0	1	1	-	-	6	2
Boundary	8	5	9	8	8	8	5	1	4	1	-	4	6	1
Canopy DF	1	2	1	3	4	2	1	0	0	1	-	0	2	2
Canopy EX	1	-	3	2	4	2	1	0	0	0	-	0	4	2
Command	9	9	9	9	10	9	9	2	6	4	8	8	-	0
Define	9	8	9	8	9	8	5	1	4	0	3	5	6	0
Dual II Magnum/Cinch	8	7	9	9	9	9	6	0	5	0	3	7	8	0
Envive	4	2	3	3	5	2	1	0	0	1	-	0	5	2
FirstRate	4	-	5	-	3	-	2	0	0	-	-	-	7	0
Gangster	1	2	3	3	3	1	1	0	0	1	-	1	2	1
Intro/Lasso/Micro-Tech	8	7	9	9	9	9	6	0	5	0	3	7	7	0
Outlook	8	-	9	9	9	-	-	0	5	0	3	7	7	0
Prefix	8	6	8	7	8	6	5	1	2	4	-	4	6	1
Prowl H <sub>2</sub> O	9	9	9	9	10	9	9	3	8	7	6	9	0	0
Pursuit	6	-	7	6	7	-	-	4	6	4	-	5	3	1
Python	6	6	6	7	6	-	7	-	6	0	6	-	-	1
Scepter	6	6	6	6	6	6	6	2	-	-	-	-	4	1
Sencor	6	6	6	6	6	6	5	0	1	2	-	-	2	2
Spartan	-	-	-	6	6	-	-	-	-	-	-	-	9	2
Lorox/Linex	6	6	6	6	6	6	4	0	0	0	-	-	0	1
Prowl H <sub>2</sub> O	9	-	8	8	9	9	7	0	6	6	5	8	0	2
Valor	2	-	2	-	2	-	-	-	-	-	-	-	-	2
Valor XLT	4	2	4	4	4	2	1	0	0	1	-	0	5	2
<b>Postemergence overtop</b>														
Aim	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Assure II	8	9	9	9	10	9	10	9	8	9	9	9	0	0
Basagran	0	0	0	0	0	0	0	0	0	0	0	0	7	0
Classic	0	0	0	0	0	0	0	0	0	0	-	0	7	1
Cobra/Phoenix	2	2	2	2	3	1	2	0	4	2	4	-	2	2
FirstRate/Amplify	3	-	4	-	5	-	6	-	5	2	-	-	7	0
Flexstar/Reflex	0	0	0	0	0	0	0	0	3	2	3	-	3	1
Fusilade DX	8	8	8	8	9	9	10	9	10	9	9	9	0	0
Glyphosate (Roundup Ready only)	10	10	10	10	10	10	10	9	10	0	10	9	7	0
Harmony GT XP/Unity	0	0	0	0	0	0	0	0	0	0	0	-	0	2
Ignite (Libery Link only)	8	8	7	7	8	7	8	6	8	6	-	7	5	1
Poast Plus	9	10	9	9	10	9	10	8	9	8	7	9	0	0
Pursuit	7	7	7	7	8	5	6	4	9	4	3	5	4	1
Raptor	7	7	7	8	9	5	8	6	9	7	6	5	5	1
Resource	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Scepter	1	1	3	3	3	0	6	0	5	4	-	-	3	1
Select/Select Max	9	9	9	9	9	9	10	9	8	9	9	9	0	0
Ultra Blazer	2	2	2	4	4	0	4	0	5	4	3	-	2	1
<b>Postemergence directed</b>														
Gramoxone Max	9	9	9	8	8	8	8	0	6	6	6	-	3	2
Lorox	7	7	8	7	7	7	7	0	-	-	-	-	2	2
2,4-DB	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Weed control: 8 to 10 = Good 6 to 7 = Fair\* Less than 6 = Poor - = No data available

\*A weed control rating of 6 to 7 indicates partial control or suppression.

\*\*Crop response: A rating of 3 or less will not result in loss of crop yield under normal growing conditions.

\*\*\*Indicates volunteer Roundup Ready© corn.

Use this table and the one on the next page as a guide for comparing the relative effectiveness of herbicides on individual weeds. Herbicides may perform better or worse than indicated due to extreme weather conditions and other variables. If you are obtaining satisfactory results under your growing conditions, changing products as a result of information in this table is not necessarily recommended.

Soybean: Guide to broadleaf weed response to herbicides

Herbicide	Black nightshade	Carpetweed	Cocklebur	Hophornbeam copperleaf	Jimsonweed	Hemp sesbania	Lambsquarters	Morningglory, annual	Pigweed, smooth/redroot	Palmer amaranth	Prickly sida	Ragweed, common	Ragweed, giant	Smartweed, annual	Spurred anoda	Sunflower	Velvetleaf	Waterhemp
<b>Preplant incorporated</b>																		
Sonalan	6	10	0	-	3	0	9	3	10	8	0	3	0	3	-	0	4	8
Treflan/others	0	10	0	0	3	0	9	3	10	8	0	3	0	3	0	0	3	8
<b>Preplant or preemergence</b>																		
Authority Assist	8	-	8	8	8	-	9	7	9	8	7	8	7	8	6	8	8	8
Authority First/Sonic	8	-	8	8	8	6	9	6	9	8	7	9	7	8	4	7	8	8
Authority MTZ	8	9	7	8	6	-	9	7	9	8	7	8	7	9	8	8	7	8
Boundary	8	9	6	5	7	2	9	4	9	8	6	8	6	8	9	8	7	8
Canopy DF	4	9	8	-	9	-	9	8	8	6	-	9	7	9	8	8	8	6
Canopy EX	4	-	8	-	9	-	9	8	7	6	6	8	7	9	-	8	8	4
Command	5	0	6	3	9	4	9	0	5	3	9	8	3	7	8	3	10	4
Define	6	-	2	3	3	0	5	4	9	9	3	7	2	3	0	0	2	9
Dual II Magnum/Cinch	9	9	2	5	4	0	6	2	9	9	4	5	3	5	0	0	2	9
Envive	9	9	8	-	9	-	9	8	8	8	8	9	7	9	9	8	8	8
FirstRate	-	-	9	-	9	2	7	8	7	5	6	9	9	-	-	9	7	5
Gangster	9	9	8	9	9	-	9	8	9	8	8	9	8	9	9	4	8	8
Intro/Lasso/Micro-Tech	9	9	0	5	4	0	6	0	9	8	4	5	3	5	0	0	2	8
Outlook	8	-	2	-	4	-	7	2	9	8	0	5	2	4	-	0	2	8
Prefix	8	9	6	-	-	-	6	4	9	8	4	8	6	8	-	6	6	8
Prowl H <sub>2</sub> O	0	10	0	0	3	0	9	3	9	8	0	3	0	3	0	0	3	8
Pursuit	9	-	6	-	7	-	8	7	8	5	-	7	6	9	-	7	8	5
Python	-	-	8	-	9	3	9	7	9	7	9	7	7	8	9	7	9	7
Scepter	8*	9	9	4	8	4	9	5	9	5	9	9	7	9	7	9	7*	5
Sencor	5	9	7	9	7	9	8	2	9	8	9	9	6	9	9	7	8	8
Spartan	8	-	3	6	6	5	9	8	8	9	-	4	3	2	-	4	6	9
Lorox/Linex	4	9	6	-	-	-	9	4	8	8	8	8	5	7	-	5	6	8
Prowl/others PRE	0	-	0	0	0	0	7	0	9	7	-	0	0	3	0	0	2	7
Valor	9	9	2	9	9	-	9	8	9	8	8	8	7	7	-	2	7	9
Valor XLT	9	9	8	9	9	-	9	8	9	8	8	9	7	9	9	8	8	8
<b>Postemergence overtop</b>																		
Aim	9	-	6	-	-	-	8	7	9	6	6	-	-	-	-	-	9	6
Assure II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basagran	2	0	9	0	9	4	6	5	4	3	8	8	7	9	8	8	8**	3
Classic	5	2	9	4	8	9	3	7	8	5	3	8	6	8	2	9	8**	5
Cobra/Phoenix	9	10	9	9	9	9	5	7	10	9	6	9	8	7	7	8	7	9
FirstRate/Amplify	5	-	9	-	9	2	4	8	7	5	6	9	9	9	-	9	9	5
Flexstar/Reflex	8	10	9	8	9	9	5	8	10	9	2	8	8	7	2	6	7	9
Fusilade DX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glyphosate (Roundup Ready only)	9	9	10	8	9	7	9	8	10	9	8	9	9	7	-	9	8	9
Harmony GT XP/Unity	4	-	6	-	4	-	8	2	9	5	4	5	4	8	2	6	9	5
Ignite (Liberty Link only)	8	9	9	8	9	9	8	9	7	8	8	8	8	9	-	9	7	8
Poast Plus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pursuit	9	-	8	2	8	1	5	7	9	5	5	8	6	8	6	8	8	5
Raptor	9	7	8	5	8	1	7	7	9	5	5	7	6	8	7	8	8	5
Resource	-	-	7	-	7	-	6	5	7	7	-	7	7	5	-	-	9	7
Scepter	6	1	9	1	4	2	3	2	9	5	1	6	5	7	2	8	4	5
Select/Select Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ultra Blazer	9	10	7	9	9	10	5	8	10	9	2	9	5	8	2	6	7**	9
<b>Postemergence directed</b>																		
Gramoxone Max	-	10	4	7	7	1	9	5	9	8	4	8	-	5	3	-	6	9
Lorox	7	7	7	7	7	8	8	8	8	-	8	8	7	7	8	-	6	7
2,4-DB	0	10	9	2	4	3	-	9	2	2	3	1	-	0	2	-	3	1

Weed control: 8 to 10 = Good 6 to 7 = Fair\*\*\* Less than 6 = Poor - = No data available

\*Shallow incorporation needed for this level of control.

\*\*Split application required for this level of control.

\*\*\*A weed control rating of 6 to 7 indicates partial control or suppression.

\*\*\*\*Waterhemp has been observed to routinely escape ALS-herbicide treatments in many areas. Resistance has been formally confirmed in some fields. Control may vary from indicated valued on ALS-inhibiting herbicides.

## Soybean

### Soil-applied herbicide rates

Herbicide	Soil texture*		
	Coarse (light, sandy)	Medium (loamy)	Fine (heavy, clay)
----- (Rate per acre) -----			
Authority First	3.2 to 6.4 oz	3.2 to 8 oz	3.2 to 8 oz
Authority MTZ	8 to 14 oz	8 to 18 oz	10 to 20 oz
Axiom 68DF	8 to 15 oz	10 to 20 oz	20 to 23 oz
Boundary 6.5L	1.2 to 1.8 pt	1.8 to 2.4 pt	2.4 to 3 pt
Canopy	2.25 to 7 oz	2.25 to 7 oz	2.25 to 7 oz
Canopy EX 29.5 WDG	1.1 to 3.3 oz	1.1 to 3.3 oz	1.1 to 3.3 oz
Cinch 7.64EC	1 to 1.33 pt	1.33 to 1.67 pt	1.33 to 2 pt
Command 3ME	2 to 3.33 pt	2 to 3.33 pt	2 to 3.33
Domain 60DF	Do not use	9 to 16 oz	9 to 16 oz
Dual II Magnum 7.64 EC	1 to 1.33 pt	1.33 to 1.67 pt	1.33 to 2 pt
Enlite	2 to 4 oz	2 to 4 oz	2 to 4 oz
Envive	2.5 to 5.25 oz	2.5 to 5.25 oz	2.5 to 5.25 oz
FirstRate 84 DG	0.6 to 0.75 oz	0.6 to 0.75 oz	0.6 to 0.75 oz
Outlook	12 to 18 flz	14 to 21 fl oz	14 to 21 fl oz
Gangster (multi-pack)	3 to 3.6 oz	3 to 3.6 oz	3 to 3.6 oz
Intro 4E	2 to 2.25 qt	2 to 2.75 qt	2 to 3 qt
Lasso 4E	2 to 3 qt	2 to 3 qt	2 to 3.5 qt
Lasso II 15G	Do not use	16 lb	20 lb
Linex 4L	1 to 2 pt	1 to 2 pt	1 to 2 pt
Micro-Tech 4E	2 to 3 qt	2 to 3 qt	2 to 3.5 qt
Partner 65G	3 to 3.8 lb	3 to 4.5 lb	3 to 4.5 lb
Prefix	2 to 2.25 pt	2 to 2.5 pt	2 to 2.5 pt
Prowl H <sub>2</sub> O 3.8ACS	1.5 to 2 pt	2.5 to 3 pt	3 pt
Pursuit 70DG	1.4 oz	1.4 oz	1.4 oz
Pursuit Plus 2.9E	2.5 pt	2.5 pt	2.5 pt
Python WDG	0.8 to 1 oz	0.89 to 1.33 oz	0.89 to 1.33 oz
Scepter 70DG	2.8 oz	2.8 oz	2.8 oz
Sencor 4L	Do not use	0.75 to 1.25 pt	1 to 1.5 pt
Sencor 75DF	Do not use	0.5 to 0.8 lb	0.66 to 1 lb
Sequence 5.25L	2.5 to 3.5 pt	3.5 to 4 pt	3.5 to 4 pt
Sonalan 3EC	1.5 to 2 pt	2 to 2.5 pt	2.5 to 3 pt
Sonic	3.2 to 6.4 oz	3.2 to 6.4 oz	3.2 to 8 oz
Spartan 4F	4 oz	4 oz	4 oz
Treflan 4EC	1 pt	1.5 pt	2 pt
Valor 51WDG	2 oz	2 to 2.5 oz	2.5 oz
Valor XLT	3 to 4 oz	3 to 5 oz	3 to 5 oz

\*Refer to herbicide labels for proper rates on your soil texture and organic matter content, and for tank mixes.

## Soybean

### Weed control recommendations for double-crop soybeans

A significant percentage of soybeans are grown in a double-crop rotation with winter wheat. Our research suggests a different weed control approach with herbicides is necessary for double-crop soybeans.

Soybeans are produced in a double-crop system with conventional or no-tillage methods. The recommendations that follow can be used for either tillage system. However, no-tillage weed control will require the use of a preemergence application of a “burndown” herbicide to control weeds at the time of planting. You should use Gramoxone Max or glyphosate if weeds are less than 6 inches tall at the time of planting. You should use glyphosate if weeds are taller than 6 inches or if you have rhizome johnsongrass infesting the field at the time of planting.

Preemergence herbicides or postemergence herbicides are the two herbicide strategies used to control weeds in soybeans. Preemergence applications often must be followed with postemergence herbicides applications to control weed escapes. Our research indicates you should strongly consider a postemergence-only approach to weed control in double-crop soybeans (following a preemergence “burndown” application if needed at the time of planting). The postemergence approach is more successful in a double-crop system because of the lower rainfall amounts in late June and July when double-crop soybeans are planted. Lack of rainfall will frequently result in poor “activation” of preemergence

herbicides. In addition, if rainfall is low, weeds may not germinate which will eliminate the need to apply postemergence herbicides at all. Our experience suggests low weed germination will occur about 1 in 3 years in Missouri.

If you choose to use a preemergence herbicide program you should consider only using shorter residual herbicides. These herbicides are less likely to have carryover problems for crop rotation than some of the newer, long-residual herbicides. Be aware that crop rotation intervals are extended for many herbicides if they are applied late in the summer. Check the label or the crop rotation guide in this book for more information.

The preemergence and no-till programs listed in this guide will work in double-crop soybeans if you will also follow the above suggestions. Postemergence herbicide listings in this guide will perform the same in any system. However, be aware that postemergence herbicide performance is reduced during the hot, dry weather frequently encountered during late summer. Be sure to use the higher rates listed and the proper additives.

Planting soybeans in narrow or drilled rows has several advantages in double-crop soybeans. One of the main advantages is faster canopy closure, which enhances weed control by shading the soil and preventing late weed germination. We strongly recommend you use narrow (< 15 inches) or drilled rows when growing double-crop soybeans.

### Soybean, Burndown

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
The following preemergence soybean herbicides may be used for burndown: Spartan, FirstRate, Pursuit, Python, Scepter, Sencor, Boundary, Canopy EX, Pursuit Plus, Squadron and Valor. Application information is listed in the preemergence herbicide section. In most cases, a broad-spectrum, foliar burndown herbicide such as glyphosate or Gramoxone Max should be tank-mixed with the preemergence herbicide.				
Aim 2E + Nonionic surfactant	0.25 to 2 fl oz/A + 2 pt/100 gal	carfentrazone 0.004 to 0.031 lb/A	No restrictions listed.	Should be applied with a broad-spectrum burndown herbicide.
Canopy EX + Crop oil concentrate or Nonionic surfactant	1.1 to 3 oz/A + 1 gal/100 gal or 2 pt/100 gal	chlorimuron + tribenuron 0.016 + 0.0005 lb/A to 0.04 + 0.012 lb/A	Assure II, glyphosate, Gramoxone, Sencor, 2,4-D	Soybeans may be planted 7 days after application for rates up to 2.2 oz/A. Rates higher than 2.2 oz/A require a 14-day planting interval.
Gramoxone Inteon + Nonionic surfactant or Crop oil concentrate	2 to 3.5 pt/A + 1 to 2 pt/100 gal or 1 gal/100 gal	paraquat 0.7 to 1.2 lb/A	Aim, Command, Dual, Harmony Extra, Lasso, Lorox, Micro-Tech, Prowl, Pursuit, Python, Scepter, Sencor, Squadron, Surflan, Valor, 2,4-DB	May be applied early preplant (EPP) through planting, but before crop emergence. See label for specific rates and weed stages for application. Rate should normally be at least 1.67 pt/A.
Harmony GT XP/Unity 75WDG + Crop oil concentrate or Nonionic surfactant	0.3 to 0.6 oz/A + 1 gal/100 gal or 2 pt/100 gal	thifensulfuron 0.014 to 0.028 lb/A	Dicamba, glyphosate, 2,4-D	Applications up to 0.6 oz/A can be made preplant through planting in soybeans.
Harmony Extra XP	0.3 to 0.6 oz/A	thifensulfuron + tribenuron 0.009 + 0.005 lb/A to 0.018 + 0.01 lb/A	Gramoxone, glyphosate, 2,4-D	Use for control of smartweed and dock. Tank mix with Gramoxone or glyphosate. DO NOT APPLY WITHIN 14 DAYS OF PLANTING.

## Soybean, Burndown

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
Roundup brands/ Touchdown brands/ other glyphosates		glyphosate 0.38 to 1.12 lb/A	Aim, Command, Dual, Lasso, Lorox, Lorox Plus, Micro-Tech, Prowl, Python, Scepter, Sencor, Squadron, Valor	May be applied early preplant (EPP) through planting. Use lower rate for small, susceptible weeds and higher rates for large or difficult to control weeds.
Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L +	1 to 3 pt/A or 11 to 32 fl oz/A or 11 to 32 fl oz/A +			
Recommended additives	See label			
2,4-D	0.5 to 2.66 pt/A	2,4-D 0.25 to 1.33 lb/A	Aim, Command, Dual, Domain, Glyphosate, Gramoxone, Harmony Extra, Lasso, Lorox, Lorox Plus, Micro-Tech, Prowl, Python, Scepter, Select, Sencor, Squadron, Valor	Be sure to use a formulation labeled for burndown in soybeans. <b>Preplant intervals:</b> 30 days for greater than 1 pint, 15 days for 1 pint or less of amine, 7 days for 1 pint or less of ester. Plant soybean seed 1.5 to 2 inches deep and ensure seed slot closure.

## Fall and early preplant applications of preemergence herbicides for reduced tillage

Many preemergence herbicides may be used two or more weeks before planting in an early preplant (EPP) application. Advantages include: Early preplant applications will prevent weed emergence and aid or eliminate a formal burndown application. They may limit weed growth if weather moderately delays planting. Some preemergence herbicides have significant postemergence, burndown activity (adjuvants are sometimes required). Some preemergence herbicides increase the activity or spectrum of burndown herbicides. Finally, combining a preemergence herbicide with a burndown herbicide may simply save time and costs by eliminating a second trip for the traditional preemergence, after-planting application.

Several herbicides are registered for fall application. A fall herbicide application may be beneficial if it eliminates the need for a burndown application in the spring and soil erosion is not a problem. Fall applications could also benefit

drying of the soil in the spring and could reduce the need for tillage before planting.

There are many choices and an option that works well in one field may work poorly in another. For most situations we recommend that growers target early preplant applications 15 or less days before planting. The sooner a herbicide is applied, the sooner it will break down and lose effectiveness. If rain delays planting too long, most advantages of extra-early preplant applications may be lost. Also, after 30 days, there is a much higher probability that a burndown application will be needed and most labels specify that additional preemergence herbicide be applied at planting. Finally, exceptionally long (>30 day) preplant intervals remove winter vegetation and leave the soil vulnerable to erosion and may increase the probability of herbicide contamination of ground and surface water.

## Early preplant (EPP) labels for soybean herbicides

Herbicide	Burndown activity**	Label allows preplant application		
		45 days	30 days	15 days
Authority First	Yes	Yes	Yes	Yes
Authority MTZ	Yes	Yes	Yes	Yes
Axiom	No	No	No	Yes
Boundary	Yes	No	No	Yes
Canopy 75DF	Yes	Yes	Yes	Yes
Canopy EX	Yes	Yes	Yes	Yes
Command	No	No	Yes	Yes
Domain	Yes	No	No	Yes
Dual II/ Magnum/Cinch	No	Yes*	Yes*	Yes
Enlite	Yes	Yes	Yes	Yes
Envive	Yes	Yes	Yes	Yes
Express TotalSol	Yes	Yes	Yes	Yes
FirstRate	Yes	No	Yes	Yes
Outlook	No	Yes*	Yes*	Yes
Gangster	Yes	Yes	Yes	Yes
Harmony Extra XP	Yes	Yes	Yes	Yes
Harmony GT XP/Unity	Yes	Yes	Yes	Yes
Lasso/Microtech/Intro	No	Yes*	Yes*	Yes
Linex 4L	Yes	No	Yes	Yes
Prefix	Yes	No	No	Yes
Prowl H <sub>2</sub> O	No	No	No	Yes
Pursuit	Yes	Yes	Yes	Yes
Pursuit Plus	Yes	Yes	Yes	Yes
Python	No	No	Yes	Yes
Scepter	Yes	Yes	Yes	Yes
Sencor	Yes	Yes	Yes*	Yes
Sequence	Yes	Yes	Yes	Yes
Spartan	Yes	No	Yes	Yes
Treflan/others	No	Yes	Yes	Yes
Valor/Valor XLT	Yes	Yes	Yes	Yes

\*Label requires reapplication at the time of planting (Typically 2/3 applied EPP and 1/3 preemergence at planting)  
\*\*Burndown activity may not necessarily be broad spectrum.

## Soybean, Preplant incorporated

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated tank-mix partners	Application method and precautions
Sonalan 3EC	1.5 to 3 pt/A	ethalfluralin 0.6 to 1.12 lb/A	Command, Sencor	See label for incorporation directions.
Treflan/others 4EC	1 to 2 pt	trifluralin 0.5 to 1 lb/A	Command, Salute, Scepter, Sencor	See label for incorporation directions. Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.

## Soybean, Preplant or preemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated or preemergence tank-mix partners	Application method and precautions
Spartan 4F	4.5 to 12 fl oz/A	sulfentrazone 0.14 to 0.37 lb/A	Assure II, Canopy XL, Command, Dual, Lasso, Outlook, Prowl, Sonalan, Treflan, 2,4-D	May be applied preplant, preplant incorporated or preemergence. See label restrictions for coarse (light, sandy) soils with low organic matter.
Command 3ME	2 to 3.33 pt/A	clomazone 0.75 to 1.25 lb/A	Dual, Lasso, Lorox, Micro-Tech, Prowl, Scepter, Sencor, Sonalan, Squadron, trifluralin	See label for incorporation directions. Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Do not apply within 1,200 feet of housing developments, commercial vegetable or fruit production, nurseries or greenhouses. See label for precautions for application near other desirable vegetation.

**Soybean, Preplant or preemergence**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated or preemergence tank-mix partners	Application method and precautions
Dual II Magnum 7.64L/ Cinch 7.64L	1 to 2 pt/A	S-metolachlor 0.96 to 1.91 lb/A	Command, Lorox, Pursuit, Scepter, Sonalan, trifluralin	May be applied preplant, preplant incorporated or preemergence. Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
FirstRate 84DG/Amplify 84 DG	0.6 to 0.75 oz/A (2 to 2.5 A/pkt)	cloransulam 0.031 to 0.039 lb/A	None listed.	Use lower rate on soils with less than 3% organic matter and higher rate on soils more than 3% organic matter.
Outlook	12 to 21 fl oz/A	dimethenamid 0.56 to 1 lb/A	Command, Lorox, Pursuit, Prowl, Scepter, Sonolan, Treflan	May be applied preplant, preplant incorporated or preemergence. May be applied postemergence to crop, but emerged weeds will not be controlled. Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
Intro 4L or Lasso 4EC or Micro-Tech 4L	2 to 3 qt/A or 2 to 4 qt or 1.5 to 3 qt/A	alachlor 2 to 3 lb/A or 2 to 4 lb/A or 2 to 4 lb/A	(Excluding 15G) Canopy, Command, Lorox, Pursuit, Scepter, Sencor, trifluralin	May be applied preplant, preplant incorporated (shallow) or pre-emergence. Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. Do not use Lasso II (15G) on coarse soils.
Prowl H <sub>2</sub> O 3.8 ACS	1.5 to 3 pt/A	pendimethalin 0.7 to 1.4 lb/A	Command, Dual, Lasso, Lorox, Pursuit, Scepter, Sencor	See label for incorporation directions. Caution: Under cool wet conditions, preemergence, surface-applied Prowl may cause stem brittleness.
Pursuit 2 AS	4 fl oz/A	imazethapyr 0.063 lb/A	Dual, Lasso, Outlook, Prowl, Treflan	Use the same rate for all soil types. May be applied preplant, preplant incorporated or preemergence. Incorporation provides better weed control than surface application.
Python 80WDG	0.8 to 1.33 oz/A (5 to 3 A/pkt)	flumetsulam 0.04 to 0.07 lb/A	Not specified	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils.
Scepter 70DG	2.8 oz/A	imazaquin 0.125 lb/A	Dual, Lasso, Prowl, Sencor, trifluralin	Use the same rate for all soil types.
Sencor 4L or Sencor 75DF	0.75 to 1.5 pt or 0.5 to 1 lb/A	metribuzin 0.38 to 0.75 lb/A	Command, Commence, Dual, Lasso, Prowl, Pursuit, Pursuit Plus, Scepter, Sonalan, trifluralin	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. See label for proper rate for your soil type and percent organic matter. Plant seed at least 1.5 inches deep.

**Package mixes, preplant or preemergence**

Authority First	3.2 to 8 oz/A	sulfentrazone + cloransulam 0.14 + 0.016 to 0.35 + 0.04	Aim, Glyphosate, Gramoxone Inteon, Gramoxone Max, 2,4-D	Apply at plant or within 3 days after planting.
Authority MTZ	8 to 20 oz/A	sulfentrazone + metribuzin 0.9 + 0.14 lb/A to 0.23 + 0.34 lb/A	Glyphosate, 2,4-D	Apply at 8 to 14 oz/A as a setup in Roundup Ready soybeans. Apply at 10 to 20 oz/A in conventional beans.
Axiom 68DF	8 to 13 oz/A	flufenacet + metribuzin 0.27 + 0.07 to 0.44 + 0.12 lb/A	Authority/Spartan, Canopy XL, Command, FirstRate, Gramoxone, Lorox, Pentagon, Prowl, Pursuit, Python, Roundup, Sencor, Scepter, Sonalan, Treflan	May be applied preplant, preplant incorporated or preemergence. See label statement regarding rate: The 13-ounce rate should provide season-long control of annual grass and small-seeded broadleaf weeds on coarse (light, sandy) soils, but only early-season control on heavier soils.
Boundary 6.5EC	1.5 to 3 pt	S-metolachlor + metribuzin 1 + 0.24 to 2 + 0.48 lb/A	Canopy XL, Command, FirstRate, Prowl, Python, Scepter	Plant soybeans at least 1.5 inches deep and do not use rates higher than 1.25 pt/A on soils with pH above 7.

## Soybean, Preplant or preemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated or preemergence tank-mix partners	Application method and precautions
Canopy 75DF	4 to 7 oz/A	metribuzin + chlorimuron 0.16 + 0.03 to 0.28 + 0.05 lb/A	Sencor, Linex	Use low rates on coarse (light, sandy) soils and higher rates on fine (heavy, clay) soils. On soils with a composite pH greater than 7.0, do not exceed 2.25 oz/A.
Domain 60DF	9 to 16 oz/A	metribuzin + flufenacet 0.20 + 0.14 to 0.36 + 0.24 lb/A	Any registered soybean herbicide that does not prohibit a Domain tank mixture.	See label for soybean variety restrictions. Plant soybeans at least 1.5 inches deep. Use rates are designed for a relatively short residual period. See label for discussion of rates.
Prefix	2 pts/A	S-metolachlor + fomesafen 0.95 lb + 0.25 lb	Canopy, Glyphosate, Gramoxone Inteon, Lorox, Lorox Plus, Preview, Pursuit, Scepter, Sencor, Treflan	May also be applied postemergence to soybeans but will control only weeds that have not emerged.
Pursuit Plus 3E	2.5 pt/A	imazethapyr + pendimethalin 0.063 + 0.94 lb/A	None	Use the same rate for all soil types. May be applied preplant, preplant incorporated or preemergence. Incorporation provides better weed control than surface application.
Sonic	3.2 to 8 oz/A	sulfentrazone + cloransulam 0.14 + 0.016 to 0.35 + 0.04	Aim, Glyphosate, Gramoxone Inteon, Gramoxone Max, 2,4-D	Apply at plant or within 3 days after planting.
<b>Preemergence only</b>				
Linex 4L	1 to 2 pt/A	linuron 0.5 to 1 lb/A	Boundary, Classic, domain, Dual Magnum, Dual II Magnum, Gangster, Prowl, Sencor, Synchrony	Consult label for specific rates according to soil type. For preemergence burndown applications, addition of an adjuvant is required.
Valor 51WDG	2 to 2.5 oz/A	flumioxazin 0.064 to 0.08 lb/A	Command, FirstRate, Gramoxone Max, Lorox, Prowl, Python, Roundup, Scepter, Sencor, 2,4-D	Do not use in combination with Axiom, Boundary, Domain, Dual, Intro, Micro-Tech, or Outlook unless directed by state 24c labeling.
<b>Package mixes, Preemergence only</b>				
Canopy EX	1.1 to 33 oz/A	chlorimuron + tribenuron 0.016 + 0.005 to 0.047 + 0.014 lb/A	Command, Lasso, Dual, Outlook, Prowl, Treflan, Sencor, Sonolan, 2,4-D	May be applied after fall harvest anytime up to 7 or 14 days before soybean planting, depending on rate.
Enlite	2 to 4 oz/A	flumioxazin + chlorimuron 0.045 + 0.035 + 0.01 lb/A to 0.089 + 0.007 + 0.02 lb/A	2,4-D	Can be applied in fall or spring up to 3 days after planting.
Envive	2.5 to 5.25 oz/A	flumioxazin + chlorimuron + trifluralin 0.045 + 0.014 + 0.0045 lb/A to 0.094 + 0.03 + 0.009 lb/A	2,4-D	Can be applied in fall or spring up to 3 days after planting.
Gangster 51DF+81DF	1.8 to 3.6 oz/A	flumioxazin + cloransulam 0.08 + 0.026 to 0.09 + 0.032 lb/A	Command, Glyphosate, Gramoxone Max, Prowl, Select, 2, 4-D	Do not apply after soybean emergence, or severe crop injury will occur. Do not use in combination with Axiom, Boundary, Domain, Dual, Intro, Micro-Tech, or Outlook unless directed by state 24c labeling.
Prefix	2 pt/A	S-metolachlor + fomesafen 1.0 + 0.24 lb/A	Gramoxone, Glyphosate, Fusilade, Fusion, Poast Plus, Select, 2,4-D	Can be applied up to 15 days preplant to preemergence.
Sequence 5.25L	2.5 to 4 pt/A	glyphosate + S-metolachlor 0.7 + 0.9 to 1.1 + 1.5 lb/A	Authority, Boundary, Canopy, Canopy XL, Command, Dual, FirstRate, Flexstar, Fusilade, Fusion, Linex, Lorox, Outlook, Prowl, Pursuit, Reflex, Scepter, Sencor, Squadron, Steel, 2,4-D, 2,4-DB	Contains glyphosate. May be applied before, during, or after planting but before the crop emerges on conventional soybeans.

**Soybean, Preplant or preemergence**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Preplant incorporated or preemergence tank-mix partners	Application method and precautions
Valor XLT	3 to 5 oz/A	flumioxazin + chlorimuron 0.06 + 0.02 lb/A to 0.09 + 0.03 lb/A	Dicamba, Express, Gramozone, Glyphosate, Harmony, 2,4-D	On soils with pH >6.8, use at 2.5 oz/A. Do not incorporate.

**Soybean, Postemergence**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Postemergence tank-mix partners	Application method and precautions
Aim 2E + Nonionic surfactant (80%)	0.25 fl oz/A + 2 pt/100gal	carfentrazone 0.004 lb/A	Glyphosate/others	Primarily targets velvetleaf. Consult labels of other products for tank mixes.
Assure II 0.88EC + Crop oil concentrate or Nonionic surfactant (80%)	4 to 12 oz/A + 4 qt/100 gal or 1 qt/100 gal	quizalofop 0.027 to 0.083 lb/A	Basagran, Classic, Harmony GT/ Pinnacle, Synchrony	See label directions for specific weeds, rates and tank-mix instructions. Use 4 fl oz for volunteer corn control up to 12 inches tall. Do not use more than 18 oz/A in one season. Do not cultivate within 7 days before or 7 days after application.
Basagran 4S + Crop oil concentrate (Optional) or 28% (UAN) nitrogen (Optional)	1.5 to 2 pt/A + 1 qt/A (1 pt/A by air) or 1 gal/A	bentazon 0.75 to 1 lb/A	Assure II, Blazer, Fusilade, Fusion, Poast, Poast Plus, Harmony GT, Pinnacle, Pursuit, Scepter, Select, Storm, 2,4-DB	The use of 28% urea is recommended only for velvetleaf and may result in reduced control of other weed species. See label directions for specific weeds, rates, and tank-mix instructions. The split application should be made 10-14 days apart.
Blazer 2L + Nonionic surfactant (80%) or UAN	1.5 to 2 pt/A + 1 to 4 pt/100 gal or 2 to 4 qt/A	acifluorfen 0.38 to 0.5 lb/A	Basagran, Fusilade, Fusion, Poast, Poast Plus, Pursuit, Scepter, Select, Storm, 2,4-DB	See label directions for specific weeds, rates and tank-mix instructions. Hemp sesbania may be controlled until bloom with 1 pt/A of Blazer + surfactant. The use of 28% (UAN) nitrogen fertilizer is recommended only for velvetleaf and may result in reduced control of other weed species.
Classic 25DF + Nonionic surfactant (80%) or Crop oil concentrate and 28% UAN or 10-34-0 liquid fertilizer (Optional)	0.5 to 0.75 oz/A + 1 qt/100 gal or 1 gal/100 gal and 1 gal/A (UAN) or 1 to 2 qt/A (10-34-0)	chlorimuron 0.008 to 0.012 lb/A	Assure II, Basagran, Cobra, FirstRate, Flexstar, Fusilade, Fusion, Harmony GT/Pinnacle, Poast, Reliance, Poast Plus, Reflex, Roundup, Select, 2,4-DB	See label directions for specific weeds, rates and tank-mix instructions. No pH restrictions for Classic in Missouri. The use of 28% nitrogen or 10-34-0 is recommended only for velvetleaf and must be used with a surfactant.
Cobra 2EC + Crop oil concentrate or Nonionic surfactant (80%) and UAN (optional) or Ammonium sulphate (optional)	6 to 12.5 oz/A + 1 pt/A or 2 pt/100 gal and 1 gal/A or 2.5 lb/A	lactofen 0.094 to 0.2 lb/A	Assure II, Basagran, Classic, FirstRate Fusilade, Fusion, Harmony GT/ Pinnacle, Pursuit, Reliance STS, Roundup, Scepter, Select, Synchrony STS, 2,4-DB	Crop oil is the preferred adjuvant. See label directions for specific weeds, rates and tank-mix instructions.
FirstRate 84DG + Nonionic surfactant or methylated seed oil and UAN or Crop oil concentrate and Ammonium sulphate (optional)	0.3 oz/A (5 A/pkt) + 1 to 2 pt/100 gal or 5 qt/100 gal and 2.5 gal/100 gal or 5 qt/100gal and 2.5 gal/100 gal or 2 lb/A	cloransulam 0.016 lb/A	Assure II, Basagran, Blazer, Classic, Cobra, Flexstar, Fusion, Harmony GT/Pinnacle, Poast Plus, Pursuit, Raptor, Reflex, Reliance, Resource, Roundup/others, Select, Stellar, Synchrony	See label directions for specific weeds, adjuvant and tank-mix instructions. Special labeling allows a 0.6 oz/A rate to be used in the Delta Counties of Southeast Missouri.

## Soybean, Postemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Postemergence tank-mix partners	Application method and precautions
Flexstar 1.88ME + adjuvant	1 to 1.3 pt/A + see label	fomesafen 0.24 to 0.31 lb/A	Fusilade DX, Fusion, Select, Assure, Poast Plus, Basagran, Classic, Harmony GT/Pinnacle, Raptor, Synchrony STS, Scepter, Scepter OT, Butyrac	Same active ingredient as Reflex with increased activity and burn. Consult label for particular adjuvant recommendations.
Fusilade DX 2E + Crop oil concentrate or Nonionic surfactant (80%)	0.375 to 1.5 pt/A + 1 qt/25 gal or 0.5 pt/25 gal	fluazifop 0.094 to 0.375 lb/A	Basagran, Blazer, Classic, Pursuit, Reflex	See label directions for specific weeds, rates and tank-mix instructions.
Harmony SG + Nonionic surfactant (80%) and UAN or 10-34-0 liquid fertilizer (Optional)	1/8 oz/A + 1 pt/100 gal and 1 gal/A	thifensulfuron 0.004 lb/A	Assure II, Basagran, Classic, Fusion	See label directions for specific weeds and rates. The use of 28% nitrogen or 10-34-0 is recommended only for velvetleaf and must be used with a surfactant.
Phoenix 2L + Nonionic surfactant (80%) or Crop oil concentrate	8 to 12.5 fl oz/A + 2 pt/100 gal or See label	lactofen 0.13 to 0.2 lb/A	Basagran, Classic, FirstRate, Harmony GT, Pursuit, Raptor, Resource, Roundup, Scepter, Select, Synchrony, 2,4-DB	Crop oil can significantly increase crop injury, see label for suggested rates and mixtures. Phoenix has the same active ingredient as Cobra; however, crop response is slightly reduced.
Poast Plus + Crop oil concentrate or Dash	18 to 48 fl oz/A + 2 pt/A or 2 pt/A	sethoxydim 0.14 to 0.38 lb/A	Basagran, Blazer, Classic, Storm	See label directions for specific weed stages, rates and tank-mix instructions. Addition of 28% N or ammonium sulphate may improve control of certain species. Crop oil concentrate or Dash must be used in addition to the fertilizer. Refer to label for specific weeds to control with addition of fertilizer.
Pursuit 2EC + Crop oil concentrate or Nonionic surfactant (80%) + UAN or 10-34-0 or Ammonium sulphate	0.7 to 1.4 fl oz/A + 1.25 gal/100 gal or 2 pt/100 gal + 1 to 2 qt/A or 2.5 lb/A	imazethapyr 0.031 to 0.063 lb/A	Basagran, Cobra, Fusilade, Fusion, Harmony GT/ Pinnacle, Prestige, Roundup, Scepter, Select	Apply to 1- to 3-inch tall weeds for best performance. Ammonium sulphate may be used at 2.5 lb/A instead of liquid fertilizer. See label directions for specific weed stages, rates and tank-mix instructions.
Python 80WDG + Nonionic surfactant (80%) + UAN	0.125 oz/A + 1 qt/100gal + 2 to 5 gal/100 gal	flumetsulam 0.0063 lb/A	None specified	Control of prickly sida, supplemental label.
Raptor 1AS + Crop oil concentrate or Nonionic surfactant + UAN or 10-34-0 or Ammonium sulphate	4 to 5 fl oz/A + 1 gal/100 gal or 2 pt/100 gal + 1 to 2 qt/A or 2.5 lb/A	imazamox 0.031 to 0.039 lb/A	Assure II, Blazer, FirstRate, Fusilade DX, Fusion, Post Plus, Prestige, Select	Apply to 1- to 3-inch tall weeds for best performance. See label directions for specific weed stages, rates, tank-mix instructions and adjuvants.
Reflex 2LC + Nonionic surfactant (80%) or Crop oil concentrate	0.75 to 1.25 pt/A + 0.5 to 1 pt/100 gal or 1 qt/25 gal	fomesafen 0.18 to 0.31 lb/A	Basagran, Classic, Fusilade, Fusion, Scepter, Select, 2,4-DB	The 1.25 pt/A rate may only be used in the Bootheel counties of Missouri. The 1 pt/A rate may give slightly lower weed control than indicated in the performance chart. Do not apply Reflex in the same field more than once every two years.
Resource 0.86 EC + Crop oil concentrate + Ammonium sulphate (optional)	2 to 4 fl oz/A + 1 to 2 pt/A + 2.5 lb/A	flumiclorac pentyl, 0.013 to 0.027 lb/A	Glyphosate	Velvetleaf control and lambsquarters suppression only. When tank-mixed with glyphosate, follow adjuvant recommendation for the glyphosate formulation.

**Soybean, Postemergence**

<b>Herbicide and formulation</b>	<b>Formulated material per broadcast acre</b>	<b>Herbicide (lb active per acre)</b>	<b>Postemergence tank-mix partners</b>	<b>Application method and precautions</b>
Scepter 70 DG + Nonionic surfactant or Crop oil concentrate	1.4 to 2.8 oz/A + 2 pt/100 gal or 1 qt/A	imazaquin 0.063 to 0.125 lb/A	Basagran, Blazer, Cobra	See label directions for specific weed application stages, rates and tank-mix instructions.
Select 2EC/Clethodim 2EC + Crop oil concentrate + UAN (optional) or Ammonium sulfate (optional)	6 to 10 fl oz/A + 1 qt/A + 1 to 2 qt/A or 2.5 to 4 lb/A	clethodim 0.094 to 0.156 lb/A	Basagran, Blazer, Classic, Cobra, FirstRate, Flexstar, Glyphosate, Phoenix, Pursuit, Reflex, Reliance, Resource, Storm, Synchrony	See label directions for specific applications stages, rates, tank-mix and adjuvant instructions
Select Max + Crop oil concentrate + UAN (optional) or Ammonium sulfate (optional)	12 to 24 fl oz/A 1 qt/A 1 to 2 qt/A or 2.5 to 4 lb/A	clethodim 0.09 to 0.18 lb/A	Glyphosate	Nonionic surfactants may be used in place of crop oil concentrate in certain situations. For volunteer Roundup Ready corn control, apply 6 to 12 oz/A with glyphosate. Apply 6 oz rate to corn less than 12 inches tall, 9 oz to 24-inch-tall corn, and 12 oz to 36-inch-tall corn.
Ultra Blazer 2L + Nonionic surfactant (80%) or Crop oil concentrate + UAN or Ammonium sulfate	1 to 1.5 pt/A + 1 to 2 pt/100 gal or 1 to 2 pt/A + 2-4 qt/A or 1.5 lb/A	acifluorfen 0.25 to 0.38 lb/A	Assure, Basagran, Classic, Dual, FirtRate, Fusilade, Fusion, Glyphosate, Harmony GT, Lasso, Outlook, Poast Plus, Pursuit, Resource, Scepter, Select, 2,4-DB	See label directions for specific weeds, rates and tank-mix instructions. Hemp sesbania may be controlled until bloom with 1 pt/A of Blazer + surfactant. The use of 28% (UAN) nitrogen fertilizer is recommended only for velvetleaf and may result in reduced control of other weed species.
<b>Package mixes – Overtop</b>				
Conclude Xact B 4EC + Conclude Xact G 2EC + Crop oil concentrate	1.5 pt/A + 1.5 pt/A + 1 gal/100 gal water	bentazon + acifluorfen + sethoxydim 0.5 + 0.25 + 0.375 lb/A	None	Apply to small, actively growing weeds.
Frontrow 84 + 80 WDG + Crop oil concentrate or Nonionic surfactant + UAN (optional) or Ammonium sulphate (optional)	0.21 oz/A (1 pkt/5A) + 4.75 qt/100 gal or 1 qt/ 100 gal + 2.5 gal/100 gal or 2 lb/A	cloransulam + flumetsulam 0.009 + 0.004 lb/A	Assure II, Basagran, Blazer, Cobra, Flexstar, Fusion, Glyphosate, Harmony GT/Pinnacle, Reflex, Poast Plus, Pursuit, Select, Touchdown	Apply to small, actively growing weeds. Grass control antagonism can occur with Assure II and Fusion tank mixes.
Fusion 2.66 EC + Crop oil concentrate or Nonionic surfactant (80%) + UAN liquid fertilizer or similar (Optional)	6 to 12 fl oz/A + 1 to 2 pt/100 gal or 0.5 to 1 pt/25 gal + 1 gal/100 gal	fluazifop + fenoxaprop 0.094 + 0.031 to 0.188 to 0.062 lb/A	Basagran, Blazer, Classic, Harmony GT/ Pinnacle, Pursuit, Reflex, Storm	See label directions for specific weeds, rates and tank-mix instructions. Only for shattercane and volunteer corn control.
Prefix + Nonionic surfactant	2 pt/A + 1 pt/100 gal	metolachlor + fomesafen 1.09 + 0.24 lb/A	Glyphosate in Roundup Ready soybeans only	Prefix may be applied from cracking to the third trifoliolate stage. Necrotic bronzing and spotting may occur after an application of Prefix POST. For broader spectrum weed control, tank-mix with glophosate and add NIS only to unloaded glyphosate formulations. Do not tank-mix Prefix POST with COC as increased crop injury may result.

## Soybean, Postemergence

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Postemergence tank-mix partners	Application method and precautions
Storm 4SL + Nonionic surfactant (80%) or Crop oil concentrate or UAN liquid fertilizer	1.5 pt/A + 1 to 2 pt/100 gal or 1 to 2 pt/A or 2 to 4 qt/A	bentazon + acifluorfen 0.5 + 0.25 lb/A	Classic, 2,4-DB	See label directions for specific weeds, rates and tank-mix instructions. The use of 28% UAN fertilizer is recommended only for velvetleaf control, and may result in reduced control of other weed species.
Synchrony XP + Nonionic surfactant + Ammonium sulfate	0.375 oz/A + 1 pt/100 gal + 2 to 4 lb/A	chlorimuron + thifensulfuron 0.005 + 0.002 lb/A	Glyphosate, others	

## Herbicide-resistant soybeans

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
<b>Liberty Link soybeans</b>				
Ignite 280SL + AMS	22 fl oz/A + 17 lbs/100 gal	Glufosinate 0.4 lb/A	Assure II, Classic, Cobra, Firstrate, Flexstar, Fusilade DX, Fusion, Harmony, Phoenix, Poast Plus, Pursuit, Raptor, Reflex, Resource, Select Max, Synchrony, Ultra Blazer	Use on Liberty Link soybeans only. Do not apply more than two applications made at least 10 to 14 days apart. Do not apply more than 44 fl oz/A per growing season.
<b>Roundup Ready soybeans</b>				
Roundup brands/ Touchdown brands/ other glyphosates		glyphosate 0.375 to 0.1.5 lb/A	Consult labels	Use on Roundup Ready soybeans only. Use caution to prevent drift and to avoid spraying the wrong field. Consult label to refine rates for particular weed species and sizes. Roundup has no residual control. Do not apply more than 3 quarts per acre per year to soybeans, including preharvest treatments.
Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	1 to 4 pt/A or 11 to 42 fl oz/A or 11 to 42 fl oz/A + See label			
<b>Package mixes</b>				
Extreme 1.67 + Nonionic surfactant (80%) + UAN or Ammonium sulfate (optional)	3 pt/A + 1 pt/100 gal + 1-2 qt/A or 2.5 lb/A	glyphosate + imazethapyr 0.56 + 0.064 lb/A	None listed	Use on Roundup Ready soybeans only. The formulation stated on the label is 2.17 lb/gal; however, this is for the IPA salt of glyphosate. All other glyphosate listings in this guide are for glyphosate acid. Extreme contains 1.67 lb/gal calculated on a glyphosate-acid basis.
Sequence 5.25C	2.5 to 3 pt/A	glyphosate + S-metolachlor 0.7 + 0.9 to 0.8 + 1.1 lb/A	—	On Roundup Ready soybeans, may be used from cracking up to the 3rd trifoliolate stage of soybean growth.
<b>STS soybeans</b>				
Synchrony XP + Nonionic surfactant + Ammonium sulfate	0.375 to 1.125 oz/A + 1 pt/100 gal + 2 to 4 lb/A	chlorimuron + thifensulfuron 0.005 + 0.002 to 0.015 + 0.005 lb/A	Assure II, Cobra, FirstRate, Flexstar, Fusilade, Fusion, Poast Plus, Select, 2,4-DB	For use only on soybean varieties designated as "STS" in the variety name. The use of crop oil concentrate plus an ammonium nitrogen fertilizer is required. See label directions for specific weeds, rates and tank-mix instructions.

## Broadleaf-Grass weed herbicide tank mixes

Many tank-mix combinations are not labeled; however, these applications do not necessarily need to be labeled by the manufacturers for use. When broadleaf and grass herbicides are tank-mixed, antagonism in the form of reduced grass control frequently (but not always) occurs. Some of this antagonism is due to the rapid “burn” of many broadleaf herbicides preventing the slower uptake and translocation of most grass herbicides. There are three recommended ways to avoid antagonism: (1) Apply the grass herbicide first (which allows it to be absorbed and translocated); then apply the broadleaf herbicide a day later. (2) Apply the broadleaf herbicide first and then wait seven days (which allows the grass to resume active growth); then apply the grass herbi-

cide. (3) Increase the rate of the grass herbicide by 50 percent to overcome the antagonism. A tank mix may provide good control of small, actively growing grass, but avoid tank mixes when grass is large or stressed. Package-mixes and co-packages of grass herbicides (Conclude, Typhoon) usually provide a higher-than-normal rate of the grass herbicide at a discounted price. Read the label before tank-mixing a grass and broadleaf herbicide. The manufacturer may not be liable for performance or may restrict certain mixtures. Antagonism is not exclusive to grass-broadleaf herbicide mixtures. Several herbicides will reduce the grass and broadleaf performance of glyphosate in burndown and Roundup Ready soybean situations.

### Soybean, Special problems

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
<b><i>Johnsongrass, Preplant burndown</i></b>				
Roundup brands/other glyphosates		glyphosate 0.75 to 2.25 lb/A	Seedling and rhizome johnsongrass.	Apply glyphosate when johnsongrass is at least 18 inches tall and has reached the boot-to-head stage of growth. Allow 7 or more days after application before tillage. Roundup may be tank-mixed with several preemergence herbicides.
Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	2 to 6 pt/A or 21 to 64 fl oz/A or 21 to 64 fl oz/A + See label			
<b><i>Johnsongrass, Preplant incorporated</i></b>				
Prowl 3.3E/others	2.4 to 4.8 pt/A	pendimethalin 1 to 2 lb/A	Seedling and rhizome johnsongrass, red rice, certain other grass and broadleaf weeds.	Follow rate and incorporation directions on label. Use for two consecutive years. Do not plant winter wheat or winter barley in the fall after application.
Treflan 4HFP, others	2 to 4 pt	1 to 2 lb/A	Seedling and rhizome johnsongrass, red rice, certain other grass and broadleaf weeds.	Follow rate and incorporation directions on label. Use for two consecutive years. In the season following this double-rate treatment, plant only rice and those crops for which Treflan can be applied as a preplant treatment.
<b><i>Johnsongrass, Postemergence</i></b>				
Assure II 0.88EC + Crop oil concentrate or Nonionic surfactant (80%)	5 to 10 oz/A + 4 qt/100 gal or 1 qt/100 gal	quizalofop 0.034 to 0.069 lb/A	Seedling and rhizome johnsongrass, certain other grasses.	Use 5-oz rate for seedling johnsongrass that is 2 to 8 inches tall. Apply 10 oz/A rate to 10- to 24-inch rhizome johnsongrass. If regrowth occurs, apply 7 oz/A in a second application when johnsongrass is 6 to 10 inches tall. Follow label directions for tank mixes and sequential applications with postemergence broadleaf herbicides. Do not cultivate within 7 days before or 7 days after application.

## Soybean, Special problems

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
Fusilade DX 2E + Crop oil concentrate or Nonionic surfactant (80%)	0.38 to 0.75 pt/A + 1 qt/25 gal or 0.5 pt/25 gal	fluazifop 0.09 to 0.19 lb/A	Seedling and rhizome johnsongrass, certain other grasses.	Use 0.75 pt/A for seedling johnsongrass that is no more than 8 inches tall. Apply 1.5 pt/A rate to 8- to 18-inch rhizome johnsongrass and before boot stage. If regrowth occurs, apply 1 pt/A in a second application when johnsongrass is 6 to 12 inches tall. Follow label directions for tank mixes and sequential applications with postemergence broadleaf herbicides. Make last application before first bloom.
Fusion 2.66EC + Crop oil concentrate or Nonionic surfactant (80%)	6 to 12 fl oz/A + 1 qt/25 gal or 0.5 pt/25 gal	fluazifop + fenoxaprop 0.09 + 0.03 to 0.19 + 0.05 lb/A	Seedling and rhizome johnsongrass, certain other grasses.	Use 0.75 pt/A for seedling johnsongrass that is no more than 8 inches tall. Apply 1.5 pt/A rate to 8- to 18-inch rhizome johnsongrass and before boot stage. If regrowth occurs, apply 1 pt/A in a second application when johnsongrass is 6 to 12 inches tall. Follow label directions for tank mixes and sequential applications with postemergence broadleaf herbicides. Make last application before first bloom.
Poast Plus 1E + Crop oil concentrate or Dash	1.5 pt/A + 2 pt/A or 2 pt/A	sethoxydim 0.19 lb/A	Seedling and rhizome johnsongrass, certain other grasses.	Apply to 15- to 20-inch-tall rhizome johnsongrass. If regrowth occurs, reapply when johnsongrass is 6 to 12 inches tall. Follow label directions for tank mixes and sequential applications with postemergence broadleaf herbicides.
Roundup brands/other glyphosates  Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	  1 to 2 pt/A or 11 to 21 fl oz/A or 11 to 21 fl oz/A + See label	glyphosate 0.38 to 0.75 lb/A	Seedling and rhizome johnsongrass and most other broadleaf and grass weeds.	Roundup Ready soybeans only. Apply to 15- to 20-inch-tall rhizome johnsongrass. If regrowth occurs, reapply when johnsongrass is 6 to 12 inches tall.
Select 2EC + Crop oil concentrate	6 to 10 fl oz/A + 1 qt/A	clethodim 0.094 to 0.156 lb/A	Seedling and rhizome johnsongrass, certain other grasses.	Use 6 to 8 oz/A rate for seedling johnsongrass 4 to 10 inches tall. Apply 8 to 10 oz/A rate for rhizome johnsongrass 12 to 24 inches tall. A repeat application of 6 to 8 oz/A can be applied if regrowth occurs when johnsongrass is 6 to 10 inches tall. Follow label directions for tank mixes and sequential applications with postemergence broadleaf herbicides.
<b>Red rice</b>				
General Comments: Red rice control requires an integrated program. Dual Magnum, Lasso, Outlook or an equivalent product should be applied preemergence. This will provide excellent, early-season red rice control; season-long weed control will be inadequate. Then one of the following postemergence, grass-controlling herbicides should be applied.				
Assure II 0.88EC + Crop oil concentrate or Nonionic surfactant (80%)	9 oz/A + 4 qt/100 gal or 1 qt/100 gal	quizalofop 0.062 lb/A	Red rice and certain other grass weeds.	Apply early postemergence when red rice has 1 to 4 leaves. Repeat if regrowth occurs.

Soybean, Special problems

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
Roundup brands/other glyphosates		glyphosate 0.375 to 0.75 lb/A	Red rice and most other grass and broadleaf weeds	Roundup Ready soybeans only. Only use lower rates on red rice less than 2 inches tall under optimum growing conditions.
Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L +	1 to 2 pt/A or 11 to 21 fl oz/A or 11 to 21 fl oz/A +			
Recommended additives	See label			
Select 2EC +	6 to 8 fl oz/A +	clethodim 0.94 to 0.125 lb/A	Red rice and certain other grass weeds.	Apply early postemergence before red rice is 3 inches tall.
Crop oil concentrate	1 qt/A			
Select 2EC/Section 2EC/ Clethodim 2EC +	4 fl oz/A +	clethodim 0.0625 lb/A	Late-season seed head suppression of red rice	Timing is critical. Apply from 4" internode elongation up to boot stage of red rice. Seedhead suppression only.
Crop oil concentrate	1 qt/A			
<b>Spot-spray treatment of severe weed infestations</b>				
Roundup brands/other glyphosates	0.66 to 6.5 fl oz/gal	glyphosate 0.5 to 5% by volume	Johnsongrass, cocklebur, giant ragweed, pigweed, sunflower, volunteer corn, shattercane, velvetleaf.	Use 0.5% solution on annual weeds less than 6 inches tall and 1% solution when annual weeds are more than 6 inches tall. Apply 2% when johnsongrass is in boot to early head stage, and to other perennial weeds. Cover foliage thoroughly on a spray-to-wet basis.
Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L +				
Recommended additives	See label			
<b>Harvest aid</b>				
Aim	0.5 to 0.9 fl oz/A	carfentrazone	Desiccation of some green weed foliage.	Do not apply within 3 days of harvest.
Gramoxone Inteon +	0.5 to 1 pt/A +	paraquat 0.175 to 0.35 lb/A	Desiccation of green weed foliage.	<b>Determinate varieties:</b> Apply when soybeans are fully mature, at least half of leaves have dropped and remaining leaves are turning yellow. <b>Indeterminate varieties:</b> Apply when at least 65% of seed pods have mature brown color or when seed moisture is 30% or less. Do not pasture livestock within 15 days of treatment. Mature cocklebur is tolerant of Gramoxone and desiccation will not be complete. Restricted Use Pesticide.
Nonionic surfactant or	1 to 2 pt/100 gal or			
Crop oil concentrate	1 gal/100 gal			
Roundup brands/other glyphosates		glyphosate 0.75 to 4.5 lb/A	Suppression of many annual and perennial weeds.	Apply after soybean pods have set and lost all green color. Allow a minimum of 7 days between application and harvest. Do not apply to soybeans grown for seed. A maximum rate of 1 qt/A may be applied by air. Roundup Ready soybeans may be treated 14 days or earlier before harvest.
Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 45L +	2 to 12 pt/A or 21 to 128 fl oz/A or 21 to 44 fl oz/A +			
Recommended additives	See label			
Sodium chlorate	2 gal/A of 3 lb/gal formulation	sodium chlorate 6 lb/A	Desiccation of green weed foliage.	Apply 7 to 10 days before harvesting.
Seed crops only Reglone 2L	1.5 to 2 pt/A	diquat 0.38 to 0.5 lb/A	Desiccation of green weed foliage.	Apply 1 week before harvest. Do not use treated plants for food feed or oil purposes.

**Small grain**  
Guide to weed response to small-grain herbicides

Herbicide	Winter weeds														Summer weeds					
	Annual ryegrass	Cheat/downy brome	Chickweed	Cornflower	Dandelion	Field pennycress	Henbit	Horseweed (marestail)	Prickly lettuce	Shepherdspurse	Wild buckwheat	Wild garlic	Wild mustard	Common lambsquarters	Common ragweed	Giant ragweed	Redroot/smooth pigweed	Annual smartweed species	Velvetleaf	
2,4-D	0	0	5	8	9	1	5	8	9	9	5	6	9	9	9	9	9	6	8	
Achieve	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Aim	-	-	-	3	-	9	-	-	-	-	-	-	-	9	7	6	9	9	9	
Banvel/Clarity	0	0	6	-	8	6	6	9	8	8	9	5	6	9	9	9	9	9	7	
Buctril	0	0	6	8	8	8	8	6	6	8	9	0	9	9	9	8	7	9	-	
Finesse	8	6	8	7	-	8	8	-	-	8	-	4	8	8	-	-	4	-	-	
Harmony Extra	0	0	7	2	0	7	9	-	4	9	7	8	9	8	5	4	9	8	9	
Hoelon	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
MCPA	0	0	5	8	9	9	5	8	9	9	8	5	9	9	9	9	9	7	5	
Olympus Flex	9	7	4	-	2	9	6	-	-	9	2	2	9	-	-	-	-	-	-	
Osprey	9	2	8	6	-	-	8	-	-	8	-	3	8	-	-	-	-	-	-	
Peak	-	-	8	-	5	9	5	0	9	8	8	8	9	7	9	7	8	7	9	
Sencor	3	7	8	3	-	8	8	-	-	8	-	0	8	-	-	-	-	-	-	

Weed control: 8 to 10 = good 6 to 7 = Fair\* Less than 6 = poor -=No data available

\*A weed control rating of 6 to 7 indicates partial control or suppression.

Use this table as a guide for comparing the relative effectiveness of herbicides on individual weeds. Herbicides may perform better or worse than indicated due to extreme weather conditions and other variables. If you are obtaining satisfactory results under your growing conditions, changing products as a result of information in this table is not necessarily recommended.

Due to the overwhelming number of package mixes and tank mixes, it has become impractical to list and distinguish these combinations. In the interest of fairness, we are therefore listing no package mixes in this table. A reasonable accurate estimate may be obtained by combining the control ratings from the individual package or tank-mix components.

**Small grain, Burndown**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Labeled tank-mix partners	Application method and precautions
Aim 2E + Nonionic surfactant	0.25 to 2 fl oz/A + 2 pt/100 gal	carfentrazone 0.004 to 0.031 lb/A	No restrictions listed.	Should be applied with a broad-spectrum burndown herbicide.
Gramoxone Inteon + Nonionic surfactant or Crop oil concentrate	2 to 4 pt/A + 1 to 2 pt/100 gal or 1 gal/100 gal	paraquat 0.7 to 1.4 lb/A	not specified	
Roundup/Others Glyphosate 3L or Roundup WeatherMax 4.5L or Roundup PowerMax 4.5L + Recommended additives	1 to 3 pt/A or 11 to 32 fl oz/A or 11 to 32 fl oz/A + See label	glyphosate 0.38 to 1.12 lb/A		May be applied early preplant (EPP) through planting. Use lower rate for small, susceptible weeds and higher rates for large or difficult to control weeds.

**Small grain herbicides**

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
<b>Preemergence or fall postemergence</b>				
Finesse 75DF + Nonionic surfactant	0.2 to 0.5 oz/A + 1 qt/100 gal	chlorsulfuron + metsulfuron 0.008 + 0.0016 to 0.02 + 0.004 lb/A	Ryegrass and common broadleaf weeds.	Use on wheat or barley. Use surfactant when applying postemergence to weeds. Read label for crop rotation restrictions. <b>STS varieties of soybeans must be planted if double-crop soybeans are to follow wheat.</b>
Hoelon 3EC	Preemergence: 2.7 pt/A 1-3 lf ryegrass: 1.3 pt/A 4-5 lf ryegrass: 2 pt/A 5 lf to 2 tiller ryegrass: 2.7 pt/A	diclofop 0.5 to 1 lb/A	Ryegrass	Use on winter wheat only. Expect slow results. Larger weeds require higher rates. Hoelon will kill oats.
<b>Postemergence, fall only</b>				
Achieve 40DG + Supercharge brand adjuvant	0.44 to 0.6 lb/A + 2 qt/100 gal	tralkoxydim 0.18 to 0.24 lb/A	Ryegrass	Use on winter wheat only. Expect slow results. Achieve will kill oats.
Peak 57 WG + Nonionic surfactant or Crop oil concentrate	0.5 oz/A + 1 to 2 qt/100 gal or 1-4 pt/A	prosulfuron 0.018 lb/A	Wild garlic, field pennycress, chickweed, prickly lettuce, common ragweed, velvetleaf, shepherdspurse, wild mustard, wild buckwheat	Label prohibits the planting of soybeans following application. Apply to oats and wheat from 3-leaf stage to before second node is detectable.
General information for Sencor: Wheat cultivars vary in their tolerance to Sencor. Check Bayer's list of Sencor-tolerant varieties before application.				
Sencor, 75DF	1 to 10.5 oz/A	metribuzin 0.05 to 0.5 lb/A	Cheat, downy brome, shepherdspurse, field pennycress, wild mustard, henbit, other winter annual broadleaf weeds	Contact a Bayer representative to determine if your wheat variety is Sencor-tolerant. See label to refine rates for soil texture, organic matter and crop and weed size. Low rates are for exceptionally early application to small weeds, higher rates require larger wheat.
<b>Fall or spring postemergence</b>				
Finesse Grass & Broadleaf + Nonionic surfactant + UAN or AMS	0.6 to 0.9 oz/A + 2 pt/100 gal + 2 qt/A or 2 lb/A	chlorsulfuron + flucarbazone 0.009 + 0.018 lb/A to 0.014 + 0.026 lb/A	Ryegrass, mustards, cutleaf eveningprimrose, pennycress, henbit, shepherdspurse	Apply postemergence to crop and weeds. Read label for crop rotation restrictions.

## Small grain herbicides

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
Harmony Extra TotalSol	0.45 to 0.9 oz/A	thifensulfuron + tribenuron 0.009 + 0.004 to 0.018 + 0.009 lb/A	Wild garlic, field pennycress, henbit, shepardspurse, wild mustard, smartweed	Apply to wheat or barley. Do not apply to wheat or barley crops underseeded with another crop. Apply from when crop is in the 2-leaf stage up to before the flag leaf is visible. Wild garlic plants should be less than 12 inches tall with 2 to 4 inches of new growth. Refer to label for additional rate information on weed size and density. When applied using liquid nitrogen fertilizer as the carrier, early crop yellowing and stunting may occur. Control is enhanced when applications are made during warm temperatures (60 degrees F or more) to actively growing weeds. Do not harvest sooner than 45 days after application.
Prowl H <sub>2</sub> O	1.5 to 3 pt/A	pendemethalin 0.7 to 1.4 lb/A	henbit, field pennycress	Should be applied before weed emergence. Can be applied from the first-leaf stage of wheat until just before the flag leaf is visible.
Olympus 70D + Nonionic surfactant	0.6 to 0.9 oz/A + 1 to 2 qt/100 gal	propoxycarbazone-sodium 0.03 to 0.04 lb/A	Downy brome, cheat, other <i>Bromus</i> species, some mustards	May be applied from emergence up to jointing.
Olympus Flex + Nonionic surfactant + UAN or AMS	3 to 3.5 oz/A + 2 qt/100 gal + 1 to 2 qt/A 3 lb/A	propoxycarbazone + mesosulfuron 0.013 + 0.008 to 0.015 + 0.009 lb/A	Downy brome, cheat, wild oat, annual ryegrass, some mustards	May be applied from emergence up to jointing.
Osprey 4.5 D + Methylated seed oil	4.75 oz/A + 1.5 pt/A	mesosulfuron 0.013 lb/A	Ryegrass control and suppression of common broadleaf weeds.	See label regarding insecticide and fertilizer restrictions. Apply to winter wheat when ryegrass is between the 1-leaf to the 2-tiller stage.
<b>Spring postemergence</b>				
Aim 2E + Nonionic surfactant (80%) + UAN (optional)	0.5 to 1 fl oz/A + 2 pt/100 gal + 2 to 4 gal/100 gal	carfentrazone 0.008 to 0.016 lb/A	Catchweed bedstraw, field pennycress, flixweed, tansy mustard, nightshade, pigweed, velvetleaf	Wheat. Apply before jointing.
Special note regarding safe application stages for hormone herbicides: The stage at which winter wheat is treated with growth-regulator-type herbicides such as 2,4-D, Banvel and MCPA is critical if crop damage is to be avoided. This growth stage has traditionally been described as "after fully tillered but before jointing." A newer, more accurate and safer evaluation is based on the distance from the soil surface to the top of the highest exposed leaf sheath. When this distance is between 2 and 4 inches, wheat has the most tolerance to growth-regulator herbicides.				
2,4-D amine (4 lb/gal formulation) or 2,4-D LV ester (4 lb/gal formulation)	1 to 1.5 pt or 0.5 to 1 pt/A	2,4-D 0.5 to 0.75 lb or 0.25 to 0.5 lb/A	Dandelion, field pennycress, shepherdspurse, wild mustard, common and giant ragweed, lambsquarters, pigweed, velvetleaf.	Barley, oats, rye and wheat. Apply in spring after full tillering stage but before jointing (stem elongation). Use lower rates on oats, which are less tolerant than other small grains. Underseeded legumes will be severely injured.
2,4-D LV ester (4 lb/gal formulation)	1.5 to 2 pt/A	0.75 to 1 lb/A	Wild garlic, vetch, many other broadleaf weeds.	Barley, rye and wheat. Apply in spring after full tillering stage but before jointing (stem elongation). Wild garlic will not be killed, but dockage should be reduced. Do not use unless possible crop injury is acceptable. Underseeded legumes will be severely injured.
Banvel/Clarity (4 lb/gal formulation)	2 to 4 fl oz/A	dicamba 0.0625 to 0.125 lb/A	Field pennycress, wild buckwheat, common and giant ragweed, kochia, lambsquarters, pigweed, smartweed.	Barley and wheat. Apply in spring after winter dormancy but before jointing (stem elongation). Underseeded legumes will be severely injured.
Buctril 2EC or Buctril 4 lb/gal	1.5 to 2 pt or 0.75 to 2 pt	bromoxynil 0.38 to 0.5 lb/A	Wild buckwheat, common ragweed, lambsquarters, velvetleaf.	Apply to wheat or barley from emergence to boot stage. Apply on weeds up to 4-leaf stage or rosettes less than 1.5 inches across. Underseeded legumes will be severely injured.

## Small grain herbicides

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
MCPA 4L	0.3 to 0.5 pt/A	MCPA 0.15 to 0.25 lb/A	Field pennycress, shepherdspurse, wild mustard, common and giant ragweed, lambsquarters, pigweed.	May be applied to oats, barley and wheat. Apply in spring just prior to jointing (stem elongation). Apply in 5 to 10 gallons of water per acre. Some legume tolerance if covered by small grain foliage and weeds.
Bronate 4L	1 to 2 pt/A	bromoxynil + MCPA 0.25 + 0.25 to 0.5 + 0.5 lb/A	Field pennycress, lambsquarters, other broadleaf weeds.	May be applied to oats, barley, rye and wheat. See label for weeds and rates. Apply between the 3- to 4-leaf stage and the boot stage of the crop. Weeds should be less than 6 inches tall and not past the 3- to 4-leaf stage. Underseeded legumes will be severely injured.

## Small grain, Special problems

Herbicide and formulation	Formulated material per broadcast acre	Herbicide (lb active per acre)	Weeds controlled	Application method and precautions
<b>Harvest aid</b>				
2,4-D amine (4 lb/gal formulation) or 2,4-D ester (4 lb/gal formulation)	1 to 2 pt or 1 to 2 pt/A	2,4-D 0.5 to 1 lb/A	Suppression of wild garlic and broadleaf weeds that interfere with harvesting.	Apply when small grains are in the hard dough stage. Ester formulation may be more effective on wild garlic than the amine formulation. Best results will be obtained when soil moisture is sufficient to cause succulent weed growth. Underseeded legumes will be severely injured.
Clarity 4L	8 oz/A	dicamba 0.25 lb/A	Suppression of broadleaf weeds that interfere with harvesting.	Apply when wheat is in the hard dough stage and green color is gone from nodes (joints). Do not use wheat for seed unless germination tests are 95% or better. Can be tank-mixed with Roundup or 2,4-D. Do not apply within 7 days of harvest.
Roundup/Others Glyphosate 3L or Others + Recommended additives	1 to 2 pt/A or See label + See label	glyphosate 0.38 to 0.75 lb/A	Suppression of grass and broadleaf weeds that interfere with harvesting	Apply when small grains are in the hard dough stage (30% moisture or less). Do not apply to wheat grown for seed.

### Crop replant and rotation guide for herbicides

(See end of table for key to abbreviations)

Herbicide	Corn	Cotton	Grain sorghum	Rice	Soybean	Wheat	Unspecified crops	Other crops	Rotation interval	+Additional precautions and information
	Months between application & planting									
2,4-D (various trade names)	0.5	-	-	1	+	-	FY	FG	+	+Wait 30 days before planting if more than 1 pint is used, 15 days for 1 pint or less of amine, 7 days for 1 pint or less of ester. +For forage grasses, wait 2 weeks per pint of 2,4-D used before seeding.
Accent	0	10	18+	18+	+	4	18+	B, RG O SC, AL SF	4 mo. 8 mo. 10 mo. 18 mo.+	<b>Grain sorghum</b> is 10 months if pH is less than 7.5. <b>Soybeans</b> are 15 days. <b>Unspecified crops</b> are 10 months if pH is less than 6.5 <b>Sunflower</b> is 11 months if pH is less than 7.5
Achieve	1	1	1	1	1	1	4+			<b>Unspecified crops:</b> Actual wording is that all other rotational crops must be planted 106 days after application.
Aim	0	0	0	0	0	0	1			
Amplify	9	9	9	9	0	3	30	AL, O PT T	9 mo. 18 mo. +	<b>Unspecified crops</b> require a successful bioassay. <b>Tobacco:</b> See label for rates and transplant intervals.
Assure II	4	0	4	4	0	4	4			
Atrazine	0	FY+	0	FY+	FY+	FY	FY+			If applied after June 10, only corn and grain sorghum can be planted the following year.
Authority First	10+	18	12	10	0	4	30	AL, B, RG	12 mo.	+Corn interval is 18 months if Sonic is applied at 6.45 to 8 oz on soils of 1.5% organic matter or less.
Authority MTZ	10+	18	12	10	4	4	18	AL B	12 mo. 4 mo.	+Field corn may be planter after 4 months when applied at 14 oz/A or less.
Autumn	1	9	9	18	9	4	+	AL	18 mo.	+Unspecified crops may be seeded only after the completion of a successful field bioassay.
Axial	4	4	4	4	4	0	4	-	-	
Axiom	0	+	24	12	0	12	24	PT RG, AL, O, B, CL	1 mo. 12 mo.	<b>Cotton</b> rotational interval not determined at the time of printing.
Axiom AT	0	+	FY	+	FY	+	+			+No information on label.
Balance Flexx	0	6	6	6	6	4	18	B, SC, PT SF AL	6 mo. 10 mo.	
Banvel	+	+	+	+	+	+	+	Corn Sorghum Wheat	7 da. 14 da. 30 da/pt	Actual label wording is "following normal harvest of crop." <b>Wheat</b> planting must be delayed 30 days after application per pint of Banvel used.
Basagran	0	+	+	+	0	+	+			No restrictions on label.
Basis	0	10	10	18	1+	4	18	AL	10	Crop rotation interval for soybeans is intended to support a soybean replant following a failed corn crop where Basis has been applied. Not intended for use as part of a planned soybean herbicide program.
Beacon	+	8	8	NI	8	3	18	B, RY AL, SC	3 mo. 8 mo.	<b>Corn</b> is 14 days. Injury may occur if dry weather prevails during much of the time between Beacon application and seeding of wheat or sorghum.
Bicep II Magnum, Bicep Lite II Magnum/Cinch ATZ	0	FY	0+	NI	FY	15	18	SG	15 mo.	<b>Grain sorghum:</b> Use Concep-treated seed. If applied after June 10, only corn and grain sorghum can be planted the following year.
Blazer	FY	FY	FY	FY	0	FA	FY+			<b>Root crops</b> (such as carrots, turnips, sweet potatoes, etc.) must not be planted in treated fields for a period of 18 months following treatment.
Boundary	8	8	12	8	0	4.5	18+	AL PT	4.5 mo. 8 mo.	<b>Root crops</b> are 18 months.
Bronco	0	FY	0+	FY	0	FA	FA			<b>Grain sorghum:</b> use SCREEN-TREATED seed.
Buctril + atrazine	0	NI	0	NI	FY+	NI	+			<b>Soybean and unspecified crops:</b> If applied after June 15, plant only corn or grain sorghum the next year. Unspecified crops should not be planted the year following application.
Buctril	0		0			FA				

### Crop replant and rotation guide for herbicides

(See end of table for key to abbreviations)

Herbicide	Corn	Cotton	Grain sorghum	Rice	Soybean	Wheat	Unspecified crops	Other crops	Rotation interval	+Additional precautions and information
	Months between application & planting									
Bullet	0	16	0+	16	FY	16	16			<b>Grain sorghum:</b> use SCREEN-TREATED seed.
Butyrac/ Butoxone (2,4-DB)	-	-	-	-	-	-	-			No restrictions on label.
Callisto	0	FY	FY	18	FY	4	18	SC, SF, CA, PT, T	FY	
Canopy 75DF	10+	10	12	10	0	4	30	AL	10	+Seed corn inbred lines may vary in their sensitivity to trace amounts of herbicide carryover.
Canopy EX	10	10	12	10	0.5	4	30	AL FG	10 mo. 4 mo	Even though Canopy EX may be applied in the fall, for purposes of recropping, do not start counting months for recropping until normal soybean planting time in the spring.
Camix	0	FY	FY	18	FY	4.5	18	RG	FY	If applied after June 10, do not rotate to crops other than corn or sorghum the following year.
Clarity	+	+	+	+	+	+	+			<b>Corn:</b> 7 days. <b>Grain sorghum:</b> 15 days. <b>Wheat</b> planting must be delayed 22 days after each 8 fl oz used. For other crops, actual label wording is "following normal harvest of crop."
Classic (All of MO with soil pH 7 or less)	9+	9+	9+	9+	0	3	18+	SG, RG AL, CL, T	3 mo. 15 mo.+	<b>Corn, cotton, grain sorghum and rice</b> intervals must be extended by 2 months if applied after Aug. 1. If applied the same year as Scepter or Pursuit, do not plant anything except soybeans for 15 months. <b>Unspecified crops</b> require a successful bioassay. See label for information.
Cobra	1	0	1	1	0	1	-			No restrictions on label
Command	9+	9+	12+	12+	0	12	16+	T DB SC	0 mo. 9 mo. 12 mo.	<b>Corn</b> is 9 months at rates of 2 pt/A and less. <b>Cotton</b> may be replanted immediately if Disyston or Thimet are applied (reapplied) in-furrow. <b>Cover crops</b> may be planted anytime, but stand reductions may occur. <b>Rice</b> may be replanted immediately if the Command rate is within the label for rice.
Command Xtra	10	18	10	10	0	12	18	T B, O, RG SC	0 16 mo. 18 mo.	
Conclude Xact B	FY	FY	FY	FY	0	FA	FY+			<b>Root crops</b> (such as carrots, turnips, sweet potatoes, etc.) Must not be planted for 18 months following treatment
Conclude Xact G	-	-	-	-	-	-	-			No restrictions on label.
Corvus	0	17	17	17	9	4	17	AL	17 mo.	
Distinct	+	4	4	4	4	4	4			<b>Corn:</b> 7 days.
Domain	1	24	12	12	0	24	12	PT	1 mo.	
Dual II Magnum	0	0	0+	FY	0	4.5	FY	SG, AL	4.5 mo.	<b>Grain sorghum:</b> Use Concep-treated seed.
Epic	0	6	12	12	6	12	24	PT	6 mo.	See label for specific vegetable crops.
Equip	0.5	9	9	18	9	2	18	AL, SF B, RG O	18 2 9	See label for specific soil insecticide restrictions.
Expert	0	FY	0+	-	FY	15	-			<b>Grain Sorghum:</b> Use Concep-treated seed. If applied after June 10, do not rotate to crops other than corn or sorghum the following year.
Extreme	8.5+	18	18	40	0	4	40	AL, RG, DB	4 mo.	Corn: IMI, IR, IT or Clearfield corn may be replanted immediately
Fieldmaster	0	+	+	+	FY	+	+	T	FY	No additional information on label
Finesse	11	14	14	NI	14+	0	+			<b>Soybeans:</b> STS soybeans may be planted the spring following Finesse <b>Other crops:</b> Other crops will require a successful bioassay.

### Crop replant and rotation guide for herbicides

(See end of table for key to abbreviations)

Herbicide	Corn	Cotton	Grain sorghum	Rice	Soybean	Wheat	Unspecified crops	Other crops	Rotation interval	+Additional precautions and information
	Months between application & planting									
FirstRate	9	9	9	9	0	3	30	AL PT T	9 mo. 18 mo. 30 mo.	<b>Unspecified crops</b> require a successful bioassay. <b>Tobacco:</b> See label for rates and transplant intervals.
Flexstar	10	10	18+	10	0	4	18	SG AL	4 mo. 10 mo.	<b>Grain sorghum</b> is 10 months in Southeast Missouri Delta counties.
Frontrow	9	9	9	26	0	3	26+	SG	3 mo.	<b>Unspecified crops</b> require a successful bioassay.
Fultime	0	+	FY	+	FY	15	+			<b>Cotton, rice and soybeans</b> should not be planted the year following application.
Fusilade DX	2	0	2	2	0	2	2			
Fusion	2	0	2	2	0	2	2			
Gangster	9	9	9	9	0	3	-	SF	30	
Gauntlet	10	18	10	10	0	4	-	AD, DB SC AL, DB	12 mo. 18 mo.+ 30 mo.	<b>Popcorn</b> is 9 months
Glyphosate <sup>a</sup>	0	0	0	0	0	0	0+	T	1 mo.	<b>Tobacco</b> is an exception to Unspecified crops.
Goal	10	1+	10	10	1+	10	10			<b>Cotton and soybeans</b> may be planted 7 days after application if soil is worked 2" deep. See label for additional rainfall restrictions.
Gramoxone Max	-	-	-	-	-	-	-			No restrictions on label
Guardsman Max	0	FY	FY	+	FY	+	+			<b>Rice, wheat and unspecified crops:</b> do not plant the year following application.
G-Max Lite	FY	FY	FY	-	FY	-	+			Do not plant wheat and unspecified crops the year following application.
Halex GT	0	10	0+	18	10	4	18	AL	10 mo.	+If grain sorghum is replanted, it must be Concep treated.
Harmony GT XP/Unity	0	0	0	0	+	1.5	1.5			+ <b>Soybeans</b> may be planted 7 days after application for rates up to 2.2 oz/A.
Harmony Xtra	2	2	2	2	2	0	2	B, O	0 mo.	
Harness Xtra	0	+	+	+	FY	+	+	T	FY	No additional information on label
Harness	0	+	+	+	FY	+	+	T	FY	No additional information on label
Hoelon	-	-	-	-	-	-	-			No information on label.
Hornet	0	18	12	10.5	10.5	4	26+	B, O, RG AL PT, SF, T	4 mo. 10.5mo. 18 mo.	<b>Unspecified crops</b> require a successful bioassay.
Impact	0	9	9	18	9	3	18	AL, SF	18 mo.	
Intrro	0	FY	0+	FY	0	FA	FY			<b>Grain Sorghum:</b> Apply only to grain sorghum planted with seed that has been properly treated with a seed protectant or safener.
Keystone/Breakfree ATZ	0	+	FY	+	FY	15	+	T+	FY	<b>Cotton, rice and unspecified crops:</b> Do not plant the year following application. If applied after June 10, only corn may be replanted the following year.
Laddok S-12	+	+	+	+	+	+	+			See label.
Lariat	0	16	0+	16	0	16	16			<b>Grain sorghum:</b> use Screen-treated seed.
Lasso	0	FY	0+	FY	0	FA	FY			<b>Grain sorghum:</b> use Screen-treated seed.
Liberty	0	4	3+	4	0	3+	4			<b>Grain sorghum and wheat:</b> Actual wording is 70 days
Liberty ATZ	0	FY	0	FY	FY	FY	FY			
Lexar	0	FY+	0+	FY+	FY+	FY+	+			+ <b>Cotton, grain sorghum rice soybeans and wheat:</b> If applied after June 10, do not rotate with crops other than corn the following year. <b>Other crops</b> should not be planted the season following application.
Linex	0+	4	0+	4	0+	4	4			<b>Corn, grain sorghum and soybeans:</b> Thoroughly rework soil before replanting. Plant corn at least 1.75 inches deep and grain sorghum at least 1 inch deep.

### Crop replant and rotation guide for herbicides

(See end of table for key to abbreviations)

Herbicide	Months between application & planting							Other crops	Rotation interval	+Additional precautions and information
	Corn	Cotton	Grain sorghum	Rice	Soybean	Wheat	Unspecified crops			
Lumax	0	FY+	0+	FY+	FY+	4.5+	+			<b>+Cotton, grain sorghum rice soybeans and wheat:</b> If applied after June 10, do not rotate with crops other than corn the following year. <b>Other crops</b> should not be planted the season following application.
Microtech	0	FY	0+	FY	0	FA	FA			<b>Grain sorghum:</b> Use screen-treated seed.
NorthStar	+	8	8	18	8	4	18	B AL, SC, DB, PT, SF, T	3 mo. 8 mo.	<b>Corn</b> is 14 days, IR corn may be replanted immediately
Olympus	18	12	12	-	12+	0	-			<b>+STS Soybean</b> may be planted 4 months after application. Specific mitigation measures are required in certain MO counties where endangered species occur. See label for specific guidelines and restrictions.
Olympus Flex	12	10	9	-	5	0	+	AL, O, PT	24 mo.	<b>+A field bioassay</b> must be conducted for crops not listed on this label and for crops for which the cumulative precipitation requirements are not satisfied.
Option	0.5	2	2	2	0.5	2	2			
Osprey	12	3	-	3	3	0.25	10	B, SF	1 mo.	
Outlook	0	FY	0+	FY	0	4	FY	SG	4 mo.	<b>+Use Concep or Screen-treated seed.</b>
Paramount	10	10	0	10	10	0	24	AL, CL, PT, SF	+	<b>+These crops require 24 months and a successful bioassay</b>
Partner	0	FY	0+	FY	0	FA	FA			<b>Grain sorghum:</b> Use Screen-treated seed.
Peak	1+	10	1	10	10	0	18+	SG SC, FG, PT, T, CA AL, CL PT, SF	1 10 mo. 15 mo. 24 mo.	<b>See label for specific pH and application time restrictions.</b> <b>Corn:</b> IR corn may be replanted immediately. <b>Sunflower and potato</b> is an exception to the 18-month-all interval
Permit	1+	4	2	1	9	2	+	SG SC AL, CL, DB, PT CA SF	2 mo. 3 mo. 9 mo. 15 mo. 18 mo.	<b>Corn:</b> IR may be replanted immediately. <b>Unspecified crops:</b> Label does not have an "Unspecified-crops" interval.
Phoenix	1	0	1	1	0	1	-			No restrictions on label
Pinnacle	1.5	1.5	1.5	1.5	1.5	1.5	1.5			
Poast/ Poast Plus	-	-	-	-	-	-	-			No restrictions on label.
Prefix	FY	-	FY	FY	0	4.5	-	AL	4	
Princep	0	+	+	+	+	+	+			<b>Cotton, grain sorghum, rice, soybean, wheat and unspecified crops:</b> Do not plant the year following application
Prowl H <sub>2</sub> O	FY	0	FY	FY	0	4	FY	B, RG, Al, T, CL	4 mo.	
Prowl (2X Rate)	FY	0	FY	FY	0	FY	FY			Do not rework soil deeper than treated zone.
Pursuit	8.5+	18	18	40	0	3	40	AL, RG T, B O, SC PT	4 mo. 9.5 mo. 18 mo. 26 mo.	<b>Corn:</b> IMI, IR, IT and Clearfield corn may be replanted immediately. See label for restrictions regarding the use of other ALS-inhibiting herbicides.
Pursuit Plus	8.5+	18	18	40	0	3	40	AL, RG T, B O, SC PT	4 mo. 9.5 mo. 18 mo. 26 mo.	<b>Corn:</b> IMI, IR, IT and Clearfield corn may be replanted immediately. See label for restrictions regarding the use of other ALS-inhibiting herbicides.
Python	0	18	12	6	0	4	26+	AL, DB, B, O, RG PT SF, SC+	4 mo. 12 mo. 18 mo.	<b>Popcorn</b> is 9 months. <b>Unspecified crops</b> require a successful bioassay.

### Crop replant and rotation guide for herbicides

(See end of table for key to abbreviations)

Herbicide	Months between application & planting								Other crops	Rotation interval	+Additional precautions and information
	Corn	Cotton	Grain sorghum	Rice	Soybean	Wheat	Unspecified crops				
Ramrod	0	FY	0	FY	FY	FA	FA				
Raptor	8.5	9	9	9	0	3	18	B, RG AL, SC, DB, O, PT, SF	4 mo. 9 mo.		
Reflex	10	10	18	18	0	4	18	SG	4 mo.	All of Missouri except the Boot heel: Do not apply to any field more than once every two years.	
Resolve	0	10	10	10	10	4	-	AL PT	10 mo. 0 mo.	For alfalfa and grain sorghum, rotational intervals should be extended to 18 months if drought conditions prevail after application.	
Resource	-	-	-	-	-	-	-			No restrictions on label.	
Scepter	9.5	18	11	FY	0	3	18	T B, O, RG	9.5 mo. 11 mo.	See label for additional dry-weather restrictions.	
Select/ Select Max	1	0	1	1	0	1	1+			<b>Unspecified crops:</b> do not plant crops for which Select is not registered for 30 days following application.	
Sencor	4	8	12	8	4	8	18+	AL, FG PT, B+	4 mo. 8 mo.	<b>Barley and wheat</b> are 4 months if Sencor was applied to soybeans. <b>Unspecified crops:</b> Non-root crops are 12 months.	
Sequence	0	0	0	FY	0	4.5	-	AL	4 mo.		
Shotgun	+	-	+	-	-	-	-			+Corn and grain sorghum are 3 weeks. Label does not specify rotation intervals for other crops. Use atrazine restrictions as a guideline.	
Sonalan	FY	FY	FY	FY	0	FA	FA				
Sonic	10+	18	12	10	0	4	30	AL, B, RG	12 mo.	+Corn interval is 18 months if Sonic is applied at 6.45 to 8 oz on soils of 1.5% organic matter or less.	
Spartan (Midwest areas)	10	30	10	-	0	4	30	AL, B RG, DB CL, SF, SC CA, PT	12 mo. 18 mo. 30 mo.		
Spirit	1+	10	10+	10+	18+	3+	18+	B, O SC FG, DB	3 mo. 8 mo. 10 mo.	+Label includes a June-30-last-application date for rotational crop safety. IR or IMR corn may be replanted immediately	
Starane	0	4	0	4	4	0	4	B, O	0 mo.		
Status	4	4	4	4	4	4	4			<b>Corn:</b> 7 days	
Steadfast	0	10	18+	18+	0.5	4	18+	SF	18 mo+	<b>+Grain sorghum:</b> 10 months if pH is less than 7.5. <b>+Rice:</b> 10 months if pH is less than 6.5. <b>+Sunflower:</b> 11 months if pH is less than 7.5. <b>+Unspecified crops:</b> 10 months if pH is less than 6.5.	
Storm	FY	FY	FY	FY	FY	FA	FA+			<b>Unspecified crops</b> do not include root crops which should not be planted for 18 months following application.	
Stout	0	10	10	18	0.5	4	18	AL	10+	+Rotational intervals should be extended to 12 months if drought conditions prevail after application.	
Surestart	0	26	12	26	FY	4	26	SF AL	18 mo. FY		
Surpass/Breakfree	0	+	FY	+	FY	4	+	T	FY	<b>Cotton, rice and unspecified crops:</b> Do not plant the year following application.	
Synchrony	9	9	9	15	0	3	17	SG AL, CL	3 mo. 12 mo.	See label for several exceptions depending on the use of chlorimuron-containing products, soil pH and application date.	
Topnotch	0	+	FY	+	FY	4	+	T	FY	<b>Cotton, rice and unspecified crops:</b> Do not plant the year following application.	
Touchdown HiTech	0	0	0	0	0	0	-				
Touchdown Total	0	0	0	0	0	0	-				
Treflan	FY	0	FY	FY	0	FA	FY	B	Fall		
Treflan (2X rate)	+	0	+	+	0	+	+			+Do not plant for 2 years.	

## Crop replant and rotation guide for herbicides

(See end of table for key to abbreviations)

Herbicide	Corn	Cotton	Grain sorghum	Rice	Soybean	Wheat	Unspecified crops	Other crops	Rotation interval	+Additional precautions and information
	Months between application & planting									
Typhoon	10	10	18	10	0	4	18	SG	4 mo.	
Ultra Blazer	FY	FY	FY	FY	0	FA	FY+			<b>Root crops</b> (such as carrots, turnips, sweet potatoes, etc.) must not be planted in treated fields for a period of 18 months following treatment.
Valor, 3 oz rate	2	2	2	2	0	2	12	B, DB, RG, SC	4 mo.	
Valor, 2 oz rate	1	1	1	1	0	1	12	B, DB, RG, SC	4 mo.	
Valor XLT	10	10	10	10	0	4	30	AL	12 mo.	
Yukon	1	3	2	3	9	2	NI	RY PC AL, CL, DB, PT CA SF	2 mo. 3 mo.+ 9 mo. 15 mo. 18 mo.	<b>+Seed corn:</b> 2 months
Zorial	16	0	16	16	0	16	16			

**Key to abbreviations:**

**Crops:**

- |                     |                             |
|---------------------|-----------------------------|
| AL = Alfalfa        | O = Oats                    |
| B = Barley          | PT = Potatoes               |
| CA = Canola (rape)  | RG = Rye                    |
| CL = Clovers        | SC = Sweet corn/<br>Popcorn |
| DB = Dry beans      | SF = Sunflower              |
| FG = Forage grasses | SG = Small grains           |
| FL = Forage legumes | T = Tobacco                 |

**Timings:**

- FA = Fall  
FY = Following year

**Notes:**

This table applies to the major field and forage crops of Missouri. Refer to the herbicide labels for the latest recrop and rotation information for horticultural crops. The University of Missouri does not warrant herbicides and regrets any omissions or errors in this guide. Always refer to product labels before using a pesticide or replanting into treated fields.

A “successful bioassay” where the rotational crop is test planted in soil from the field in question is often required for unlisted crops. A bioassay can be performed in the field or in a container (flower pot) indoors. If possible, similar, untreated soil (such as from an adjoining fence row) should also be planted as a check. A bioassay is also advisable if weather conditions have been unfavorable for herbicide breakdown (cool temperatures and little rainfall) or when you are planting extremely close to the specified rotation interval. Soil sampling should be thorough. Use the same procedures as for fertility samples. If possible, a hypersensitive plant should be planted in addition to the desired crop (for example, a grower who is planting wheat but is concerned with potential atrazine carryover should use both wheat and soybeans as test crops since soybeans are also sensitive to atrazine). Field bioassays, where strips are planted perpendicular to the previous crop rows, are also useful.

## Forage, feed and grazing restrictions for herbicides

Herbicide	Restrictions
2,4-D	Do not forage or feed corn fodder for 7 days following application. Do not permit dairy animals or meat animals being finished for slaughter to forage treated grain fields within 2 weeks after treatment. Do not feed treated straw to livestock if a preharvest or emergency treatment is used. See label for further information.
Accent	Do not graze or feed forage or grain from the treated areas to livestock within 30 days after application.
Achieve	Mature straw and grain may be fed to livestock 45 days after treatment. Immature crops (forage) may be grazed or cut for hay 30 days after treatment.
Aim	Product is labeled for use on corn for silage. Do not feed treated soybean forage to livestock. No information on other crops.
Amplify	Do not harvest soybeans for forage or hay for 14 days after application.
Assure II	Do not graze treated fields or harvest for forage or hay.
Atrazine	Do not graze or feed forage from treated areas for 60 days following application, or illegal residues may result.
Authority First	Do not feed treated soybean forage or hay to livestock. Do not harvest soybeans for 65 days after application.
Authority MTZ	Do not graze treated fields or harvest for forage or hay.
Axiom	No restrictions on corn. Do not graze or feed forage, hay or straw to livestock from treated soybeans.
Axiom AT	No restrictions on corn.
Balance Flexx	No information on label.
Banvel	Do not graze or harvest for livestock feed prior to crop maturity.
Basagran	Do not graze treated fields for at least 21 days after application.
Basis	Do not graze or feed forage, grain or stover from treated areas within 30 days of application.
Beacon	Do not graze or feed forage from treated corn to livestock within 30 days after application.
Bicep II Magnum	Do not graze or feed forage from treated areas for 30 days following application.
Bicep Lite II Magnum	Do not graze or feed forage from treated areas for 30 days following application.
Blazer	Do not use treated plants for feed or forage.
Boundary	Soybean plants or hay may be grazed or fed to livestock 40 days after application.
Bronate	Do not graze treated fields for 30 days following application.
Buctril + atrazine	Do not cut crop for feed or graze within 30 days after application.
Buctril	Do not cut for feed or graze within 30 days after application.
Bullet	Do not graze treated area or feed treated forage to livestock for 21 days following application.
Butyrac/Butoxone (2,4-DB)	Do not graze or feed soybean hay within 60 days after application of a 2, 4-DB tank-mix application.
Callisto	Do not harvest forage, grain or stover within 45 days after application.
Camix	Do not graze or feed forage from treated areas for 45 days following application.
Canopy 75DF	Do not graze treated fields or harvest for forage or hay.
Canopy EX	Do not feed treated soybean forage or hay to livestock.
Cinch ATZ	Do not graze or feed forage from treated areas for 30 days following application.
Clarity	For lactating dairy animals, do not harvest forage within 37, 51 or 70 days for 1, 2 and 4 pint use rates. No restrictions for other animals.
Classic	Do not graze treated fields or harvest for forage or hay.
Cobra	Do not graze animals on green forage or stubble. Do not use hay or straw for animal feed or bedding.
Command	Do not allow livestock to graze on treated fields or crop residue or feed treated forage to livestock.
Command Xtra	Do not allow livestock to graze on treated soybean vines or feed treated soybean leaves or vine trash to livestock.
Conclude	Do not use treated plants for feed or forage.
Degree	No information on label.
Degree Xtra	No information on label.
Domain	Do not graze or feed forage, hay or straw to livestock.
Distinct	Do not apply within 32 days of forage harvest. Do not apply within 72 days of corn grain and stover harvest.
Dual II Magnum	Do not graze or feed forage from treated areas for 30 days following application.
Epic	No information on label
Equip	Do not harvest corn grain within 70 days and corn forage within 45 days of an application. Do not graze within 45 days of an application.
Expert	Do not graze or feed forage from treated areas for 30 days following application.
Extreme	Do not graze or feed treated soybean forage, hay or straw to livestock.
Finesse	No grazing restrictions.
FirstRate	Do not harvest soybeans for forage or hay for 14 days after application.

**Forage, feed and grazing restrictions for herbicides**

<b>Herbicide</b>	<b>Restrictions</b>
Flexstar	Do not graze treated areas or harvest for forage or hay. Do not graze rotated small grain crops or harvest for livestock forage or straw.
Frontrow	Do not graze or feed treated soybean forage, hay or straw to livestock.
Fultime	No restrictions on label.
Fusilade DX	Do not graze or harvest for forage or hay.
Fusilade 2000	Do not graze or harvest for forage or hay.
Fusion	Do not graze or harvest for forage or hay.
Gangster	Do not graze treated fields or feed treated forage or hay to livestock.
Gramoxone Inteon	Soybean post directed: Do not graze treated areas or feed treated forage to livestock. Corn harvest aid: Do not use on corn grown for fodder or forage. Do not pasture livestock in treated fields. Soybean harvest aid: Do not pasture livestock within 15 days of treatment and remove 30 days before animal harvest.
Guardsman Max	May be grazed or fed to livestock at 40 or more days after application.
G-Max Lite	Sorghum may be grazed or fed to livestock 60 days or more after preemergence application or 45 days or more after postemergence application.
Halex GT	Do not graze or feed forage from treated areas for 45 days following application.
Harmony Xtra SG	Do not graze or feed forage for 7 days after application. Do not feed hay for 30 days following application. Harvested straw may be used for bedding 45 days between application and harvest.
Harmony GT XP/Unity	Do not graze or feed forage, hay or straw from treated areas to livestock.
Harness	No restrictions on label.
Harness Xtra	No restrictions on label.
Hoelon	Do not allow livestock to graze treated fields. Do not harvest forage, hay or straw from treated fields.
Hornet	No restrictions on label.
Impact	Do not apply within 45 days of corn harvest. Do not graze or feed treated corn forage, silage, fodder or grain for at least 45 days after application.
Intrro	Grain sorghum: Do not graze harvest forage for 70 days following application. Soybeans: Do not feed forage, hay or straw. Do not ensile treated soybeans.
Keystone	No information on label.
Laddok S-12	Do not graze treated areas or feed treated forage to livestock for 21 days following application.
Lariat	Do not graze treated area or feed treated forage to livestock for 21 days following application.
Lasso	Corn: Do not graze treated areas or feed treated forage to livestock for 21 days following application. Grain sorghum: Do not graze harvest forage for 70 days following application. Soybeans: Do not feed forage, hay or straw. Do not ensile treated soybeans.
Lexar	Do not graze or feed forage from treated areas for 45 days following application.
Liberty	Do not harvest corn forage within 60 days of application.
Liberty ATZ	Do not harvest corn forage within 60 days of application. Do not feed treated green immature growing soybean plants to livestock.
Linex	Do not graze treated fields or feed forage from treated areas to livestock. Do not feed gin trash to livestock.
Lumax	Do not graze or feed forage from treated areas for 45 days following application.
MCPA	Do not forage or graze meat or dairy animals on treated areas within 7 days of slaughter.
Microtech	Corn: Do not graze treated areas or feed treated forage to livestock for 21 days following application. Grain sorghum: Do not graze harvest forage for 70 days following application. Soybeans: Do not feed forage, hay or straw. Do not ensile treated soybeans.
NorthStar	Do not graze or feed forage from NorthStar-treated corn to livestock within 30 days following application. Do not harvest silage within 45 days after application.
Olympus Flex	Wheat may be harvested for forage 30 days after application, or for grain and straw 71 days after application.
Option	Do not harvest corn grain within 70 days and corn forage within 45 days of an application. Do not graze within 45 days of an application.
Osprey	Wheat: Do not apply within 30 days of grazing; 60 days for hay, grain and straw.
Outlook	May be grazed or fed to livestock at 40 or more days after application.
Paramount	No information on label
Partner	Corn: Do not graze treated areas or feed treated forage to livestock for 21 days following application. Grain sorghum: Do not graze harvest forage for 70 days following application. Soybeans: Do not feed forage, hay or straw. Do not ensile treated soybeans.
Peak	Do not graze or feed forage from treated crops until 30 days following application. Do not harvest for silage until 40 days following application.
Permit	Allow 30 days before grazing and harvest of forage or silage.
Phoenix	Do not graze animals on green forage or stubble. Do not feed treated soybean silage (ensiled soybeans) to cattle. Do not use hay or straw for animal feed or bedding.

## Forage, feed and grazing restrictions for herbicides

Herbicide	Restrictions
Poast/Poast Plus	Do not graze treated fields and do not feed treated soybean forage (green succulent) or ensilage to livestock. Treated soybean hay may be fed. Do not apply within 60 days of harvest for fodder or 45 days for corn forage/silage.
Prefix	Do not graze or feed treated soybean forage, hay or straw to livestock 30 after treatment; do not graze or feed treated forage or hay from soybeans to livestock following a postemergence application.
Princep	Do not graze treated areas, or illegal residues may occur.
Prowl H <sub>2</sub> O	Do not graze treated cotton or rice fields. Do not use rice straw for feed or bedding. Livestock can graze or be fed soybean forage from treated corn 21 days following application.
Pursuit Plus	Do not graze or feed treated soybean forage, hay or straw to livestock.
Pursuit	Do not graze or feed treated soybean forage, hay or straw to livestock.
Python	Do not graze or feed treated soybean forage, hay or straw to livestock. No corn information on label.
Raptor	Do not graze treated soybean forage, hay or straw to livestock.
Reflex	Do not graze treated areas or harvest for forage or hay. Do not graze rotated small grain crops or harvest for livestock forage or straw.
Resolve	Do not graze or feed forage for 7 days after application. Do not feed hay for 30 days following application. Harvested straw may be used for bedding 45 days between application and harvest.
Resource	Do not graze animals or green forage or use as a feed fewer than 28 days after application.
Roundup Original Max	Roundup Ready Soybean: Allow a minimum of 14 days between final application and feeding of grain, forage, or hay. Roundup Ready Corn: Do not harvest or feed treated crops for 8 weeks after application. Spot treatment: Allow 14 days following spot treatment or selective equipment before grazing domestic livestock. Corn harvest aid: Allow a minimum of 7 days between application and feeding of treated vegetation. Grain sorghum harvest aid: Allow a minimum of 7 days between application and feeding of treated vegetation. Soybean harvest aid: Do not graze or harvest treated crop for livestock feed within 25 days of last preharvest application. Wheat harvest aid: Wheat stubble may be grazed immediately after harvest.
Scepter	Do not graze or feed treated soybean forage, hay or straw to livestock.
Select/ Select Max	Do not graze treated fields or feed treated forage or hay to livestock.
Sencor	Treated vines may be grazed or fed to livestock 40 days after application.
Sequence	Do not feed treated soybean forage or hay for 30 days after application.
Shotgun	Do not graze for feed forage from treated areas for 21 days following application.
Sodium chlorate	Grain sorghum: Do not graze treated fields or feed treated fodder, forage or seeds within 14 days of application. Rice: No information on label. Soybeans: Do not graze treated fields or feed treated soybean foliage or fodder.
Sonic	Do not feed treated soybean forage or hay to livestock. Do not harvest soybeans for 65 days after application of Sonic.
Spartan	No information on label.
Spirit	Do not graze or feed forage from Spirit-treated crops to livestock until 30 days after application.
Starane	Do not allow livestock to graze treated areas or harvest treated forage within 7 days of application to wheat, barley or oats, 47 days to corn, and 40 days to grain sorghum.
Status	Do not apply within 32 days of forage harvest. Do not apply within 72 days of corn grain and stover harvest.
Steadfast	Do not graze or feed forage, hay or straw from treated areas to livestock within 30 days of application.
Stellar	Do not graze animals on green forage or stubble. Do not use hay or straw for animal feed or bedding.
Storm	Do not use treated plants for feed or forage.
Stout	Do not graze or feed forage, hay, or straw from treated areas to livestock within 30 days of application.
Surestart	No restrictions on label.
Surpass EC	No restrictions on label.
Synchrony	Do not graze treated fields for forage or hay.
TopNotch	No restrictions on label.
Touchdown	Do not graze or harvest treated cover crops for feed.
Touchdown HiTech	Roundup Ready Corn: Allow a minimum of 50 days between postemergence application and harvest of forage. Roundup Ready Soybean: Do not graze or harvest for forage or hay.
Touchdown Total	Roundup Ready Corn: Allow a minimum of 50 days between postemergence application and harvest of forage. Roundup Ready Soybean: Do not graze or harvest for forage or hay.
Treflan	No information on label.
Ultra Blazer	Do not use treated plants for feed or forage.
Valor	Do not graze treated fields or feed treated forage or hay to livestock.
Valor XLT	Do not graze treated fields or feed treated forage or hay to livestock.
Yukon	Following application to forage, corn may be grazed or harvested for feed after the crop reaches the ensilage (milk) stage, at least 30 days after foliar application.
Zorial	Do not graze treated cotton fields with livestock or feed treated cotton forage to livestock. Cover crops planted after harvest should be plowed under and not grazed or harvested.

**Herbicide compatibility with fertilizers as application carriers\***

Fertilizer			Fertilizer		
Herbicide	Fluid	Dry	Herbicide	Fluid	Dry
<b>Burndown herbicides:</b>			Keystone/Breakfree ATZ	Yes	Yes
2,4-D Amine	No	No	Lariat	Yes	Yes
2,4-D Ester	Yes	No	Lasso	Yes	Yes
Glyphosate	No	No	Lexar	Yes*	No
Gramoxone Inteon	Yes	No	Linex	Yes	Yes
Harmony Extra	Yes	No	Lumax	Yes*	No
Touchdown	No	No	Outlook	Yes	Yes
<b>Preemergence herbicides:</b>			Paramount	No	No
Atrazine	Yes	No	Partner	Yes	Yes
Axiom	Yes	Yes	Prefix	Yes	No
Axiom AT	Yes	Yes	Prowl H <sub>2</sub> O	Yes	Yes
Balance Flexx	Yes	No	Pursuit	Yes	No
Banvel	Yes	No	Pursuit Plus	Yes	Yes
Bicep II Magnum/Cinch ATZ	Yes	Yes	Python	Yes	Yes
Bicep Litell Mag./Cinch Lite ATZ	Yes	Yes	Ramrod	Yes	No
Boundary	Yes	Yes	Scepter	Yes	Yes
Bullet	Yes	Yes	Sencor	Yes	Yes
Callisto	Yes*	No	Sonolan	Yes	Yes
Caparol	No	No	Surpass/Breakfree	Yes	Yes
Command	Yes	Yes	TopNotch	Yes	Yes
Command Xtra	Yes	No	Treflan	Yes	Yes
Commence	Yes	Yes	Valor	NI	NI
Cotoran	Yes	No	Zorial	Yes	Yes
Clarity	Yes	No	<b>Small grain postemergence herbicides:</b>		
Degree	Yes	Yes	2,4-D Amine	No	No
Degree Xtra	Yes	Yes	2,4-D Ester	Yes	No
Domain	No	Yes	Achieve	No	No
Dual II/ Magnum/Cinch	Yes	Yes	Aim	No	No
Epic	Yes	Yes	Banvel	Yes	No
Extreme	No	No	Buctril	Yes	No
Fieldmaster	Yes	No	Bronate	Yes	No
FirstRate	Yes	Yes	Harmony Extra	Yes	No
Fultime	Yes	Yes	Hoelon	Yes	No
Guardsman Max	Yes	Yes	MCPA	No information on label.	
Harness	Yes	Yes	Olympus	Yes	-
Harness Xtra	Yes	Yes	Olympus Flex	Yes	No
Hornet	Yes	Yes	Osprey	No	No
Impact	Yes	Yes	Peak	Yes	No
Karmex	No	No	Sencor	Yes	No

**Note:** There are many specific fertilizer incompatibilities and restrictions with most herbicides. Be sure to read the herbicide label for specific mixing or impregnation instructions. Compatibility agents are required for many mixes. A typical compatibility test procedure for mixing herbicides in fluid fertilizers is given in the introductory section of this publication.

NI: No information on label

\*Do not use with suspension fertilizers.

## Rainfall-free periods, preharvest intervals (PHI), and crop safety restrictions for postemergence herbicides

Herbicide	Time before rainfall	PHI (crop safety restriction)
2,4-DB	NI*	Soybeans: 60 days
2,4-D and MCPA	6 to 8 hr	Corn: 7 days (Overtop- 8"; drop nozzles- before tasseling) Grain sorghum: (Overtop- 8"; drop nozzles- 15") Rice: (Before internode exceeds 1/2") Wheat: (Before jointing) Wheat harvest aid: Hard dough
Accent	4 hr	Corn: 30 days (overtop- before 20"/6 collars; drop nozzles-before 36"/10 collars)
Achieve	1 hr	Wheat: 60 days
Aim	1 hr	Corn: (14 collars) Cotton: 7 days Grain sorghum: (6-leaf stage post; harvest aid: 3 days) Rice: 60 days Soybeans: (V3-V10 post; harvest aid: 3 days) Wheat: (Jointing; harvest aid: 3 days)
Assure II	1 hr	Cotton: 80 days Soybeans: 80 days
Atrazine	1 to 2 hr	Corn: (12") Grain sorghum: (12")
Authority MTZ	NI*	Soybeans: 120 days
Banvel	6 to 8 hr	Corn: (1 pt- 5"; 1/2 pt- 36") Grain sorghum: (Overtop- 8"; drop nozzles- 15") Wheat: (Before jointing)
Basagran	8 hr***	Corn: No Restrictions Rice: No Restrictions Soybeans: No restrictions
Basis	4 hr	Corn: (4-leaf)
Beacon	4 hr	Corn: 60 days (overtop- before 20"; drop nozzles- before tassel emergence)
Bicep products	1 to 2 hr	Corn: NA, (5")
Blazer	6 hr	Rice: 50 days (Before boot stage) Soybeans: 50 days
Bronate	NI*	Wheat: NI*
Buctril		Corn: 30 days Sorghum: (Before boot stage) Cotton: 60 days Wheat: NI*
Buctril + Atrazine	1 hr	Corn: NI* Grain sorghum: NI*
Callisto	1 hr	Corn: 45 days (30" or 8-leaf)
Clarity	4 hr	Corn: (1 pt- 5"; 1/2 pt- 36") Grain sorghum: (Overtop- 8"; drop nozzles- 15") Wheat: (Before jointing)
Classic	1 hr	Soybeans: 45 days
Clincher	2 hr	Rice: 60 days
Cobra	30 min.	Cotton: 70 days Soybeans: 45 days
Concert	1 hr	Soybeans: 60 days
Conclude Xact	4 hr	Soybeans: 75 days
Distinct	4 hr	Corn: 72 days (24")
Dual II Magnum	NA**	Corn: (5")
Extreme	NI*	Soybeans: 85 days (before bloom)
Fultime	NA**	Corn: 60 days (11")
Fusilade	1 hr	Cotton: 90 days Soybeans: (First bloom)
Fusion	1 hr	Cotton: 90 days Soybeans: 1st bloom
FirstRate	2 hr	Soybeans: 65 days for grain, 14 days for forage (50% flowering)
Flexstar	1 hr	Soybeans: 45 days
Frontrow	2 hr	Soybeans: 70 days
Gramoxone Inteon	30 min	Burndown: NA** Corn harvest aid: 7 days Soybean harvest aid: 14 days
Guardman Max	1-2 hours	Corn: 40 days (8")
Halex GT	NI*	Corn: 45 days

## Rainfall-free periods, preharvest intervals (PHI), and crop safety restrictions for postemergence herbicides

Herbicide	Time before rainfall	PHI (crop safety restriction)
Harmony Extra	“Several hours”	Burndown: NA** Wheat: 45 days
Harmony GT XP/Unity	1 hour	Soybeans: 60 days Wheat: Before flag leaf stage
Harness/Degree	NA**	Corn: (11")
Harness Xtra/ Degree Xtra	1 to 2 hr	Corn: NA (11")
Hoelon	1 hr	Wheat: 77 days
Hornet	2 hr	Corn: 85 days (20")
Keystone/Breakfree ATZ	NA**	Corn: 60 days (11")
Laddok S-12	8 hr***	Corn: 21 days (Fifth leaf) Grain sorghum: NI*
Lexar	1 hr	Corn: 60 days (12")
Liberty	4 hr	Corn: 70 days for grain, 60 days for forage (Overtop- 24" or 7 collars, drop nozzles- 36")
Liberty ATZ	4 hr	Corn: 70 days for grain, 60 days for forage (12" corn)
Linex	NI*	Corn: NI* Grain sorghum: NI* Soybeans: 60 days
Lumax	1 hr	Corn: 45 days (5")
NorthStar	4 hr	Corn: 60 days for grain, 45 days for silage (Overtop- 20" or 4 collars, drop nozzles- 36")
Olympus	4 hr	Wheat: 71 days
Olympus Flex	4 hr	Wheat: 71 days
Osprey	4 hr	Wheat hay, grain, and straw: 60 days; Wheat forage: 30 days
Outlook	NA**	Corn: 40 days (8")
Paramount	6 hr	Grain sorghum: (12 inches)
Peak	4 hr	Corn: 60 days (48 inches) Grain sorghum: 60 days (30 inches) Wheat: 60 days (Second node)
Phoenix	30 min.	Soybeans: 45 days
Permit	4 hr	Corn: Forage/Silage- 30 days (grain- lay-by) Grain sorghum: Forage/Silage- 30 days (grain- lay-by) Rice: 28 days (Preflood application only)
Pinnacle	1 hr	Soybeans: 60 days Wheat: Before flag leaf stage
Poast/Poast Plus/ Prestige	1 hr	Corn: Grain- 60 days; Forage/Silage- 45 days Cotton: 40 days Soybeans: 75 days
Prefix	NA**	Soybeans: 90 days
Pursuit	1 hr	Corn: 45 days Soybeans: 85 days (Before bloom)
Raptor	1 hr	Soybeans: 85 days (Before bloom)
Ready Master ATZ	2 hr	Corn: 50 days (12")
Reflex	4 hr	Soybeans: 45 days
Resource	1 hr	Corn: Forage/Silage- 28 days; Grain- 60 days Soybeans: 60 days
Roundup	2 hr (1 hour UltraMax) (30 min WeatherMax)	Burndown: NA** Corn: 50 days (24 inches or 6 collars) Cotton: 7 days (Overtop- 4 leaf; directed- not specified) Soybeans: 14 days Harvest aid (Corn, Cotton, Grain sorghum, Small grain, Soybeans) : 7 days
Scepter	2 hr	Soybeans: 90 days
Select/ Select Max	1 hr	Cotton: 60 days Soybeans: 60 days (40 days for 4-oz red rice seedhead suppression label)
Sencor	NI*	Wheat: 21 days Corn: prior to tasseling
Shotgun	NI*	Corn: (Overtop- 4 leaf or 8", drop nozzles- 12") Grain sorghum: (Overtop- 4 leaf or 8", drop nozzles- 12")
Spirit	4 hr	Corn: Forage/Silage 40 days; Grain- 60 days (Overtop- 20" or 6 collars, drop nozzles- 24")
Steadfast	4 hr	Corn: 30 days (12inches or 6 collars)
Storm	6 hr	Rice: 50 days (End of tillering) Soybeans: 50 days
Surpass/Breakfree XP	NA**	Corn: (11")
Surestart	NI*	Corn: 85 days

## Rainfall-free periods, preharvest intervals (PHI), and crop safety restrictions for postemergence herbicides

Herbicide	Time before rainfall	PHI (crop safety restriction)
Synchrony STS	1 hr	Soybeans: 60 days
Touchdown HiTech		RR Soybean: 14 days with no more than 20 fl oz/A RR Corn: 7 days with no more than 20 fl oz/A Conventional soybean: 7 days with no more than 3.6 Qts/a Conventional corn: 7 days
Touchdown Total	NI*	Corn and soybeans: 7 days
Ultra Blazer	4 hr	Rice: 50 days Soybeans: 50 days
Valor	1 hr	
Valor XLT	1 hr	No information on label
Yukon	4 hr	Corn: 30 days (36") Grain sorghum: 30 days (Overtop- 8" drop nozzles 15")

\*No information on label.

\*\*Not applicable

\*\*\*Label now states that rainfall soon after application may decrease effectiveness.

## Corn diseases and their management

Corn diseases can and do occur each year in Missouri. Problems with germination and stand establishment that are related to seed decay, damping-off and seedling blights are often encountered in the field. These losses can be costly, especially if replanting is necessary. Diseases may cause leaf spots or leaf blights, wilts or premature death of plants. Corn diseases also can cause harvest losses, affect the quality of the harvested crop and cause storage losses. The extent of the damage due to corn diseases in a given season depends on a number of factors including the susceptibility of the corn hybrid to the specific disease, the level of pathogen inoculum present and the environmental conditions during that season.

To minimize losses due to corn diseases, it is important to correctly identify the disease or diseases present so that appropriate management steps can be taken. The principal diseases of corn in Missouri can be divided into seed rots and seedling diseases, foliage diseases, stalk rots, ear and kernel rots and a few miscellaneous diseases. For more detailed information including color pictures of diseases of corn in Missouri please see University of Missouri publication IPM 1001, *Corn Diseases*.

Finally, although the common diseases of corn are basically the same, regardless of the type of corn being grown; inbreds, some sweet corn hybrids and some specialty corn hybrids may be more susceptible to some of the common corn diseases than field corn. A pesticide label may also designate that the product is to be used on a specific type of corn. The tables included in this manual cover products registered for use on field corn. For other types of corn, always check the pesticide label and follow label specifications.

### Seed rots and seedling blights

Seed rots and seedling blights are caused by a number of different fungal species. Some of these, such as *Pythium* species, *Fusarium* species and *Rhizoctonia solani*, are common soil fungi found wherever corn is grown. Some, such as *Fusarium moniliforme* and *Penicillium oxalicum*, may be either soilborne or seedborne.

Most of the seed rots and seedling blights on corn are more severe in wet soils, in low-lying areas in a field and in soils that have been compacted or remain wet for an extended period of time. Low soil temperatures (below 50-55 degrees F) favor seed rot and seedling blights. Disease severity is also affected by planting depth, soil type, seed quality, mechanical

injury to seed, crusting, herbicide injury or other mechanical factors that delay germination and emergence of corn. Residues left on the soil surface may influence the incidence and severity of seedling blight through their effect on soil temperature and soil moisture.

### Management options for seed rot and seedling blight

- Plant good quality seed under good seedbed conditions, especially at soil temperatures above 50-55 degrees F.
- Use fungicide-treated seed. Almost all commercial field corn seed comes with a fungicide treatment already applied to the seed. Bags should have labels that list the products applied to the seed and the rate of each material applied. Occasionally there may be a need to apply additional fungicide treatment or a combination insecticide plus fungicide treatment for added protection. See accompanying table of seed treatment fungicides labeled for use on field corn.

### Seed treatment fungicides for corn

Although seed treatment fungicides can be an effective means of preventing or reducing losses from various seedborne and soilborne microorganisms, there are several important laws or guidelines concerning fungicide-treated seed. Always read the pesticide label and follow all directions and restrictions on the label but in particular for seed treatment fungicides remember the following points.

- Do not use treated seed for food, feed or oil purposes.
- All treated seed must be colored with an EPA-approved dye that imparts an unnatural color to the seed.
- Federal law requires that bags containing treated seed shall be labeled with the following information: "This seed has been treated with (common chemical name of active ingredients) fungicide(s). Do not use treated seed for feed, food or oil purposes. Store away from feeds and food stuffs."

The following table was prepared using current product labels and manufacturers' Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

## Seed treatment fungicides labeled for use on field corn

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Allegiance Dry</b> Chemtura (formerly Trace Seed Protection Products)	metalaxyl	12.50%	1.5 to 2.0 oz per 100 lb of seed	For Pythium damping-off control.  For planters with electronic eye monitors, periodically clean them with brushes provided by the planter manufacturer, according to their directions.  Treat only those seeds needed for immediate use, minimizing the interval between treatment and planting.  Do not carry over excess treated seed to next season.  Do not use this product on seed that has been commercially treated with metalaxyl (Allegiance) fungicide.  Hopper box seed treatment.
<b>Allegiance-FL</b> Bayer CropScience	metalaxyl	28.35%	0.75 fl oz per 100 lb of seed	For Pythium damping-off control.  Allegiance-FL is a systemic fungicide seed dressing specifically for control of downy mildews, <i>Pythium</i> and <i>Phytophthora</i> spp. For control of other soilborne diseases, combination with Bayer CropScience Captan registered formulations is compatible. Do not use with other seed treatment products unless previous experience assures compatibility.  Reduced rates in combination with other fungicides: to aid in the control of seed decay and damping-off caused by <i>Pythium</i> , apply 0.10 to 0.375 fl oz per 100 lb of seed only in combination with EPA registered rates of Bayer CropScience broad-spectrum seed treatment fungicides.  Allegiance-FL may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment.
<b>Allegiance LS</b> Bayer CropScience	metalaxyl	17.70%	1.2 fl oz per 100 lb of seed	Allegiance LS is a systemic seed dressing specifically for control of downy mildews, <i>Pythium</i> and <i>Phytophthora</i> spp. For control of seedborne and other soilborne diseases, the combination of Bayer CropScience Captan and Thiram registered formulations are compatible. Do not use with other seed treatment products unless previous experience assures compatibility.  Reduced rates in combination with other fungicides: to aid in the control of seed decay and damping-off caused by <i>Pythium</i> , apply 0.175 to 0.66 fl oz per 100 lb of seed only in combination with EPA registered rates of Bayer CropScience broad-spectrum seed treatment fungicides.  Allegiance LS may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment. Allegiance LS may be applied at planting time by thoroughly mixing with seed in the planter box or by application through on-farm seed treatment equipment.
<b>Apron XL LS</b> Syngenta	mefenoxam	33.30%	0.32 to 0.64 fl oz per 100 lb of seed	Apron XL LS is a systemic fungicide seed dressing used specifically for protection against systemic downy mildews and diseases caused by soilborne <i>Pythium</i> and <i>Phytophthora</i> spp. When a rate range is specified, use higher rates of Apron XL LS when the disease pressure is expected to be high.  Apron XL LS may be applied in combination with Maxim, Maxim XL or captan products. See label for rates and information on using Apron XL LS in such combinations.  Apron XL LS may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment.
<b>Captan 400</b> Bayer CropScience	captan	37.40%	1.25 to 2.375 fl oz per 100 lb of seed	Captan 400 and Captan 400-C Seed Protectants are flowable concentrates especially formulated for treatment of seed prior to storage and planting to protect seed from molds and other fungi causing storage loss and to protect seed from seedborne and soilborne fungi that cause seed decay, damping-off and seedling blights.  Thoroughly mix the recommended amount of Captan 400 or Captan 400-C Seed Protectant into the required amount of water for the slurry treater equipment and dilution rate to be used. Not for use on agricultural establishments in hopper box, planter box, slurry box or other seed treatment applications at or immediately before planting.
<b>Captan 400-C</b> Bayer CropScience	captan	37.40%	1.25 to 2.375 fl oz per 100 lb of seed	

## Seed treatment fungicides labeled for use on field corn

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Concur</b> Winfield Solutions, LLC	imidacloprid metalaxyl	25.00% 1.00%	1.5 oz per 42 lb of seed	For the protection of seeds and seedlings of field corn against damping-off, seed decay caused by <i>Pythium</i> ; also for protection of seed against seed corn beetle, seed corn maggot, wireworm, white grub, flea beetle (up to first true leaf) and imported fire ants.  Concur may be used on seed previously treated with a full dosage of protective fungicide to give added protection against <i>Pythium</i> damping-off or seed decay.  Treat only those seeds needed for immediate use, minimizing the interval between treatment and planting. Do not store excess treated seed beyond planting time.  See label for rotational crop restrictions.  Hopper box seed treatment.
<b>Dithane DF Rainshield</b> Dow AgroSciences	mancozeb	75.00%	2.9 to 5.8 oz per 100 lb of seed	For control of damping-off, seed rots and seedling blights.  May be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.
<b>Dithane F-45 Rainshield</b> Dow AgroSciences	mancozeb	37.00%	4.3 to 8.6 fl oz per 100 lb of seed	
<b>Dithane M45</b> Dow AgroSciences	mancozeb	80.00%	2.7 to 5.4 oz per 100 lb of seed	
<b>Dynasty</b> Syngenta	azoxystrobin	9.60%	0.153 fl oz per 100 lb of seed	Target diseases: seedborne and soilborne fungi causing decay, damping-off and seedling blight as well as seedling damping-off ( <i>Rhizoctonia</i> spp., <i>Pythium</i> spp., <i>Fusarium</i> spp., and <i>Penicillium</i> spp.).  For optimum disease control, use Dynasty in combination with labeled rates of Maxim, Maxim XL and Apron XL products.  Apply as a water-based slurry using seed treatment application equipment that will provide uniform coverage on the seed surface.
<b>Kernel Guard Supreme</b> Chemtura (formerly Trace Seed Protection Products)	permethrin carboxin	10.42% 14.00%	1.5 oz canister per 42 lb of seed	Kernel Guard Supreme may be used on seed previously treated with a full dosage of protective fungicide, to give added protection against seedling blight, damping-off or seed decay.  Treat only those seed needed for immediate use, minimizing the interval between treatment and planting.  Hopper box seed treatment.
<b>Kodiak HB</b> Chemtura (formerly Trace Seed Protection Products)	<i>Bacillus subtilis</i>	0.30%	4.0 oz per 100 lb of seed	For suppression of root diseases caused by <i>Fusarium</i> and <i>Pythium</i> .  Contains bacteria that colonize the developing root system, suppressing disease organisms such as <i>Fusarium</i> and <i>Pythium</i> that attack root systems. When used with a chemical seed treatment, the combination of chemicals and Kodiak provides protection to the root for a much longer time than with chemicals alone.  Kodiak HB is a hopper box seed treatment.
<b>Latitude</b> Chemtura (formerly Trace Seed Protection Products)	imidacloprid carboxin metalaxyl	25.00% 14.00% 1.00%	1.5 oz per 42 lb of seed	For protection of seeds and seedlings against damping-off, seed decay and seedling blight caused by <i>Pythium</i> and <i>Rhizoctonia</i> . Also for protection of seed against seed corn beetle, seed corn maggot and wireworm.  Latitude may be used on seed previously treated with a full dosage of protective fungicide to give added protection against seedling blight, <i>Rhizoctonia</i> and <i>Pythium</i> damping-off or seed decay.  See label for rotational crop restrictions.  Hopper box seed treatment.
<b>Maxim 4FS</b> Syngenta	fludioxonil	40.30%	0.08 to 0.16 fl oz per 100 lb of seed	For protection against seedborne and soilborne fungi that cause seed decay, damping-off and seedling blight. Maxim 4FS is active against <i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Helminthosporium</i> and weakly pathogenic fungi such as <i>Aspergillus</i> and <i>Penicillium</i> . When rate ranges are given, use higher rate when disease pressure is expected to be severe.  Apply Apron XL LS seed treatment in combination with Maxim 4FS for protection against <i>Pythium</i> spp.

## Seed treatment fungicides labeled for use on field corn

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>MetaStar ST</b> Chemtura (formerly Trace Seed Protection Products)	metalaxyl	28.35%	0.75 fl oz per 100 lb of seed	For Pythium damping-off control.  MetaStar ST is a systemic fungicide seed dressing specifically for control of systemic downy mildews, <i>Pythium</i> and <i>Phytophthora</i> spp. For control of other soilborne diseases, combination of Captan and Vitavax registered formulations are compatible. Do not use with other seed treatment products unless previous experience assures compatibility.  MetaStar ST may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment.
<b>Penncozeb 4FL</b> Cerexagri	mancozeb	37.00%	4.3 to 8.6 fl oz per 100 lb of seed	For control of damping-off, seed rots and seedling blights. May be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.
<b>Penncozeb 75DF</b> Cerexagri	mancozeb	75.00%	2.9 to 5.8 oz per 100 lb of seed	
<b>Penncozeb 80WP</b> Cerexagri	mancozeb	80.00%	2.7 to 5.4 oz per 100 lb of seed	
<b>Prevail</b> Chemtura (formerly Trace Seed Protection Products)	carboxin PCNB metalaxyl	15.00% 15.00% 3.12%	1.5 to 3.0 oz per bushel of seed	For protection against Pythium and Rhizoctonia seedling disease complex.  Do not graze or feed livestock on treated areas for six weeks after planting.  Prevail may be applied at planting time, using an on-farm mechanical treater to maximize seed coverage.
<b>Raxil 2.6F</b> Bayer CropScience	tebuconazole	28.30%	0.075 to 0.10 fl oz per 100 lb of seed for soilborne and seedborne <i>Fusarium</i>  0.37 to 0.74 fl oz per 100 lb of seed for soilborne and seedborne head smut ( <i>Sphacelotheca</i> <i>reiliana</i> )	Apply as a seed treatment using standard slurry or mist-type seed treatment equipment. Uniform application of seed is necessary to ensure seed safety and best disease protection. Seed should be sound and well-cured prior to treatment.  Product should be diluted with sufficient water to ensure complete seed coverage. Add dye to the resulting slurry.  The length of control will vary depending on the rate used.  For use only by commercial seed treaters.
<b>42-S Thiram</b> Bayer CropScience	thiram	42.00%	1.5 fl oz per bushel of seed	Used according to directions, Bayer CropScience 42-S Thiram will usually increase stands and yields by reducing losses from seed decay, damping-off and seedling blights caused by many seedborne and soilborne organisms.  42-S Thiram should be applied with water as a suspension in the slurry-type treater specifically designed and approved for this use.
<b>Trilex</b> Bayer CropScience	trifloxystrobin	22.00%	0.32 to 0.64 fl oz per 100 lb of seed	Provides seed and seedling protection against seedborne fungi causing seed decay and the soilborne pathogen, <i>Rhizoctonia solani</i> . The length of control will vary depending on the rate used.  Apply as a seed treatment using standard slurry or mist-type seed treatment equipment.
<b>VITAFLO-280</b> Chemtura (formerly Trace Seed Protection Products)	carboxin thiram	14.90% 13.20%	4.5 fl oz per 100 lb of seed  8.5 to 11.5 fl oz per 100 lb of seed for protection against head smut ( <i>Sphacelotheca</i> <i>reiliana</i> )	Combination of a systemic fungicide (carboxin) and a contact fungicide (thiram) providing plant protection against seedborne and soilborne seedling diseases including damping-off and seed decay.  Do not graze or feed livestock on treated areas for six weeks after planting.  VITAFLO-280 can be diluted with water for use in slurry treaters. Use closed loading system. Not for use on agricultural establishments in hopper box, planter box, slurry box or other seed treatment applications at or immediately prior to planting.

## Corn foliage diseases

A number of fungi and a few bacteria can cause foliage diseases of corn. These various foliar pathogens cause leaf spots, leaf blights and similar symptoms on corn. Symptoms may range from the small, oval to elliptical water-soaked lesions of *Helicium* leaf spot to the long, elliptical, grayish-green or tan lesions of northern corn leaf blight. Lesion size, shape and color may vary among hybrids and with environmental conditions.

The fungi that cause most of these corn foliage diseases survive in infested corn residues left on the soil surface. The following growing season, spores are produced during moist periods and are carried by wind currents to susceptible corn leaves where infection may begin. Disease problems tend to be more severe when corn is planted in fields with infested corn residue left on the soil surface. Eventually spores that are produced in initial lesions on leaves are wind blown to other leaves or plants, causing secondary infection.

Common rust and southern rust of corn are two exceptions to this simplified explanation of disease development. The rust fungi do not survive in infested residues left in a field and, in fact, do not survive the winter months in Missouri. Rather, the rust fungi are reintroduced into this area each season when spores are carried on air currents from the southern United States.

Most of these foliage diseases of corn are favored by warm temperatures and wet or humid weather or heavy dews. They tend to start on the lower leaves and, if weather conditions are favorable, move up through the plant.

Generally, if foliage diseases do not become established until six weeks after tasseling, yield losses are minimal. If disease is established before tasseling or becomes severe within

two to three weeks after tasseling and pollination, significant yield losses may occur.

### Management options for corn foliage diseases

- Plant disease-resistant corn hybrids.
- Rotate crops with at least one year between corn crops.
- Manage corn residues. In reduced tillage systems, hybrid selection and crop rotation are especially important.
- Apply foliar fungicides if warranted. Foliar fungicides tend to give the best economic return on specialty corns such as seed corn, white corn or popcorn rather than on field corn. See accompanying table for foliar fungicides labeled for use on field corn.

### Foliar fungicides for corn

In addition to crop rotation, residue management and resistant hybrids, foliar fungicides can be used to control corn foliage diseases. Products labeled for use on field corn are listed in the following table. Fungicide labels do differentiate among field corn, popcorn, seed corn, sweet corn and processing sweet corn. Other products not listed in this table may be labeled for use on other types of corn.

The following table was prepared using current company product labels and manufacturers' Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

### Foliar fungicides labeled for use on field corn

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Bumper 41.8 EC</b> Makhteshim Agan	propiconazole	41.80%	2.0 to 4.0 fl oz per acre	For control of <i>Helminthosporium</i> leaf blights ( <i>Helminthosporium maydis</i> , <i>H. turcicum</i> , and <i>H. carbonum</i> ), apply 2.0 to 4.0 fl oz per acre. Apply when disease first appears and continue on a 7- to 14-day schedule. Use the low rate when disease pressure is low. Under heavy disease pressure or when conditions favor disease development, apply the high rate. Apply Bumper 41.8 EC at recommended rates by ground, air or chemigation.  For control of rusts ( <i>Puccinia</i> spp.), gray leaf spot and eye spot, apply 4.0 fl oz per acre. Apply Bumper 41.8 EC at recommended rates by ground, air or chemigation, when rust pustules first appear and continue on a 7- to 14-day schedule when conditions favor disease development. For best disease control, early applications at initial disease onset perform better.  Do not apply more than 16.0 fl oz of Bumper 41.8 EC per acre per season. Do not apply more than 8.0 fl oz of Bumper 41.8 EC per acre per season on field corn harvested for forage. Do not apply more than 0.45 lb a.i. propiconazole per acre per season.  Do not apply within 30 days of harvest for forage, grain and stover.
<b>Dithane DF Rainshield</b> Dow AgroSciences	mancozeb	75.00%	1.5 lb per acre	For control of common corn rust and <i>Helminthosporium</i> leaf blight on field corn and hybrid seed corn.
<b>Dithane F-45 Rainshield</b> Dow AgroSciences	mancozeb	37.00%	1.2 qt per acre	Start applications when disease symptoms first appear and, depending on severity of infection, continue on a 4- to 14-day schedule. The addition of Latron CS-7 will improve performance.
<b>Dithane M45</b> Dow AgroSciences	mancozeb	80.00%	1.5 lb per acre	Amount of product that can be applied over course of season will vary with formulation — see label.  Do not apply within 40 days of harvest.

## Foliar fungicides labeled for use on field corn

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Folicur 3.6 F</b> Bayer CropScience	tebuconazole	38.70%	4.0 to 6.0 fl oz per acre	<p>For control of rust (<i>Puccinia</i> spp.), northern leaf blight, southern leaf blight, northern leaf spot and gray leaf spot.</p> <p>Apply Folicur 3.6 F in a protective spray schedule or when weather conditions are favorable for disease development. Repeat applications at 7- to 14-day intervals or as necessary to maintain control.</p> <p>For optimum disease control, the lowest labeled rate of a spray surfactant should be tank-mixed with Folicur 3.6 F. Folicur 3.6 F must have at least two hours of drying time on corn foliage for the active ingredient to move systemically into plant tissue before rain or irrigation occurs. After this time period, Folicur 3.6 F will be resistant to weathering.</p> <p>A maximum of 24.0 fl oz (1.5 pt) of Folicur 3.6 F may be applied per acre per season.</p> <p>Restricted-entry interval (REI) for field corn is 12 hours.</p> <p>For field corn: Folicur 3.6 F may be applied up to 21 days before the harvest of forage and 36 days before the harvest of grain or fodder.</p>
<b>Headline</b> BASF	pyraclostrobin	23.60%	6.0 to 9.0 fl oz per acre or 9.0 to 12.0 fl oz per acre	<p>The 6.0 to 9.0 fl oz per acre rate targets common rust, southern rust and gray leaf spot.</p> <p>The 9.0 to 12.0 fl oz per acre rate targets anthracnose, northern corn leaf blight, northern corn leaf spot, Physoderma brown spot, southern corn leaf blight and yellow leaf blight.</p> <p>For optimal disease control, begin applications of Headline prior to disease development and continue on a 7- to 14-day interval if conditions are conducive for disease development. Use the higher rate and shorter interval when disease pressure is high. The optimal application timing for Headline in corn is VT through R2 stages (full tassel through blister) and/or the onset of disease.</p> <p>An adjuvant may be used with Headline only after corn reaches the VT stage or later. Do not use adjuvants prior to the VT stage. Prior to the VT stage, do not combine other products or additives with Headline. At the VT stage or later, Headline may be mixed with other products. Consult the label for products tank mixed with Headline.</p> <p>See label for information on resistance management.</p> <p>Minimum time from last application to harvest (PHI) is seven days.</p>
<b>Manzate Pro-Stick</b> DuPont	mancozeb	75.00%	1.5 lb per acre	<p>For control of common rust, Helminthosporium leaf blight and gray leaf spot on field corn and field corn for hybrid seed production.</p>
<b>Manzate Flowable</b> Griffin L.L.C.	mancozeb	37.00%	1.2 qt per acre	<p>Use sufficient water for thorough coverage. Start applications when disease first appears and repeat at 4- to 7-day intervals.</p> <p>Do not apply more than 15 lb or 12 qt per acre per season.</p> <p>Do not feed treated forage to livestock.</p> <p>Do not apply within 40 days of harvest.</p>
<b>Orius 3.6F</b> Makhteshim Agan	tebuconazole	38.70%	4.0 to 6.0 fl oz per acre	<p>Target diseases: rust (<i>Puccinia</i> spp.), northern leaf blight, southern leaf blight, northern leaf spot and gray leaf spot.</p> <p>Apply Orius 3.6F in a protective spray schedule or when weather conditions are favorable for disease development. Repeat applications at 7- to 14-day intervals, or as necessary to maintain control.</p> <p>For optimum disease control, the lowest labeled rate of a spray surfactant should be tank-mixed with Orius 3.6F. Orius 3.6F must have two to four hours of drying time on corn foliage for the active ingredient to move systemically into plant tissue before rain or irrigation occurs. After this period of time Orius 3.6F will be resistant to weathering.</p> <p>A maximum of 24 fl oz (1.5 pt) of Orius 3.6F may be applied per acre per season.</p> <p>Restricted-entry interval (REI) for all corn except sweet corn is 12 hours.</p> <p>For field corn: Orius 3.6F may be applied up to 21 days before the harvest of forage and 36 days before the harvest of grain or fodder.</p>

## Foliar fungicides labeled for use on field corn

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Penncozeb 4FL</b> Cerexagri	mancozeb	37.00%	0.8 to 1.2 fl oz per acre	For control of common rust, gray leaf spot and Helminthosporium leaf blight on field corn and corn grown for seed.
<b>Penncozeb 75DF</b> Cerexagri	mancozeb	75.00%	1.0 to 1.5 lb per acre	Start application at the onset of disease and repeat as needed. Amount of product that can be applied over course of season will vary with formulation — see label.
<b>Penncozeb 80WP</b> Cerexagri	mancozeb	80.00%	1.0 to 1.5 lb per acre	Do not apply within 40 days of harvest.
<b>PropiMax EC</b> Dow AgroSciences	propiconazole	41.80%	2.0 to 4.0 fl oz per acre	For control of Helminthosporium leaf blights ( <i>Helminthosporium maydis</i> , <i>H. turcicum</i> and <i>H. carbonum</i> ), rusts ( <i>Puccinia</i> spp.), gray leaf spot ( <i>Cercospora zeae maydis</i> ), and eye spot ( <i>Kabatella zeae</i> ), apply PropiMax EC by ground, aerial or chemigation equipment.  Helminthosporium leaf blights: apply PropiMax EC at the rate of 2.0-4.0 fl oz per acre when disease first appears. Continue on a 7- to 14-day schedule. Use the low rate when disease pressure is low. Apply the high rate under heavy disease pressure or if conditions are favorable for disease.  Rusts, eye spot and gray leaf spot: apply PropiMax EC at the rate of 4.0 fl oz per acre when disease first appears. If conditions favorable for disease persist, continue to apply on a 7- to 14-day schedule. For best disease control, early applications at initial disease onset perform better.  Do not apply more than 16.0 fl oz of PropiMax EC per acre per season. Do not apply more than 8.0 fl oz of PropiMax EC per acre per season on field corn harvested for forage.  Do not apply within 30 days of harvest for forage, grain and stover.
<b>Quadris</b> Syngenta	azoxystrobin	22.90%	6.0 to 15.5 fl oz per acre	Target diseases: rust ( <i>Puccinia sorghi</i> ), anthracnose leaf blight, gray leaf spot, northern corn leaf blight, northern corn leaf spot, southern corn leaf blight and eye spot.  See label for information on integrated pest management and resistance management.  Application directions: for gray leaf spot apply Quadris at the onset of disease. A second application may be required 14 days later if disease pressure persists. For all other diseases, Quadris applications should begin before disease development and may continue throughout the season every 7 to 14 days following the resistance management guidelines. Applications may be made by ground, air or chemigation. An adjuvant may be added at recommended rates.  Do not apply more than 3.75 qt per acre per season.  Do not apply within 7 days of harvest.  Quadris is extremely toxic to certain apple varieties. See “General Use Instructions” on the label for additional information on safety precautions to avoid injury to apple trees.
<b>Quilt</b> Syngenta	azoxystrobin propiconazole	7.00% 11.70%	7.0 to 14.0 fl oz per acre for northern corn leaf blight, northern corn leaf spot and southern corn leaf blight  10.5 to 14.0 fl oz per acre for rusts, gray leafspot and eye spot	For leaf blights apply Quilt when disease first appears. Continue on a 7- to 14-day schedule. Use the low rate when disease pressure is low. Under heavy disease pressure or if conditions are favorable for disease apply the high rate.  Apply no more than two applications of Quilt or any other Group 11 fungicide per year.  Quilt is most effective when applied and allowed to dry before a rainfall. For best results, sufficient water volume should be used to provide adequate coverage.  Quilt may be applied by ground, air or chemigation.  Do not apply to field corn and field corn grown for seed after brown silk.  Do not apply within 30 days of harvest for forage, grain or stover.  Do not apply more than 56.0 fl oz per acre per season of Quilt.  Quilt is extremely toxic to certain apple varieties. See “General Use Instructions” on label for additional information on safety precautions to avoid injury to apple trees.

## Foliar fungicides labeled for use on field corn

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Stratego</b> Bayer CropScience	propiconazole trifloxystrobin	11.40% 11.40%	7.0 to 10.0 fl oz per acre for rust ( <i>Puccinia sorghi</i> )  10.0 to 12.0 fl oz per acre for eye spot, gray leaf spot or Helminthosporium leaf blights	Applications may be made to corn between the V4 (4-leaf) to after silking growth stages.  Apply when disease first appears and continue on a 7- to 14- day interval if favorable conditions for disease development persist.  Use the higher rates and shorter intervals when disease pressure is severe.  Do not apply Stratego to field corn and field corn grown for seed after silking.  Do not apply more than 24.0 fl oz of Stratego per acre per crop. Do not apply more than two sequential applications of Stratego. Limit the number of Stratego or other Group 11 containing fungicide applications to no more than two per acre per crop.  Do not graze or harvest for forage within 30 days of application.
<b>Tilt</b> Syngenta	propiconazole	41.80%	2.0 to 4.0 fl oz per acre	Northern corn leaf blight, northern corn leaf spot and southern corn leaf blight (also known as Helminthosporium leaf blights): 2.0 to 4.0 fl oz per acre. For leaf blights apply Tilt when disease first appears. Continue on a 7- to 14- day schedule. Use the low rate when disease pressure is low. Under heavy disease pressure or if conditions are favorable for disease, apply the high rate.  Rusts ( <i>Puccinia</i> spp.), gray leaf spot and eye spot: 4.0 fl oz per acre. Apply Tilt when disease first appears. If conditions favorable for disease persist, continue to apply on a 7- to 14-day schedule. For best disease control, early applications (at initial disease onset) perform better.  Tilt is most effective when applied and allowed to dry before a rainfall. For best results, sufficient water volume should be used to provide thorough coverage. Tilt may be applied by ground, air or chemigation.  Do not apply more than 16.0 fl oz per acre per season of Tilt. Do not apply more than 8.0 fl oz per acre per season of Tilt on field corn harvested for forage.  Do not apply within 30 days of harvest for forage, grain and stover.

## Corn virus diseases

**Maize dwarf mosaic** is a virus disease of corn that is spread by several species of aphids. Although the symptoms of maize dwarf mosaic are highly variable, the most common symptom is a light green to yellow mottling or mosaic pattern in the leaf tissue.

Scattered, individual plants with symptoms of maize dwarf mosaic may be found in most years. Periodically, weather conditions favor the large-scale movement of virus-carrying aphids from southern regions of the United States. These aphids may then “rain out” or be deposited in large numbers in fields in Missouri or more northern areas of the Corn Belt. Under these conditions, maize dwarf mosaic virus may be prevalent and serious over a significant acreage.

Maize dwarf mosaic is caused by several strains of the maize dwarf mosaic virus (MDMV). Corn and sorghum are the main crop hosts of MDMV; however, johnsongrass and other wild grasses are also hosts. Some strains of MDMV overwinter in johnsongrass and are spread from the johnsongrass to corn by the aphid vectors. More than 15 species of aphids can transmit MDMV.

Many commercial corn hybrids have high levels of tolerance to MDMV.

**Maize chlorotic dwarf** is caused by a virus that is spread by the leafhopper, *Graminella nigrifrons*. Again, symptoms of maize dwarf chlorotic are highly variable. The most characteristic symptom of maize chlorotic dwarf is veinbanding or veinclearing, but other symptoms that may occur include

reddening or yellowing of leaf tissue, distortion of leaf tissue and shortening of the upper internodes of the plant.

The maize dwarf chlorotic virus can overwinter in johnsongrass. It is transmitted to corn by its leafhopper vector. Although proso millet, pearl millet, sorghum, Sudan grass and wheat are also hosts of the maize chlorotic dwarf virus, corn appears to be the principal host in the field.

### Management options for corn virus diseases

- Plant resistant or tolerant hybrids.
- Plant early.
- Maintain good weed control, especially of johnsongrass.
- In some cases, control of the insect vectors through application of an appropriate insecticide may be warranted.

## Crazy top of corn

Crazy top of corn is caused by the downy mildew fungus, *Sclerophthora macrospora*. The pathogen is a soilborne fungus that causes infection when corn plants are subjected to saturated soil conditions for 24 to 48 hours from planting to about the five-leaf stage of growth.

The disease causes a deformation of plant tissues, including excessive tillering and rolling or twisting of leaves. On severely infected plants, leaves may be narrow and straplike. There may be a proliferation of the tassel until it resembles

a mass of leafy structures. Plants may produce numerous ear shoots. Infected plants are frequently stunted.

In seasons with wet springs, young corn plants subjected to saturated soil conditions may show symptoms of crazy top. Occasionally a band of affected plants may encircle a drowned out spot in a field. Some hybrids may be more susceptible to crazy top. This disease is seldom severe enough to cause significant losses.

**Management options for crazy top**

- Provide good soil drainage.

**Stewart’s bacterial wilt of corn**

Stewart’s bacterial wilt of corn is caused by the bacterium *Erwinia stewartii* and is spread by corn flea beetles. Foliage symptoms include linear, pale green to yellow streaks that tend to follow the veins of leaves and originate from feeding marks of the corn flea beetle. These streaks soon become dry and brown and tend to be irregular and vary in size and shape.

The bacterium that causes Stewart’s bacterial wilt overwinters in the guts of corn flea beetles. Adult corn flea beetles feed on corn seedlings in late spring and early summer and contaminate the feeding wounds with the bacterium. Warm winter weather conditions favor the survival of the corn flea beetle and disease development the following spring. Cold winters reduce beetle populations and limit disease development and spread.

Although the foliage symptoms of Stewart’s bacterial wilt are common on field corn in Missouri, the damage is seldom of economic significance. Stewart’s bacterial wilt can be especially destructive on some sweet corn hybrids and corn inbreds.

**Management options for Stewart’s bacterial wilt**

- Plant resistant hybrids. Most commercial field corn hybrids have good tolerance to Stewart’s bacterial wilt.
- Maintain good weed control in and around corn fields.
- Although insecticide applications to control the flea beetle vector may be warranted on sweet corn and corn inbreds, decisions to treat flea beetles on field corn should be based more on direct insect feeding damage than potential damage from Stewart’s bacterial wilt.

**Common smut of corn**

Common smut caused by the fungus *Ustilago maydis* results in the formation of galls on the aboveground portions of the corn plant. Initially the galls are firm and silver to grayish white in color throughout. As the galls age, the center of the gall turns into a mass of powdery, black spores while the outer covering of the gall remains silver to grayish white.

The black, resting spores (known as chlamydospores or teliospores) fall from the smut galls to the soil where they overwinter. The spores may be spread by surface drainage water, farm machinery, insects and wind. Under favor-

able conditions, the resting spores germinate and produce another type of spores (sporidia) which are spread by wind or splashing water to young, actively dividing corn tissues. Moisture is needed for the spores to germinate and penetrate the host, so rainfall or humid conditions are assumed to be critical during this phase of the disease cycle. The spores of the common smut fungus are able to infect only tissue that has been damaged by insects, hail, blowing soil particles, herbicides, detasseling or other factors, or young meristematic tissues (such as young silks, young cob tissues and young developing kernels). Visible galls may develop within a few days of infection.

Common smut usually causes only small yield losses (less than 2 percent), but in rare years it may cause yield losses of 10 percent or more depending on where gall formation occurs and the number of ears infected.

**Management options for common smut**

- Plant tolerant or resistant hybrids.
- Avoid mechanical injury to plants.
- Maintained balanced fertility. Excessive nitrogen tends to increase disease incidence and severity.

**Corn nematodes**

Several species of nematodes, or microscopic roundworms, can cause damage on corn. Some corn nematode species spend most of their lives in the soil, while others live mostly in the roots. During feeding nematodes may directly harm plants or they may cause wounds through which fungi and bacteria can enter plants and cause secondary rots.

**Corn nematodes**

lesion nematode	<i>Pratylenchus</i> spp.
stunt nematode	<i>Tylenchorhynchus</i> spp.
lance nematode	<i>Hoplolaimus</i> spp.
spiral nematode	<i>Helicotylenchus</i> spp.
ring nematode	<i>Criconemella</i> spp.
dagger nematode	<i>Xiphinema</i> spp.
root-knot nematode	<i>Meloidogyne</i> spp.
stubby-root nematode	<i>Paratrichodorus</i> spp.
needle nematode	<i>Longidorus breviannulatus</i>
sting nematode	<i>Belonolaimus</i> spp.

The presence of nematodes in a field depends on the soil type and its properties, other soil microorganisms, cropping history, tillage, the use of pesticides and climatic factors such as temperature and rainfall. Although damage can occur in any soil type, corn growing in well-drained soils, especially sandy soils, is most susceptible to damage. In poorly drained soils, nematode populations usually increase slowly or may even decline. The extent of nematode damage is often related to the growing conditions of the plant. Corn that is stressed by poor fertility or lack of moisture cannot withstand the additional stress of nematode feeding and will show more pronounced symptoms.

It is difficult to generalize about the symptoms caused by nematodes because they vary with the nematode species, the number of nematodes present and the soil environmental factors. Aboveground symptoms are due to nematode injury

to the roots. Early-season symptoms may include stunting or off-color leaves. Symptoms later in the season include a ragged or uneven appearance to the field, lodging, general unthriftness and reduced yields. Common evidence of nematode feeding on roots includes root pruning, especially of feeder roots, proliferation of fibrous roots, thickening or swelling of the smaller roots, and slight to severe discoloration of roots. Damage may be localized in one part of a field or spread over large areas of a field.

Because nematodes cannot be seen with the naked eye and because symptoms of nematode injury are easily confused with other types of corn production problems, nematode problems should be diagnosed by submitting soil and root samples to a laboratory qualified to run a nematode analysis on the samples.

### Management options for corn nematodes

- Rotate to a crop other than corn in fields with nematode problems. The length of the rotation may vary with nematode species and population levels.
- Maintain good weed control.
- Fertilize according to soil test recommendations, because corn suffering from improper fertility is more susceptible to injury from nematodes.
- Although several nematicides are labeled for use on corn, economic and environmental concerns limit their use.

### Corn stalk rots

Stalk rots are important worldwide and are among the most destructive diseases of corn. A number of different fungi and bacteria cause stalk rots of corn. Although many of these pathogens cause distinctive symptoms, certain general symptoms are common to all stalk rot diseases. Early symptoms, which occur a few weeks after pollination, usually start with premature dying of bottom leaves. Eventually, the entire plant may die and appear light green to gray. Diseased stalks usually begin losing firmness during August. The cells in the interior of the stalk are dissolved, resulting in a loss of stalk firmness and strength. Stalks may then lodge, particularly if harvest is delayed or wind storms occur.

Stalk rots are caused by several different fungi and bacteria that are part of the complex of microorganisms that decompose dead plant material in the soil. They survive from one growing season to the next in soil, in infested corn residues or on seed. Stalk rot pathogens enter the corn plant in a variety of ways. The spores may be blown into the base of the leaf sheath, where they may germinate and grow into the stalk. Spores may enter directly into a plant through wounds made by corn borers, hail or mechanical injury. When fungi are present in soil or infested residue as either spores or mycelium, they may infect the root system, causing root rot early in the growing season and later grow up into the stalk causing stalk rot.

Stalk rot becomes a problem when plants are stressed during the grain filling stage of development. Water shortage, extended periods of cloudy weather, temperature stresses, hail damage, corn borer infestation, low potassium

in relation to nitrogen, leaf diseases and other stresses that occur in August and September may be associated with an increase in stalk rot.

Losses from stalk rots vary from season to season and from region to region. Yield losses of 10 to 20 percent may occur on susceptible hybrids. Tolls greater than 50 percent have been reported in localized areas. Losses may be direct losses due to poor filling of the ears or lightweight and poorly finished ears or indirect through harvest losses because of stalk breakage or lodging. Harvest losses may be reduced if fields are scouted 40 to 60 days after pollination to check for symptoms of stalk rot. Stalk rot can be detected by either pinching stalks or pushing on stalks. If more than 10 to 15 percent of the stalks are rotted, the field should be harvested as soon as possible.

### Management options for corn stalk rots

- Select hybrids with good stalk strength and lodging characteristics.
- Plant at recommended plant populations for that hybrid.
- Follow proper fertility practices.
- Maintain good insect and weed control.
- If irrigating, try to deliver optimum water from silking to late dough stage.
- Avoid or minimize stress to corn (especially during pollination and grain fill).
- Harvest in a timely manner.

### Ear and kernel rots of corn

A number of fungi can invade and cause damage to corn ears or kernels. Field fungi invade the kernels before harvest while the corn is still in the field. These fungi may affect the appearance and quality of kernels. Usually damage caused by field fungi occurs before harvest, can be detected by routine inspection of corn in the field and does not continue to develop in storage if the grain is stored at proper moisture content and temperature. Some of the field fungi on corn in Missouri include species of *Alternaria*, *Cladosporium*, *Aspergillus*, *Penicillium*, *Diplodia*, *Fusarium* and *Gibberella*. Most of these fungi are more prevalent when rainfall is above normal from silking to harvest. One exception is *Aspergillus flavus*, which is favored by drought stress to corn during pollination and by warm temperatures as kernels mature. For all field fungi, damage tends to be more severe on ears with insect, bird or hail damage. Ears well covered by husks and maturing in a downward position usually have less rot than ears with open husks or ears maturing in an upright position. Some of these fungi, in particular species of *Penicillium* and *Aspergillus*, can also be problems on corn in storage. If grain is not stored at the proper moisture content and temperature, these fungi can cause extensive damage to the stored grain.

### ***Mycotoxins associated with ear and kernel rots of corn***

An additional concern with ear and kernel rots of corn is the possibility of mycotoxin production. Mycotoxins are naturally produced chemicals that in small amounts may be deleterious to animal or human health. Three genera of fungi – *Aspergillus*, *Penicillium* and *Fusarium* (*Gibberella*) – are most frequently involved in cases of mycotoxin contamination in corn. The presence of molds or their spores on or in corn does not necessarily mean that mycotoxins will be produced. Circumstances that favor mold growth may allow production of mycotoxins in some situations but frequently mold growth occurs with little or no mycotoxin production. Once formed, mycotoxins are stable and may remain in grain long after the fungus has died. In general, swine and poultry are more susceptible than ruminants to mycotoxin-induced health problems at an equivalent dosage. Where mycotoxin problems are suspected, a sample should be submitted to a qualified laboratory for mycotoxin analysis.

Little can be done to prevent or reduce the invasion of corn by field fungi. However, the following recommendations should help minimize damage from field fungi on corn, especially corn going into storage.

### **Management options for corn ear and kernel rots**

- Plant locally adapted hybrids with husks that close over ear tips.
- Plant at recommended plant populations for that hybrid and maintain good plant vigor over the growing season.
- Use a balanced fertility program.
- Select planting dates appropriate for your area.
- Follow recommended management practices to limit damage by ear feeding insects.
- If irrigating, try to deliver optimum water from silking to late dough stage.
- Harvest in a timely fashion.
- Adjust the harvesting equipment for minimum kernel damage and maximum cleaning.
- Clean the grain and bins thoroughly before storage to remove dirt, dust and other foreign matter, crop debris, chaff and cracked or broken kernels.
- Store grain in watertight structures that are free from insects and rodents.
- Store grain at proper moisture content and temperature.
- Monitor grain on a regular basis throughout storage life to ensure moisture content and temperature are maintained at correct levels.

## Grain sorghum diseases and their management

Grain sorghum diseases can and do occur each year in Missouri. Problems with germination and stand establishment that are related to seed decay, damping-off and seedling blights are often encountered in the field. These losses can be costly, especially if replanting is necessary. Diseases may cause leaf spots or leaf blights, wilts or premature death of plants. Sorghum diseases also can cause harvest losses, affect the quality of the harvested crop and cause storage losses. The extent of the damage due to sorghum diseases in a given season depends on a number of factors including the susceptibility of the sorghum cultivar to the specific disease, the level of pathogen inoculum present and the environmental conditions during that season.

To minimize losses due to sorghum diseases, it is important to correctly identify the disease or diseases present so that appropriate management steps can be taken. The principal diseases of sorghum in Missouri can be divided into seed and seedling diseases, foliage diseases, root and stalk rot diseases, head blights and molds and a few miscellaneous diseases. Descriptions and management strategies for each of these categories of sorghum diseases are given below. For additional information see MU publication G4356, *Management of Grain Sorghum Diseases in Missouri*.

### Seed and seedling diseases

There are a number of pathogens that live in the soil or can be carried on or in seed that can cause seed and seedling diseases of sorghum. The symptoms may include discolored and/or rotted seed, seedlings may show a general rotting, they may have discolored embryos, leaves and roots or they may die. Stands may be thin and uneven.

Seed and seedling diseases tend to be more severe in poorly drained soils. They may be more severe if prolonged periods of wet, cool weather follow planting or if hot weather occurs when seedlings are emerging and secondary roots are developing.

#### Management options for sorghum seed and seedling diseases

- Plant high-quality seed that is free of undersized, cracked or discolored kernels.

- Plant in good seedbed conditions, especially in warm (above 70 degrees F), well-drained soils.
- Plant into fertile soils that have a pH of 6.0 to 6.5. Plants growing in low pH soil (e.g., pH 5.0) are more likely to be infected by *Fusarium* sp.
- Avoid excessively high plant populations.
- Use fungicide seed treatments. Almost all commercial grain sorghum seed comes with a fungicide treatment already applied to the seed. Seed bags should have labels that list the products applied to the seed and the rate of each material applied. Occasionally there may be a need to apply additional fungicide treatment or a combination of insecticide plus fungicide treatment for added protection. See accompanying table of seed treatment fungicides labeled for use on grain sorghum.

### Seed treatment fungicides for grain sorghum

Although seed treatment fungicides can be an effective means of preventing or reducing losses from various seed- and soilborne microorganisms, there are several important laws or guidelines concerning fungicide-treated seed. Always read the pesticide label and follow all directions and restrictions on the label; for seed treatment fungicides in particular, remember the following points.

1. Do not use treated seed for food, feed or oil purposes.
2. All treated seed must be colored with an EPA-approved dye that imparts an unnatural color to the seed.
3. Federal law requires that bags containing treated seed shall be labeled with the following information: "This seed has been treated with (common chemical name of active ingredients) fungicide(s). Do not use treated seed for feed, food or oil purposes. Store away from feeds and food stuffs."

The following table was prepared using current company product label books and Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

## Seed treatment fungicides labeled for use on grain sorghum

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Allegiance FL</b> Bayer	metalaxyl	28.35%	0.375 to 0.75 fl oz per 100 lb of seed	For control of Pythium damping-off.
<b>Apron XL or XL LS</b> Syngenta	mefenoxam	33.30%	0.32 to 0.64 fl oz per 100 lb of seed	For Pythium damping-off protection on all sorghum cultivars use 0.32 to 0.64 fl oz per 100 lb of seed. For Pythium damping-off protection when disease pressure is expected to be low apply Apron XL LS as a seed treatment at 0.085 to 0.32 fl oz per 100 lb of seed in combination with Maxim or Captan products at label rates.  For systemic downy mildew protection apply 0.32 to 0.64 fl oz per 100 lb of seed on cultivars that possess downy mildew resistance. To those cultivars that do not possess resistance to a particular race of downy mildew grown in areas with recent history of severe disease, apply 1.28 fl oz of Apron XL LS per 100 lb of seed. Seed treated with the 1.28 fl oz rate should be planted and not carried over to the following year.  Only high-quality sorghum seed (90 percent germ and above) should be treated with Apron XL LS.  Apron XL LS may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry- or mist-type commercial seed treatment equipment.
<b>Dithane F-45 Rainshield</b> Dow AgroSciences	mancozeb	7.00%	4.3 to 7.2 fl oz per 100 lb of seed	For control of covered kernel smut, damping-off, seed rots and seedling blights.  May be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.
<b>Dithane M45</b> Dow AgroSciences	mancozeb	80.00%	2.7 to 4.5 oz per 100 lb of seed	
<b>Manex</b> DuPont	maneb	37.00%	4.3 to 7.2 fl oz per 100 lb of seed	For protection against covered kernel smut, damping-off, seed rots and seedling blights.  Manex may be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.
<b>Manzate Pro-Stick</b> DuPont	mancozeb	75.00%	2.7 to 4.5 oz per 100 lb of seed	For protection against covered kernel smut, damping-off, seed rots and seedling blights.
<b>Manzate Flowable</b> DuPont	mancozeb	37.00%	4.3 to 7.2 fl oz per 100 lb of seed	For commercial seed treatments, seeds should be clean and well-cured before treatment. Apply to dry seed with conventional slurry or mist seed treating equipment.  Manzate Pro-Stick may also be applied as planter box applications.
<b>Maxim 4FS</b> Syngenta	fludioxonil	40.30%	0.08 to 0.16 fl oz per 100 lb of seed	For protection against seedborne and soilborne fungi that cause seed decay, damping-off and seedling blight. Maxim 4FS is active against <i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Helminthosporium</i> and weakly pathogenic fungi such as <i>Aspergillus</i> and <i>Penicillium</i> . When rate ranges are given, use higher rate when disease pressure is expected to be severe.  Apply Apron XL LS seed treatment in combination with Maxim 4FS for protection against <i>Pythium</i> spp. See label for additional information of the addition of Apron XL LS to control downy mildew of sorghum.
<b>Penncozeb 75DF</b> Cerexagri	mancozeb	75.00%	2.9 to 4.8 oz per 100 lb of seed	May be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.
<b>Penncozeb 80WP</b> Cerexagri	mancozeb	80.00%	2.7 to 4.5 oz per 100 lb of seed	
<b>Vortex</b> Bayer CropScience	ipconazole	40.7%	0.051 to 0.17 fl oz per 100 lb of seed	For protection against seedborne and soilborne fungi, which cause seed decay, damping-off and seedling blight.

### Foliage diseases

Sorghum is susceptible to a large number of both fungal and bacterial foliage diseases. Symptoms range from small, insignificant spots and stripes on leaves to extensive damage of large areas of leaf tissue that may result in premature death of leaves and even entire plants. Diagnosing specific leaf diseases on sorghum can be difficult because cultivars respond differently to the same pathogen, symptoms may vary with environmental conditions and several foliage diseases may occur on the same leaf at the same time. Severity

of these foliage diseases depends on the specific disease, the susceptibility of the cultivar and the weather conditions during the growing season. Foliage diseases are usually favored by warm temperatures and wet weather or high humidity.

Fungal foliage diseases of sorghum in Missouri include anthracnose, leaf blight, gray leaf spot, zonate leaf spot, rough spot and sooty stripe. Symptoms range from small, circular to elliptical spots to large elongated spots that may extend several inches in length. Symptoms usually develop on lower, older leaves first.

Zonate leaf spot, caused by the fungus *Gloeocercospora sorghi*, forms circular lesions that have concentric bands of reddish brown and light tan. These lesions have irregular borders and usually develop along the leaf margins. Both leaf blades and leaf sheaths may be infected. Zonate leaf spot is favored by wet conditions. When it develops early in the season on young plants, defoliation and even death of plants may occur. If disease is severe late in the season loss of leaf tissue can lead to poorly filled seed. The fungus that causes zonate leaf spot of sorghum can also affect corn, millet and numerous other grasses. The pathogen forms survival structures called sclerotia in infected leaf tissue of sorghum, millet and other grass hosts.

The initial symptoms of rough leaf spot of sorghum are small, somewhat circular to oblong, reddish lesions with well-defined margins. As the lesions mature fruiting bodies of the causal fungus, *Ascochyta sorghina*, develop in the lesions. These pycnidia are evident as small black bumps or specks within the infected tissue. As the disease progresses, lesions may merge killing larger areas of leaf tissue. Rough leaf spot is favored by wet weather. The fungus that causes this leaf spot on sorghum has also been found on sudangrass, johnsongrass and other wild sorghum species. It survives in infested crop residues of sorghum and perennial weed hosts.

Bacterial foliage diseases of sorghum include bacterial spot, bacterial streak and bacterial stripe. Bacterial spot tends to produce water-soaked elliptical spots on leaves. Bacterial streak and bacterial stripe both result in long, narrow stripes on leaves. Lesions from all three bacterial foliage diseases tend to have a reddish color or reddish margin.

#### Management options for foliage diseases of sorghum

- Plant disease-free seed of locally adapted, resistant cultivars.
- Rotate crops with at least one year out of susceptible crops.
- Manage crop residues.
- Eliminate alternate or weed hosts of these diseases, especially weed grasses such as johnsongrass.
- Use a foliar application of Quadris if needed.

### Root and stalk rot diseases

Several root and stalk rot diseases occur on sorghum. These diseases are usually most evident late in the season as plants are maturing. Stalk rots likely to occur on sorghum in Missouri include charcoal rot, Fusarium stalk rot, anthracnose or Colletotrichum stalk rot and Rhizoctonia stalk rot. Stalks tend to be soft, discolored and deteriorated. Plants may die prematurely. Lodging may be a problem in fields with high levels of stalk rot. Stress to plants at flowering and grain-filling stages may increase the incidence and severity of stalk rots.

The charcoal rot fungus, *Macrophomina phaseolina*, can cause seedling blight, damping-off and dry rot early in the season. Later in the season symptoms include root rot with infected roots turning brown or black and stalk rot with stalks becoming soft and spongy. Plants tend to lodge. If infected

plants are split open, the pith usually shows signs of deterioration and small, dark sclerotia (survival structures of the fungus) are evident in the disintegrating tissues. Charcoal rot is favored by high soil temperatures (95 to 98 degrees F) and low soil moisture. The fungus that causes charcoal rot of sorghum can also infect corn and soybean.

Fusarium root and stalk rot may begin as small, circular to elongate, light red to dark purple lesions on roots, seed, stalks and peduncles. Plants with insect damage or other injuries may show more severe symptoms of Fusarium root and stalk rot. Leaves may turn off color or gray-green and plants may die prematurely. When stalks are split open, the lowest internodes may have large areas of pith that is reddish in color and the upper internodes may show a red to reddish brown discoloration of the vascular bundles. Lodging may occur.

#### Management options for root and stalk rots of sorghum

- Select cultivars with good stalk strength and tolerance to stalk rots.
- Plant at proper plant populations.
- Provide adequate moisture at planting and adequate irrigation through season.
- Maintain balanced soil fertility.
- Control weeds.
- Harvest in timely fashion to minimize lodging and harvest losses.

### Miscellaneous diseases of sorghum

**Crazy top**, caused by the fungus *Sclerophthora macrospora*, is another disease likely to occur in sorghum in wet seasons. This disease develops on young seedlings growing in saturated soils. The first symptom of crazy top is a mottled yellowing of the leaves. Leaves become thickened and puckered, and plants may tiller excessively. Infected plants may be stunted and have a bunched appearance. Diseased plants typically either do not produce heads or produce barren heads.

#### Management options for crazy top of sorghum

- Plant cultivars tolerant to crazy top if available.
- Land prone to flooding should not be planted to sorghum unless adequate drainage is provided.

**Maize dwarf mosaic virus (MDMV)** is the most common virus disease of sorghum in Missouri. MDMV produces a distinct mottling of the leaf tissue. Infected leaves have a light green to yellow mottled pattern. Symptoms are most evident on young leaves. Red leaf, a red discoloration that may appear on leaves, sheaths and peduncles, may develop in infected plants if night temperatures fall below 55 degrees F. Infected plants may be stunted, tillering may be reduced and yield may be reduced.

Many annual and perennial grasses, including corn and johnsongrass, are susceptible to maize dwarf mosaic virus. The virus that causes this disease is transmitted mechanically and vectored by more than 20 species of aphids.

**Management options for sorghum virus diseases**

- Plant resistant or tolerant cultivars.
- Follow cultural practices that eliminate johnsongrass and other susceptible annual grasses in and around sorghum fields.

**Sorghum downy mildew**, caused by the fungus *Peronosclerospora sorghi*, is a serious problem in the southern United States but is not typically found on sorghum in Missouri. Sorghum downy mildew may occur as either a systemic or a localized infection within the plant. Systemic infections may occur early in the season and affected seedlings are yellow, stunted and may die prematurely. During periods of cool, humid weather the lower surfaces of infected yellow leaves may be covered with a white, cottony mold growth. Infected leaves may also show striking patterns of long green and white stripes running the length of the leaves.

Localized infections of sorghum downy mildew begin as small brown spots on leaves. Under cool, humid conditions, the white, cottony mold growth may be evident on lower leaf surfaces and the disease may become systemic within the plants.

Sorghum downy mildew is caused by a soil fungus that invades the roots of sorghum seedlings. The pathogen survives in the soil and in perennial host plants.

**Management options for sorghum downy mildew**

- In areas where downy mildew is a serious problem, plant resistant cultivars.
- Rotate crops to help manage sorghum downy mildew.
- Apply appropriate fungicide seed treatments. See accompanying table of seed treatment fungicides labeled for use on grain sorghum.

**Plant parasitic nematodes** such as root-knot nematode, root lesion nematode and stunt nematode may occur on sorghum. With these nematodes, aboveground symptoms depend on the level of nematode infestation. At high levels, plants may be stunted, yellowed and have an unthrifty appearance. Yields may be reduced. These symptoms may be mistaken for herbicide injury, root rots, nutrient deficiencies and drought. Root growth may be limited and roots may be discolored or have small brown to black lesions. With root-knot nematode, galls and excessive branching may be evident on roots. When nematode injury is suspected, it is important to collect soil and root samples and send them to a nematology laboratory for identification of the nematode species involved.

**Management options for sorghum nematodes**

- Rotate crops. Effectiveness of crop rotation may vary depending on the nematode species present.
- Although there are several nematicides labeled for use for the control of nematodes in grain sorghum, environmental and economic concerns limit their use.

**Head smut, blights and molds**

**Head smut** primarily affects the head although foliage symptoms may occur on occasion. Smut galls replace part or all of the sorghum panicle. Initially the galls are protected by a thin, white covering. Eventually this covering ruptures, releasing masses of powdery black spores of the causal fungus, *Sporisorium reilianum*. Plants may be stunted and may produce excessive tillers. Smutted plants may also have more root and stalk rots. Smut spores can survive for long periods of time in the soil.

**Management options for head smut of sorghum**

- Plant the most resistant or least susceptible cultivars in areas where the disease occurs.
- Rotate crops to help reduce the level of smut in subsequent crops. Crop rotation will not eliminate the disease.

**Covered kernel smut** is found in every sorghum-growing region of the world. Before the use of fungicide seed treatments, covered kernel smut was a serious disease of sorghum. The fungus, *Sporisorium sorghi*, replaces individual sorghum kernels with smut balls of sori. These sori vary in size and shape but resemble elongated sorghum seeds. They range in color from white to gray to brown. The entire sorghum head may be affected or only portions of the head. The fungus that causes covered kernel smut is seedborne.

**Management options for covered kernel smut of sorghum**

- Use an appropriate fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on grain sorghum.
- Cultivars vary in their susceptibility to covered kernel smut, so cultivar selection may also help reduce losses from covered kernel smut.

Several fungi cause **head blights and molds** on sorghum. Pink, gray, white or black mold growth on the heads or grain surface is the most obvious sign of a problem. The development of these head blights and molds is favored by wet weather and high relative humidity during flowering and grain fill. There is some variation in susceptibility among sorghum hybrids to head molds.

**Management options for head blights and molds on sorghum**

- Plant adapted, tolerant cultivars.
- Rotate crops.
- Manage residues.
- Harvest in a timely manner.

## Soybean diseases and their management

Soybean diseases can and do occur each year in Missouri. Problems with germination and stand establishment that are related to seed decay, damping-off and seedling blights are often encountered in the field. These losses can be costly, especially if replanting is necessary. Diseases may cause leaf spots or leaf blights, wilts or premature death of plants. Soybean diseases also can affect the quality of the harvested crop and cause storage losses. The extent of the damage due to soybean diseases in a given season depends on a number of factors, including the susceptibility of the soybean variety to the specific disease, the level of pathogen inoculum present and the environmental conditions during that season.

To minimize losses due to soybean diseases, it is important to correctly identify the disease or diseases present so that appropriate management steps can be taken. The soybean diseases most likely to occur in Missouri include early-season seed and seedling diseases, foliage diseases, virus diseases, root and lower stem diseases, and stem, pod and seed diseases. For more detailed information including color pictures of soybean diseases in Missouri please see University of Missouri publication IPM 1002, *Soybean Diseases*.

### Seed and seedling diseases

The early-season soybean diseases include those that cause seed decay, seedling blights and soybean root rots. Most of these early-season soybean diseases are caused by fungi that are found in the soil wherever soybeans are grown. *Pythium*, *Phytophthora*, *Rhizoctonia* and *Fusarium* are the most common of these early-season pathogens, although *Phomopsis* (pod and stem blight fungus) and *Macrophomina* (charcoal rot fungus) may also cause early-season seedling problems. Symptoms of these early-season soybean diseases may range from seed decay to preemergence or postemergence damping-off to wilt and death of established seedlings.

**Pythium seed decay and damping-off** are generally associated with wet soil conditions. At least three of the *Pythium* species involved in these early-season diseases on soybean have an optimum temperature range for infection of 50 to 59 degrees F. Because of this lower optimum temperature range, these species are more common problems in northern areas or on early-planted soybean. The other *Pythium* species prefer soil temperatures in the range of 86 to 95 degrees F and are more common in southern areas, in late-planted fields or on plants later in the season. Crusting, deep planting, compaction, herbicide injury and similar factors that delay germination and seedling emergence may lead to an increase in incidence and severity of *Pythium* seed decay and damping-off.

#### Management options for *Pythium* seed decay and damping-off

- Plant good quality seed with a good germination rate.
- Plant in good seedbed conditions. Delaying planting until soil temperatures are above 59 degrees F may

reduce infection by some *Pythium* species.

- *Pythium* diseases may be more likely to develop in low, wet areas or compacted areas of a field. Tiling to improve drainage and taking steps to reduce or prevent compaction may help minimize problems with this disease.
- Fungicide seed treatment or at-planting fungicide treatment may help protect seedlings from this disease. Products containing either metalaxyl or mefenoxam as an active ingredient are particularly effective against water mold fungi such as *Pythium* species. See accompanying tables of seed treatment fungicides and at-planting fungicides labeled for use on soybean.

**Phytophthora seedling blight** is caused by another soil-inhabiting fungus. *Phytophthora* can cause seed decay, preemergence or postemergence damping-off and seedling blight of soybean. This fungus produces structures called oospores, which enable it to survive from year to year in crop residues or in the soil. In the spring, the oospores germinate to produce sporangia. When soils are flooded or saturated, the sporangia release zoospores, which are attracted to the growing soybean root tip where infection occurs.

*Phytophthora* root rot is more severe in areas that are low or poorly drained, in compacted areas or in clay or heavy soils, but the disease can appear on plants growing in lighter soils or higher ground if the soil remains wet after planting. Significant rain after planting favors the development of *Phytophthora* in all sites. A dry period after planting drastically reduces this disease. *Phytophthora* may occur at soil temperatures as low as 50 degrees F, but greatest root damage occurs when soil temperatures are 59 degrees F or above.

#### Management options for *Phytophthora* seedling blight

- Plant varieties with race-specific resistance, tolerance or a combination of race-specific resistance and tolerance in fields with a history of *Phytophthora*. More than 39 races of *Phytophthora sojae* have been identified based on their ability to overcome specific Rps genes or combinations of Rps genes in soybean varieties. Race-specific varieties contain a single gene or combination of genes (i.e., Rps1c, Rps1d, Rps1k or Rps3a) that confer resistance to specific races of *Phytophthora sojae*. Tolerant varieties have a non-race-specific, partial resistance and may also be called field-resistant varieties.
- Plant in good seedbed conditions.
- *Phytophthora* is more likely to occur in low, wet areas, poorly drained areas or compacted areas of a field. Tiling to improve drainage and taking steps to reduce or prevent compaction may help minimize disease problems.
- Avoid the application of high levels of manure or fertilizer (KCl) just before planting.
- Rotate crops to prevent the increase of inoculum levels in a field.
- Use an appropriate fungicide seed treatment or at planting fungicide treatment. Products containing either metalaxyl or mefenoxam as an active ingredient are particularly effective against water mold fungi such as *Phy-*

*tophthora sojae*. See accompanying tables of seed treatment fungicides and at-planting fungicides labeled for use on soybean.

**Rhizoctonia seedling blight**, caused by *Rhizoctonia solani* another common soil-inhabiting fungus, can result in seed decay and preemergence damping-off of soybean seedlings. The causal fungus can survive well in the absence of host plants because it grows well in the soil, colonizes many types of plant debris and can also survive as resting mycelium or sclerotia in the soil.

*Rhizoctonia solani* can survive under a wide range of soil moistures and soil temperatures. Populations of the fungus may decline when soils are flooded or when soil temperatures are unusually high. Symptoms, especially on above-ground portions of the seedlings, are usually more severe during periods of drying winds or warm to hot weather. During such conditions seedlings may wilt, yellow or die.

Crusting, hardpan layers, herbicide injury, deep planting, poor seed quality, hail damage, insect damage, mechanical injuries, poor fertility or other factors that delay germination and emergence favor the development of *Rhizoctonia* root rot. *Rhizoctonia* root rot is frequently found in combination with other diseases such as soybean cyst nematode or *Fusarium* root rot. Damage from *Rhizoctonia* may be more severe when it occurs in combination with other diseases.

### Management options for *Rhizoctonia* seedling blight

- Plant good quality seed with a good germination rate.
- Plant in good seedbed conditions.
- Minimize or avoid stresses that delay germination or emergence, i.e., avoid or prevent herbicide injury and insect injury, correct soil compaction and hardpan layer problems and reduce injury from soybean cyst nematode.
- Use an appropriate fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on soybean.

***Fusarium* seedling blight** and root rot of soybean may be caused by either *Fusarium oxysporum* or *Fusarium solani*. These two fungi can persist in the soil, colonize various plant residues and survive as chlamydospores (fungal survival structures) or mycelium.

*Fusarium* root rot can occur at any time during the growing season, but it is most common on seedlings and young plants. Disease is most severe when the soil is saturated and soil temperatures are around 57 degrees F. Crusting, hardpan layers, herbicide injury, deep planting, poor seed quality, hail damage, insect damage, mechanical injuries, poor fertility or other factors that delay germination and emergence favor the development of *Fusarium* seedling blight and root rot. *Fusarium* root rot is frequently found in combination with other diseases such as *Rhizoctonia* root rot or soybean cyst nematode. Damage from *Fusarium* may be more severe when it occurs in combination with other diseases or stresses.

### Management options for *Fusarium* seedling blight

- Plant good quality seed with a good germination rate.
- Plant in good seedbed conditions.
- Minimize or avoid stresses that delay germination or emergence, i.e., avoid or prevent herbicide injury and insect injury, correct soil compaction and hardpan layer problems and reduce injury from soybean cyst nematode.
- Use an appropriate fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on soybean.

**Charcoal rot**, caused by the fungus *Macrophomina phaseolina*, occurs worldwide. The fungus is widely distributed in soils and has a wide host range attacking a number of crops, including soybean, corn and sorghum. *Macrophomina phaseolina* produces small survival structures called microsclerotia, which allow it to survive in soil or in host residues for long periods of time.

Charcoal rot may be more commonly recognized as a mid- to late-season disease on maturing soybeans (see charcoal rot in section on Root and Lower Stem Diseases), but it can also occur early in the season on young seedlings. *Macrophomina phaseolina* grows best at temperatures between 82-95 degrees F. Infection of seedlings is most likely to occur if conditions of high soil temperatures and low soil moisture exist during the first two to three weeks after planting.

### Management options for charcoal rot

- Rotate to cereals, cotton or other non-host crops for one to two years.
- Maintain good crop vigor to reduce losses from charcoal rot.
- In irrigated fields, watering during periods of high temperatures and drought stress when soybean plants are in bloom to pod fill may help reduce charcoal rot.

*Phomopsis longicolla* and the other *Phomopsis* and *Diaporthe* species that cause *Phomopsis* seed decay and pod and stem blight can survive in infested crop residues and in the soil. These fungi can also survive on the seed and *Phomopsis* seedling blight is more likely to be a serious problem if infected seed is planted. *Phomopsis* seedling blight tends to be more severe if weather conditions after planting are cool and wet.

### Management options for *Phomopsis* seedling blight

- Plant disease-free seed with a good germination rate.
- Plant in good seedbed conditions.
- Use an appropriate fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on soybean.

## Seed treatment fungicides for soybean

Although seed treatment fungicides can be an effective means of preventing or reducing losses from various

seedborne and soilborne microorganisms, there are several important laws or guidelines concerning fungicide-treated seed. Always read the pesticide label and follow all directions and restrictions on the label but in particular for seed treatment fungicides remember the following points.

- Do not use treated seed for food, feed or oil purposes.
- All treated seed must be colored with an EPA-approved dye that imparts an unnatural color to the seed.
- Federal law requires that bags containing treated seed shall be labeled with the following information: “This seed has been treated with (common chemical name of

active ingredients) fungicide(s). Do not use treated seed for feed, food or oil purposes. Store away from feeds and food stuffs.”

The following table was prepared using current company product label books and manufacturers’ Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions on the label accompanying that product. Product trade names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

### Seed treatment fungicides labeled for use on soybean

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Allegiance Dry</b> Chemtura (formerly Trace Seed Protection Products)	metalaxyl	12.50%	1.5 to 2.0 oz per 100 lb of seed	For Pythium damping-off and early-season Phytophthora control. For control of other soilborne diseases, such as <i>Rhizoctonia</i> spp., Allegiance Dry should be applied in combination with other registered seed dressing fungicides.  Treat only those seeds needed for immediate use, minimizing the interval between treatment and planting. Do not carry over excess treated seed to next season.  Do not use this product on seed that has been commercially treated with metalaxyl fungicide.  Hopper box treatment.
<b>Allegiance-FL</b> Bayer CropScience	metalaxyl	28.35%	0.75 to 1.5 fl oz per 100 lb of seed	For Pythium damping-off and early-season Phytophthora control. For control of other soilborne diseases, combination with Bayer CropScience Captan registered formulations is compatible. Do not use with other seed treatment products unless previous experience assures compatibility.  Reduced rates in combination with other fungicides: to aid in the control of seed decay and damping-off caused by <i>Pythium</i> , apply 0.10 to 0.375 fl oz per 100 lb of seed only in combination with EPA-registered rates of Bayer CropScience broad-spectrum seed treatment fungicides.  Allegiance-FL may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment.
<b>Apron XL LS</b> Syngenta	mefenoxam	33.30%	0.16 to 0.64 fl oz per 100 lb of seed	For Pythium damping-off and early-season Phytophthora control. For best early-season control of <i>Phytophthora</i> , use the higher rate. For Pythium damping-off protection when disease pressure is expected to be low: apply Apron XL LS as a seed treatment at 0.085 to 0.32 fl oz per 100 lb of seed in combination with other seed treatment products labeled for soybeans.  For control of other soilborne diseases, such as <i>Rhizoctonia</i> species, Apron XL LS should be applied in combination with other registered seed dressing fungicides.  Apron XL LS may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry- or mist-type commercial seed treatment equipment.
<b>ApronMAXX RFC</b> Syngenta	fludioxonil mefenoxam	2.31% 3.46%	1.5 fl oz per 100 lb of seed	Provides protection against damping-off and seed rots due to <i>Pythium</i> , <i>Phytophthora</i> , <i>Fusarium</i> , <i>Rhizoctonia</i> spp. and early-season Phytophthora root rot and suppresses seedborne <i>Sclerotinia</i> and <i>Phomopsis</i> spp.  If target fields have a history of high Phytophthora pressure, then use 1.5 fl oz of ApronMAXX RFC with 0.16 to 0.48 fl oz of Apron XL per 100 lb of seed.  ApronMAXX RFC is especially formulated for on-farm or commercial treatment to be used with liquid rhizobia products, using standard mechanical slurry or mist-type seed treatment equipment.

## Seed treatment fungicides labeled for use on soybean

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>ApronMAXX RTA</b> Syngenta	mefenoxam fludioxonil	1.10% 0.73%	5.0 fl oz per 100 lb of seed	Seed treatment fungicide that protects against damping-off and seed rots due to <i>Pythium</i> , <i>Phytophthora</i> , <i>Fusarium</i> , <i>Rhizoctonia</i> spp. and early-season <i>Phytophthora</i> root rot. ApronMAXX RTA also suppresses seedborne <i>Sclerotinia</i> and <i>Phomopsis</i> spp.  If the target fields have a history of high <i>Phytophthora</i> pressure, then use 5.0 fl oz of ApronMAXX RTA with 0.16 to 0.48 fl oz of Apron XL per 100 lb of seed.  ApronMAXX RTA is especially formulated for on-farm treatment, using standard mechanical slurry or mist-type seed treatment equipment.
<b>ApronMAXX RTA + Moly</b> Syngenta	mefenoxam fludioxonil	1.02% 0.68%	5.0 fl oz per 100 lb of seed	Provides protection against damping-off and seed rots due to <i>Pythium</i> , <i>Phytophthora</i> , <i>Fusarium</i> , <i>Rhizoctonia</i> spp. and early-season <i>Phytophthora</i> root rot and suppresses seedborne <i>Sclerotinia</i> and <i>Phomopsis</i> spp.  ApronMAXX RTA + Moly is especially formulated for on-farm treatment, using standard mechanical slurry or mist-type seed treatment equipment.
<b>Bean Guard Allegiance</b> Chemtura (formerly Trace Seed Protection Products)	captan carboxin metalaxyl	24.45% 12.50% 3.75%	2.0 oz per 60 lb of seed	Bean Guard Allegiance combines the systemic action of carboxin and metalaxyl with the contact action of captan to control certain seed and seedling diseases of soybeans. It is particularly effective against <i>Pythium</i> and <i>Rhizoctonia</i> and shows good activity against <i>Fusarium</i> and <i>Helminthosporium</i> . It also provides 0.2 oz of molybdenum per acre for plant nutrition and nitrogen fixation.  Treat only seed for immediate use, minimizing the interval between treatment and planting. Do not store excess treated seeds beyond planting time.  Hopper box seed treatment.
<b>Captan 400</b> Bayer CropScience	captan	37.40%	1.5 to 2.5 fl oz per 100 lb of seed	Captan 400 and Captan 400-C Seed Protectants are flowable concentrates especially formulated for the treatment of seed prior to storage and planting to protect seed from molds and other fungi causing storage loss and to protect seed from seedborne and soilborne fungi that cause seed decay, damping-off and seedling blights.
<b>Captan 400-C</b> Bayer CropScience	captan	37.40%	1.5 to 2.5 fl oz per 100 lb of seed	Not for use on agricultural establishments in hopper box, planter box, slurry box or other seed treatment applications at or immediately before planting.
<b>Catapult XL</b> Winfield Solutions, LLC	chloroneb mefenoxam	30.00% 1.95%	5.5 to 7.0 fl oz per 100 lb of seed	For early-season <i>Phytophthora</i> control and <i>Pythium</i> and <i>Rhizoctonia</i> damping-off. Use the high rate when conditions for disease expression are favorable.  Do not graze soybeans within 45 days of planting.  See label for information on use with specific types of planters.  Hopper box seed treatment.
<b>CruiserMaxx</b> Syngenta	thiamethoxam mefenoxam fludioxonil	22.6% 1.70% 1.12%	3.0 fl oz per 100 lb of seed	CruiserMaxx is a seed treatment product containing the active ingredients thiamethoxam (insecticide) and fludioxonil and mefenoxam (fungicides). It protects against damage from certain early-season insects, soilborne and seedborne diseases including damping-off and seedborne rots due to <i>Pythium</i> , <i>Phytophthora</i> , <i>Fusarium</i> , <i>Rhizoctonia</i> , species and early-season <i>Phytophthora</i> root rot. It also suppresses seedborne <i>Sclerotinia</i> and <i>Phomopsis</i> species.
<b>CruiserMaxx Beans</b> Syngenta	thiamethoxam mefenoxam fludioxonil			CruiserMaxx Beans brand product is one or more separately registered products or combination of products containing the following: CruiserMaxx Seed Treatment; CruiserMaxx Seed Treatment + Apron XL; Cruiser + Maxim + Apron XL or Cruiser + an ApronMaxx brand seed treatment fungicide.  For use directions, please see individual product labels.
<b>Dynasty</b> Syngenta	azoxystrobin	9.60%	0.153 to 0.382 fl oz per 100 lb of seed	Target diseases are seedborne and soilborne fungi causing decay, damping-off and seedling blight as well as suppression of white mold ( <i>Sclerotium rolfsii</i> )  It is recommended that Dynasty be combined with a <i>Pythium</i> -active seed treatment such as Apron XL LS to offer broad-spectrum protection against the seed and seedling disease complex ( <i>Rhizoctonia</i> spp. and <i>Pythium</i> spp.)
<b>Enhance Enhance AW</b> Chemtura (formerly Trace Seed Protection Products)	captan carboxin	19.55% 20.00%	5.0 oz per 100 lb of seed	Tends to reduce seed rot and seedling blight caused by soil fungi.  Do not graze or feed livestock on soybean forage or hay.  Apply as a planter box treatment (including air and vacuum planters), mixing thoroughly with the seed before planting. For best results, follow directions given on label.

## Seed treatment fungicides labeled for use on soybean

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>HiMoly/Captan-D</b> Chemtura (formerly Trace Seed Protection Products)	captan molybdenum	48.90% 10.00%	2.0 oz per bushel of seed	To protect against seedborne and soilborne diseases such as seedling blights, damping-off and seed decay. Also provides 0.2 oz of molybdenum per acre for plant nutrition and nitrogen fixation.  Treat only those seeds needed for immediate use, minimizing the interval between treatment and planting. Do not store excess treated seed beyond planting time.  Hopper box seed treatment.
<b>Kernel Guard Supreme</b> Chemtura (formerly Trace Seed Protection Products)	permethrin carboxin	10.42% 14.00%	3.0 oz per 100 lb of seed	Kernel Guard Supreme may be used on seed previously treated with a full dosage of protective fungicide, to give added protection against seedling blight, damping-off or seed decay.  Treat only those seed needed for immediate use, minimizing the interval between treatment and planting. Do not store excess treated seeds beyond planting time.  Hopper box seed treatment.
<b>Kodiak HB</b> Chemtura (formerly Trace Seed Protection Products)	<i>Bacillus subtilis</i>	0.30%	4.0 to 8.0 oz per 100 lb of seed	For suppression of root diseases caused by <i>Rhizoctonia</i> and <i>Fusarium</i> and for improvement of nodulation by <i>Bradyrhizobium</i> .  Contains bacteria that colonize the developing root system, suppressing disease organisms such as <i>Fusarium</i> and <i>Pythium</i> that attack root systems. When used with a chemical seed treatment, the combination of chemicals and Kodiak provides protection to the root for a much longer time than with chemicals alone.  Kodiak HB is a hopper box seed treatment.
<b>Latitude</b> Chemtura (formerly Trace Seed Protection Products)	imidacloprid carboxin metalaxyl	25.00% 14.00% 1.00%	4.0 oz per 100 lb of seed	For the protection of seeds and seedlings against seed and seedling diseases caused by <i>Pythium</i> and <i>Rhizoctonia</i> ; also suppression of seed corn maggots and early-season control of overwintering bean leaf beetles.  Use only at the recommended rate. Lower amounts may not give desired control. Excessive amounts may cause seed injury.  Do not graze or feed livestock on forage and hay on treated areas for six weeks after planting soybeans. Do not graze or feed livestock on vines grown from treated soybean seed.
<b>LSP</b> Bayer CropScience	thiabendazole	30.00%	0.125 to 0.250 fl oz per 100 lb of seed	For control of pod and stem blight.  Formulated as a liquid suspension seed protectant for use as a spray mist or slurry seed treatment. For use only by commercial seed treaters.
<b>Maxim XL</b> Syngenta	fludioxonil mefenoxam	21.00% 8.40%	0.167 fl oz per 100 lb of seed  or  0.334 fl oz per 100 lb of seed	For protection against seedborne and soilborne fungi that cause decay, damping-off and seedling blight, and early-season Phytophthora protection, apply Maxim XL and Apron XL LS.  See label for specific rate recommendations depending on expected disease pressure.  Apply as a water-based slurry using standard slurry seed treatment equipment that provides uniform seed coverage.
<b>Maxim 4FS</b> Syngenta	fludioxonil	40.30%	0.08 to 0.16 fl oz per 100 lb of seed	For protection against seedborne and soilborne fungi that cause decay, damping-off and seedling blight.  Maxim 4FS does not control diseases caused by <i>Pythium</i> spp. or <i>Phytophthora</i> spp. If these diseases are expected to be a problem, apply Maxim 4FS tank mixed with Apron XL LS.  Apply as a water-based slurry using standard slurry seed treatment equipment that provides uniform seed coverage.
<b>MetaStar ST</b> Chemtura (formerly Trace Seed Protection Products)	metalaxyl	28.35%	0.75 to 1.5 fl oz per 100 lb of seed	For <i>Pythium</i> damping-off and early-season <i>Phytophthora</i> control.  MetaStar ST is a systemic fungicide seed dressing specifically for control of systemic downy mildews, <i>Pythium</i> and <i>Phytophthora</i> spp. For control of other soilborne diseases, combinations with Captan and Vitavax registered formulations are compatible. Do not use with other seed treatment products unless previous experience assures compatibility.  MetaStar ST may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment.
<b>Prevail</b> Chemtura (formerly Trace Seed Protection Products)	carboxin PCNB metalaxyl	15.00% 15.00% 3.12%	2.0 to 4.0 oz per bushel of seed	For protection against <i>Pythium</i> and <i>Rhizoctonia</i> seedling disease complex.  Do not graze or feed livestock on hay grown from treated seed.  May be used as a planter box treatment or applied at planting time using on farm mechanical treater to maximize seed coverage.

## Seed treatment fungicides labeled for use on soybean

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Protector-D</b> Chemtura (formerly Trace Seed Protection Products)	thiram	35.00%	2.0 oz per bushel of seed	Contains thiram to protect against seedborne and soilborne diseases, such as seedling blights, damping-off and seed decay organisms, as well as 0.2 oz. of molybdenum per acre for plant nutrition and to aid in nitrogen fixation.  Plant as soon as possible after treating.  Hopper box seed treatment.
<b>Protector-L-Allegiance</b> Chemtura (formerly Trace Seed Protection Products)	thiram metalaxyl	14.29% 1.61%	6.7 fl oz per 100 lb of seed	A ready-to-use product combining the action of thiram and metalaxyl to reduce seed rot/seedling blight diseases including <i>Pythium</i> and <i>Rhizoctonia</i> and providing molybdenum to aid in nitrogen fixation.  Apply as a pour-on hopper box application or through on-farm seed treatment equipment.
<b>RTU-PCNB</b> Bayer CropScience	PCNB	24.00%	3.0 to 6.0 fl oz per 100 lb of seed	For control of seedling disease complex caused by <i>Rhizoctonia</i> and <i>Fusarium</i> .  RTU-PCNB should be applied using on-farm or commercial seed treating equipment, which can be calibrated to accurately and uniformly apply the product to the seed.
<b>42-S Thiram</b> Bayer CropScience	thiram	42.00%	2.0 fl oz per 100 lb of seed	When used as directed will usually increase stands and yields by reducing loss from seed decay, damping-off and seedling blights caused by many seedborne and soilborne organisms.  42-S Thiram should be applied with water as a suspension in the slurry-type treater specifically designed and approved for this use.
<b>Trilex AL Flowable Fungicide</b> Bayer CropScience	trifloxystrobin	1.28%	5.7 fl oz per 100 lb of seed	Provides seed and seedling protection against seedborne fungi causing seed decay and the soilborne pathogens <i>Rhizoctonia solani</i> and <i>Pythium</i> spp. causing seed and seedling damping-off.  Ready-to-use seed treatment especially formulated for on-farm equipment for direct application, or may be applied using standard slurry or mist-type seed treatment equipment.
<b>Trilex Flowable Fungicide</b> Bayer CropScience	trifloxystrobin	22.00%	0.32 fl oz per 100 lb of seed	Provides seed and seedling protection against seedborne fungi causing seed decay and the soilborne pathogen <i>Rhizoctonia solani</i> .  Apply as a seed treatment using standard slurry or mist-type seed treatment equipment. Uniform application of seed is necessary to ensure seed safety and best disease protection. Seed should be sound and well-cured before treatment. Product should be diluted with sufficient water to ensure complete seed coverage.
<b>VITAFLO-280</b> Chemtura (formerly Trace Chemicals LLC)	carboxin thiram	14.90% 13.20%	4.0 fl oz per 100 lb of seed	A combination of a systemic fungicide and a contact fungicide to control seedborne and soilborne seedling diseases including damping-off and seed decay.  Do not graze or feed livestock on treated areas for six weeks after planting.  For use only by commercial treaters.  Not for use on agricultural establishments in hopper box, planter box, slurry box or other seed treatment applications at or immediately before planting.
<b>Vitavax CT</b> Helena Chemical Corporation	carboxin thiram	5.70% 5.70%	12.0 fl oz per 100 lb of seed	For control of <i>Rhizoctonia solani</i> .  Do not graze or feed livestock on forage and hay on treated areas.  Ready-to-use seed treatment for hopper box application.
<b>Vitavax M</b> Helena Chemical Corporation	carboxin thiram molybdenum	5.70% 5.70% 2.90%	12.0 fl oz per 100 lb of seed	For control of various seed and seedling diseases, including <i>Rhizoctonia solani</i> .  Do not graze or feed livestock on forage and hay on treated areas.  Ready-to-use seed treatment for hopper box application.
<b>Vitavax M DC</b> Helena Chemical Corporation	captan carboxin molybdenum	23.90% 12.50% 10.00%	2.0 oz per bushel of seed	For control of many seedborne and soilborne diseases of soybean.  Planter box treatment.
<b>Warden CZ</b> Winfield Solutions, LLC	thiamethoxam mefenoxam fludioxonil	21.50% 3.21% 1.07%	3.2 fl oz per 100 lb of seed	Provides protection against damping-off and seedborne rots due to <i>Pythium</i> , <i>Phytophthora</i> , <i>Fusarium</i> and <i>Rhizoctonia</i> species and early-season <i>Phytophthora</i> root rot. Warden CZ also suppresses seedborne <i>Sclerotinia</i> and <i>Phomopsis</i> species.  If target fields have a history of high <i>Phytophthora</i> pressure, add additional Apron XL LS as directed in the rate table or on the Apron XL LS label.

## Seed treatment fungicides labeled for use on soybean

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Warden RTA</b> Agrilience, LLC	mefenoxam fludioxonil	2.15% 0.72%	5.0 fl oz per 100 lb of seed	Protects against damping-off and seed rots due to <i>Pythium</i> , <i>Phytophthora</i> , <i>Fusarium</i> , <i>Rhizoctonia</i> spp. and early-season <i>Phytophthora</i> root rot. Also suppresses seedborne <i>Sclerotinia</i> and <i>Phomopsis</i> spp.  Especially formulated for on-farm treatment, using standard mechanical or mist-type seed treatment equipment.
<b>Yield Shield</b> Bayer CropScience	<i>Bacillus pumilus</i>	0.28%	0.1 oz per 100 lb of seed	Yield Shield is a biological fungicide that, when applied to seed, colonizes the developing root system and provides protection against disease organisms such as <i>Rhizoctonia</i> and <i>Fusarium</i> that attack the root system.  May be applied as a water-based slurry either alone or with other registered seed treatment insecticides and fungicides through standard slurry or mist commercial seed treatment equipment.

## At-planting fungicides for soybean

The following table was prepared using current company product label books and manufacturers' Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying

that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

## At-planting fungicides labeled for use on soybean

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Ridomil Gold GR</b> Syngenta	mefenoxam	2.50%	6 oz per 1,000 linear feet of row in a 7-inch band over the row or as a seed-furrow application at the time of planting for full-season control.  1.5 to 3.0 oz per 1,000 linear feet of row in the seed furrow for early to mid-season control.  When making the seed furrow applications, position the applicator tubes so the granules are mixed with the soil covering the seed or are applied in a "T-band."	For use in the control of <i>Phytophthora</i> root and stem rot and <i>Pythium</i> damping-off. It may be applied in a 7-inch band over the row at planting or in the seed furrow before seeds are covered. The seed-furrow applications will provide more consistent results if rain is not expected before the seeds germinate.  Ridomil Gold GR is specific for <i>Pythium</i> and <i>Phytophthora</i> and will not control other diseases that may attack soybeans.  For best results against <i>Phytophthora</i> root and stem rot, use Ridomil Gold GR with soybean varieties that have some tolerance to the races of <i>Phytophthora</i> present in the field. The higher rate of Ridomil Gold GR should be used in areas with a history of heavy <i>Phytophthora</i> damage. Under heavy late-season <i>Phytophthora</i> pressure, Ridomil Gold GR may not provide complete control.  Rotational restrictions may apply.  See label for additional information on application techniques and restrictions.
<b>Ridomil Gold SL</b> Syngenta	mefenoxam	45.30%	0.08 to 0.28 fl oz per 1,000 row feet for in- furrow application  or  0.37 to 1.25 pt per acre for soil spray application	For use in the control of <i>Phytophthora</i> root and stem rot and <i>Pythium</i> damping-off.  In-furrow spray: apply in-furrow with water or liquid fertilizer. Position the spray so fungicide is mixed with the soil covering the seed directly or crop injury may occur. Use the high rate for full-season control. Use 0.08 to 0.15 fl oz for early- to mid-season control.  Soil spray (broadcast or band): apply in water or liquid fertilizer. Use the high rate for full-season control. Use 0.37 to .75 pt for early- to mid-season control. For banded applications, a 7-inch band is recommended.  For best results, use soybean varieties that have some degree of resistance to races of <i>Phytophthora</i> present in the field.  Use the higher rate in areas with a history of heavy <i>Phytophthora</i> damage.  Under heavy late-season <i>Phytophthora</i> pressure, Ridomil Gold SL may not provide complete control.

## Soybean foliage diseases

### Foliage diseases other than soybean rust

Foliage diseases such as Septoria brown spot, bacterial blight, bacterial pustule, frogeye leaf spot, downy mildew and powdery mildew can occur on soybeans in Missouri. Generally these diseases occur in low levels and do not cause significant losses. However, under favorable conditions for disease development, losses can be serious.

The fungi that cause most of these soybean foliage diseases survive in infested soybean residues left on the soil surface. The following growing season, spores are produced during moist periods and are carried by wind currents to susceptible soybean leaves. Foliage disease problems tend to be more severe when soybeans are planted in fields with infested soybean residue left on the soil surface. Eventually spores that are produced in initial lesions on leaves are wind blown to other leaves or plants causing secondary infection.

Most of the foliage diseases of soybean are favored by moderate to warm temperatures and wet or humid weather and heavy dews. They tend to start on the lower leaves and, if weather conditions are favorable, move up through the plant.

### Management options for soybean foliage diseases

- Plant disease-free seed.
- Plant resistant varieties.
- Rotate crops with at least one year between soybean crops.
- There are foliar fungicides labeled for use on soybean to control fungal foliage diseases other than soybean rust. These foliar fungicides have Section 3 labels or full federal registration and are listed in the following table. Use of these foliar fungicides may be more economical on high-value fields (e.g., seed production fields or specialty beans) or in years when weather is quite favorable for disease development.

The following table was prepared using current company product label books and manufacturers' Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Alto 100SL</b> Syngenta	cyproconazole	8.9%	2.75 to 5.5 fl oz per acre	<p>For soybean rust: apply 2.75 to 5.5 fl oz per acre prior to disease development. Repeat at 14- to 28-day intervals if conditions persist for rust development. Depending on the conditions, application timing should be R1 (beginning flowering, approximately 50 days after planting) up to the R6 stage (seed fully developed), but could be earlier. Tank mixes with a strobilurin fungicide such as Quadris will optimize performance against rust. Use the 2.75 fl oz per acre rate when disease is present in the vegetative stage.</p> <p>For diseases other than soybean rust including aerial blight, Alternaria leaf spot, anthracnose, brown spot, Cercospora blight and leaf spot, frogeye leaf spot and pod and stem blight: use 4.0 to 5.5 fl oz per acre. For best results, begin Alto 100SL applications prior to disease development. Apply a minimum of 4.0 fl oz per acre based on local recommendations for timing and thresholds. Tank mixes with a strobilurin fungicide such as Quadris will enhance performance on these diseases.</p> <p>For maximum performance, Alto 100SL applications should begin prior to disease development. Use the high rates under conditions favorable for severe disease pressure, dense plant canopies or when disease is present.</p> <p>Application directions: a spreading/penetrator type adjuvant is recommended when used solo or in tank mix. Coverage and penetration are important for best results. Use sufficient water volume to provide thorough and uniform plant coverage. Applications may be made by ground, air or chemigation.</p> <p>Resistance management: do not alternate or tank mix with fungicides to which resistance has developed in the pathogen population.</p> <p>Do not apply more than 11.0 fl oz Alto 100LS per acre per season. Do not apply more than 0.072 lb a.i. per acre per year of cyproconazole-containing products.</p> <p>Do not graze forage within 14 days of application. Do not use soybean forage or hay as livestock feed if making more than one application at the 5.5 fl oz per acre rate.</p> <p>Do not apply within 30 days of harvest of soybeans (beans).</p>

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Bravo Ultrex</b> Syngenta	chlorothalonil	82.50%	rate varies with diseases targeted for control and application program — see next column	1.4 to 2.2 lb per acre for control of anthracnose, Diaporthe pod and stem rot, frogeye leaf spot, purple seed stain, Cercospora leaf blight and Septoria brown spot with a two-application program. For determinate varieties, make the first application at R3 stage (early pod set) and the second application at R5. For indeterminate varieties, make the first application when largest pods are 1 to 1.25 inches in length. Make the second application 14 days later.
				0.9 to 1.4 lb per acre for control of anthracnose, Diaporthe pod and stem rot, frogeye leaf spot, purple seed stain, Cercospora leaf blight and Septoria brown spot with a three-application program. For determinate varieties, make the first application at the beginning of flowering (R1), the second at early pod set (R3) and the third at beginning of seed formation (R5). For indeterminate varieties, make the first application one week after first flowering and continue applications at 14-day intervals.
				0.9 lb per acre for control of stem canker. Apply in 10 to 20 gallons of water per acre as a band treatment directing the spray to provide coverage of entire plant. Make the first application at the time of emergence of the second trifoliolate leaves (V2). If conditions favor stem canker disease, make a second and a third application. Make all applications at 14-day intervals.  Do not apply more than 5.4 lb Bravo Ultrex per acre during each growing season.  Do not apply within 6 weeks of harvest.  Do not feed soybean hay or threshings from treated fields to livestock.
<b>Bravo Weather Stik</b> Syngenta	chlorothalonil	54.00%	rate varies with diseases targeted for control and application program — see next column	1.5 to 2.25 pt per acre for control of anthracnose, Diaporthe pod and stem rot, frogeye leaf spot, purple seed stain, Cercospora leaf blight, Septoria brown spot and rust(suppression) with a two-application program. For determinate varieties, make the first application at early pod set (R3 stage when majority of pods are 1/8 to 3/8 inch in length) and the second at beginning of seed formation (R5), which occurs about 14 days later. For indeterminate varieties, make the first application when largest pods are 1 to 1.5 inches in length. Make the second application 14 days later.
<b>Chloronil 720</b> Syngenta	chlorothalonil	54.00%	— see next column	1.0 to 2.0 pt per acre for control of anthracnose, Diaporthe pod and stem rot, frogeye leaf spot, purple seed stain, Cercospora leaf blight, Septoria brown spot and rust(suppression) with three application program. For determinate varieties, make the first application at the beginning of flowering (R1), the second at early pod set (R3) and the third at beginning of seed formation (R5). For indeterminate varieties, make the first application one week after first flowering and continue applications at 14-day intervals.  1.0 pt per acre for control of stem canker on determinate varieties. Apply in 10 to 20 gallons of water per acre, as a band treatment directing the spray to provide coverage of entire plant. Make the first application at the time of emergence of the second trifoliolate leaves (V2). If conditions favor stem canker disease make a second and a third application. Make all applications at 14-day intervals.  Check label for other restrictions.

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Bumper 41.8 EC</b> Makhteshim Agan	propiconazole	41.80%	4.0 to 8.0 fl oz per acre	<p>For control of aerial web blight, anthracnose, brown spot, frogeye leaf spot and soybean rust.</p> <p>Applications may be made using ground or aerial application equipment. Use dilution rates found in the "Application Instructions" section of the label. When applying by air, adding an oil-based additive is recommended for improved coverage and penetration.</p> <p>Aerial web blight: apply 5.0 to 6.0 fl oz at the first appearance of aerial web blight and repeat the application 14 to 21 days later. Under severe conditions, use the higher rate and shorter interval.</p> <p>Other foliage diseases: apply 6.0 fl oz at growth stage R3 (early pod set) when pods are 1/8- to 1/4-inch long and 21 days later at growth stage R5 (pod fill).</p> <p>Soybean rust: apply 4.0 to 6.0 fl oz at first indication that soybean rust is in the area. For best control, preventative applications work best. Repeat on a 14- to 21-day interval using the higher rate and shorter interval when disease is present in field and incidence is less than 2% (2 plants in 100 infected). If incidence is greater than this or if disease is mid-canopy, control will not be acceptable.</p> <p>On certain varieties, Bumper 41.8 EC applications may cause crinkled or smaller green leaves. Yields of dry beans displaying these characteristics have not been reduced due to propiconazole treatments.</p> <p>Do not apply more than 12.0 fl oz of Bumper 41.8 EC per acre per season. Do not apply more than 0.34 lb a.i. propiconazole per acre per season.</p> <p>Applications may be made up to growth stage R6.</p>
<b>Domark 230 ME</b> Valent	tetraconazole	20.50%	4.0 to 5.0 fl oz per acre	<p>Target diseases: Asian soybean rust, Cercospora blight, frogeye leaf spot, powdery mildew, brown spot and anthracnose.</p> <p>Domark 230 ME has preventative and curative disease activity.</p> <p>Apply in 10 to 25 GPA: ground.</p> <p>For Asian soybean rust, apply prior to disease development when rust infections are likely to occur. If necessary repeat with a second application before growth stage R6. Curative applications are most effective when disease incidence does not exceed 5% of the soybean plants at the time of application.</p> <p>For other diseases, make applications at soybean growth stage R3 (early pod fill) or when conditions are favorable for disease development. Repeat applications 15 to 21 days after first application if disease pressure is heavy. Under severe disease conditions the higher rate and shorter spray interval should be used.</p> <p>Do not apply Domark 230 ME after soybean growth stage R5 (beginning seed).</p> <p>Do not make more than two applications of Domark 230 ME to soybeans per year. Do not apply more than 5 fl oz per acre in a single application. Do not apply more than 10 fl oz of Domark 230 ME per acre per season.</p> <p>Do not graze or feed soybean forage or hay to livestock.</p> <p>A restricted entry interval (REI) of 12 hours is to be followed.</p> <p>Do not apply Domark 230 ME through any type of irrigation system.</p> <p>Do not harvest immature soybeans for consumption once plants are treated with Domark 230 ME. Do not use on vegetable soybean varieties grown for their immature pods.</p>

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Echo 90DF</b> SIPCAM AGRO USA, INC.	chlorothalonil	90.00%	rate varies with diseases targeted for control and application program — see next column	1.25 to 2.0 lb Echo 90 DF per acre, 1.5 to 2.5 pt Echo 720 per acre or 2.0 to 3.5 pt Echo Zn per acre for control of anthracnose, Diaporthe pod and stem rot, frogeye leaf spot, purple seed stain, Cercospora leaf blight, Septoria brown spot and rust with a two-application program. For determinate varieties, make the first application at early pod set (R3 stage) and the second seed formation (R5). For indeterminate varieties, make the first application when largest pods are 1 to 1.5 inches in length. Make the second application 14 days later.
<b>Echo 720</b> SIPCAM AGRO USA, INC.	chlorothalonil	54.00%		.875 to 1.625 lb Echo 90 DF per acre, 1.0 to 2.0 pt Echo 720 per acre or 1.5 to 2.75 pt Echo Zn per acre for control of anthracnose, Diaporthe pod and stem rot, frogeye leaf spot, purple seed stain, Cercospora leaf blight, Septoria brown spot and rust with a three-application program. For determinate varieties, make the first application at early flowering (R1), the second at early pod set (R3) and the third at beginning of seed formation (R5). For indeterminate varieties, make the first application one week after first flowering and continue applications at 14-day intervals.
<b>Echo Zn</b> SIPCAM AGRO USA, INC.	chlorothalonil	38.50%		.875 lb Echo 90 DF per acre, 1.0 pt Echo 720 per acre or 1.5 pt Echo Zn per acre for control of stem canker. Apply in 10 to 20 gallons of water per acre, as a band treatment directing the spray to provide coverage of entire plant. Make the first application at the time of emergence of the second trifoliolate leaves (V2). If conditions favor stem canker disease make a second and a third application. Make all applications at 14-day intervals.  Do not feed soybean hay or threshings from treated fields to livestock.
<b>Equus DF</b> FarmSaver.com LLC	chlorothalonil	82.50%	rate varies with diseases targeted for control and application program — see next column	1.4 to 2.1 lb Equus DF per acre, 2.1 to 3.4 pt per acre Equus 500 Zn or 1.5 to 2.4 pt per acre Equus 720 SST for control of anthracnose, Diaporthe pod and stem blight, frogeye leaf spot, purple seed stain, Cercospora leaf blight and Septoria brown spot with a two-application program. Make the first application at early pod set (R3) stage, when majority of pods are 1/8- to 3/4-inch in length) and the second at beginning of seed formation (R5), which occurs about 14 days later.
<b>Equus 500 Zn</b> FarmSaver.com LLC	chlorothalonil	38.50%		0.9 to 1.4 lb Equus DF, 1.4 to 2.8 pt per acre of Equus 500 Zn per acre or 1.0 or 2.0 pt per acre of Equus 720 SST for control of anthracnose, Diaporthe pod and stem blight, frogeye leaf spot, purple seed stain, Cercospora leaf blight and Septoria brown spot with a three-application program. Make the first application at the beginning of flowering (R1), the second at early pod set (R3) and the third at the beginning of seed formation (R5). Make all applications at 14-day intervals.
<b>Equus 720 SST</b> FarmSaver.com LLC	chlorothalonil	54.00%		For control of stem canker apply 0.9 lb Equus DF per acre or 1.0 pt per acre Equus 720 SST on determinate or indeterminate soybean varieties or 1.4 pt per acre of Equus 500 Zn on determinate soybean varieties. Apply in 10 to 20 gallons of water per acre, as a directed band treatment, directing spray to provide coverage of entire plant. Make the first application at the time of emergence of the second trifoliolate leaves (V2). If conditions favor stem canker disease, make a second and a third application. Make all applications at 14-day intervals.  1.25 to 2.2 lb Equus DF per acre or 1.37 to 2.25 pt per acre Equus 720 SST for control of soybean rust. Apply in sufficient water to obtain complete coverage, generally 10 to 20 gallons per acre. Make first application at first sign of disease and retreat at 14-day intervals. For resistance management of rust, alternate with another fungicide registered for soybean rust control.  Do not exceed a total of three applications per season.  Do not apply within 6 weeks of harvest.  Do not feed treated parts to live stock or allow grazing in treated fields.

## Foliar fungicides labeled for use on soybean

Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Folicur 3.6 F</b> Bayer CropScience	tebuconazole	38.70%	3.0 to 4.0 fl oz per acre	<p>Rust (<i>Phakopsora pachyrhizi</i>) and powdery mildew.</p> <p>Apply Folicur 3.6 F as a broadcast foliar spray as a preventative spray or at first visible symptoms of disease. Repeat applications on a 10- to 14-day interval if environmental conditions are favorable for continued disease development. Use of the higher rates and shorter spray intervals are recommended when disease pressure is severe.</p> <p>The lowest label recommended rate of a spray surfactant must be tank-mixed with Folicur 3.6 F.</p> <p>Folicur 3.6 F should be applied in a minimum of 10 gallons of spray solution per acre by ground sprayer or in a minimum of 5 gallons per acre by aircraft spray equipment.</p> <p>Do not apply more than three applications per season. Do not apply more than 12.0 fl oz per acre per use season.</p> <p>Restricted-entry interval (REI) is 12 hours.</p> <p>Applications may not be made within 21 days of harvest.</p>
<b>Headline</b> BASF	pyraclostrobin	23.60%	6.0 to 12.0 fl oz per acre	<p>Target diseases: Alternaria leaf spot, anthracnose, Septoria brown spot, Cercospora blight, frog-eye leaf spot, pod &amp; stem blight, Rhizoctonia aerial blight and Asian soybean rust. The 12.0 fl oz per acre rate is for suppression only of southern blight.</p> <p>For optimal disease control, apply Headline at early flowering (R1-R3 growth stage) or prior to disease development, whichever is earlier. Make a second application 7 to 21 days later if monitoring shows disease development or if conditions are conducive for disease infection. Use the higher labeled rate and shorter interval when disease pressure is high.</p> <p>Headline may be applied with adjuvants. It may be applied by ground sprayer, aerial equipment or through sprinkler irrigation systems.</p> <p>See label for information on resistance management.</p> <p>The minimum time from application to harvest (PHI) is 21 days.</p> <p>Soybean forage may be fed no sooner than 14 days after last application. Soybean hay may be fed no sooner than 21 days after last application.</p>
<b>Laredo EC</b> Dow AgroSciences	myclobutanil	25.00%	4.0 to 8.0 fl oz per acre	<p>Apply using ground or aerial equipment, in an adequate spray volume to achieve good coverage and canopy penetration. For aerial application, apply Laredo EC in a minimum spray volume of 5 gallons per acre. For best results apply preventively or as early as possible after an infection has occurred (a delay in fungicide application after an infection period has already occurred may result in yield loss), and make a subsequent application 14 to 21 days later. For maximum residual activity when used as a preventive treatment or optimum activity on established disease, use the higher rate in the rate range.</p> <p>Do not allow worker entry into treated areas during the restricted entry interval of 24 hours.</p> <p>Do not feed soybean forage or hay to livestock.</p> <p>Do not make applications within 28 days of harvest.</p> <p>Do not make more than two applications of myclobutanil-containing products to soybeans per season. Do not apply more than 16.0 fl oz of Laredo EC to soybeans per acre per year.</p>
<b>Microthiol</b> Cerexagri	sulfur	80.00%	10.0 to 15.0 lb per acre	<p>For leaf spot and powdery mildew. Apply at early leaf stage and repeat at 14-day intervals or as needed.</p>

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Orius 3.6F</b> Makhteshim Agan	tebuconazole	38.70%	3.0 to 4.0 fl oz per acre	<p>Rust and powdery mildew.</p> <p>Apply Orius 3.6F as a broadcast foliar spray, as a preventative spray or at first visible symptoms of disease. Repeat applications on a 10- to 14-day spray interval if environmental conditions are favorable for continued disease development. Use of the higher rates and shorter spray intervals are recommended when disease pressure is severe.</p> <p>The lowest labeled rate of a spray surfactant must be tank-mixed with Orius 3.6F.</p> <p>Orius 3.6F should be applied in a minimum of 10 gallons of spray solution per acre by ground sprayer or in a minimum of 5 gallons per acre by aircraft spray equipment.</p> <p>Do not apply more than three applications per season. Do not apply more than 12.0 fl oz per acre per season.</p> <p>Restricted-entry interval (REI) is 12 hours.</p> <p>Applications may not be made within 21 days of harvest.</p>
<b>Proline 480 SC</b> Bayer CropScience	prothioconazole	41.0%	2.5 to 3.0 fl oz per acre	<p>For control of Asian soybean rust and powdery mildew.</p> <p>Apply Proline 480 SC as a broadcast foliar spray as a preventative spray or at first visible symptoms of disease. Repeat applications on a 10 to 21-day spray interval if environmental conditions are favorable for continued disease development. Use of the higher rate and shorter spray intervals are recommended when disease pressure is severe.</p> <p>Use of spray adjuvants may enhance performance of Proline 480 SC, especially when disease is present at time of application. If utilized, apply the lowest labeled rate of a registered nonionic surfactant or spreader sticker.</p> <p>Proline 480 SC should be applied in a minimum of 15 gallons of spray solution by ground sprayer or in a minimum of 5 gallons per acre by aircraft spray equipment.</p> <p>Do not apply more than three applications per season. Do not apply more than 9.0 fl oz per use season.</p> <p>Applications may not be made within 21 days of harvest.</p>
<b>Quadris</b> Syngenta	azoxystrobin	22.90%	<p>6.0 to 15.5 fl oz per acre</p> <p>0.40 to 0.80 fl oz per 1,000 row feet for soilborne diseases- southern blight or <i>Rhizoctonia solani</i></p>	<p>Target diseases include aerial blight, anthracnose, Alternaria leaf spot, brown spot, Cercospora blight and leaf spot, frogeye leafspot, pod and stem blight and rust.</p> <p>Quadris applications should begin before disease development. Use the high rates under conditions favorable for disease pressure, dense plant canopies or when susceptible varieties are planted.</p> <p>Resistance management: follow the resistance management guidelines in the resistance management section of the Quadris label.</p> <p>Applications may be made by ground, air or chemigation. An adjuvant may be added at recommended rates. Use of a crop oil concentrate or nonionic surfactant with the lower use rate is recommended.</p> <p>Soybean rust: Quadris may be used at 4.0 fl oz per acre when tank mixed with triazol registered for use on soybean rust.</p> <p>Quadris is extremely toxic to certain apple varieties. See "Ground Use Instructions" on label for additional information on safety precautions to avoid injury to apple trees.</p> <p>Do not apply more than 1.5 lb a.i. per acre per season.</p> <p>Do not make more than one application of 15.4 fl oz product per acre to soybean forage and hay.</p> <p>Do not apply within 14 days of harvest of soybeans (beans).</p> <p>May be applied the day of harvest to soybean forage and hay.</p>

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Quadris Xtra</b> Syngenta	azoxystrobin cyproconazole	18.20% 7.30%	4.0 to 6.8 fl oz per acre	<p>For soybean rust: apply 4.0 to 6.8 fl oz per acre. Repeat at 14- to 28-day interval if conditions persist for rust development. Lower use rates may require a shorter spray interval. Depending on the conditions, application timing should be R1 (beginning flowering, approximately 50 days after planting) up to the R6 stage (seed development), but could be earlier.</p> <p>For disease other than soybean rust including aerial blight, <i>Alternaria</i> leaf spot, anthracnose, brown spot, <i>Cercospora</i> blight and leaf spot, frog-eye leaf spot and pod and stem blight: apply 5.0 to 6.8 fl oz per acre. For best results begin Quadris Xtra applications prior to disease development. Use the higher rates under conditions favorable for severe disease pressure, dense plant canopies or when disease is present. An adjuvant may be added at recommended rates to improve coverage.</p> <p>Application directions: coverage and penetration are important for best results. Use sufficient water volume to provide thorough and uniform plant coverage. Applications may be made by ground, air or chemigation. Addition of an additive with spreading and penetrating qualities will enhance coverage and efficacy.</p> <p>Resistance management: no more than two foliar applications of Quadris Xtra or other strobilurin fungicides should be made per growing season. Do not alternate or tank mix with fungicides to which resistance has developed in the pathogen population.</p> <p>Do not apply more than 13.6 fl oz Quadris Xtra per acre per season. Do not apply more than 0.072 lb a.i. per acre per year of cyproconazole containing products. Do not apply more than 1.5 lb a.i. per acre per year of azoxystrobin containing products.</p> <p>Do not graze forage within 14 days of application. Do not use soybean forage or hay as livestock feed if making more than one application at 6.8 fl oz per acre rate.</p> <p>Do not apply within 30 days of harvest of soybeans (beans).</p> <p>Quadris Xtra is extremely toxic to certain apple varieties. See "General Use Instructions" on label for additional information on safety precautions to avoid injury to apple trees.</p>
<b>Quilt</b> Syngenta	azoxystrobin propiconazole	7.0% 11.7%	14.0 to 20.5 fl oz per acre	<p>Target diseases: aerial web blight (<i>Rhizoctonia solani</i>), anthracnose (<i>Colletotrichum truncatum</i>), brown spot (<i>Septoria glycines</i>), frog-eye leaf spot (<i>Cercospora sojina</i>), soybean rust (<i>Phakopsora pachyrhizi</i>) and <i>Alternaria</i> leaf spot (<i>Alternaria</i> spp.) <i>Cercospora</i> blight and leaf spot (<i>Cercospora kickuchii</i>) and pod and stem blight (<i>Diaporthe</i> spp.)</p> <p>Aerial web blight: apply 14.0 to 20.5 fl oz per acre at the first appearance of disease and repeat the application 14 to 21 days later. Under severe disease conditions use the higher rate and the shorter interval.</p> <p>Other foliar diseases (except rust): apply 20.5 fl oz per acre at growth stage R3 (early pod set when pods are 1/8 to 1/4 inch long) and 14 to 21 days later at growth stage R5 (pod fill).</p> <p>Soybean rust: apply 14.0 to 20.5 fl oz per acre at first indication that disease is in the area. For best control, preventive applications work best. Repeat on a 14- to 21-day interval. Use the higher rate and shorter interval when disease is present in the field and incidence is less than 2% (2 plants in 100 are infected). If incidence is greater than this or disease is in mid-canopy, control will not be acceptable. Scouting for the disease and/or being aware of the proximity of the disease via monitoring systems will aid in the proper timing to maximize the effectiveness of the fungicide applications.</p> <p>On certain varieties, Quilt applications may cause crinkled, smaller and/or greener leaves. Yields of beans displaying these characteristics have not been reduced due to Quilt treatments.</p> <p>Quilt is extremely toxic to certain apple varieties. See "General Use Instructions" on label for additional information on safety precautions to avoid injury to apple trees.</p> <p>Do not apply more than 42.0 fl oz per acre per season of Quilt.</p> <p>Do not apply within 21 days of harvest for seed and zero days for forage and hay.</p>

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Stratego</b> Bayer CropScience	propiconazole trifloxystrobin	11.40% 11.40%	7.0 to 10.0 fl oz per acre	<p>For Asian soybean rust apply 7.0 to 10.0 fl oz per acre.</p> <p>For Alternaria leaf spot, anthracnose, Septoria brown spot and Cercospora blight apply 10.0 fl oz per acre.</p> <p>Apply Stratego as a broadcast foliar spray at early flowering (R1 to R3 growth stage) or prior to disease development, whichever is earlier. Repeat applications on a 10- to 21-day spray interval if disease monitoring or environmental factors indicate disease pressure is severe. Use of adjuvants may enhance the performance of Stratego. If utilized, apply the lowest label recommended rate of the adjuvant to enhance disease control. Applications may be made by ground or air. Stratego should be applied in a minimum of 10 gallons of spray solution per acre by ground sprayer or in a minimum of 5 gallons per acre by aircraft spray equipment.</p> <p>Applications may not be made within 21 days of harvest.</p> <p>Do not apply more than three applications per season.</p> <p>Do not apply more than 30.0 fl oz per acre per season.</p> <p>Do not apply more than two sequential applications of Stratego or any other QoI Group 11 fungicide without alternation with a fungicide from another group.</p>
<b>Thiolux Jet</b> Syngenta	sulfur	80.00%	7.5 to 12.0 lb per acre	<p>For powdery mildew.</p> <p>Apply when disease first appears and repeat as necessary or with the regularly scheduled insect control program.</p>
<b>Thiophanate Methyl 85 WDG</b> Makhteshim Agan	thiophanate methyl	85.00%	0.4 to 0.8 lb per acre	<p>For anthracnose, brown spot, frog-eye leaf spot, stem and pod blight and purple seed stain apply 0.4 to 0.8 lb per acre. Apply from full bloom when pods are 1/8 to 1/4 inch in length. Make a second application 14 to 21 days later. Do not make the second application later than 14 days after pods average 1/4 inch in length or when beans form in the pod. Use the high rate under severe disease pressure. For seed beans only make a single application at the high rate when beans form in the pod.</p> <p>For <i>Sclerotinia</i>, apply 0.6 to 0.8 lb per acre. Make one application at early bloom (R1 to R2 stage) followed by a second application 7 to 14 days later if conditions are favorable for continued disease pressure. Use a minimum of five gallons by air.</p> <p>For aerial blight (suppression), apply 0.8 lb per acre. Make initial application when disease threatens and repeat 14 to 21 days later if needed.</p> <p>Do not make more than two applications per year.</p> <p>Do not graze or feed treated vines to livestock.</p>

## Foliar fungicides labeled for use on soybean

### Products with Sec. 3 labels (full federal registrations)

Trade name Company	Common chemical name	% active ingredients	Rate	Additional label information
<b>Tilt</b> Syngenta	propiconazole	41.80%	4.0 to 6.0 fl oz per acre	<p>Target diseases: aerial web blight (<i>Rhizoctonia solani</i>), anthracnose (<i>Colletotrichum truncatum</i>), brown spot (<i>Septoria glycines</i>), frogeye leaf spot (<i>Cercospora sojina</i>) and soybean rust (<i>Phakopsora pachyrhizi</i>).</p> <p>Aerial web blight: apply 5.0 to 6.0 fl oz per acre at the first appearance of disease and repeat the application 14 to 21 days later. Under severe disease conditions use the higher rate and the shorter interval.</p> <p>Other foliar diseases (except rust): apply 6.0 fl oz per acre at growth stage R3 (early pod set when pods are 1/8- to 1/4-inch long) and 14 to 21 days later at growth stage R5 (pod fill).</p> <p>Soybean rust: apply 4.0 to 6.0 fl oz per acre at first indication that disease is in the area. For best control, preventive applications work best. Repeat on a 14- to 21-day interval. Use the higher rate and shorter interval when disease is present in the field and incidence is less than 2% (2 plants in 100 are infected). If incidence is greater than this or disease is in mid canopy, control will not be acceptable. Scouting for the disease and/or being aware of the proximity of the disease via monitoring systems will aid in the proper timing to maximize the effectiveness of the fungicide applications.</p> <p>On certain varieties, Tilt applications may cause crinkled, smaller and/or greener leaves. Yields of beans displaying these characteristics have not been reduced due to Tilt treatments.</p> <p>Tilt is most effective when applied and allowed to dry before a rainfall. For best results, sufficient water volume should be used to provide thorough coverage. Tilt may be applied by either ground or aerial application. Addition of an oil-based additive is recommended for improved coverage and penetration when applying by air.</p> <p>Do not apply more than 12.0 fl oz per acre per season of Tilt.</p> <p>Apply up to Stage R6.</p>
<b>Topsin M 70WP</b> Cerexagri	thiophanate-methyl	70.00%	rate varies with diseases targeted for control and application program-see next column	<p>0.5 to 1.0 lb of Topsin M 70WP or Topsin M WSB or 10.0 to 20.0 fl oz per acre of Topsin 4.5FL per acre for anthracnose, Septoria brown spot, frogeye leaf spot, pod and stem blight and purple seed stain. Apply from full bloom to when pods are 1/8 to 1/4 inch in length. Make a second application 14 to 21 days later. Do not make the second application later than 14 days after pods average 1/4 inch in length or when beans form in the pod. Use the high rate under severe disease pressure.</p>
<b>Topsin M WSB</b> Cerexagri	thiophanate-methyl	70.00%		
<b>Topsin 4.5FL</b> Cerexagri	thiophanate-methyl	45.00%		<p>For seed beans only: for seed quality, make a single application at the high rate when beans form in the pod.</p> <p>0.75 to 1.0 lb of Topsin M 70WP or Topsin M WSB or 15.0 to 20.0 fl oz of Topsin 4.5FL per acre for white mold (<i>Sclerotinia</i>). Make one application at early bloom (R-1 to R-2 stage) followed by a second application 7 to 14 days later if conditions are favorable for continued disease pressure. Use a minimum of 5 gallons of water by air.</p> <p>1.0 lb of Topsin M 70WP or Topsin M WSB or 20.0 fl. oz of Topsin 4.5FL per acre for suppression of aerial blight. Make initial application when disease threatens and repeat 14 to 21 days later if needed.</p> <p>Preharvest interval: 21 days.</p> <p>Do not make more than two applications per year.</p> <p>Do not graze or feed treated vines or hay to livestock.</p>

## Soybean rust

Asian soybean rust (*Phakopsora pachyrhizi*) was found in eight states in the continental United States during November 2004. During 2005 soybean rust was reported in soybean sentinel plots, in commercial soybean fields and in kudzu patches in nine southern states. During the 2006 season, soybean rust was reported on soybeans in 231 counties in 15 states (including five counties in southeast Missouri) and on kudzu in 38 counties. During the 2007 season, soybean rust was reported on soybeans in 290 counties in 19 states (including 37 counties across Missouri) as well as in one province in Canada and two municipalities in the Mexican state of Veracruz-Llave. It is critical that anyone involved in soybean production be familiar with the disease and its identification and management. See MU publication G4442, *Soybean Rust*, for more detailed information on this disease.

The most common symptom of soybean rust is a foliar lesion. On the upper leaf surface, initial symptoms may be small, yellow flecks or specks in the leaf tissue. These lesions darken and may range from dark brown to reddish brown to tan or gray-green in color. The lesions tend to be angular to somewhat circular in shape and may be concentrated near leaf veins. The fungus produces spores in cone-shaped structures on the lower leaf surface. At first these pustules might appear to be small, raised blisters or callous bumps on the lower leaf surface. But as the pustules mature, they begin to produce large numbers of light-colored, powdery spores, which emerge through a distinct hole or pore in the cone-shaped structure. Masses of light-colored (gray to buff to light tan or brown) spores may lodge in the opening or mound up out of the opening in the pustule. The pustules and spores are difficult to see without magnification.

Soybean rust is usually found first on the lower leaves of plants, especially at or near flowering. As the plants mature, lesions may be found in the middle and upper canopy. When conditions are favorable for disease development, yellowing of the foliar may be evident and defoliation and premature death of plants may occur.

### Management options for soybean rust

- Stay informed about the development of soybean rust in the southern United States and about weather patterns that might transport rust spores north.

- Scout or monitor fields on a regular basis, especially if reports indicate that soybean rust is active and moving north or if plants in fields are approaching flowering.
- If there is a risk of soybean rust developing, the only management option is the application of foliar fungicides. Since soybean rust is a relatively new disease in the continental United States there is limited data on the efficacy of fungicides in the control of the soybean rust in the United States. There has been, and will continue to be, an evolution in fungicide recommendations for the control of soybean rust as we gain experience with the disease and its management. *At this time, foliar fungicides available for use in managing soybean rust include many of the fungicides listed in the preceding table, which lists fungicides that have received full federal registration and thus have Section 3 labels. Another group of foliar fungicides has received special Section 18 labels (quarantine exemption labels) for use on soybeans only if there is a threat of soybean rust and only for management of soybean rust.* These Section 18 fungicides are listed in the following table. Other fungicides have been submitted for Section 18 labels, but approval has not been granted as of December 2008. Continue to check Extension newsletters and Web sites during the growing season for information on additional Section 18 fungicides.

The following table was prepared using current company product label books and manufacturers' Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

For Section 18 products, the Section 18 label for the state in which the application is being made must be in possession of the user at the time of pesticide application. A maximum of three total applications using approved Section 18 products collectively may be made under the Section 18 labels. In particular, with these Section 18 products, recommended rates and recommended time of application (i.e. preventative vs. curative) may change as companies evaluate data on their products. Check for the most current updates before using these materials.

## Foliar fungicides labeled for use on soybean

Products with Sec. 18 Labels (Quarantine Exemption Labels for use only against soybean rust)

Trade name Company	Common chemical name	% of active ingredients	Rate	Additional label information
<b>Punch</b> DuPont	flusilazole	37.80%	3.0 to 4.0 fl oz per acre	Use Punch at 3.0 to 4.0 fl oz per acre for control of Asian soybean rust.  Apply Punch as a broadcast foliar spray. Apply on a 14- to 21-day schedule.  Do not apply Punch within 30 days of harvest.  Apply no more than two applications per 12-month period.  Do not use soybean hay or forage for livestock feed.  The reentry interval for soybeans is seven days.
<b>Topguard</b> Cheminova	flutriafol	11.80%	7.0 fl oz per acre	For use in soybeans to control soybean rust.  Apply Topguard as a broadcast foliar spray when conditions are favorable for development of soybean rust. Repeat application 21 days after first treatment if environmental conditions are favorable for continued disease development.  Apply in a minimum of 10 gallons of spray solution per acre by ground sprayer or in a minimum of 5 gallons per acre by aircraft spray equipment.  Topguard fungicide may be tank-mixed with other approved soybean fungicides, herbicides or insecticides unless prohibited on the label.  Applications may not be made within 21 days of harvest.  Do not enter treated fields for 12 hours after application.  Do not feed soybean forage or hay to livestock.  Do not make more than two applications of flutriafol containing products to soybeans per season. A maximum of three total applications using approved Section 18 products collectively are allowed under this soybean rust Section 18.  Observe a plant-back interval of 120 days for all crops.

## Soybean virus diseases

Bean pod mottle, soybean mosaic, tobacco ringspot and bean yellow mosaic are among several viruses that occur on soybean in Missouri. These virus diseases tend to cause green to yellow mottling of leaf tissue, stunting of plant growth and deformation of plant tissues. Symptoms of bean pod mottle and soybean mosaic are similar and difficult to distinguish in the field. Also, these viruses may occur in combination. Laboratory tests are the only means of accurately identifying which virus or combination of viruses is present in infected plants.

**Bean pod mottle** causes a green to yellow mottling of young leaves in the upper canopy. This virus is sap-transmissible and vectored by beetle species such as the bean leaf beetle. The host range of bean pod mottle virus is limited to legumes. In addition to soybean, other possible hosts are lespedeza, alfalfa and clover. The bean pod mottle virus is not considered to be seedborne at very high levels.

**Soybean mosaic** causes a green to yellow mottling or mosaic pattern on leaf tissue as well as puckering and distortion of the leaf shape. Soybean mosaic virus is sap-transmissible and vectored by several aphid species. Soybean mosaic virus may also be seedborne. Infected seed may show a bleeding hilum symptom or a brown to black mottling of the seed coat. However, seed coat discoloration is not a definite indication of seed infection because infected seed can be symptomless and seed coat discoloration can be caused by factors other than soybean mosaic virus.

When bean pod mottle and soybean mosaic occur in combination in the same plant, symptoms are more severe and yield losses higher than those caused by either virus alone.

**Soybean budblight**, caused by the tobacco ringspot virus, results in the curving of the terminal in the shape of a crook. Plants are usually stunted with a bushy appearance, leaves are rugose and rolled and pods may be poorly developed or aborted. Plants tend to remain green after uninfected plants have matured and turned in color. Tobacco ringspot virus is readily sap-transmissible. Although no efficient insect vector has yet been discovered, thrips are implicated in the spread of the virus. The soybean budblight virus has a wide host range including a number of weed species. Pastures or uncultivated areas containing other hosts for tobacco ringspot virus may serve as sources of inoculum for nearby soybean fields. The virus may also be seedborne.

**Soybean yellow mosaic** is caused by the bean yellow mosaic virus. The leaves exhibit brilliant yellow mosaic patches. The virus has a wide host range and is transmitted by several aphids. Seed transmission has not been reported.

### Management options for soybean virus diseases

- Plant disease-free seed.
- Plant varieties resistant to soybean mosaic virus.
- Maintain good weed control.
- In some situations, the control of insect vectors may be warranted.

## Soybean cyst nematode (SCN)

The soybean cyst nematode, *Heterodera glycines*, is a serious problem throughout the state and in most soybean-producing areas of the United States. Symptoms of soybean cyst nematode (SCN) range from no obvious symptoms to subtle differences in plant height and vigor or unexpected decreases in yield to severe stunting and discoloration of plants. Plants with SCN may have poorly developed root systems. If plants are carefully dug up, females may be evident on the roots. The females appear as tiny (smaller than nitrogen-fixing nodules), whitish to yellow to brownish, lemon-shaped structures on the roots. Symptom expression may be more severe if plants are subjected to other stresses such as moisture stress, nutrient deficiencies or herbicide injury.

The cysts are the bodies of the dead female nematodes. The cysts are actually protective egg cases, which contain up to 250 SCN eggs. Eggs in cysts may survive in the soil for extended periods even in the absence of soybean crops. Anything that moves cyst-infested soil can spread SCN including machinery, animals, migratory birds, people, wind, water and soil peds associated with seed. Once in a field, SCN may take several years to build up to damaging levels.

For more detailed information on SCN, soil sampling for SCN and strategies for managing SCN, please refer to MU publication G4450, *Soybean Cyst Nematode: Diagnosis and Management*.

### Management options for soybean cyst nematode

- Employ a program of soil sampling to identify problem fields and to determine the extent and severity of the problem in the field.
- Select resistant varieties. If at all possible, it is important to rotate sources of genetic resistance to SCN in soybean varieties grown.
- Rotate to non-host crops (the length of time out of susceptible soybean varieties will depend on population levels of the soybean cyst nematode in a given field).
- Maintain good plant vigor.
- Although several nematicides are labeled for use on soybean, economic and environmental concerns limit their use.

## Sudden death syndrome (SDS)

In Missouri, sudden death syndrome (SDS) tends to be a continual problem in river bottom fields in the central and eastern portions of the state. However, the pathogen, *Fusarium virguliforme* (formerly known as *Fusarium solani* f. sp. *glycines*), appears to be present in soybean-producing areas throughout the state. In years when environmental conditions are favorable for infection and symptom development, SDS may be found in most areas of the state.

SDS has been associated with maximum yield potential soybean production, i.e., fields with optimum fertility, irrigation and lime application. Field observations suggest that SDS is more likely to occur and to be more severe with high soil moisture, whether that is supplied by rainfall or by irrigation. High soil moisture during vegetative stages of soybean growth seems to be the most conducive to disease

development. The onset of SDS symptoms frequently is associated with wet conditions and below normal temperatures at or near bloom.

### Management options for sudden death syndrome

- Plant varieties that have performed well where sudden death syndrome has been a problem.
- Improve drainage in poorly drained fields and avoid compacting soils.
- Stagger planting dates and delay planting until soils are warm and dry.
- Avoid continuous cropping soybean.
- Maintain good crop vigor and avoid crop stress including stress from soybean cyst nematode.
- Harvest fields with sudden death syndrome in a timely fashion.

## Charcoal rot

Charcoal rot may cause a seedling infection, but is more commonly considered a mid- to late-season soybean disease. Symptoms typically begin to develop as plants move into reproductive stages of growth.

The fungus that causes charcoal rot, *Macrophomina phaseolina*, is a common soil fungus in Missouri. Corn and grain sorghum are also hosts of the charcoal rot fungus. Charcoal rot is favored by hot, dry weather, so symptoms usually appear when temperatures are in the range of 82 to 95 degrees F.

### Management options for charcoal rot

- Rotate to cereals, cotton or other non-hosts for one or two years; with corn or grain sorghum a rotation of three years may be necessary.
- Maintain good crop vigor to help reduce losses from charcoal rot.
- Irrigate properly from just before bloom to pod fill.

## Sclerotium blight (southern blight)

Sclerotium blight, also called southern blight or white mold, is caused by the fungus *Sclerotium rolfsii*. This disease tends to be a problem primarily in the southeastern part of Missouri. *Sclerotinia rolfsii* produces small, tan to brown sclerotia (small survival structures) that allow it to survive for extended periods of time in the soil.

### Management options for Sclerotium blight

- Rotate crops with at least one year between soybean crops. If Sclerotium blight has been severe, a three- to four-year rotation may be necessary.

## Sclerotinia stem rot (white mold)

Sclerotinia stem rot or white mold, caused by *Sclerotinia sclerotiorum*, is a problem for soybean farmers in Michigan, Wisconsin, Minnesota, northern Iowa and northern Illinois. It has been reported in Missouri but has not been a widespread or serious problem in the state's soybean crop. The disease appears to be favored by moderate temperatures in the

canopy (less than 82 degrees F) and frequent rainfalls especially as the crop begins to flower and set pods. When those conditions occur during the growing season, *Sclerotinia* white mold certainly may occur in Missouri soybean fields.

This fungus has a wide host range including dry beans, potatoes, canola, sunflower, peas and many broadleaf weeds. *Sclerotinia sclerotiorum* produces small, black survival structures called sclerotia. These sclerotia can survive in the soil for years.

**Management options for Sclerotinia stem rot**

- Plant resistant varieties.
- Rotate crops with at least one year between soybean crops and do not plant soybean after common bean, sunflower or other susceptible crops.
- Plant disease-free seed that is free of sclerotia.
- Maintain good weed control.

**Brown stem rot**

Although brown stem rot has been reported in Missouri, it is not a widespread or serious problem in the state. When brown stem rot is found in Missouri, it tends to be in the northern part of the state. Brown stem rot is caused by the fungus *Phialophora gregata*, which survives in infested crop residues and in the soil.

Development of brown stem rot is favored by temperatures in the range of 59 to 81 degrees F. As air temperatures increase above 81 degrees F, both incidence and severity of brown stem rot decrease. Leaf symptoms are most pronounced if cool weather occurs as the crop enters the reproductive stages of growth. Internal browning of stem tissues is greatly reduced at higher temperatures.

**Management options for brown stem rot**

- Plant resistant varieties.
- Rotate crops with at least one year between soybean crops. Longer rotations may be necessary in fields with established brown stem rot problems.

**Pod and stem blight and Phomopsis seed decay**

*Phomopsis longicolla* and the other *Diaporthe* and *Phomopsis* species that cause pod and stem blight and *Phomopsis* seed decay can survive in infested crop residues, in the soil and in seed. Symptoms usually develop on stems of plants during later reproductive stages of growth.

Prolonged periods of warm, wet weather during flowering and pod fill favor the development of pod and stem blight. If wet weather continues through harvest, levels of *Phomopsis* seed decay may be high.

**Management options for pod and stem blight**

- Rotate crops with at least one year out of soybeans.
- Use disease-free seed (pathogen may survive on infested seed and cause seedling blights if that seed is planted the next year).

- Use an appropriate fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on soybean.
- Use of a foliar fungicide during the growing season is seldom warranted, except in seed production fields in seasons favorable for pod infection.

**Anthraco**

*Colletotrichum truncatum* and several other *Colletotrichum* species cause anthracnose of soybean. Typically, anthracnose develops as a stem and pod disease on soybean plants during later reproductive stages of growth. However, in some seasons anthracnose may cause a tip blight on plants in early pod filling stages of growth.

Anthraco

**Management options for anthracnose**

- Rotate crops with at least one year between soybean crops.
- Plant disease-free seed (pathogen may survive on infested seed and cause seedling blights if that seed is planted the next year).
- Use an appropriate fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on soybean.
- Use of a foliar fungicide during the growing season is seldom warranted, except in seed production fields in seasons favorable for pod infection.

**Cercospora blight, leaf spot and purple seed stain**

*Cercospora kikuchii* can infect soybean seeds, pods, stems and leaves but is most commonly found on the seed. The pathogen survives in infested crop residues and on seed.

Warm, humid weather favors disease development. Yields are not usually reduced, but a high percentage of seed stain may be evident at harvest. Heavily infected seed, if planted, could produce diseased seedlings resulting in stand problems.

**Management options for Cercospora blight, leaf spot and purple seed stain**

- Rotate crops with at least one year between soybean or other legumes.
- If infected seed must be planted, use an appropriate fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on soybean.

## Stem canker

Although stem canker can occur in Missouri, this disease is usually not widespread or serious in the state. *Diaporthe phaseolina*, the fungus that causes stem canker, survives in infested residues. Infection by the stem canker pathogen is favored by extended periods of rainy weather during early vegetative stages of soybean growth. However, symptoms

may not be evident until later in the season.

### Management options for stem canker

- Rotate crops with at least one year between soybean crops.
- Plant resistant varieties.

## Winter wheat diseases and their management

Wheat diseases can and do occur each year in Missouri. Problems with germination and stand establishment that are related to seed decay, damping-off and seedling blights may be encountered in the field. Diseases may cause leaf spots or leaf blights, wilts or premature death of plants. Wheat diseases can also cause harvest losses, affect the quality of the harvested crop and cause storage losses. The extent of the damage due to wheat diseases in a given season depends on a number of factors, including the susceptibility of the wheat variety to the specific diseases, the level of the pathogen inoculum present and the environmental conditions during that season.

To minimize losses due to wheat diseases, it is important to correctly identify the disease or diseases present so that appropriate management steps can be taken. The principal diseases of wheat in Missouri are of five types: (1) seedling diseases, (2) virus diseases, (3) foliage diseases, (4) root, crown and wilt diseases, and (5) head diseases. For more detailed information including color pictures of winter wheat diseases in Missouri, see University of Missouri publication IPM 1022, *Management of Soft Red Winter Wheat*.

### Seedling diseases of winter wheat

There are a number of seedborne and soilborne pathogens that can cause seedling diseases in wheat. Seed may be rotted before germination or developing seedlings may be infected before or after emergence. Stands may be thin or uneven. Seedlings may be yellow and stunted. Root systems may be poorly developed with root and crown tissue brown to black in color and soft or rotted. Seedling diseases tend to be more severe if poor quality or diseased seed is used and if conditions at planting are not favorable for quick germination and stand establishment. Planting good quality, disease-free seed is the most effective means of preventing problems from seedborne pathogens. If seed contaminated with a seedborne pathogen must be used for planting, it is impor-

tant to clean the seed lot thoroughly to remove as much of the small, damaged seed as possible, to have a germination test done on the cleaned seed lot and to consider the use of a fungicide seed treatment.

### Management options for wheat seedling diseases

- Plant good-quality, disease-free seed under good seed-bed conditions.
- Use a fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on winter wheat.

### Seed treatment fungicides for use on winter wheat

Although seed treatment fungicides can be an effective means of preventing or reducing losses from various seedborne and soilborne microorganisms, there are several important laws or guidelines concerning fungicide treated seed. Always read the pesticide label and follow all directions and restrictions on the label but in particular for seed treatment fungicides remember the following points.

- Do not use treated seed for food, feed or oil purposes.
- All treated seed must be colored with an EPA-approved dye which imparts an unnatural color to the seed.
- Federal law requires that bags containing treated seed shall be labeled with the following information: "This seed has been treated with (common chemical name of active ingredients) fungicide(s). Do not use treated seed for feed, food or oil purposes. Store away from feeds and food stuffs."

The following table was prepared using current company product labels and manufacturers' Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

## Seed treatment fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Allegiance Dry</b> Chemtura (formerly Trace Seed Protection Products)	metalaxyl	12.50%	1.5 to 2.0 oz per 100 lb of seed	<p>For <i>Pythium</i> damping-off control.</p> <p>Treat only those seeds needed for immediate use, minimizing the interval between treatment and planting. Do not carry over excess treated seed to next season.</p> <p>Do not use this product on seed that has been commercially treated with metalaxyl (Allegiance) fungicide.</p> <p>Hopper box seed treatment.</p>
<b>Allegiance-FL</b> Bayer CropScience	metalaxyl	28.35%	0.75 fl oz per 100 lb of seed	<p>Allegiance-FL is a systemic fungicide seed dressing specifically for control of downy mildews, <i>Pythium</i> and <i>Phytophthora</i> spp. For control of other soilborne diseases, combination of Bayer CropScience Captan registered formulations are compatible. Do not use with other seed treatment products unless previous experience assures compatibility.</p> <p>Reduced rates in combination with other fungicides: to aid in the control of seed decay and damping-off caused by <i>Pythium</i>, apply 0.10 to 0.375 fl oz per 100 lb of seed only in combination with EPA registered rates of Bayer CropScience broad-spectrum seed treatment fungicides.</p> <p>Allegiance-FL may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment.</p>
<b>Allegiance LS</b> Bayer CropScience	metalaxyl	17.70%	1.2 fl oz per 100 lb of seed	<p>Allegiance LS is a systemic fungicide seed dressing specifically for control of downy mildews, <i>Pythium</i> and <i>Phytophthora</i> spp. For control of seedborne and other soilborne diseases, the combination of Bayer CropScience Captan and Thiram registered formulations are compatible. Do not use with other seed treatment products unless previous experience assures compatibility.</p> <p>Reduced rates in combination with other fungicides: to aid in the control of seed decay and damping-off caused by <i>Pythium</i>, apply 0.175 to 0.66 fl oz per 100 lb of seed only in combination with EPA-registered rates of Bayer CropScience broad-spectrum seed treatment fungicides.</p> <p>Allegiance LS may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment. Allegiance LS may be applied at planting time by thoroughly mixing with seed in the planter box or by application through on-farm seed treatment equipment.</p>
<b>Apron XL LS</b> Syngenta	mefenoxam	33.30%	0.32 to 0.64 fl oz per 100 lb of seed	<p>Apron XL LS is a systemic fungicide seed dressing used specifically for protection against systemic downy mildews and diseases caused by soilborne <i>Pythium</i> and <i>Phytophthora</i> spp. When a rate range is specified, use higher rates of Apron XL LS when the disease pressure is expected to be high.</p> <p>For <i>Pythium</i> damping-off protection in wheat when applied in combination with Dividend or other seed treatment products labeled for disease control in this crop: apply Apron XL LS as a seed treatment at 0.0425 to 0.085 fl oz per 100 lb of seed.</p> <p>Apron XL LS may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry- or mist-type commercial seed treatment equipment.</p>
<b>Captan 400</b> Bayer CropScience	captan	37.40%	1.5 to 4.0 fl oz per 100 lb of seed	<p>Captan 400 and Captan 400-C Seed Protectants are flowable concentrates especially formulated for treatment of seed prior to storage and planting to protect seed from molds and other fungi causing storage loss and to protect seed from seedborne and soilborne fungi which cause seed decay, damping-off and seedling blights. Not for control of bunt and smut diseases of wheat.</p> <p>Thoroughly mix the recommended amount of Captan 400 or Captan 400-C Seed Protectant into the required amount of water for the slurry treater equipment and dilution rate to be used.</p>
<b>Captan 400-C</b> Bayer CropScience	captan	37.40%	1.5 to 4.0 fl oz per 100 lb of seed	

## Seed treatment fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Charter</b> BASF	triticonazole	2.40%	3.1 fl oz per 100 lb of seed	Charter Fungicide is a liquid seed treatment used for the control of loose smut and common bunt in wheat; will generally increase emergence and plant stands by controlling seedling blights and will also suppress early-season infections caused by <i>Fusarium</i> crown and root rot and control seed rot and seedborne seedling blight caused by <i>Fusarium</i> sp.  Do not store treated seed for more than 18 months.  Charter Fungicide may be applied using standard commercial seed treatment equipment or on-farm seed treatment equipment, but is not intended for direct application into a planter box.
<b>Charter PB</b> BASF	triticonazole thiram	1.25% 12.50%	5.5 fl oz per 100 lb of seed	Charter PB is a liquid seed treatment used for the control of loose smut and common bunt in wheat. It will increase emergence and plant stands by reducing seed and soilborne seed rots ( <i>Cochliobolus</i> spp.) seedling blights ( <i>Fusarium</i> spp.) and damping-off ( <i>Pythium</i> spp.).  Charter PB may be applied using standard commercial seed treatment equipment (such as, but not limited to, slurry or mist-type equipment) or on-farm seed treatment equipment including "On the Go" type air seeder treatment systems. This product is not intended for direct application into a planter box.
<b>CruiserMaxx Cereals</b> Syngenta	thiamethoxam mefenoxam difenoconazole	2.80% 0.56% 3.36%	5.0 fl oz per 100 lb of seed	For winter wheat: diseases controlled include general seed rots, seedling blight, root rot and damping-off caused by seedborne and soilborne <i>Fusarium</i> and soilborne <i>Pythium</i> , common and dwarf bunt and loose smut. Diseases suppressed include common root rot, <i>Fusarium</i> crown and foot rot and take-all.  For additional <i>Pythium</i> protection, add 0.0425 fl oz of Apron XL LS per 100 lb of seed.  CruiserMaxx Cereals is a ready-to-use water-based formulation for use in commercial seed treatment facilities utilizing closed-system application techniques. In addition, CruiserMaxx Cereals may also be applied by on-site/on-farm applications.
<b>Dithane DF Rainshield</b> Dow AgroSciences	mancozeb	75.00%	2.3 to 3.5 oz. per 100 lb of seed	For control of bunt, damping-off, seed rots and seedling blights.  May be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.
<b>Dithane M45</b> Dow AgroSciences	mancozeb	80.00%	2.2 to 3.3 oz. per 100 lb of seed	
<b>Dividend XL</b> Syngenta	difenoconazole mefenoxam	16.50% 1.38%	1.0 fl oz per 100 lb of seed  or  2.0 fl oz per 100 lb of seed	Dividend XL is a combination of Dividend and Apron XL LS. The Apron XL LS provides <i>Pythium</i> damping-off activity and the Dividend provides activity on the remaining diseases claimed on the label.  The 1.0 fl oz rate of Dividend Extreme and the 2.5 fl oz rate of Dividend XL RTA are for control of common bunt and loose smut.
<b>Dividend XL RTA</b> Syngenta	difenoconazole mefenoxam	3.21% 0.27%	2.5 fl oz per 100 lb of seed	The 1.0 fl oz rate of Dividend XL is for control of common bunt, dwarf bunt, flag smut, seedborne <i>Septoria</i> , loose smut, general seed rots, <i>Fusarium</i> seed scab and <i>Pythium</i> damping-off and for early-season control of common root rot and <i>Rhizoctonia</i> root rot.
<b>Dividend Extreme</b> Syngenta	difenoconazole mefenoxam	7.73% 1.93%	1.0 fl oz per 100 lb of seed	The 2.0 fl oz rate of Dividend XL is for control of common bunt, dwarf bunt, flag smut, seedborne <i>Septoria</i> , loose smut, general seed rots, <i>Fusarium</i> seed scab and <i>Pythium</i> damping-off and for early-season control of common root rot, <i>Fusarium</i> root rot, <i>Fusarium</i> crown rot, take-all and <i>Rhizoctonia</i> root rot as well as fall season powdery mildew, leaf rust and <i>Septoria</i> leaf blotch. Dividend XL provides control of the fall season foliage diseases for the first six weeks after planting.  Green wheat forage may not be grazed until 55 days after planting.  Apply Dividend XL or Dividend Extreme as a water-based slurry through standard slurry or mist-type seed treatment equipment. Dividend XL RTA is especially formulated for on-farm treatment, using standard mechanical slurry- or mist-type seed treatment equipment.
<b>Dynasty</b> Syngenta	azoxystrobin	9.60%	0.153 to 0.382 fl oz per 100 lb of seed	Target diseases: seedborne and soilborne fungi causing decay, damping-off and seedling blight; seedling damping-off caused by <i>Rhizoctonia solani</i> , dwarf bunt and common bunt.  Where appropriate use Dynasty in combination with Dividend Extreme and/or Maxim seed treatment products.  Apply as a water-based slurry using seed treatment application equipment that will provide uniform coverage on the seed surface.

## Seed treatment fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Enhance Enhance AM</b> Chemtura (formerly Trace Seed Protection Products)	captan	19.55%	4.0 oz per 100 lb of seed	Enhance Seed Protectant and Enhance AM are formulations specifically designed for treatment of wheat on the farm at planting time. They control covered smut ( <i>Tilletia caries</i> and <i>Tilletia foetida</i> ) and loose smut ( <i>Ustilago nuda</i> ) on wheat.  Apply as a planter box treatment (including air and vacuum planters), mixing thoroughly with the seed before planting. For best results, follow application directions on label.  Do not graze or feed livestock on treated areas for 45 days after planting.
	carboxin	20.00%		
<b>FLO-PRO IMZ</b> Bayer CropScience	imazalil	31.00%	0.25 to 0.5 fl oz per 100 lb of seed	For the control of common root rot. It is recommended for use in combination with Vitavax-200 or other flowable suspension seed treatments to provide additional protection against diseases.  Apply using commercial slurry or on-farm seed treating equipment.
<b>Gaucht XT</b> Bayer CropScience	imidacloprid	12.70%	3.4 fl oz per 100 lb of seed	Early-season disease control of Pythium damping-off, stinking smut, flag smut, loose smut, early-season Septoria disease complex, early-season Rhizoctonia root rot, early-season common root rot, early-season Fusarium root rot, early-season suppression of powdery mildew and early-season suppression of leaf rust as well as control of certain insects.  Do not graze or feed livestock on treated areas for 45 days after planting.  See label for rotational crop restrictions.  Apply as a slurry treatment prior to planting.
	metalaxyl	0.82%		
	tebuconazole	0.62%		
<b>Grain Guard</b> Chemtura (formerly Trace Seed Protection Products)	mancozeb	50.00%	2.0 oz per bushel of seed	For control of bunt of wheat, and damping-off and seedling blights.  Treat only those seeds needed for immediate use, minimizing the interval between treatment and planting. Do not store excess treated seeds beyond planting time.  Apply as a drill box treatment mixing thoroughly so all seeds are covered.
<b>Incentive RTA</b> Winfield Solutions LLC	difenoconazole	3.21%	2.5 fl oz per 100 lb of seed or 5.0 fl oz per 100 lb of seed or 10.0 fl oz per 100 lb of seed	Incentive RTA is a combination of Incentive and Apron XL LS. The Apron XL LS provides Pythium damping-off activity and the Incentive provides activity on the remaining diseases claimed on the label.  The 2.5 fl oz rate of Incentive RTA is for control of common bunt and loose smut.  The 5.0 fl oz rate of Incentive RTA is for control of common bunt, dwarf bunt, flag smut, seedborne Septoria, loose smut, general seed rots, Fusarium seed scab and Pythium damping-off and for partial control of common root rot and Rhizoctonia root rot.  The 10.0 fl oz rate of Incentive RTA is for control of common bunt, dwarf bunt, flag smut, seedborne Septoria, loose smut, general seed rots, Fusarium seed scab and Pythium damping-off and for partial control of common root rot, Fusarium root rot, Fusarium crown rot, take-all and Rhizoctonia root rot as well as fall season powdery mildew, leaf rust and Septoria leaf blotch. Incentive RTA provides control of the fall season foliage diseases for the first six weeks after planting.  Green wheat forage may not be grazed until 55 days after planting.  Incentive RTA is especially formulated for on-farm treatment, using standard mechanical slurry- or mist-type seed treatment equipment.
	mefenoxam	0.27%		
<b>Kodiak HB</b> Chemtura (formerly Trace Seed Protection Products)	<i>Bacillus subtilis</i>	0.30%	4.0 to 8.0 oz per 100 lb of seed	For suppression of root diseases caused by <i>Fusarium</i> and <i>Pythium</i> .  Contains bacteria that colonize the developing root system, suppressing disease organisms such as <i>Fusarium</i> and <i>Pythium</i> that attack root systems. When used with a chemical seed treatment, the combination of chemicals and Kodiak provides protection to the root for a much longer time than with chemicals alone.  Kodiak HB is a hopper box seed treatment.

## Seed treatment fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>LSP</b> Bayer CropScience	thiabendazole	30.00%	2.0 to 4.0 fl oz per 100 lb of seed	<p>For control of seedborne and soilborne common bunt (stinking smut). For ready mix or slurry seed treaters, disperse 2.0 fl oz of Bayer CropScience LSP for seedborne common bunt or 4.0 fl oz per 100 lb of seed for soilborne common bunt.</p> <p>For wheat seed having high infection levels of seedborne <i>Fusarium</i> scab, a lower rate of 0.25 fl oz per 100 lb of seed is recommended.</p> <p>Bayer CropScience LSP should be used as a co-fungicide combined with Raxil or broad-spectrum fungicides to include seed and seedling protection against the broad spectrum of diseases associated with the wheat crop.</p> <p>For use only by commercial seed treaters.</p>
<b>Manex</b> DuPont	maneb	37.00%	3.5 to 5.2 fl oz per 100 lb of seed	<p>For protection against bunt, damping-off, seed rots and seedling blights.</p> <p>Manex may be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.</p>
<b>ManKocide</b> Griffin L.L.C.	mancozeb copper hydroxide	15.00% 46.10%	4.0 oz per 100 lb of seed	<p>Target diseases: <i>Pseudomonas syringae</i>, <i>Xanthomonas translucens</i> and <i>Tilletia caries</i>.</p> <p>ManKocide may be applied to dry seed with conventional slurry or mist seed treating equipment or as a planter box application.</p>
<b>Manzate Pro-Stick</b> DuPont	mancozeb	75.00%	2.2 to 3.3 oz per 100 lb of seed	For protection against bunt, covered smut, damping-off, seed rots and seedling blights.
<b>Manzate Flowable</b> Griffin L.L.C.	mancozeb	37.00%	3.5 to 5.2 fl oz per 100 lb of seed	<p>For commercial seed treatments, seeds should be clean and well-cured before treatment. Apply to dry seed with conventional slurry or mist seed treating equipment.</p> <p>Manzate Pro-Stick may also be applied as planter box applications.</p>
<b>Maxim XL</b> Syngenta	fludioxonil mefenoxam	21.00% 8.40%	0.167 to 0.334 fl oz per 100 lb of seed	<p>For protection against damping-off caused by <i>Fusarium</i> spp., <i>Rhizoctonia</i> spp. and <i>Pythium</i> spp. and general seed rots caused by <i>Aspergillus</i> spp. and <i>Penicillium</i> spp. and for protection against <i>Tilletia</i> (common bunt).</p> <p>Maxim XL at the 0.084 fl oz may be combined with labeled rates of Dividend XL for a broader spectrum of seedling disease protection.</p> <p>Apply Maxim XL as a water-based slurry using standard slurry seed treatment equipment that provides uniform coverage.</p>
<b>Maxim 4FS</b> Syngenta	fludioxonil	40.30%	0.08 to 0.16 fl oz per 100 lb of seed	<p>For protection against seedborne and soilborne fungi that cause seed decay, damping-off and seedling blight.</p> <p>Cereal forage may not be grazed until 30 days after planting.</p> <p>Apply Maxim 4FS as a water-based slurry using standard slurry seed treatment equipment.</p>
<b>MetaStar ST</b> Chemtura (formerly Trace Seed Protection Products)	metalaxyl	28.35%	0.75 fl oz per 100 lb of seed	<p>For <i>Pythium</i> damping-off control.</p> <p>MetaStar ST is a systemic fungicide seed dressing specifically for control of systemic downy mildews, <i>Pythium</i> and <i>Phytophthora</i> spp. For control of other soilborne diseases, combination of Captan and Vitavax registered formulations are compatible. Do not use with other seed treatment products unless previous experience assures compatibility.</p> <p>MetaStar ST may be applied as a water-based slurry with other registered seed treatment insecticides and fungicides through standard slurry or mist-type commercial seed treatment equipment.</p>
<b>Penncozeb 75DF</b> Cerexagri	mancozeb	75.00%	2.3 to 3.5 oz per 100 lb of seed	For control of bunt, damping off, seed rots and seedling blights.
<b>Penncozeb 80WP</b> Cerexagri	mancozeb	80.00%	2.2 to 3.3 oz per 100 lb of seed	For planter box treatment only.
<b>Prevail</b> Chemtura (formerly Trace Seed Protection Products)	carboxin PCNB metalaxyl	15.00% 15.00% 3.12%	1.5 to 3.0 oz. per bushel of seed	<p>For protection against <i>Pythium</i> and <i>Rhizoctonia</i> seedling disease complex and loose smut and common bunt or stinking smut.</p> <p>Do not graze or feed livestock on treated areas for six weeks after planting.</p> <p>Prevail may be applied at planting time, using an on-farm mechanical treater to maximize seed coverage.</p>

## Seed treatment fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Raxil MD</b> Bayer CropScience	tebuconazole metalaxyl	0.48% 0.64%	5.0 to 6.5 fl oz per 100 lb of seed	<p>Aids in the control or suppression of the following seed, seedling and soilborne diseases of wheat: stinking smut, flag smut, loose smut, early-season Septoria disease complex, general seed rots, Pythium damping-off, early-season Rhizoctonia root rot, early-season common root rot, seedborne Fusarium scab, early-season Fusarium foot rot, early-season suppression of powdery mildew and rust.</p> <p>Wheat green forage may be grazed or harvested for hay 31 days after seeding.</p> <p>Applications should be made using standard slurry or mist-type seed treatment equipment. This product is for commercial or on-farm application. This product is not intended for direct application into a planter box.</p>
<b>Raxil-Thiram</b> Bayer CropScience	tebuconazole thiram	0.60% 20.00%	3.5 to 4.6 fl oz per 100 lb of seed	<p>Targeted diseases: stinking smut, flag smut, loose smut early-season Septoria complex, general seed rots, Pythium damping-off, early-season Rhizoctonia root rot, early-season common root rot, seedborne Fusarium scab, early-season Fusarium foot rot, early-season suppression of powdery mildew, early-season suppression of wheat leaf rust.</p> <p>Wheat green forage may be grazed or harvested for hay 31 days after seeding.</p> <p>Application should be made using standard slurry or mist-type seed treatment equipment.</p>
<b>Raxil XT Wettable Powder</b> Bayer CropScience	tebuconazole metalaxyl	15.00% 20.00%	0.16 to 0.20 oz per 100 lb of seed	<p>Targeted diseases: stinking smut, flag smut, loose smut, early-season Septoria disease complex, early-season Rhizoctonia root rot, early-season common root rot, early-season Fusarium foot rot, early-season suppression of powdery mildew, early-season suppression of wheat leaf rust, seedborne Fusarium scab, general seed rots and Pythium damping-off</p> <p>Wheat green forage may be grazed or harvested for hay 31 days after seeding.</p> <p>The pouches of Raxil XT are water soluble. Applications should be made using standard slurry or mist-type seed treatment equipment.</p>
<b>Raxil 2.6F</b> Bayer CropScience	tebuconazole	28.30%	0.1 fl oz per 100 lb of seed	<p>On wheat for stinking smut, flag smut, loose smut, early-season Septoria disease complex, early-season Rhizoctonia root rot, early-season common root rot, early-season Fusarium root rot, early-season suppression of powdery mildew and early-season suppression of leaf rust.</p> <p>Apply Raxil 2.6F as a water-based slurry through standard slurry or mist-type commercial seed treatment equipment. Prepare a slurry by mixing the specified dosage in 9.0 to 20.0 fl oz of water per 100 lb of seed. Add dye to the resulting slurry. Mix the slurry thoroughly with the seeds to provide uniform coverage.</p> <p>Wheat may be grazed or harvested for hay 31 days after seeding.</p>
<b>RTU-Baytan-Thiram</b> Bayer CropScience	triadimenol thiram	5.00% 15.30%	4.5 to 9.0 fl oz per 100 lb of seed	<p>Target diseases: scab, stinking smut, flag smut, loose smut, glume blotch, foot rot, take-all, Pythium rot; as well as early-season powdery mildew, leaf rust and stripe rust.</p> <p>Apply the 4.5 fl oz rate for control of smuts and the 9.0 fl oz rate for control or suppression of the other diseases.</p> <p>Green forage may be grazed 40 days after seeding.</p> <p>Ready-to-use seed treatment and application should be made using standard slurry or mist-type commercial seed treatment equipment. Not for use on agricultural establishments in hopper box, planter box, slurry box or other seed treatment applications at or immediately before planting.</p>
<b>42-S Thiram</b> Bayer CropScience	thiram	42.00%	2.0 fl oz per bushel of seed	<p>Used according to directions, Bayer CropScience 42-S Thiram will usually increase stands and yields by reducing losses from seed decay, damping-off and seedling blights caused by many seedborne and soilborne organisms. It will usually control covered smuts or bunt of wheat.</p> <p>42-S Thiram should be applied with water as a suspension in the slurry-type treated specifically designed and approved for this use.</p>

## Seed treatment fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>VITAFLO-280</b> Chemtura (formerly Trace Seed Protection Products)	carboxin thiram	14.90% 13.20%	3.5 to 5.0 fl oz per 100 lb of seed	Combination of a systemic fungicide (carboxin) and a contact fungicide (thiram) providing plant protection against seedborne and soilborne seedling diseases including damping-off and seed decay as well as loose smut and common bunt. The 3.5 fl oz rate will give partial control of true loose smut. Use the 5.0 fl oz rate for control of true loose smut.  Do not graze or feed livestock on treated areas for six weeks after planting.  For use only by commercial seed treaters.  VITAFLO-280 can be diluted with water for use in slurry treaters. Use closed loading system. For use only by commercial seed treaters. Not for use on agricultural establishments in hopper box, planter box, slurry box or other seed treatment applications at or immediately prior to planting.
<b>Vitavax CT</b> Helena Chemical Corporation	carboxin thiram	5.70% 5.70%	9.0 to 12.0 fl oz per 100 lb of seed	Provides control of loose smut and common bunt. Use the higher rate under conditions of expected heavy disease pressure.  Do not graze or feed livestock on treated area for six weeks after planting.  Ready-to-use seed treatment for hopper box application.
<b>Vitavax M</b> Helena Chemical Corporation	carboxin thiram	5.70% 5.70%	9.0 to 12.0 fl oz per 100 lb of seed	Provides control of loose smut and common bunt. Use the higher rate under conditions of expected heavy disease pressure. Also contains the micronutrient molybdenum.  Do not graze or feed livestock on treated area for six weeks after planting.  Ready-to-use seed treatment for hopper box application.

## Virus diseases of winter wheat

The virus diseases most likely to occur on winter wheat in Missouri are wheat spindle streak mosaic, soilborne wheat mosaic, barley yellow dwarf and wheat streak mosaic. Symptoms of barley yellow dwarf may be evident on young wheat plants in the fall, may show up on young plants early in the spring or may be evident later in the season primarily on the flag leaves of plants. Symptoms of wheat spindle streak mosaic and soilborne wheat mosaic typically show up during spring green-up and are most pronounced when air temperatures are around 50 degrees F. Wheat streak mosaic symptoms tend to become obvious as air temperatures increase later in the spring.

Both **wheat spindle streak mosaic** and **soilborne wheat mosaic** are vectored or spread by the soil fungus *Polymyxa graminis*. This fungus prefers wet conditions and is most likely to infect wheat roots during wet falls. Plants infected in the fall usually show the symptoms described above the following spring. Spring infections may occur during wet springs but usually spring infections occur too late to cause significant injury. In most years the symptoms of these two wheat virus diseases are evident as the wheat crop is greening-up and tend to fade as air temperatures increase. In years with late, cool springs, symptoms may be evident much later in the season, even on plants that have headed.

**Barley yellow dwarf** (also called yellow dwarf and red leaf) is an extremely widespread virus disease of cereals. Symptoms include leaf discoloration ranging from a light-green or yellowing to a red or purple discoloration of leaf tissue. Symptoms are most pronounced when temperatures are in the range of 50-65 degrees F. The barley yellow dwarf

virus persists in small grains, corn and perennial and annual weed grasses. More than 20 species of aphids can transmit the barley yellow dwarf virus. Symptoms may be more severe and yield losses higher if plants are infected in the fall or early in the spring. Infections developing in late spring or summer may cause discoloration of upper leaves but little stunting of plants or yield loss.

**Wheat streak mosaic** is the other virus disease likely to occur on winter wheat in Missouri. It causes a light-green to yellow-green mottling and streaking of leaves. The wheat streak mosaic virus is spread by the wheat curl mite. Symptoms are frequently found along the edges of fields where the mite vector first entered the field. Both the wheat streak mosaic virus and the wheat curl mite survive in susceptible crop and weed hosts including winter and spring wheat, barley, corn, rye, oats and a number of perennial grasses. Thus, the destruction of volunteer wheat and grass weed control are important management options for wheat streak mosaic.

Mixed infections of wheat viruses in the same field or even the same plant are common in Missouri. When plants are infected with more than one virus disease, it may not be possible to identify the specific viruses present by symptoms. It may be necessary to submit a plant sample to a plant diagnostic laboratory for virus testing.

Most of the management options for virus diseases in wheat are preventative measures such as planting resistant or tolerant wheat varieties, avoiding continuous wheat production, destroying volunteer wheat and weed grasses near wheat production fields, delaying wheat planting until all corn is harvested and avoiding early fall planting of wheat. Proper fertility may help reduce the impact of virus diseases on wheat.

**Management options for virus diseases of wheat**

- Plant good-quality seed of resistant varieties.
- Avoid planting too early in the fall to minimize opportunity for vectors to transmit viruses to young wheat plants.
- Destroy volunteer wheat and control weed grasses that may be hosts of the virus pathogens or insect vectors.
- Rotate crops.
- Maintain good plant vigor with adequate fertility.
- For barley yellow dwarf, insecticide applications (either as a seed treatment or foliar application) to control the aphid vectors may be warranted.

**Foliage diseases of winter wheat**

Many different fungi and bacteria can cause foliage diseases on wheat. These pathogens cause a wide range of leaf spots, leaf blights and similar symptoms on wheat. Foliage diseases that can cause significant injury to wheat in Missouri include Septoria leaf blotch, Stagonospora glume blotch, tan spot, leaf rust, stem rust, stripe rust, powdery mildew and bacterial stripe or black chaff.

The fungi that cause most of these wheat foliage diseases survive in infested wheat residues left on the soil surface. The next growing season spores are produced during moist periods and are carried by wind currents to susceptible wheat leaves, where infection may begin. Disease problems tend to be more severe when wheat is planted in fields with infested wheat residue left on the soil surface. Eventually spores that are produced in the initial lesions on plants are wind blown to other leaves or other plants causing secondary infection.

Leaf rust, stem rust and stripe rust are exceptions to this simplified explanation of disease development. The rust fungi do not survive in infested residue left in a field and, in fact, do not survive the winter months in this area at all. Rather, the rust fungi are reintroduced into this area each season when spores are carried up on air currents from the southern United States.

Most of the foliage diseases of wheat are favored by warm, wet or humid weather. Frequently infection begins on the lower portion of the plant. If weather conditions are favorable for disease development, the disease may move up through the plant. Severely infected leaves may yellow and die prematurely. Yield losses tend to be highest when the flag leaves are heavily infected.

There are several fungicides that are labeled for use on wheat to control fungal foliage diseases. It is important to scout wheat fields and determine which leaf diseases are occurring as well as the level of their severity before making a decision to apply a foliar fungicide. In particular be

on the lookout for Septoria leaf blotch, Stagonospora glume blotch, tan spot, leaf rust and stripe rust. When scouting fields, try to identify the disease or diseases that are present, determine the average percent of infection on a leaf and the number of leaves showing infection and determine the stage of growth of the crop.

Generally, the profitable use of foliar fungicides on wheat depends on a number of factors, including varietal resistance, disease severity, effectiveness of the specific fungicides and timing of fungicide application. The greatest increases in yield are usually obtained when fungicides are applied to disease-susceptible varieties with high-yield potential at the early boot to head emergence growth stage when the flag leaf is in danger of severe infection. Fungicide applications are seldom beneficial if applied after flowering or after the flag leaf is already severely infected. It is also important to read the fungicide label for specific information on rates, recommended timing of application, frequency of applications, preharvest intervals and grazing restrictions.

**Management options for foliage diseases of wheat**

- Plant disease-free seed of varieties with resistance to diseases likely to occur in your area.
- Rotate with non-host crops.
- Manage residues: if tillage system is a conservation tillage system, particular care should be given to rotation and variety selection.
- Maintain good plant vigor with adequate fertility.
- Use foliar fungicides if warranted. See table of foliar fungicides labeled for use on winter wheat.

Black chaff (also called bacterial stripe) is a bacterial disease which produces symptoms on both leaves and heads. Water-soaked lesions that turn into reddish-brown to brown to brownish black streaks develop on the leaves. Glumes and awns show brown-black blotches or streaks. The bacterium that causes this disease, *Xanthomonas campestris* pv. *translucens*, is seedborne; therefore the use of disease-free seed is a primary control measure. Use of resistant or tolerant varieties and crop rotation should also reduce the incidence of bacterial stripe and black chaff.

**Foliar fungicides for use on winter wheat**

The following table was prepared using current company product labels and manufacturers' Web sites. However, label registrations can change at any time. Before using any agricultural pesticide, read and follow directions accompanying that product. Product names have been used for clarity. Reference to specific trade names does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not listed.

## Foliar fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Bumper 41.8 EC</b> Makhteshim Agan	propiconazole	41.80%	4.0 fl oz per acre	<p>Controls rusts (<i>Puccinia</i> spp.), powdery mildew (<i>Erysiphe</i> spp.), leaf blight and glume blotch (<i>Septoria</i> spp.), tan spot (<i>Pyrenophora tritici-repentis</i>) and Helminthosporium leaf blight.</p> <p>Apply 4.0 fl oz of Bumper 41.8 EC by ground or aerial application or through irrigation equipment.</p> <p>Highest yields are normally obtained when Bumper 41.8 EC is applied to the emerging flag leaf. For wheat only, Bumper 41.8 EC can be applied until full head emergence (Feekes growth stage 10.5). Do not apply after this growth stage to avoid possible illegal residues. Bumper 41.8 EC may be applied earlier if disease symptoms appear.</p> <p>Do not apply more than 4.0 fl oz of Bumper 41.8 EC per acre per season.</p> <p>Do not graze or feed livestock treated wheat forage or cut the green crop for hay or silage. After harvest, the straw may be used for bedding or feed.</p>
<b>Caramba</b> BASF	metconazole	8.60%	10.0 to 17.0 fl oz per acre	<p>Target diseases: black point, powdery mildew, rust, Septoria leaf and glume blotch and tan spot 10.0 to 14.0 fl oz per acre.</p> <p>For optimum disease control, begin applications of Caramba prior to disease development. To maximize yields in cereals, it is important to protect the flag leaf. For diseases other than head scab, apply Caramba immediately after flag leaf emergence for optimum results.</p> <p>Suppression only of head scab (<i>Fusarium</i> spp.): 14.0 to 17.0 fl oz per acre. For optimum suppression of Fusarium head blight, apply Caramba at the beginning of anthesis. When head blight is a concern, growers should manage this disease with fungicides that are labeled for and effective in managing this disease and with cultural practices like crop rotation and plowing to reduce crop residues that serve as an inoculum source.</p> <p>Rates up to 17.0 fl oz per acre of Caramba may be used under severe disease pressure. The minimum treatment interval is six to eight days.</p> <p>No livestock feeding restrictions.</p> <p>Resistance management: To limit the potential for development of resistance, DO NOT make more than two applications of Caramba or other DMI (Group 3) fungicides per season.</p> <p>Minimum time from application to harvest is 30 days</p>
<b>Dithane DF Rainshield</b> Dow AgroSciences	mancozeb	75.00%	2.1 lb per acre	<p>For control of Helminthosporium leaf spot, leaf rust, Septoria glume blotch, Septoria leaf spot and tan spot.</p>
<b>Dithane F-45 Rainshield</b> Dow AgroSciences	mancozeb	37.00%	1.6 qt per acre	<p>Start applications at the onset of disease or when plants are in the tillering to jointing stage and repeat at 7- to 10-day intervals. The addition of Latron CS-7 to spray solutions will improve performance.</p> <p>Do not make more than three applications during the season.</p>
<b>Dithane M45</b> Dow AgroSciences	mancozeb	80.00%	2.0 lb per acre	<p>Do not apply after Feekes growth stage 10.5 or heading, but not less than 26 days of harvest.</p> <p>Do not graze livestock in treated area prior to harvest.</p>

## Foliar fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Embrace 3.6 L</b> Winfield Solutions, LLC	tebuconazole	38.70%	4.0 fl oz per acre	<p>For leaf, stem and stripe rusts (<i>Puccinia</i> spp.) and suppression of head blight or scab (<i>Fusarium</i> spp.).</p> <p>Rusts: apply at the earliest sign of rust pustules on foliage.</p> <p>Fusarium head blight: optimal timing for Fusarium head blight suppression is the beginning of flowering on main stem heads (Feekes 10.51).</p> <p>Wheat fields should be observed closely for early disease symptoms, particularly when susceptible varieties are planted and/or under prolonged conditions favorable for disease development.</p> <p>Apply Embrace 3.6 L in a minimum of 10 gallons of spray solution per acre by ground sprayer or in a minimum of 5 gallons of spray solution by aircraft spray equipment.</p> <p>For optimum disease control, the lowest specified rate of a spray surfactant should be tank-mixed with Embrace 3.6 L.</p> <p>Embrace 3.6 L must have two to four hours of drying time on plant foliage for the active ingredient to move systemically into plant tissue before rain or irrigation occurs. After this period of time, embrace 3.6 L will be resistant to weathering.</p> <p>A maximum of 4.0 fl oz of Embrace 3.6 L may be applied per acre per crop season.</p> <p>Do not allow livestock to graze or feed green forage to livestock prior to six days after treatment with Embrace 3.6 L. Straw cut after harvest may be fed or used for bedding.</p> <p>Do not apply within 30 days of harvest.</p>
<b>Folicur 3.6 F</b> Bayer CropScience	tebuconazole	38.70%	4.0 fl oz per acre	<p>Leaf, stem and stripe rusts (<i>Puccinia</i> spp.) and head blight or scab (<i>Fusarium</i> spp.) suppression.</p> <p>Rusts: apply Folicur 3.6 F at the earliest sign of rust pustules on foliage.</p> <p>Fusarium head blight: optimal timing of Folicur 3.6 F for Fusarium head blight suppression is the beginning of flowering on main stem heads (Feekes 10.51).</p> <p>Wheat fields should be observed closely for early disease symptoms, particularly when susceptible varieties are planted and/or under prolonged conditions favorable for disease development.</p> <p>Apply Folicur 3.6 F in a minimum of 10 gallons of spray solution per acre by ground or in a minimum of 5 gallons of spray solution per acre by air.</p> <p>For optimum disease control, the lowest specified rate of a spray surfactant should be tank-mixed with Folicur 3.6 F. Folicur 3.6 F must have two to four hours of drying time on plant foliage for the active ingredient to move systemically into plant tissue before rain or irrigation occurs. After this time period, Folicur 3.6 F will be resistant to weathering.</p> <p>A maximum of 4.0 fl oz of Folicur 3.6 F may be applied per acre per crop season.</p> <p>Straw may be feed or used for bedding. Do not allow livestock to graze or feed green forage to livestock prior to 6 days after treatment with Folicur 3.6 F.</p> <p>Restricted-entry interval is 12 hours.</p> <p>Do not apply within 30 days of harvest.</p>

## Foliar fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Headline</b> BASF	pyraclostrobin	23.60%	6.0 to 9.0 fl oz per acre	<p>For control of leaf rust, powdery mildew, Septoria leaf and glume blotch, spot blotch, stem rust, stripe rust and tan spot.</p> <p>For optimal disease control, begin Headline applications before disease development. To maximize yields in cereals it is important to protect the flag leaf. Apply Headline immediately after flag leaf emergence for optimum results.</p> <p>Headline does not control Fusarium head blight (head scab) or prevent the reductions in grain quality that can result from this disease.</p> <p>Resistance management: To limit the potential for development of resistance, do not make more than two applications of Headline or other strobilurin fungicides per season.</p> <p>Apply no later than the beginning of flowering (Feekes 10.5).</p> <p>Do not harvest wheat hay or feed green-chopped wheat within 14 days after last application</p>
<b>Kocide DF</b> Griffin LLC	copper hydroxide	61.40%	1.5 to 2.0 lb per acre	<p>Target diseases: Helminthosporium spot blotch and Septoria leaf blotch.</p> <p>Make first application at early heading and follow with second spray 10 days later. Use the higher rates when conditions favor disease.</p>
<b>Kocide 4.5FL</b> Griffin LLC	copper hydroxide	37.50%	1.0 to 1.33 pt per acre	<p>Target diseases: Helminthosporium spot blotch and Septoria leaf blotch.</p> <p>Make first application at early heading and follow with second spray 10 days later. Use the higher rates when conditions favor disease.</p>
<b>Kocide 101</b> Griffin LLC	copper hydroxide	77.00%	1.5 to 2.0 lb per acre	<p>Target diseases: Helminthosporium spot blotch and Septoria leaf blotch.</p> <p>Make first application at early heading and follow with second spray 10 days later. Use the higher rates when conditions favor disease.</p>
<b>Kocide 2000</b> DuPont	copper hydroxide	53.80%	1.0 to 1.5 lb per acre	<p>Target diseases: Helminthosporium spot blotch and Septoria leaf blotch.</p> <p>Make first application at early heading and follow with second spray 10 days later. Use the higher rates when conditions favor disease.</p>
<b>Kumulus DF</b> Micro Flo Company LLC	sulfur	80.00%	6 to 15 lb per acre	<p>For the control of powdery mildew.</p> <p>Apply when disease first appears and repeat as necessary or with the regularly scheduled insecticide program.</p>
<b>Manzate Pro-Stick</b> DuPont	mancozeb	75.00%	2.0 lb per acre	<p>For control of Helminthosporium leaf spot, leaf rust, Septoria glume blotch, Septoria leaf spot and tan spot.</p>
<b>Manzate Flowable</b> Griffin L.L.C.	mancozeb	37.00%	1.6 qt per acre	<p>Start applications at the onset of disease or when plants are in the tillering to jointing stage and repeat at 7- to 10-day intervals.</p> <p>Do not make more than three applications during the season.</p> <p>Do not apply more than 6 lb or 4.8 qt per acre per crop.</p> <p>Do not apply within 26 days of harvest.</p> <p>Do not graze livestock in treated areas prior to harvest.</p>
<b>ManKocide</b> Griffin L.L.C.	mancozeb copper hydroxide	15.00% 46.10%	2.0 to 2.5 lb per acre	<p>For control of Helminthosporium leaf spot, Septoria glume blotch and Septoria leaf spot</p> <p>Make first application at early heading and follow with second spray 10 days later. Use higher rates when conditions favor disease.</p> <p>Do not apply within 26 days of harvest.</p> <p>Do not graze livestock in treated areas prior to harvest.</p>

## Foliar fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Orius 3.6F</b> Makhteshim Agan	tebuconazole	38.70%	4.0 fl oz per acre	<p>For leaf, stem and stripe rusts (<i>Puccinia</i> spp.), and suppression of Fusarium head blight or scab (<i>Fusarium</i> spp.), apply 4.0 fl oz per acre.</p> <p>Wheat fields should be observed closely for early disease symptoms, particularly when susceptible varieties are planted and/or under prolonged conditions favorable for disease development.</p> <p>Rusts: apply Orius 3.6F at the earliest sign of rust pustules on foliage.</p> <p>Fusarium head blight: optimal timing of Orius 3.6F for Fusarium head blight suppression is the beginning of flowering on main stem heads (Feekes 10.51).</p> <p>Apply Orius 3.6F in a minimum of 10 gallons of spray solution per acre by ground or in a minimum of 5 gallons of spray solution per acre by air. For optimum disease control, the lowest specified rate of a spray surfactant should be tank-mixed with Orius 3.6 F.</p> <p>Orius 3.6F must have two to four hours of drying time on plant foliage for active ingredient to move systemically into plant tissue before rain or irrigation occurs. After this period of time, Orius 3.6F will be resistant to weathering.</p> <p>A maximum of 4.0 fl oz of Orius 3.6F may be applied per acre per crop season.</p> <p>Straw may be fed or used for bedding. Do not allow livestock to graze or feed green forage to livestock prior to six days after treatment with Orius 3.6F.</p> <p>Do not apply within 30 days of harvest.</p>
<b>Penncozeb 4FL</b> Cerexagri	mancozeb	37.00%	0.8 to 1.6 qt per acre	<p>For control of Helminthosporium leaf spot, Septoria leaf spot, Septoria glume blotch, leaf rust and tan spot.</p>
<b>Penncozeb 75DF</b> Cerexagri	mancozeb	75.00%	1.0 to 2.0 lb per acre	<p>Start application at the onset of disease or when plants are in tillering to jointing stage and repeat at 7- to 10-day intervals.</p>
<b>Penncozeb 80WP</b> Cerexagri	mancozeb	80.00%	1.0 to 2.0 lb per acre	<p>Do not apply more than three applications in one season. Do not apply more than 6.4 lb Penncozeb 75DF or 6.0 lb Penncozeb 80WP per acre per crop.</p> <p>Do not apply within 26 days of harvest.</p> <p>Do not graze livestock in treated areas prior to harvest.</p> <p>Do not apply after heading (around Feekes 10.5).</p>
<b>Proline 480 SC</b> Bayer CropScience	prothioconazole	41.0%	4.3 to 5.7 fl oz per acre	<p>Leaf and stem diseases including leaf rust, Septoria leaf and glume blotch, stem rust and tan spot: 4.3 to 5.0 fl oz per acre. Apply Proline 480 SC as a preventive foliar spray when the earliest disease symptoms appear on the leaves or stems. Wheat fields should be observed closely for early disease symptoms, particularly when susceptible varieties are planted and/or under prolonged conditions favorable for disease development.</p> <p>Fusarium head blight (suppression only): apply Proline 480 SC within the time period from when at least 75% of the wheat heads on the main stem are fully emerged (~Feekes growth stage 10.4) to when 50% of the heads on the main stem are in flower (~Feekes 10.52). Optimal timing of application may be at or around 15% flowering (Feekes 10.51). Spray equipment must be set up to provide good coverage to wheat heads — see label for details.</p> <p>Apply up to two applications of Proline 480 SC per year. Repeat applications using a 14-day spray interval if conditions remain favorable for continued or increased disease development. Applications may be made by ground or aerial spray equipment.</p> <p>A maximum of 9.37 fl oz of Proline 480 SC may be applied per acre per year. Do not apply two applications at 5.7 fl oz per acre per year.</p> <p>Proline 480 SC may be applied up to the point where wheat heads are in full flower (Feekes growth stage 10.52).</p> <p>Do not apply within 30 days of harvest.</p>

## Foliar fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>PropiMax EC</b> Dow AgroSciences	propiconazole	41.80%	2 to 4.0 fl oz per acre	<p>Early-season suppression of powdery mildew, Septoria leaf blight, Stagonospora glume blotch and tan spot: apply 2.0 to 4.0 fl oz per acre. Apply in the spring. Follow up with a second application up to Feekes growth stage 10.5 for season long control. Applications may be made no closer than a 14-day interval.</p> <p>Control of leaf diseases including rust (<i>Puccinia</i> spp.), powdery mildew, Septoria leaf blight, Stagonospora glume blotch and tan spot: apply 4.0 fl oz per acre. Protecting the flag leaf is important for maximizing the potential yield. Highest yields are normally obtained when PropiMax EC is applied when the flag leaf is 50% to fully emerged. Applications may be made no closer than a 14-day interval. The use of oil-base adjuvant may improve the spray coverage and canopy penetration.</p> <p>Foot rot: apply 4.0 fl oz per acre. Apply PropiMax EC plus half rates of other EPA registered fungicides such as thiophanate-methyl. Apply at tillering, but before elongation has occurred.</p> <p>Fusarium head blight suppression (ca. 50% control): 4.0 fl oz per acre. Apply PropiMax EC at approximately 50% flowering. Addition of a penetrating type adjuvant may increase Fusarium head blight suppression.</p> <p>Do not apply within 30 days of harvest for forage, 40 days before harvest for grain and straw and 45 days before harvest for hay.</p> <p>Do not apply more than 8.0 fl oz per acre per season of PropiMax EC. Do not apply more than 4.0 fl oz of PropiMax EC per acre per season if forage or hay will be harvested.</p>
<b>Prosaro 421 SC</b> Bayer CropScience	prothioconazole tebuconazole	19.0% 19.0%	6.5 to 8.2 fl oz per acre	<p>Leaf and stem diseases including leaf rust, Septoria leaf and glume blotch, stem rust and tan spot. Apply Prosaro 421 SC as a preventive foliar spray when the earliest disease symptoms appear on the leaves and stems. Wheat fields should be observed closely for early disease symptoms, particularly when susceptible varieties are planted and/or under prolonged conditions favorable for disease development.</p> <p>Fusarium head blight (suppression only): Prosaro 421 SC may be applied up to mid-flowering. This is when 75% to 100% of the wheat heads on the main stem are fully emerged and when 50% of the heads on the main stem are in flower (~Feekes growth stage 10.52). Spray equipment must be set up to provide good coverage to wheat heads — see label for details.</p> <p>Apply up to two applications of Prosaro 421 SC per year. Repeat applications as needed using a 7- to 14-day spray interval if conditions remain favorable for continued or increasing disease development. For optimum disease control the lowest labeled rate of a spray surfactant must be tank mixed with Prosaro 421 SC.</p> <p>Applications may be made by ground or aerial spray equipment. A maximum of 8.2 fl oz of Prosaro 421 SC may be applied per acre per crop year.</p> <p>Prosaro 421 SC may be applied up to the point where wheat heads are in the full flower growth stage (Feekes 10.52).</p> <p>Do not apply within 30 days of harvest.</p> <p>Straw may be fed or used for bedding. Do not allow livestock to graze or feed green forage to livestock prior to 6 days after treatment with Prosaro 421 SC.</p>

## Foliar fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Quadris</b> Syngenta	azoxystrobin	22.90%	4.0 to 12.0 fl oz per acre for leaf rust, stripe rust, stem rust, Septoria leaf and glume blotch, and tan spot  7.5 to 11.0 fl oz per acre for powdery mildew	<p>Quadris should be applied prior to disease development from jointing to (Feekes 6 or Zadoks 31) up to late head emergence (Feekes 10.5 or Zadoks 59). A crop oil concentrate adjuvant may be added at 1.0% v/v to optimize efficacy.</p> <p>Resistance management: Follow the resistance management guidelines in the resistance management section of the Quadris label.</p> <p>Do not apply until after forage stage (Feekes 6 or Zadoks 31).</p> <p>Do not apply later than Feekes growth stage 10.5 (Zadoks growth stage 59).</p> <p>Do not harvest treated wheat for forage.</p> <p>Do not apply more than 0.40 lb a.i./acre/per season of azoxystrobin-containing products.</p> <p>Do not apply within 14 days of harvest for hay.</p> <p>Do not apply within 45 days of harvest for grain and straw.</p> <p>Quadris is extremely toxic to certain apple varieties. See "General Use Instructions" on label for additional information on safety precautions to avoid injury to apple trees.</p>
<b>Quilt</b> Syngenta	azoxystrobin propiconazole	7.00% 11.70%	7.0 to 14.0 fl oz per acre	<p>7.0 to 14.0 fl oz per acre for early-season suppression of powdery mildew, Septoria leaf blotch, Stagonospora glume blotch and tan spot. 10.5 to 14.0 fl oz per acre for control of leaf diseases (rusts, powdery mildew, Septoria leaf blotch, Stagonospora glume blotch, tan spot).</p> <p>Protecting the flag leaf is important for maximizing the potential yield. Highest yields are obtained when Quilt is applied when the flag leaf is 50% to fully emerged. If disease pressure is low, 10.5 fl oz per acre may be applied.</p> <p>Applications may be made no closer than a 14-day interval. For wheat only, Quilt may be applied through full head emergence (Feekes growth stage 10.5). Do not apply after this stage to avoid illegal residues.</p> <p>Quilt is most effective when applied and allowed to dry before a rainfall. For best results, sufficient water volume should be used to provide thorough coverage. Quilt may be applied by ground, air or chemigation.</p> <p>Do not apply more than two applications per acre per year. Do not apply more than 20.5 fl oz per acre per season.</p> <p>Do not apply within 45 days of harvest for grain and straw.</p> <p>Do not harvest wheat for forage.</p> <p>Do not graze or feed livestock treated forage or cut green crop for hay or silage.</p> <p>Under certain environmental conditions, tank mixes of Quilt plus herbicides and/or fertilizers may cause crop injury in barley, triticale and wheat.</p> <p>Quilt is extremely toxic to certain apple varieties. See "General Use Instructions" on label for additional information on safety precautions to avoid injury to apple trees.</p>
<b>Stratego</b> Bayer CropScience	propiconazole trifloxystrobin	11.40% 11.40%	10.0 fl oz per acre	<p>For control of glume blotch, leaf blight, powdery mildew, rusts and tan spot.</p> <p>Begin applications preventively when conditions are favorable for disease development. A second application (minimum interval of 14 days) may be made if needed.</p> <p>Early-season leaf disease suppression: apply 6.0 to 8.0 fl oz per acre of Stratego for suppression of tan spot, Septoria and powdery mildew.</p> <p>Do not apply more than two applications per season. Do not apply Stratego after Feekes growth stage 10.5 (full head emergence).</p> <p>Do not apply Stratego within 35 days of harvest.</p> <p>See label for grazing restrictions.</p>

## Foliar fungicides labeled for use on winter wheat

Trade name Company	Common chemical name	% active ingredient	Rate	Additional label information
<b>Tilt</b> Syngenta	propiconazole	41.80%	2.0 to 4.0 fl oz per acre	<p>Early-season suppression of powdery mildew, Septoria leaf blight, Stagonospora glume blotch and tan spot: apply 2.0 to 4.0 fl oz per acre. Apply in the spring. Follow up with a second application up to Feekes growth stage 10.5 for season long control. Applications may be made no closer than a 14-day interval.</p> <p>Control of leaf diseases including rust, powdery mildew, Septoria leaf blight, Stagonospora glume blotch and tan spot: apply 4.0 fl oz per acre. Protecting the flag leaf is important for maximizing the potential yield. Highest yields are normally obtained when Tilt is applied when the flag leaf is 50% to fully emerged. Applications may be made no closer than a 14-day interval. The use of oil-base adjuvant may improve the spray coverage and canopy penetration.</p> <p>Foot rot: apply 4.0 fl oz per acre. Apply Tilt plus half rates of other EPA-registered fungicides such as thiophanate-methyl. Apply at tillering, but before elongation has occurred.</p> <p>Fusarium head blight suppression: 4.- fl oz per acre. Apply Tilt at approximately 50% flowering. Addition of a penetrating type adjuvant may increase Fusarium head blight suppression.</p> <p>Do not apply within 30 days of harvest for forage, 40 days before harvest for grain and straw and 45 days before harvest for hay.</p> <p>Do not apply more than 8.0 fl oz per acre per season of Tilt.</p> <p>Do not apply more than 4.0 fl oz per acre per season of Tilt if forage or hay will be harvested.</p>
<b>TwinLine</b> BASF	pyraclostrobin metconazole	12.0% 7.40%	6.0 to 11.0 fl oz per acre	<p>Target diseases: black point, powdery mildew, rust, Septoria leaf and glume blotch and tan spot. Twinline is not labeled for the suppression of Fusarium head scab.</p> <p>For optimum disease control, begin applications of Twinline prior to disease development. To maximize yields in cereals, it is important to protect the flag leaf. For diseases other than head scab, apply Twinline immediately after flag leaf emergence for optimum results. Do not apply after Feekes growth stage 10.5.</p> <p>Rates up to 11.0 fl oz per acre of Twinline may be used for severe disease pressure.</p> <p>The minimum retreatment interval (RTI) is 6 to 8 days after the first application.</p> <p>Use the higher rate and shorter interval when disease pressure is high.</p> <p>Resistance management: To limit the potential for development of resistance, DO NOT make more than two applications of Twinline per season.</p> <p>Minimum time from application to harvest (PHI) is 30 days.</p>

### Root, crown and wilt diseases of winter wheat

Several soilborne fungi can cause root and crown diseases of wheat. Affected plants may be stunted or less vigorous than healthy plants. Plants may yellow, wilt and die prematurely. Dead plants may have a bleached or white appearance. When affected plants are dug up, root systems may be poor with roots and crown tissues discolored and deteriorated.

**Cephalosporium stripe** had not been a significant problem on wheat in most of Missouri. With recent wet seasons, shorter rotations between wheat crops, and reduced tillage, this disease has become more common in the northern part of the state. Foliage symptoms are most evident during jointing and heading. Light green to yellow-green longitudinal stripes develop on the leaves of infected plants. The stripes run parallel to the leaf midrib and may extend the entire length of

the plant. Older lesions are predominantly yellow or even brown. Severely infected plants may be stunted, produce few tillers and die prematurely. The fungus that causes this disease, *Cephalosporium gramineum*, persists in association with wheat residues and may also be soilborne. Fungicides are not effective in controlling *Cephalosporium stripe*, and resistant varieties are not available for Missouri.

#### Management options for cephalosporium stripe

- Crop rotation to corn or legumes for at least two years.
- Residue management.
- Proper fertility.
- Proper weed control.

**Take-all** is one of the more common root and crown rot diseases of wheat in Missouri. The fungus that causes this disease may infect seedlings in the fall. Symptoms are

usually most evident after heading as white heads on wheat plants. Infected plants are also stunted, slightly yellow, have few tillers and ripen prematurely. A shiny, black discoloration of the lower stem and crown may be evident if the lowest leaf sheath is scraped off with a knife or fingernail.

Take-all of wheat is caused by the fungus *Gaeumannomyces graminis*. This fungus survives in infected host plants (wheat, barley, rye and weed grasses such as smooth brome-grass, quackgrass and bentgrass) and in infested host debris. Infection occurs when the fungus penetrates the young roots of a living host plant. Infection can occur throughout the growing season but is more severe when the temperature is between 54 and 64 degrees F. Because the take-all fungus is more active in wet soils, the disease is typically most severe in wet areas or years or in irrigated fields. Root infections in the fall and early spring are most likely to progress to the crown and foot of the plant. Hot, dry weather after heading increases the water stress on plants infected with take-all and may lead to the sudden development of white heads on plants that were actually infected earlier in the season or the previous fall.

Take-all is favored by continuous cropping of wheat. It is also more severe in lighter, alkaline, infertile and poorly drained soils. Plant nutrients offer increased resistance to take-all and a greater capacity to tolerate infections by producing more roots. It is important to maintain good levels of available nitrogen, phosphorus and potassium. Soil pH also affects the development of this disease. Disease damage is usually worse as soil pH approaches 7.0.

#### Management options for take-all

- Plant good-quality seed of adapted, disease-resistant varieties.
- Plant in well-drained sites under good seedbed conditions.
- Rotate with non-host crops for one to three years.
- Control weed grass hosts and volunteer wheat.
- Use seed treatment fungicides. See accompanying table of fungicides labeled for use on winter wheat.
- Maintain good plant vigor with adequate fertility.

### Head diseases of winter wheat

Diseases such as smuts, bunts and scab affect primarily the head of the wheat plant. Smut and bunt diseases such as stinking smut or loose smut tend to replace the normal kernels in the head with galls that contain masses of powdery black spores. The scab fungus can colonize heads, producing kernels that are shrunken, shriveled and discolored.

**Loose smut** is obvious as heads emerge from the boot. All portions of the head except the rachis are converted to masses of dusty black spores. The fungus that causes loose smut, *Ustilago tritici*, survives within the embryo of wheat seeds; therefore planting disease-free seed and using systemic fungicide seed treatments are important management tools. Stinking smut (also called covered smut or common bunt) is not as obvious as loose smut. The kernels are replaced with

smut galls, but the pericarp covering the smut gall remains intact masking the smut gall. At harvest the pericarps are broken releasing clouds of dark spores. Grain contaminated with stinking smut has a strong fishy odor and a darkened appearance. The fungus that causes stinking smut can survive on wheat seed and in the soil. Disease development is favored by cool, wet conditions.

#### Management options for smut and bunt diseases

- Plant disease-free seed.
- Use a systemic fungicide seed treatment. See accompanying table of seed treatment fungicides labeled for use on winter wheat.

**Scab** or Fusarium head blight of wheat is characterized by premature bleaching of a portion of the head or the entire head. Superficial mold growth, usually pink or orange in color, may be evident at the base of the diseased spikelets. Bleached spikelets are usually sterile or contain shriveled or discolored seed.

Scab is caused by the fungus *Fusarium graminearum*. This fungus overwinters on host residues such as wheat stubble, corn stalks and grass residues. Wind currents carry spores to wheat heads from the residues on which they have survived. If environmental conditions are favorable, i.e., warm and moist, the spores germinate and invade flower parts, glumes and other portions of the spike. Scab infection occurs when the wheat crop is in the flowering to early grain fill stages. Infection is dependent on environmental conditions while wheat is in susceptible stages of growth. Moderate temperatures in the range of 77 to 86 degrees F, frequent rain, overcast days, high humidity and prolonged dews favor infection and development of the scab fungus.

An additional concern with wheat scab is the possibility of mycotoxin production in the infected grain. Mycotoxins are naturally produced chemicals that in small amounts may be deleterious to animal or human health. The fungus that causes wheat scab may produce several different mycotoxins, including vomitoxin (deoxynivalenol or DON) and zearalene. This is a primary concern where grain is fed to non-ruminant animals. Ruminants are fairly tolerant of these two mycotoxins. Swine and poultry may refuse to eat grain containing high levels of these mycotoxins. In cases where mycotoxin problems are suspected, a sample should be submitted to a qualified laboratory for mycotoxin analysis.

#### Management options for wheat scab

- Plant adapted varieties with tolerance to scab.
- Rotate to non-host crops (corn is also a host, so rotation should be to crops other than small grains or corn).
- Manage residues.
- Plant disease-free seed. (If planting seed from a field that had scab, clean seed thoroughly before planting, have a germination test done on the lot, and use a fungicide seed treatment to minimize seedling blight problems caused by seedborne *Fusarium*).

## Insect management for field corn

Insect pests can cause substantial damage to field corn throughout the growing season, but especially during early stages of plant growth. Insect problems are best managed through the use of integrated pest management (IPM) programs where all viable control strategies are considered and appropriate strategies are selected for use against specific insect pests. Control strategies used in an IPM program may include chemical, cultural, mechanical, biological and genetic options. It is essential that proper identification of target insects and knowledge about pest biologies be considered when making management decisions.

In recent years additions to available management strategies for insect control in field corn include the introductions of (1) commercially applied seed treatments, (2) transgenic insect-resistant corn hybrids, (3) nontraditional types of insecticides, and (4) formulations that contain two or more complementary insecticides.

Several different commercially applied seed treatments are now labeled for field corn and include clothianidin (Poncho 250 and 1250), fipronil (Regent TS), tefluthrin (ProShield), and thiamethoxam (Cruiser 250 and 1250). Benefits derived from seed treatments include general control or suppression of several seedling corn pests, easy handling and reduced pesticide exposure to users.

Transgenic insect-resistant corn hybrids continue to be introduced for control of insects that consistently cause excessive economic losses and are often difficult to control with traditional management strategies. The accompanying table includes registered transgenic products in field corn.

**Bt Corn, Refugia requirement and resistance management:** A concern associated with the use of Bt (*Bacillus thuringiensis*) transgenic corn hybrids is the development of Bt-resistance in target insect populations. The EPA along with entomologists from land-grant universities and industry developed a resistance management plan that must be implemented on all farms planting Bt corn.

### Transgenic products registered for field corn.

Product	Insects controlled
YieldGard Corn Borer	European corn borer, southwestern corn borer
YieldGard Rootworm	Northern, western, and Mexican corn rootworms
YieldGard Plus	European corn borer, southwestern corn borer, northern, western, Mexican corn rootworms,
Herculex I	European corn borer, southwestern corn borer, black cutworm, fall armyworm, western bean cutworm
Herculex RW	Northern, western, and Mexican corn rootworms
Herculex Xtra	European corn borer, southwestern corn borer, black cutworm, fall armyworm, western bean cutworm, northern, western, and Mexican corn rootworms
AgriSure RW	Northern, western, and Mexican corn rootworms

To prevent the development of insect resistance to these transgenic hybrids, producers are required to plant at least 20 percent of their corn acres in non-Bt corn varieties. These non-Bt areas must be planted in blocks and located within ¼ to ½ mile of the Bt corn. Each farm using Bt corn hybrids must have their own refuge of non-Bt corn planted on that farm.

Scouting and proper insect identification are still important in any insect pest management program. Although seed treatments and Bt transgenic corn hybrids are effective at controlling many insect pests of field corn, there are other insects they only suppress or do not target. To protect against economic loss from insects not controlled by these new management strategies, producers are encouraged to scout crop fields often throughout the growing season. Monitoring and proper pest identification are essential components of all integrated pest management programs.

Insecticides for field corn

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Armyworm (true)	permethrin	*Ambush 25W	6.4 to 12.8 fl oz	Broadcast	Treat seedling corn when 25% or more of plants are being damaged. Control is justified after pollen shed if leaves above ear zone are being consumed by larvae.  Optimal control from Success or Tracer is best achieved when the insecticide is applied at peak egg hatch or when larvae are small.
	esfenvalerate	*Asana XL	5.8 to 9.6 fl oz	Broadcast	
	cyfluthrin	*Baythroid XL	1.6 to 2.8 fl oz	Broadcast (for 1st & 2nd instars only)	
	bifenthrin	*Brigade 2EC	2.1 to 6.4 fl oz	Broadcast	
		*Brigade 2EC	2.56 fl oz	PRE (pre-emergence)	
		*Brigade 2EC	3 to 4 fl oz	PPI (pre-plant incorporated)	
	bifenthrin	*Capture LFR	3.4 to 6.8 fl oz	Broadcast, band, in-furrow	
		*Capture LFR	3.4 fl oz	PRE (pre-emergence)	
		*Capture LFR	4 to 5.3 fl oz	PPI (pre-plant incorporated)	
	chlorpyrifos + gamma-cyhalothrin	*Cobalt	13 to 26 fl oz	Broadcast	
		bifenthrin	*Fanfare 2EC	2.1 to 6.4 fl oz	
	zeta-cypermethrin + bifenthrin		*Hero	4 to 10.3 fl oz	
		methoxyfenozide	Intrepid 2F	4 to 8 fl oz	
	methomyl		*Lannate LV	0.75 to 1.5 pt	
		chlorpyrifos	*Lorsban 4E	1 to 2 pt	
	chlorpyrifos		*Lorsban Advanced	1 to 2 pt	
		zeta-cypermethrin	*Lorsban Advanced	1 to 2 pt	
	chlorpyrifos		*Mustang Max	3.2 to 4 fl oz	
		microencapsulated methyl parathion	*Nufos 4E	1 to 2 pt	
	permethrin		*Pennacp-M	2 to 3 pt	
gamma-cyhalothrin		*Pounce 3.2EC	4 to 8 fl oz	Broadcast	
	carbaryl	*Proaxis	2.56 to 3.84 fl oz	Broadcast	
spinosad		Sevin XLR Plus	2 to 4 pt	Broadcast	
	spinosad	Success	3 to 6 fl oz	Broadcast	
lambda-cyhalothrin		Tracer 45C	1 to 3 fl oz	Broadcast	
		*Warrior	2.56 to 3.84 fl oz	Broadcast	

Billbugs

<b>Postemergence insecticide rescue treatment</b>	chlorpyrifos + gamma-cyhalothrin	*Cobalt	38 to 42 fl oz	Direct spray at base of plants	Maize, claycolored, and southern corn billbug species damage corn in Missouri.
	chlorpyrifos	*Lorsban 4E	2 to 3 pt	Direct spray at base of plants	
<b>Postemergence insecticide applications</b>	chlorpyrifos	*Nufos 4E	2 to 3 pt	Direct spray at base of plants	No thresholds available. Treat when significant damage is visible on seedling corn and numerous billbugs are present in field. Insecticide sprays are most effective if applied at 20 to 40 gallons per acre of formulated material directed over row on corn less than 6 inches tall or directed at plants for taller corn seedlings.
	chlorpyrifos	*Lorsban 15G	8 to 16 oz/ 1000 ft row	Band or 7-inch band over row	
	tefluthrin	*Force 3G	5 oz/ 1000 ft row	7-inch band over row, see specific label.	
	terbufos	*Counter 15G	8 oz/ 1000 ft row	7-inch band or in furrow	
<b>Seed treatment</b>	thiamethoxam	Cruiser 5FS	5.64 oz/ 80,000 seeds	On seed	Use of Accent or Beacon herbicides following Counter 15G applications may cause severe crop damage.
	clothianidin	Poncho 1250	5.64 oz/ 80,000 seeds	On seed	

\*Designates a restricted-use pesticide. Use is restricted to certified applicators only. Regardless of the formulation selected, read the label to determine appropriated insecticide rates, directions, precautions and restrictions.

## Insecticides for field corn

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Black cutworm	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Broadcast	Apply as postemergent rescue treatment when 1% to 2% or more of plants have been cut above ground or 2% to 3% of the plants are cut above ground and larvae are present.  Corn planted late into fields supporting winter annual weeds such as henbit and chickweed is at greater risk.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	Broadcast	
	cyfluthrin	<b>*Baythroid XL</b>	0.8 to 1.6 fl oz	Broadcast	
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz	Broadcast	
		<b>*Brigade 2EC</b>	2.56 fl oz	PRE (pre-emergence)	
		<b>*Brigade 2EC</b>	3 to 4 fl oz	PPI (pre-plant incorporated)	
	bifenthrin	<b>*Capture LFR</b>	3.4 to 6.8 fl oz	Broadcast, band, in-furrow	
		<b>*Capture LFR</b>	4 to 5.3 fl oz	PRE (pre-emergence)	
		<b>*Capture LFR</b>	3.4 fl oz	PPI (pre-plant incorporated)	
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz	Broadcast	
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	2.6 to 6.1 fl oz	Broadcast	
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt	Broadcast	
	chlorpyrifos	<b>*Lorsban Advanced</b>	1 to 2 pt	Preplant, at-plant, preemerge	
		<b>*Lorsban Advanced</b>	1 to 2 pt	Postemergence	
	zeta-cypermethrin	<b>*Mustang Max</b>	1.2 to 2.8 fl oz	Broadcast	
		<b>*Mustang Max</b>	2.88 fl oz	At plant (30-inch row)	
chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt	Broadcast		
permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz	Broadcast		
gamma-cyhalothrin	<b>*Proaxis</b>	1.92 to 3.2 fl oz	Broadcast		
lambda-cyhalothrin	<b>*Warrior</b>	1.92 to 3.2 fl oz	Broadcast		
Chinch bug	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	Broadcast	Use ground equipment to treat border rows when insects begin migration from small grains to corn. Direct spray toward base of plants.
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	gamma-cyhalothrin	<b>*Proaxis</b>	3.84 fl oz		
	carbaryl	<b>Seven XLR Plus</b>	2 to 4 pt		
	lambda-cyhalothrin	<b>*Warrior</b>	3.84 fl oz		
Corn earworm	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Broadcast	Treatment is usually justified on field corn grown for seed as control of larvae is difficult once larvae enter the ear tip. Best results are achieved when spray is directed toward ear zone.  Optimal control from Success or Tracer is best achieved when the insecticide is applied at peak egg hatch or when larvae are small.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	1.76 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
	spinosad	<b>Success</b>	3 to 6 fl oz		
	spinosad	<b>Tracer 45C</b>	2 to 0 fl oz		
lambda-cyhalothrin	<b>*Warrior</b>	1.92 to 3.2 fl oz			

\*Designates a restricted-use pesticide. Use is restricted to certified applicators only. Regardless of the formulation selected, read the label to determine appropriated insecticide rates, directions, precautions and restrictions.

**Insecticides for field corn**

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Corn leaf aphids	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	Broadcast	This pest rarely requires treatment unless severe drought conditions persist. Under droughtstress, apply insecticide during late whorl to early tassel when 50% or more of plants support 50 to 400 aphids per plant. If crop not under drought stress, aphids in excess of 400 per plant are required for treatment to be justified. Do not apply dimethoate during corn pollen-shed.
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	0.6 to 1 pt		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	2 to 3 pt		
Corn rootworm adults	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Beetles may reduce pollination by early silk clipping. Treatment is justified if pollination is not complete, silks are being clipped and there are five or more beetles per plant.	
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.72 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	1 to 2 pt		
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz			
carbaryl	<b>Sevin XLR Plus</b>	2 to 4 pt			
lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz			
Corn rootworm larvae	cyfluthrin	<b>*Aztec 2.1G</b>	6.7 oz/ 1000 ft row	Band, furrow with incorporation Band, furrow with incorporation (for smartbox use) Band Band, furrow Band, furrow Band Band, furrow Band, furrow Band, furrow Band Band See label	
	cyfluthrin	<b>*Aztec 4.67</b>	3 oz/ 1000 ft row		
	bifenthrin	<b>*Brigade 2EC</b>	0.3 fl oz/ 1000 ft row		
	bifenthrin	<b>*Capture LFR</b>	0.39 to 0.49 fl oz/ 1000 ft row		
	terbufos	<b>*Counter 15G</b>	8 oz/ 1000 ft row		
	bifenthrin	<b>*Fanfare 2EC</b>	0.3 fl oz/ 1000 ft row		
	tefluthrin	<b>*Force 3G</b>	4 to 5 oz/ 1000 ft row		
	tefluthrin	<b>*Force CS</b>	0.46 to 0.57 oz/ 1000 ft row		
	chlorethoxyfos	<b>*Fortress 2.5G</b>	7.5 to 9 oz/ 1000 ft row		
	chlorethoxyfos	<b>*Fortress 5G</b>	3 to 4.5 oz/ 1000 ft row		
	chlorpyrifos	<b>*Lorsban 4E</b>	2.4 fl oz/ 1000 ft row		
	chlorpyrifos	<b>*Lorsban 15G</b>	8 oz/ 1000 ft row		
	fipronil	<b>*Regent 4SC</b>	0.24 fl oz/ 1000 ft row		
<b>Seed treatments</b>	clothianidin	<b>Poncho 1250</b>	Commercially applied to seed	Commercial seed treatment	
	Transgenic seed:	<b>Herculex RW/Extra</b>	Commercial seed	Bt toxin produced inside plant. Follow resistance guidelines for all transgenic hybrids.	
		<b>Yieldgard YGRW/ YG Plus</b>	Commercial seed		
		<b>Agrisure RW</b>	Commercial seed		

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## Insecticides for field corn

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments		
	Common name	Trade name					
European corn borer (first generation)	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Broadcast	Treat corn for first-generation ECB larvae when 50% of the plants show leaf feeding and live larvae are present.  Sprays applied by ground equipment should be directed over the row to increase insecticide performance. Granular formulations applied by air generally perform better than spray formulations applied by air.  Optimal control from Success or Tracer is best achieved when the insecticide is applied at peak egg hatch or when larvae are small.		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz	Broadcast			
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz	Broadcast			
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	26 to 38 fl oz	Broadcast			
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz	Broadcast			
	carbofuran	<b>*Furadan 4F</b>	1.5 to 2 pt	Broadcast			
	carbofuran	<b>*Furadan LFR</b>	1.5 to 2 pt	Broadcast			
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz	Broadcast			
	methoxyfenozide	<b>Intrepid 2F</b>	4 to 8 fl oz	Broadcast			
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt	Broadcast			
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt	Over whorls			
	chlorpyrifos	<b>*Lorsban 15G</b>	3.5 to 8 oz/ 1000 ft row	Over whorls			
	chlorpyrifos	<b>*Lorsban 15G</b>	5 to 6.5 lb	Broadcast			
	zeta-cypermethrin	<b>*Mustang Max</b>	2.72 to 4 fl oz	Broadcast			
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt	Over whorls			
	chlorpyrifos	<b>*Nufos 15G</b>	3.5 to 8 oz/ 1000 ft row	Over whorls			
	microencapsulated methyl parathion	<b>*Pennacp-M</b>	2 pt	Over whorls			
	microencapsulated methyl parathion	<b>*Pennacp-M</b>	3 to 4 pt	Broadcast			
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz	Broadcast			
	permethrin	<b>*Pounce 1.5G</b>	6.7 to 13.3 lb	Broadcast			
	lambda-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz	Broadcast			
	spinosad	<b>Success</b>	3 to 6 fl oz	Over whorls			
	spinosad	<b>Tracer 45C</b>	1 to 3 fl oz	Broadcast			
	lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz	Broadcast			
	<b><i>bacillus thuringiensis</i></b>	Bt formulations:	<b>Agree, Biobit, Condor, Delivery, Lepinox, Javelin, Xentari, others.</b>	See specific labels		Broadcast	
		transgenic seed containing Bt events:	<b>Herculex I/Xtra Yieldgard CB/Plus</b>	Commercial seed Commercial seed		Bt toxin produced inside plant. Follow resistance guidelines for all transgenic hybrids	
European corn borer (second generation)	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Broadcast	For second-generation ECB larvae, treat when 50% of plants have egg masses and/or larvae on the first leaf above and below the ear.  Optimal control from Success or Tracer is best achieved when the insecticide is applied at peak egg hatch or when larvae are small.		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz				
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz				
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz				
	carbofuran	<b>*Furadan 4F</b>	1.5 to 2 pt				
	carbofuran	<b>*Furadan LFR</b>	1.5 to 2 pt				
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz				
	methoxyfenozide	<b>Intrepid 2F</b>	4 to 8 fl oz				
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt				
	chlorpyrifos	<b>*Lorsban 15G</b>	6.5 lb				
	zeta-cypermethrin	<b>*Mustang Max</b>	2.72 to 4 fl oz				
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt				
	microencapsulated methyl parathion	<b>*Pennacp-M</b>	2 to 4 pt				
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz				
	permethrin	<b>*Pounce 1.5G</b>	6.7 to 13.3 lb				
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz				
	spinosad	<b>Success</b>	3 to 6 fl oz				
	spinosad	<b>Tracer 45C</b>	1 to 3 fl oz				
	lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz				
	<b><i>bacillus thuringiensis</i></b>	Bt formulations:	<b>Agree, Biobit, Condor, Delivery, Lepinox, Javelin, Xentari, others.</b>			See specific labels	Broadcast
		transgenic seed containing Bt events:	<b>Herculex I/Xtra Yieldgard CB/Plus</b>			Commercial seed Commercial seed	Bt toxin produced inside plant. Follow restriction guidelines for transgenic hybrids.

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**Insecticides for field corn**

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Fall armyworm	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz	Broadcast	Treat when 75% or more of plants have whorl damage and larvae are present in whorls. Ground-applied sprays directed over the row are recommended for best control of this pest in whorls. Control of this pest in ear tips is difficult to achieve. Optimal control from Success or Tracer is best achieved when the insecticide is applied at peak egg hatch or when larvae are small.
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz	Postemergence	
	methoxyfenozide	<b>Intrepid 2F</b>	4 to 8 fl oz		
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	zeta-cypermethrin	<b>*Lorsban Advanced</b>	1 to 2 pt		
	chlorpyrifos	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	permethrin	<b>*Nufos 4E</b>	1 to 2 pt		
	carbaryl	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	spinosad	<b>Sevin XLR Plus</b>	2 to 4 pt		
	spinosad	<b>Success</b>	3 to 6 fl oz		
lambda-cyhalothrin	<b>Tracer 4SC</b>	1 to 3 fl oz			
	<b>*Warrior</b>	2.56 to 3.84 fl oz			
Flea beetle	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Spray over row	Treat when five or more beetles per plant are present or when seedling plants are being severely damaged or killed and beetles are present. For Lorsban 4E, use ground equipment to apply 20 to 40 gallons of formulated spray per acre.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	0.8 to 1.6 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4.0 to 10.3 fl oz		
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Lorsban Advanced</b>	1 to 2 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>*Pennacp-M</b>	2 to 3 pt		
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz		
carbaryl	<b>Sevin XLR Plus</b>	2 to 4 pt			
lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz			
<b>Seed Treatments</b>	thiamethoxam	<b>Cruiser</b>	See product label	Commercially applied to seed	
	clothianidin	<b>Poncho</b>	See product label		
	tefluthrin	<b>Proshield with Force ST</b>	See product label		
Grasshoppers	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	Broadcast	Control grasshoppers when they are small by applying spot treatments to hatching sites in field borders and grass waterways. Treatment is justified in corn field when seven or more grasshoppers per square yard are present and foliage is being severely damaged. After pollen shed, control may be necessary if grasshoppers are damaging foliage above ear zone. Dimethoate should not be applied to corn during pollen-shed.
	cyfluthrin	<b>*Baythroid XL</b>	2.1 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	7 to 13 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	2.6 to 6.1 fl oz		
	chlorpyrifos	<b>*Lorsban 4E</b>	.5 to 1 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.72 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	.5 to 1 pt		
	microencapsulated methyl parathion	<b>*Pennacp-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz		
	carbaryl	<b>Sevin XLR Plus</b>	1 to 3 pt		
lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz			

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## Insecticides for field corn

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Japanese beetle adults	esfenvalerate	*Asana XL	5.8 to 9.6 fl oz	Broadcast	Treatment is justified if three or more beetles per ear are present during the silking period and pollination is not complete.
	cyfluthrin	*Baythroid XL	1.6 to 2.8 fl oz		
	bifenthrin	*Brigade 2EC	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	*Cobalt	38 to 42 fl oz		
	bifenthrin	*Fanfare 2EC	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	*Hero	4 to 10.3 fl oz		
	zeta-cypermethrin microencapsulated	*Mustang Max	3.2 to 4 fl oz		
	methyl parathion	*PennCap-M	2 to 4 pt		
	gamma-cyhalothrin carbaryl	*Proaxis	2.56 to 3.84 fl oz		
	lambda-cyhalothrin	*Sevin XLR Plus	2 to 4 pt		
		*Warrior	2.56 to 3.84 fl oz		
Seedcorn maggot					
<b>Soil applied</b>	beta-cyfluthrin	*Baythroid XL	0.12 to 0.16 oz/ 1000 ft row (30-inch row spacing)	In furrow at planting (apply with water or fertilizer)	Seedbox treatments or commercial seed treatments recommended for use in fields with high organic matter or those receiving animal manures prior to planting. Not necessary if soil insecticide used at planting.
	bifenthrin	*Brigade 2EC	0.15 to 0.30 fl oz/ 1000 ft row (30-inch row spacing)	In furrow at planting (apply with water or fertilizer)	
	bifenthrin	*Capture LFR	0.2 to 0.39 fl oz/ 1000 ft row	Band or furrow at planting (LFR applied with fertilizer)	
	chlorpyrifos	*Lorsban 15G	8 oz/ 1000 ft row	Band or furrow at planting	
	chlorpyrifos	*Nufos 15G	8 oz/ 1000 ft row	Band or furrow at planting	
	fipronil	*Regent 4SC	0.24 fl oz/ 1000 ft row (30-inch row spacing)	In furrow at planting (apply with water or fertilizer)	
<b>Seedbox treatment</b>	imidacloprid (25%)	*Concur	1.5 oz/42 lb seed	Seed treatment	
	imidacloprid (25%)	*Latitude	1.5 oz/42 lb seed		
	permethrin	*Kernel Guard Supreme	See product label		
<b>Seed treatments</b>	thiamethoxam	Cruiser	See product label	Seed treatment	
	imidacloprid	Gaucho	See product label		
	clothianidin	Poncho	See product label		
	tefluthrin	Proshield with Force ST	See product label		
	fipronil	*Regent TS	2 fl oz/ 100 lb seed		
Southern corn leaf beetle	cyfluthrin	*Baythroid XL	1.6 to 2.8 FL oz	Broadcast	No economic thresholds have been established at this time.  Treatment is justified if adults are present and causing significant damage through foliage or stem feeding.
	bifenthrin	*Brigade 2EC	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	*Cobalt	13 to 26 fl oz		
	bifenthrin	*Fanfare 2EC	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	*Hero	4 to 10.3 fl oz		
	chlorpyrifos	*Lorsban 4E	1 to 2 pt		
	zeta-cypermethrin	*Mustang Max	2.72 to 4 fl oz		
	chlorpyrifos	*Nufos 4E	1 to 2 pt		
	lambda-cyhalothrin	*Warrior	3.84 fl oz		

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**Insecticides for field corn**

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Southwestern corn borer (second generation)	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Broadcast	Apply control at peak second generation oviposition or when 25% of plants have eggs and live larvae present.  Optimal control from Success or Tracer is best achieved when the insecticide is applied at peak egg hatch or when larvae are small.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	carbofuran	<b>*Furadan 4F</b>	1 to 2 pt		
	carbofuran	<b>*Furadan LFR</b>	1 to 2 pt		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	methoxyfenozide	<b>Intrepid 2F</b>	4 to 8 fl oz		
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Lorsban 15G</b>	6.5 lb		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.7 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Nufos 15G</b>	6.5 lb		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	2 to 4 pt		
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz		
	spinosad	<b>Success</b>	3 to 6 fl oz		
spinosad	<b>Tracer 4SC</b>	2 to 3 fl oz			
lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz			
transgenic seed containing Bt events:	<b>Herculex I/Xtra</b> <b>Yieldgard CB/Plus</b>	Commercial seed Commercial seed	Bt toxin produced inside plant. Follow resistance guidelines for transgenic hybrids.		
Spider mites	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz	Broadcast	Treatment is justified if high mite numbers are causing yellowing or browning of lower plant leaves before dent growth stage of field corn. Do not apply dimethoate during pollen-shed.
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	2.6 to 6.1 fl oz		
Stalk borer	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	Broadcast  Broadcast, band, in-furrow	Apply postemergence sprays when young larvae are moving from weed hosts to corn.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	bifenthrin	<b>*Capture LFR</b>	3.4 to 6.8 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	38 to 42 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	2.6 to 6.1 fl oz		
	chlorpyrifos	<b>*Lorsban 4E</b>	2 to 3 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.7 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	2 to 3 pt		
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz		
lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz			
Stink bugs	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz	Broadcast	Apply as postemergence rescue treatment. Stink bug problems in field corn often occur initially in border rows located adjacent to areas supporting woody shrubs and trees.
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	38 to 42 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.72 to 4 fl oz		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	1 to 3 pt		
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz		
lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz			

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## Insecticides for field corn

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Webworms	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz	Broadcast	Many webworm species readily feed on grass and occasionally become pests of field corn.  Lorsban application is more effective if incorporated with rotary hoe or other equipment following treatment.
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	zeta-cypermethrin permethrin	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	gamma-cyhalothrin lambda-cyhalothrin	<b>*Pounce 3.2EC</b> <b>*Proaxis</b> <b>*Warrior</b>	4 to 8 fl oz 2.56 to 3.84 fl oz 2.56 to 3.84 fl oz		
Western bean cutworm	esfenvalerate	<b>*Asana XL</b>	2.9 to 5.8 fl oz	Broadcast	Scout from first tassel until silks brown. Scout for round, white eggs in groups of a few to 200 located on upper surface of leaves above ear zone. Pale larvae have light-brown stripe running the length of back. Treat when 95% of corn is tasseled and contains 8% or more of plants with eggs or larvae present.  Control is difficult once larvae enter corn ears.  Optimal control from Success or Tracer is best achieved when the insecticide is applied at peak egg hatch or when larvae are small.
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	bifenthrin	<b>*Fanfare 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + bifenthrin	<b>*Hero</b>	4 to 10.3 fl oz		
	methoxyfenozide	<b>Intrepid 2F</b>	4 to 8 fl oz		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.72 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	3 pt		
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	1.92 to 3.20 fl oz		
	carbaryl	<b>Sevin XLR Plus</b>	4 pt		
	spinosad	<b>Success</b>	3 to 6 fl oz		
spinosad lambda-cyhalothrin	<b>Tracer 4SC</b> <b>*Warrior</b>	2 to 3 fl oz 1.92 to 3.20 fl oz			
White grub	tebupirimphos + cyfluthrin	<b>*Aztec 2.1G</b>	6.7 oz/ 1000 ft row	Band, furrow with incorporation	Corn planted into pastures, grasslands, weedy fields and river bottom fields bordered by willows, sycamore, cottonwood and other wetland trees may be at greater risk of grub damage.
	tebupirimphos + cyfluthrin	<b>*Aztec 4.67</b>	3 oz/ 1000 ft row	Band, furrow with incorporation (for smartbox use)	
	bifenthrin	<b>*Brigade 2EC</b>	0.15 to 0.3 fl oz/ 1000 ft row	Band, furrow	
	bifenthrin	<b>*Brigade 2EC</b>	3 to 4 fl oz	Broadcast-PPI	
	bifenthrin	<b>*Capture LFR</b>	3.4 to 6.8 fl oz	Band, furrow	
	terbufos	<b>*Counter 15G</b>	8 oz/ 1000 ft row	Band, furrow	
	bifenthrin	<b>*Fanfare 2EC</b>	0.15 to 0.3 fl oz/ 1000 ft row	Band, furrow	
	bifenthrin	<b>*Fanfare 2EC</b>	3 to 4 fl oz	Broadcast-PPI	
	tefluthrin	<b>*Force 3G</b>	4 to 5 oz/ 1000 ft row	Furrow	
	tefluthrin	<b>*Force CS</b>	0.46 to 0.57 oz/ 1000 ft row	Furrow	
	chlorethoxyfos	<b>*Fortress 2.5G</b>	6.0 to 7.5 oz/ 1000 ft row	Furrow	
	chlorethoxyfos	<b>*Fortress 5G</b>	3 to 3.75 oz/ 1000 ft row	Furrow (for smartbox use)	
	chlorpyrifos	<b>*Lorsban 4E</b>	4 pt	Broadcast-PPI	
	chlorpyrifos	<b>*Lorsban 4E</b>	2.6 pt	Band,	
	chlorpyrifos	<b>*Lorsban 15G</b>	8 oz/ 1000 ft row	Band, furrow	
	gamma-cyhalothrin	<b>*Proaxis</b>	0.66 fl oz/ 1000 ft row	Band, furrow	
	chlorpyrifos	<b>*Nufos 4E</b>	4 pt	Broadcast-PPI	
chlorpyrifos	<b>*Nufos 4E</b>	2.6 pt	Band		
chlorpyrifos	<b>*Nufos 15G</b>	8 to 16 oz/ 1000 ft row	Furrow		
fipronil	<b>*Regent 4SC</b>	0.24 fl oz/ 1000 ft row	Furrow		
phorate	<b>*Thimet 20G</b>	6 oz/ 1000 ft row	Band only, see label		
lambda-cyhalothrin	<b>*Warrior</b>	0.66 fl oz/ 1000 ft row	Band		
<b>Seed treatments</b>	thiamethoxam	<b>Cruiser</b>	See product label	On seed	
	clothianidin	<b>Poncho</b>	See product label	On seed	

\*Designates a restricted-use pesticide. Use is restricted to certified applicators only. Regardless of the formulation selected, read the label to determine appropriated insecticide rates, directions, precautions and restrictions.

## Insecticides for field corn

Insect	Insecticide		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Wireworm	tebufos + cyfluthrin	<b>*Aztec 2.1G</b>	6.7 oz/ 1000 ft row	Band, furrow with incorporation	Treatment is justified if field has chronic history of wireworm problems or if the number of wireworm larvae collected from solar bait stations exceed the economic threshold (average of one or more per trap).
	tebufos + cyfluthrin	<b>*Aztec 4.67</b>	3 oz/ 1000 ft row	Band, furrow with incorporation	
	bifenthrin	<b>*Brigade 2EC</b>	0.15 to 0.3 fl oz/ 1000 ft row	Band, furrow	
	bifenthrin	<b>*Brigade 2EC</b>	3 to 4 fl oz	Broadcast-PPI	
	bifenthrin	<b>*Capture LFR</b>	3.4 to 6.8 fl oz	Band, furrow	
	terbufos	<b>*Counter 15G</b>	6 oz/ 1000 ft row	Band, furrow	
	bifenthrin	<b>*Fanfare 2EC</b>	0.15 to 0.3 fl oz/1000 ft row	Band, furrow	
	bifenthrin	<b>*Fanfare 2EC</b>	3 to 4 fl oz	Broadcast-PPI	
	tefluthrin	<b>*Force 3G</b>	4 to 5 oz/ 1000 ft row	Furrow	
	tefluthrin	<b>*Force CS</b>	0.46 to 0.57 oz/ 1000 ft row	Furrow	
	chlorethoxyfos	<b>*Fortress 2.5G</b>	6 to 7.5 oz/ 1000 ft row	Furrow	
	chlorethoxyfos	<b>*Fortress 5G</b>	3 to 3.75 oz/ 1000 ft row	Furrow	
	carbofuran	<b>*Furadan LFR</b>	2.5 fl oz/ 1000 ft row	Broadcast-PPI	
	chlorpyrifos	<b>*Lorsban 4E</b>	4 pt	Furrow	
	chlorpyrifos	<b>*Lorsban 15G</b>	8 oz/ 1000 ft row	Band, furrow	
	gamma-cyhalothrin	<b>*Proaxis</b>	0.66 fl oz/ 1000 ft row	Broadcast-PPI	
	chlorpyrifos	<b>*Nufos 4E</b>	4 pt	Furrow	
	chlorpyrifos	<b>*Nufos 15G</b>	8 to 16 oz/ 1000 ft row	Furrow	
	fipronil	<b>*Regent 4SC</b>	0.24 fl oz/ 1000 ft row	Band only, see label	
	phorate	<b>*Thimet 20G</b>	6 oz/ 1000 ft row	Band	
lambda-cyhalothrin	<b>*Warrior</b>	0.66 fl oz/ 1000 ft row			
<b>Seed treatments</b>	thiamethoxam	<b>Cruiser</b>	See product label	On seed	
		<b>Poncho</b>	See product label		
		<b>Regent TS</b>	See product label		

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## Insect management for grain sorghum (milo)

Several insect pests of field corn, along with the green-bug, sorghum midge and sorghum webworm, may cause severe damage to grain sorghum. Management of these insect pests is best achieved through the use of an integrated pest management (IPM) program. In such a program, all

available management strategies are reviewed, and appropriate ones are selected and implemented depending on the specific target insect. Control strategies may consist of cultural, mechanical, biological or chemical options. An individual control strategy or a combination of several control strategies may be used to achieve effective pest control. Proper identification of pest species and knowledge of pest biologies are essential when making management decisions.

## Insecticides for grain sorghum (milo)

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Chinch bug	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	At plant base	Use ground equipment to treat border rows when migration of insects from small grains begins.  Direct spray toward base of plant.
	cyfluthrin	<b>*Baythroid XL</b>	2 to 2.8 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 38 fl oz		
	lambda-cyhalothrin	<b>Karate w Zeon Tech</b>	1.92 fl oz		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Proaxis</b>	3.84 fl oz		
	carbaryl	<b>Sevin XLR Plus</b>	2 to 4 pt		
	lambda-cyhalothrin	<b>*Warrior</b>	3.84 fl oz		

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## Insecticides for grain sorghum (milo)

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments				
	Common name	Trade name							
Corn earworm	esfenvalerate cyfluthrin chlorpyrifos + gamma-cyhalothrin lambda-cyhalothrin methomyl chlorpyrifos zeta-cypermethrin chlorpyrifos gamma-cyhalothrin carbaryl spinosad lambda-cyhalothrin	*Asana XL	5.8 to 9.6 fl oz	Over row	Treat when larvae average two or more worms per head.				
		*Baythroid XL	1.3 to 2.8 fl oz						
		*Cobalt	19 to 38 fl oz						
		Karate w Zeon Tech	1.28 to 1.92 fl oz						
		*Lannate LV	.75 to 1.5 pt						
		*Lorsban 4E	2 pt						
		*Mustang Max	1.76 to 4 fl oz						
		*Nufos 4E	2 pt						
		*Proaxis	2.56 to 3.84 fl oz						
		Sevin XLR Plus Tracer 4SC *Warrior	2 to 4 pt 1.5 to 3 fl oz 1.92 to 3.2 fl oz						
Corn leaf aphid	dimethoate chlorpyrifos chlorpyrifos	Dimethoate 4EC	.5 to 1 pt	Over row	Rarely cause economic damage unless plants are under drought stress.				
		*Lorsban 4E	1 to 2 pt						
		*Nufos 4E	1 to 2 pt						
Cutworms	esfenvalerate cyfluthrin chlorpyrifos + gamma-cyhalothrin lambda-cyhalothrin chlorpyrifos zeta-cypermethrin chlorpyrifos gamma-cyhalothrin carbaryl lambda-cyhalothrin	*Asana XL	5.8 to 9.6 fl oz	Broadcast	Apply postemergence rescue treatment when 2% to 4% or more of plants are cut and larvae are present.				
		*Baythroid XL	1 to 1.3 fl oz						
		*Cobalt	13 to 38 fl oz						
		Karate w Zeon Tech	0.96 to 1.28 fl oz						
		*Lorsban 4E	1 to 2 pt						
		*Mustang Max	1.28 to 4 fl oz						
		*Nufos 4E	1 to 2 pt						
		*Proaxis	1.92 to 2.56 fl oz						
		Sevin XLR Plus *Warrior	4 pt 1.92 to 3.2 fl oz						
		Fall armyworm	chlorpyrifos + gamma-cyhalothrin lambda-cyhalothrin methomyl chlorpyrifos zeta-cypermethrin chlorpyrifos gamma-cyhalothrin carbaryl spinosad lambda-cyhalothrin			*Cobalt	13 to 38 fl oz	Over row	Treat when larvae average two or more larvae per head. Leaf and whorl damage rarely economic.
Karate w Zeon Tech	1.28 to 1.92 fl oz								
*Lannate LV	0.75 to 1.5 pt								
*Lorsban 4E	1 to 2 pt								
*Mustang Max	1.76 to 4 fl oz								
*Nufos 4E	1 to 2 pt								
*Proaxis	1.92 to 3.2 fl oz								
Sevin XLR Plus Tracer 4SC *Warrior	2 to 4 pt 1.5 to 3 fl oz 2.56 to 3.84 fl oz								
Grasshoppers	cyfluthrin chlorpyrifos + gamma-cyhalothrin dimethoate lambda-cyhalothrin chlorpyrifos zeta-cypermethrin chlorpyrifos gamma-cyhalothrin carbaryl lambda-cyhalothrin			*Baythroid XL	2 to 2.8 fl oz	Broadcast	Control grasshoppers when they are small by applying spot treatments to hatching sites in field borders and grass waterways. Treatment in field is justified when seven or more grasshoppers per square yard are present.		
				*Cobalt	7 to 13 fl oz				
		Dimethoate 4EC	.5 to 1 pt						
		Karate w Zeon Tech	1.28 to 1.92 fl oz						
		*Lorsban 4E	1 to 2 pt						
		*Mustang Max	3.2 to 4 fl oz						
		*Nufos 4E	1 to 2 pt						
		*Proaxis	2.56 to 3.84 fl oz						
		Sevin XLR Plus *Warrior	1 to 3 pt 2.56 to 3.84 fl oz						
		Greenbug	chlorpyrifos + gamma-cyhalothrin dimethoate chlorpyrifos chlorpyrifos	*Cobalt	13 to 38 fl oz			Over row	Treat seedling plants when an average of 10 or more aphids are present per plant or if greenbug feeding caused the death of three or more fully expanded leaves prior to hard-dough stage.
Dimethoate 4EC	.5 to 1 pt								
*Lorsban 4E *Nufos 4E	.5 to 1 pt .5 to 1 pt								

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## Insecticides for grain sorghum (milo)

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Sorghum midge	esfenvalerate cyfluthrin chlorpyrifos + gamma-cyhalothrin	*Asana XL	2.9 to 5.8 fl oz	Over row	Apply during bloom when 50% of heads are in bloom and adult midges average one or more per sorghum head.
		*Baythroid XL	1 to 1.3 fl oz		
		*Cobalt	7 to 13 fl oz		
	lambda-cyhalothrin chlorpyrifos zeta-cypermethrin chlorpyrifos gamma-cyhalothrin lambda-cyhalothrin	Karate w Zeon Tech	0.96 to 1.28 fl oz		
		*Lorsban 4E	.5 to 1 pt		
		*Mustang Max	1.28 to 4 fl oz		
		*Nufos 4E	.5 to 1 pt		
Sorghum webworm	cyfluthrin chlorpyrifos + gamma-cyhalothrin	*Baythroid XL	1.3 to 2.8 fl oz	Over row	Treat when five or more larvae per head are present.
		*Cobalt	19 to 38 fl oz		
		Karate w Zeon Tech	1.28 to 1.92 fl oz		
	lambda-cyhalothrin chlorpyrifos zeta-cypermethrin chlorpyrifos gamma-cyhalothrin spinosad lambda-cyhalothrin	*Lorsban 4E	1 pt		
		*Mustang Max	1.76 to 4 fl oz		
		*Nufos 4E	1 pt		
		*Proaxis	2.56 to 3.84 fl oz		
Yellow sugarcane aphid	chlorpyrifos + gamma-cyhalothrin dimethoate chlorpyrifos chlorpyrifos	*Cobalt	7 to 13 fl oz	Over row	Treat seedling sorghum when an average of 5 to 10 or more aphids are present per plant.
		Dimethoate 4EC	.5 to 1 pt		
		*Lorsban 4E	.5 to 1 pt		
		*Nufos 4E	.5 to 1 pt		

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## Insect management for soybean

In recent years the bean leaf beetle, soybean aphid, stink bug and white grub have emerged as important pests of soybean. Some less frequent pest of this crop include burrower bugs, Japanese beetles, grasshopper and spider mites. Management of these insect pests is best achieved through the use of an integrated pest management (IPM) program. In such a program, all available management strategies are reviewed and appropriate ones selected and implemented depending on the specific target insect. Control strategies may consist

of cultural, mechanical, biological or chemical options. An individual control strategy or a combination of several control strategies may be used to achieve effective pest control. An additional control option consisting of commercially applied seed treatments have recently been introduced for soybean. As with corn, the soybean seed treatments target several different early-season insect pests. Proper identification of pest species and knowledge about pest biologies are essential when making management decisions.

## Insecticides for soybean

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Bean leaf beetle	permethrin	<b>*Ambush 25W</b>	3.2 to 6.4 fl oz	On foliage	Treatment on seedling soybean is rarely needed. If necessary, treat when five or more beetles are present per foot of row and one or more plants per foot of row are destroyed. Cold, dry growing conditions may lead to increased BLB problems on emerging and seedling soybean. Before bloom, treat when five or more beetles are present per foot of row and defoliation exceeds 30%. At stages from bloom to pod fill, treat when defoliation reaches 20% and beetles average 10 or more per foot of row (30-inch rows) or one to three beetles (7-inch rows). At seed maturity, treat when 5 to 10% of pods are damaged, plants are still green and 10 or more beetles per foot of row are present.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	0.8 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	carbofuran	<b>*Furadan 4F</b>	.25 to .50 pt — 2(ee) label		
	zeta-cypermethrin + methomyl	<b>*Hero</b>	2.6 to 6.1 fl oz		
	chlorpyrifos	<b>*Lannate LV</b>	.75 to 1 pt		
	zeta-cypermethrin	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	acephate	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>Orthene 97</b>	.75 to 1 lb		
	permethrin	<b>*PennCap-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
	carbaryl	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
	spinosad	<b>Sevin XLR Plus</b>	1 to 2 pt		
spinosad	<b>Success</b>	3 to 6 fl oz			
lambda-cyhalothrin	<b>Tracer 4SC</b>	1 to 3 fl oz			
	<b>*Warrior</b>	1.92 to 3.2 fl oz			
Blister beetle	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz	On foliage	An occasional to rare pest on soybean. Treat when defoliation reaches 30% prebloom or 20% from bloom to pod fill.
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	3.2 to 3.84 fl oz		
	carbaryl	<b>Sevin XLR Plus</b>	1 to 2 pt		
lambda-cyhalothrin	<b>*Warrior</b>	3.2 to 3.84 fl oz			
Corn earworm	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	On foliage	Treat when defoliation reaches 30% prebloom or 20% from bloom to pod fill or when larval numbers exceed one per foot of row and 5% or more of pods are damaged.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	0.8 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	zeta-cypermethrin + methomyl	<b>*Hero</b>	2.6 to 6.1 fl oz		
	chlorpyrifos	<b>*Lannate LV</b>	.75 to 1 pt		
	zeta-cypermethrin	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	permethrin	<b>*Nufos 4E</b>	1 to 2 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	carbaryl	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
	indoxacarb	<b>Sevin XLR Plus</b>	1 to 2 pt		
spinosad	<b>Steward 1.25SC</b>	4.6 to 11.3 fl oz			
lambda-cyhalothrin	<b>Tracer 4SC</b>	1.5 to 2 fl oz			
	<b>*Warrior</b>	1.92 to 3.2 fl oz			
Cutworms	permethrin	<b>*Ambush 25W</b>	5.8 to 9.6 fl oz	Broadcast	Scout emerging plants and treat if cutting reaches or exceeds 20% and cutworms are present.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
	permethrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
lambda-cyhalothrin	<b>*Warrior</b>	1.92 to 3.2 fl oz			

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## Insecticides for soybean

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Grasshoppers	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	Broadcast	Treat when defoliation reaches 30% before bloom, 20% bloom to pod fill, or when 5% to 10% of pods are damaged.
	cyfluthrin	<b>*Baythroid XL</b>	2 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	7 to 13 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	carbofuran	<b>*Furadan 4F</b>	.25 to .50 pt		
	carbofuran	<b>*Furadan LFR</b>	.25 to .50 pt		
	chlorpyrifos	<b>*Lorsban 4E</b>	.25 to 1 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	chlorpyrifos	<b>*Nufos 4E</b>	.5 to 1 pt		
	acephate	<b>Orthene 97</b>	.25 to .50 lb		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	2 to 3 pt		
	permethrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	3.2 to 3.84 fl oz		
carbaryl	<b>Sevin XLR Plus</b>	1 to 3 pt			
lambda-cyhalothrin	<b>*Warrior</b>	3.2 to 3.84 fl oz			
Green cloverworm	permethrin	<b>*Ambush 25W</b>	3.2 to 6.4 fl oz	On foliage	Treat when defoliation reaches 20% or more during bloom, pod set, or pod fill and 10 to 15 or more half-grown or larger larvae are present per foot of row.
	esfenvalerate	<b>*Asana XL</b>	2.9 to 5.8 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	7 to 13 fl oz		
	zeta-cypermethrin + chlorpyrifos	<b>*Hero</b>	2.6 to 6.1 fl oz		
	zeta-cypermethrin	<b>*Lorsban 4E</b>	.5 to 1 pt		
	chlorpyrifos	<b>*Mustang Max</b>	2.8 to 4.0 fl oz		
	acephate	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>Orthene 97</b>	.75 to 1 lb		
	permethrin	<b>*PennCap-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
	carbaryl	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
	spinosad	<b>Sevin XLR Plus</b>	1 to 2 pt		
lambda-cyhalothrin	<b>Tracer 4SC</b>	1 to 2 fl oz			
	<b>*Warrior</b>	1.92 to 3.2 fl oz			
Japanese beetle adults	permethrin	<b>*Ambush 25W</b>	3.2 to 6.4 fl oz	On foliage	Treat when defoliation reaches 30% before bloom and 20% between bloom and pod fill.
	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	0.8 to 1.6 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	zeta-cypermethrin + zeta-cypermethrin	<b>*Hero</b>	4 to 10.3 fl oz		
	microencapsulated methyl parathion	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	permethrin	<b>*PennCap-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
	carbaryl	<b>*Proaxis</b>	3.2 to 3.84 fl oz		
lambda-cyhalothrin	<b>Sevin XLR Plus</b>	1 to 2 pt			
	<b>*Warrior</b>	3.2 to 3.84 fl oz			

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## Insecticides for soybean

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Mexican bean beetle	permethrin	<b>*Ambush 25W</b>	3.2 to 6.4 fl oz	On foliage	Treat when defoliation reaches 30% before bloom and 20% between bloom and pod fill.
	esfenvalerate	<b>*Asana XL</b>	2.9 to 5.8 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	zeta-cypermethrin + chlorpyrifos	<b>*Hero</b>	4 to 10.3 fl oz		
	zeta-cypermethrin	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	acephate	<b>*Nufos 4E</b>	1 to 1.5 pt		
	microencapsulated methyl parathion	<b>Orthene 97</b>	.75 to 1 lb		
	permethrin	<b>*Pennacap-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
carbaryl	<b>*Proaxis</b>	1.92 to 3.2 fl oz			
lambda-cyhalothrin	<b>Sevin XLR Plus</b>	1 to 2 pt			
	<b>*Warrior</b>	1.92 to 3.2 fl oz			
Potato leafhopper	permethrin	<b>*Ambush 25W</b>	3.2 to 6.4 fl oz	On foliage	Treat when potato leafhopper numbers (adults + nymphs) average six or more per plant at bloom, or 13 or more per plant at seed set and edges of leaves appear burned.
	esfenvalerate	<b>*Asana XL</b>	2.9 to 5.8 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	0.8 to 1.6 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	zeta-cypermethrin + zeta-cypermethrin	<b>*Hero</b>	4 to 10.3 fl oz		
	acephate	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	microencapsulated methyl parathion	<b>Orthene 97</b>	.5 to 1 lb		
	permethrin	<b>*Pennacap-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
	carbaryl	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
	lambda-cyhalothrin	<b>Sevin XLR Plus</b>	2 pt		
	<b>*Warrior</b>	1.92 to 3.2 fl oz			
Seedcorn maggot					
<b>Seedbox treatment</b>	permethrin		See product label	Seed treatment	Planter box or commercial seed treatments provide good control of seedcorn maggot infestations in soybean. Fields most at risk are those with high organic matter content or those receiving applications of animal manure.
<b>Seed treatments</b>	thiamethoxam	<b>Cruiser</b>	See product label	Seed treatment	
	imidacloprid	<b>Gaucher</b>	See product label	Seed treatment	
Soybean aphid	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	On foliage	Treat when 250 or more aphids are present per plant when soybean plants are in the R1 through R5 growth stages. Larger yield responses will be realized when the insecticide is applied closer to the R1 stage of growth as compared to later growth stages.  In Missouri, beneficial insects are very important and can often control light to moderate soybean aphid infestations if give an opportunity to do so.
	cyfluthrin	<b>*Baythroid XL</b>	2 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	carbofuran	<b>*Furadan 4F</b>	.25 to .50 pt — 2(ee) label		
	zeta-cypermethrin + chlorpyrifos	<b>*Hero</b>	4 to 10.3 fl oz		
	zeta-cypermethrin	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	acephate	<b>*Nufos 4E</b>	1 to 2 pt		
	microencapsulated methyl parathion	<b>Orthene 97</b>	.75 to 1 lb		
	permethrin	<b>*Pennacap-M</b>	1 to 3 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	lambda-cyhalothrin	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
	<b>*Warrior</b>	1.92 to 3.2 fl oz			

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## Insecticides for soybean

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Soybean looper	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	On foliage	Treat when defoliation reaches 30% before bloom and 20% from bloom to pod fill.
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	zeta-cypermethrin + zeta-cypermethrin	<b>*Hero</b>	4 to 10.3 fl oz		
	microencapsulated methyl parathion	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	permethrin	<b>*Pennacap-M</b>	2 to 3 pt		
	permethrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	spinosad	<b>Tracer 4SC</b>	1 to 3 fl oz		
Spider mites	bifenthrin	<b>*Brigade 2EC</b>	5.12 to 6.4 fl oz	On foliage	Before pod set, treat when foliage yellowing reaches 20% and mites are present on plants.  After pod set, treat when foliage yellowing reaches 10% and mites are present on plants. Spider mite infestations on soybean are often associated with drought conditions.
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	chlorpyrifos	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Nufos 4E</b>	1 to 2 pt		
Stink bugs	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	On foliage	Treat when adult stink bugs or large nymphs average one or more per foot of row during pod fill.  In Missouri, "delayed senescence" of soybean has been attributed to heavy feeding by green stink bug during soybean reproductive growth stages.
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	zeta-cypermethrin + chlorpyrifos	<b>*Hero</b>	4 to 10.3 fl oz		
	zeta-cypermethrin	<b>*Lorsban 4E</b>	2 pt		
	chlorpyrifos	<b>*Mustang Max</b>	3.2 to 4 fl oz		
	acephate	<b>*Nufos 4E</b>	2 pt		
	microencapsulated methyl parathion	<b>Orthene 97</b>	.5 to 1 lb		
	gamma-cyhalothrin	<b>*Pennacap-M</b>	1 to 3 pt		
	carbaryl	<b>*Proaxis</b>	3.2 to 3.84 fl oz		
lambda-cyhalothrin	<b>Sevin XLR Plus</b>	2 to 3 pt			
	<b>*Warrior</b>	3.2 to 3.84 fl oz			
Thistle caterpillar	esfenvalerate	<b>*Asana XL</b>	5.8 to 9.6 fl oz	On foliage	Treat when defoliation reaches 30% before bloom and 20% from bloom to pod fill.
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	dimethoate	<b>Dimethoate 4EC</b>	1 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	1.28 to 4 fl oz		
	permethrin	<b>*Pounce 3.2EC</b>	2.0 to 4 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
	carbaryl	<b>Sevin XLR Plus</b>	2 to 3 pt		
	lambda-cyhalothrin	<b>*Warrior</b>	1.92 to 3.2 fl oz		
Thrips	cyfluthrin	<b>*Baythroid XL</b>	0.8 to 2.8 fl oz	On foliage	Treat when serious injury and some mortality of seedling plants occur and thrips are present.
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	19 to 38 fl oz		
	zeta-cypermethrin + acephate	<b>*Hero</b>	4 to 10.3 fl oz		
	microencapsulated methyl parathion	<b>Orthene 97</b>	.25 to .5 lb		
	gamma-cyhalothrin	<b>*Pennacap-M</b>	2 to 3 pt		
	carbaryl	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
lambda-cyhalothrin	<b>Sevin XLR Plus</b>	2 pt			
	<b>*Warrior</b>	1.92 to 3.2 fl oz			
Webworms	permethrin	<b>*Ambush 25W</b>	6.4 to 12.8 fl oz	On foliage	Treat when 10 to 12% of plants show heavy webbing on top leaflets or when defoliation reaches 30% before bloom or 20% from bloom to pod fill.
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	bifenthrin	<b>*Brigade 2EC</b>	2.1 to 6.4 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	zeta-cypermethrin + zeta-cypermethrin	<b>*Hero</b>	4 to 10.3 fl oz		
	permethrin	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	4 to 8 fl oz		
	carbaryl	<b>*Proaxis</b>	3.2 to 3.84 fl oz		
	lambda-cyhalothrin	<b>Sevin XLR Plus</b>	2 to 3 pt		
		<b>*Warrior</b>	3.2 to 3.84 fl oz		

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## Insecticides for soybean

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name	Trade name			
Woollybear caterpillar	permethrin	<b>*Ambush 25W</b>	3.2 to 6.4 fl oz	On foliage	Treat when defoliation reaches 30% before bloom and 20% from bloom to pod fill.
	esfenvalerate	<b>*Asana XL</b>	2.9 to 5.8 fl oz		
	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz		
	chlorpyrifos + gamma-cyhalothrin	<b>*Cobalt</b>	13 to 26 fl oz		
	zeta-cypermethrin + chlorpyrifos	<b>*Hero</b>	4 to 10.3 fl oz		
	zeta-cypermethrin	<b>*Lorsban 4E</b>	1 to 2 pt		
	chlorpyrifos	<b>*Mustang Max</b>	2.8 to 4 fl oz		
	permethrin	<b>*Nufos 4E</b>	1 to 2 pt		
	gamma-cyhalothrin	<b>*Pounce 3.2EC</b>	2 to 4 fl oz		
	carbaryl	<b>*Proaxis</b>	1.92 to 3.2 fl oz		
lambda-cyhalothrin	<b>Sevin XLR Plus</b>	2 to 3 pt			
	<b>*Warrior</b>	1.92 to 3.2 fl oz			

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## Insect management for wheat

Wheat acreage in Missouri is once again on the rise after several years in which the number of acres in wheat declined. This trend may continue as grain prices for wheat increase worldwide. Although wheat has few severe insect pests, one group of insects generating controversy is the aphid complex. This complex consists of greenbug, bird cherry-oat aphid, English grain aphid, corn leaf aphid, yellow sugarcane aphid and possibly others. Changes in wheat varieties, tillage practices, fertility levels, pest pressure and other factors all

affect economic threshold numbers. Traditional economic thresholds developed for these pests now seem outdated with the adoption of “high performance wheat production systems.” Recent research in Missouri suggests that aphid threshold levels may need to be more conservative to better protect loss of potential yield. An important goal in this state is to assess and modify economic thresholds for aphids and other wheat insect pests to better reflect Missouri field conditions.

## Insecticides for wheat

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments	
	Common name <sup>1</sup>	Trade name				
Greenbug	cyfluthrin	<b>*Baythroid XL</b>	1.8 to 2.4 fl oz	On foliage	See below.	
Bird cherry-oat aphid	chlorpyrifos + dimethoate	<b>*Cobalt Dimethoate 4EC</b>	7 to 13 fl oz			
	methomyl	<b>*Lannate LV</b>	1/2 to 3/4 pt			
English grain aphid	chlorpyrifos	<b>*Lorsban 4E</b>	3/4 to 1-1/2 pt			
	zeta-cypermethrin	<b>*Mustang Max</b>	1/2 to 1 pt			
	microencapsulated methyl parathion	<b>*PennCap-M</b>	3.2 to 4.0 fl oz			
	chlorpyrifos	<b>*Nufos 4E</b>	2 to 3 pt			
	gamma-cyhalothrin	<b>*Proaxis</b>	1/2 to 1 pt			
	lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz			
<b>Seed Treatments</b>	imidacloprid	<b>Gaucho</b>	2.56 to 3.84 fl oz			Commercially applied on seed
	thiamethoxam	<b>Cruiser</b>	See product label			
			See product label			

Greenbug tend to be an occasional problem on winter wheat in fall and again the following spring when winged aphids migrate into the state from more southern locations. Treatment is justified if 25 to 50 or more aphids are present per linear foot of row during early seedling stage (one or two tillers present). Later stages of wheat rarely require aphid control. Other control strategies include use of greenbug resistant wheat varieties and preservation of beneficial insect populations by avoiding nonessential insecticide applications.

Bird cherry-oat aphid has increased in importance in Missouri wheat during the past few years. This insect builds in numbers during the fall and may transmit barley yellow dwarf virus to wheat plants during this period. It has been found overwintering in Missouri wheat fields and builds in numbers the following spring. Economic damage is mainly caused by the barley yellow dwarf virus although this aphid does suck plant juices from wheat plants by using its piercing sucking mouthpart. Recent Missouri wheat trials indicate that both fall and spring populations of this aphid can cause substantial yield reductions in some years. Based on these data, the economic threshold for bird cherry-oat aphids is to treat when 12 to 25 aphids or more per linear foot of row from seedling emergence in the fall to heading of plants the following year.

English grain aphid does not transmit barley yellow dwarf, so damage to wheat is only through feeding, which removes plant juices. The economic threshold for this aphid is to treat when populations of 100 or more aphids per tiller are present. Corn leaf aphids and yellow sugarcane aphids rarely reach damaging levels due to heavy mortality of these aphids from biological control agents.

True armyworm	lambda-cyhalothrin	<b>*Karate</b>	1.28 to 1.92 fl oz	On foliage	Occasional severe pest of wheat and grass pastures. Treat when an average of four or more half-grown or larger worms per square foot are present during late spring and before more than 2 to 3% of heads are cut from stems. Scout at dusk, dawn or at night as small larvae feed on foliage at night and remain in plant debris near ground during day. Optimal control from Success and Tracer insecticides is best achieved when they are applied at peak egg hatch or when larvae are small.
	methomyl	<b>*Lannate LV</b>	.75 to 1.5 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	1.76 to 4 fl oz		
	microencapsulated methyl parathion	<b>*PennCap-M</b>	2 to 3 pt		
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz		
	carbaryl	<b>Sevin XLR Plus</b>	2 to 3 pt		
	spinosad	<b>Success</b>	3 to 6 fl oz		
	spinosad	<b>Tracer 4SC</b>	1 to 3 fl oz		
	lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz		
	Fall armyworm	lambda-cyhalothrin	<b>*Karate</b>		
methomyl		<b>*Lannate LV</b>	1.5 pt		
zeta-cypermethrin		<b>*Mustang Max</b>	3.2 to 4 fl oz		
gamma-cyhalothrin		<b>*Proaxis</b>	2.56 to 3.84 fl oz		
carbaryl		<b>Sevin XLR Plus</b>	2 to 3 pt		
spinosad		<b>Success</b>	3 to 6 fl oz		
spinosad		<b>Tracer 4SC</b>	1 to 3 fl oz		
lambda-cyhalothrin		<b>*Warrior</b>	2.56 to 3.84 fl oz		
Cereal leaf beetle	cyfluthrin	<b>*Baythroid XL</b>	1.6 to 2.8 fl oz	On foliage	Occasional pest in years with dry springs. Treat when an average of one or more larvae are present per flag leaf or stem. Optimal control from Success and Tracer insecticides is best achieved when they are applied at peak egg hatch or when larvae are small.
	lambda-cyhalothrin	<b>*Karate</b>	1.28 to 1.92 fl oz		
	methomyl	<b>*Lannate LV</b>	0.75 to 1.5 pt		
	zeta-cypermethrin	<b>*Mustang Max</b>	1.76 to 4 fl oz		
	gamma-cyhalothrin	<b>*Proaxis</b>	2.56 to 3.84 fl oz		
	carbaryl	<b>Sevin XLR Plus</b>	2 pt		
	spinosad	<b>Success</b>	2 to 6 fl oz		
	spinosad	<b>Tracer 4SC</b>	1 to 3 fl oz		
	lambda-cyhalothrin	<b>*Warrior</b>	2.56 to 3.84 fl oz		

<sup>1</sup>Designates a restricted-use pesticide. Use is restricted to certified applicators only. Regardless of the formulation selected, read the label to determine appropriated insecticide rates, directions, precautions and restrictions.

## Insecticides for wheat

Insect	Insecticides		Rate of formulated material per acre	Placement	Comments
	Common name <sup>1</sup>	Trade name			
Grass sawfly	chlorpyrifos + zeta-cypermethrin gamma-cyhalothrin lambda-cyhalothrin	*Cobalt *Mustang Max *Proaxis *Warrior	13 to 25 fl oz 1.76 to 4.0 fl oz 3.2 to 3.84 fl oz 2.56 to 3.84 fl oz	On foliage	Occasional pest found on wheat heads, but rarely builds to levels requiring management with a pesticide.
Grasshoppers	cyfluthrin chlorpyrifos + dimethoate carbofuran carbofuran lambda-cyhalothrin zeta-cypermethrin microencapsulated methyl parathion lambda-cyhalothrin carbaryl lambda-cyhalothrin	*Baythroid XL *Cobalt *Dimethoate 4EC *Furadan 4F *Furadan LFR *Karate *Mustang Max *PennCap-M  *Proaxis *Sevin XLR Plus *Warrior	1.8 to 2.4 fl oz 7 to 13 fl oz .75 pt .25 to .50 pt .25 to .50 pt 1.28 to 1.92 fl oz 3.2 to 4 fl oz 2 to 3 pt  2.56 to 3.84 fl oz 1 to 3 pt 2.56 to 3.84 fl oz	On foliage	Treat when eight or more adults per square yard are present within crop. Barrier treatments in border areas may be required to prevent migration into the crop if more than 20 adults per square yard are present in field margins.
Wheat curl mite					Control of this pest best achieved by alternative pest strategies. Insecticide applications not feasible for this pest.
White grub	chlorpyrifos	*Lorsban 4E	1 to 2 pt	Incorporate at plant Missouri 2ee (emergency use) label must be in hand before application. Commercially applied on seed	White grub in wheat often cause seedling damage during fall, which results in stand loss and replacement by weed species. Damage is often observed as yellowing of seedling foliage and plant mortality when damage is severe. Grubs feed on roots, but some species will surface feed if wet conditions exist. If grubs are present prior to planting, consider either a soil incorporated insecticide or insecticide treated seed.
<b>Seed treatment</b>	imidacloprid thiamethoxam	<b>Gaucho</b> <b>Cruiser</b>	See product label See product label		

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