



IPM-0458

Small Grains

Insect, Disease, and Weed Control
Recommendations for 2023

INSECT PEST MANAGEMENT

Small grain fields provide an ideal habitat for many beneficial as well as harmful insect species. Some closely resemble each other, so accurate identification is important. Insects can be identified by visual appearance, location in the field, and seasonal occurrence. After identification, it is important to determine if the insect population level has increased to the point of economic damage. This level is called the *economic injury level* and refers to the projected loss of crop that is equivalent to the cost of treatment. Many factors influence the amount of damage that occurs. Determining when an insect infestation causes economic damage is the basis of pest management. Most insect pests including aphids can be controlled by applying foliar insecticides when population numbers exceed economic thresholds. Economic thresholds presented here apply to wheat unless otherwise indicated. Pest impact on other small grains has not been well studied in the Southeast.

The primary insect pests of wheat and triticale in the Southeast are aphids and the Hessian fly. Aphids are important because they transmit barley yellow dwarf virus. Cereal leaf beetle occurs in the northern two-thirds of the state. A number of other insects also attack small grains, but these pests occur sporadically. Insect pests of oats are similar to those of wheat, except that oats are not attacked by Hessian fly. Rye is frequently interplanted and/or planted early as a forage crop. As such, it is often prone to damage from fall armyworms, winter grain mites, and green June beetle grubs. Cereal leaf beetle, Hessian fly, and chinch bug are also pests of rye. The major insect pests of barley are aphids, cereal leaf beetle, and occasionally Hessian fly.

See the Alabama Winter Wheat Production Guide at www.alabamacrops.com for more information on best management practices for small grains in Alabama.

General Insect Pest Management Recommendations for Wheat

- Avoid continuous planting of wheat in the same field.
- Select a Hessian fly resistant variety.
- Control volunteer wheat.
- If possible, chisel plow and disk harrow fields to bury wheat debris.
- Do not plant wheat for grain before the recommended planting date for your area.
- Consider planting oats or ryegrass instead of wheat for grazing.

- Scout fields (sample 5 to 10 sites per field) for insect pests and control with foliar-applied insecticides when numbers exceed treatment thresholds.

General Scouting Procedure

It is a good management practice to scout fields for damaging infestations of insects. At a minimum, check grain fields in the fall, in late winter before applying nitrogen, and during the boot and heading stages. Scouting during the first 20 to 50 days after planting is especially critical, because this is when insect control with a foliar spray can provide greatest economic returns. Check fields as often as possible after this time, particularly before applying fertilizer, herbicides, or fungicides. If insect populations exceed thresholds, it may be possible to apply an insecticide as a tank mix with another chemical.

Check five to 10 spots in the field, examining at least 1 row-foot at each location. Be sure to include at least two samples near the field edges. Check closely because insects, particularly aphids and pupae of the Hessian fly, can sometimes be found at the base of the plant below ground level. It may be necessary to pull some plants out of the ground in order to sample for insect infestations. For larger plants, slap the plants to jar insects to the ground for counting or use a sweep net.

Aphids

Aphids have become the number one insect pest of wheat in the Southeast. Aphids cause two types of damage. They directly damage plants by sucking sap and, in the case of the greenbug, by injecting a toxin while feeding. Wheat in the Southeast is attacked by a number of species of aphids. These include the greenbug, *Schizaphis graminum*; English grain aphid, *Sitobion avenae*; yellow sugarcane aphid, *Sipha flava*; bird cherry-oat aphid, *Rhopalosiphum padi*; rice-root aphid, *Rhopalosiphum rufiabdominale*; and corn leaf aphid, *Rhopalosiphum maidis*. All of these species attack a wide range of grass hosts including all of the small grain crops.

In spring 2015, *Sipha maydis* was found feeding on Johnsongrass in central Alabama. In fall 2015, it was found on early planted oats in Montgomery County. It is a known pest of wheat and barley in many parts of the world, and it is known to be a vector of barley yellow dwarf virus. This aphid is a relatively recent arrival in the United States. Isolated infestations had been found previously in California and in a greenhouse in Georgia. It was also intercepted in Florida on shipments from California. In winter 2014 – 2015, it was found in production fields of small grains in New Mexico and Colorado.

In general, the greenbug and English grain aphid cause more direct damage than the other species. Yellow sugarcane aphid can also cause direct damage. It is less common than the other aphids and is more likely to be found in southwest Alabama than in other parts of the state. The greenbug is particularly prevalent in the fall, and it can cause economic losses due to direct feeding on the young plants. Feeding by the greenbug causes the wheat plant to turn yellow, and heavy feeding will cause it to die. Heavy feeding also causes typical “greenbug spots” in a field. The centers of the spots are made of dead plants with visible skins of greenbugs, surrounded by living plants that are heavily infested and beginning to turn yellow. English grain aphid, more common in the spring, can cause reduction in yield during heading. Mild, dry winters and cool, dry springs often favor aphid outbreaks.

Indirect damage from aphids is more important than the direct damage, because aphids transmit plant disease viruses of which barley yellow dwarf and cereal yellow dwarf viruses are the most devastating. The bird cherry-oat and other *Rhopalosiphum* spp. aphids are the most important vectors in our area. Infection of seedling and vegetative stage plants in the fall and winter is much more damaging than infection during the spring. Fall infection stunts plants, increases susceptibility to cold injury, and reduces grain yield of infected plants by about 50 percent. Early planting enhances fall aphid infestations and infection of barley yellow dwarf virus.

Description and Life Cycle. Aphids are small, soft-bodied insects. They are about 1/8 inch long when fully grown. Most species have a pair of cornicles, which extend like exhaust tailpipes from the hind end of the aphid. Some aphids have wings; some do not.

Aphids do not have distinct generations, but population numbers are greatest in the fall and spring. Winged adults move from summer grass crops, weeds, and volunteer small grain plants to newly sown fields in the fall.

The winged adult produces wingless forms that feed in clusters on all vegetative parts of the plants and on the grain heads. In the Southeast, aphids overwinter in wheat fields as nymphs and wingless adults. Several aphid species often occur together in the same field. Aphid populations are predominantly greenbug, bird cherry-oat, and rice root aphids in the fall and winter, whereas English grain aphid becomes predominant in the spring.

Aphids are born pregnant; consequently, populations can increase and reach economic levels rapidly. Dry, warm (but not hot) weather promotes rapid population increase. Heavy and violent rainstorms can reduce populations considerably during the spring when aphids are exposed on grain heads. Aphids also are attacked and killed by parasitic wasps, which cause aphids to become light brown “mummies.” Several species of ladybird beetle adults and larvae are important predators of aphids. Ladybird beetle adults move into wheat fields from overwintering sites usually in March or early April where they feed voraciously on aphids and often control aphid infestations. This is too late to prevent transmission of barley yellow dwarf virus but may prevent direct aphid injury to developing grain. Hover fly larvae also can be found eating aphids in wheat fields.

Scouting Procedure. Follow the General Scouting Procedure (above) to scout for aphids.

Threshold Level and Management. The incidence of barley yellow dwarf may be reduced by controlling aphids in

the fall and late winter using foliar insecticides or by using an insecticide seed treatment at planting. The cost of these treatments should be weighed against the historic or expected loss from aphid infestation and barley yellow dwarf infection. For wheat planted for grain during the recommended plantings dates (Table 2), insecticide seed treatments for control of aphid vectors are more likely to pay off in north Alabama than in south Alabama. Insecticides to control aphids are most likely to reduce barley yellow dwarf when applied in the fall in North Alabama and when applied in early spring (at the time of nitrogen-topdress application) in the Coastal Plain. Setting threshold levels for aphids is difficult because of the influence of factors other than the number of aphids per foot of row. The planting date, temperature, time of year, moisture conditions, stage of growth, presence of parasites and predators, and the number of virus sources all need to be taken into consideration in deciding whether to apply insecticides. Yield-limiting infections of barley yellow dwarf occur before heading. Do not treat to control barley yellow dwarf after flag leaf emergence.

Threshold levels in Table 1 are based on research conducted in South Carolina and Georgia.

Table 1. Aphid Thresholds in Wheat

Growth Stage	Treat if there are more than:
Seedling (0–30 days after planting)	1–2 bird cherry-oat aphids per foot of row (North Ala.) or 10+ greenbugs or sugarcane aphids per foot of row
6- to 10-Inch Tall Plants	6 aphids per foot of row
Stem Elongation	2 aphids per stem
Boot/Flag Leaf Stage	5 aphids per stem
Head Emergence	10 aphids per head
Soft/Hard Dough	Do Not Treat

Hessian Fly

Hessian fly, *Mayetiola destructor*, populations were high in Alabama in 2012 and 2013. Changes in the biotype of the Hessian fly, combined with increased wheat acreage and increased areas planted to continuous wheat, contributed to the problem. In outbreak years this insect is a major factor limiting wheat production throughout the southern United States. In 1989, the Hessian fly destroyed many fields and caused losses of \$28 million in Georgia alone. Wheat is the primary host of the Hessian fly, but the insect also will infest barley, triticale, and rye. Hessian fly does not attack oats or ryegrass.

Description and Life Cycle. The adult fly is dark with long legs and is the size of a small mosquito. Adult females live for 2 to 3 days during which they mate. Females lay about 200 eggs in the grooves of the upperside of the wheat leaves. Eggs are orange-red, 1/32 inch long and hatch in 3 to 5 days. Young reddish larvae move along a leaf groove to the leaf sheath and then move between the leaf sheath and stem where they begin to feed on the stem above the crown or joints along the stem. Maggots become white after molting and appear greenish white when full grown. These white maggots discharge a toxic salivary secretion which stunts plant growth. Feeding by a single larva for several days will completely stunt the growth of a vegetative tiller. Maggots molt into a resting stage

(puparium), which is often referred to as the “flaxseed” stage because the puparium resembles a seed of flax. The entire life cycle requires about 35 days at 70°F. Newly hatched larvae are prone to drying while they are exposed on the leaf surface, but once larvae move to the stem base, they are protected from weather extremes. Plants infested in the fall may die or fail to form heads. Spring-infested wheat often lodges or has smaller heads.

The Hessian fly is a cool season insect and is active during the fall, winter, and spring. The insect overwinters as puparia in wheat stubble. The number of generations during the year is governed largely by temperature. Generally, three to four generations occur in the Piedmont region of the Southeast, and four to five generations occur in the Coastal Plain. Adults emerge from overwintered pupae in wheat stubble about September 1. Because wheat has not yet been planted, the first generation develops entirely in volunteer wheat and weed hosts. Little barley is the only important non-crop host in our area. A second and sometimes a third generation occur in late fall and winter. One generation usually occurs in the spring. The fall and first spring generations stunt and kill seedling plants and vegetative tillers. The spring generation infests jointed stems during stem elongation with larvae feeding between the stem and leaf sheath above a joint (node).

Management Strategies for Hessian Fly. Host plant resistance is the most economical means of Hessian fly control. However, use of resistant plant varieties has resulted in the development of numerous Hessian fly biotypes. Biotypes are identical to each other and to the parental type, except each biotype contains the ability to overcome a specific set of wheat genes for resistance to the pest.

Laboratory studies and field surveys of the Hessian fly in Alabama have shown that wheat varieties with the H13 gene (so-called Biotype L resistant varieties) provide the most protection from Hessian fly in Alabama. However, varieties with very good H7H8 resistance are still more helpful than varieties that are known to be susceptible to Hessian fly. See the latest version of the Alabama wheat production guide for more information on specific varieties.

Generally, Hessian fly damage is more severe in early wheat plantings. Early plantings allow insects to become established and increase before freezing temperatures limit activity. Damage by many insects can be minimized or avoided by not planting before the recommended planting date in your area. Growers who plant fly-susceptible varieties should plant near the end of the recommended planting dates for their area (see Table 2). Planting after the recommended planting date usually results in a loss of yield potential. For more information, see ANR-1442, “Planting Date and Variety Selection and Effects on Wheat Yield” (www.aces.edu/pubs/docs/A/ANR-1442/).

Table 2. Recommended Planting Dates for Wheat in Alabama

	Grain	Forage Plus Grain	Forage Only
North	Oct. 15–	Sept. 15–	Aug. 25–
	Nov. 10	Nov. 1	Sept. 10
Central	Oct. 15–	Sept. 15–	Sept. 1–
	Nov. 15	Nov. 1	Sept. 15
South	Nov. 15–	Oct. 1–	Sept. 15–
	Dec. 1	Nov. 15	Sept. 30

The average Hessian fly-free date in North Alabama is around November 1. South Alabama is similar to Georgia's coastal plain region and does not have a fly-free date. Risk of Hessian fly infestations will be greater during the La Niña phase of the El Niño Oscillation. Rainfall in late August and September also increases the risk of Hessian fly.

The effect of planting date on Hessian fly populations in wheat is shown in Table 3. Fall infestations decline in later planting dates. Therefore, damage by the Hessian fly may be minimized by timely planting, but fall damage probably will not be eliminated, particularly in the coastal plain region where activity can occur throughout the winter. Several other cultural practices can aid in the management of Hessian fly in wheat. Most insect pests, including the Hessian fly, aphids, fall armyworms, and others can become established in a field on volunteer wheat growing in the summer annual crop before wheat planting. Therefore, control of volunteer wheat by reducing combine losses of grain at wheat harvest and effective subsequent weed control will help in reducing early fall pest buildup. Tillage can have a large impact on fall populations of insects in wheat. Insect populations and damage generally are greater under no tillage than under conventional tillage systems. Table 4 shows the effect of moldboard plowing on fall Hessian fly infestations in wheat. Fall infestations were almost three times greater in the no-till than the plow tillage systems. Plowing buries wheat stubble where Hessian flies overwinter and suppresses volunteer wheat.

Table 3. Effect of Planting Date on Hessian Fly Infestation in Susceptible Winter Wheat at Plains, Georgia

Planting Date	% Infested Tillers		
	Dec. 5	Feb. 9	May 12
Oct. 23	42	24	65
Nov. 5	16	23	70
Nov. 20	0	20	77
Dec. 5	—	2	70

SOURCE: David Buntin, University of Georgia, Field trials from Plains and Griffin, Georgia.

Table 4. Effect of Moldboard Plowing on Hessian Fly Infestation in the Fall and Spring

Tillage Treatment	% Infested Tillers	
	Fall	Spring
Plowing (fall and spring)	8	40
Plowing (fall only)	7	44
No-tillage	23	43

SOURCE: David Buntin, University of Georgia

Using a seed treatment will provide some control of Hessian fly. Growers who plant fly-susceptible wheat in high-risk situations may benefit from high rates of seed treatments such as clothianidin, thiomethoxam, and imidacloprid. Seed treatments will not prevent reinfestation by subsequent generations during the winter and spring. Foliar application of insecticide at or before the second to third leaf stage may protect the young wheat plants from attack by Hessian fly. See the North Carolina small grain production guide for more information (www.smallgrains.ncsu.edu/production-guide.html). Foliar applications of insecticides in the spring for Hessian fly control are highly variable in effectiveness. Apply

when adults are actively laying eggs. More information on the proper timing of foliar applications can be found at www.ces.ncsu.edu/plymouth/pubs/ent/HFLYupdate03.html.

Several non-stinging, parasitic wasps attack and kill Hessian fly larvae. *Platygaster hiemalis* attacks Hessian fly larvae in the fall and winter, and several other parasitic wasps attack the spring generation. Because of the number of generations, parasites cannot control the Hessian fly during an outbreak year, but natural enemies probably provide long-term regulation of Hessian fly populations.

Scouting Procedure. Hessian fly-stunted vegetative tillers usually have a bottom leaf which is darker blue-green and wider than the leaf of a non-infested plant. The infested tillers do not elongate or produce new leaves, and often die after the maggots pupate. If the infested tiller survives, it may not produce a head. Separating the leaf sheath from the stem reveals the white maggots or brown flaxseed stage. Infested jointed stems are short, and the stem is weakened at the joint where feeding occurs. Grain filling of infested stems is reduced and damaged stems often lodge before harvest.

Threshold Level. Yield loss usually becomes significant when fall infestations exceed 5 to 8 percent infested tillers or spring infestations exceed 20 percent infested stems. Growers who plant fly-susceptible varieties should inspect the wheat prior to making their customary nitrogen application between Feb. 15 and March 15. If 20 percent of the tillers are infested with Hessian fly maggots or pupae at this time, significant yield losses can be expected and the money spent for nitrogen may not produce the desired yield response.

Information on varietal selection and Hessian fly resistance is provided by the annual Small Grain Performance Tests (Univ. of Georgia), and the Performance of Small Grain Varieties for Grain in Alabama (www.alabamavarietytesting.com) (Auburn University).

Fall Armyworm and Its Relatives

The fall armyworm, *Spodoptera frugiperda*; beet armyworm, *S. exigua*; and yellowstriped armyworm, *S. ornithogalli*, can move into wheat in the autumn as summer crops mature. Damage usually is limited to early plantings for forage production. There is the potential for armyworm damage until the first heavy frost. Small larvae often produce clear windowpane-like areas on leaves which normally does not reduce grain yield. Older, larger larvae can destroy seedling plants, but most years they do not occur in sufficient numbers to cause damage. Fall armyworm damage is likely after a dry summer.

Description and Life Cycle. The full-grown caterpillar is from 1 to 1.5 inches long. Within a species, larvae (caterpillars) of these moths are highly variable in size and color. Beet armyworm larvae generally have a spot on the side of the second segment behind the head. Fall armyworms and yellow-striped armyworms have an inverted, light colored, Y-shaped line on the front of the head. Fall armyworms have four black spots on the back of each segment behind the legs, and three white lines on the back on the first segment just behind the head. Yellow-striped armyworms do not have these markings. Eggs are laid in clusters at night on grasses or other plants. Eggs hatch in a few days, and the larvae mature in about 3 weeks. A complete cycle requires as little as 30 days. There are several generations each year.

Scouting Procedure. Record the number of caterpillars per linear foot of drill row, or square foot of broadcast wheat. Include the small larvae. Be sure to take samples from the edge as well as the interior of the field because this pest is often heaviest near the field margins. Sometimes, only the field margins require treatment.

Threshold Level. These armyworms attack grain in the fall in the seedling stage; therefore, a relatively small number of larvae per foot of row can do heavy damage. The threshold level is about two larvae per linear row foot for seedling wheat. For older plants, three to four larvae and obvious foliage loss justify control measures.

“True” Armyworm

The armyworm, *Mythimna unipuncta*, typically attacks wheat during the stem-elongation and heading stages during the spring. It is often called “true armyworm” to separate it from the fall armyworm and various cutworms. True armyworms can be hard to detect because they hide on or in the soil during the daytime. At night, larvae climb stalks to chew holes in leaves, eat spike glumes and kernels, and sometimes cut seed heads. The most severe damage to wheat is caused by cutting through the stem below the head and separating it from the plant. Heavy populations may destroy the leaves and beards in only a few nights of feeding. *Damage usually occurs during cool, wet springs.*

Description and Life Cycle. Mature larvae are about 1.5 inches long, smooth-bodied, and dark gray to greenish-black. The chief distinguishing feature is five stripes extending lengthwise on the body, three on the back and one on each side. The true armyworm adult is a moth. For egg deposition, the moth is especially attracted to thick-growing grains in low-lying areas. The destructive period of the armyworm’s life cycle lasts about 10 days. At the end of this time, the worms may disappear as suddenly as they came. In most years, armyworms are attacked by numerous parasites and several diseases, which prevent them from causing economic damage.

Scouting Procedure. The heaviest infestations of true armyworms are generally found near field margins and in low-lying areas of thick-growing grain, especially where it has lodged. Check for this pest in and under debris at the base of the plants, as well as in the heads. The presence of frass (feces) and dropped plant material can be an indication that worms were or are present. Shake or beat the heads and straw to dislodge the larvae. Check several locations in the field and average the counts for each. A sweep net can be a useful tool to find armyworms before they cause damage.

Threshold Level. Three to four armyworms per linear row foot is a commonly accepted economic threshold. However, if the crop is nearly mature and there is no evidence of head clipping, control may not be necessary. If the larvae are all mature, insecticidal control is not advised because these larvae will soon drop to the soil and pupate.

Cereal Leaf Beetle

The cereal leaf beetle, *Oulema melanopus*, was introduced from Europe into Michigan in the 1950s and is slowly spreading southward. It is now found as far south as central Alabama and Georgia. The immature stage (larva) of cereal leaf beetle feeds on the leaves of barley, wheat, oats, and certain other grasses; it prefers oats but also readily accepts winter wheat and barley.

Feeding activity by cereal leaf beetle larvae results in long, window-like slits in the leaves. Feeding occurs in the spring usually from the boot stage through early heading.

Description and Life Cycle. Cereal leaf beetle adults are about 3/16 inch long and 1/16 inch wide. The adults have dark, metallic blue wing covers, orange legs, and an orange collar. The head and the rest of the body are black. Eggs are cylindrical with rounded edges. They are light orange when laid and darken gradually over time to brown. Eggs are usually deposited singly or in rows of two to four on the top side of the leaves. Each female lays from 12 to 50 eggs. Larvae are pale yellow with a brown head and legs. In the field, they look mostly black because they smear excrement over their bodies. People walking through a field infested with cereal leaf beetle larvae may emerge with black-stained pants legs because this black coating easily rubs off the larvae. The larvae are about 1/16 inch long just after hatching and 1/3 inch long when fully grown.

Cereal leaf beetle has one generation per year. Adult beetles spend the winter in the woods and field borders. During the first warm days of spring, the beetles fly into small grain fields, mate, and begin to lay eggs in mid to late March. Eggs hatch in about seven days, and larvae begin to feed on the cereal leaves. The larvae feed for about 3 to 4 weeks, then leave the plant, and move into the soil. The adults of the new generation come out in late May and early June, feed briefly, then move out of the fields, and remain inactive until the following spring. New generation adults may feed on corn leaves but seldom cause serious damage.

Scouting Procedure. Start checking for cereal leaf beetle eggs, larvae, and adults in early March in the vicinity of Talladega County and in mid-March in the Tennessee Valley region. Check fields weekly for about a month. Look for feeding damage, adult beetles, eggs, and larvae. Stop in five to ten areas in each field, and count the eggs and larvae on the top two leaves of five stems at each location. Sample the middle of the fields as well as the edges.

Threshold Level and Management. If cereal leaf beetle larvae have begun to hatch and there is more than one cereal leaf beetle egg or larva per two stems, treat with one of the suggested insecticides. All suggested insecticides provide good control of cereal leaf beetle larvae, but best yield response occurred when a long-residual insecticide, such as lambda-cyhalothrin, was applied at or before 30 percent egg hatch. Because dying larvae are hard to distinguish from living ones, wait 2 to 3 days after treatment before checking to make sure the treatment was successful. Heavy rains can kill larvae, so if heavy rains occur between the time a field is checked and insecticides are to be applied, wait for the foliage to dry and recheck the fields. Cereal leaf beetle has few natural enemies in the southern United States, but exotic parasites of the egg and larval stages are being released throughout the region.

See “Management of Cereal Leaf Beetles, Pests of Small Grains,” ANR-984 (www.aces.edu/pubs/docs/A/ANR-0984), for more information.

Chinch Bugs

Adult chinch bugs, *Blissus leucopterus*, are 1/6 to 1/5 inch long and are black with white wings that are marked with a triangular black patch on the outer margins. The white wings give the insect a spotted appearance. Nymphs are brown to reddish with a transverse pale colored band. Both nymph and

adult chinch bugs feed on grasses, including all the small grain crops, by sucking sap. Feeding can discolor and stunt plants, but populations usually are not large enough to cause economic damage on small grains. The insect overwinters as an adult and the entire life cycle takes about 40 days. Chinch bugs avoid damp, shaded areas; therefore, they are usually found along field edges and in thinner stands where sunlight reaches the soil. Chinch bugs are mainly a problem in dry years. They also may increase in small grain crops in the spring and move, as the wheat matures, to summer annual grass crops such as corn, sorghum, and millet in adjacent fields or to double-cropped plants in the same field. Chinch bugs can be very damaging to double cropped corn, sorghum and millet seedlings, especially under dry conditions. Economic thresholds have been estimated as one to two adults per five seedling plants. In spring, the economic threshold is one adult per stem.

Pathogenic fungi are especially important in suppressing populations of chinch bugs. These fungi require wet, humid conditions to develop; consequently, *populations of these pests typically are worse in dry than wet years.*

Grasshoppers

Grasshoppers destroy leaves of seedlings during fall and occasionally during the spring. The damage is usually along field margins. The economic threshold is three to five per square yard within the field.

Lesser Cornstalk Borer

The lesser cornstalk borer, *Elasmopalpus lignosellus*, is a moth whose larvae bore into the stem base at or below the soil surface and kill seedling plants in the fall. This insect feeds on many host plants and often moves from weeds and stubble of the previous crop to newly planted small grain plants in the same field. Damage by lesser cornstalk borers usually is restricted to small grains that are planted early for grazing.

Stink Bugs

Large numbers of brown, *Euschistus* spp., or Southern green, *Nezara viridula*, stink bugs sometimes infest wheat in the coastal plain region during grain filling to harvest. Stink bugs feed by sucking fluid from developing grain, causing grain to be shriveled. The impact of stink bug feeding injury on wheat has not been determined, but most likely infestations rarely cause economically important damage. Instead, stink bugs disperse from wheat fields at harvest to infest adjacent summer crops where they may cause significant damage.

Thrips

Thrips are very small (3 inches or less in length) slender-bodied insects either wingless or winged with two pairs of very slender wings fringed with long hairs. Studies in Georgia and Florida found that the predominant species attacking small grains in the Southeast are the tobacco thrips, *Frankliniella fusca*, and cereal thrips, *Limothrips cerealium*. Nymphs are variously colored but adults are typically black. Thrips feed between the leaf sheath and stem where they suck plant fluids. Although thrips may become very abundant, they do not cause significant damage in small grains and do not require control in wheat. Wheat is not a host for tomato spotted wilt virus, which can be transmitted by tobacco thrips. However, as wheat matures, thrips may disperse to new plantings of adjacent summer crops where they can cause direct feeding damage.

Winter Grain Mites

Winter grain mites (*Penthaleus major*) are large, dark brown or black mites with red legs. They attack wheat, barley, and oats, particularly when these grains are over-seeded into perennial grass sod. Damage often appears between Thanksgiving and Christmas. See “Winter Grain Mite”: <http://pubs.ext.vt.edu/444/444-037/444-037.html>.

Organic Insecticides That Can be Applied to Small Grains

Organic producers may want to consider the following insecticides, most if not all of which are OMRI approved. Be sure to read the insecticide label to make sure it meets your needs. The following products contain azadirachtin: Neemix 4.5, Azatrol EC, Azera, and Ecozin Plus. The following products contain *Bacillus thuringiensis*: Biobit HP (subsp.

kurstaki strain ABTS-351), Dipel DF (subsp. *kurstaki* strain ABTS-351), Javelin WG (subsp. *kurstaki* strain SA-11), and Xentari (subsp. *aizawai* strain ABTS-1857). Surround WP contains kaolin. Microthiol Disperss and Yellow Jacket Special Dusting Sulfur contain sulfur. Ecotec contains rosemary and peppermint oils. Gemstar LC contains an insecticidal virus. Venerate XC Bioinsecticide contains *Burkholderia* spp. strain A 396. M-Pede contains potassium salts of fatty acids. Entrust and Entrust SC contain spinosad. Other formulations of spinosad can be found. Be sure to check the labels to see if they meet the requirements for your cropping system. Pest Out contains garlic, clove, and cottonseed oils. Biolink Insect and Bird Repellent contains garlic. Venerate XC contains *Burkholderia* spp. strain A396. Grandevo contains *Chromobacterium subtsugae* strain PRA4-1. Mycotrol ESO

and BotaniGard ES contain *Beauveria bassiana* strain GHA. PyGanic Crop Protection EC 1.4_{II} and PyGanic Crop Protection EC 5.0_{II} insecticides are OMRI approved and contain natural pyrethrins. There are other insecticides that contain pyrethrins. Be sure to choose one that does not contain piperonyl butoxide, as that chemical is not considered organic. Other organic insecticides may be available.

Table 5. Small Grains (Barley, Oats, Rye, Triticale, and Wheat) Insect Control ¹

Insecticide and Formulation	Acres per Gallon	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Comments
APHIDS–SEED TREATMENT					
clothianidin NIPSIT INSIDE	—	0.75–1.79 fl.oz./100 lb. seed	0.03–0.07 lb./100 lb. seed	Not specified	For commercial seed treatment only.
imidacloprid GAUCHO 600 Other trade names ²	—	0.8–2.4 fl.oz./100 lb. seed	0.03–0.09 lb./100 lb. seed	45	Use as a seed treatment. Apply as a slurry either on-farm or as a commercial seed treatment. Ensure thorough coverage. See label for plantback restrictions.
imidacloprid + captan + carboxin ENHANCE AW	—	4 oz/100 lb. seed	0.07 lb. imidacloprid/100 lb. seed	45	For oats, barley, and wheat. See label for plantback restrictions. Apply as a planter box treatment.
imidacloprid + ipconazole + metalaxyl WARDEN CEREALS HR Other trade names ²	—	5–8 fl.oz./100 lb. seed	0.05–.08 lb. imidacloprid/100 lb. seed	45	For wheat, barley, oats, rye, or triticale on-farm or commercial seed treatment.
imidacloprid + metalaxyl + tebuconazole GAUCHO XT	—	3.4–4.5 fl.oz./100 lb. seed	0.03 lb. imidacloprid/100 lb. seed	45	For barley, oats, rye, and wheat. See label for plantback restrictions.
imidacloprid + metalaxyl + tebuconazole + fludioxonil SATIVA IMF MAX Other trade names ²	—	3.4–5 fl.oz./100 lb. seed	0.026–0.04 lb. imidacloprid/100 lb. seed	45	For barley and wheat. See label for plantback restrictions. Commercial seed treatment only. Not for planter boxes.

¹ See Table 6 for a list of insecticides, formulations, restricted entry intervals, days to grazing or harvest, and maximum amount to apply.

² See Table 6 for other trade names.

Table 5. Small Grains (Barley, Oats, Rye, Triticale, and Wheat) Insect Control ¹ (cont.)

Insecticide and Formulation	Acres per Gallon	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Comments
thiamethoxam CRUISER 5FS	—	0.75–1.33 fl.oz./100 lb. seed	0.03–0.07 lb./100 lb. seed	Do not graze.	Apply as a water-based slurry for seed treatment. See label for plantback restrictions. For on-farm or commercial use.
APHIDS–SEED TREATMENT (cont.)					
thiamethoxam + mefenoxam + difenoconazole CRUISER MAXX cereals	—	5 fl.oz./100 lb. seed	0.01 lb./100 lb. seed	Not specified	Add an additional amount of Cruiser 5FS (0.48 to 1 fluid ounces of Cruiser 5FS). For on-farm or commercial use.
thiamethoxam + sedaxane + mefenoxam + difenoconazole CRUISERMAXX VIBRANCE		5–10 fl. oz./100 lb. seed	0.01–0.02 lb. thiamethoxam/cwt	45	Apply additional Cruiser 5 FS (0.5 – 1 fl. oz/ 100 lb. seed) to provide a sufficient dose of thiamethoxam. For on-farm or commercial use.
APHIDS–FOLIAR TREATMENT					
alpha-cypermethrin FASTAC EC Other trade names ²	33–40	3.2–3.9 fl.oz.	0.02–0.025	14	For wheat and triticale only. Fastac EC is a RESTRICTED USE pesticide.
beta-cyfluthrin BAYTHROID XL	53–71	1.8–2.4 fl.oz.	0.014–0.019	30 (h), 3 (g)	Baythroid XL is a RESTRICTED USE pesticide. Aphid control may be variable depending on species present. Aids in control of greenbug.
cyfluthrin TOMBSTONE Other trade names ²	53–71	1.8–2.4 fl.oz.	0.028–0.038	30 (h), 3 (g)	For wheat only. Tombstone is a RESTRICTED USE pesticide. Not for control of greenbug. For best control, applications must be made prior to insects damaging the plants. Use the higher rate range and increased water volume for applications occurring after plant damage has taken place or following booting to receive better coverage. Once damage occurs or plant growth stage reaching booting, control may be limited to suppression only.
dimethoate CHEMINOVA DIMETHOATE 4EC Other trade names ²	12–16	0.5–0.75 pt.	0.25–0.375	35 (h)	For wheat only. Other formulations are registered on triticale.
flupyradifurone SIVANTO PRIME	12.2–18.3	7–10.5 fl. oz.	0.09–0.14	21 (h, straw), 7 (g)	
gamma-cyhalothrin DECLARE Other trade names ²	83–125	1.02–1.54 fl.oz.	0.01–0.015	30 (h), 7 (g)	Declare is a RESTRICTED USE pesticide. Best control is obtained before insects begin to roll leaves. Once wheat has started to boot, this insecticide may provide suppression only. Higher rates and increased coverage will be necessary. Use highest rate for greenbug.

² See Table 6 for other trade names.³ For suppression after boot stage.

Table 5. Small Grains (Barley, Oats, Rye, Triticale, and Wheat) Insect Control ¹ (cont.)

Insecticide and Formulation	Acres per Gallon	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Comments
lambda-cyhalothrin WARRIOR II with Zeon Technology Other trade names ²	67–100	1.28–1.92 fl.oz.	0.02–0.03	30 (h), 7 (g)	WARRIOR II is a RESTRICTED USE pesticide. Best control is obtained before insects begin to roll leaves. Once wheat has started to boot, this insecticide may provide suppression only. Higher rates and increased coverage will be necessary. Use highest rate for greenbug.
APHIDS–FOLIAR TREATMENT (cont.)					
lambda-cyhalothrin + thiamethoxam ENDIGO ZC	28–36	3.5–4.5 fl.oz.	0.024–0.03 + 0.03–0.04	30 (h, straw), 7 (g)	For barley only. Endigo is a RESTRICTED USE pesticide. Best control is obtained before insects begin to roll leaves. Once wheat has started to boot, this insecticide may provide suppression only. Higher rates and increased coverage will be necessary. use highest rates for greenbug. Observe all Pollinator Precautions on the label.
lambda-cyhalothrin + chlorantraniliprole BESIEGE INSECTICIDE	12.8–21.3	6–10 fl. oz.	0.02–0.03 + 0.04–0.06	30 (h, straw), 7 (g)	Best control is achieved before boot stage. Besiege is a RESTRICTED USE pesticide. Best control is obtained before insects begin to roll leaves. Once wheat has started to boot, this insecticide may provide suppression only. Higher rates and increased coverage will be necessary. Use highest rate for greenbug.
sulfoxaflor TRANSFORM WG	–	0.75–1.5 oz.	0.023–0.047	14 (grain, straw) 7 (grazing, forage, fodder, hay)	For wheat, triticale, and barley.
zeta-cypermethrin MUSTANG MAXX INSECTICIDE ² Other trade names ²	32–40	3.2–4 fl.oz.	0.02–0.025 lb. a.i./A	14	Mustang Maxx is a RESTRICTED USE pesticide. Aphid control may be variable depending on species present. Aids in control of greenbug.
ARMYWORMS (FALL AND TRUE)					
alpha-cypermethrin FASTAC EC Other trade names ²	33–71	1.8–3.9 fl.oz.	0.012–0.025	14	For wheat and triticale only. Fastac EC is a RESTRICTED USE pesticide. Use higher rate for fall armyworms.
beta-cyfluthrin BAYTHROID XL	53–71	1.8–2.4 fl.oz.	0.014–0.019	30 (h), 3 (g)	For first and second instar armyworm. Baythroid XL is a RESTRICTED USE pesticide.
chlorantraniliprole PREVATHON Other trade names ²	6–9	14–20 fl. oz.	0.047–0.067	14	
cyfluthrin TOMBSTONE Other trade names ²	53–71	1.8–2.4 fl.oz.	0.028–0.038	30 (h), 3 (g)	For wheat only. For true armyworm or first and second instar fall armyworm. Tombstone is a RESTRICTED USE pesticide.
gamma-cyhalothrin DECLARE Other trade names ²	83–125	1.02–1.54 fl.oz.	0.01–0.015	30 (h), 7 (g)	Declare is a RESTRICTED USE pesticide.
lambda-cyhalothrin WARRIOR II with Zeon Technology Other trade names ²	67–100	1.28–1.92 fl.oz.	0.02–0.03	30 (h), 7 (g)	Apply when worms are small. Karate is a RESTRICTED USE pesticide.

² See Table 6 for other trade names.

Table 5. Small Grains (Barley, Oats, Rye, Triticale, and Wheat) Insect Control ¹ (cont.)

Insecticide and Formulation	Acres per Gallon	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Comments
lambda-cyhalothrin + chlorantraniliprole BESIEGE INSECTICIDE	12.8–21.3	6–10 fl. oz.	0.02–0.03 + 0.04–0.06	30 (h, straw), 7 (g)	Besiege is a RESTRICTED USE pesticide.
lambda-cyhalothrin + thiamethoxam ENDIGO ZC	28–36	3.5–4.5 fl.oz.	0.024–0.03 + 0.03–0.04	30 (h, straw), 7 (g)	For barley only. Endigo is a RESTRICTED USE pesticide. Observe all Pollinator Precautions on the label.
ARMYWORMS (FALL AND TRUE) (cont.)					
spinosad BLACKHAWK Other trade names ²	4.8–14.5 per lb.	1.1–3.3 oz.	0.024–0.074	21 (grain, straw) 3 (forage, fodder, hay)	Most effective when timed to coincide with peak egg hatch. Use lower rate for true armyworms.
spinetoram RADIANT SC	21–43	3–6 fl.oz.	0.023–0.046	21 (grain, straw) 3 (forage, fodder, hay)	Apply during peak egg hatch and/or small larval stage of each generation.
zeta-cypermethrin MUSTANG MAXX INSECTICIDE ² Other trade names ²	32–72	1.76–4 fl.oz.	0.011–0.025	14	Use 3.2 to 4 fluid ounces per acre for fall armyworm. Mustang Maxx is a RESTRICTED USE pesticide.
CEREAL LEAF BEETLES					
<i>General Comments: See the scouting section for information on action thresholds and timing of application.</i>					
alpha-cypermethrin FASTAC EC Other trade names ²	34–71	1.8–3.8 fl.oz.	0.012–0.025	14	For wheat and triticale only. Fastac EC is a RESTRICTED USE pesticide.
beta-cyfluthrin BAYTHROID XL	71–128	1.0–1.8 fl.oz.	0.008–0.014	30 (h), 3 (g)	Baythroid XL is a RESTRICTED USE pesticide.
cyfluthrin TOMBSTONE Other trade names ²	71–128	1.0–1.8 fl.oz.	0.016–0.028	30 (h), 3 (g)	For wheat only. Tombstone is a RESTRICTED USE pesticide.
gamma-cyhalothrin DECLARE Other trade names ²	83–125	1.02–1.54 fl.oz.	0.01–0.015	30 (h), 7 (g)	Declare is a RESTRICTED USE pesticide.
lambda-cyhalothrin WARRIOR II with Zeon Technology Other trade names ²	67–100	1.28–1.92 fl.oz.	0.02–0.03	30 (h), 7 (g)	WARRIOR II is a RESTRICTED USE pesticide.
lambda-cyhalothrin + chlorantraniliprole BESIEGE INSECTICIDE	12.8–21.3	6–10 fl. oz.	0.02–0.03 + 0.04–0.06	30 (h, straw), 7 (g)	Besiege is a RESTRICTED USE pesticide.
lambda-cyhalothrin + thiamethoxam ENDIGO ZC	28–36	3.5–4.5 fl.oz.	0.024–0.03 + 0.03–0.04	30 (h, straw), 7 (g)	For barley only. Endigo is a RESTRICTED USE pesticide. Observe all Pollinator Precautions on the label.
malathion CHEMINOVA MALATHION 57% Other trade names ²	5–8	1–1.5 pt.	0.6–0.9 lb.	7	For wheat, oats, rye, and barley.
spinosad BLACKHAWK Other trade names ²	4.8–14.5 per lb.	1.1–3.3oz.	0.024–0.074	21 (grain, straw) 3 (forage, fodder, hay)	

²See Table 6 for other trade names.

Table 5. Small Grains (Barley, Oats, Rye, Triticale, and Wheat) Insect Control ¹ (cont.)

Insecticide and Formulation	Acres per Gallon	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Comments
spinetoram RADIANT SC	21–64	2–6 fl.oz.	0.016–0.046	21 (grain, straw) 3 (forage, fodder, hay)	
zeta-cypermethrin MUSTANG MAXX INSECTICIDE ² Other trade names ²	32–72	1.76–4 fl.oz.	0.011–0.025	14	Mustang Maxx is a RESTRICTED USE pesticide.
CHINCH BUGS					
alpha-cypermethrin FASTAC EC Other trade names ²	33–40	3.2–3.9 fl.oz.	0.012–0.025	14	For wheat and triticale only. Fastac EC is a RESTRICTED USE pesticide.
beta-cyfluthrin BAYTHROID XL	53	2.4 fl.oz.	0.019	30 (h), 3 (g)	Baythroid XL is a RESTRICTED USE pesticide.
cyfluthrin TOMBSTONE Other trade names ²	53	2.4 fl.oz.	0.038	30 (h), 3 (g)	For wheat only. Tombstone is a RESTRICTED USE pesticide.
gamma-cyhalothrin DECLARE Other trade names ²	83	1.54 fl.oz.	0.015	30 (h), 7 (g)	Declare is a RESTRICTED USE pesticide.
lambda-cyhalothrin WARRIOR II with Zeon Technology Other trade names ²	67	1.92 fl.oz.	0.03	30 (h), 7 (g)	Warrior II is a RESTRICTED USE pesticide.
lambda-cyhalothrin + chlorantraniliprole BESIEGE INSECTICIDE	16	10 fl. oz.	0.03 + 0.06	30 (h, straw), 7 (g)	Besiege is a RESTRICTED USE pesticide.
lambda-cyhalothrin + thiamethoxam ENDIGO ZC	28	4.5 fl.oz.	0.03 + 0.04	30 (h, straw), 7 (g)	For barley only. Endigo is a RESTRICTED USE pesticide. Observe all Pollinator Precautions on label.
zeta-cypermethrin MUSTANG MAXX INSECTICIDE Other trade names ²	32–40	3.2–4 fl.oz.	0.02–0.025	14	Mustang Maxx is a RESTRICTED USE pesticide.
GRASSHOPPERS					
<i>General Comments: Apply pesticide when 50 percent or more foliage has been lost. It may be possible to spot treat the edge of fields. Large, black and yellow lubber grasshoppers will probably not be controlled with any insecticide.</i>					
alpha-cypermethrin FASTAC EC Other trade names ²	33–40	3.2–3.9 fl.oz.	0.012–0.025	14	For wheat and triticale only. Fastac EC is a RESTRICTED USE pesticide.
beta-cyfluthrin BAYTHROID XL	53–71	1.8–2.4 fl.oz.	0.014–0.019	30 (h), 3 (g)	Baythroid XL is a RESTRICTED USE pesticide.
cyfluthrin TOMBSTONE Other trade names ²	53–71	1.8–2.4 fl.oz.	0.028–0.038	30 (h), 3 (g)	For wheat only. Tombstone is a RESTRICTED USE pesticide.
dimethoate CHEMINOVA DIMETHOATE 4EC Other trade names ²	12	0.75 pt.	0.375	35 (h)	For wheat. Some formulations are also registered on triticale.
gamma-cyhalothrin DECLARE Other trade names ²	83–125	1.02–1.54 fl.oz.	0.01–0.015	30 (h), 7 (g)	Declare is a RESTRICTED USE pesticide.

²See Table 6 for other trade names.

Table 5. Small Grains (Barley, Oats, Rye, Triticale, and Wheat) Insect Control ¹ (cont.)

Insecticide and Formulation	Acres per Gallon	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Comments
lambda-cyhalothrin WARRIOR II with Zeon Technology Other trade names ²	67–100	1.28–1.92 fl.oz.	0.02–0.03	30 (h), 7 (g)	See General Comments, above. WARRIOR II is a RESTRICTED USE pesticide.
lambda-cyhalothrin + chlorantraniliprole BESIEGE INSECTICIDE	12.8–21.3	6–10 fl. oz.	0.02–0.03 + 0.04–0.06	30 (h, straw), 7 (g)	Besiege is a RESTRICTED USE pesticide.
GRASSHOPPERS (cont.)					
lambda-cyhalothrin + thiamethoxam ENDIGO ZC	28-36	3.5–4.5 fl.oz.	0.024–0.03 + 0.03–0.04	30 (h, straw), 7 (g)	For barley only. Endigo is a RESTRICTED USE pesticide. Observe all Pollinator Precautions on the label.
malathion CHEMINOVA MALATHION 57% Other trade names ²	5	1.5 pt.	0.9	7	For wheat, oats, rye, and barley. Apply when nymphs are young.
zeta-cypermethrin MUSTANG MAXX INSECTICIDE ² Other trade names ²	32–40	3.2–4 fl.oz.	0.02–0.025	14	Mustang Maxx is a RESTRICTED USE pesticide.
HESSIAN FLIES					
Seed Treatment					
<i>General Comments: Plant resistant or tolerant varieties. Avoid planting wheat in consecutive years.</i>					
clothianidin NIPSIT INSIDE	—	1.79 fl.oz./100 lb. seed	0.07 lb./100 lb. seed	Not specified	Suppression of early season Hessian fly. For commercial seed treatment only.
imidacloprid GAUCHO 600 Other trade names ²	—	1.6–2.4 fl.oz./100 lb. seed	0.06–0.09 lb./100 lb. seed	45	Use as a seed treatment. Apply as a slurry either on-farm or as a commercial seed treatment. Ensure thorough coverage. See label for plantback restrictions.
imidacloprid + carboxin + captan ENHANCE AW	—	4 oz./100 lb. seed	0.07 lb. imidacloprid/100 lb. seed	45	For on-farm use.
imidacloprid + metalaxyl + tebuconazole GAUCHO XT	—	4.5 fl.oz./100 lb. seed	0.04 lb. imidacloprid/100 lb. seed	45	Apply additional imidacloprid seed treatment to bring total amount of imidacloprid to 0.06–0.09 lb. ai/100 lb. seed.
imidacloprid + metalaxyl + tebuconazole + fludioxonil SATIVA IMF MAX Other trade names ²	—	3.4–5.0 fl.oz./100 lb. seed	0.025–0.04 lb. imidacloprid/100 lb. seed	45	Apply additional imidacloprid seed treatment to bring total amount of imidacloprid to 0.06–0.09 lb. ai/100 lb. seed. Not for use in planter boxes.
imidacloprid + ipconazole + metalaxyl WARDEN CEREALS HR Other trade names ²	—	8 fl.oz./100 lb. seed	0.08 lb. imidacloprid/100 lb. seed.	45	Suppression of early season Hessian fly. On-farm or commercial seed treatment.

² See Table 6 for other trade names.

Table 5. Small Grains (Barley, Oats, Rye, Triticale, and Wheat) Insect Control ¹ (cont.)

Insecticide and Formulation	Acres per Gallon	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Comments
thiomethoxam CRUISER 5FS	—	1.33 fl.oz./ 100 lb. seed	0.06 lb./ 100 lb. seed	—	Use as a seed treatment. Apply as a slurry either on-farm or as a commercial seed treatment. Ensure thorough coverage. See label for plantback restrictions.
thiamethoxam + mefenoxam + difenoconazole CRUISER MAXX cereals	—	5 fl.oz./ 100 lb. seed	0.01 lb./ 100 lb. seed	Not specified	Add an additional amount of Cruiser 5FS (0.48 to 1 fluid ounces of Cruiser 5FS). For on-farm or as a commercial seed treatment.
Foliar Treatment					
<i>General Comments: Foliar application of insecticide at the 2 to 3 leaf stage may protect young when plants from attack by Hessian fly. Foliar application at the time Hessian fly adults are laying eggs in winter to early spring may reduce further damage in fields where moderate to heavy Hessian fly infestations have been found. See "Hessian Fly Scouting Guide," www.aces.edu/anr/crops/smallgrains/documents/HessianFlyScoutingGuide.pdf and North Carolina small grains production guide www.smallgrains.ncsu.edu/ProductionGuide.html.</i>					
gamma-cyhalothrin DECLARE	83–125	1.02–1.54 fl.oz.	0.01–0.015	30 (h), 7 (g)	Declare is a RESTRICTED USE pesticide. Apply when adults emerge.
lambda-cyhalothrin WARRIOR II with Zeon Technology	67–100	1.28–1.92 fl.oz.	0.02–0.03	30 (h), 7 (g)	Timing is critical in the effectiveness of this treatment. Apply when adult Hessian flies emerge. WARRIOR II is a RESTRICTED USE pesticide.
lambda-cyhalothrin + chlorantraniliprole BESIEGE INSECTICIDE	12.8– 21.3	6–10 fl. oz.	0.02–0.03 + 0.04–0.06	30 (h, straw), 7 (g)	Besiege is a RESTRICTED USE pesticide.
lambda-cyhalothrin + thiamethoxam ENDIGO ZC	28	4.5 fl.oz.	0.03 + 0.04	30 (h, straw), 7 (g)	For barley only. Barley is considered tolerant to Hessian fly. Damage only occurs under severe infestations. Endigo is a RESTRICTED USE pesticide. Make applications when insects emerge. Observe all Pollinator Precautions on the label.
WINTER GRAIN MITES					
<i>The following insecticides may provide helpful control.</i>					
alpha-cypermethrin FASTAC EC Other trade names ²	33	3.9 fl.oz.	0.025	14	For wheat and triticale only. Fastac EC is a RESTRICTED USE pesticide.
gamma-cyhalothrin DECLARE	83	1.54 fl.oz.	0.015	30 (h), 7 (g)	For wheat, wheat hay, and triticale ONLY .
lambda-cyhalothrin WARRIOR II WITH ZEON TECHNOLOGY Other trade names ²	67	1.92 fl.oz.	0.03	30 (h), 7 (g)	WARRIOR II is a RESTRICTED USE pesticide.
zeta-cypermethrin MUSTANG MAXX Other trade names ²	32–40	3.2–4 fl.oz.	0.02–0.025	14	Mustang Maxx is a RESTRICTED USE pesticide.

² See Table 6 for other trade names.**Table 6. Insecticides Labeled for Use on Small Grains**

Insecticide and Trade Name	A.I./ Formulated Product	Formulation	Restricted Entry Interval (hr)	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Bee Hazard Restriction
alpha-cypermethrin (triticale, wheat) *MoA Group 3A					
FASTAC CS (RESTRICTED USE)	0.83 lb./gal.	capsule suspension	12	14	yes ¹

Table 6. Insecticides Labeled for Use on Small Grains

Insecticide and Trade Name	A.I./ Formulated Product	Formulation	Restricted Entry Interval (hr)	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Bee Hazard Restriction
FASTAC EC (RESTRICTED USE)	0.83 lb./gal.	emulsifiable concentrate	12	14	
beta-cyfluthrin (barley, buckwheat, millet, oat, rye, triticale, wheat) MoA Group 3A					
BAYTHROID XL (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	12	30 (h), 3 (g)	yes ⁴
chlorantraniliprole (barley, buckwheat, pearl and proso millet, oats, rye, triticale, and wheat) MoA Group 28					
DUPONT CORAGEN	1.67 lb./gal.	suspension concentrate	4	1	no
DUPONT PREVATHON	0.43 lb./gal.	suspension concentrate	4	1	no
clothianidin (wheat, oats, triticale, barley, rye, buckwheat, proso and pearl millet) MoA Group 4A					
NIPSIT INSIDE	5 lb./gal.	seed treatment	12	Not specified	yes ²
clothianidin + metalaxyl + metconazole (barley, oats, wheat) MoA Group 4a					
NIPSIT SUITE	0.256 + 0.077 +0.038 lb./ gal.	seed treatment	24	Not specified	yes ⁵
cyfluthrin (wheat) MoA Group 3A					
TOMBSTONE (RESTRICTED USE)	2 lb./gal.	emulsifiable concentrate	12	30 (h), 3 (g)	yes ¹
TOMBSTONE HELIOS (RESTRICTED USE)	2 lb./gal.	emulsifiable concentrate	12	30 (h), 3 (g)	yes ¹
dimethoate (wheat) MoA Group 1B					
CHEMINOVA DIMETHOATE 4E	4 lb./gal.	emulsifiable concentrate	48	35 (h)	yes ¹
DIMETHOATE 400	4 lb./gal.	emulsifiable concentrate	48	35 (h)	yes ¹
DIMETHOATE 4EC (also triticale)	4 lb./gal.	emulsifiable concentrate	48	35 (h), 14 (g)	yes ¹
DIMATE 4E	4 lb./gal.	emulsifiable concentrate	48	35 (h), 14 (g)	yes ¹
DIMETHOATE LV-4	4 lb./gal.	emulsifiable concentrate	48	27	yes ¹
flupyradifurone (including barley, buckwheat, oats, rye, triticale, wheat) MoA Group 4D					
SIVANTO PRIME	1.67 lb./gal.	soluble liquid	4	21 (h, straw), 7 (grazing, hay)	yes ³
gamma-cyhalothrin (wheat, oats, triticale, barley, rye, and buckwheat) MoA Group 3A					
DECLARE (RESTRICTED USE)	1.25 lb./gal.	microencapsulated suspension	24	30 (h, straw), 7 (g)	yes ¹
PROAXIS (wheat and triticale only) (RESTRICTED USE)	0.5 lb./gal.	microencapsulated suspension	24	30 (h, straw), 7 (g)	yes ¹
imidacloprid (wheat, oats, rye, barley, triticale) MoA Group 4A					
AXCESS	5 lb./gal.	seed treatment	12	45	no
ATTENDANT 480 FS	4 lb./gal.	seed treatment	12	45	yes ²
DYNA-SHIELD IMIDACLOPRID 5	5 lb./gal.	seed treatment	12	45	yes ²

¹ Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds.

² Ensure that planting equipment is functioning properly in accordance with manufacturing specifications to minimize seed coat abrasion during planting to reduce dust that can drift to blooming crops or weeds. This compound is highly toxic to bees exposed directly (contact).

³ Toxic to adult bees in laboratory studies via oral exposure; however, not toxic to bees through contact exposure. Field studies conducted with this product have shown no effects on honeybee colony development. General pollinator best management practice: in order to minimize exposure to pollinators, it is recommended that foliar insecticides be applied late in the afternoon, evening, or at night outside of daily peak foraging periods.

⁴ This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds on which bees are actively foraging. Additional information may be obtained by consulting your Cooperative Extension Service.

⁵ This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift if bees are visiting the treatment area. Ensure that planting equipment is functioning properly in accordance with manufacturer specifications to minimize seed coat abrasion during planting to reduce dust, which can drift to blooming crops or weeds.

* MoA = Mode of Action classification from the Insecticide Resistance Action Committee (www.ircac-online.org). Insecticides with different MoAs should be used for insecticide resistance management.

Table 6. Insecticides Labeled for Use on Small Grains (cont.)

Insecticide and Trade Name	A.I./ Formulated Product	Formulation	Restricted Entry Interval (hr)	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Bee Hazard Restriction
MACHO 600 ST	5 lb./gal.	seed treatment	12	45	yes ¹
NITRO SHIELD IV	4 lb./gal.	seed treatment	12	45	yes ⁵
NITRO SHIELD	5 lb./gal.	seed treatment	12	45	yes ⁵
RESONATE 600 ST	5 lb./gal.	seed treatment	12	45	yes ⁵
SENATOR 600 FS	5 lb./gal.	seed treatment	12	45	no
GAUCHO 600	5 lb./gal.	seed treatment	12	45	no
SHARDA IMICACLOPRID 5SC	5 lb./gal.	seed treatment	12	45	yes ²
imidacloprid + captan + carboxin (oats, wheat, barley) MoA Group 4A					
ENHANCE AW	Per lb: 3.2 oz. + 3.1 oz. + 3.2 oz.	seed treatment	12	45	no
imidacloprid + ipconazole + metalaxyl (oats, wheat, barley, rye, triticale) MoA Group 4A					
WARDEN CEREALS HR	Per gal: 1.28 lb. + 0.038 lb. + 0.051 lb	seed treatment	24	45	yes ²
RANCONA CREST	Per gal: 1.28 lb. + 0.038 lb. + 0.051 lb.	seed treatment	24	45	yes ²
imidacloprid + metalaxyl + tebuconazole (oats, wheat, barley) MoA Group 4A					
GAUCHO XT	Per gal: 1.16 lb. + 0.056 lb. + 0.075	seed treatment	24	45	no
imidacloprid + metalaxyl + tebuconazole + fludioxonil (wheat, barley) MoA Group 4A					
SATIVA IMF MAX (also oats)	Per gal: 1.00 lb. + 0.05 lb. + 0.04 lb + 0.03 lb.	seed treatment	24	45	yes ²
SATIVA IMF RTU (also oats and triticale)	Per gal: 0.13 lb + 0.05 lb + 0.04 lb. + 0.03 lb.	seed treatment	24	45	yes ²
DYNA-SHIELD FOOHOLD VIROCK	Per gal: 1.0 lb + 0.05 lb + 0.04 lb. + 0.03 lb.	seed treatment	24	45	yes ²
SATIVA IMF SEMBOLITE MAX (also oats)	Per gal.: 1.00 lb. + 0.05 lb. + 0.04 lb. + 0.03 lb. +	seed treatment	24	45	yes ²

¹ Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds.

² Ensure that planting equipment is functioning properly in accordance with manufacturing specifications to minimize seed coat abrasion during planting to reduce dust that can drift to blooming crops or weeds. This compound is highly toxic to bees exposed directly (contact).

Table 6. Insecticides Labeled for Use on Small Grains (cont.)

Insecticide and Trade Name	A.I./ Formulated Product	Formulation	Restricted Entry Interval (hr)	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Bee Hazard Restriction
lambda-cyhalothrin (barley, oats, rye, buckwheat, wheat, triticale) MoA Group 3A					
WARRIOR II with ZEON TECHNOLOGY (RESTRICTED USE)	2.08 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
KENDO (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
LAMBDA-CY AG (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
LAMBDA-CY EC (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
lambda-cyhalothrin (barley, oats, rye, buckwheat, wheat, triticale) MoA Group 3A (cont.)					
LAMBDA-CY 1 EC (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
NUFARM LAMBDA CYHALOTHRIN 1EC (RESTRICTED USE)	1 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
LAMBDASTAR (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
LAMBDASTAR ICS (RESTRICTED USE)	1 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
LAMBDASTAR PLUS (RESTRICTED USE)	2 lb./gal.	aqueous-based formulation	24	30 (grain, straw), 7 (g)	yes ¹
LAMBDA-T (RESTRICTED USE)	1 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
L-C INSECTICIDE (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
PARADIGM (RESTRICTED USE)	1 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
PROVINCE (RESTRICTED USE)	1 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
PROVINCE II (RESTRICTED USE)	2.08 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
RAVAGE (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
SILENCER (RESTRICTED USE)	1 lb./gal.	emulsifiable concentrate	24	30 (grain, straw), 7 (g)	yes ¹
SILENCER VXN (RESTRICTED USE)	1 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹
GRIZZLY TOO (RESTRICTED USE)	2.08 lb./gal.	capsule suspension	24	30 (grain, straw), 7 (g)	yes ¹

¹ Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds.

Table 6. Insecticides Labeled for Use on Small Grains (cont.)

Insecticide and Trade Name	A.I./ Formulated Product	Formulation	Restricted Entry Interval (hr)	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Bee Hazard Restriction
lambda-cyhalothrin + thiamethoxam (barley only) MOA Groups 3A + 4A					
ENDIGO ZC (RESTRICTED USE)	28	4.5 fl.oz.	0.03–0.04	30 (h, straw), 7 (g)	For barley only. Barley is considered tolerant to Hessian fly. Damage only occurs under severe infestations. ENDIGO is a RESTRICTED USE pesticide. Make applications when insects emerge. Observe all Pollinator Precautions on the label.
lambda-cyhalothrin + chlorantraniliprole (barley, buckwheat, oats, rye, triticale, wheat) MoA Groups 3A + 28					
BESIEGE	0.417 lb./gal. + 0.835 lb./gal.	aqueous suspension	24	30	yes ¹
malathion (barley, oats, rye, wheat) MoA Group 1B					
FYFANON ULV AG	9.9 lb./gal.	emulsifiable concentrate	12	7	yes ¹
FYFANON	5 lb./gal.	emulsifiable concentrate	12	7	yes ¹
FYFANON 8LB EMULSION	8 lb./gal.	emulsifiable concentrate	12	7	yes ¹
CHEMINOVA MALATHION 57% ORGANOPHOSPHATE (rye, oats, barley)	5 lb./gal.	emulsifiable concentrate	12	7	yes ¹
MALATHION 5, 5E, 57EC, others	5 lb./gal.	emulsifiable concentrate	12	7	yes ¹
GOWAN MALATHION 8, others	8 lb./gal.	emulsifiable concentrate	12	7	yes ¹
spinetoram MoA Group 5 (barley, buckwheat, oats, triticale, wheat)					
RADIANT SC	1 lb./gal.	suspension concentrate	4	21 (grain, straw) 3 (forage, fodder, hay)	yes ⁶
spinosad (barley, buckwheat, oats, rye, triticale, wheat) MoA Group 5					
BLACKHAWK	5.8 oz./lb.	water dispersible granule	4	21 (grain, straw) 3 (forage, fodder, hay) Graze when hay is dry.	yes ⁶
ENTRUST	12.8 oz./lb.	wettable powder	4	same as above	yes ⁶
ENTRUST SC	2 lb./gal.	soluble concentrate	4	same as above	yes ⁶
SPINTOR 2SC	2 lb./gal.	soluble concentrate	4	same as above	yes ⁶
sulfoxaflor (triticale, wheat, and barley) MoA Group 4C					
TRANSFORM WG	8 oz./lb.	water dispersible granule	24	14 (grain, straw) 7 (grazing, forage, fodder, hay)	yes ⁸
thiamethoxam (barley, buckwheat, oats, rye, triticale, wheat) MoA Group 4A					
CRUISER 5FS	5 lb./gal.	seed treatment	12	not specified	yes ⁷
thiamethoxam + mfenoxam + difenoconazole (barley, wheat, triticale) MoA Group 4A					
CRUISER MAXX CEREALS	0.26 lb. + 0.05 lb. + 0.31 lb./gal.	seed treatment	48	not specified	yes ⁷

Other products may be available. Always read the label to make sure the specific crop is listed and to determine what rate to use.

Insect Pest Management section prepared by **Katelyn Kesheimer**, *Extension Specialist*, Assistant Professor, Entomology and Plant Pathology, Auburn University. Portions of the introduction were adapted from Hudson, R., G. D. Buntin, and K. Flanders. Wheat Insects. In Southern Small Grains Resource Management Handbook. University of Georgia Cooperative Extension Service Bulletin 1190.

Table 6. Insecticides Labeled for Use on Small Grains

Insecticide and Trade Name	A.I./ Formulated Product	Formulation	Restricted Entry Interval (hr)	Minimum Days from Last Application to Harvest (h) or Grazing (g)	Bee Hazard Restriction
thiamethoxam + sedaxane + difenoconazole + mefenoxam (barley, triticale, wheat) MoA Group 4A					
CRUISERMAXX VIBRANCE CEREALS	Per gal: 0.26 lb + 0.07 lb + 0.31 lb. + 0.08 lb.	water dispersible granule	24	not specified	yes ⁷
zeta-cypermethrin (triticale, buckwheat, wheat, barley, oats, rye) MoA Group 3A					
MUSTANG MAXX INSECTICIDE (RESTRICTED USE)	0.8 lb./gal.	emulsifiable concentrate	12	14	yes ¹
For wheat and triticale					
RESPECT INSECTICIDE OR RESPECT EC INSECTICIDE (RESTRICTED USE)	0.8 lb./gal.	emulsifiable concentrate	12	14	yes ¹

¹ Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds.

⁶ This product is toxic to bees exposed to treatment for 3 hours following treatment. Do not apply this pesticide to blooming, pollen-shedding or nectar-producing parts of plants if bees may forage on the plants during this time period.

⁷ Thiamethoxam is highly toxic to bees exposed to direct treatment and effects may be possible as a result of exposure to translocated residues in blooming crops.

⁸ If blooming vegetation is present 12 feet out from the downwind edge of the field, a downwind 12-foot on-field buffer must be observed.

DISEASE CONTROL

Small grain production in Alabama can be critically limited by diseases. They are important factors in lowering both the yield and the quality of grain. Diseases must be managed effectively to achieve optimum yields of quality grains.

Many diseases can be managed without applying fungicides. Maintaining soil fertility, planting resistant varieties, rotating with nonhost crops, and following other good management practices are essential. These other practices include tilling, seedbed preparation, delayed planting, weed control, and using treated seed. However, foliar-applied fungicides may still sometimes be required to control stem and foliage disease outbreaks.

Most disease management decisions are made prior to planting! Variety selection, the type of tillage, crop rotation, planting dates, and the fertility of the soil will greatly influence diseases in small grains. The only decisions that may be required for disease control after planting will concern foliar pesticide applications needed to control leaf and head diseases and aphid outbreaks that can result in barley yellow dwarf.

Variety Selection

Selecting varieties is a very important disease control consideration. There are commercial varieties available that are tolerant and some that are resistant to many of the common diseases in Alabama. Selecting the varieties that are resistant to the prevailing diseases in a particular area can make the difference between the crop's success or failure. Also, it is important to plant more than one variety with resistance to the commonly occurring diseases to prevent the disease from overcoming the resistance of a single variety. Other factors such as the varieties' maturity dates, their ability to withstand any inclement environmental conditions, and other pests that may reduce grain production must be considered in selecting varieties.

Tillage

Destroying small grain stubble by disking grain fields speeds up the decomposition of stalks that can host diseases such as take-all, Septoria glume blotch, and scab.

Crop Rotation

Rotating crops prevents the buildup of certain small grain diseases and insect pests and improves weed control and soil fertility. Rotation is especially important in preventing take-all outbreaks in wheat. Also, rotation with nonhost crops causes a decline of foliage and stem fungal diseases such as rust, scab, septoria leaf and glume blotch, and smut by removing the hosts needed to maintain the disease-causing organisms.

¹ Apply fungicides in a minimum of 5 gallons per acre for aerial applications and 5 to 15 gallons per acre for ground applications. Thorough coverage of the lower and upper leaf surface is essential for optimum disease control.

Soil Fertility

High nitrogen rates can produce excessive vegetative growth in the fall, increasing the incidence of foliage diseases and barley yellow dwarf. Excessive growth and dense stands increase humidity in the canopy, which favors the development of powdery mildew, Septoria leaf blotch, and leaf rust. Also, excessive vegetation prolongs the feeding activity of aphids, which transmit the barley yellow dwarf virus.

Planting Date

The development of barley yellow dwarf is greatly influenced by planting dates. Delaying the planting date to miss aphid migrations can reduce barley yellow dwarf incidence. Be careful, however, not to delay the planting date too long because planting too late can reduce small grain yields in Alabama.

Quality Seed

Selecting good seed is essential for good stands in the fall. Fungicide seed treatment provides added protection against seed- and soilborne seedling disease fungi. Though expensive, the newer sterol inhibitor class of seed treatment fungicides provides good systemic protection against loose smut, common bunt, and fall infection of powdery mildew.

Seed treatment is more effective when the fungicide covers the entire seed surface. Poor coverage of the seed will result in poor performance. Seed treatments applied at the factory are superior to on-farm treatments. However, on-farm or on-site treatments provide better coverage than hopperbox treatments.

Table 7. Small Grains Seed Treatments

Fungicide and Formulation	Rate/Cwt	Crops ¹	Comments
carboxin + captan ENHANCE	4.0 oz.	B, O, W	Hopper box treatment for control of loose smut, common and kernal, bunt, seed rots, and seedling diseases of small grains.
difenoconazole + mefenoxam DIVIDEND EXTREME DIVIDEND XL RTA (for on-farm use)	1.0–4.0 fl.oz. 2.5–10.0 fl.oz.	B, W B, W	Good to excellent fall-season control of powdery mildew, leaf rust, and Septoria leaf blotch when applied at highest rate. Excellent loose smut and bunt control. Low rate controls only loose smut and common bunt. Gives good Pythium damping off control; partial control of Fusarium root rot, crown rot, and take-all.
difenoconazole + mefenoxam + sedaxane VIBRANCE EXTREME	2.8–5.6 fl.oz.	B, O, R, W	For control of seed rots and damping-off, early season Septoria disease complex, bunt and smut diseases, root rots, take-all, and Septoria diseases.
difenoconazole + mefenoxam + thiamethoxam CRUISER MAXX	5.0 fl.oz.	B, W	Suppresses barely yellow dwarf virus by controlling aphids. Also controls seed rots and damping-off, bunt and smut diseases, root rots, and take-all diseases.
difenoconazole + metalaxyl + tebuconazole + imidacloprid SALIENT TMI	5.0–7.5 fl.oz.	B, O, W	For control of seed rots and damping-off, dwarf and kernal bunt, common bunt, loose smut, Rhizoctonia root rot, common root rot, and Fusarium scab and foot rot. Early season suppression of powdery mildew, wheat leaf rust, and Septoria leaf blotch.
difenoconazole + fludioxonil + mefenoxam + sedaxane VIBRANCE QUATTRO	5.0 fl.oz.	B, O, R, W	For control of seed rots and damping-off, early season Septoria disease complex, bunt and smut diseases, root rots, take-all, and Septoria diseases.
difenoconazole + fludioxonil + mefenoxam + sedaxane + thiamethoxam CRUISER VIBRANCE QUATTRO	5.0 fl.oz.	B, O, R, W	Suppresses barely yellow dwarf virus by controlling aphids. Also controls seed rots and damping-off, early season Septoria disease complex, bunt and smut diseases, root rots, take-all, and Septoria diseases. See comments for imidacloprid in Table 5.
fluxapyroxad + metalaxyl + pyraclostrobin + triticonazole STAMINA F4 CEREALS	4.6 fl.oz.	B, O, R, W	For the control of seed rots and damping-off, crown and root rot, and bunt and smut diseases.
imidacloprid + metalaxyl + prothioconazole + tebuconazole RAXIL PRO SHIELD	5.0 fl.oz.	B, W	Suppresses barely yellow dwarf virus by controlling aphids. Also controls seed rots and damping-off, early season Septoria disease complex, bunt and smut diseases, root rots, take-all, and Septoria diseases. See comments for imidacloprid in Table 5.
imidacloprid + metalaxyl + tebuconazole GAUCHO XT SATIVA IM RTU	3.4–4.5 fl.oz.	B, W, O	Suppresses barley yellow dwarf virus by controlling aphids. Also controls Pythium seed rot and seedling damping-off, loose smut, covered bunt, and suppresses early season Septoria disease complex, powdery mildew, leaf rust, and root rot. See comments for imidacloprid in Table 5.
ipconazole + metalaxyl RANCONA CTS RANCONA SUMMIT	0.93–1.53 fl.oz. 2.5–4.0 fl.oz.	B, O, R, W	For control of seed rots, damping-off, seedling blight, and smut and bunt diseases.

Table 7. Small Grains Seed Treatments

Fungicide and Formulation	Rate/Cwt	Crops ¹	Comments
ipconazole + metalaxyl + imidacloprid RANCONA CREST	5.0-8.33 fl.oz.	B, O, R, W	For control of seed rots and seedling damping-off caused by <i>Penicillium</i> , <i>Aspergillus</i> , <i>Fusarium</i> , <i>Pythium</i> , and <i>Cochliobolus</i> , common bunt and smut diseases, and early season suppression of common foot rot, powdery mildew, and rust and Septoria diseases. Suppresses barley yellow dwarf virus by controlling aphids. See comments for imidacloprid in Table 5.
mefentrifluconazole RELENYA	0.2–0.4 fl.oz.	B, O, R, W	For control of seedling diseases caused by <i>Fusarium</i> and <i>Rhizoctonia</i> .
metalaxyl ACQUIRE ALLEGIANCE-FL BELMONT 2.7 FS SEBRING 318 FS STARTUP METXL	0.75 fl.oz.	B, O, R, W	Add if <i>Pythium</i> seedling disease is a problem.
metalaxyl + pyraclostrobin + triticonazole STAMINA F3 CEREALS	4.6 fl.oz.	B, O, R, W	For control of seed rots, damping-off, seedling blight, and smut and bunt diseases. Also for suppression of <i>Fusarium</i> crown and root rots.
penflufen EVERGOL PRIME	0.16–0.32 fl.oz.	B, O, R, W	For control of seed rots and seedling damping-off caused by <i>Rhizoctonia</i> , common bunt, and smut diseases.
picarbutrazox VAYANTIS	0.05–0.10 fl.oz.	B, O, R, W	For control of <i>Pythium</i> root rot due to <i>Pythium</i> spp. Use the higher rate when disease pressure is expected to be severe.
prothioconazole + penflufen + metalaxyl EVERGOL ENERGY	1.0 fl.oz.	B, O, R, W	For control of seed rots and seedling damping-off caused by <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Cochliobolus</i> , and <i>Pythium</i> , common bunt and smut diseases, and early season suppression of common foot rot, powdery mildew, and rust and Septoria diseases.
prothioconazole + tebuconazole + metalaxyl RAXIL PRO MD	5.0–7.5 fl.oz.	B, O, W	For suppression or control of seed, seedling, and soilborne diseases, common smut and bunt diseases, Septoria disease complex, <i>Rhizoctonia</i> root rot, and <i>Fusarium</i> foot rot and scab. Includes early season control of powdery mildew (7.5 fluid ounce rate only), and rust.
sedaxane + difenoconazole + mefenoxam + thiamethoxam CRUISERMAXX VIBRANCE CEREALS	5.0–10.0 fl.oz.	B, O, R, W	For control of seed rots and seedling damping-off caused by <i>Rhizoctonia</i> ; <i>Fusarium</i> ; <i>Pythium</i> ; common, karnal, and dwarf bunt; flag; and loose smut as well as early suppression of take-all, common root (foot rot), <i>Fusarium</i> and <i>Rhizoctonia</i> root rot, powdery mildew, <i>Fusarium</i> scab, <i>Fusarium</i> foot rot, and rust and Septoria diseases.

¹ B = Barley, O = Oats, R = Rye, W = Wheat.

Table 8. Foliar Fungicides Recommended for Control of Leaf, Stem, and Head Diseases

Fungicide	Formulation Rate/ Acre ¹	Comments
azoxystrobin AFRAME ARIUS 250 AZOXY 2SC AZOXY STAR AZOXYSTOBIN SC DEXTER SC QUADRIS FLOWABLE	4.0–12.0 fl.oz. 7.5–11.0 fl.oz. 12.0 fl.oz.	For control of leaf rust, tan spot, Septoria glume, and leaf blotch on barley, wheat, and triticale. Apply just before or during early stage of disease development and at any growth stage between jointing (Feekes Growth Stage 6) and flowering (Feekes Growth Stage 10.5). Add a crop oil concentrate at 1% v/v. DO NOT make more than two applications of Quadris or other group 11 fungicides per year. See label for application rates on barley. For control of powdery mildew on wheat. Apply just before or when disease first appears and at any growth stage between jointing (Feekes Growth Stage 6) and flowering (Feekes Growth Stage 10.5). Add crop oil concentrate at 1% v/v. DO NOT make more than two applications of Quadris or other group 11 fungicides per year. For control of powdery mildew on barley, oats, and rye. Apply prior to disease development. DO NOT apply more than two sequential applications of Quadris or other group 11 fungicides per year. DO NOT apply after Feekes Growth Stage 10.5.4.

Table 8. Foliar Fungicides Recommended for Control of Leaf, Stem, and Head Diseases (cont.)

Fungicide	Formulation Rate/ Acre ¹	Comments
azoxystrobin + benzovindiflupyr + propiconazole TRIVAPRO	9.4–13.7 fl.oz.	For control of leaf rust, tan spot, powdery mildew, spot blotch, and Septoria leaf and glume blotch on barley, oats, rye, triticale, and wheat. Apply prior to disease development at no closer than 14-day intervals apart. Can be applied through full head emergence (Feekes growth stage 10.5.4)
azoxystrobin + flutriafol TOPGUARD EQ	4.0–7.0 fl.oz.	For control of Septoria leaf and glume blotch, rust diseases, powdery mildew, spot blotch, and tan spot on wheat and triticale. Apply when conditions favor disease at flag leaf emergence. Reapply after 14 days as needed. DO NOT apply past Feekes 10.5.4.
azoxystrobin + propiconazole AFRAME PLUS AZOXYPROP QUILT XCEL	7.0–14.0 fl.oz. 10.5–14.0 fl.oz.	For early season (winter) suppression on wheat of Septoria leaf and glume blotch, tan spot, powdery mildew, and rust on wheat. Follow with second application at Feekes 9 as needed for full season control. For control of Septoria leaf and glume blotch, rust diseases, powdery mildew, spot blotch and tan spot on wheat as well as barley scald, barley stripe, Helminthosporium leaf spot, net blotch, powdery mildew, rust, spot blotch, and tan spot on barley, oats, rye, and triticale. Apply when flag leaf is 50% to fully emerged followed by a second applications 14 days later at flowering (Feekes 10.5) as needed for disease control. DOES NOT suppress Fusarium scab on wheat. DO NOT apply after flowering. See label for additional use restrictions.
azoxystrobin + tebuconazole AZOXY TEB CUSTODIA TEBUSTROBIN SC	6.4–8.6 fl.oz.	For control of Septoria leaf and glume blotch, rust diseases, powdery mildew, and tan spot on wheat and rust diseases on barley. Also for scab suppression on barley and wheat. Apply prior to disease development up to late head emergence (Feekes 10.5). For rust suppression, apply at beginning of flowering (anthesis) at Feekes 10.5. DO NOT make more than one application per year.
benzovindiflupyr + azoxystrobin + propiconazole TRIVAPRO	9.4–13.7 fl.oz.	For control of Septoria diseases, rusts, powdery mildew, spot blotch, tan spot on wheat, triticale, rye, oats, and barley. Apply immediately at or during flag leaf emergence followed by a second application 14 days later to no later than full head emergence (Feekes 10.5.4). DOES NOT control Fusarium head mold on small grains. For early season disease control at Feekes stages 2 through 7, apply prior to disease development at above application rates. DO NOT make more than two applications of Trivapro or other Group 7 or Group 11 before alternating with fungicides that are not Group 7 or 11.
bixafen + flutriafol LUCENTO	3.0-5.5 fl.oz.	For control of leaf and stem rusts, Septoria leaf blotch, tan spot, and powdery mildew on wheat and triticale. Apply Lucento preventively or when conditions favor disease development. Apply lower rates early in the season. Application of high rate at flag leaf ligule emergence to protect the upper foliage during grain fill period. For optimum control of foliar diseases mix with a surfactant. DO NOT make more than 2 sequential applications per year before alternating to another fungicide FRAC group different from FRAC groups 7 and 3.
cyproconazole ALTO 100 SL	1.5–5.5 fl.oz. 3.0–5.5 fl.oz.	For early season suppression on wheat of Septoria leaf and glume blotch, tan spot, powdery mildew, and rust on wheat and triticale. Apply in winter and early spring at Feekes 5 and follow with a second application as needed 14 days later or full season disease control program at flag leaf extension. For control of rust diseases, powdery mildew, Septoria leaf and glume blotch, spot blotch and tan spot of wheat and triticale. Apply between Feekes 8 (flag leaf emergence) and 10.5.1 (flowering or anthesis). Follow with second application 14 days later as needed. DO NOT apply more than 5.5 fluid ounces of product per acre.
flutriafol TOPGUARD	10.0–14.0 fl. oz.	For control of rust diseases, powdery mildew, and leaf and glume blotch as well as Fusarium scab suppression on wheat and triticale. Apply when conditions favor disease or at anthesis (Feekes 10.5.1) for scab control. DO NOT make more than two applications per crop or apply more than 28 fluid ounces of product per acre.
fluoxastrobin EVITO 480 SC	2.0–4.0 fl.oz. 2.5–4.0 fl.oz.	For control of leaf stripe, stem rust, tan spot, and Septoria leaf and glume blotch on wheat. For optimum control, apply preventively and repeat as needed 14 to 21 days later. DO NOT apply after 50 percent head emergence (Feekes Growth State 10.5) more than 8 fluid ounces per acre per year or make more than two sequential applications. For control of powdery mildew on wheat. See above for application timing.

*MOA=Mechanism of action. Herbicides with different MOAs should be used in weed resistance management programs. See Table 12 for classifications of mechanisms of action.

Table 8. Foliar Fungicides Recommended for Control of Leaf, Stem, and Head Diseases (cont.)

Fungicide	Formulation Rate/ Acre ¹	Comments
fluoxastrobin + flutriafol FORTIX PREEMPTOR SC	2.0–3.0 fl.oz. 4.0–6.0 fl.oz.	For early season suppression on wheat of Septoria diseases, tan spot, powdery mildew, and rust. Follow with a second application 14 days later as needed or full season disease control program at flag leaf extension. For control of rust diseases, powdery mildew, Septoria leaf and glume blotch, and tan spot of wheat. Apply when flag leaf is 50 percent fully emerged. Do not apply past Feekes 10.5. DOES NOT control scab. DO NOT make more than two applications per crop or apply more than 12 fluid ounces product per acre.
fluoxastrobin + tebuconazole EVITO T	4.0–6.0 fl.oz.	For control of leaf stripe, stem rust, tan spot, and Septoria leaf and glume blotch. For best results, apply at Feekes Growth Stage 5 followed by a second application no later than 50 percent head emergence (Feekes Growth Stage 10.5). DO NOT apply more than 12 fluid ounces of product per acre per season or more than two applications per crop per season.
fluxapyroxad + pyraclostrobin + propiconazole NEXICOR XEMIMUM	7.0–13.0 fl.oz.	For control of Septoria leaf and glume blotch, rust diseases, powdery mildew, spot blotch, and tan spot on wheat and triticale as well as barley scald, Septoria diseases, spot blotch, Helminthosporium leaf spot, rust diseases, and tan spot on barley, rye, and oats. For optimal control, begin Nexicor applications prior to disease development. Apply immediately after flag leaf emergence followed by a second application no later than 50% head emergence (Feekes 10.3). Minimum retreatment interval is 14 days. DOES NOT control fusarium head mold on small grains. DO NOT apply more than 13.0 fluid ounces per acre per season if forage will be harvested. Otherwise the maximum product rate per acre per year is 26 fluid ounces.
fluxapyroxad + pyraclostrobin PRIAXOR XEMIMUM	2.0–4.0 fl.oz. 4.0–8.0 fl.oz.	For early season (spring) suppression on barley, triticale, and wheat for Septoria diseases, leaf and net blotch, powdery mildew, scald, spot blotch, and tan spot apply prior to flag leaf emergence. Apply when symptoms appear and repeat no later than flag leaf emergence for full season control. May be tank mixed with herbicide. DO NOT apply more than two sequential applications per season or more than 16 fluid ounces of product per acre per season. For control of powdery mildew, rust diseases, Septoria leaf and glume blotch, spot blotch, tan spot, and scald on barley, oat, rye, triticale, and wheat. See label for disease listing for each small grain. Apply at full flag leaf extension and again 10 to 14 days later at beginning of flowering (Feekes Growth Stage 10.5) as needed. DOES NOT suppress Fusarium head blight/scab on wheat and barley.
metaconazole CARAMBA	5.0–8.3 fl.oz. 13.0–17.0 fl.oz. 10.0–14.0 fl.oz.	For early season (spring) suppression on barley, triticale, and wheat for Septoria diseases, leaf and net blotch, powdery mildew, scald, spot blotch, and tan spot prior to flag leaf emergence. Apply when symptoms appear and repeat no later than flag leaf emergence for full season control. May be tank mixed with herbicide. Early season application will not control Fusarium head scab. DO NOT apply more than 34 fluid ounces of product per acre per season. For optimum suppression of Fusarium scab on wheat and barley. Apply at early flowering (Feekes Growth Stage 10.5.1). DO NOT make more than two applications of Caramba or other triazole (group 3) fungicides per year to wheat. For control of powdery mildew, rust diseases, leaf and glume blotch, spot and rust blotch, tan spot, and scald on wheat, barley, oats, and triticale. Apply at full flag leaf extension and again 10 to 14 days later if conditions favor disease. DO NOT make no more than two applications of Caramba per crop.
metconazole + prothioconazole SPHAEREX	4.0–5.0 fl. oz. 5.5–7.3 fl. oz. 7.3 fl. oz.	For early season control of leaf and stem diseases of barley, oats, rye, triticale, and wheat including powdery mildew, rust, Septoria blotch, and tan spot. Apply when conditions favor disease development or disease pressure is high prior to flag leaf emergence. When an early season application is used, a second application may be required to protect the flag leaf. Early season applications will not suppress or control head scab. In order to maximize yield, it is important to protect the flag leaf. For optimal disease control, begin applications prior to disease development or immediately after flag leaf emergence. For control of Fusarium head scab, apply during early flowering using forward and reverse facing nozzles to ensure thorough coverage of the heads. For ground applications, apply a minimum of 10 gpa.

Table 8. Foliar Fungicides Recommended for Control of Leaf, Stem, and Head Diseases (cont.)

Fungicide	Formulation Rate/ Acre ¹	Comments
picoxystrobin APROACH	3.0–4.0 fl.oz. 6.0–12.0 fl.oz. 6.0–12.0 fl.oz.	Apply between jointing and flag leaf emergence for early season control of Septoria disease, powdery mildew, and tan spot. Follow with a second application at flag leaf emergence for full season disease control. DO NOT apply more than 36 fluid ounces of product per crop per season. DO NOT make more than two sequential applications of Approach before switching to a fungicide with a different MOA. For control of rust diseases, powdery mildew, Septoria leaf and glume blotch, black point, spot blotch, and tan spot as well as Fusarium head scab suppression on triticale and wheat. For best results, apply at flag leaf emergence (Feekes growth stage 9.0) and 14 days later. Use higher rate when disease pressure is high and for Fusarium scab suppression. DO NOT apply after Feekes growth stage 10.5. Make no more than two applications per year.
picoxystrobin + cyproconazole APROACH PRIMA	3.4 fl.oz. 3.4–6.8 fl.oz.	For early season (spring) suppression on triticale and wheat for Septoria diseases, powdery mildew, and tan spot prior to flag leaf emergence. Follow with a second application at flag leaf emergence for full season disease control. DO NOT make more than two applications or apply more than 6.8 fluid ounces of product per acre per year. For control of rust diseases, powdery mildew, Septoria leaf and glume blotch, black point, spot blotch, and tan spot on triticale and wheat. For best results, apply at flag leaf emergence (Feekes growth stage 9.0) and 14 days later. Use higher rate when disease pressure is high. Also suppresses Fusarium head scab when applied at high rate. DO NOT apply after Feekes growth stage 10.5. Make no more than two applications per year.
propiconazole BUMPER BUMPER ES BUMPER 41.8 EC PROPIMAX EC PROPICON 3.6EC TILT	2.0–4.0 fl.oz. 4.0 fl.oz. 4.0 fl.oz.	For early season disease suppression on wheat (Tilt only). Apply when powdery mildew or leaf blotch is seen. Make a second application no later than flowering. DO NOT apply more than 8 fluid ounces of product per acre per year. Fusarium head mold (scab) suppression in wheat. Apply at 50 percent flowering. DO NOT apply more than 4 fluid ounces for wheat harvested as grain. For control of leaf rust, Septoria glume blotch, leaf blotch, powdery mildew, and Fusarium head blight on wheat and triticale as well as for control of crown rust and leaf blotch on oats. Apply up to flowering (Feekes Growth Stage 10.5). Make up to two applications per year. Add a spreader for good leaf coverage.
prothioconazole + tebuconazole + fluopyram PROSARO PRO 400 SC	10.3–13.6 fl. oz.	For control of Fusarium head blight, powdery mildew, rusts, Septoria leaf blotch, and tan spot on wheat and barley. Apply as a preventative foliar spray at early flower (Feekes Growth Stage 10.5.1) and set spray equipment to provide good coverage of the heads to control Fusarium head blight. For control of leaf and stem diseases, apply as preventative foliar spray at the first sign of disease.
propiconazole + trifloxystrobin STRATEGO	4–8 fl.oz. 10.0 fl.oz.	For early season control of tan spot, Septoria, and powdery mildew and suppression of rust on wheat and triticale. For control of leaf rust, Septoria leaf blight, glume blotch, powdery mildew, and tan spot on wheat and triticale. Begin applications preventively or when conditions favor disease development. A second application (minimum interval of 14 days) may be made if needed. DO NOT apply after Feekes growth stage 10.5 (full head emergence).
prothioconazole PROLINE 480 SC	4.3–5.0 fl oz 5.0–5.7 fl oz	For control of Septoria leaf and glume blotch, rust diseases, powdery mildew, and tan spot on wheat and triticale. Apply as a preventive foliar spray when the earliest disease symptoms appear on the leaves or stems. Up to 2 applications can be made per year. Repeat applications at 14-day intervals when conditions remain favorable for disease development. A maximum of 9.37 fluid ounces of Proline may be applied per season. For Fusarium head blight suppression on wheat and triticale. Apply at early flowering (Feekes Growth Stage 10.51) for fusarium scab control on wheat and barley. Spray equipment must be set to obtain good coverage of the heads. Will control above diseases when applied at early flowering.
prothioconazole + trifloxystrobin STRATEGO YLD	4.0 fl.oz.	For control of leaf and glume blotch, powdery mildew, tan spot, and rust diseases on wheat. DO NOT make more than two applications of Stratego YLD per acre per year. If harvesting, DO NOT apply more than 4 fluid ounces per acre per year.

Table 8. Foliar Fungicides Recommended for Control of Leaf, Stem, and Head Diseases

Fungicide	Formulation Rate/ Acre ¹	Comments
DELARO 325 SC	2.3 fl.oz. 4.0–6.0 fl.oz. 5.7 or 8.0 fl.oz.	For control of glume and leaf blotch, net and spot blotch, powdery mildew, rust, and scald on barley. Make first preventive spray when conditions favor disease and repeat after 14 days as needed. DO NOT apply after full head emergence (Feekes Growth Stage 10.51) on wheat or flag leaf emergence (Feekes Growth Stage 8) on barley. DO NOT make more than two applications of Stratego YLD per acre per year. If harvesting, DO NOT apply more than 2.3 fluid ounces per acre per year. For early season control of Septoria, tan spot, powdery mildew, and suppression of rust on wheat. For control of Septoria, tan spot, powdery mildew, and rust on barley and wheat at 5.7 or 8.0 fl.oz., respectively. Begin applications preventively when conditions favor disease development. A second application (minimum interval of 14 days) may be made if needed.
prothioconazole + trifloxystrobin + fluopyram DELARO COMPLETE	8.0 fl.oz. 4.0–6.0 fl.oz.	For control of powdery mildew, rusts, Septoria blotch, and Tan Spot of wheat. Begin applications preventively when conditions favor disease development. If needed, a second application at a minimum interval of 14 days can be made. DO NOT apply after Feekes growth stage 10.5 (full head emergence). If more than 8.0 fluid ounces of Delaro complete is applied per year, 4.0 to 6.0 fl.oz. For control of early season powdery mildew, Septoria, tan spot, and suppression of rusts.
pydiflumetofen + propiconazole MIRAVIS ACE	13.7 fl.oz.	For control of glume and leaf blotch, net and spot blotch, tan spot, Helminthosporium leaf spot, Septoria blotch, and powdery mildew. Apply between Feekes growth stage 10.3 and 10.5.2. DO NOT make more than two applications of Miravis ACE or other Group 7 and 3 fungicides before alternation with a fungicide that is not in Group 7 or 3. DO NOT make more than two applications at the maximum rate of 13.7 fluid ounces per year.
pyraclostrobin HEADLINE HEADLINE SC	3.0–6.0 fl.oz. 6.0–9.0 fl.oz.	For early season control of Septoria glume and leaf blotch, apply with post-emergent herbicide in February. A second application may be needed to protect the flag leaf. For control of leaf and glume blotch, rust diseases, tan spot, and powdery mildew in barley, oats, rye, triticale, and wheat. Apply immediately after flag leaf emergence and repeat if conditions favor disease spread 10 to 14 days later. Apply no later than flowering (Feekes Growth Stage 10.5) on oat, triticale, and wheat. DO NOT apply Pyrac 2 EC more than twice or 18 fluid ounces of product per acre per year. See label for resistance management instructions.
pyraclostrobin + metaconazole TWINLINE	7.0–9.0 fl.oz.	For control of all rust diseases, powdery mildew, glume and leaf blotch, and tan spot on wheat; rust diseases, net and spot blotch, and scald on barley and triticale; and crown rust and spot blotch on oats. For optimum control of above diseases, apply when flag leaf is 50 percent to fully emerged. A second application can be made at 14 days or later, preferably at full head extension. Use higher rate at shorter interval when disease is severe. DO NOT make no more than two applications or apply more than 18 fluid ounces per acre per season.
tebuconazole MONSOON ORIOUS 3.6F TEB 3.6 SC TEBUSTAR 3.6L TEBUZOL 3.6F	4.0 fl.oz. 4.0 fl.oz.	For control of leaf, stem, and stripe rust on wheat and leaf rust on barley. For rust control, apply at earliest sign of pustules on leaves. For Fusarium scab suppression on wheat and barley. Apply at early flowering (Feekes Growth Stage 10.51). Make only one application for a total of 4 fluid ounces per acre per year.
tebuconazole + prothioconazole PROSARO 421 SC	6.5–8.2 fl.oz.	For control of all rust diseases, powdery mildew, glume and leaf blotch, and tan spot on wheat as well as rust diseases, net and spot blotch, and scald on barley. Apply at early flowering (Feekes Growth Stage 10.5.1) for Fusarium scab control on wheat and barley. Spray equipment must be set to obtain good coverage of the heads. Make only one application for a total of 8.2 fluid ounces per acre per year. Apply a minimum of 5 gallons of spray volume per acre.
tebuconazole + trifloxystrobin ABSOLUTE MAX ABSOLUTE 500 SC	5.0 fl.oz.	For control of Septoria leaf and glume blotch, rust diseases, powdery mildew, and tan spot on wheat. Begin preventative applications when conditions are favorable for disease development. Single application only. Reduced rate (3 to 4 fl.oz./A) may be applied for early season disease suppression for tan spot, Septoria leaf spot, and powdery mildew. DO NOT make more than two applications of Absolute Max or another Group 11 before alternating with fungicides that are not Group 11.

Table 8. Foliar Fungicides Recommended for Control of Leaf, Stem, and Head Diseases (cont.)

Fungicide	Formulation Rate/ Acre ¹	Comments
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¹ Apply fungicides in a minimum of 5 gallons per acre for aerial applications and 5 to 15 gallons per acre for ground applications. Thorough coverage of the lower and upper leaf surface is essential for optimum disease control.

Table 9. Efficacy of Foliar Fungicides for Wheat Disease Control (Compiled by the North Central Regional Committee on Management of Small Grain Diseases (NCERA))

Fungicide	Trade Name	Powery Mildew	Tan Spot	Leaf Rust	Stem Rust	Stripe Rust	Leaf and Glume Blotch	Septoria Tritici Blotch	Head Scab
azoxystrobin	Quadris Flowable	G ¹	E	E	VG	E ²	VG	VG ³	NL
benzovindiflupyr + propiconazole + azoxystrobin	Trivapro SE	VG	VG	E	VG	E	VG	VG	NL
cyproconazole + picoxystrobin	Approach Prima SC	VG	VG	VG	–	E	VG	VG	NR
flutriafol + azoxystrobin	Topguard EQ	VG	VG	E	VG	E	NL	VG	NL
fluxapyroxad + pyraclostrobin	Priaxor Xemium	G	E	VG	G	VG	VG	VG	NL
fluxapyroxad + pyraclostrobin + propiconazole	Nexicor Xemium	VG	E	E	VG	E	VG	E	NL
Metconazole	Caramba	VG	VG	E	E	E	VG	–	G
picoxystrobin	Approach SC	G	VG	VG	VG	E ²	VG	VG ³	NL
propiconazole	Tilt 3.6 EC	VG	VG	VG	VG	VG	VG	VG	P
propiconazole + azoxystrobin	Quilt Xcel	VG	VG	E	VG	E	VG	VG	NL
prothioconazole	Proline 480 SC	–	VG	VG	VG	VG	VG	VG	G
prothioconazole + tebuconazole	Prosaro 421 SC	G	VG	E	E	E	VG	VG	NL
prothioconazole + trifloxystrobin	Delaro 325 SC	G	VG	VG	VG	VG	VG	VG	NL
prothioconazole + trifloxystrobin	Stratego YLD	G	VG	VG	VG	VG	VG	VG	NL
pydiflumetofen + propiconazole	Miravis Ace SE	VG	VG	VG	VG	VG	VG	VG	G ⁵
pyraclostrobin	Headline SC	G	E	E	G	E ²	VG	VG ³	NL
tebuconazole + trifloxystrobin	Absolute Maxx SC	G	VG	E	VG	VG	VG	VG	NL
tebuconazole	Tebuzol 3.6 F ⁴	NL	NL	E	E	E	NL	NL	F

¹ Efficacy Categories: NL = Not Labeled, NR = Not Recommended, P = Poor, F = Fair, G = Good, VG = Very Good, E = Excellent, none (–) = Insufficient data to make statement about efficacy of this product.

² Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.

³ Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.

⁴ Multiple generic products containing the same active ingredients also may be labeled in some states.

⁵ Based on application timing at the beginning of anthesis.

Disease Control section prepared by **Amanda Strayer-Scherer**, *Extension Plant Pathologist*, Assistant Professor, Entomology and Plant Pathology, Auburn University.

WEED CONTROL

The major weed problems in Alabama small grains are annual ryegrass, wild garlic, and horseweed (marestail). Annual ryegrass is becoming more troublesome because of resistant biotypes to glyphosate (Group 9) and ALS-herbicides (Group 2). The weed control recommendations note which herbicides will not control ALS-resistant annual ryegrass. It is very important to start with a clean field for easier planting and to reduce competition. The use of recommended mechanical and cultural weed control practices can minimize the effect of weeds in small grain production. Shallow tillage during seedbed preparation will kill many germinating weed seeds and existing plants.

A burndown application of Gramoxone, Glyphosate, or Sharpen plus Gramoxone or Glyphosate will desiccate summer weeds to reduce competition.

Horseweed (Marestail)

Horseweed, once considered a winter annual, now germinates throughout the year. Populations throughout Alabama have been found to be resistant to glyphosate, which has been a common burndown herbicide for all crops.

For the best control of horseweed and the least amount of injury to the small grains (wheat, barley, oats, rye, and triticale), apply Sharpen at 2.0 fl. oz./A plus glyphosate (4 lb. a.i./A) at 32 fl. oz./A plus an MSO (methylated seed oil) at a minimum of 1 pt./A. (MSO-based adjuvant MUST contain at least 60% methylated seed oil).

Wild Garlic

Wild garlic, often referred to as wild onion, is a troublesome weed in small grains. Wild garlic at harvest will significantly affect the quality of the small grain and could result in dockage.

For the best control of wild garlic and the least amount of injury to the small grains (wheat, barley, triticale, and oats), apply 0.75 to 0.9 ounce Harmony SG per acre plus surfactant when wild garlic plants are less than 12 inches tall with 2 to 4 inches of new growth. Use the higher rate for severe infestations. Control is enhanced when applications are to actively growing wild garlic plants during warm temperatures. Symptoms of dying wild garlic plants (discoloration and collapse) may not be noticeable for 2 to 5 weeks. Thorough coverage of all garlic plants is essential. Mixing with metribuzin may result in reduced control of wild garlic.

Ryegrass

Herbicide-resistant ryegrass has become very problematic in small grains. Hoelon-resistant (Group 1 - ACCase) ryegrass was the first to be identified since Hoelon (diclofop-methyl) has been used for years to control ryegrass in wheat. Now populations are becoming resistant to Osprey and PowerFlex, which is in the ALS chemistry of herbicides. In addition, glyphosate-resistant ryegrass is also becoming prevalent in Alabama. Therefore, it is extremely important that multiple modes of action be utilized in a weed management plan. Starting clean at planting with a good burndown program for conservation tillage or with a clean, prepared seedbed in conventional small grains will be most important.

Apply glyphosate 10 days before planting. Follow with gramoxone at planting if needed. After planting when 80% of the seed have germinated but prior to ryegrass emergence, apply Zidua 0.7 to 2.0 oz./A (see label for specific rate for soil type and timing). This is a delayed preemergence timing. In areas where ACCase-resistant ryegrass is NOT present, apply Axial XL at 16.4 fl. oz./A Osprey at 4.75 oz./A or Powerflex HL at 2 oz./A may be applied from 2-leaf through jointing if ALS-resistance is not present. Be sure to add the appropriate adjuvant. *Do not mix any ryegrass herbicide(s) with 2,4-D, MCPA, or Nitrogen!*

The following growth stages of small grains are ranked in order from the most tolerant stages to the most susceptible stages.

1. Soft dough to maturity.
2. Fully tillered to jointing (five or more leaves per plant; each plant 5 to 8 inches tall).
3. Jointing through flowering.
4. Germination to the four-leaf stage.

Final Remarks about Herbicide Use

If herbicides are used properly, they will effectively control most weeds in small grains. If they are used incorrectly, they will injure small grains. Herbicides should be used along with good tillage practices for best weed control. The following precautions should be observed when using any herbicide:

1. Choose the right herbicide for the specific weed problem that exists in the small grain crop.
2. Read the label and follow the directions. The label specifies the correct use rate of the herbicide for maximum benefit and minimum injury.
3. If winter grazing is planned, be sure to note the grazing restrictions given for the herbicide selected.
4. Be sure that the growth stage of the small grain is right for the use of the herbicide.
5. Pick a warm day, if possible, to apply the herbicide. Weeds are easier to kill when the temperature is 60 degrees F or above.
6. Use enough carrier with the herbicide to get good coverage, and spray when the wind is low for proper herbicide placement.
7. Calibrate the equipment carefully to apply the herbicides accurately.

Table 10. Small Grains Weed Control Recommendations

Herbicide Trade Name	Herbicide Common Name	REI/PHI (Hours or Days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Crops	Comments
			Formulation	Active Ingredient					
BURNDOWN/PREPLANT/PREEMERGENCE									
FIERCE EZ	flumioxazin + pyroxasulfone	12 hr./60 d.	6 fl. oz.	0.14 lb.	14 & 15	Apply no sooner than 14 days prior to planting	Annual ryegrass and wild radish, along with other small-seeded broadleaves and annual grasses	Wheat	Use only on no-till or minimum tillage fields. Wheat must be planted at least 1-inch deep. Burndown tank-mix partners must be added to control emerged weeds.
FIRSTSHOT SG	thifensulfuron-methyl + tribenuron-methyl	12 hr./N/A	0.5–0.8 oz.	0.06–0.1 lb.	2	Apply as a burndown treatment to control emerged weeds prior to planting.	Broadleaf weeds	Wheat, barley, triticale, oats	The addition of nonselective products such as glyphosate or paraquat may be necessary for increased control of emerged weeds especially when applying less than 0.8 oz/A Firstshot. Sequential treatments are allowed but should be at least 30 days apart, and the total should not exceed 1.0 oz/A per year.
GRAMOXONE SL	paraquat	12 hr./N/A	2–4 pt.	0.5–1.0 lb.	22	Apply before crop emerges when weeds are actively growing and 1 to 6 inches in height.	Annual broadleaf weeds and grasses	Wheat, barley	Apply in a minimum of 5 gallons of spray solution per acre. Use a non-ionic surfactant or crop oil concentrate/methylated seed oil. Complete coverage is essential for good weed desiccation. See label for specific application instructions.
VARIOUS	glyphosate	4 hr./N/A	24–36 fl. oz. (3 lb./A) 23–34 fl. oz. (3.7 lb./A) 22–32 fl. oz. (4.5 lb./A)	0.75–1.13 lb./A	9	Apply before crop emerges.	Broadleaf and grass weeds.	Wheat, barley	Adjuvant recommendations vary by glyphosate brand. See label for tank mixing partners. Tank mixes must follow the most-restrictive REI/PHIs.
SHARPEN	saflufenacil	12 hr./N/A	1–2 fl. oz.	0.022–0.045 lb.	14	Apply for burndown and/or residual control before crop emerges.	Horseweed	Wheat, barley, oats, rye, triticale	An MSO is a required adjuvant for use with this product. See label for specifics.

¹ Does not control ALS-resistant ryegrass.

Table 10. Small Grains Weed Control Recommendations (cont.)

Herbicide Trade Name	Herbicide Common Name	RE/PHI (Hours or Days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Crops	Comments
			Formulation	Active Ingredient					
DELAYED PREEMERGENCE AND EARLY POSTEMERGENCE									
ANTHEM FLEX	pyroxasulfone and carfentrazone	12 hr./7 d.	2.0–4.5 oz.	0.063–0.141 lb.	14 & 15	Apply from spiking to 4 th tiller growth stage.	Annual rye grass, henbit, common chickweed	Wheat	Make application to actively growing weeds up to 4 inches tall and rosettes less than 3 inches across. Coverage is essential. Use of an adjuvant is recommended. See label for additional requirements. Apply with water only. Use only on no-till or minimum tillage fields. Do Not apply to fields where wheat seed has been broadcast and shallow incorporated. Wheat must be planted at least 1-inch deep.
FIERCE EZ	flumioxazin + pyroxasulfone	12 hr./60 d.	3 fl. oz.	0.07 lb.	14 & 15	Early Postemergence. Apply when 95% of wheat is in the spike to 2-leaf stage of growth.	Annual ryegrass and wild radish below 1/2-inch tall.	Wheat	Apply broadcast as a Delayed Preemergence following wheat planting when 80% of germinated wheat seeds have a shoot at least 1/2-inch long until wheat spiking. See label for tank-mixing products and for additional rates according to soil texture. This herbicide WILL NOT control germinated or emerged weeds.
ZIDUA 85 WG ZIDUA SC	pyroxasulfone	12 hr./7 d.	0.7–2.0 oz. 1.25–3.25 fl.oz.	0.037–0.1 lb.	15	Apply after wheat seeds have germinated and have shoots up until the fourth tiller stage.	Italian ryegrass, annual bluegrass, small-seeded broadleaves, and annual grasses, including ACCase, ALS inhibitors, and glyphosate-resistant weeds	Wheat	Apply broadcast as a Delayed Preemergence following wheat planting when 80% of germinated wheat seeds have a shoot at least 1/2-inch long until wheat spiking. See label for tank-mixing products and for additional rates according to soil texture. This herbicide WILL NOT control germinated or emerged weeds.
POSTEMERGENCE									
AXIAL BOLD	pinoxaden + fenoxaprop-p-ethyl	48 hr./70 d.	15 fl. oz.	0.08 lb.	1	Apply postemergence to actively growing weeds, up to the pre-boot stage in wheat and prior to jointing in barley	Grass weeds.	Wheat and barley	Apply when grass weeds are small and actively growing. See label for tank mix partners. Surfactant is not required

Table 10. Small Grains Weed Control Recommendations (cont.)

Herbicide Trade Name	Herbicide Common Name	REI/PHI (Hours or Days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Crops	Comments
			Formulation	Active Ingredient					
POSTEMERGENCE (cont.)									
AXIAL XL	pinoxaden	48 hr./60 days	16.4 fl. oz.	0.054 lb	1	Apply from 2-leaf to pre-boot stage in wheat. Apply to 1-leaf to 2-tiller stage ryegrass.	Annual ryegrass, annual bluegrass	Wheat, barley	Additional surfactant is not required. See label for tank-mixing partners.
AXIOM DF	flufenacet + metribuzin	12 hr./30 d.	4–10 oz.	0.136–0.34 + 0.034–0.085 lb.	5 + 15	Apply between spiking until the 2-leaf stage.	Annual ryegrass, annual bluegrass, radish and henbit, mouseear chickweed	Wheat, triticale	DO NOT apply before wheat emerges. Axiom must be activated prior to ryegrass emergence. Plant wheat at a depth of 1 to 2 inches. Check label on cultivars NOT tolerant to Axiom, crop rotation intervals, and tank-mixing partners. DO NOT apply in tax mixtures with COCs, vegetable, or petroleum oil as crop injury may result.
CLARITY or VISION	dicamba	24 hr./7 d.	4 oz.	0.125 lb.	4	Apply immediately after winter dormancy and before jointing.	Most annual broadleaf weeds including wild garlic/onions, wild mustard, vetch, buttercup	Wheat, oats, triticale, barley	DO NOT graze treated areas or harvest for dairy feed prior to crop maturity. Proper timing and calibration are necessary to prevent delayed crop maturity and crop stunting. YIELD REDUCTION will occur when wheat. See label for tank-mixing partners and adjuvant requirements.
ET X HERBICIDE	pyraflufen-ethyl	12 hr./60 d.	0.3–0.6 fl. oz.	0.00079–0.002 lb.	14	Apply after 2-leaf stage but before the flag leaf is visible.	Cutleaf evening-primrose, wild radish, wild mustard, henbit, pepperweed	Wheat, triticale	Apply in the fall for wild radish and wild mustard. See label for tank-mixing partners and adjuvant requirements.

Table 10. Small Grains Weed Control Recommendations (cont.)

Herbicide Trade Name	Herbicide Common Name	RE/PHI (Hours or Days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Crops	Comments
			Formulation	Active Ingredient					
POSTEMERGENCE (cont.)									
HARMONY SG WITH TOTALSOL ¹	thifensulfuron-methyl	4 hr./81 d.	0.45–0.90 oz.*	0.014–0.028 lb.	2	Apply from 2-leaf but before flag leaf is visible.	Wild garlic, curly dock, most winter annual broadleaf weeds	Wheat, barley, triticale, oats	Wild garlic should be less than 12 inches tall. See label for wild radish control. Herbicidal action requires 2 to 5 weeks. Any crop may be planted 60 days after treatment. See label for tank-mixing partners and adjuvant requirements. *Rates for wheat, barley, and triticale are 0.45–0.9 oz./A. Rates for oats are 0.45–0.6 oz./A.
OSPREY ¹	mesosulfuron-methyl	4 hr./30 d.	4.75 oz.	0.013 lb.	2	From emergence through jointing. For best ryegrass control, apply on 1-leaf to 2-tiller stage ryegrass, when it is actively growing. Ryegrass normally best with fall application.	Annual ryegrass, annual bluegrass	Wheat, triticale	Osprey application must include one of these two suggested adjuvant systems: (1) high-quality MSO with 10% emulsifier or greater at a rate of 1.3 to 1.5 pints/acre (2) an NIS at 0.5% v/v plus either AMS (1.5 to 3 lbs./A.) or UAN (1 to 2 qt./A.). Osprey will only control 1- to 2-inch tall wild mustard. Apply in a minimum 10 gallons of spray solution per acre with ground equipment. Make only one application per season. See label for tank-mixing products and crop rotation intervals.
PEAK 57 WDG ¹	prosulfuron	12 hr./60 d.	0.38–0.5 oz.		2	Apply postemergence over the top to actively growing small grain crops from emergence to before the second node is detectable in stem elongation (Feeks Stage 7).	Most winter annual broadleaf weeds, wild garlic	Wheat, barley, triticale, rye, oats	Controls several winter annual weeds including wild garlic and wild mustard. See label for tank-mixing partners and crop rotation intervals (10 months for cotton, peanuts, and soybean), and adjuvant requirements. Do not make a foliar or soil application of any organophosphate insecticide within 15 days before or 10 days after an application of Peak.

Table 10. Small Grains Weed Control Recommendations (cont.)

Herbicide Trade Name	Herbicide Common Name	REI/PHI (Hours or Days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Crops	Comments
			Formulation	Active Ingredient					
POSTEMERGENCE (cont.)									
POWERFLEX HL ¹	pyroxsulam	12 hr./28 d.	2 oz.	0.016 lb.	2	Apply from the 2-leaf to 2-tiller growth stage and before broadleaf weeds are larger than 2 inches tall or 2 inches in diameter.	Annual ryegrass and many other annual grasses and broadleaf weed species	Wheat, triticale	DO NOT mix with products containing dicamba or amine formulations of 2,4-D or MCPA. DO NOT tank mix with organophosphate insecticides or apply organophosphate products for 5 days before or 5 days after application. See label for tank-mixing products and crop rotation intervals, tank cleanout, applications with liquid N fertilizer, and harvest and grazing intervals. Do not use on wheat varieties sensitive to ALS herbicides.
PROWL H2O	pendimethalin	24 hr./60 d.	1.3-3 pt.	0.7-1.4 lb.	3	Apply after the 1-leaf stage but before the flag leaf is visible. Must be applied before weed emergence.	Small-seeded broadleaf weeds and annual grasses including annual ryegrass	Wheat, triticale	Prowl H2O will not control emerged weeds. Plant wheat at least 0.5 to 1 inch deep to avoid injury. See label for tank-mixing partners and crop rotation intervals. Plant residue may inhibit weed control, so only use in prepared (tilled) seedbeds.
QUELEX ₁	haloxifen-methyl + florasulam	12 hr./60 d	0.75 oz.	0.009 lb.	2 + 4	Apply from 2 leaf to flag leaf emergence stage.	Broadleaf weeds	Wheat, barley, triticale	Quelex only controls emerged weeds. For best results, apply when weeds are actively growing in the 2 to 4 leaf stage or less than 4 inches tall. DO NOT apply more than 0.75 oz. per year.
2,4-D AMINE OR ESTER	2,4-D	48 hr./14 d.	0.5-2.5 pt.	0.25-1.25 lb.	4	Apply after grain is fully tilled, until stem elongation begins-Feekes Stages 3 to 5 (usually 4- to 8-inch-tall wheat). Check the labels for rates and application stage.	Wild mustards, buttercups, vetch, plantains, pepperweed. Poor control of henbit, wild garlic, and curly dock.	Wheat, barley, rye, oats	Apply during warm (60° F), sunny weather in early spring when grain is fully tilled and has five or more leaves, but before jointing. Usually this occurs in February. For oats, use (0.5 to 1 pt.). Do not forage or graze treated fields for 2 weeks after treatment. See label for tank-mixing partners and the rate of product selected. Oats are less tolerant of 2,4-D than wheat. Do not apply when grains are in boot to dough stage.

Table 10. Small Grains Weed Control Recommendations (cont.)

Herbicide Trade Name	Herbicide Common Name	REI/PHI (Hours or Days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Crops	Comments
			Formulation	Active Ingredient					
HARVEST AID									
2, 4-D AMINE	2,4-D	48 hr./14 d.	1 pt.	0.5 lb.	4	Apply when grain is in hard-dough stage.	Desiccation of broadleaf weeds	Wheat, barley, oats, rye	Use only the amine formulation as sensitive crops are most likely nearby. Best results will be obtained when soil moisture is adequate for plant growth and weeds are growing well. DO NOT feed treated straw. Read label carefully.
AIM	carfentrazone-ethyl	12 hr./7 d.	1–2 fl. oz.	0.016–0.031 lb.	14	Apply after grain has reached physiological maturity (30% grain moisture) and at least 3 days before harvest.	Desiccation of broadleaf weeds, such as pigweeds and morning glories	Wheat, barley, oats, triticale	Coverage is essential for good control. Use a minimum of 10 gallons of finished spray per acre for ground applications. An NIS, MSO, or COC is required. May be tank-mixed with glyphosate to improve control of grasses and other weeds.
CLARITY OR VISION	Dicamba	24 hr./7 d.	8 oz.	0.25 lb.	4	Apply when grain is in hard-dough stage and the green color is gone from the nodes of the stem.	Desiccation of broadleaf weeds.	Wheat, barley, oats, triticale	Several tank mix partners are available for wheat and barley. For oats, dicamba may be tank-mixed with MCPA amine or ester. In triticale, dicamba may be tank-mixed with bromoxynil. See label for tank mix partners for wheat and barley.
SHARPEN	saflufenacil	12 hr./3 d	1–2 fl. oz.	0.022–0.044 lb.	14	After wheat has reached 30% grain moisture and at least 3 days before harvest.	Broadleaf weeds	Wheat, barley, triticale	DO NOT apply on labeled crops grown for seed production. Thorough spray coverage is essential for satisfactory performance. Allow up to 10 days for optimum desiccation, depending on environmental conditions. Add methylated seed oil at 1% v/v plus ammonium sulfate.

Table 11. Weed Response to Small Grain Herbicides

Herbicides	2,4-D	Harmony Extra	Osprey	Axial XL	Axiom	Peak	Zidua	Powerflex HL	Anthem Flex
Site of Action Group	4	2	2	1	5 + 15	2	15	2	14 + 15
WEEDS									
Bluegrass, annual	N	N	G ¹	N	G	N	G-E	N	G-E
Buttercup	E	E		N	P-G			P	
Cheat	N	N	N		E	N	F	F	F
Chickweed, common	P	G	F-G ²	N	E		F	P	F
Corncockle	P	P		N					
Cornflower	P	P	P	N	F			N	
Cudweed	G-E	E		N					
Dandelion	E			N					
Dock, curly	F	E	P	N	P			P	
Dogfennel	G	E		N					
Downy brome	N	N		N	G	N			
Eveningprimrose, cutleaf	G-E	F	P	N		F-G		P	
Field pennycress	G	G		N					
Garlic, wild	F	G-E	P	N	P	E		F	
Geranium, Carolina	E	P		N	G			P	
Goldenrod	F			N					
Henbit/deadnettle	P	F	G-E ²	N		F-G	P-F	P	F
Horsenettle	F	P		N					
Horseweed (marestail)	G	F		N	G		F	P	F
Knawel	P	G		N					
Lambsquarters, common	G	E		N		G	F		F
Mayweed	F	E		N	F				
Mustard, wild	E	F-G	G	N	F	G	P-F		
Pepperweed, Virginia	E	G		N	E			N	
Plantains	E	E		N					
Radish, wild	E	F-G	G	N		G	P-F		
Ragweed, common	E			N	E	E	F-G		F
Ryegrass, annual	N	N	G-E	G-E	G	N	G-E	G	G-E
Shepherdspurse	G-E	E		N	P	G	F		
Swinecress	G	E	E	N					
Thistles	G	F-G		N		F-G			
Turnip, wild	G	E		N	F				
Vetch, hairy	F-G	P		N					
Vetch	G	F	P-F ²	N	P				

¹ Will not control ALS-resistant ryegrass. ² Weeds must not be larger than 2 inches at time of application.

Table 12. Herbicide Classified by Mechanism of Action

Mechanism of Action	Site of Action Group	Herbicide
Acetyl CoA Carboxylase (ACCase) inhibitor	1	Axial XL
Acetolactase Synthase ALS inhibitors	2	Harmony, Peak, Osprey, Powerflex
Enolpyruval shikimate-3-phosphase (EPSP) inhibitor	9	Roundup
Mitosis inhibitor	3	Axiom DF, Prowl, Prowl H ₂ O
Photosystem I inhibitor	22	Gramoxone
Photosystem II inhibitor	5	Axiom DF
Protoporphyrinogen osidase (PPO) inhibitor	14	Aim, ET X, Sharpen, Fierce EZ
Synthetic auxin	4	2,4-D, Clarity
Very long-chain fatty acid synthesis inhibitor	15	Zidua, Anthem Flex, Fierce EZ, Axiom DF

Weed Control section prepared by **David Russell**, *Assistant Extension Professor*, Assistant Research Professor, Crop, Soil, and Environmental Sciences, Auburn University.



FOR MORE INFORMATION on pesticides, pesticide safety, or submitting samples for analysis, see the following publications in the IPM series:

IPM 1293, "Safety." Safety contact information; worker protection standards; the safe use, handling, and storage of pesticides

IPM 1294, "Submitting Samples." Procedures for submitting samples for diagnosis, analysis, and identification

IPM 1295, "General Pesticide Information." Federal and state restricted use pesticide lists; pesticides and water quality

IPM 1317, "Appendix." Pesticide guidelines for agronomic crops, including preharvest intervals; rain-free requirements; grazing restrictions; crop rotation guidelines; and the names, classifications, and toxicities of pesticides.

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