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OHIO STATE UNIVERSITY EXTENSION

WEED CONTROL GUIDE

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OHIO, INDIANA AND ILLINOIS

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF ILLINOIS EXTENSION

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Weed Control Guide for Ohio, Indiana and Illinois

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Weed Control Principles

Importance of Weed Control

Weed control is an essential part of all crop production systems. Weeds reduce yields by competing with crops for water, nutrients, and sunlight, and may directly reduce profits by hindering harvest operations, lowering crop quality, and producing chemicals which are harmful to crop plants (allelopathy). Left uncontrolled, weeds may harbor insects and diseases and produce seed or rootstocks which infest the field and affect future crops. Despite large expenditures for weed control, it is estimated that losses in U.S. crops due to weeds left uncontrolled exceed $8 billion annually.

Years of research have shown that good weed control within the first 4 to 6 weeks after crops are planted is critical in order to avoid a yield reduction from weeds. The effectiveness of any weed control program depends largely upon one factor - timeliness**.** There are many cultural, mechanical, and chemical methods of weed control that are effective if applied at the correct time. Fields that are kept free of weeds for the first four to six weeks after planting give the crop a “head start” which enables it to shade out or otherwise out compete weeds that emerge later in the season.

Identify specific weed problems. Weed species vary greatly in their ability to compete with crops and reduce yields. Is 100% control of all weeds necessary? Perhaps this can be answered by stating that most successful producers design control programs to maximize profit, not just to control weeds. While it is true that crops are able to tolerate a certain threshold number of weeds without suffering a yield reduction, there are some weeds for which 100% control may be desirable because they are particularly competitive, persistent, or difficult to control.

Cultural and Mechanical (Non-chemical) Weed Control

Herbicide performance is strongly related to environmental conditions, so not even the best herbicides are equally effective from year to year. The most desirable weed control program is one that will economically control existing weeds and prevent a buildup of weed seed or tubers, rhizomes, etc. in the soil. Such a weed control program includes integrating several crop management practices in addition to use of herbicides.

Crop rotation is one of the most effective cultural practices for improving long-term weed control. Crop rotation aids in controlling weeds by: (1) allowing rotation of herbicides as well as crops, and (2) providing the opportunity to plant highly competitive crops that prevent weed establishment. Many herbicides available for use in corn are extremely effective at controlling weeds for which there are no adequate controls in soybeans or other crops. Rotation to a densely planted crop such as alfalfa or small grains helps control annual weeds with little, if any, chemical input. Rotating to small seeded legumes (e.g. alfalfa) or other densely grown perennial grass-legume forage mixtures is effective at reducing populations of some perennial weeds.

Any practice that promotes optimum early and vigorous crop growth helps give crops a competitive edge over weeds. The following are some of these practices:

- Narrow row spacings (15 inches or less) for soybeans
- Proper planting date and seeding rate
- Use of insect-,disease-, and nematode-resistant varieties
- Insect and disease control
- Adequate soil fertility
- Adequate drainage

The following are several other preventative cultural practices that help prevent weeds from becoming established and spreading:

- Control weeds in noncropland areas, including fencerows, drainage ditch banks, and rights-of-way
- Plant only high quality weed-free crop seed
- Do not spread manure, hay, or crop residues contaminated with weed seed on cropland
- Clean farm machinery between fields to avoid transport of weed seed, rhizomes, tubers, and rootstocks
- If “new” or unfamiliar weeds appear, have them identified quickly and take appropriate control measures

Mechanical weed control is still an important component of many weed control programs. Primary tillage involves moldboard plowing or some type of reduced tillage that destroys existing vegetation and allows adequate seedbed preparations. Secondary tillage is performed with a tandem disk, field cultivator, or similar implement for final seedbed preparation. Selective cultivation is performed with a rotary hoe, rolling cultivator, shovel (sweep) cultivator, or similar implement to control weeds after the crop has emerged from the soil.

If selective cultivation is used, it should be done early. Rotary hoes operated at a relatively high speed (7 to 10 mph) on fairly dry soil are effective for controlling small weeds (less than 1 inch tall). For maximum effec-

tiveness, a rotary hoe should be used when weeds are in the “white stage”, or just emerging from the soil. Cultivation with a shovel, sweep, or rolling cultivator is more effective than a rotary hoe on larger weeds, but should still be operated when weeds are very small. Cultivations should be shallow (1 to 2 inches deep) to prevent excessive root damage to the crop, depletion of soil moisture, or excessive ridging, which creates problems at harvest for some crops.

Conventional tillage systems involve primary and secondary tillage. These operations may be followed by selective cultivation, depending on the crop and its row spacing. Conventional tillage is effective for reducing populations of many biennial and perennial weeds that may may arise from rhizomes or rootstocks. Annual weeds that reproduce only from seed will most likely still be a problem and require additional controls.

Conservation or reduced tillage systems do not involve moldboard plowing, and maintain some previous crop residue on the soil surface. Tillage in a reduced tillage system consists of using a disk, field cultivator, or chisel plow and may be the last operation before planting. **No-till crop production** involves no primary or secondary tillage. The crop is planted directly into a sod or the previous year’s crop residue. Conservation tillage systems generally rely more heavily on chemical weed control than conventional tillage systems. For additional details on reduced tillage systems, refer to other sections of this chapter.

Chemical Control of Weeds

When designing a weed control program based on herbicide use, consider soil type, tillage practices, crops (current and following), weed problems, and overall farming operations. It is important to select herbicides based on the weeds known to be present in a field. Herbicides are often combined to control a broader spectrum of weed species, reduce carryover, or reduce crop injury. Herbicide activity is affected by the weather, soil conditions, weed size, accuracy of application, and other factors.

While research has shown that weeds will not reduce crop yields if controlled within 4 to 6 weeks after emergence, preplant and preemergence herbicides have the advantage of eliminating weeds before they reach this threshold. Postemergence herbicides are comparable to soil-applied herbicides in effectiveness and economics if applied within the same threshold period. Some weeds are better controlled by soil-applied herbicides, while others are more susceptible to postemergence herbicides. Consider using a program consisting of preemergence and postemergence herbicides for maximum weed control and protection of crop yield.

Herbicide Nomenclature and Formulations

There is often more than one formulation of a particular herbicide. This can make selection and application of various products somewhat confusing. Each herbicide has at least one trade name, a common name, and a chemical name. For example, Lasso and Intrro are registered trade names, alachlor is the common name, and 2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl) acetamide is the chemical name for a herbicide used in corn and soybeans.

Prepackaged mixtures contain two or more different herbicides. For example, Bicep II Magum/Cinch ATZ (trade names for the same product) is actually a mixture of s-metolachlor and atrazine. For this reason it is important to know common names of herbicides so that one knows exactly what a product contains.

Herbicides are sold in various liquid or solid formulations, depending upon (1) the solubility of the active ingredient in water, and (2) the manner in which the product is applied (i.e. dispersed in water or applied in the dry form). The formulation type is listed on the herbicide label and may be designated by a letter or letters following the trade name. A herbicide label must also give a list of all herbicideally active ingredients and the amount of active ingredient contained in the product. For liquid formulations, the amount of active ingredient is expressed both as a percentage of the total ingredients and as the amount of active ingredients ins in a gallon of product. Active ingredients contained in dry formulations are expressed only as a percentage by weight. Several formulations and abbreviations are listed below.

Emulsifiable concentrate (E or EC) - a liquid formulation containing various emulsifiers that aid in dispersing the active ingredient in water.

Water Soluble (S, AS, or WS) - usually a liquid formulation containing the active ingredient, water, and sometimes a surfactant and an antifreeze agent.

Oil Soluble (OS) - a liquid formulation containing the active ingredient dissolved in oil or some other organic solvent. These herbicides must be applied in an oil-based carrier such as diesel fuel or kerosene.

Liquid Flowable (F or LF) - a thick liquid with a slurry-like consistency containing the active ingredient, water, and stabilizers to help the active ingredient stay in suspension. Spray tank agitation is necessary to keep the product from settling out of the spray solution.

Suspension Concentrate (SC) - similar to Liquid Flowable.

Wettable Powder (W or WP) - a dry powder containing the active ingredient, a diluent or carrier (usually bentonite or attapulgite clay), and surfactants. Spray tank agitation is necessary to keep the product from settling out of the spray solution.

Dry Flowable (DF) - a dry herbicide-impregnated granules that easily disperses in water. Dry flowables are easier to handle and measure than wettable powders. Spray tank agitation is necessary to avoid settling.

Dispersible Granules (DG) or Water-Dispersible Granules (WDG) - a dry formulation similar to dry flowable formulations. The ingredients are in granules that easily disperse in water. Spray tank agitation is necessary to avoid settling.

Granules (G) - a dry formulation consisting of the active ingredient coating or adhered to some type of inert granule such as clay, vermiculite, or sand. These formulations are applied as a ready-to-use product. Granular application equipment is required.

Pellets (P) - a dry formulation of active ingredient coating or adhered to some type of inert pelleted material - similar to granules only much larger. Pellets are applied directly to the target area by hand or with spreaders.

Herbicide rates are sometimes expressed on an active ingredient basis in technical publications. To convert pounds of active material to pounds of a commercial dry formulation use:

Pounds of commercial product/A =
Pounds of active ingredient/A
Percent Active Ingredient in Product

To convert pounds of active material to gallons of a commercial liquid formulation use:

Gallons of commercial product/A =
Pounds of Active Ingredient/A
Pounds of Active Ingredient in Gallon

Soil-Applied Herbicides

Soil-applied herbicides can be applied preplant (or early preplant), preplant incorporated, or preemergence to the crop. The activity of these herbicides is affected by soil texture, organic matter content, pH, moisture, and tillage. Soil-applied herbicides are more readily available for plant uptake in coarse-textured, low organic matter soils than in fine-textured, high organic matter soils. Selection of the appropriate herbicide rate is often important to avoid injury. Many herbicide labels specify application rates based on soil texture and organic matter content. Some herbicides are not labeled for use in sandy soils low in organic matter.

Soil pH can influence the activity of herbicides. Triazine herbicides are more available for plant uptake in soils with high pH, resulting in better weed control but increased risk of crop injury. The low pH resulting from continuous no-tillage or lack of lime application may reduce the availability of some herbicides, causing less effective weed control. In general, herbicides are most effective when soil pH is in the range recommended for optimum crop growth.

Soil-applied herbicides require adequate soil moisture for activity since uptake into germinating weeds occurs from the soil solution only. In the presence of adequate soil moisture, less herbicide is adsorbed onto the soil and more is available in the soil solution for weed control. Under dry conditions, herbicide is tightly adsorbed by soil colloids, and insufficient amounts may be available to provide acceptable weed control. Soil-applied herbicides require rainfall (usually 1/2 inch or more) to move them from the soil surface into the zone where weed seed germinate and emerge.

Early preplant herbicides are applied to the soil surface from a few weeks to more than a month prior to planting. Herbicides with a long residual soil activity can be applied early preplant. Herbicides with a shorter soil residual activity may not provide late season control when applied early. Early preplant herbicide programs frequently do not provide adequate season-long annual grass control in fields with moderate to high grass populations.

Advantages

- Allows more time for rainfall to move herbicides from the soil surface into the zone where weed seeds germinate.
- Herbicides can be applied with fertilizer, eliminating field trips.
- Reduces workload at planting time.
- Prevents the emergence of annual weeds and eliminates the need for a burndown herbicide application at the time of planting.
- Allows more time for herbicide degradation in the soil, reducing the risk of herbicide carryover problems.

Disadvantages

- Limits herbicide options since not all herbicides have sufficient soil residual for early application.
- May require higher rates, split applications, or subsequent postemergence applications for later season control.
- May cause soil compaction from operating application equipment when soils are wet.

Preplant incorporated herbicides are mixed into the soil prior to planting. Incorporation of some herbicides is necessary to prevent surface-loss from volatility or photodecomposition. Other herbicides are incorporated to reduce the dependence upon rainfall to move herbicide into the weed seed germination zone.

Advantages

- Reduced dependence upon rainfall to position herbicides in the soil, providing more reliable weed control than preemergence applications.
- More effective control of yellow nutsedge than with preemergence applications.
- Herbicide may be applied with fertilizer.

Disadvantages

- Incorporation may result in added tillage and fuel costs.
- Incorporation can result in soil compaction and crusting.
- Weed control can be reduced if the herbicide is diluted by incorporation that is too deep.
- Streaking of herbicides due to improper incorporation can result in erratic weed control.
- Planting operations can be slowed due to the time required for herbicide application and incorporation.

The depth and thoroughness of incorporation depend upon the type of equipment used, the depth and speed of operation, soil texture, and the amount of soil moisture. Incorporation should place the herbicide uniformly throughout the upper 1 to 2 inches of soil for best control of small-seeded annual weeds. Slightly deeper placement may improve control of certain weeds from deep-germinating seeds, especially under dry conditions. The field cultivator and tandem disk place most of the herbicide at about one-half the depth of operation, so the suggested depth of operation for these implements is 3 to 4 inches.

Thorough and uniform incorporation, especially with a tandem disk or field cultivator, requires two passes at an angle to each other. However, some of the newer combination tools can provide uniform single-pass incorporation. The effectiveness of single-pass incorporation depends upon soil condition as much as the implement. One-pass incorporation is not a good approach with less than optimum soil tilth. Incorporation into soils that are too wet can result in streaked weed control; this may be increased with one-pass as compared to two pass incorporation. High crop residue levels make one-pass incorporation difficult to achieve.

Field cultivators are frequently used for herbicide incorporation. Two passes are recommended for uniform weed control, but field cultivators can give acceptable one-pass incorporation with proper set-up and operation. They should have 3 or more rows of shanks with an effective shank spacing of no more than 8 to 9 inches. Shanks can be equipped with points or sweeps. Sweeps usually provide better incorporation, especially when soil conditions are too wet or dry for optimum soil flow and mixing. Sweeps for "C" shank cultivators should be at least as wide as the effective shank spacing. For one-pass incorporation, wider sweeps or narrower spacing with a 3- to 5- bar harrow or rolling baskets will improve uniformity of incorporation and weed control.

The recommended operating depth for the field cultivator is 3 to 4 inches with a ground speed of at least 6 miles per hour. The field cultivator must be operated in a level position. If the back shanks are lower than the front, untreated soil will be brought to the surface resulting in streaked weed control.

Tandem disk harrows invert the soil and usually place the herbicide deeper in the soil than most other incorporation tools. Tandem disks used for herbicide incorporation should have disk blade diameters of 20 inches or less and a blade spacing of 7 to 9 inches. Spherical disk blades provide better herbicide mixing than conical disk blades. The tandem disk should be operated at a depth of 3 to 4 inches with a ground speed between 4 and 6 miles per hour. The speed should be sufficient to move the soil the full width of the blade spacing. Two passes are recommended to obtain uniform incorporation with a tandem disk. A leveling device (harrow or rolling baskets) should be used behind the disk to obtain proper mixing.

Combination tools are tillage and incorporation tools that combine disk gangs, field cultivator shanks, and leveling devices. Many of these tools can handle large amounts of surface residue without clogging while still leaving considerable residue on the surface for erosion control. Combination tools may provide more uniform one-pass incorporation than a disk or field cultivator. Good soil tilth is still a prerequisite for effective one-pass incorporation. One-pass incorporation with these tools is generally no better than two passes with a disk or field cultivator.

Preemergence herbicides are applied to the soil surface after the crop is planted but before crop seedlings and weeds appear above the ground. For maximum preemergence activity, 1/2 to 1 inch of rainfall should occur within one week following application. Where this rain does not occur, a rotary hoe is recommended for control of weeds as they are emerging.

Advantages

- Planting and herbicide application may be done in one operation.
- When rainfall is adequate to move herbicide into the soil, preemergence applications can provide better weed control than preplant incorporated applications.
- Preemergence herbicides can be used in all tillage systems.

- Preemergence herbicides can be applied in liquid fertilizers.

Disadvantages

- Rainfall is required for herbicide activity
- On sandy soil, heavy rains may leach the herbicide down to the germinating crop seed and cause injury.
- Perennial and deep-germinating weeds are not as well-controlled compared to preplant incorporated applications.

Postemergence Herbicides

Postemergence herbicides are applied after the crop and weeds have emerged. Most postemergence herbicides have foliar activity only, while a few do provide foliar and soil activity.

Advantages

- Soil type does not affect herbicide activity.
- Herbicide decisions are based on a known weed species present at the time of application.
- Postemergence herbicides can be used in any tillage system.

Disadvantages

- Application timing is critical for good weed control and to avoid crop injury.
- Weed control can be reduced if environmental conditions cause weeds to be stressed at the time of application.
- Rain may prevent herbicide application at the proper crop or weed growth stage.

In order to achieve effective postemergence control, it is critical to follow label recommendations on rate and timing of applications, weed species controlled, and the use of spray additives. The rate and timing of application are based on weed size and climatic conditions. Weeds can usually be controlled with a lower application rate when they are small and tender. Larger weeds often require a higher rate or an additional herbicide or spray additive, especially if the weeds have developed under droughty conditions. Avoid applying postemergence herbicides during abnormally cool or dry weather, since weeds may not be actively growing under these conditions. Delaying application until weeds resume active growth will ensure better control. Herbicide penetration and activity are usually greater when the temperature and relative humidity are high, resulting in better weed control but possibly greater crop injury.

Many postemergence herbicides can cause crop injury. Crop size limitations are listed on product labels. Weed control can be reduced if rainfall occurs too soon after application. Postemergence herbicides labels specify an interval of anywhere between 1/2 and 8 hours between application and rainfall, depending upon the herbicide.

The use of an adjuvant such as surfactant, crop-oil concentrate, MSO, or fertilizer solution is often recommended to improve spray coverage and herbicide uptake. Weed control may be increased with the use of additives, but crop injury may be also increase. For this reason, follow label directions regarding the use of additives.

Other considerations for postemergence applications are spray volume, pressure, and nozzle selection. Translocated herbicides (those that move throughout plant) can be effective with partial foliar coverage, while contact herbicides (active only where they contact the plant) require more complete spray coverage. Foliar coverage increases as spray volume and pressure increase. For contact herbicides, 15 to 40 gallons per acre are often recommended for ground application. Translocated herbicides can often be applied in a minimum volume of 5 to 10 gallons per acre. Minimum spray pressures of 30 to 40 psi are recommended; this pressure range produces smaller droplets and improves penetration of dense canopies. Flat-fan nozzles are generally preferred for postemergence applications. Most labels do not recommend the use of low-pressure flooding nozzles for postemergence application.

Directed Postemergence Herbicides

Directed postemergence applications minimize crop injury because the herbicide is placed on the weeds rather than on the crop. Precise application and a height differential between the crop and the weeds are required for directed applications. If the weeds are smaller than the crop, the spray can be directed at the base of the crop so that little herbicide reaches the upper parts of the crop plant. Spray pressure should be set fairly low for this type of application to prevent fine spray particles or mist. Shielded nozzles can increase the safety of applications directed at the base of the crop plants.

"Wipers" (sponge or rope wick applicators) operate above the crop canopy to control weeds growing taller than the crop. This type of application works well for soybeans, since weeds must generally be at least a foot taller than the crop. Control of johnsongrass, hemp dogbane, and volunteer corn is often achieved using concentrated solutions of glyphosate or postemergence grass herbicides applied in this manner.

No-Tillage Weed Control

No-till production systems are more dependent upon herbicides for weed control than conventional or reduced-tillage systems. In no-till, those weeds that

emerge from the previous fall through spring must be controlled with fall-applied residual herbicides, or with foliar-applied (e.g. glyphosate, Gramoxone, 2,4-D) and/or residual herbicides applied in the spring. Spring weed populations can consist of perennials (e.g. Canada thistle, dandelion), winter annuals (e.g. mustards, pennycress, chickweed), and early-emerging summer annuals (e.g. common lambsquarters, giant ragweed, Pennsylvania smartweed). If not killed at the time of planting, these weeds often become too large to be controlled by postemergence herbicides applied about three weeks after planting, and may reduce crop yield.

Broadleaf weeds emerge earlier in the spring than grasses, and application of 2,4-D with a preplant herbicide program may provide adequate burndown where grasses are not present. Several preplant herbicides have foliar activity in addition to soil activity, which can control or help control small broadleaf weeds. These herbicides include atrazine, mesotrione (Lumax, Lexar), chlorimuron (Canopy, Valor XLT, Envive), Hornet, Balance, cloransulam (FirstRate, Surveil, Sonic, Authority First), Python, and metribuzin. Where weeds are more than few inches tall, or annual grasses are present, a burndown herbicide program using paraquat or glyphosate should be considered. Glyphosate should be applied in the spring if perennial weed such as quackgrass are present. Combinations of glyphosate or paraquat plus 2,4-D will provide more complete control of a mixed population of weeds than either herbicide alone.

Applying preplant herbicides earlier in the spring when weeds have not emerged or are very small will minimize the need for glyphosate or paraquat. Early applications, compared to application at the time of planting, allow more opportunity for herbicides to receive adequate rain and move into the upper few inches of soil, However, early applications can result in poor late-season control of some weeds, especially giant foxtail, fall panicum, and waterhemp, especially when crop growth is slow and rain is abundant in the early part of the growing season. Moving herbicide application closer to the time of planting can prevent this problem to some extent. Preemergence herbicides applied at or after planting can provide acceptable control in no-till, but more rainfall will be needed for activity compred to a conventional tillage seedbed, since herbicide must move through crop residue to reach the soil surface.

Postemergence herbicide programs fit well into no-till production systems. There can be a reduction over time in the population of large-seeded annual broadleaf weeds in no-till, possibly reducing the need for a broad-spectrum preplant herbicide program. The application of postemergence herbicides on an as-needed basis may ultimately result in a reduction in herbicide inputs and costs in no-till. Giant foxtail and waterhemp populations often increase in no-till during the first several years, but effective control will eventually reduce the foxtail population, due to a lack of seed return to the soil surface. When planning a successful postemergence herbicide program for no-till, it is essential that the field is free of weeds at planting. Do not rely on postemergence herbicides to control weeds that have already emerged at planting.

A major challenge for weed management programs in no-till is increased populations of perennial weeds, which become more prevalent and difficult to control as tillage is reduced. These can include hemp dogbane, bindweeds, milkweeds, dandelion, and tree seedlings, to name a few. Most of these emerge fairly late in the season and cannot be killed by a glyphosate application at planting. Likewise, most postemergence herbicides only suppress perennials, which are more easily controlled in corn than in soybeans. The key to controlling perennial weeds is an application of glyphosate, dicamba, and/or 2,4-D when they are in the bud to bloom stage, or as late in the fall as possible before the weeds senesce or growth ceases due to frost or freeze. At this growth stage, the weeds will move herbicide throughout the plant and into the roots, resulting in maximum kill of the entire plant. The best opportunity for making this type of application is during the late-summer through fall after wheat harvest when plants have grown undisturbed for several months. Including wheat in a rotation to allow fall herbicide applications will aid greatly in the management of perennial weeds. Throughout the rest of the rotation, apply burndown or postemergence herbicides as necessary to at least suppress perennials, since this can keep infestations in check until a fall application can be made.

Pesticide Interactions in Crops and Weeds

When crop plants and weeds are exposed to more than one pesticide, the effects may be described as: a) additive - when no interaction occurs and effects on plants are independent and predictable, b) synergistic - when the biological activity of the pesticide mixture is greater than the sum activity of its individual components, or c) antagonistic - when the biological activity of the mixture is less than the sum activity of its individual components. Interactions of pesticide combinations in crops or weeds may be due to an alteration in the uptake, translocation, or metabolism of one or more of the active ingredients. The response of crops and weeds to pesticide mixtures is highly species-dependent. A given

mixture might be synergistic in a weed while showing no adverse effects on the crop or vice-versa.

Herbicide Antagonism

When two or more herbicides are mixed together, the result can be a reduction in the activity of one of the herbicides on certain weeds. This is known as herbicide antagonism. The most common example of this is the reduction in grass control that can occur in soybeans when postemergence grass herbicides (Assure II, Fusion, etc.) are mixed with postemergence broadleaf herbicides. The degree of antagonism is dependent upon the grass species as well as the herbicides applied. Antagonism rarely is a problem when volunteer corn or shattercane is the target grass, but tends to occur to some degree for giant foxtail, and can be a severe problem when the target grass is yellow foxtail or a perennial such as johnsongrass.

While all postemergence broadleaf herbicides are capable of causing antagonism to some degree in soybeans, those most likely to do so are Pursuit, Classic, Basagran, Raptor, FirstRate, Synchrony, and thifensulfuron. Mixtures of postemergence grass herbicides with Pursuit are generally labeled for control of volunteer corn and shattercane only. Classic, Basagran, Synchrony, and thifensulfuron can be mixed with grass herbicides for control of certain grasses only (including giant foxtail), but an increased rate of the grass herbicide may be required. When grass plants are stressed and herbicide activity is reduced, the control of grass from Pursuit and Raptor can be reduced when mixed with Cobra and other contact herbicides. Herbicide labels generally indicate the grass herbicide rates required and grasses controlled when they are combined with other herbicides. Antagonism can sometimes be reduced by using different spray additives or including UAN or AMS in the spray mixture.

Antagonism between postemergence grass and broadleaf herbicides is most likely to occur when grasses are stressed due to cold or dry conditions and not actively growing. Antagonism will also tend to be more evident when grass size exceeds that indicated on the herbicide label. To minimize antagonism, apply the herbicides when grass size is well within label guidelines and make the application when conditions are favorable for active plant growth. Applying herbicides separately is the most effective method for avoiding problems with antagonism. However, antagonism may still occur when the grass herbicide is applied too soon after the broadleaf herbicide. In general, allow 7 days after the broadleaf herbicide application before applying the grass herbicide. Where the grass herbicide is applied first, the waiting period is usually only a day or so.

Herbicide - Insecticide Interactions

Herbicide-insecticide interactions are of special concern because they usually result in synergistic action and injury to crop plants. Crop injury results because some insecticides temporarily render crop plants unable to metabolize and detoxify herbicides that otherwise cause little or no injury. Application of some organophosphate corn rootworm insecticides (Thimet, Lorsban, etc.) in combination with or followed by treatment with ALS inhibitor herbicides (Accent, Beacon, Lightning, Option, Steadfast, etc.) can injure corn. Symptoms of this injury include stunting, yellowing, and a failure of the corn leaves to properly unfurl.

The severity of injury is dependent upon environmental conditions, the insecticide used, and the method of insecticide application. Injury is most likely when insecticides are applied in-furrow, rather than T-banded. Thimet is the insecticide that tends to cause the most problems, especially when applied in-furrow. Some herbicide labels prohibit application where Thimet has been or will be applied to corn, while others prohibit in-furrow application.

Most research indicates that injury from a herbicide-insecticide interaction is likely to be most severe when rain is adequate to ensure effective insecticide and herbicide uptake and activity. Some studies have shown that significant rain during the week prior to the postemergence application of an ALS inhibitor increases the severity of injury. Injury may be more likely when the corn plant is under stress from weather or a previous herbicide application. However, conditions suitable for rapid crop growth following injury will provide an opportunity for the crop to outgrow injury.

To avoid problems with herbicide-insecticide interactions, make sure the use of an insecticide is warranted based on scouting or cropping history. Pyrethroid-type insecticides (Force, for example) do not increase the risk of injury from an herbicide, and can be substituted for organophosphate insecticides where use of an insecticide is warranted. Applying an organophosphate insecticide in a T-band rather than in-furrow can minimize the risk of injury. See Tables 11 and 12 for a list of restrictions on insecticide use for ALS-inhibiting herbicides.

Herbicide Use Precautions

Herbicides, like all pesticides, should be handled with extreme care and respect in order to protect the applicator and others from poisoning, to protect the environment, and to avoid crop injury. Labels provide specific safety suggestions and requirements for handling particular products. The following are general guidelines to reduce the risks from herbicides.

- Apply herbicides only to those crops for which use has been approved.
- Clean tanks thoroughly when changing herbicides, especially when using a postemergence herbicide. Most postergence herbicide labels contain specific instructions for sprayer clean out.
- Correctly calibrate the sprayer and check the nozzle output before adding herbicide to a tank.
- Use recommended rates. Applying too much herbicide is costly, may damage crops, and is against the law. Using too little herbicide can result in poor weed control.
- Apply herbicides only as specified on the label. Observe the recommended intervals between application and livestock pasturing or crop harvesting. Observe the recommended interval between application and planting of follow crops.
- Wear goggles, rubber gloves, and other protective clothing as suggested by the label.
- Guard against drift injury to nearby susceptible plants, such as ornamental, vegetables, or other agronomic crops.
- Apply herbicide only when all animals and persons not directly involved in the application have been removed from the area. Avoid unnecessary exposure.
- Check the label for the proper method of container disposal. Triple rinse, puncture, and haul metal containers to an approved sanitary landfill. Deposit paper containers in a sanitary landfill or burn them in an approved manner.
- Promptly return unused herbicides to a safe storage space. Store them in original containers away from unauthorized persons, especially children. Keep storage areas locked.
- Formulations and labels are frequently changed and government regulations modified, so always refer to the most recent product label.

Sprayer Calibration

Proper application of herbicides helps ensure crop safety, weed control performance, and cost efficiency. For these reasons, **calibration and maintenance of spray equipment are essential.** Over-application of herbicides is costly and may result in crop injury or carryover. Under-application may result in poor weed control. Similarly, sprayers that are not well-maintained may deliver an uneven spray pattern, resulting in weedy "streaks" throughout the field.

The procedures for maintaining and calibrating spray equipment are really quite simple and consist of two major steps: (1) selection of the proper nozzle tip, and (2) calibrating the equipment to deliver the correct amount of spray.

Selecting the Proper Nozzle Tip

Many different nozzle tips are available for applying herbicides, and a number of new tips have been introduced recently that can greatly reduce spray drift. With the exception of drift concerns, almost any nozzle can be used to apply preemergence herbicides to tilled soil when control of emerged weeds is not a concern. However, nozzle selection is more of a concern for application of postemergence herbicides to emerged weeds. Nozzles that result in relatively large droplets can work well for glyphosate and other translocated herbicides, but should generally be avoided with contact herbicides. For example, two nozzles that reduce drift, the Turbo Teejet and AI (air induction) Teejet nozzle, are rated excellent for translocated herbicides but only good for contact herbicides in the Spraying Systems nozzle selection guide.

Droplet size is an important consideration when applying herbicides alone or in combination with fungicides or insecticides. The generally recommended droplet sizes: fungicides is 150 – 250 microns; insecticides, 200-300 microns; contact herbicides, 250-400 microns; and translocated herbicides, 400 microns or higher. Droplet size will influence herbicide efficacy, and the recommended ranges should be used as a guide to select the appropriate nozzle and spray pressure to maximize performance. Consult technical information from nozzle manufacturers or a professional with knowledge of spray technology for more information on proper nozzle selection and use and appropriateness of herbicide mixtures with insecticides or fungicides.

Nozzles on the spray boom should be spaced according to the equiment manufacturers' recommendations, because the correct amount of spray overlap between adjacent nozzles is critical to achieve a uniform spray pattern. For the same reason, it is important that the height of the boom and pressure be adjusted according to the manufacturers' recommendations. The pressure and size of the nozzle tip orifice determine the spray output, so nozzle tip sizes should be matched with the desired spray application rate and ground speed. Nozzle tip manufacturers have selection guides that simplify this process.

Nozzle tips are available in a variety of materials, which vary considerably in price and wear life. The most common materials are hardened stainless steel, stainless steel, thermoplastics, and ceramics. Hardened stainless steel and ceramic are the most wear-resistant materials, but also the most expensive. Stainless steel, ceramic, and hardened stainless steel tips have excel-

lent wear-resistance with abrasive or corrosive materials (e.g. wettable powders, liquid fertilizer solutions). Thermoplastic tips have shown good resistance to abrasion and corrosion, but may vary in wear life depending on the specific material used to mold the tips.

In general, flat fan or extended range flat fan nozzles give the most satisfactory performance over a wide variety of conditions. Nozzles placed on 15- to 30-inch spacings, with the height and angle adjusted to give 100% overlap, provide uniform coverage and some insurance against pattern skips in the event of a plugged nozzle or boom rocking in rough terrain. Do not angle tips more than 30 degrees from vertical as the drift potential greatly increases. For floaters and sprayers with boom heights greater than 3 feet, 80 degree flat fan tips are recommended. For lower boom heights, 110 degree tips are recommended. The 110 degree tips are needed to maintain 100% overlap at lower boom heights. For farmer application with lower boom heights and 110 degree tips, recommended nozzles types include extended range flat fan, Turbo TeeJet, air induction (AI), and Turbo Floodjet.

Formula for Nozzle Tip Selection and Calibration

A single formula may be used both for nozzle tip selection and sprayer calibration. The formula is:

$$\text{GPM (per nozzle)} = \frac{\text{GPA} \times \text{MPH} \times \text{W}}{5940}$$

Where:
GPM = required output per nozzle in gallons per minute
GPA = desired total carrier volume in gallons per acre
MPH = desired ground speed in miles per hour
W = space between nozzles in inches (or band width if making band applications)

A. Nozzle tip size (orifice) selection:

Select a nozzle that will give the required flow rate when the nozzle is operated within the recommended pressure range. Recommended carrier volumes (GPA) are specified on herbicide labels and typically range from 10 to 40 gallons per acre. Ground speed (MPH) should be accurately determined, since speedometers on many tractors are unreliable.

B. Measuring ground speed:

Mark off a distance of 200 feet in the field to be sprayed or in a field with similar surface conditions. At the engine throttle speed (rpm) and gear to be used for actual spraying, determine the time required to travel the 200 feet. Use the table below to determine actual speed in MPH.

Time (seconds) required to travel 200 feet	Speed in MPH
45	3.0
39	3.5
34	4.0
30	4.5
27	5.0
23	6.0
19	7.0
18	7.5
17	8.0
15	9.0
14	10.0

C. Calibrating the sprayer

Install the selected nozzle tips in the sprayer. Using only water in the tank, turn the sprayer on and collect the output from a single nozzle for one minute in a container marked in ounces. The number of ounces collected in one minute can be converted to GPM by dividing by 128 (1 gallon = 128 ounces). If the GPM collected from the nozzle is below that required by the above formula, then increase the spray pressure. Decrease pressure if the output is too large. Check each nozzle separately for the correct output. Ideally, they should all be within 5% of the correct output.

Maintaining Spray Equipment

Check nozzle flow rates frequently and adjust the pressure to compensate for small changes in nozzle output resulting from normal wear. It is also important to recalibrate each time a different material is applied - for example, when changing from application of a wettable powder to a soluble liquid product, or from a water carrier to liquid fertilizer. Since each of these spray mixtures have different densities, actual flow rates can be quite different at a single pressure setting. Replace nozzle tips and recalibrate when output has changed 10% or more from that of new nozzle tips or when the spray pattern becomes uneven.

Cleaning Spray Equipment

Clean sprayers immediately after use. Most herbicides will injure crops other than those for which they are labeled, and small quantities of herbicides remaining in the sprayer from a previous application can cause extensive damage to the next field sprayed. The amount of these products in the spray lines, filters, sumps, tank, or screens can be sufficient to injure nonlabeled crops even when diluted by refilling the tank. Sprayer con-

tamination can be more of a problem with plastic or poly spray tanks, compared to stainless steel, since small amounts of some herbicides can adhere to the plastic. These herbicides can then be released from the tank walls when UAN or solvent-based herbicides are used in subsequent applications.

Use of water alone is usually not sufficient to adequately clean spray tanks, especially for glyphosate, growth regulator herbicides, or many low-rate translocated herbicides. Labels for these products generally recommend use of household ammonia or a commercial tank cleaner. The labels of postemergence herbicides contain specific instructions on clean out procedures for a specific product. A publication titled "Cleaning Field Sprayers to Avoid Crop Injury" (Publication G4852) contains a concise summary of the cleanout procedures for most products, and is available on the web at http://muextension.missouri.edu/xplor/aguides/crops/g04852.htm.

The following is an example of a thorough sprayer cleanup procedure:

1. Drain sprayer and spray tank completely from the lowest point.
2. Thoroughly hose down the interior surfaces of the tank. Flush the tank, boom, and hoses with clean water for a minimum of 5 minutes.
3. Partially fill the tank with water and add household ammonia (one gallon per 100 gallons of water) or a commercial tank cleaner (follow label directions). Completely fill the tank with water, then flush the cleaning solution through the boom, hoses, and nozzles, and drain the system from the lowest point again. Then go to 4a or 4b.

4a. When spraying crops that are relatively tolerant to the product used in the previous load, add water to completely fill the tank again, and allow to agitate or recirculate for at least 15 minutes. Flush the boom, hoses, and nozzles again, and drain the system from the lowest point.

4b. If growth regulators were used and sensitive crops will be sprayed next, add more water and ammonia to the spray tank, agitate or recirculate, flush a portion of the solution through the booms, hoses and nozzles, and let the solution sit in the sprayer overnight.

5. Remove the nozzles and screen, and clean separately in a bucket containing water and the cleaning agent.
6. Thoroughly rinse the tank with clean water for a minimum of 5 minutes, flushing water through the boom and hoses. This procedure may need to be preceded by a pressure wash or steam cleaning of the tank to help remove caked deposits. To prepare spray equipment for storage over the winter, disconnect all hoses and allow the water to drain out. Coat bare metal parts with oil or a rust inhibitor. Disassemble metal nozzles and store in oil. Prepare the spray pump for storage based on the manufacturer's recommendations.

Spray Adjuvants

(adapted from NDSU weed control guide)

Surfactants (nonionic surfactants = NIS) are used at a rate of 1 to 4 qt/100 gal of spray solution (0.25 to 1% v/v) regardless of spray volume. NIS rate depends on the amount of active ingredient in the formulation, plant species, and herbicides applied. The main function of an NIS is to increase spray droplet retention, but it may, to a lesser degree, enhance herbicide absorption. When a range of surfactant rates is given, the high rate is for use with low herbicide rates, drought stress and tolerant weeds, or when the surfactant contains less than 90% active ingredient. Surfactants vary widely in chemical composition and in their effect on spray droplet retention, herbicide deposition, and absorption. Silicone-based surfactants are most commonly known for "super spreading" characteristics, which may or may not provide a benefit for herbicide activity compared to traditional NIS products. Too much spreading of the droplets on the leaf surface can actually result in faster drying times which may impede herbicide uptake.

Oil concentrates generally are used at 2 pts/A or 1 gal/100 gal of spray solution, depending upon herbicide and adjuvant label. Oil adjuvants, which increase spray retention and herbicide adsorption, are petroleum (PO) or methylated vegetable or seed oils (MSO) plus an emulsifier for dispersion in water. The emulsifier, the oil class (petroleum, vegetable, etc.), and the specific type of oil in a class all influence effectiveness of an oil adjuvant. Oil adjuvants enhance POST herbicide effectiveness to a greater extent than NIS. They ared are effective with all POST herbicides except glufosinate, and can antagonize glyphosate activity. Note – we use the term COC in this guide to designate a petroleum-based oil concentrate, and MSO to designate a vegetable- or seed-oil based concentrate. MSO adjuvants generally enhance POST herbicide activity more than NIS and COC adjuvants. MSO adjuvants are more aggressive in dissolving leaf wax and cuticle resulting in faster and greater herbicide absorption. The greater herbicide activity from MSO adjuvants may be most evident in low humidity/low rainfall environments where weeds develop a thicker leaf cuticle.

University research has shown considerable differences among adjuvants with regard to enhancement of

herbicide activity. However, in many studies, differences have not occurred or were slight, depending on environmental conditions at application, growing conditions of weeds, rate of herbicide used, and size of weeds. For example, under warm, humid conditions with actively growing weeds, NIS plus nitrogen fertilizer may enhance weed control to the same degree as oil adjuvants. The following are conditions where MSO-type additives may increase weed control more than other adjuvant types:

1. Low humidity, hot weather, lack of rain, and drought-stressed weeds or weeds not actively growing due to some stress condition.
2. Weeds larger than recommended on the label.
3. Herbicides used at the low end of the recommended rate range.
4. Target weeds are somewhat tolerant to the herbicide.
5. When university data supports crop safety and improved weed control. Most herbicides, except glyphosate, glufosinate, and paraquat, have greater activity when applied with MSO type adjuvants.

Labels of many POST herbicides recommend oil adjuvants at 1% v/v. At a water volume of 15 or 20 gpa, the 1% rate provides only a minimum adjuvant concentration (1% v/v COC in 17 gpa = 1.4 pt/A). The optimum rate of a COC is generally 2 pt/A. Spray volumes of 10 gpa or lower are not uncommon, and a COC at 1% v/v in 8.5 gpa = 0.68 pt/A and does not provide an adequate amount of oil adjuvant. Some herbicide labels contain information on adjuvant rates for different spray volumes. To ensure sufficient adjuvant concentration, add the oil adjuvant at 1% v/v or higher but make sure the rate on an area basis is at least 1.25 pt/A at all spray volumes. In contrast, surfactant rates of 0.25 to 1% v/v are generally sufficient regardless of spray volume. Hard-to-wet weeds (lambsquarters) will require a higher NIS concentration and use of more effective surfactants that cause greater droplet retention on plant foliage.

High surfactant oil concentrates (HSOC) were developed to enhance lipophilic herbicides without antagonizing glyphosate. Glyphosate must sometimes be applied with other herbicides to control glyphosate- resistant weeds. Glyphosate, which is highly hydrophilic, is enhanced by NIS and nitrogen fertilizer surfactant type adjuvants and antagonized by oil adjuvants. Many POST herbicides mixed with glyphosate to increase weed control are lipophilic (e.g. clethodim, Sharpen, Laudis), and require oil adjuvants for optimum activity. HSOC adjuvants contain at least 50% w/w oil plus 25 to 50% w/w surfactant, and are PO or MSO based. The rate used is often 50% of the typical oil adjuvant rate (on an area basis). University research has shown wide variability among petroleum oil-based HSOC adjuvants, with many performing no differently than common COC adjuvants. However, MSO-based HSOC adjuvants enhance both glyphosate and the lipophilic herbicide, the latter to a greater extent than petroleum oil-based HSOC, or MSO or COC adjuvants. Apply MSO-based HSOC adjuvants at full rates on an area basis (1 to 1.5 pt/A) rather than a volume basis to provide greater herbicide enhancement and more consistent weed control.

Water pH modifiers are used to lower (acidify) spray solution pH, primarily because many insecticides and some fungicides degrade in high pH water. Most spray solutions are not high or low enough in pH to cause herbicide degradation in the spray tank. Water conditioners that reduce spray solution pH were developed from the theory that acidifying the spray solution results in greater absorption of weak-acid-type herbicides. However, low pH is not essential to optimize herbicide absorption, and many herbicides are formulated as salts, which are absorbed more readily than acid forms. Salts in the spray water may antagonize formulated salt herbicides. In theory, acid conditions would convert the herbicide to an acid and overcome salt antagonism. However, herbicides in the acid form are less water soluble than in salt form. An acid herbicide with pH modifiers may precipitate and plug nozzles when solubility is exceeded, such as with high herbicide rates in low water volumes. Antagonism of herbicide efficacy by spray solution salts can be overcome without lowering pH by adding AMS or, for some herbicides, 28% UAN.

The ingredients of acidic AMS replacement (AAR) adjuvants include monocarbamide dihydrogensulfate (urea and sulfuric acid), and some adjuvants in this class are similar to NIS plus AMS in enhancing glyphosate and other weak acid herbicides. The sulfuric acid forms sulfate when reacting with water, which can condition water and prevent herbicide antagonism from salts in water. The conversion of urea to ammonium is slow but the ammonium formed can partially enhance herbicides. AAR adjuvants must be applied at 1% v/v or greater to achieve a similar level of herbicide enhancement as AMS.

Basic pH blend adjuvants are blends of nonionic surfactant, fertilizer, and basic pH enhancer. They are used at 1% v/v regardless of spray volume to increase spray solution pH and enhance herbicide activity. They contain a surfactant to aid in spray retention, spray deposition, and herbicide absorption, and a buffer to increase water pH. Basic pH blends adjuvants increase water pH to near pH 9, which increases water solubility of some herbicides and increases herbicide phytotoxicity. The solubility of sulfonylurea herbcides can increase from 40 fold (Harmony GT*) to 3,670 fold (UpBeet) with increased spray solution pH. The solubility of herbicides in some other chemical families also increases with high pH:

Sharpen (14), and diflufenzopyr (19), Callisto and Laudis (27-triketone), and pyrasulfatole and Impact (27-pyrazolone) (numbers represent herbicide sites of action). Research indicates that basic blend adjuvants at the 1% v/v rate will provide adequate adjuvant enhancement for spray volumes of 5 to 20 gpa. Some herbicides degrade rapidly in high pH spray solution. Cobra (diphenylether), Resource and Valor (N-phenylphthalimide), and Sharpen (pH 9) degrade within a few minutes in high pH water but are stable for several days at low pH. Optimum use of pH adjusting adjuvants requires some knowledge of herbicide chemistry or experience. Research has shown that basic pH blend adjuvants may enhance weed control similar to MSO adjuvants and can be used in situations where oil adjuvants are restricted.

Spray Carrier Water Quality

(adapted from NDSU weed control guide)

Minerals, clay, and organic matter in spray carrier water can reduce the effectiveness of herbicides. Clay particles and organic matter readily adsorb paraquat, diquat, and glyphosate. Hard water cations or micronutrients such calcium, magnesium, manganese, sodium, and iron reduce efficacy of all weak-acid herbicides. Cations antagonize glyphosate efficacy by complexing with glyphosate to form salts (e.g. glyphosate-Ca) that are not readily absorbed by plants. Antagonistic minerals can reduce the activity of most POST herbicides, including glyphosate, growth regulators (not esters), ACCase inhibitors, ALS inhibitors, HPPD inhibitors, and glufosinate. The degree of antagonism is determined by the salt concentration. At low salt levels, weed control may not decrease under normal environmental conditions, but will be more noticeable under drought conditions or when applied to partially susceptible weeds. The precise salt concentration in water that causes a visible loss in weed control is difficult to establish because weed control is influenced by other factors. Midwestern water often contains a combination of sodium, calcium, magnesium, and iron, and these cations generally are additive in the antagonism of herbicides. Calcium levels above 150 ppm and sodium bicarbonate levels above 300 ppm in spray water can reduce weed control in all situations.

Ammonium nitrogen increases effectiveness of most weak acid herbicides that are formulated as a salt. Nitrogen fertilizers should thus always be used with foliar herbicides unless prohibited by label. Ammonium ions greatly enhance herbicide absorption and phytotoxicity even in the absence of antagonistic salts in the spray carrier. However, enhancement of glyphosate and most other POST herbicides from ammonium is most pronounced when spray water contains large quantities of antagonistic cations. Herbicide enhancement by nitrogen compounds appears in most weed species but is most pronounced in species like volunteer corn and species that accumulate antagonistic salts on or in leaf tissue (lambsquarters, velvetleaf, and sunflower). AMS enhances phytotoxicity and overcomes salt antagonism for weak acid herbicides formulated as a salt, including glyphosate, growth regulators (not esters), ACCase inhibitors, ALS inhibitors, HPPD inhibitors, and Liberty. The antagonism may be overcome by increasing the glyphosate concentration relative to the cation content or by adding AMS and some water conditioners to the spray solution. Effective water conditioners include EDTA, citric acid, AMS, and some acidic AMS replacements. Of these, AMS has been the most widely adopted. When added to a spray solution, the ammonium (NH+) ion complexes with the glyphosate molecule and reduces glyphosate interaction with the hard water cations.

Most glyphosate labels specify the use of AMS at the rate of 8.5 to 17 lb/100 gal spray volume (1 to 2%). An AMS rate of 4 lb/100 gal (0.5%) is adequate to overcome most salt antagonism, but 8.5 lbs/100 gal is generally required to fully optimize herbicide activity. Use at least 1 lb/A of AMS when spray volume is more than 12 gpa. The amount of AMS needed to overcome antagonistic ions in the spray solution can be determined as follows: *Lbs AMS/100 gal = (0.002 X ppm K)+(0.005 X ppm Na)+(0.009 X ppm Ca)+(0.014 X ppm Mg)+(0.042 X ppm Fe).* This does not account for antagonistic minerals on or in the leaf tissue in species such as lambsquarters, sunflower, and velvetleaf which may require additional AMS. Use spray grade AMS to prevent nozzle plugging. Commercial liquid solutions of AMS are available and contain approximately 3.4 lbs of AMS/gallon. For 8.5 lbs of AMS/100 gallons of water, add 2.5 gallons of liquid AMS solution. Spray water sources can be tested to determine salt concentration, and the possible effects on herbicide efficacy. The analysis may report salt levels in ppm or grains. To convert from grains to ppm, multiply by 17 (Example: 10 grains calcium X 17 = 170 ppm calcium).

The addition of 28% UAN fertilizer can enhance weed control and overcome mineral antagonism for most POST herbicides, but not calcium antagonism of glyphosate. Sodium bicarbonate antagonism of Poast is overcome by 28% UAN and AMS. Use of AMS or 28% UAN does not preclude the need for an oil adjuvant with lipophilic herbicides. Generally, 4 gal of 28% UAN/100 gal of spray has been adequate. AMS and 28% UAN enhance herbicide control of most weeds even in water

without antagonistic salts. Nitrogen fertilizer/surfactant blends may enhance weed control of most herbicides formulated as a salt.

Commercial water conditioner adjuvants are typically sold in liquid form for user convenience. These are advertised to replace AMS, and thus are called AMS replacement adjuvants. They are applied at low use rates, may contain no or very little AMS, and may lower spray solution pH. Pesticide applicators often prefer the convenience of low use rate water conditioners, but performance has been inconsistent. Glyphosate plus commercial water conditioner products that include AMS at the equivalent rate of 1% w/w can provide similar control to AMS used at 1% w/w (8.5 lbs/100 gal). Commercial water conditioners that do not provide an equivalent amount of AMS are less effective when used with glyphosate, compared with AMS at 1 to 2% w/w, and are often no better than glyphosate applied alone. Keep in mind that AMS can improve herbicide activity even in the absence of hard water, since it performs a function in herbicide uptake that goes beyond eliminating problems with hard water cations.

Acidic AMS replacement (AAR) adjuvants have been developed for use with glyphosate and other weak acid herbicides. These are often claimed to enhance activity, negate affects of antagonistic salts in spray water and the antagonism from micronutrient solutions added for crop health. Most adjuvants in this class contain monocarbamide dihydrogen sulfate or AMADS (urea plus sulfuric acid), which lowers spray solution pH to 1.4 to 3. The low pH is below the pKa of postemergence herbicides, causing most herbicide molecules to be in the acid state which results in fewer molecules binding to positively charged salts. Some water conditioner adjuvants and acidic AMS replacement adjuvants (AAR) are marketed to modify spray water pH, but low pH is not required for herbicide efficacy. The type of acid or components of buffering agents and the specific herbicide all need to be considered before using pH-modifying agents.

Principles of Glyphosate Use

(adapted from NDSU weed control guide)

1. Use full rates that will kill weeds. Commercial glyphosate formulations contain 3 to 5 lbs acid equivalent (4 to 6.1 lb active ingredient) per gallon. Reduced glyphosate rates will select for both low- and high-level resistance in weed progeny. A reduced glyphosate rate may cause temporary injury symptoms allowing plants to recover, resume growth, and produce seed. Progeny from recovered plants can have a higher level of resistance and require higher herbicide rates to give the same level of control than parental plants. Surviving plants will contribute seed to the seed bank with amplified level of resistance.
2. Apply to small, actively growing annual plants. This early timing will not coincide with the preferred timing of early bud to early flower for most perennial weeds. Larger and older annual plants can be more difficult to control.
3. To optimize glyphosate phytotoxicity from sequential applications, delay the second application until new growth appears (usually 2 to 3 weeks). However, do not delay the second application until plants are large enough to be visible from a drive-by survey.
4. Delay tillage at least 1 day after treating annual weeds and 3 days after treating perennial weeds for greater weed control from increased glyphosate absorption and translocation.
5. Glyphosate has high water solubility, which causes slow absorption through waxy plant cuticles. High air humidity increases glyphosate absorption and activity by hydrating leaf cuticle. Glyphosate activity also increases when plants are growing under good soil moisture. Inversely, weed control is reduced under low humidity and when weeds are drought stressed.
6. Always add reputable surfactant (NIS) to glyphosate products that do not contain a full adjuvant load. Consider adding NIS with all glyphosate products to increase retention of spray droplets and improve control of hard-to-wet species such as lambsquarters unless prohibited by the label. Glyphosate absorption into plant tissue is slow and generally only 20 to 40% of that applied is absorbed in most weed species. When adding NIS, use: 1 qt/100 gal water to full adjuvant load glyphosate formulations; 1 to 2 qt/100 gal water to partial adjuvant formulations; and 2 to 4 qt/100 gal water v/v to glyphosate formulations with no adjuvant.
7. When mixing glyphosate with lipophilic herbicides that require the use of an oil adjuvant, use MSO-based 'high surfactant oil concentrate' (HSMOC) where possible. These adjuvants contain a higher concentration of surfactant than COC and MSO and enhance oil soluble herbicides without decreasing glyphosate activity. Most other oil adjuvants (COC) antagonize glyphosate. Most COC/petroleum based 'high surfactant oil concentrate' (HSPOC) adjuvants are inferior to HSMOC adjuvants and usually do not perform differently than common COC or petroleum oil adjuvants.
8. Apply oil adjuvants on an area basis (i.e. pt/A) rather than a volume basis (1% v/v/ or 1 qt /100 gal of water). HSMOC adjuvants are commercially recommended

at half the COC and MSO rate (0.5% v/v vs 1% v/v). HSMOC adjuvants applied at full rates and on an area basis (1 to 1.5 pt/A) rather than on a volume basis (0.5% v/v spray water) will provide greater herbicide activity enhancement and more consistent weed control. HSMOC applied on a volume basis at low gpa does not contain enough oil adjuvant to optimize glyphosate and POST herbicides.

9. Always add AMS to glyphosate. AMS can be added at any time during spray tank loading when applying glyphosate but should be added first if applying several active ingredients in the tank with glyphosate. Allow granular AMS to dissolve before application or use a liquid formulation. Glyphosate labels suggest use of AMS at 8.5 to 17 lb/100 gallons of water, but analyses of water across the U.S. show 4 to 6 lbs/100 gal of AMS are adequate to overcome most hard water. Add AMS at a minimum of 1 lb/A if using greater than 12 gpa spray volume, or 8.5 lb/100 gallons of water. The following equation can be used to calculate the amount of AMS needed to overcome antagonistic ions in the spray solution: *lbs AMS/100 gal = (0.002 X ppm K) + (0.005 X ppm Na) + (0.009 X ppm Ca) + (0.014 X ppm Mg) + (0.042 X ppm Fe).* If using adjuvants called "Water Conditioning", or "AMS Replacement" adjuvants, use only those containing at least 4 lbs of AMS/100 gallons of water at their recommended rates.
10. Applying contact herbicides (Group 10, 14, and 22) with glyphosate may result in antagonism and reduced weed control, especially of large weeds, winter-annual, biennial and perennial weeds. Contact herbicides cause rapid wilting and desiccation before the systemic glyphosate is absorbed reducing uptake and translocation within the plant. Contact herbicides may quickly kill small and susceptible weeds but regrowth of large weeds may be noticeable only a few days after application. High spray water volumes may overcome some antagonism.
11. Cold weather is a stress to plants. Generally, weed control from glyphosate applied during or after cold weather may be the same as when applied in warm weather but the end result (weed control) may take longer. However, cold weather can decrease glyphosate activity on certain weeds. Ideal temperatures for applying POST herbicides are between 65 and 85 F. Use higher rates to overcome reduced control from cold temperatures before or after application. Glyphosate applied during cold weather, to large weeds, and weeds with low-level resistance will result in reduced weed control. AMS enhances weed control and can partially overcome reduced control of stressed plants. Research shows that wide temperature fluctuations (>15 F) 1 to 2 days before and after application are more likely to reduce weed control than consistently cool or cold temperatures.
12. Excessive dew on plant foliage at application may reduce weed control by diluting the glyphosate concentration in spray droplets and negate the effect of low spray volume at application. In addition, herbicide application to leaves with a heavy dew may result in the droplets coalescing and running off the leaf. Glyphosate absorption in plants is slow which partially explains the 6 to 12 hour rainfast period. Allow a 6 to 12 hour rainfast period for all glyphosate formulations regardless of label statements. Research has consistently shown increased glyphosate activity in humid conditions when leaf cuticles are hydrated. Dew on leaves will hydrate leaf cuticles and facilitate absorption.
13. Time of day application studies show that activity of glyphosate is greatest when applied in full sunlight after 8:00 am and before 6:00 pm.
14. Use drift management techniques. Glyphosate is a non-selective, non-residual, translocated, foliar herbicide. Glyphosate can cause severe injury or death of plants intercepting even a small amount of active ingredient in down-wind spray droplet drift. Several drift reducing nozzles (e.g. turbulence chamber, air induction) can reduce drift without reducing phytotoxicity. Do not use 'thickener' drift reducing adjuvants that negatively alter the spray pattern and reduce herbicide activity.
15. Glyphosate is not volatile and does not produce fumes or vapor after application. Off-target movement of glyphosate from wind or during temperature inversions is in the form of droplets or particle drift, not volatility.
16. Glyphosate can be applied in the fall after several frosts and will result in excellent control of annual, biennial, and perennial weeds. However, plant tissue must be green or purple and leaves firmly attached to the stem to absorb and translocate the herbicide. Do not apply glyphosate to desiccated plant tissue following freezing temperatures.
17. Glyphosate is deactivated by strong adsorption to soil (including dust) and organic matter. Slow absorption allows glyphosate on the plant leaf surface to be inactivated by dust present either on the leaf surface or transported by wind. This applies also to using slough or river water for spraying. The addition of NIS or AMS will not overcome inactivation. Placing nozzles before or after wheels may reduce

inactivation from dust. Applying glyphosate perpendicular to the previous application or shifting the sprayer to one side of the previous path may also reduce inactivation by dust.

18. Do not apply glyphosate products formulated with surfactant (partial or full adjuvant formulations) to bodies of water. Surfactant components are toxic to fish and aquatic life. Only no-adjuvant formulations, such as Aquamaster, Rodeo, and some 4 lb ae/gal formulations of glyphosate can be applied to water. An aquatic-approved surfactant must be added to no-adjuvant glyphosate formulations for adequate weed control in these situations.
19. Glyphosate has been reported to inhibit manganese (Mn) uptake in plants from soil. Glyphosate is a strong nutrient chelator and can immobilize micronutrients through enzyme inhibition and reduce micronutrient efficiency. These responses have only occurred in micronutrient deficient soils and can be managed by applying micronutrients as needed based on soil test analysis and fertilizer recommendation.
20. Glyphosate does not require low spray solution pH, and efficacy is unchanged within the typical pH range for water used for herbicide application. A theory has been promoted that at low spray solution pH, glyphosate and other weak acid herbicides would be more lipophillic (nonpolar) and more readily absorbed across nonpolar plant cuticles. Some adjuvants for glyphosate formulations lower pH, but glyphosate is soluble at low pH and activity is unchanged. Adding acidifiers with the purpose of lowering the pH of spray solutions containing glyphosate is not justified. Most AMS replacement adjuvants used at the rate of 2 qt/100 gal water reduce spray solution pH, which may prevent some binding of glyphosate with antagonistic minerals in spray water. However, they do not contain sulfate to bind with cationic minerals and do not contain ammonia, which binds with glyphosate and is required for glyphosate optimization. “Acidic AMS Replacement” adjuvants contain AMADS or monocarbamide dihydrogen sulfate (urea + sulfuric acid), can reduce spray solution pH to ~2 to reduce cation antagonism, and can optimize glyphosate similar to AMS but only when applied at a minimum of 2 qt/100 gal water.
21. Potassium (K) salt formulations of glyphosate may negatively interact with dma (dimethyl amine) salt formulations of 2,4-D in the spray tank, resulting in precipitation. Factors that increase the risk of precipitation are low spray volume, cold water, and high herbicide rates. This is an example of two dissimilar salts causing physical incompatibility and the possibility of reduced weed control. Another example of negative herbicide salt interaction is grass antagonism from tank- mixing glyphosate-ipa (isopropyl amine) and 2,4-D-dma (dimethyl amine).

Compatibility of Herbicide-Fertilizer Combinations

Many soil-applied herbicides can be applied using fertilizer solution as the carrier. The compatibility of the components of these mixtures is critical, and should be tested prior to application even though product labels allow mixing. Most labels contain instructions for testing the compatibility of herbicides with fertilizer solution. Follow label directions closely when applying these combinations.

Testing for compatibility requires a glass jar and the herbicides and liquid fertilizer to be mixed. Place one pint of liquid fertilizer in the jar and add two teaspoons of the liquid herbicide. If the herbicide is a dry formulation, mix two teaspoons of herbicide with sufficient water to form a slurry, and add the slurry to the fertilizer. Cover the jar, shake well, and observe the mixture for 30 seconds. Check the mixture again after 30 minutes. If the mixture does not separate, it is compatible. Each batch of liquid fertilizer should be checked, as they vary in mixing properties. The pH and mineral content of water will also influence compatibility.

If more than one herbicide is to be mixed with water or liquid fertilizer, the herbicides should be premixed in liquid fertilizer or water and tested for compatibility by mixing appropriate proportions of all components. The combination should be thoroughly agitated before each additional herbicide is added, and a specific mixing order followed. Unless label directions state otherwise, add the herbicide to water or fertilizer in the following order:

1. wettable powders or dispersible granules,
2. flowable or aqueous liquids (solutions),
3. emulsifiable concentrates,
4. COCs.

Spray tanks should be at least half filled with the carrier before the herbicides are added. Compatibility agents are available to improve compatibility. If the mixture foams excessively, separates, or becomes syrupy, do not apply. Even if all components appear compatible, the tank mixture will require constant agitation to prevent separation or poor distribution in the tank. Be sure the entire tank mixture is agitated before spraying. Do not store tank mixtures of herbicides for long periods or

overnight without constant agitation. Best results will be obtained by applying tank mixtures promptly.

Off-Target Movement of Herbicides

Spray drift is the downwind movement of spray particles from the application site to non-target areas, some with sensitive plant species. The extent of spray drift increases as (1) the size of spray droplets decreases, (2) the height above the ground from which the droplets are released increases, and (3) wind speed increases. Drift can be minimized by following these guidelines.

- Spray when wind speed is low.
- Use the maximum nozzle orifice size without distorting spray pattern.
- Reduce spray pressure to the lowest setting without distorting spray pattern.
- Using nozzles that minimize drift, such as Air Induction, Turbo Teejet, or Flat Fan DriftGuard nozzles.
- Use drift control agents when permitted by the label.
- Follow label precautions for drift reduction measures.

Volatility and vapor drift is the tendency of an herbicide to vaporize and drift through the air as a gas. A herbicide with a high vapor pressure has a greater tendency to volatilize than one with a low vapor pressure. Application of Command is prohibited near sensitive plants because of the phytotoxicity of spray particles and vapors. Dicamba and the ester formulations of 2,4-D may vaporize at temperatures as low as 70°F and move with prevailing air currents to areas with sensitive plants, including ornamentals, soybeans, and vegetable crops. Amine formulations of 2,4-D are essentially nonvolatile. The volatility of dicamba varies with the formulation. Clarity and Status are less volatile than Banvel, but still have some potential to volatilize.

The rate of herbicide volatilization increases with increasing temperature. In the summer, temperatures at the soil surface may exceed 140°F on a clear day, greatly enhancing conditions for volatility. Vapors drift farther and over a longer period of time than do spray droplets. Changes in temperature and wind direction following application can move damaging vapors to sensitive plants. To avoid vapor drift, carefully observe label precautions when applying a volatile herbicide.

Herbicide Carryover

The length of time an herbicide remains active in the soil determines the period of weed control that can be expected through the current growing season and the potential for carryover to the following year. Although most herbicides dissipate within the same growing season in which they are applied, some herbicides persist longer than others and may be especially harmful to specific crops grown next in the rotation. The overall potential for carryover is a function of the herbicide, the accuracy of application, the rotational crop grown, and the environmental conditions following herbicide application.

Degradation of most soil-applied herbicides is the result of chemical and microbial breakdown processes. The rate of degradation increases with soil temperature, and degradation requires adequate soil moisture. Because a large portion of the herbicide is degraded in the summer and early fall following application, very dry conditions during this period will increase the potential for carryover of many herbicides.

The rotational crop is more likely to show injury symptoms from herbicide carryover if it is not tolerant to the herbicide or weakened by stress from adverse climate, disease, or nutritional deficiencies. Yield reduction from herbicide carryover injury is more likely to occur if adverse growing conditions continue throughout the growing season.

Herbicide carryover is also influenced by herbicide rate, distribution, soil type, soil pH, and timing of application. While most herbicides are safe to rotational crops when applied at normal use rates, higher rates in areas of fields where herbicides are not uniformly distributed may result in carryover problems. Poor distribution is generally the result of improper calibration, poor agitation, sprayer overlaps, or non-uniform incorporation.

Longer intervals between herbicide application and rotational crop planting allow the herbicide more time to degrade, thus reducing the risk of carryover. Delayed planting the year following application reduces the probability of injury from carryover. Where double cropping or intercropping practices are used, carryover problems may increase due to the number of crops planted within a fairly short period of time.

Herbicides are more persistent in fine-textured, high organic matter soils than in coarse-textured, low organic matter soils. The soil's adsorptive capacity for herbicide increases as organic matter and clay content increases. Because microbial and chemical degradation reactions occur mainly in the soil solution, adsorption of herbicide on soil can "protect" the herbicide from breakdown. However, adsorption also reduces the availability of herbicide for plant uptake, so increased persistence may not always result in increased carryover injury.

The persistence of some triazine (atrazine) and sulfonylurea (chlorimuron, prosulfuron) herbicides is longer at high soil pH than at low pH. The persistence of Command is longest at low pH (<5.9). Follow label

directions regarding the application of herbicides and soil pH.

The sensitivity of a crop to an herbicide affects the potential for carryover injury. Vegetable and ornamental crops are generally more sensitive to herbicide carryover than field crops. Within a specific crop, some varieties are more tolerant of a given herbicide than others. Herbicide labels contain restrictions regarding the interval that must occur between application of a herbicide and the planting of rotational crops.

Guidelines To Avoid Carryover Problems:

1. Select the appropriate herbicide rate based on soil type.
2. Calibrate the sprayer and apply herbicide accurately and uniformly.
3. If incorporating, make sure it is done thoroughly and uniformly.
4. Consider applying reduced rates of a persistent herbicide in combination with a less persistent herbicide.
5. Select herbicides based on rotation plans. Follow the recrop restrictions on herbicide labels.
6. Apply the herbicide as early as possible and delay planting of the rotational crop if carryover is suspected.

Testing for Herbicide Residues

In fields where a carryover problem is suspected, bioassays or soil tests may be performed to determine if unacceptable levels of herbicide residue are present. With a bioassay, one or more sensitive species are grown in the “suspect” soil and compared to the growth in “check” soil not treated with an herbicide. This comparison makes it possible to separate carryover injury from injury caused by plant disease, environmental stress, or lack of soil moisture. It may be necessary to bioassay soils with the plant species that will be planted in the “suspect” field. For suspected triazine carryover, a bioassay using oat plants is often effective. For sulfonylurea (e.g. Classic) and imidazolinone (e.g. Pursuit), herbicides, corn can be an effective bioassay species. These classes of herbicide chemistry inhibit corn root growth, so it is important to observe root growth when conducting a bioassay.

Samples for bioassays should be taken from the field in early to mid-spring, leaving enough time to observe the effects before making a recrop decision. The method of sampling can be critical. A group of samples mixed together may not be accurate because the resulting average will not show whether “hot spots” of high herbicide concentration exist. Where soil has been moldboard plowed, sample to the depth of tillage (about 6 inches). In no-till or where soil has been chisel plowed, herbicides remain more concentrated in the upper few inches of the soil, and samples should be taken from fairly shallow depths (about 3 inches).

Commercial laboratories will test soil samples for herbicide residues, but the procedure can be expensive. The interpretation of test results is difficult since carryover potential depends upon both the actual herbicide concentration detected and the availability of the herbicide to plants. The availability of an herbicide varies with soil texture, organic matter content, and moisture. For the triazine herbicides and others that have been used for a number of years, it is possible to estimate carryover potential from test results. For some of the newer herbicides, a lack of information in general may preclude meaningful interpretation of test results.

The following table provides a rough guideline for planting various crops based on laboratory soil test results for triazine residues.

Triazine Residue Level		“Safe” to plant
3 inch sample (no-till)	6 inch sample (moldboard plow)	
less than 0.17 ppm	less than 0.08 ppm	oats, alfalfa
0.17 to 0.35 ppm	0.08 to 0.17 ppm	soybeans
greater than 0.35 ppm	greater than 0.17	corn

Residual Herbicides and Fall Cover Crop Establishment

Recently, there has been increased interest in utilizing cover crops in Midwestern corn and soybean production systems in response to government-sponsored cost-share programs and to improve soil health. Concurrently, there also has been increased utilization of soil-residual herbicides in corn and soybean to help manage herbicide-resistant weeds, such as marestail, pigweeds, and ragweeds. Persisting residues of soil-residual herbicides can interfere with establishment of fall-seeded cover crops, and there is a lack of information with regard to the necessary rotational intervals for establishment of many cover crop species. The length of time a residual herbicide remains biologically active in the soil is influenced by soil type, soil pH, organic matter content, rainfall, and temperature, and can range from days to months. These factors will vary from field to field, so establishing definitive time intervals of residual herbicide persistence can be difficult.

Experiments designed to evaluate the impact of commonly used soil-residual herbicides on the establishment of many cover crop species have been conducted in Indiana and Ohio during recent growing seasons, and weed scientists in adjacent states have conducted similar research. As a general rule, residual herbicides that

have activity on grass weeds can interfere with the establishment of some grass cover crop species, especially smaller-seeded ryegrass species. Residual herbicides from group 2 (ALS), group 5 (triazine), group 14 (PPO), or group 27 (HPPD) can interfere with the establishment of some broadleaf cover crop species.

More specifically, research results indicate the following with regard to application of herbicides in the spring and planting of cover crops in late summer or fall:

Corn herbicides

- Pyroxasulfone (Zidua) and metolachlor (Dual, etc.) can hinder ryegrass establishment.
- Atrazine or simazine at > 1 lb will be problematic for legumes and mustards if limited precipitation occurred following application
  - < 0.75 lb/A may allow for most legume cover crops, mustards, and annual ryegrass.
  - cereal grains usually can be established following <1 lb/A atrazine
- Mesotrione (Callisto, Lumax EZ, Lexar EZ etc.), flumetsulam (Python) and clopyralid (Stinger, Hornet, SureStart II) can severely injury legumes and mustards, such as canola and forage radish.

Soybean herbicides

- Chlorimuron (Classic, Canopy, Cloak, etc.), imazethapyr (Pursuit), and fomesafen (Flexstar, Reflex etc.) can cause injury to fall-seeded legume or mustard cover crops, including forage radish. However, establishment of cereal grains generally is feasible.

Where there is a specific situation not addressed by the previous statements, a bioassay is one way to assess whether or not the remaining residual herbicide concentration could preclude cover crop establishment. To conduct a bioassay, collect soil from the area where you intend to seed the cover crop and also from an area with a similar soil type, but no herbicide residue. Plant seed of the cover crop of interest and observe growth for 3 weeks. Where the growth of plants in the untreated and treated soil appears similar, it should be possible to establish the cover. Another alternative, especially if there is insufficient time to conduct a bioassay, is to plant a cover crop mixture. Cover crop establishment may be more reliable when mixtures of grass and broadleaf species are planted. Residual herbicides may interfere with establishment of some species in the mix, but not hinder the other species. The use of mixtures may reduce the chances of complete failure due to excessive herbicide residues in the soil. It would be important, however, to know that at least one or two of the species in the mixture is tolerant to the specific herbicide(s).

Cover Crop Termination

Cover crops are unique in that most are planted primarily to reduce soil erosion and otherwise enhance soil quality, and are not harvested for their seed, fruit, or forage (although some are grazed or used as forage). Instead, cover crops are terminated before planting of summer annual grain crops such as soybeans and corn. When not effectively terminated, cover crops have the potential to become weeds in the grain crop and can slow soil drying and warming in the spring. Many cover crop species have characteristics that make them both desirable as cover crops, and troublesome as weed species. Weedy cover crop escapes not only affect the current production crop, but also can produce seeds and establish a seed bank that will result in future weed problems.

Cover crops can be terminated by a number of methods, although herbicide application is the most common method. When selecting a herbicide program for termination of a cover crop, consider:

- the cover crop species
- the cover crop growth stage
- other weed species present
- the production crop to be planted
- the weather conditions at application

Cover Crop Species. Cover crop systems that contain only grass species or only broadleaf species can be terminated using selective grass or broadleaf herbicides. However, producers will often grow combinations of grass, legumes, and non-legume broadleaf species together to receive the maximum benefits that each group presents. Successfully terminating a cover crop that contains grasses and broadleaves will require a nonselective herbicide such as glyphosate, glufosinate (Liberty®), or paraquat (Gramoxone®). It is possible to combine a **selective** grass herbicide (sethoxydim, clethodim, quizalifop, fluazifop) and **selective** broadleaf herbicide (2,4-D, dicamba) to terminate a mixed crop, but it is not advisable because many of these combinations can be antagonistic and poor control will result. Combining glyphosate with either 2,4-D or dicamba can ensure more complete termination of broadleaf species than spraying glyphosate, 2,4-D, or dicamba alone. Effective herbicide control of grasses and broadleaves varies by species. Consult a weed control guide or herbicide label to ensure the herbicide will be effective on a particular cover crop species. See species-specific recommendations below for herbicide programs for some common cover crops.

Cover Crop Growth Stage. The growth stage and height of the cover crop at the time of termination is

critical in determining what herbicide and rate will be most effective. Crops that are bolting, jointing, or producing reproductive structures can be difficult to control with herbicides and may require other termination methods. Always take cover crop heights into consideration because taller, more mature plants may require higher herbicide rates than smaller, less mature plants.

Other Weed Species Present. Before choosing a herbicide to terminate a cover crop, carefully consider all the plant species that are present — including weeds. Decide on a herbicide plan before planting or seeding the cover crop, and then amend the plan according to any additional weed species that occur.

Cash Crop to Be Planted. When planning a herbicide termination program, use only herbicides that are labeled for burndown or preplant applications with the summer annual crop you will plant. Be sure you also observe crop rotational restrictions. For example, there is a 14-day restriction when planting soybean after using high rates of 2,4-D in a cover crop termination. The rotational restrictions for corn after applications of selective grass herbicides (sethoxydim, clethodim, quizalifop, fluazifop) range from 30 to 120 days.

Weather Conditions at Application. Environmental conditions affect herbicide performance, and unfortunately these are factors that cannot be controlled or predicted. Typically, cover crop terminations take place in the early spring, so while the exact weather may vary, temperatures tend to be cool with variable cloudiness and high soil moisture. Take these typical weather conditions into account when planning an herbicide termination program — cool, cloudy conditions slow the rate at which herbicides kill plants. Wet soil can also keep sprayers out of fields, which delays spray applications and allows cover crops to reach undesirable heights and growth stages.

A wide variety of cover crop species are available and recommended for specific cropping systems, soil types, and regions. The following section provides herbicide termination recommendations for the cover crop species most commonly planted in Indiana, Ohio and Illinois.

Annual ryegrass (*Lolium multiflorum*), also called Italian ryegrass or common ryegrass, has become a very popular cover crop throughout the Midwest. Do not confuse annual ryegrass with cereal rye (*Secal cereal*). Annual ryegrass is a good cover crop because of its ability to rapidly germinate in the fall, grow aggressively in the spring, and add substantial root and forage mass to the soil profile. However, this plant's aggressive and competitive nature can also make it a weed problem in grain crops. The introduction of annual ryegrass as a cover crop in Indiana and the possibility of it escaping as a weed is a concern. Annual ryegrass has established itself as a weed in orchards, vineyards, and grain crops throughout the western and southern United States and is recognized by multiple scientific weed societies as an invasive weed species. Annual ryegrass is also able to quickly adapt to herbicide selection pressure. The International Survey of Herbicide Resistant Weeds (Heap 2015) reports herbicide-resistant annual ryegrass populations in ten states and across six herbicide sites of actions. Follow these guidelines for successful termination of annual ryegrass cover crops:

- Make applications prior to 8" plant height
- Glyphosate rates of at least 1.25 lb ae/A are required, although 2.5 lb is preferred for annual ryegrass termination
- Ryegrass must be actively growing, and it is recommended that applications occur only following three consecutive days when air temperatures have been above 45 F
- The addition of saflufenacil (Sharpen) to glyphosate can improve control of annual ryegrass
- Combinations of Gramoxone, metribuzin and 2,4-D or dicamba can control small ryegrass (<6" in height), but are not recommended for control of larger plants
- Avoid using PSII herbicides (atrazine & metribuzin) in mixtures with glyphosate, as they can cause antagonism and poor control of annual ryegrass.

Cereal rye and oats. Glyphosate at a rate of 0.75 lb ae/A will effectively control both species up to 18 inches tall. Mixtures of glyphosate plus 2,4-D, chlorimuron, chloransulam, atrazine, or saflufenacil can also be applied for additional control of other cover crop species (specifically broadleaf species) and residual control of summer annual broadleaf weeds. The nonselective herbicides Gramoxone and Liberty® are less effective than glyphosate on these species.

Crimson clover and Austrian winter peas are two popular legume species used as cover crops that typically do not winter kill and require a spring termination. Escapes and failed control of crimson clover and Austrian peas have been documented as rare, so they pose less threat as potential weed species in production crops than annual ryegrass. Information on control of these species with herbicides is limited, but cover crop guides advise that glyphosate and 2,4-D easily control crimson clover and winter peas.

More detailed information on cover crop termination can be found in the Purdue Extension Publication WS-50: "Terminating Cover Crops: Successful Cover Crop Termination with Herbicides."

Avoiding Water Contamination

Surface Water

Traces of several common herbicides have been found in some municipal water sources in Ohio, Illinois, and Indiana. Herbicides and other pesticides can reach streams, lakes, and reservoirs from treated fields when dissolved in runoff water or adsorbed onto the surface of eroded soil particles. Runoff risk is greatest when heavy rains closely follow herbicide application to fields with steep slopes. Surface water quality can be protected by reducing water runoff and soil erosion from treated fields.

Conservation tillage systems generally reduce water runoff and soil erosion compared to conventional tillage due to the crop residue remaining on the soil surface. Incorporating herbicides may reduce runoff potential by reducing the concentration of herbicide on the soil surface. Grass strips are somewhat effective in reducing herbicide runoff because they trap sediment carrying herbicides and slow runoff water, allowing more herbicide to fall out of solution. Leaving untreated grass strips next to streams and ponds will help protect water quality. Never clean or dump sprayers or dispose of empty containers near streams, ponds, or lakes due to the risk of contamination.

Some herbicide labels contain a surface water advisory stamement, indicating they may have a potential for runoff into surface water under some conditions. All products containing sulfentrazone, atrazine, isoxaflutole, flufenacet, diflufenzopyr, terbacil, mesotrione, pyroxsulam, foramsulfuron, saflufenacil, terbacil, tembotrione, and cloransulam-methyl have this advisory.

Groundwater

In Ohio, Illinois, and Indiana, the groundwater contamination from herbicides is minor compared to many other states. However, herbicide users should be aware that groundwater can become contaminated by herbicides. Most instances of groundwater contamination are due to leaching of herbicides from loading or disposal sites. The potential for groundwater contamination can be reduced through careful application, handling, and storage of herbicides.

Leaching. While the majority of herbicide applied generally remains in the top few inches of soil and degrade, a small percentage of certain herbicides can leach below the root zone to possibly contaminate shallow groundwater. This is most likely to happen in sandy soils, which have a low capacity for adsorbing herbicide. Herbicides are less likely to leach if they have low water solubility, are strongly adsorbed on soil particles, or are fairly nonpersistent. Conversely, herbicides that are high in solubility, weakly abdsorbed on soil, and very persistent are most likely to leach.

The potential for groundwater contamination can be reduced by selecting and using herbicides with low leaching potential. This is especially important where soils are sandy. Applying lower herbicide rates and reducing the total amount applied, as in banding, can lower contamination potential.

Groundwater warning statements are required on the labels of herbicides that have been detected frequently in groundwater monitoring. Most groundwater statements have a similar wording: “This product is a chemical which can travel (seep or leach) through the soil and can contaminate groundwater which may be used as drinking water. This product has been found in groundwater as a result of agricultural use. Users are advised not to apply this product where the water table (groundwater) is close to the surface and where soils are very permeable, i.e., well drained soils such as loamy sands. Your local agricultural agencies can provide further information on the type of soil in your area and the location of groundwater.”

All products containing any of the following active ingredients are labeled with a groundwater advisory statement:

acetochlor	alachlor	isoxaflutole
atrazine	metolachlor	flufenacet
cyanazine	clopyralid	diflufenzopyr
metribuzin	flumetsulam	terbacil
simazine	dimethenamid	hexazinone
sulfentrazone	cloransulam-methyl	saflufenacil
tembotrione	sulfosulfuron	halosulfufon
lactofen	tebuthiuron	

Leaching from mixing or disposal areas. High soil herbicide concentrations occur through spillage or improper disposal of herbicides in small areas. These high concentrations can overload the ability of the soil to adsorb and degrade herbicides. Leaching of herbicides from these areas is much greater than in treated fields. If sprayers are drained or cleaned out in the same place over years, concentrated sources of herbicide are created. If this activity takes place near a well, contamination risks increase, especially if the well is not properly cased allowing surface runoff to enter the well. Herbicides should be stored and mixed away from a water well.

The best method to dispose of excess spray mixture and rinsate is to use them on a crop field. The excess can sometimes be applied at low rates on a portion of

the field by increasing sprayer speed or diluting the mixture with additional water. Be careful not to exceed the total label rates for the crop, risking crop injury, carryover, or illegal applications.

Backsiphoning into wells can allow large quantities of herbicide to directly enter groundwater. This happens when the end of the water hose is allowed to extend into the spray solution when filling sprayers. If the water is shut off with the hose in the tank, the spray solution can backsiphon down the well or into the water system. To avoid backsiphoning, position the hose above the spray solution while filling and remove the hose prior to shutting off the water. Use an anti-backflow valve when drawing water from a well or pond. Inexpensive anti-backflow devices for hoses that are used to fill sprayers can be purchased from sprayer equipment dealers. A state regulation in Ohio requires an anti-backsiphoning device in certain sprayer systems.

Herbicide Resistance in Weeds

A number of crops and weeds exhibit tolerance to some herbicides by preventing their absorption and/or translocation, or by rapidly metabolizing the herbicide to a non-toxic form. These are the basic mechanisms of herbicide selectivity upon which modern herbicide use is based. Herbicide-resistant plants have biochemical differences in the site of action normally attacked by a herbicide in susceptible plants, thus leaving them unaffected by the herbicide. In weed populations throughout the world, large populations of single weed species can contain a relatively small number of biotypes that have slight genetic differences from the rest of the population. Experience since the herbicide revolution began in the 1940s indicates that some naturally occurring weed biotypes can be resistant to herbicides that are normally lethal to the majority of the population.

The phenomenon of resistance can be explained as follows. When the same herbicide or herbicides having the same site of action (for example, a photosynthesis inhibitor) are applied to an area repeatedly over time, the portion of a weed population susceptible to that herbicide is gradually depleted. This creates an opportunity for other weeds naturally resistant to that herbicide (including resistant biotypes of species normally susceptible to the herbicide) to become established. If the same herbicide or others with an identical site of action are applied on a year-to-year basis, there is no interruption of the resistant weeds' yearly reproductive cycle, and the population will continue to expand rapidly over time.

Common lambsquarters and pigweed species are examples of weeds that have developed populations resistant to the triazine herbicides. In Ohio, triazine-resistant populations are most prevalent in areas where atrazine and/or simazine have been applied annually in continuous corn-growing areas. Some wild carrot populations have developed resistance to 2,4-D in Ohio. Elsewhere in the United States, there are reports of triazine-resistant velvetleaf, triazine-resistant giant foxtail, dinitroaniline-resistant goosegrass, and ACCase resistant giant and green foxtail and johnsongrass. More recently, there is growing concern because of reports that some weed biotypes are showing resistance to the newer herbicides, especially HPPD inhibitors. The latter is of special concern because both classes of herbicides attack exactly the same site of action in plants, and evidence is growing that weeds resistant to imidazolinones may also be resistant to sulfonylureas and sulfonamides, a phenomenon known as cross-resistance. Populations of several weeds in Ohio, Illinois and Indiana have developed resistance to ALS inhibitors, including: giant and common ragweed, horseweed (marestail), waterhemp, cocklebur, Powell amaranth, smooth pigweed, and shattercane. More recently, populations of horseweed (marestail), waterhemp, palmer amaranth, and giant and common ragweed with resistance to glyphosate have been identified in Illinois, Indiana and Ohio, and some populations are resistant to both glyphosate and ALS inhibitors.

Prevention is the key to avoiding development of herbicide-resistant weed populations in agricultural land. The following management techniques help keep resistant populations from developing:

Crop rotation - Some weed problems are more easily managed in some crops than others because different control options may be available. Crop rotation also helps disrupt weed life cycles and helps prevent any single weed species from becoming firmly established.

Herbicide rotation - Herbicide rotation is generally practiced along with crop rotation, and as long as herbicides used in one crop have a different site of action from those used in other crops in the rotation, it will be more difficult for resistant populations to become established. Herbicides should also be rotated in a continuous monoculture system. Where two herbicide applications are made to a crop in the same year, avoid using herbicides with the same site of action in both applications. Be sure to understand the components of premix herbicides when planning herbicide programs.

Timely postemergence practices - In general, triazine-resistant weed populations appear to develop more rapidly in no-till cropping systems. Timely cultivation and/or postemergence herbicide application are possible control options for conventional tillage. No-till

growers have a number of postemergence herbicide options available for timely control of weed escapes. Control of escaped weeds is necessary to prevent reseeding and development of resistant weed populations.

When rotating herbicide site of action to minimize resistance problems, it is essential to know the site(s) of action for herbicide products. Site of action definitions are as follows. - the group number refers to the Weed Science Society of America approved codes for herbicide site of action, which also appear on some herbicide labels.

Group 1. ACC-ase Inhibitors (ACC). The ACC-ase inhibitors block the activity of an enzyme (Acetyl-CoA Carboxylase) involved in fatty acid biosynthesis. Group 1 herbicides are applied postemergence, and translocate within the plant.

Group 2. ALS Inhibitors (ALS). ALS (acetolactate synthase) is an enzyme involved in the synthesis of several amino acids. This enzyme is also referred to as acetohydroxy acid synthase (AHAS). Group 2 herbicides are applied preemergence and postemergence, and translocate within the plant.

Group 3. Microtubule Assembly Inhibitors (MAI). The dinitroanilines and other herbicides in this class interfere with the organization of microtubules. They prevent polymerization of the protein tubulin into microtubules. Microtubules are involved in cell division and cell wall structure. Preemergence activity only. Uptake by shoots and roots, not translocated.

Group 4. Synthetic Auxins (SA). The synthetic auxins interfere with plant growth by disrupting hormone balance and protein synthesis. The exact site of action is unclear, and it is believed these herbicides have several sites of action. Applied preemergence and postemergence, but have primarily foliar activity. Group 4 herbicides translocate within the plant.

Group 5. Photosynthesis Inhibitors Binding Site A (PS2 - A). Several classes of herbicides disrupt photosynthesis by blocking electron transfer in Photosystem II (PSII). Herbicides in Classes PS2-A, PS2-B, and PS2-C bind to the same protein in PSII, but the herbicides exhibit different binding characteristics. For example, resistance to the triazine herbicides usually is due to a modification of the binding site. This modification usually provides resistance to herbicides in class PS2-A, but not for herbicides in classes PS2-B and PS2-C. Because of this, Basagran and Buctril will control triazine resistant weeds, even though the binding site for these herbicides has been modified. Applied preemergence and postemergence, but no translocation when applied postemergence.

Group 6. Photosynthesis Inhibitors Binding Site A (PS2 - B). See Photosynthesis Inhibitors Binding Site A.

Group 7. Photosynthesis Inhibitors Binding Site A (PS2 - C). See Photosynthesis Inhibitors Binding Site A.

Group 8. Lipid Synthesis Inhibitors (LSI). The thiocarbamate herbicides inhibit lipid synthesis, but the exact site and site of action is unclear. These herbicides may have multiple sites of action. Premergence activity only.

Group 9. EPSP Inhibitors (EPSP). Glyphosate inhibits EPSP synthase (5-enolpyruvyl-shikimate-3 phosphate synthase), an enzyme involved in the production of several amino acids. Both ALS-inhibiting and EPSP-inhibiting herbicides inhibit amino acid synthesis, but their target sites affect different enzymes and they disrupt the synthesis of different amino acids. Foliar activity only, translocate within the plant.

Group 10. Glutamate Synthetase Inhibitors (GSI). Glufosinate inhibits glutamine synthetase, a key enzyme in incorporating ammonium into amino acids. Blockage of this enzyme allows a buildup of phytotoxic ammonia. Foliar activity only, not translocated.

Group 13. Carotenoid Biosynthesis Inhibitors (CBI). Clomazone inhibits the synthesis of carotenoids by inhibition of phytoene destaurase. A primary role of carotenoids is to protect chlorophyll from photo-oxidation. These herbicides are known as bleachers because sensitive plants turn white due to the loss of chlorophyll. Applied preemergence.

Group 14. PPO Inhibitors (PPO). These herbicides inhibit PPO (protoporphyrinogen oxidase). Inhibition of this enzyme results in the accumulation of Proto IX, a molecule that generates singlet oxygen. Singlet oxygen is highly reactive and disrupts membranes, resulting in rapid degeneration of plant tissues. Applied preemergence and postemergence, but not translocated (contact activity only).

Group 15. Mitosis Inhibitors (CDI). Herbicides inhibit proper cell division. The exact site of action for these herbicides is unknown, but they are believed to inhibit synthesis of very-long-chain fatty acids (VLCFAs) during cell division. There may be multiple sites of action. Applied preemergence.

Group 19. Auxin Transport Inhibitors (ATI). Herbicides inhibit the flow of natural and synthetic auxins, which are necessary for proper plant growth. The auxins become more concentrated in growing points, causing abnormal growth similar to synthetic auxin herbicides. Group 19. Applied postemergence, translocated within the plant.

Group 22. Photosytem I Inhibitors (PS1). These herbicides intercept electrons moving through Photosystem I (PSI). These electrons are then passed on to other compounds, resulting in the formation of hydrogen peroxide, which disrupts cellular integrity. Foliar activity only, not translocated (contact activity only).

Group 27. 4-HPPD Inhibitors (4-HPPD). Inhibit the enzyme 4-HPPD (4-hydroxyphenyl-pyruvate-dioxygenase), an enzyme involved in the synthesis of carotenoids (See Carotenoid Biosynthesis Inhibitors). Applied preemergence and postemergence, translocated within plant when applied postemergence.

Abbreviations in this guide

AMS	=	ammonium sulfate
COC	=	crop oil concentrate
MSO	=	methylated seed oil
NIS	=	nonionic surfactant
HSOC	=	high surfactant oil concentrate (specified as HSOB on some labels)
UAN	=	urea ammonium nitrate solution (28%, 32%)

Burndown Herbicide Programs for Corn and Soybeans

In no-till corn and soybean fields, it is essential to apply herbicides with foliar activity before crop emergence to control existing weeds. Depending upon the herbicide approach used in the field for that year, herbicides used to control weeds at planting may include glyphosate or Gramoxone, or it may be possible to rely solely on PRE herbicides with foliar activity (atrazine, Lexar/Lumax, Canopy, etc.) in combination with 2,4-D. The latter approach will be most suitable when the field is only sparsely populated with small winter annual weeds, and herbicides are applied in late March or early April. Use of herbicide combinations in burndown treatments is justified in most no-till fields, due to the variety of winter annual weeds that are present. Consider fall herbicide treatments in fields that are heavily infested with winter weeds, such as chickweed, dandelions, wild carrot, and poison hemlock.

Glyphosate (Roundup, Touchdown, Cornerstone, etc.)

Fields with quackgrass, Canada thistle, dandelion, and other cool-season perennial weeds will almost always require the use of glyphosate around the time of planting. This treatment can reduce the population of perennial weeds that reach an appropriate size by the time of application, such as quackgrass. For other perennials such as Canada thistle, the level of long-term control with glyphosate will be variable, since they may be small at the time of application. Application of glyphosate to small perennials often controls existing foliage, but regrowth occurs later in the growing crop. Cool-season perennials, legumes, and cool-season grasses are more effectively controlled with glyphosate the previous fall if crop rotation allows. Glyphosate is also effective on most annual broadleaf and grass weeds, although the addition of 2,4-D ester greatly improves control of marestail (horseweed), atriplex, giant ragweed, mustard species and some other key no-till weeds. Activity of glyphosate on established dandelion and some winter annuals can be extremely slow when applied in the spring under cool conditions, and use of fall application or alternative herbicides should be considered in fields where chickweed, purple deadnettle, and dandelion have been problematic (see later section on fall applications). Glyphosate is most effective when applied alone or with 2,4-D, in spray volumes of 10 gpa or less, and when AMS is included in the spray mix. AMS helps maintain glyphosate effectiveness in hard water, or when mixed with residual herbicides. Glyphosate activity can be reduced when mixed with certain residual herbicides (metribuzin, for example), and when applied using 28% nitrogen solution or a similar material as the spray carrier. For this reason, glyphosate labels often specify that these types of mixtures should be used only for control of small annual weeds.

2,4-D ester (Weedone, Salvo, etc.)

In many no-till fields, vegetation up until early May consists primarily of broadleaf weeds, and 2,4-D ester is an economical and effective tool for control of these weeds. 2,4-D ester is most often used in combination with other herbicides to ensure that complete control of emerged weeds is achieved. Weeds not well-controlled by other herbicides that 2,4-D helps out on include marestail, prickly lettuce, mustards, giant ragweed, and dandelion. When applied too close to soybean or corn planting, 2,4-D can potentially reduce crop stands and cause injury to new seedlings. With regard to soybeans, restrictions are as follows for most products: rates up to 0.5 lb ai/A must be applied at least 7 days before planting; rates between 0.5 and 1 lb ai/A must be applied at least 30 days before planting. Several 2,4-D ester products, including Salvo, Weedone 650, and E-99, can be applied at a rate of 1 lb ai/A up to 15 days before planting. With regard to corn, some labels suggest that 2,4-D be applied at least 7 to 14 days before planting or 3 to 5 days after planting. Other labels allow application anytime after planting. The risk of corn injury seems to be primarily when 2,4-D is applied around the time of corn planting, and application is followed by enough rain to move 2,4-D into the soil where seeds are germinating. There is also risk of injury when seed furrows fail to close completely and rain washes herbicide into the seed furrow where direct contact with seed is possible. Injury may be more severe when 2,4-D is applied with chloroacetamide herbicides, especially to corn in the spike stage.

Glufosinate (Liberty, Cheetah, Interline)

Glufosinate is a contact herbicide that can be applied preplant in no-till to control small. emerged weeds. It is most effective when applied with metribuzin and 2,4-D

ester, although 2,4-D ester is not needed for control of most annual weeds. This can be an effective alternative to combinations of glyphosate and 2,4-D ester where glyphosate-resistant marestail occurs, or when there is not enough time between application and planting to use 2,4-D ester. However, glufosinate is often most effective as a spring burndown in fields that were treated the previous fall. Glufosinate is most effective when applied under relatively warm, sunny conditions. It should be applied in a spray volume of at least 15 gpa, and this should be increased to 20 to 40 gpa in dense weed canopies. Avoid use of nozzles that result in coarse spray droplets.

Saflufenacil (Sharpen, Verdict, Optill)

Saflufencail is a contact herbicide with activity on annual broadleaf weeds, and especially marestail. Saflufenacil alone is not adequate on most weeds, so it is always applied with other burndown herbicides. A mix of glyphosate plus salflufenacil can be applied anytime before crop emergence, so it can subsititute for 2,4-D when time until planting is lacking. The higher saflufenacil rates have residual activity on broadleaf weeds also, including marestail. Saflufenacil does not contribute to control of perennial or biennial weeds or legumes. Saflufenacil should be applied with MSO in relatively high spray volumes (at least 15 gpa), and spray volume should be increased as weed density increases.

Paraquat (Gramoxone SL, Parazone)

Use of paraquat in no-till systems has declined greatly over the past decade due to reductions in the price of glyphosate and the greater versatility of glyphosate across a range of weed life cycles (perennial, biennial, etc.) and sizes. Paraquat is most effective on small annual weeds, and when combined with photosynthetic inhibitor-type residual herbicides (atrazine, metribuzin). Mixing 2,4-D ester with paraquat also results in more complete control of broadleaf weeds. Paraquat is probably most useful when rapid dessication of weeds is essential, in order to allow tillage or planting. For example, a combination of paraquat plus atrazine or metribuzin will result in more rapid death and dessication of chickweed or purple deadnettle, compared to glyphosate, when applied in the spring under cool conditions. Paraquat should not be used for control of perennial or biennial weeds, legumes, or cool-season grasses. Paraquat is most effective when applied with 2,4-D and COC in relatively high spray volumes (at least 15 gpa), and spray volume should be increased as weed density increases.

Residual herbicides with foliar activity (atrazine, Canopy, etc.)

A number of residual herbicides also have foliar activity, and will control or help control small annual weeds. Herbicides in this category include atrazine, Callisto, Balance Flexx, Corvus, Verdict, metribuzin, Canopy/Cloak, Surveil, Envive, Valor XLT, Sonic, Authority First, and Hornet. These herbicides have activity primarily on small weeds, and the spectrum of control varies by herbicide. All have activity on broadleaf weeds, but most have little or no activity on emerged grasses. The most effective strategy when using one of these herbicides, in order to minimize the need for glyphosate or paraquat, is to apply prior to early April with 2,4-D ester. If emerged grasses are present, consult the product label to make sure it will provide adequate grass control, and supplement the spray mix with glyphosate or paraquat as needed. Mixtures of residual herbicides with 2,4-D and/or paraquat should generally be applied with COC. Mixtures with glyphosate should include only AMS and possibly NIS, depending upon the glyphosate product used.

Fall herbicide treatments for winter annuals and dandelions

Fall herbicide treatments have become a fairly common practice for some no-till producers, who recognize their value for managing certain tough winter weeds and providing a weedfree seedbed in the spring. The most effective treatments based on our research include:

Any crop next spring	Glyphosate + 2,4-D Autumn/Autumn Super + glyphosate or 2,4-D Metribuzin + 2,4-D (excluding dandelions) dicamba + 2,4-D
Soybeans next spring	Canopy EX/Cloak EX/Fallout + 2,4-D Canopy/Cloak DF + 2,4-D (excluding chickweed) 2,4-D + Basis/Harrow (rate limited in areas)
Corn next spring	Simazine + 2,4-D 2,4-D + Basis/Harrow

For control of winter annual weeds, apply herbicide anytime after early October. For the most effective dandelion control, delay application until after a frost. We have applied as late as early December for control of winter annual weeds, but we generally recommend

application when dandelions are still mostly green, or by mid-November if possible. Apply glyphosate-containing treatments with AMS, and additional NIS if specified by the product label. Treatments that do not contain glyphosate should generally be applied with COC for best results.

The treatments listed should cost producers no more than about $8 to $15 per acre, excluding application costs. It is not necessary to use more expensive treatments, and we really question the value of treatments where the cost of the herbicide is more than about $12 per acre. One of the reasons for this is that the use of a fall treatment, even one with residual activity, does not guarantee that only one herbicide treatment will be required in Roundup Ready soybeans the following year. Excess money spent on fall treatments results in less money available for weed control in the crop, where it usually is greatly needed.

Our experience has been that the primary benefit of fall treatments is control of weeds that are present at the time of treatment, not residual control of weeds that emerge the following year. The primary exception to this is chlorimuron (Canopy/Cloak), which provides a longer period of residual control of more weed species than other fall-applied herbicides. An effective fall treatment usually results in a field that is mostly free of weeds until about late April, and this goes for treatments without residual as well as those with residual. In other words, in late April we cannot usually discern much difference between a fall treatment of glyphosate plus 2,4-D versus chlorimuron plus 2,4-D, even though the chlorimuron provides residual activity into the spring. However, the effect of the residual herbicide becomes much more apparent by the end of May, when its activity on summer annual weeds comes into play.

The issue here is not really control at the time of soybean planting, since any effective fall treatment results in a relatively weed-free field at the end of April. The issue is how well the residual herbicide controls weeds after planting, in order to build more flexibility into the postemergence application window. This flexibility can result in less risk of early-season yield loss from weed interference and result in a better chance of getting the postemergence herbicides applied to the right size weeds. We also look to the residual herbicide to help control several weeds that glyphosate can be somewhat variable on, such as giant ragweed and lambsquarters. It is our opinion that, if glyphosate is being managed properly, it is typically going to be extremely difficult to get by with one postemergence glyphosate application unless the residual herbicide applied in the fall provides substantial weed control into late May.

Herbicides other than chlorimuron can provide residual control of certain weeds when applied in the fall, but they tend to control fewer weed species and/or be generally less effective than chlorimuron. For example, Valor provides residual control of lambsquarters into early June, but is less effective than Canopy EX and provides very little control of giant ragweed.

Table 1. Weed Response to "Burndown" Herbicides

This table gives a general comparative rating of "burndown" herbicides used in no-till corn and/or soybean production. Under unfavorable conditions, some herbicides may not perform as well as indicated below. Under very favorable conditions, control may be better than indicated. Herbicide rate, weed size and stage of growth, and environmental conditions interact to influence herbicide performance.

Weed control rating: 9 = 90% to 100%; 8 = 80% to 90%; 7 = 70% to 80%; 6 = 60% to 70% control; and - = less than 60% control, not recommended.

Ratings are for control of existing vegetation only (not residual control). Treatments containing glyphosate should be applied with AMS (and surfactant if required by the glyphosate product label). Most other treatments should be applied with a COC or MSO (plus UAN if recommended by the label). Ratings for 2,4-D are based on a rate of 0.5 lb ae/A unless otherwise indicated - increasing the 2,4-D rate to 1.0 lb ae/A will improve control of legumes, dandelion, marestail, and some other weeds.

	Giant Foxtail	Lambsquarters	Common Ragweed	Giant Ragweed	Annual Smartweeds	Common chickweed	Mustards, Shepherd's-purse	Winter Wheat, Rye Cover	Orchardgrass/Fescue Sod	Canada Thistle	Red Clover	Alfalfa	Hairy Vetch	Marestail (group 9-R)[1]	Prickly Lettuce	Annual Bluegrass	Deadnettle, henbit	Carolina Foxtail	Dandelion	Cressleaf groundsel
Fall application																				
2,4-D (0.5 lb/1.0 lb)	-	-	-	-	-	-	9	-	-	-/6	6/8	-/7	6/8	8/9	8/9	-	-/7	-	6/7	9/9
2,4-D + dicamba	-	-	-	-	-	7	9	-	-	7	9	8	9	9	9	-	7	-	7	9
Autumn Super + glyphosate	-	-	-	-	-	9	9	-	-	-	6	-	6	9	9	9	9	9	8	9
Basis/Harrow + 2,4-D	-	-	-	-	-	9	9	-	-	6	6	-	6	9	9	9	8+	9	8	9
Chlorimuron[2] + 2,4-D	-	-	-	-	-	7	9	-	-	-	6	-	6	9	9	9	9	-	9	9
CanopyEX/CloakEX + 2,4-D	-	-	-	-	-	9	9	-	-	-	6	-	6	9	9	9	9	-	9	9
Tribenuron[3] + 2,4-D (1.0 lb)	-	-	-	-	-	9	9	-	-	6	6	-	6	9	9	-	8	-	7	9
Glyphosate	-	-	-	-	-	9	9	9	9	9	8	8	8	-	8	9	8	9	8	9
Glyphosate + 2,4-D	-	-	-	-	-	9	9	9	8	8	9	9	9	9	9	9	9	9	8	9
Glyphosate + Sharpen	-	-	-	-	-	9	9	8	8	8	7	7	7	9	9	9	8	8	7	9
Metribuzin + 2,4-D	-	-	-	-	-	7+	9	-	-	-	-	-	6	9	9	-	9	7	7	9
Simazine + 2,4-D	-	-	-	-	-	9	9	-	-	-	-	-	6	9	9	8	8+	8	7	9
Spring application																				
2,4-D (0.5 lb/1.0 lb)	NR	9	9	9	7/8	-	8/9	-	-	-	7/8	7/8	8/9	7/8	8/9	-	-/7	-	6/7	7/8
2,4-D + dicamba	NR	9	9	9	9	6	9	-	-	6	9	8	9	9	9	-	-	-	8	9
Atrazine + 2,4-D	7	9	9	9	9	8+	9	-	-	-	8	7	8	9	9	8	9	9	6	8
Atrazine + paraquat	9	9	9	9	9	9	9	8	6	-	7	-	8	9	9	9	9	9	-	9
Atrazine + Hornet/SureStart	7	9	9	9	9	8	8	-	-	8	6	6	7	8	9	8	9	9	-	8
Rimsulfuron[4] + atrazine + 2,4-D	9	9	9	9	9	9	9	-	-	-	7	7	8	9	9	8	9	9	8+	8
Chlorimuron[2] + glyphosate	9	8	9	9	9	7	8	9	-	6	7	6	6	8	8+	9	9	9	8+	9
Chlorimuron[2] + glyphosate + 2,4-D	9	9	9	9	9	7	9	9	-	6	8	8	8	9	9	9	9	9	8+	9
Cloransulam[2] + glyphosate + 2,4-D	9	9	9	9	9	7	9	9	-	6	8	8	8	9	9	9	8	9	8	9
Dicamba	NR	9	9	9	9	6	7	-	-	-	9	8	8	7	9	-	-	-	7	-
Glufosinate + atrazine or metribuzin	9	9	9	9	9	9	9	-	-	6	-	-	6	8+	9	8	9	9	8	8
Glyphosate	9	8	9	8	7	7	8	9	-	6	7	6	6	-	8	9	-	9	7	7
Glyphosate + 2,4-D	9	9	9	9	8	7	9	9	-	6	8	8	8	8+	9	9	7	9	8	9
Glyphosate + Vida	9	9	9	8	7	7	8	9	-	6	7	6	6	-	8	9	-	9	6	7
Instigate + atrazine	8	9	9	9	9	9	8	-	-	6	-	-	7	8	9	8	9	9	8+	8
Lumax/Lexar/Acuron	6	9	9	9	9	9	8	-	-	6	-	-	7	8	9	8	9	9	8+	8
Lumax/Lexar/Acuron + 2,4-D	6	9	9	9	9	9	9	-	-	6	7	7	8	9	9	8	9	9	8+	9
Metribuzin + paraquat + 2,4-D	9	9	9	9	9	9	9	7	-	-	7	7	8	8+	9	9	9	9	6	9
Saflufenacil[2] + glyphosate or glufosinate	9	9	9	9	9	8	9	8	-	6	7	6	6	9	9	9	8	9	8	8
Saflufenacil[2] + atrazine + glyphosate	9	9	9	9	9	9	9	9	-	6	7	6	8	9	9	9	9	9	8	8

[1]Ratings are for control of emerged marestail only. Marestail emerges in fall, spring, and early summer, and use of burndown plus residual herbicides in early spring results in most effective control. See "horseweed (marestail)" in the "Problem Weed" section for more information.

[2]Chlorimuron products: Canopy/Cloak DF and EX, Valor XLT, Fierce XLT, Envive, and Authority XL/MAXX. Cloransulam products: Authority First, Sonic, FirstRate, and Surveil. Saflufenacil products: Sharpen, Optill PRO, Verdict.

[3]Tribenuron products: Express, Panoflex, Nuance.

[4]Rimsulfuron products: Basis, Resolve, Harrow, Prequel, Crusher.

Table 2. Application Intervals for Early Preplant Herbicides

This table gives the time interval, in days, that herbicides and herbicide combinations can be applied before planting corn or soybeans. Herbicide rates may increase when applied early preplant; consult labels for detailed information on application rates. Soil-applied herbicides not included in this table are not labeled for early application, and should be applied close to the time of planting or as directed by the label. Fall applications are usually targeted for control of emerged winter annuals, biennials, and dandelion, and herbicides applied in fall usually provide only limited control of weeds that emerge the following spring.

Corn	Single Preplant Application in Spring	Labeled for Fall Application
Acuron	up to 28 days	No
Zidua, Anthem	up to 45 days	Yes
Acetochlor, acetochlor+atrazine, Anthem ATZ	up to 45 days	No
FulTime NXT	up to 40 days	No
SureStart/TripleFLEX/TripleFLEX II, Python, Sharpen, Verdict	up to 30 days	Yes
Atrazine, Hornet, metolachlor, metolachlor+atrazine, Expert, Outlook[1]	up to 30 days	No
Balance Flexx, Corvus, Prequel	up to 21 or 30 days[2]	No
Lumax, Lexar, Zemax, Instigate	up to 14 days	No
Metribuzin, simazine	up to 14 days	Yes
Flumioxazin, Fierce	7 to 30 days before planting	Yes
Soybeans	**Single Preplant Application in spring**	**Labeled for Fall Application**
Sharpen (burndown use), Sonic	anytime	Yes
Afforia	anytime up to 1 or 7 days before planting	Yes
Envive/Enlite, Trivence, Valor XLT/Rowel FX, Fierce/Fierce XLT, BroadAxe XC	anytime, but no later than 3 days after planting	Yes
Authority First/MTZ/Assist, Latir/Militia	up to 45 days, no later than 3 days after planting	Yes
Canopy EX/Cloak EX/Fallout[3]	at least 7 to 14 days before planting[3]	Yes
Authority XL/MAXX	up to 60 days	Yes
Torment	up to 45 days	No
Canopy/Cloak DF, pendimethalin, Zidua, Anthem	up to 45 days	Yes
Optill PRO, Sharpen (residual use), Python	up to 30 days	Yes
Boundary/Tailwind/Ledger, Intimidator, Matador, Pummel, metolachlor, Synchrony XP, Outlook[1]	up to 30 days	No
Metribuzin	up to 15 days	Yes
Prefix/Vise/Statement	up to 15 days	No
Surveil	up to 14 days	Yes
Flumioxazin	up to 14 days before, no later than 3 days after plant	Yes
Random	up to 30 days before, no later than 3 days after plant	Yes

[1]Early application of Outlook not recommended in areas where average annual rainfall exceeds 40 inches.
[2]Can be applied 30 days before planting if followed with planned postemergence treatments - otherwise it can be applied 21 days before planting.
[3]Canopy/Cloak EX rates of 2.2 oz or less should be applied at least 7 days before planting; rates of 2.2 to 3.3 oz should be applied at least 14 days before planting.

Burndown Herbicides in No-Tillage Corn and Soybeans

Herbicide	Formulation	Product Rate Range
2,4-D amine	**Various**	**0.5 - 1 lb ae/A**
2,4-D ester	**Various**	**0.5 - 1 lb aieA**
2,4-D acid	**1.74L**	**1 - 4.5 pts**

- Apply in fall or spring for control of emerged annual broadleaf weeds, including ragweeds, lambsquarters, mustard species, marestail, prickly lettuce, and dandelion. Controls or suppresses perennial broadleaf weeds and legume sods (alfalfa, clover).
- Site of action: group 4 (see pages 22-23).
- 2,4-D can be applied preplant or preemergence to corn, but labels vary with regard to specific recommendations on timing of application. Labels for some products recommend application either 7 to 14 days before planting or 3 to 5 days after planting before the corn has emerged, while others specify application any time after planting.
- Applications of 2,4-D around the time of planting can injure corn. This is more likely to occur in coarse-textured soils with low organic matter content, and when above-average rainfall and prolonged soil moisture occur within a week after planting. When applied preemeergence, 2,4-D amine or acid is more likely to injure corn than 2,4-D ester. Labels for some products do not allow preplant or preemergence use of 2,4-D on light, sandy soils. Injury may be more severe when 2,4-D is applied with chloracetamide herbicides.
- Many 2,4-D products are labeled for use in the spring prior to no-till soybean planting. Ohio State and Purdue University recommend the use of only 2,4-D low-volatile ester (LVE) or similar products for this application. 2,4-D amine and acid products are more water soluble and may leach into the seed zone, and should generally be applied at least 30 days before planting. For 2,4-D LVE, rates up to 0.5 lb ae/A must be applied at least 7 days before soybean planting. Application rates of more than 0.5 lb up to 1.0 lb ae/A generally must be applied at least 30 days before planting. Several 2,4-D ester products, including E-99, Salvo, and Weedone 650, can be applied at a rate of 1.0 lb aieA up to 15 days before planting. Do not apply more than 1 lb ae/A. Only one spring application is allowed per year.
- 2,4-D is more effective than glyphosate for control of legume sods, marestail, dandelion, and prickly lettuce. For best control of alfalfa prior to corn planting, apply in combination with 1/2 pint of dicamba. If legume sods are cut prior to application of 2,4-D or 2,4-D plus dicamba, allow sufficient regrowth (4 to 6 inches) before herbicide application, or poor control may result.
- When applied at rate of 0.5 to 1 lb ae/A in the fall, 2,4-D will suppress/control mustards, marestail, purple deadnettle, and many other broadleaf weeds. Add glyphosate for effective control of common chickweed, wild carrot, poison hemlock, cressleaf groundsel, Canada thistle, dandelion, and grasses.

Herbicide	Formulation	Product Rate Range
Autumn Super	**51 WDG**	**0.3 - 0.5 oz**

- Autumn Super (iodosulfuron-methyl and thiencarbazone) can be applied in fall before corn or soybean planting, or early spring at least 30 days before corn planting, for control of winter annual weeds and dandelion. Most effective control occurs when mixed with glyphosate or 2,4-D and applied in the fall. Apply with 2,4-D for control of marestail resistant to group 2 and/or 9.
- Provides some residual control of winter annual grasses.
- Site of action: group 2 (see pages 22-23).
- Apply with COC, MSO or oil blend (1% v/v) plus UAN (1.5 - 2 qts/A) or AMS (1.5 - 3 lbs/A).
- Do not apply to frozen ground.

Herbicide	Formulation	Product Rate Range
Rimsulfuron + thifensulfuron (active ingredient)		
Basis Blend	**30DF**	**0.825 - 2 oz**
Resolve Q	**22.4WDG**	**1.25 - 2.5 oz**
Crusher	**50DF**	**1 - 1.8 oz**
Harrow	**75DF**	**0.33 - 1.0 oz**

Burndown Herbicides in No-Tillage Corn and Soybeans

Thifensulfuron + tribenuron (active ingredient)		
Harmony Extra	**50DF**	**0.75 - 0.9 oz**
Nimble	**75WDG**	**0.5 - 0.6 oz**
Panoflex	**50SG**	**0.3 - 0.6 oz**
Tribenuron (active ingredient)		
Express	**50DF**	**0.25 - 0.5 oz**
Nuance	**75WDG**	**1/6 - 1/3 oz**

- Tribenuron products can be applied in the fall and/or spring before planting corn or soybeans for control of wild garlic and other broadleaf weeds. When used in the spring, replant intervals for tribenuron products are generally 14 days between application and planting of corn and soybean. The Panoflex label specifies 1 and 7 days until soybean planting for rates up to 0.3 and 0.6 oz, respectively.
- The premix of thifensulfuron and tribenuron-methyl controls wild garlic and annual broadleaf weeds, including lambsquarters, mustard species, Pennsylvania smartweed, field pennycress, and shepherd's purse. Tribenuron controls purple deadnettle, chickweed, and field pennycress, and provides partial control of shepherd's-purse and other mustard species. Apply with 2,4-D ester for best results.
- Premixes of rimsulfuron plus thifensulfuron can be applied in the fall or spring before planting field corn for control of winter annual weeds. Basis Blend can be applied in the fall prior to seed corn also, at the rate of 0.825 oz/A. When mixed with 2,4-D ester, these herbicides control chickweed, deadnettle, henbit, dandelion, mustards, and other winter weeds. Spring applications with other corn herbicides (2,4-D ester, atrazine) before corn planting can provide burndown of small annual grass and broadleaf weeds, and several weeks of residual control of foxtails, lambsquarters, and pigweeds. See labels for adjuvants recommendations. Can be mixed with other herbicides approved for these uses.
- Basis Blend can be applied in the fall or early spring prior to soybean planting with the following guidelines: 0.825 oz—at least 15 days before planting; 1.25 oz—at least 60 days before planting. These guidelines assume that at least one of the following conditions has been met (if not then soybeans should not be planted for 10 months after Basis Blend application): the soil temperature is above 50 degrees for at least 10 days between application and planting; the field is tilled; or the soybean variety used has high tolerance to sulfonylurea herbicides. Crusher can be applied at rates up to 1 oz/A in fall or early spring, at least 30 days before soybean planting.
- Site of action: group 2 (see pages 22-23).
- To control wild garlic, apply the higher rates of thifensulfuron+tribenuron when garlic plants are less than 12 inches tall with 2 to 4 inches of new growth. Control will be better if applied during warm weather (60 F or more) to actively growing garlic plants. Thorough spray coverage of garlic plants is essential.
- All of these products should be applied with NIS or COC, and UAN or AMS can be added. See labels for specific adjuvant recommendations. Use flat fan or low-volume flood nozzles for best results.

Herbicide	Formulation	Product Rate Range
Chlorimuron (active ingredient)		
Canopy EX/Cloak EX/Fallout	**29.5 DF**	**1.1 - 3.3 oz**
Canopy/Cloak DF	**75 DF**	**2.25 - 7 oz**
Envive	**41 DG**	**2.5 - 5 oz**
Enlite	**47.9 DG**	**2.8 - 4.235 oz**
Valor XLT	**40 WDG**	**2.5 - 5 oz**
Fierce XLT	**62.4 WDG**	**3.75 - 5.25 oz**
Authority XL	**70 DF**	**3 - 9.6 oz**
Authority MAXX	**66DF**	**6 - 9.6 oz**
Trivence	**61.3 WDG**	**6 - 10 oz**

- These products provide residual control of broadleaf weeds, and the chlorimuron component helps control many emerged no-till weeds in mixtures with 2,4-D and glyphosate in preplant burndown treatments. See descriptions of

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these herbicides in "Soybean: Soil-Applied Herbicides" section for more information.

- Do not apply to frozen or snow-covered ground.
- Maximum rate on soils where the composite pH exceeds 7.0 (pH 6.8 for Valor XLT/Fierce XLT): Canopy/Cloak EX—1.1 oz; Canopy/Cloak DF—2.25 oz; Valor XLT and Envive—2.5 oz; Fierce XLT—3.75 oz; Trivence—6 oz. Authority XL cannot be applied on soils with pH greater than 7.6. Authority XL rates are not pH-dependent, but XL rotation intervals for most crops are extended to at least 18 months for soil pH between 7.2 and 7.6 regardless of rate. Authority MAXX and Enlite rates and rotation intervals are not pH-dependent.
- These products can be applied to no-till or conservation tillage fields in the fall for burndown of existing vegetation and limited residual control into the following growing season. 2,4-D should be included with all fall-applied treatments. Do not apply to frozen ground.
- Canopy/Cloak EX controls common chickweed, but the other products listed here require the addition of glyphosate or Express for chickweed control.
- Spring treatments should include 2,4-D ester and/or glyphosate for most effective control of emerged weeds. Glyphosate should be included if applied later than early April and where marestail, dandelion, and other perennials are present.
- Apply with COC (1 gallon/100 gallons spray) for best control of emerged weeds, unless glyphosate is included in the treatment.

Herbicide	Formulation	Product Rate Range
Dicamba (various)	**4L**	**1/2 - 1 pt**
Distinct	**76.4DF**	**2 - 3 oz**

- Dicamba is sold under a number of trade names, including Banvel, Clarity, Sterling Blue, DiFlexx, and Oracle. Dicamba is a translocated herbicide that can be applied before, during, or after no-till corn planting for control of emerged broadleaf weeds.
- Site of action: group 4 (see pages 22-23).
- Use 1/2 pint on coarse-textured soils, and 1 pint on medium- or fine-textured soils containing at least 2 percent organic matter.
- Dicamba is more effective than glyphosate for control of legume sods, especially when applied in combination with 2,4-D. When planting into a legume sod, apply dicamba after regrowth of 4 to 6 inches has occurred.
- The addition of crop oil, surfactant, or fluid fertilizer may improve control of emerged weeds. Do not apply with crop oil when corn is more than 5 inches tall.
- Corn should be planted at least 1½ inches deep with good-seed furrow closure. May injure corn if recommended rates are exceeded, application is not uniform, or corn is planted too shallow.
- The 1 pint rate provides limited residual control of small-seeded, annual broadleaf weeds.
- Some dicamba products are labeled for application in the spring prior to soybean planting, but there is more risk of injury to soybeans compared with preplant application of 2,4-D ester. Labels specify at least 14 to 28 days between application and soybean planting, and the waiting period starts after the accumulation of one inch of rain. For example, the Clarity label states the following: following application of Clarity and a minimum accumulation of one inch of rain, a waiting interval of 14 days until planting is required for rates of 8 oz/A or less, and 28 days for rates up to 16 oz/A."
- DiFlexx is a premix of dicamba and cyprosulfamide, a safener that reduces risk of injury to corn. DiFlexx can be applied at 8 to 16 oz/A (use the higher rates on soils high in organic matter) up to 14 days before, during, or after planting corn. The addition of COC or MSO (1% v/v) is recommended for control of emerged weeds.
- Distinct is a premix of dicamba and diflufenzopyr, and is more active that dicamba on a number of weeds. Distinct rates: corn—2 to 3 oz/A applied at least 14 days before planting; soybeans—2 to 4 oz/A, at least 30 days. Following application, at least 1 inch of rain must occur before the 14 or 30-day waiting period starts.

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Herbicide	Formulation	Product Rate Range
Dicamba + 2,4-D premix	**3.87L**	**0.5 - 6 pts**

- This product is available from various manufacturers, and product names and rates vary. It controls emerged weeds in the fall after corn or soybean harvest, or in the summer or fall after wheat harvest. Similar products are available from other manufacturers.
- Site of action: group 4 (see pages 22-23).
- Controls mustards, marestail, cressleaf groundsel, dandelion and some other winter annual weeds, but is weak on purple deadnettle and common chickweed.
- Apply when annual weeds are less than 6 inches tall, when biennials are in the rosette stage, and when perennials are at least 6 inches tall or in the bud to bloom stage.
- Any crop can be planted 120 days after application of rates up to 6 pints per acre. For some products/rates, crops may be planted sooner than 120 days, enabling preplant use in spring. See labels for more information.
- Can be applied prior to wheat planting, but allow an additional 10 days between application and planting for each pint applied (e.g. for a 2 pint rate allow 20 days).
- The standard adjuvant recommendation is 2 to 4 pints of NIS per 100 gallons of spray solution.

Herbicide	Formulation	Product Rate Range
Dicamba + atrazine premix	**3.2L**	**2 - 3 1/2 pt**

- Dicamba plus atrazine is sold under a number of trade names, including Marksman, Sterling Plus, Banvel-K+atrazine, and Stratos. These products control most emerged annual broadleaf weeds, and suppress or control perennial broadleaf weeds, and provide some residual control of broadleaf weeds.
- Site of action: group 5 (atrazine), group 4 (dicamba). See pages 22-23.
- Can be applied before, during, or after planting to emerged, actively growing weeds. Apply 2 pints on coarse soils with at least 2 percent organic matter, and 3½ pints on medium- or fine-textured soils with at least 2 percent organic matter.
- The addition of crop oil, surfactant, or fluid fertilizer may improve control of emerged weeds. Do not apply with crop oil after corn is 5 inches tall.
- When planting into a legume sod, apply after regrowth of 4 to 6 inches has occurred.
- Corn should be planted at least 1½ inches deep with good seed-furrow closure. May injure corn if recommended rates are exceeded, application is not uniform, or corn is planted too shallow.

Herbicide	Formulation
Expert	**4.88L**

- Expert is a premix of glyphosate, S-metolachlor (Dual II Magnum), and atrazine for burndown and residual control of grass and broadleaf weeds in no-till and conservation tillage corn. See descriptions of glyphosate and metolachlor/S-metolachlor plus atrazine for more information on these herbicides.
- Site of action: group 9 (glyphosate), group 5 (atrazine), group 15 (S-metolachlor). See pages 22-23.
- Use rates provide the equivalent of 0.4 to 0.75 lbs of glyphosate acid and 1.75 to 2.6 quarts/A of Bicep II Magnum. Use rate ranges from 2.5 to 3.75 qts/A on coarse-textured soils with less than 3% organic matter, and from 3 to 3.75 on all other soils.
- Apply before, during, or after planting but before crop emergence.
- Can be applied postemergence to glyphosate-resistant corn. Use water as the spray carrier for postemergence applications.
- Can be applied in water or UAN (28% or 32% only). Control of emerged weeds, especially perennial and large annual weeds, may be reduced if fertilizer is used as the carrier.
- The addition of AMS (17 lbs/100 gallons) can improve control of emerged annual weeds under cool or dry conditions.

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Herbicide	Formulation	Product Rate Range
Glufosinate		
Liberty/Cheetah/Interline	**2.34L**	**29 - 36 oz**

- Glufosinate is a contact herbicide that controls small, annual grass and broadleaf weeds, and suppresses some perennials.
- Site of action: group 10 (see pages 22-23).
- Application of glufosinate alone controls marestail and ragweeds, but may not provide adequate control of all of the weeds that can found in a typical no-till burndown situation. Apply in combination with 2,4-D ester and/or a metribuzin-containing herbicide (at least 0.2 lb ai metribuzin) for most effective control, or with Sharpen, especially where the field was not treated the previous fall.
- Apply in a minimum spray volume of 15 gpa, and use 20 to 40 gpa in dense weed canopies. Apply using nozzles and spray pressures that result in medium-size spray droplets (250 to 350 microns). Control can be reduced when nozzles and pressure result in coarse droplets.
- Apply in sunny, warm weather for best results. Control can be reduced when applied to weeds under stress from drought or cold conditions.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**0.75 - 1.5 lbs acid/A**

- Do not apply broadcast after the crop has emerged, unless the crop has resistance to glyphosate (Roundup Ready, Agrisure GT, etc.).
- To reduce the risk of developing glyphosate-resistant weed populations, Ohio State and Purdue University recommend application of glyphosate with 2,4-D ester wherever practical, including preplant applications to no-till corn and soybeans, in the summer/fall following wheat harvest, and in the fall for control of winter annuals and dandelion. An exception to this occurs when Canada thistle is the primary weed target for a fall application, in which case the 2,4-D ester should be omitted.
- Glyphosate is a nonselective, translocated herbicide that controls emerged annual and perennial grass and broadleaf weeds, volunteer cereals, and grass cover crops. Application rates, adjuvant recommendations, and other guidelines for use vary among glyphosate products, and users should consult labels and local product use guides for more specific information. The following comments are meant as general guidelines for the use of glyphosate.
- Site of action: group 9 (see pages 22-23).
- The minimum glyphosate rate for most situations where weeds are no more than about 6 inches tall should be 0.75 lbs of glyphosate acid/A. Rates should be increased accordingly as weeds become taller. Pennsylvania smartweed, atriplex, giant ragweed, crabgrass, fall panicum, barnyardgrass, marestail, dandelion, and a number of winter annual weeds can be difficult to control, and should be as small as possible at the time of application. A mixture of glyphosate plus 2,4-D ester (0.5-1 lb ai/A) will improve control of most broadleaf weeds.
- Glyphosate resistance has developed in populations of marestail, waterhemp, and Palmer amaranth, and common and giant ragweed in Ohio, Indiana and Illinois, and some lambsquarters populations appear to have become less sensitive to glyphosate. To improve control of these populations and reduce the risk of resistance, apply a mixture of glyphosate plus 2,4-D ester at least 7 days before soybean planting, and include preemergence herbicides that have residual activity on these weeds (e.g. Valor, metribuzin, Surveil). Avoid use of herbicide programs in glyphosate-resistant crops consisting solely of multiple glyphosate applications. See the “Problem Weeds” section of this guide for additional information on management of these weeds.
- For control of rye or overwintered wheat, apply in a spray volume of 10 gpa or less and use the appropriate rate for small grain size. Wheat should be treated before reaching a height of 18 inches.
- A number of glyphosate products can be applied immediately prior to alfalfa harvest in spring or fall, and the treated alfalfa then harvested and fed to livestock. This application is useful where corn will be planted immediately after alfalfa harvest, since it provides more effective alfalfa and perennial grass control, compared to application after harvest. Allow a minimum of 36 hours between application and harvest. Alfalfa should be harvested 3 to 7 days

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after application to avoid loss of quality and maximize perennial control. The preemergence herbicide program for corn should include atrazine at a rate of 1¼ to 1½ quarts (or the equivalent amount in a premix).

- Glyphosate activity will be maximized when applied in water in a spray volume of 10 gpa or less. When mixing with residual herbicides, apply in 10 or more gallons of water or UAN per acre.
- Glyphosate activity on perennial and large annual weeds may be reduced when mixing with residual herbicides or applying in UAN. Residual herbicides with contact activity on emerged weeds (Valor, metribuzin, atrazine, etc.) are most likely to reduce glyphosate activity. Consult labels for rates and precautions when mixing with residual herbicides.
- Recommendations for the use of AMS (17 lbs/100 gallons of water) with glyphosate vary among products. Addition of AMS may improve control, and is recommended under the following conditions: when mixing with residual corn or soybean herbicides, when air temperature is 55 degrees or less, or when hard or high pH water is used as the carrier.

Herbicide	Formulation	Product Rate Range
Gramoxone SL	**2L**	**2 - 4 pts**
Parazone	**3SL**	**1.3 - 2.7 pts**

- Do not apply broadcast after the crop has emerged.
- Gramoxone SL and Parazone contain paraquat, a nonselective contact herbicide that controls emerged annual grass and broadleaf weeds. Paraquat usually provides acceptable control of a rye cover, but is less effective than glyphosate for control of forage grasses such as orchardgrass and tall fescue. Paraquat is not effective for control of perennial broadleaf weeds, legume sods, perennial grass sods, or volunteer wheat although some suppression of these may occur.
- Site of action: group 22 (see pages 22-23).
- May not control marestail and prickly lettuce. May not control smartweed, giant ragweed, and fall panicum that are more than 4 to 6 inches tall. Control of these and many other weeds will be improved when paraquat is mixed with photosynthetic inhibitor herbicides (atrazine, metribuzin, and Lorox). Paraquat should generally be applied with a metribuzin-containing product and 2,4-D ester in no-till soybeans.
- Application rates for Gramoxone SL: 2 to 2.5 pints for 1- to 3-inch weeds; 2.5 to 3 pints for 3- to 6-inch weeds; and 3 to 4 pints for weeds more than 6 inches tall. Application rates for Parazone: 1.3 to 1.7 pints for 1- to 3-inch weeds; 1.7 to 2 pints for 3- to 6-inch weeds; and 2 to 2.7 pints for weeds more than 6 inches tall.
- Apply with COC (1 gallon/100 gallons spray) or NIS (1 quart/100 gallons). COC is the preferred spray adjuvant, especially when mixing with other herbicides.
- When using flat fan nozzles spaced at 20 inches or less, apply in a spray volume of at least 10 gpa with a pressure of at least 30 psi. Increase spray volume to at least 15 to 20 gpa if weeds are more than 3 inches tall. For large spray equipment with flood type nozzles, use a spray volume of at least 20 gpa with a pressure of at least 30 psi.
- Allow 30 minutes between application and rainfall.
- Do not apply with suspension or high-phosphate liquid fertilizers.

Herbicide	Formulation
Lumax EZ	**4L**
Lexar WZ	**3.7L**
Acuron	**3.44L**

- Lumax and Lexar are premixes of atrazine plus S-metolachlor (Dual II Magnum) plus mesotrione (Callisto). Acuron contains these ingredients and also bicyclopyrone.
- Site of action: group 5 (atrazine); group 15 (S-metolachlor); group 27 (mesotrione, bicyclopyrone). See pages 22-23.
- These products have been among the most effective preplant burndown treatments for no-till corn in Ohio State and Purdue University research, for control of dandelion and most winter annual weeds.

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- Lexar use rates: soils with less than 3% organic matter—3 qts/A; soils with more than 3% organic matter—3.5 qts/A. Lumax use rates: soils with less than 3% organic matter—2.5 qts/A; soils with more than 3% organic matter—3.0 qts/A. Acuron use rates: soils with less than 3% organic matter—2.5 qts/A; soils with more than 3% organic matter—3 qts/A.
- See descriptions of these products in "Corn: Soil-Applied Herbicides" section for additional information.

Herbicide	Formulation	Product Rate
Sharpen (corn)	**2.85SC**	**2 to 3.5 oz**
Sharpen (soybeans)		**1 to 2 oz**
Sharpen (wheat)		**1 to 2 oz**
Optill PRO (soybeans)	**co-pack**	
Verdict (corn)	**5.57 EC**	**10 to 18 oz**
Verdict (soybeans)		**5 to 10 oz**

- These products contain saflufenacil, which can help control emerged weeds, especially marestail, in preplant no-till burndown treatments. When used in soybeans, saflufenacil products should be combined with glyphosate or glufosinate for broad-spectrum burndown. The combination of Verdict/Sharpen and atrazine may provide adequate burndown of small weeds in no-till corn, but glyphosate should be added when weeds are more than about 4 inches tall, and for weeds Verdict/Sharpen does not control (see label). For more information on these products, see their descriptions in "Soybeans: Soil-applied Herbicides" and "Corn: Soil-applied Herbicides."
- Can be applied in the fall prior to soybeans. The lower rates for soybeans can be applied anytime prior to crop emergence, unless mixed with products that contain flumioxazin, sulfentrazone, or fomesafen. The higher rates must be applied 14 to 44 days before planting depending upon rate and soil type. See rate tables for these products in the "Soybeans: Soil-applied Herbicides" section for detailed information.
- Burndown activity requires the addition of MSO (1% v/v) plus either AMS (8.5 to 17 lbs/100 gallons) or UAN (1.25 to 2.5% v/v). Use a spray volume of 15 to 20 gpa in fall/spring no-till burndown situations, or where emerged weeds are present. Flat fan nozzles are recommended for burndown applications.
- Salfufenacil products used in soybeans cannot be mixed with or applied within 30 days of products containing flumioxazin (Valor products, Envive, Surveil, etc.), sulfentrazone (Sonic, Authority products), or fomesafen (Prefix, Intimidator, etc.), with the following exception: Sharpen can be applied 14 days before planting when mixed with these herbicides except on coarse-textured soils with less than 2% organic matter.

Herbicide	Formulation	Product Rate Range
Vida	**0.208L**	**1 - 2 oz**

- Vida (pyraflufen ethyl) is a contact herbicide with limited activity on primarily small annual broadleaf weeds, for use in mixtures with other effective burndown herbicides. The addition of this product to other herbicides may result in more rapid development of symptoms on weeds but has not generally improved final control.
- Site of action: group 14 (see pages 22-23).
- If using a water source with pH greater than 5.0, add an approved agricultural buffering agent to reduce pH to 5.0 or less.

Corn Herbicide Management Strategies

Preemergence herbicide programs have long been the mainstay of weed management in corn, due in large part to the low cost of atrazine and its broad spectrum of control. A total preemergence approach can still be effective in fields with low to moderate populations of most annual weeds. The commonly used premix of atrazine plus an acetamide herbicide (Bicep II Magnum, Degree Xtra, Keystone, etc.) can be supplemented as necessary with Balance, Python, Callisto (Lexar, Lumax), Hornet, or simazine to improve control of weeds such as fall panicum, triazine-resistant lambsquarters, giant ragweed, and velvetleaf. In fields with moderate to high weed populations, a preemergence plus postemergence approach will provide more consistent control with less risk of corn injury. A number of options are available for this type of program at a reasonable cost. A preemergence plus postemergence approach is especially effective in fields with giant ragweed, burcucumber, moderate to high annual populations of annual grasses and triazine-resistant lambsquarters, and perennial weeds. A number of effective total postemergence herbicide programs are also available. However, research indicates that total postemergence programs lacking residual activity should be used only in fields with low weed populations. A total postemergence herbicide program should be applied before most weeds in a field exceed 2 to 4 inches in height, and reinfestation with later-emerging weeds is likely if a herbicide with residual activity is not included.

Preemergence Corn Herbicide Programs

Total preemergence (PRE) herbicide programs fit fields with:

- low to moderate annual grass populations
- low giant ragweed populations
- any level of population of most annual broadleaf weeds

Total preemergence programs do not fit fields with:

- high grass populations
- moderate to high giant ragweed, cocklebur, velvetleaf, and annual morningglory populations
- perennial weeds
- waterhemp, Palmer amaranth, and burcucumber

Advantages of PRE programs:

- one-pass, can apply while planting
- with adequate rain, provides control through the first 6 weeks, and later-emerging weeds have little impact on corn yield
- effective on many annual grass and broadleaf weeds

Disadvantages of PRE programs:

- dependence upon adequate rain within narrow period of time
- not effective enough on tough broadleaf or perennial weeds or in high grass populations
- corn needs to be competitive with weeds earlier in season compared to PRE plus POST programs

Approaches:

Atrazine premix products (Lexar EZ, Harness Xtra, etc.) or similar mixes are effective broad-spectrum treatments for fields suited to total preemergence.

- can add simazine or Balance Flexx to improve grass control
- can add Balance Flexx to improve consistency under low rainfall conditions
- can add Balance Flexx, Callisto, Python, or Hornet to improve triazine-resistant lambsquarters, giant ragweed, and velvetleaf control, or apply premix products that contain these herbicides.
- atrazine rates of 1.5 to 2 lb/A can improve control of velvetleaf and giant ragweed. Some premix products have less than 1.5 lbs/A

Preemergence plus Postemergence Corn Herbicide Programs

Preemergence (PRE) plus Postemergence (POST) herbicide programs fit any field, but are especially well-suited for fields with:

- moderate to high annual grass populations
- moderate to high giant ragweed, cocklebur, velvetleaf, and annual morningglory populations
- perennial weeds
- waterhemp, Palmer amaranth, and burcucumber

Advantages of PRE plus POST programs:

- very consistent, as long as some rain on PRE
- creates wider window for POST application, compared to total POST programs
- good on many tough weeds

Disdvantages of PRE plus POST programs:

- dependence upon rain for PRE activity (although have planned POST backup)
- two-pass
- cost

Approaches:

In fields with low to moderate grass populations, can take an approach of preemergence grass herbicide followed by postemergence broadleaf herbicide (without much grass activity). Examples:

- Outlook followed by dicamba + atrazine
- Surpass followed by Hornet + Clarity

To provide postemergence control of a few grass escapes, can take an approach of a preemergence grass or grass and broadleaf herbicide followed by a postemergence broadleaf herbicide that also has activity on small grasses. Examples:

- Dual II Magnum followed by NorthStar
- Outlook followed by Status + atrazine

In fields with moderate to high grass and/or problem broadleaf populations, can take an approach of preemergence grass or grass+broadleaf herbicide (full or reduced rate) followed by broad-spectrum postemergence herbicide with grass and broadleaf activity. Examples:

- Corvus followed by Liberty (Liberty Link corn)
- Harness Xtra followed by glyphosate (RR corn)

Total Postemergence Corn Herbicide Programs (with residual)

Total postemergence (POST) herbicide programs that provide substantial residual control can be used in fields with:

- most annual weed populations

Avoid use in fields with:

- perennial broadleaf weeds (might emerge too late for control)
- high giant ragweed and annual grass populations

Advantages of total POST with residual:

- one-pass, can plant first and apply later
- not dependent upon rainfall for postemergence activity (although soil moisture status affects weed response to herbicides)
- consistent control of many annual weed populations

Disadvantages of total POST with residual:

- should be applied before weeds exceed 2 to 4 inches in height to avoid yield loss
- application too early for best control of perennial weeds
- need rain within 2 weeks of application for residual activity

Approaches:

Can make a single postemergence application before weeds exceed 4 inches in height with mix of postemergence herbicides with grass and broadleaf activity and residual herbicides with primarily broadleaf activity (if grass population not high). Examples:

- Liberty + atrazine (Liberty Link corn)
- glyphosate plus atrazine (glyphosate-resistant corn)

In fields with moderate to high grass pressure, may need residual component with more activity on grasses than those listed above. Examples:

- Glyphosate + Degree Xtra (glyphosate-resistant corn)
- Halex GT (glyphosate-resistant corn)
- Liberty + atrazine/chloroacetamide premix (Liberty Link corn)

Table 3. Weed Response to Preplant/Preemergence Herbicides in Corn—Grasses

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables. See pages 22-23 for additional information on site of action classification.

Weed control rating:
9 = 90% to 100% control
8 = 80% to 90% control
7 = 70% to 80% control
6 = 60% to 70% control
- = less than 60% control, not recommended.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

Crop injury of 1 or less is rarely significant.

	Grasses												
	Site of Action	Crop tolerance	Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Giant foxtail	Yellow foxtail	Shattercane	Rhizome johnsongrass	Quackgrass	Woolly cupgrass	Yellow nutsedge
Preplant or Preemergence													
Acetochlor[1]	15	1	9	9	8	7	9	9	-	-	-	7+	8+
Acetochlor+atrazine[1]	5/15	1	9	9	8	7	9	9	-	-	6	7+	8+
Acuron	5/27/15	1	9	9	8+	6	9	9	-	-	6	7	8+
Anthem	15	1	8	8	8	6	9	8	-	-	-	6	-
Anthem ATZ	5/15	1	8	8	8	6	9	8	-	-	6	6	6
Atrazine	5	0	8	-	-	6	7	7	-	-	8	-	7
Balance Flexx	27	1	7	7	7	6	7	6	6	6	-	8	-
Callisto	27	1	-	6	-	-	-	-	-	-	-	-	-
Corvus	2/27	1	8	8+	8+	6	8+	8+	7	7	-	7	7
Fierce[2,3]	14/15	1	8	8	8	6	8	8	-	-	-	6	-
Flumioxazin[3]	14	1	-	-	-	-	-	-	-	-	-	-	-
Hornet	2/4	2	-	-	-	-	-	-	-	-	-	-	-
Instigate	2/28	1	7	6	6	-	7	7	-	-	-	6	-
Lumax/Lexar EZ	5/27/15	1	9	9	8+	6	9	9	-	-	6	7	8
Metolachlor[1]	15	1	8	9	8+	6	9	9	-	-	-	7	8+
Metolachlor + atrazine[1]	5/15	1	9	9	8	6	9	9	-	-	6	7	8
Outlook	15	1	8	8+	8	6	8+	8+	-	-	-	7	8
Prequel[2]	2/27	2	8	7	8	-	8	7	6	6	-	6	-
Python	2	2	-	-	-	-	-	-	-	-	-	-	-
Resolve Q/Crusher	2	1	7	6	6	-	7	7	-	-	-	-	-
Sharpen[2]	14	1	-	-	-	-	-	-	-	-	-	-	-
Simazine	5	0	8	7	7	6	8	8	-	-	6	-	-
SureStart/TripleFlex[2]	2/4/15	2	8	8	8	-	8	8	-	-	-	6	7
Verdict[2]	14/15	1	8	8	8	6	8	8	-	-	-	7	-
Zemax	15/27	1	8	9	8+	6	9	9	-	-	-	7	8+
Zidua	15	1	8	8	8	6	9	8	-	-	-	6	-
Preemergence													
Lorox/Linex	7	2	-	-	-	-	-	-	-	-	-	-	-
Pendimethalin	3	2	8	8	8	7	8	8	6	6	-	8	-

[1]Acetochlor, alachlor, metolachlor, and s-metolachlor, and premixes of these with atrazine are available from a number of manufacturers - see corn herbicide descriptions for more information. Broadleaf weed control ratings assume an atrazine rate of 1.5 lbs ai/A - the atrazine rate in some premix products may be lower.
[2]SureStart/TripleFlex, Verdict, Sharpen, Fierce, and Prequel are intended for use in planned preemergence followed by postemergence programs, and ratings indicate early-season effectiveness, not full-season control. PRE application of these products should be followed with a POST application of Liberty, glyphosate, or other herbicides as necessary.
[3]Must be applied at least 7 days before corn planting. Use only in no-till fields.

Table 4. Weed Response to Preplant/Preemergence Herbicides in Corn—Broadleaf Weeds

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables. See pages 22-23 for additional information on site of action classification.

Weed control rating:
9 = 90% to 100% control
8 = 80% to 90% control
7 = 70% to 80% control
6 = 60% to 70% control
- = less than 60% control, not recommended.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

Crop injury of 1 or less is rarely significant.

	Broadleaf Weeds																
	Annual morningglory	Eastern black nightshade	Burcucumber	Cocklebur	Common ragweed	Common ragweed (group 2-R)	Giant ragweed	Giant ragweed (group 2-R)	Jimsonweed	Kochia	Lambsquarters	Lambsquarters (group 5-R)	Palmer amaranth (group 2-R)	Pigweed (redroot/smooth)	Smartweed	Velvetleaf	Waterhemp (group 2-R)
Preplant or Preemergence																	
Acetochlor[1]	-	8+	-	-	7	7	-	-	-	-	7+	7+	8	8+	-	-	8
Acetochlor+atrazine[1]	8	9	6	8	9	9	8	8	9	9	9	7+	9	9	9	8	9
Acuron	8	9	7	8+	9	9	8+	8+	9	9	9	9	9	9	9	9	9
Anthem	-	8	-	-	7	7	-	-	-	7+	8	8	8	8	-	7	8
Anthem ATZ	7	9	6	7	9	9	6	6	7	9	9	8	8+	9	9	8	8+
Atrazine	8	9	6	8	9	9	8	8	9	9	9	-	8	9	9	8	8
Balance Flexx	-	9	7	-	9	9	6	6	9	9	9	9	8	9	8	9	8
Callisto	6	9	7	7	7	7	6	6	-	6	9	9	7	9	9	9	7
Corvus	-	9	7	-	9	9	6	6	9	9	9	9	8	9	8	9	8
Fierce[2,3]	7	9	-	-	8	8	-	-	-	7	9	9	8	9	7	7	8
Flumioxazin[3]	7	9	-	-	7	7	-	-	-	7	9	9	8	9	7	7	8
Hornet	6	8+	-	8	8+	8+	7+	7+	8	8	9	9	-	9	8+	9	-
Instigate	6	9	7	7	8	7	6	6	-	7	9	9	7	9	9	9	7
Lumax/Lexar EZ	8	9	7	8	9	9	8	8	9	9	9	9	9	9	9	9	9
Metolachlor[1]	-	8	-	-	-	-	-	-	-	-	6	6	7	8	-	-	7
Metolachlor + atrazine[1]	8	9	6	8	9	9	8	8	9	9	9	6	8+	9	9	8	8+
Outlook	-	8+	-	-	-	-	-	-	-	-	6	6	7+	8	-	-	7+
Prequel[2]	7	8	7	-	8	8	6	6	8	9	9	9	8	9	8	9	8
Python	-	8	-	7	7	-	-	-	7	7	9	9	-	9	8	8+	-
Resolve Q/Crusher	7	-	-	-	7	-	-	-	7	8	7	7	-	7	7	6	-
Sharpen[2]	8	8	?	8	8	8	8	8	8	8	9	9	8	9	8	8	8
Simazine	7	9	6	7	9	9	7	7	8	-	9	-	8	9	8+	7	8
SureStart/TripleFlex[2]	6	8+	-	8	8+	8+	7+	7+	8	9	9	9	7	9	8+	8+	7
Verdict[2]	8	9	-	8	9	9	8	8	8	8	9	9	9	9	9	8	9
Zemax	6	9	7	7	7	7	6	6	-	8	9	9	8	9	9	9	8
Zidua	-	8	-	-	7	7	-	-	-	7+	8	8	8	8	-	7	8
Preemergence																	
Lorox/Linex	-	7	-	6	8	8	-	-	6	6	9	9	7	9	9	6	7
Pendimethalin	-	-	-	-	-	-	-	-	-	7	8	8	7	9	-	-	7

[1]Acetochlor, alachlor, metolachlor, and s-metolachlor, and premixes of these with atrazine are available from a number of manufacturers - see corn herbicide descriptions for more information. Broadleaf weed control ratings assume an atrazine rate of 1.5 lbs ai/A - the atrazine rate in some premix products may be lower.
[2]SureStart/TripleFlex, Verdict, Sharpen, Fierce, and Prequel are intended for use in planned preemergence followed by postemergence programs, and ratings indicate early-season effectiveness, not full-season control. PRE application of these products should be followed with a POST application of Liberty, glyphosate, or other herbicides as necessary.
[3]Must be applied at least 7 to 14 days before corn planting depending upon rate. Use only in no-till fields.

Table 5. Weed Response to Postemergence Herbicides in Corn—Grasses

			Grasses											
	Site of Action	Crop tolerance	Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Giant foxtail	Yellow foxtail	Shattercane	Seedling johnsongrass	Rhizome johnsongrass	Quackgrass	Woolly cupgrass	Yellow nutsedge
Postemergence														
2,4-D	4	2	-	-	-	-	-	-	-	-	-	-	-	-
Aim	14	2	-	-	-	-	-	-	-	-	-	-	-	-
Atrazine	5	1	7	-	-	-	8	8	-	-	-	7	-	7
Basagran/Broadloom	6	0	-	-	-	-	-	-	-	-	-	-	-	8
Beacon	2	2	-	-	8	6	7	7	9	9	7	8+	-	6
Bestow	2	2	7	-	7	6	7	7	7	7	-	-	7	-
Bromoxynil	5	1	-	-	-	-	-	-	-	-	-	-	-	-
Bromoxynil+Atrazine	6/5	1	-	-	-	-	-	-	-	-	-	-	-	-
Cadet	14	2	-	-	-	-	-	-	-	-	-	-	-	-
Callisto/Zemax	15/27	1	-	7*	-	-	-	-	-	-	-	-	-	-
Callisto GT[2]	9/28	1	8	8	8	9	9	9	9	9	9	9	9	7
Callisto Xtra	5/27	1	-	7*	-	-	-	-	-	-	-	-	-	-
Capreno	2/27	1	8	8	8	8	8+	9	8	8	7	7	6	-
Dicamba	4	2	-	-	-	-	-	-	-	-	-	-	-	-
Dicamba+atrazine	4/5	2	-	-	-	-	-	-	-	-	-	-	-	-
Glufosinate[1]	10	0	6	8	8	7	8	6	8	8	7	6	8+	-
Glyphosate[2]	9	0	8	8	8	9	9	9	9	9	9	9	9	7
Halex GT[2]	9/27/15	1	9	9	9	9	9	9	9	9	9	9	9	7
Hornet	2/4	1	-	-	-	-	-	-	-	-	-	-	-	-
Impact/Armezon/Armezon PRO	27	0	7	7	6	-	7+	7	6	7	-	-	6	-
Impact/Armezon + atrazine	27/5	0	8	8	6	-	8+	7+	6	7	-	-	6	-
Laudis	27	0	8	8	-	6	7	9	8	8	7	7	7+	-
Laudis + atrazine	27/5	0	8	8	-	6	8	9	8	8	7	7	7+	-
Laddok	5/6	1	-	-	-	-	-	-	-	-	-	-	-	8+
Nicosulfuron	2	1	8+	4	8+	8	9	9	9	9	9	9	8	6
NorthStar	2/4	2	-	-	7	6	6	6	9	9	6	7	-	-
Permit/Sandea/Halomax	2	1	-	-	-	-	-	-	-	-	-	-	-	9
Realm Q	2/27	1	7	-	7	6	7	7	7	7	-	-	7	-
Resolve Q	2	1	7	-	7	6	7	7	7	7	-	-	7	-
Resource	14	2	-	-	-	-	-	-	-	-	-	-	-	-
Revulin Q	2/27	1	8+	7*	8+	8	9	9	9	9	9	9	8	6
Shotgun	4/5	2	-	-	-	-	6	6	-	-	-	-	-	-
Solstice	14/27	2	-	7*	-	-	-	-	-	-	-	-	-	-
Spirit	2	2	-	-	7	-	6	6	9	9	6	7	-	-
Starane	4	1	-	-	-	-	-	-	-	-	-	-	-	-
Status	4/19	1	6	6	6	-	6	6	-	-	-	-	-	-
Steadfast Q	2	1/2	8	-	8	8	9	9	9	9	8	8	7	-
Stinger	4	0	-	-	-	-	-	-	-	-	-	-	-	-
WideMatch	4	1	-	-	-	-	-	-	-	-	-	-	-	-
Yukon	2/4	2	-	-	-	-	-	-	-	-	-	-	-	9

[1]Apply to Liberty Link (glufosinate-resistant) corn only.
[2]Apply to glyphosate-resistant (Roundup Ready, AgriSure GT, etc.) corn only.
*Large crabgrass only

Table 6. Weed Response to Postemergence Herbicides in Corn—Broadleaf Weeds

	Broadleaf Weeds																			
	Annual morningglory	Eastern black nightshade	Burcucumber	Cocklebur	Common ragweed	Common ragweed (group 2-R)	Giant ragweed	Giant ragweed (group 2-R)	Jimsonweed	Kochia	Lambsquarters	Lambsquarters (group 5-R)	Palmer amaranth (group 2-R)	Palmer amaranth (group 2+9-R)	Pigweed (redroot/smooth)	Smartweed	Velvetleaf	Waterhemp (group 2-R)	Waterhemp (group 2+9-R)	Waterhemp (group 2+9+14-R)
Postemergence																				
2,4-D	9	7	-	9	9	9	9	9	7	7+	9	9	8	8	9	6	8	8	8	8
Aim	8	8	-	-	6	6	-	-	-	7+	7	7	-	-	8+	-	9	-	-	-
Atrazine	9	9	8	9	9	9	8	8	9	9	9	-	8+	8+	9	9	8	8+	8+	8+
Basagran/Broadloom	-	-	-	9	7	7	6	6	9	7	6	6	-	-	-	9	8+	-	-	-
Beacon	6	8	9	9	9	-	9	-	9	8	-	-	-	-	9	8	8	-	-	-
Bestow	-	-	-	6	6	-	-	-	-	7+	6	6	-	-	8	6	6	-	-	-
Bromoxynil	8	9	7	9	9	9	8	8	9	8	9	9	-	-	7	8	8	-	-	-
Bromoxynil+Atrazine	9	9	9	9	9	9	9	9	9	9	9	9	8	8	9	9	9	8	8	8
Cadet	7	-	-	-	-	-	-	-	-	8	7	7	-	-	8	-	9	-	-	-
Callisto/Zemax	7	9	8	7+	7	7	8	8	9	8	9	9	8	8	8	9	9	8	8	8
Callisto GT[2]	8	9	8	9	9	9	9	9	9	8	9	9	9	8	9	9	9	9	8	8
Callisto Xtra	8	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Capreno	7	9	8	8	8	8	8	8	9	8+	9	9	8	8	9	8	9	8	8	8
Dicamba	9	8	7	9	9	9	9	9	9	8	8	8	8	8	8	8	7+	8	8	8
Dicamba+atrazine	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Glufosinate[1]	8	9	8	9	9	9	9	9	9	8	7	7	8	8	8	9	8	8	8	8
Glyphosate[2]	6	8	8	9	8+	8+	8+	8+	9	8	8+	8+	8	-	9	8	8	9	-	-
Halex GT[2]	8	9	8	9	9	9	8+	8+	9	8	9	9	9	8	9	9	9	9	8	8
Hornet	7	7	6	9	9	9	9	9	7	7	7+	7+	-	-	7+	9	8+	-	-	-
Impact/Armezon/Armezon PRO	7	9	7+	8	7	7	7	7	9	8+	9	9	8	8	9	8	9	8	8	8
Impact/Armezon + atrazine	8	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Laudis	7	9	7	8	8	8	8	8	9	8	9	9	8	8	9	8	9	8	8	8
Laudis + atrazine	8	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Laddok	8	8	6	9	9	9	9	9	9	9	9	5	7+	7+	9	9	9	7+	7+	7+
Nicosulfuron	8	-	8	-	-	-	-	-	8	-	-	-	-	-	9	8	-	-	-	-
NorthStar	8	9	9	9	9	7	9	6	9	8	9	9	7	7	9	9	8+	7	7	7
Permit/Sandea/Halomax	6	-	-	9	8	-	8	-	8	7	-	-	-	-	9	7	8	-	-	-
Realm Q	7	9	7+	8	8	7	8	8	9	8	9	9	8	8	9	9	9	8	8	8
Resolve Q	-	-	-	6	6	-	-	-	-	7+	7	7	-	-	8	6	7	-	-	-
Resource	-	-	-	7	7	7	-	-	7	-	7	7	-	-	9	-	9	-	-	-
Revulin Q	8	9	8	7+	7	7	8	8	9	8	9	9	8	8	9	9	9	8	8	8
Shotgun	9	9	7	9	9	9	9	9	9	8	9	9	8	8	9	9	8+	8	8	8
Solstice	8	9	8	8	7	7	8	8	9	8	9	9	9	8	9	9	9	9	9	8
Spirit	7	8	9	9	9	-	9	-	9	8	6	6	-	-	9	8+	8+	-	-	-
Starane	9	7	7	8	9	9	-	-	7	9	-	-	-	-	-	7	8	-	-	-
Status	9	8	7	9	9	9	9	9	9	8	9	9	8	8	9	8+	8	8	8	8
Steadfast Q	6	-	7	6	-	-	-	-	6	-	-	-	-	-	9	7	-	-	-	-
Stinger	-	8	-	9	9	9	9	9	8	-	-	-	-	-	-	-	-	-	-	-
WideMatch	9	7	7	9	9	9	9	9	8	9	-	-	-	-	-	7	8	-	-	-
Yukon	8	7	7	9	9	7	9	7	9	8	8	8	7+	7+	9	9	9	7+	7+	7+

[1]Apply to Liberty Link (glufosinate-resistant) corn only.
[2]Apply to glyphosate-resistant (Roundup Ready, AgriSure GT, etc.) corn only.
*Large crabgrass only

Corn: Soil-Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
AAtrex/atrazine	**4L**	**2 - 4 pt**
	90DF	**1.1 - 2.2 lbs**

- Site of action: group 5 (see pages 22-23).
- Atrazine is generally applied at a rate of 1.4 to 2 pounds active ingredient per acre to control broadleaf weeds.
- Rates approaching 2 pounds active ingredient can improve control of velvetleaf, giant ragweed, cocklebur, and morningglory. Velvetleaf can be effectively controlled when atrazine is mixed with Balance, Callisto, or Hornet, but the latter three weeds are most effectively controlled with a combination of preemergence and postemergence herbicides. Atrazine will not control fall panicum, regardless of rate.
- Maximum soil-applied rate on soils not highly erodible is 2 pounds of active ingredient per acre. Maximum rate on highly erodible soils is 2 pounds active ingredient on fields with at least 30% crop residue, and 1.6 pounds active ingredient on fields with less than 30% crop residue. Soil applications may be followed with a postemergence application of atrazine, but total of all treatments cannot exceed 2.5 pounds active ingredient per acre per year.
- Preplant application of atrazine with COC and/or UAN can control small, emerged annual weeds.
- Plant only corn or sorghum the year (including fall) of atrazine application.
- Where oats, forage legumes, or forage grasses will be planted the following spring, do not apply more than 0.8 pounds active ingredient per acre.

Herbicide	Formulation
Acetochlor	**various**

- Acetochlor (plus safener) is sold under various trade names, including Harness, Breakfree NXT, Surpass NXT, Confidence, Warrant, and Volley.
- Acetochlor controls annual grasses, pigweed, and black nightshade, and control or suppresses yellow nutsedge, lambsquarters, and common ragweed. Control of lambsquarters and common ragweed will generally be less effective compared to most broadleaf herbicides, but more effective than other acetamide herbicides.
- Site of action: group 15 (see pages 22-23).
- Can be applied to field corn, popcorn, and production seed corn, but should generally not be used on corn seed stock. See labels for precautions. Acetochlor can be applied preplant or preemergence to sweet corn, but not postemergence.
- Degree is an encapsulated product that can provide a longer period of annual grass control compared to other acetochlor products.
- Most acetochlor products can be applied after planting but prior to weed emergence, and before corn height exceeds 11 inches. Warrant can be applied anytime after corn has emerged until corn reaches 30 inches in height. All acetochlor products except Degree must be applied using water as the spray carrier after the corn has emerged.
- Degree or Degree plus atrazine can be applied to emerged corn in water or UAN, but corn should not exceed 6 inches in height if fertilizer solution is used as the carrier. Do not apply in fertilizer solution when air temperatures exceed 85 degrees. Mixtures with products other than atrazine should be applied only in water if the corn has emerged. Leaf burn may occur when acetochlor is applied to emerged corn.

Degree 3.8L Use Rates (pts/A)[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	2.25 to 3.25	3.25
Medium	3.25 to 4.25	3.25 to 4.25
Fine	3.25 to 4.25	4.25 to 5

a. On soils with 6 to 10% organic matter, use 4.25 to 6.25 pts/A.

Corn: Soil-Applied Herbicides — Preplant or Preemergence

Breakfree NXT/Surpass NXT/Volley 6.4EC Use Rates (pts/A) in Conventional Tillage Systems When Applied within 14 Days before Planting[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	1.5 to 2.25	1.5 to 2.5
Medium	1.5 to 2.5	1.5 to 2.5
Fine	1.5 to 2.75	2 to 3

a. Use higher end of rate range if OM content is at higher end of rate range or under anticipated heavy weed infestations.

Breakfree NXT/Surpass NXT/Volley 6.4EC Use Rates (pts/A) in Reduced or No-till System or Conventional System When Applied More than 14 Days Before Planting		
Soil Texture Group	**Less Than 3% OM**	**3% or More OM**
Coarse	2	2
Medium	2 to 2.5	2.25
Fine	3	3

Warrant Use Rates (qt/A)		
Soil Texture	**Soil Organic Matter Content**	
	Less than 3%	**3% or greater**
Coarse	1.5 to 2	2
Medium	1.5 to 2.75	2.0 to 2.75
Fine	1.5 to 2.75	2.75 to 3

Herbicide	Formulation	Product Rate Range
Acetochlor + atrazine	**Various**	

- Acetochlor plus atrazine (plus safener) is sold under various trade names, including Harness Xtra, Degree Xtra, Fultime NXT, Keystone, Confidence Xtra, Breakfree ATZ, and Volley ATZ. These premix products control annual broadleaf and grass weeds in corn. The ratio of atrazine to acetochlor varies among products, and some products require the addition of atrazine or another broadleaf herbicide for effective control of broadleaf weeds.
- Degree Xtra and Fultime NXT are encapsulated formulations that can provide a longer period of annual grass control compared to other acetochlor products.
- Site of action: group 5 (atrazine), group 15 (acetochlor). See pages 22-23.
- Can be applied to field corn, popcorn, and production seed corn, but should generally not be used on corn seed stock. See labels for precautions. Can be applied preplant or preemergence to sweet corn, but not postemergence.
- Can be applied after planting and before corn height exceeds 11 inches and before weeds reach the 2-leaf stage. When mixing with postemergence herbicides to control larger weeds, follow the most restrictive label with regard to maximum corn size.
- All acetochlor products except Degree Xtra should be applied using water as the spray carrier after the corn has emerged.
- Degree Xtra can be applied in water or UAN, but corn should not exceed 6 inches in height if fertilizer solution is used as the carrier. Do not apply in fertilizer solution when air temperatures exceed 85 degrees. Mixtures with

products other than atrazine should be applied only in water if the corn has emerged. Leaf burn may occur when applied to emerged corn.

- Can be mixed with Balance Flexx to improve control of velvetleaf, annual grasses, triazine-resistant lambsquarters, and burcucumber. See Balance Flexx description for precautions to avoid crop injury.

Degree Xtra 4L Use Rates (qts/A)	
Soil Texture Group	
Coarse	2.9
Medium[a]	2.9 to 3.7
Fine	3.2 to 3.7

a. In areas of heavy weed pressure rates can be increased to 4.3 qts/A.

FulTime NXT Use Rates (qts/A) in Conventional Tillage Systems When Applied within 14 Days Before Planting		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	2.25 to 2.7	2.7 to 3
Medium	2.7 to 3.3	3 to 3.3
Fine	3 to 3.5	3 to 5

Harness Xtra 5.6L/Confidence Xtra 5.6L Broadcast Rates (qts/A)[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	1.4	1.75
Medium	1.75 to 2.4	2.3 to 2.6
Fine	2.3 to 2.6	2.3 to 3.0

a. In areas of heavy infestations use up to 2.3 qts/A on coarse-textured soils and 2.3 to 3.0 qts/A on medium- and fine-textured soils, but do not exceed 2.4 qts/A on highly erodible soils with less than 30% plant residue.

Breakfree NXT ATZ/Keystone NXT/Volley ATZ 5.25L Use Rates in Conventional Tillage (qts/A)		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	2.2 to 2.4	2.4 to 2.6
Medium	2.4 to 2.8	2.6 to 2.8
Fine	2.6 to 3	2.6 to 3.4

Herbicide	Formulation
Acuron	**3.44L**

- Acuron is a premix of atrazine, S-metolachlor (Dual II Magnum), mesotrione (Callisto), and bicyclopyrone for control of grass and broadleaf weeds in corn. This product is overall similar to Lexar and Lumax for residual control and control of emerged weeds, but can be slightly better on large-seeded broadleaf weeds such as giant ragweed and cocklebur.
- Site of action: group 5 (atrazine); group 15 (S-metolachlor); group 27 (mesotrione, bicyclopyrone). See pages 22-23.
- Acuron use rates: soils with less than 3% organic matter - 2.5 qts/A; soils with more than 3% organic matter - 3.0 qts/A. 12 inches in height. Broadleaf weeds should be less than 3 (Lumax) or 5 (Lexar) inches tall at the time of postemergence application. Control of emerged grasses (up to 1.5 inches tall) will require additional atrazine.

Corn: Soil-Applied Herbicides — Preplant or Preemergence

- Can be applied only preplant or preemergence on yellow popcorn and sweet corn.
- NIS can be used when Acuron is applied to emerged corn. AMS can be added when mixed with glyphosate. Use of COC may result in temporary crop injury. Otherwise, do not apply with MSO or nitrogen based adjuvants (AMS, UAN, etc.), or use fertilizer solution as the carrier after corn has emerged.
- Rates of 1.5 to 2 qt/A can be applied postemergence in a mixture with glyphosate on glyphosate-resistant corn.
- Applying Lexar/Lumax postemergence to corn treated with Counter insecticide at planting may result in severe crop injury. See product label and Table 10 for more information on herbicide-insecticide interactions.

Herbicide	Formulation
Anthem	**2.15SE**
Anthem ATZ	**4.5L**

- Anthem (pyroxasulfone + fluthiacet) and Anthem ATZ (atrazine + pyroxasulfone + fluthiacet) can be applied preplant, preemergence, or early postemergence in field corn, seed corn, popcorn, and sweet corn for residual control of annual grasses and broadleaf weeds. These products should be combined with other preemergence corn herbicide(s) to improve the longevity and spectrum of weed control, or followed with a postemergence herbicide treatment.
- Site of action: Anthem - group 14/15; Anthem ATZ - group 5/14/15 (see pages 22-23).
- Corn seed must be planted a minimum of one inch deep.
- Anthem will not generally provide adequate control of emerged weeds when applied early postemergence. The addition of atrazine in Anthem ATZ improves activity on emerged weeds but will generally still require the addition of glyphosate or other postemergence herbicide.

Anthem Broadcast Rates (oz/A)[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	7 - 8	7 - 8
Medium	8 - 10	8 - 11
Fine	9 - 11	10 - 13

a. Rates may increase when applied more than 14 days prior to planting, and decrease when used postemergence - see label.

Anthem ATZ Broadcast Rates (pt/A)[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	1.75 - 2	1.75 - 2
Medium	2 - 2.5	2 - 2.75
Fine	2.25 - 3	2.5 - 4

a. Rates may increase when applied more than 14 days prior to planting, and decrease when used postemergence - see label.

Herbicide	Formulation
Balance Flexx	**2L**

- Balance Flexx (isoxaflutole + cyprosulfamide, a safener) can be applied preplant, preemergence, or early postmergence (up to V2 corn) for control of annual broadleaf weeds and early-season control of annual grasses. Control of cocklebur, giant ragweed, and morningglory is improved in mixtures with atrazine.
- Site of action: group 27 (see pages 22-23).
- Can be applied up to 30 days prior to planting of LibertyLink, glyphosate-resistant, or Clearfield hybrids, where a postemergence treatment is planned.
- Preplant application of of Balance Flexx plus atrazine (1 lb ai/A) will control small, emerged annual weeds (3 inches or less) in no-till, including field pennycress, shepherd's-purse, chickweed, henbit, and marestail. Apply with COC or MSO. Can be mixed with 2,4-D, Gramoxone, or glyphosate for improved burndown activity on larger weeds.

Corn: Soil-Applied Herbicides — Preplant or Preemergence

- Postemergence application of Balance Flexx will not generally control weeds larger than the 1-leaf stage, but can be mixed with atrazine to improve control. Do not apply with adjuvants or other herbicides after corn has emerged.
- Isoxaflutole has occasionally injured corn, especially during extended periods of cold, wet conditions during corn seed germination and early crop development. The risk of injury is reduced with Balance Flexx due to the inclusion of a safener. To reduce the risk of injury, do not exceed recommended rate for soil type, plant corn at least 1½ inches deep, and make sure seed is completely covered with soil and the seed furrow is firmed.
- Consult seed company for information on inbred tolerance to isoxaflutole before using Balance Flexx on seed corn inbreds.

Balance Flexx Use Rates (floz/A)						
Timing	Soil Texture Group					
	Coarse		Medium		Fine	
	Organic matter					
	Less than 1.5%	Greater than 1.5%	Less than 1.5%	Greater than 1.5%	Less than 1.5%	Greater than 1.5%
8 to 21 days before planting	4.0	5.0	6.0	6.0	6.0	6.0
0 to 7 days before planting or early POST	3.0	4.0	5.0	5.0	6.0	6.0

Herbicide	Formulation	Product Rate Range
Callisto	**4L**	**6 - 7.7 oz**

- Callisto (mesotrione) can be applied preplant or preemergence for control of annual broadleaf weeds, including lambsquarters (including triazine-resistant), Pennsylvania smartweed, pigweeds, waterhemp, velvetleaf, and eastern black nightshade. Control of giant ragweed, cocklebur, and morningglory is improved in mixtures with atrazine.
- Site of action: group 27 (see pages 22-23).
- Callisto does not control grass weeds, and should be applied in combination with Harness, Dual, or another acetamide grass herbicide, or an acetamide/atrazine premix (Bicep II, Magnum, Degree Xtra, etc.).
- Can be applied preplant, preemergence, or postemergence to field corn, seed corn, sweet corn, and yellow popcorn. Do not apply to white popcorn.
- Postemergence rate should not exceed 3 oz/A. To avoid crop injury, do not apply postemergence with emulsifiable concentrate herbicides or MSOs.

Herbicide	Formulation
Corvus	**2.63SC**

- Corvus is a premix of isoxaflutole and cyprosulfamide (Balance Flexx), and thiencarbazone-methyl that can be applied preplant, preemergence, or early postmergence (spike to V2 corn) for control of annual broadleaf and grass weeds. The addition of atrazine will improve control of large-seeded broadleaf weeds such as cocklebur, giant ragweed, and morningglory.
- Site of action: group 27 (isoxaflutole); group 2 (thiencarbazone). See pages 22-23.
- Corvus rates: coarse-textured soils with less than 2% OM - 3.33 oz; medium- or fine-textured soils and coarse-textured soils with more than 2% OM - 5.6 oz.
- Can be applied up to 30 days prior to planting of LibertyLink, glyphosate-resistant, or Clearfield hybrids, where a postemergence treatment is planned.
- Preplant application of Corvus can control small, emerged annual weeds (6 inches or less) in no-till, especially when combined with atrazine. Apply with COC or MSO. Can be mixed with 2,4-D, Gramoxone, or glyphosate for improved burndown activity on larger weeds or weeds not controlled by Corvus and atrazine.
- Postemergence application of Corvus will control small-emerged weeds. Mixing with atrazine will improve control. Do not apply with adjuvants or other herbicides after corn has emerged

Corn: Soil-Applied Herbicides — Preplant or Preemergence

- Corvus should not be applied to corn that will receive soil or seed treatment with organophosphate or carbamate insecticides. See product label and Table 10 for additional information on herbicide-insecticide interactions.
- Isoxaflutole has occasionally injured corn, especially during extended periods of cold, wet conditions during corn seed germination and early crop development. The risk of injury is reduced with Corvus due to the inclusion of a safener. To reduce the risk of injury, do not exceed recommended rate for soil type, plant corn at least 1½ inches deep, and make sure seed is completely covered with soil and the seed furrow is firmed.
- Consult seed company for information on inbred tolerance to isoxaflutole before using Corvus on seed corn inbreds.

Herbicide	Formulation
Fierce	**76WDG**

- Fierce is a premix of flumioxazin (Valor) and pyroxasulfone (Zidua) that controls or suppresses annual grass and broadleaf weeds. See Valor and Zidua descriptions for more information.
- The application rate, 3 oz/A, is intended to provide early-season control only. Preplant application of Fierce should be followed with a broad-spectrum postemergence herbicide treatment.
- Site of action: group 14 (flumioxazin), group 15 (pyroxasulfone). See pages 22-23.
- Fierce can be applied between 7 and 30 days prior to planting field corn. Do not apply to popcorn, sweet corn, or corn grown for seed.
- Use only in no-till fields where last year's crop residue has not been incorporated into the soil. Do not conduct any tillage operations after the Fierce has been applied.
- Do not apply in a mixture with any of the following herbicides unless following directions on a Valent supplemental label: flufenacet, metolachlor or S-metolachlor, alachlor, dimethenamid-p, or acetochlor.

Herbicide	Formulation	Product Rate Range
Flumioxazin		
Valor/Outflank/Panther/Rowel	**51WDG**	**2 - 3 oz**
Panther SC	**4SC**	**2 - 3 oz**

- Flumioxazin can be applied at 2 oz/A between 7 and 30 days prior to planting field corn, and at 3 oz between 14 and 30 days prior to planting. Flumioxazin controls lambsquarters (including triazine-resistant), black nightshade, and pigweeds. Suppresses or provides partial control of common ragweed, morningglory, velvetleaf, waterhemp, smartweed, and some annual grasses.
- Site of action: group 14 (see pages 22-23).
- Do not apply to popcorn, sweet corn, or corn grown for seed.
- Use only in no-till fields where last year's crop residue has not been incorporated into the soil. Do not conduct any tillage operations after the flumioxazin has been applied.
- Do not apply in a mixture with any of the following herbicides unless following directions on a manufacturer supplemental label: flufenacet, metolachlor or S-metolachlor, alachlor, dimethenamid-p, or acetochlor.

Herbicide	Formulation
Hornet	**78.5WDG**

- Hornet is a premix of flumetsulam (Python) plus clopyralid (Stinger). In addition to the broadleaf weeds controlled by Python, Hornet controls cocklebur and common ragweed. Expect partial control of giant ragweed.
- Site of action: group 2 (flumetsulam), group 4 (clopyralid). See pages 22-23.
- Hornet can be mixed at a rate of 3 to 4 oz/A with atrazine premix products (Bicep II, Harness Xtra, etc.) to improve control of triazine-resistant lambsquarters, giant ragweed, and other broadleaf weeds.
- Apply preplant, preemergence, or at the spike stage. When using the rates shown here, apply before the corn is 2 inches tall. Preplant application with COC can control emerged Canada thistle and small annual broadleaf weeds, including mustards, shepherd's-purse, ragweeds, and Pennsylvania smartweed.

Corn: Soil Applied Herbicides — Preplant or Preemergence

- Do not apply to sweet corn or popcorn. Corn inbred lines should be tested for crop tolerance before treating large acreages.
- Preemergence applications of Hornet can occasionally injure corn, primarily when growing conditions are unfavorable soon after application. This injury appears as stunting, temporary yellowing, and reduction in root growth. To avoid injury, plant at least 1½ inches deep and do not use Hornet in soils with an average of less than 1½ percent organic matter.
- Soil-applied organophosphate insecticides may increase the risk of crop injury, especially when applied in-furrow. See product label and Table 10 for more information on herbicide-insecticide interactions.
- Corn treated with Hornet that is stressed or damaged by herbicide or other factors should not be treated with Accent, Permit, Basis, Beacon, or other group 2 herbicides.
- Do not apply where soil pH is greater than 7.8. Do not apply to soils with a combination of pH less than 5.9 and organic matter content greater than 5%.

Hornet WDG Use Rates (oz/A)[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	4	4 to 5
Medium or Fine	4 to 5	5 to 6

a. Use higher rate in recommended range in areas of high weed infestations.

Herbicide	Formulation
Instigate	**45.8%WDG**

- Instigate is a premix of rimsulfuron (Resolve) and mesotrione (Callisto) for preplant and preemergence control or suppression of annual grass and broadleaf weeds. Instigate should generally be mixed with an atrazine premix or similar product to improve the longevity and spectrum of control. Mixing with an atrazine premix results in overall burndown and residual activity similar to Lexar/Lumax. Can also be applied alone where followed by postemergence herbicides.
- Site of action: group 2 - rimsulfuron; group 27 - mesotrione. See pages 22-23.
- Do not apply to popcorn, sweet corn, or corn grown for seed.
- The rate range is 5.25 to 7 oz/A, but 6 oz/A is the appropriate rate for most soils and application situations. Do not apply to coarse soils with less than 1% OM.
- Can be applied postemergence through the 2-collar corn stage, at rates of 5.25 to 5.4 oz/A. The preferred adjuvant system for postemergence applications is COC or MSO (1% v/v) plus UAN (2 qt/A) or AMS (2 lb/A). NIS can be used instead of COC/MSO. Consult label for adjuvant recommendations when mixing with other herbicides. Do not use spray additives that adjust the spray solution pH below 5 or above 9 as rapid product degradation can occur. Do not use UAN as the spray carrier if corn has emerged.
- Do not apply another HPPD-inhibiting herbicide (Callisto, Impact/Armezon, Laudis, Capreno) in the same season that Instigate was used. To avoid crop injury where using insecticides, consult the label and Table 10 for precautions about herbicide-insecticide interactions.

Herbicide	Formulation	Product Rate Range
Lorox	**50DF**	**2/3 - 3 lb**
Linex	**4L**	**2/3 - 3 pts**

- Lorox/Linex (linuron) controls broadleaf weeds. Linuron is generally applied at a rate of 3/4 to 1 lb/A in combination with other corn herbicides for control of triazine-resistant pigweed and lambsquarters.
- Site of action: group 7 (see pages 22-23).
- Do not use on soils with more than 3 percent organic matter.
- Apply after corn planting, but before emergence.
- To avoid injury, corn should be planted at least 1¾ inches deep and adequately covered with soil.
- Do not apply to emerged corn.

Corn: Soil Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation
Lumax EZ	**3.67L**
Lexar EZ	**3.7L**

- Lumax EZ and Lexar EZ are premixes of atrazine, S-metolachlor (Dual II Magnum), and mesotrione (Callisto) for control of grass and broadleaf weeds in corn. A use rate of Lexar contains a higher amount of atrazine per acre, compared with Lumax, and a lower amount of S-metolachlor.
- Site of action: group 5 (atrazine); group 15 (S-metolachlor); group 27 (mesotrione). See pages 22-23.
- Controls most annual broadleaf weeds, but expect partial control of giant ragweed, cocklebur, and annual morning-glory.
- Lexar and Lumax have been among the most effective preplant burndown treatments for no-till corn in Ohio State and Purdue University research, for control of dandelion and most winter annual weeds.
- Lexar use rates: soils with less than 3% organic matter - 3 qts/A; soils with more than 3% organic matter - 3.5 qts/A. Lumax use rates: soils with less than 3% organic matter - 2.7 qts/A; soils with more than 3% organic matter - 3.25 qts/A. Rates when followed with a postemergence herbicide application, or applied early postemergence in a mixture with glyphosate or glufosinate: Lexar - 2.25 qts/A; Lumax - 2 qts/A.
- Lumax and Lexar can be applied preplant, preemergence, or postemergence before field and seed corn exceeds 12 inches in height. Broadleaf weeds should be less than 3 (Lumax) or 5 (Lexar) inches tall at the time of postemergence application. Control of emerged grasses (up to 1.5 inches tall) will require additional atrazine.
- Can be applied preplant or preemergence on yellow popcorn and sweet corn.
- NIS can be used when Lumax or Lexar is applied to emerged corn. AMS can be added when mixed with glyphosate or glufosinate. Use of COC may result in temporary crop injury. Otherwise, do not apply with MSO or nitrogen based adjuvants (AMS, UAN, etc.), or use fertilizer solution as the carrier after corn has emerged.
- Lumax/Lexar may be applied postemergence in a mixture with glyphosate on glyphosate-resistant corn at a rate as low as 2 qts/A (Lumax) or 2.25 qts/A (Lexar).
- Applying Lexar/Lumax postemergence to corn treated with Counter insecticide at planting may result in severe crop injury. See product label and Table 10 for more information on herbicide-insecticide interactions.
- If applied after June 1, rotating to crops other than corn or sorghum may result in crop injury.

Herbicide	Formulation
S-metolachlor	**7.64E**
Metolachlor	**7.8E**

- S-metolachlor (Dual II Magnum, Cinch) and metolachlor (Stalwart C, Parallel) control annual grasses and pigweed, and control or suppress waterhemp, eastern black nightshade, and yellow nutsedge.
- Site of action: group 15 (see pages 22-23).
- Can be applied preplant or preemergence before the crop and weeds emerge. Can be applied broadcast with atrazine up to 5-inch corn or as a directed spray up to 12-inch corn, and before grass and broadleaf weeds exceed the 2-leaf stage. Do not apply using fertilizer solution as the spray carrier after the corn has emerged.
- May be applied up to 30 days before planting as a single application.
- Incorporation to a depth of 2 inches will improve yellow nutsedge control and reduce dependence upon rainfall.

Dual II Magnum, Cinch, Parallel, and Stalwart C Use Rates (pts/A)		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	1 to 1.33	1.33
Medium	1.33 to 1.67	1.33 to 1.67
Fine	1.33 to 1.67	1.67 to 2

Corn: Soil Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation
S-metolachlor + atrazine	**5.5L**
Metolachlor + atrazine	**5.5L**

- S-metolachlor plus atrazine (Bicep II Magnum, Brawl II ATZ, Cinch ATZ) and metolachlor plus atrazine (Stalwart Xtra, Parallel Plus, Trizmet) control annual grass and broadleaf weeds in corn.
- Site of action: group 5 (atrazine), group 15 (S-metolachlor/metolachlor). See pages 22-23.
- Can be applied preplant, preemergence, and after corn emergence until corn plants are 5 inches tall and before weeds exceed the 2-leaf stage. Do not apply using fertilizer solution as the spray carrier after the crop emerges.

Bicep II Magnum, Cinch ATZ, and Stalwart Xtra[a] Use Rates Up to 14 Days Before Planting (qts/A)		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	1.3	1.6
Medium	1.6	2.1
Fine	2.1	2.1[b] or 2.1 to 2.58

a. When using Stalwart Xtra, use 2.1 to 2.6 qts/A on fine-textured soils when applying on non-erodible land with 30% or more residue cover.
b. Do not exceed this rate on highly with less than 30% plant residue cover.

Herbicide	Formulation	Product Rate Range
Metribuzin	**75DF**	**2 - 5 1/3 oz**
	4L	**3 - 8 oz**

- Metribuzin (Dimetric, Tricor) is labeled in combination with other corn herbicides to improve residual control of broadleaf weeds, including lambsquarters, pigweed, common ragweed, Pennsylvania smartweed, and velvetleaf. In mixtures with 2,4-D, Gramoxone, and/or atrazine, metribuzin can also improve burndown of emerged weeds in no-till.
- Site of action: group 5 (see pages 22-23).
- Apply before or after planting, but before corn emergence. Application rates increase when applied more than 10 days before planting.
- Observe the following precautions to avoid corn injury: Do not apply where soil pH is 7.0 or greater or on coarse-textured soils with less than 1½% organic matter; do not apply more than 4 ounces/A of metribuzin 75DF on soils with less than 2% organic matter; plant corn seed at least 1½ inches deep.
- Metribuzin can be used on field corn and in hybrid seed corn production fields. Both inbred lines should have known tolerance to metribuzin before using in seed production.

Herbicide	Formulation
Outlook	**6EC**

- Outlook (dimethenamid-P) controls annual grasses and pigweed, and controls or suppresses yellow nutsedge and black nightshade.
- Site of action: group 15 (see pages 22-23).
- Can be applied after crop emergence, but must be applied before weed emergence, or in a tank mixture with herbicides that control emerged weeds. Do not apply to corn that is more than 12 inches tall.
- May be applied after corn has emerged with surfactant or low rates of nitrogen fertilizer solution. Do not use fertilizer solution as the spray carrier after the crop has emerged. COC should not be added after the crop has emerged unless specified for a particular tank mixture.

Corn: Soil Applied Herbicides — Preplant or Preemergence

Outlook Use Rates (floz/A)[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	12 to 14	14 to 18
Medium and fine	14 to 18	18 to 21

a. When making applications 15 to 45 days before planting or applying on muck soils, use 21 fl oz/A.

Herbicide	Formulation
Pendimethalin/Pendant/others	**3.3EC**
Prowl H2O, Satellite Hydrocap	**3.8CS**

- The active ingredient in these products, pendimethalin, controls annual grasses, pigweed, and lambsquarters (including triazine-resistant biotypes), and helps control smartweed, velvetleaf, and seedling johnsongrass. Pendimethalin is often combined with atrazine for control of grass and broadleaf weeds where triazine-resistant pigweed and lambsquarters are present.
- Site of action: group 3 (see pages 22-23).
- Can be applied postemergence until field corn is in the V8 stage or is 30 inches tall, and other types of corn are 20 to 24 inches tall. Where the corn canopy prevents spray particles from reaching the soil, use drop nozzles and apply as a directed spray. Postemergence applications provide residual control only, not control of emerged weeds.
- Apply only after planting. Do not incorporate or severe corn injury may result.
- To reduce the risk of corn injury, plant at least 1½ inches deep and ensure good seed to soil contact. Combining pendimethalin with dicamba may increase the potential for crop injury, especially when corn is under stress from cool, wet conditions.

Prowl H2O/Satellite Hydrocap Use Rates (pt/A)		
Soil Texture	**Soil Organic Matter Content[a]**	
	Less than 3%	**More than 3%**
Coarse	2 to 3	3
Medium	3	4
Fine	3 to 4	4

Pendimethalin 3.3EC Use Rates (pt/A)		
Soil Texture	**Soil Organic Matter Content**	
	Less than 3%	**More than 3%**
Coarse	1.8 to 3.6	3.6
Medium	2.4 to 3.6	3.6 to 4.8
Fine	2.4 to 4.8	3.6 to 4.8

The high rates for each soil texture above should be used if heavy weed populations are anticipated, extensive crop residues were present prior to seedbed preparation, or in no-till.

Herbicide	Formulation	Product Rate
Prequel	**45WDG**	**1.66 to 2.5 oz**

- Prequel is premix of isoxaflutole (Balance Pro) and rimsulfuron that provides residual control of grass and broadleaf weeds, and also controls some small (less than 3 inches), emerged weeds in no-till burndown situations. Residual control can be improved with the addition of atrazine. Control of larger emerged weeds can be improved with the addition of one or more of the following: 2,4-D, atrazine, glyphosate, or paraquat.
- Site of action: group 2 (rimsulfuron); group 27 (isoxaflutole). See pages 22-23.

Corn: Soil Applied Herbicides — Preplant or Preemergence

- This product is intended for use in a planned preemergence followed by postemergence program, and the product rates are not intended to provide full-season weed control. Preemergence or preplant application of Prequel should be followed by a postemergence application of glyphosate (glyphosate-resistant corn), glufosinate (Liberty Link corn), or conventional herbicides as needed.
- Use on field corn hybrids only.
- Control of emerged weeds requires the addition of NIS or COC, plus AMS or UAN. When mixed with glufosinate or a glyphosate product that contains adjuvants, no additional NIS or COC is needed.
- Crop injury can increase and rate of crop recovery from injury can slow when corn is growing slowly under adverse environmental conditions, including extremely wet, cold, or dry soils, high pH, or low fertility. Do not use on coarse soils with less than 1% organic matter. Application to coarse soils with less than 1.5% organic matter or pH greater than 7.5 can cause adverse crop response. Plant corn at least 1½ inches deep, and make sure that the seed furrow is firmed and seed is completely covered with soil.

Herbicide	Formulation
Princep/simazine	**4L**
	90DF

- Simazine is often applied at reduced rates in combination with atrazine or atrazine premix products to improve or extend grass control.
- Site of action: group 5 (see pages 22-23).
- Simazine rates will vary depending upon the herbicides in the mixture, but when used alone, rates are as follows (for simazine 4L): sand, silt, or loam with low OM - 4 pts/A; soil with moderate amounts of clay and organic matter - 4.8 pts/A; loams high in OM and clay - 6 pts/A.
- Simazine is more effective than atrazine for control of fall panicum and crabgrass, but is less effective for control of cocklebur, quackgrass, yellow nutsedge, velvetleaf, and giant ragweed.
- Can be applied at a rate of 1 lb active ingredient/A in the fall prior to corn planting for control of winter annual weeds such as chickweed, mustards, and deadnettle. Apply with 2,4-D for best results. If weeds are more than an inch or two tall, apply with Gramoxone or glyphosate.

Herbicide	Formulation
Python	**80WDG**

- Python (flumetsulam) controls annual broadleaf weeds, including triazine-resistant lambsquarters and velvetleaf. Control of common ragweed and cocklebur is variable, and Python does not control giant ragweed or annual morningglory.
- Site of action: group 2 (see pages 22-23).
- Python use rates range from 0.8 to 1 oz/A in coarse-textured soils, and 0.9 to 1.33 oz/A in medium or fine-textured soils. Reduced rates of Python can be mixed with atrazine premix products (Bicep II, Harness Xtra, etc.) to improve control of triazine-resistant lambsquarters.
- Can be applied postemergence, from spike stage to 20-inch or V6 stage, for residual control of pigweeds, lambsquarters, and velvetleaf.
- Do not apply to soils with a combination of pH less than 5.9 and organic matter content greater than 5%. Do not apply where soil pH is greater than 7.8.
- Python can occasionally injure corn, primarily when growing conditions are unfavorable soon after application. This injury appears as stunting, temporary yellowing, and reduction in root growth. To avoid injury, plant at least 1½ inches deep and do not use Python in soils with an average of less than 1½ percent organic matter.
- Soil-applied organophosphate insecticides may increase the risk of crop injury, especially when applied in-furrow. See product label and Table 10 for more information on herbicide-insecticide interactions.
- Corn treated with Python that is stressed or damaged by herbicide or other factors should not be treated with Accent, Permit, Basis, Beacon, or other group 2 herbicides.
- Do not apply to sweet corn or popcorn. Inbred lines should be tested for crop tolerance before treating large acreages.

Corn: Soil Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
Resolve Q	**22.4 WDG**	**1.25 - 2.5 oz**
Crusher	**50DF**	**1.0 - 1.8 oz**

- Resolve Q/Crusher (rimsulfuron plus thifesnsulfuron) can provide residual control of annual grasses, pigweeds, and lambsquarters. Can be combined with atrazine or other preemergence herbicides for residual control of additional weeds. Preplant or preemergence application of these products plus atrazine should be followed with a broad-spectrum postemergence herbicide program.
- Site of action: group 2 (see pages 22-23).
- Preplant application of Resolve Q/Crusher and atrazine can control small, emerged weeds in no-till corn, especially when mixed with 2,4-D.

Herbicide	Formulation
Sharpen	**2.85SC**

- Sharpen (saflufenacil) controls annual broadleaf weeds in field corn and popcorn. The addition of atrazine will improve control of large-seeded broadleaf weeds such as giant ragweed, morningglory, and cocklebur. Sharpen can also be added to other preemergence corn products to improve residual control of broadleaf weeds. Do not apply Sharpen after corn has emerged.
- Site of action: group 14. See pages 22-23.
- This product is intended for use in a planned preemergence followed by postemergence program when applied alone, and the product rates will not provide full-season weed control. Preemergence or preplant application of Sharpen should be followed by a postemergence application of glyphosate (glyphosate-resistant corn), glufosinate (LibertyLink corn), or conventional herbicides as needed.
- Sharpen rates are based on soil texture as follows: coarse - 2 to 2.5 oz; medium - 2.5 to 3 oz; fine - 3 to 3.5 oz.
- Do not apply Sharpen where an at-planting application of an organophosphate or carbamate insecticide is planned or has occurred because severe injury may occur. See product label and Table 10 for more information on herbicide-insecticide interactions.
- Preplant application of Sharpen and atrazine can control small, emerged weeds in no-till, including marestail. Glyphosate should be added when weeds are more than about 4 inches tall and for weeds Sharpen does not control (see label). For control of emerged weeds, apply with MSO (1% v/v) and AMS (8.5 to 17 lbs/100 gallons) or UAN (1.25 to 2.5% v/v). Use a spray volume of 15 to 20 gpa in no-till burndown situations, or where emerged weeds are present. Flat fan nozzles are recommended for burndown applications.

Herbicide	Formulation
SureStart II/TripleFLEX II	**4.25L**

- SureStart II/TripleFLEX II is a premix of acetochlor, clopyralid (Stinger), and flumetsulam (Python) that provides residual control of grass and broadleaf weeds.
- Site of action: group 2 (flumetsulam); group 4 (clopyralid); group 15 (acetochlor). See pages 22-23.
- This product is intended for use in a planned preemergence followed by postemergence program. Preemergence or preplant application of SureStart II/TripleFlex IIshould be followed by a postemergence application of glyphosate (glyphosate-resistant corn), glufosinate (Liberty Link corn), or conventional herbicides as needed.
- Preplant/preemergence application rates: coarse texture - 1.5 pts; medium texture with less than 3% OM - 1.5 to 1.75 pts; medium texture with >3% OM - 1.75 pts; fine texture - 2 pts.
- SureStart II/TripleFlex IIcan also be applied early postemergence (up to 11-inch corn) in a mixture with glyphosate or glufosinate, using the appropriate type of corn. This mixture will control emerged weeds and provide residual weed control after application.
- To reduce risk of crop injury, plant corn at least 1½ inches deep, and make sure seed furrow is closed. Do not use where soil pH is greater than 7.8 or soil organic matter is less than 1.5%.
- Do not apply Counter insecticide to corn that has been or will be treated with SureStart II/TripleFlex II. See product label and Table 10 for more information on herbicide-insecticide interactions.

Corn: Soil Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation
Verdict	**5.57EC**

- Verdict is a premix of dimethenamid (Outlook) and saflufenacil (Sharpen) that controls annual grass and broadleaf weeds in field corn, popcorn, and seed corn. The addition of atrazine will improve control of large-seeded broadleaf weeds such as giant ragweed, morningglory, and cocklebur. Do not apply after corn has emerged.
- Site of action: group 15 (dimethenamid); group 14 (saflufenacil). See pages 22-23.
- This product is intended for use in a planned preemergence followed by postemergence program, and the product rates are not intended to provide full-season weed control. Preemergence or preplant application of Verdict should be followed by a postemergence application of glyphosate (glyphosate-resistant corn), glufosinate (LibertyLink corn), or conventional herbicides as needed.
- Verdict rates for field corn are based on soil texture as follows: coarse - 10 to 12 oz; medium - 13 to 15 oz; fine - 16 to 18 oz. Rates for seed corn: coarse soils - 5 oz; medium to fine textured soils - 5 to 10 oz.
- Do not apply Verdict where an at-planting application of an organophosphate or carbamate insecticide is planned or has occurred to avoid severe injury. See product label and Table 10 for more information on herbicide-insecticide interactions.
- Preplant application of Verdict and atrazine can control small, emerged weeds in no-till, including marestail. Glyphosate should be added when weeds are more than about 4 inches tall and for weeds Verdict does not control (see label). For control of emerged weeds, apply with MSO (1% v/v) and AMS (8.5 to 17 lbs/100 gallons) or UAN (1.25 to 2.5% v/v). Use a spray volume of 15 to 20 gpa in no-till burndown situations, or where emerged weeds are present. Flat fan nozzles are recommended for burndown applications.

Herbicide	Formulation
Zemax	**3.76ZC**

- Zemax is a premix of mesotrione (Callisto) and s-metolachor (Dual II Magnum) that controls annual grass and broadleaf weeds in corn. The addition of atrazine will improve control of large-seeded broadleaf weeds. See Callisto and S-metolachlor descriptions for more information.
- Site of action: group 14 (S-metolachlor); group 27 (mesotrione). See pages 22-23.
- Can be applied preemergence to most types of corn, including popcorn (yellow only), sweet corn, and corn grown for seed. Can be applied postemergence to field corn and seed corn only, until corn reaches the 8-leaf stage or is 30 inches tall.
- For postemergence applications, add either NIS (0.25% v/v) or COC (1% v/v). AMS or UAN can be added but this increases the risk of crop injury. Do not apply with MSO or use UAN as the spray carrier.
- Application rates: 2 qts/A - less than 3% soil OM; 2.4 qts/A - 3% or greater soil OM. Rate can be reduced to 1.6 qt/A when applied early postemergence with glyphosate (glyphosate-resistant corn) or glufosinate (LibertyLink corn).
- Severe crop injury may occur if Zemax is applied postemergence to corn that was previously treated with organophosphate insecticides. See product label and Table 10 for more information on herbicide-insecticide interactions.

Herbicide	Formulation
Zidua	**85WDG**

- Zidua (pyroxasulfone) can be applied preplant, preemergence, or early postemergence in field corn, seed corn, popcorn, and sweet corn for residual control of annual grasses and small-seeded broadleaf weeds. This product should generally be combined with other preemergence corn herbicide(s) to improve broadleaf weed control, or followed with a postemergence herbicide treatment.
- Site of action: group 15 (see pages 22-23).
- Application rates based on soil texture: coarse - 1.5 to 2.75 oz; medium - 2 to 3 oz; fine - 2.5 to 4 oz. The label allows rates lower than those listed here when applied postemergence or used in a planned sequential (PRE + POST) program.
- Corn seed must be planted a minimum of one inch deep.
- Early postemergence applications will not control emerged weeds.

Corn: Postemergence Herbicides — Contact

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Aim	**2EW**	**0.5 -1 oz**	**Not addressed on label**

- Aim (carfentrazone-ethyl) is a contact herbicide that controls eastern black nightshade, velvetleaf, redroot pigweed, and small annual morningglories and lambsquarters. Aim is often added to herbicide programs to improve control of velvetleaf.
- Site of action: group 14 (see pages 22-23).
- Apply when weeds are 1 to 4 inches tall for best results. Velvetleaf can be controlled up to 36 inches tall. Apply broadcast before corn exceeds the 8-collar stage, and as a directed spray with drop nozzles up to the 14-collar stage.
- Apply with NIS (0.25% v/v). UAN (2 to 4 gallons/100 gallons) or AMS (2 to 4 lbs/A) can be added if recommended for use with other herbicides in a mix with Aim. The label does allow use of COC under dry conditions and in specific tank mixtures. Add Aim to the spray tank before adding other products. Application with Buctril may cause unacceptable crop injury.
- Aim can be applied with drop nozzles to seed corn production fields. Avoid directing herbicide into the whorl.
- Apply in a spray volume of 10 to 20 gpa with a pressure of 20 to 40 psi. Flat fan nozzles are recommended for adequate spray coverage.
- Aim usually causes leaf speckling and necrosis. The severity of injury varies with environmental conditions, adjuvants, and other herbicides in the mixture. To reduce injury, 1) do not apply within 6 to 8 hours of rain, 2) make sure spray nozzles are positioned at least 18 inches above the crop, and 3) avoid direction of excessive amounts of herbicide into corn whorls.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
AAtrex/atrazine	**4L**	**1.5 - 2 qt**	**1 - 1.5 qt**
	90DF	**1.67 - 2.22 lb**	**1.1 - 1.7 lb**

- Site of action: group 5 (see pages 22-23).
- Maximum rate for postemergence application to fields without soil-applied atrazine in the same year is 2 pounds active ingredient/A. When applied postemergence to fields with soil-applied atrazine the same year, total amount of atrazine applied may not exceed 2.5 pounds active ingredient.
- For annual grass control, apply 2 lbs ai/A when grasses are no more than 1½ inches tall. Atrazine will not control fall panicum.
- For control of broadleaf weeds, rates of 1.2 pounds active ingredient may be sufficient. Apply until broadleaf weeds are 4 inches tall.
- Apply with COC (1 qt/A) for best results. Mix atrazine with water first, and add oil last.
- Apply before the crop reaches 12 inches in height.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Basagran/Broadloom	**4L**	**1.5 - 2 pt**	**1.5 - 2 pt**

- Basagran/Broadloom (bentazon) is a contact herbicide that controls annual broadleaf weeds, including cocklebur, velvetleaf, and Pennsylvania smartweed. Controls or suppresses Canada thistle and yellow nutsedge.
- Site of action: group 6 (see pages 22-23).
- For best results, apply with COC when weeds are in the 2- to 6-leaf stage.
- Apply in combination with atrazine for control of pigweed, lambsquarters, and ragweeds.
- Add COC (1 qt/A) if mixing with glyphosate.

Corn: Postemergence Herbicides — Contact

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Bromoxynil	**2S**	**1 - 1.5 pt**	**Not labeled**

- Bromoxynil is sold under various trade names, including Buctril, Moxy, and Broclean. Bromxynil is a contact herbicide that controls many annual broadleaf weeds, including eastern black nightshade, cocklebur, ragweeds, lambsquarters, and smartweed, but is weak on pigweed and large velvetleaf.
- Site of action: group 6 (see pages 22-23).
- Apply at a rate of 1 pint per acre from corn emergence until tassel emergence. The 1½-pint rate may be applied after corn reaches the 4-leaf stage and before tassel emergence. Maximum corn size at the time of application varies with the tank-mix partner.
- Do not apply to seed corn inbreds or popcorn prior to the 3-leaf stage.
- Do not use surfactant or crop oil when applying bromoxynil alone or with most other herbicides. NIS and UAN are allowed in some mixtures.
- Apply in a minimum volume of 10 gpa at a minimum pressure of 30 psi using flat fan nozzles.
- May cause corn leaf burn, but effects are usually temporary.

Herbicide	Formulation	Product Rate Range
Bromoxynil + atrazine	**3L**	**1½ - 3 pt**

- Bromoxynil plus atrazine is sold under various trade names. It controls most annual broadleaf weeds.
- Site of action: group 5 (atrazine); group 6 (bromoxynil). See pages 22-23.
- Can be applied at a rate of 1½ to 2 pints per acre after corn emergence and before corn is 12 inches tall. The 3-pint rate may be applied after corn reaches the 4-leaf stage and before corn is 12 inches tall.
- Do not use surfactant, crop oil, liquid fertilizers, or other additives when applying Buctril/atrazine or Moxy/atrazine alone or with most other herbicides. NIS and UAN are allowed in some mixtures.
- Apply in a volume of at least 10 gallons per acre at a minimum pressure of 30 psi using flat fan nozzles.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Cadet	**0.91EC**	**0.4 - 0.9 oz**	**0.4 - 0.6 oz**

- Cadet (fluthiacet-methyl) is a contact herbicide that controls velvetleaf, and controls or suppresses small lambsquarters, pigweeds, eastern black nightshade, and annual morningglory at the 0.9 oz rate.
- Site of action: group 14 (see pages 22-23).
- Can be applied to field corn and seed corn from prior to planting up to 48 inches tall. Apply before tassel emergence.
- Apply with NIS (0.25% v/v), COC, or MSO (1 to 2 pts/A). UAN (1 to 2 qts/A) or AMS can be added. When combined with other herbicides, Cadet can generally be applied with any adjuvants required for those herbicides.
- Apply in a minimum spray volume of 15 gpa and pressure of 20-40 psi. Increase volume and pressure in dense crop and weed canopies.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

Herbicide	Formulation	Product Rate Range
Laddok S-12	**5L**	**1 1/3 - 2 1/3 pt**

- Laddok is a 1:1 premix of bentazon (Basagran) plus atrazine for control of most broadleaf weeds, and suppression or control of yellow nutsedge, Canada thistle, and some perennial vines.
- Site of action: group 5 (atrazine); group 6 (bentazon). See pages 22-23.
- Application rate varies with weed species and size. Apply with UAN, AMS, or nonphytotoxic oil concentrate. The label allows combinations of spray additives, which vary with the weed species present. UAN or AMS should be added when velvetleaf is the target weed, and may also improve control of cocklebur and Pennsylvania smartweed.

Corn: Postemergence Herbicides — Contact

COC should also be added when common lambsquarters, common ragweed, Canada thistle, yellow nutsedge, or field bindweed is present.

- Apply in a spray volume of at least 10 gpa with a minimum pressure of 40 psi. Increasing the spray volume (up to 50 gpa) will improve control when the crop and weed foliage is dense.
- To suppress Canada thistle, apply 2 1/3 pints when thistle plants are 8 to 10 inches tall until the bud stage.
- A single application of 2 1/3 pints of Laddok can suppress yellow nutsedge that is 1 to 4 inches tall.
- Provides better control of velvetleaf, annual morningglory, lambsquarters, and pigweed than Basagran alone, but is no more effective on triazine-resistant lambsquarters.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Resource	**0.86EC**	**4 to 6 oz (broadcast)**	**Glyphosate: 2 - 4 oz**
		4 to 8 oz (directed)	**Glufosinate: 2 oz**

- Resource (flumiclorac) is a contact herbicide that controls velvetleaf (up to 10 inches tall) and pigweeds. Control of lambsquarters is variable, and some other broadleaf weeds will be suppressed.
- Site of action: group 14 (see pages 22-23).
- Apply when corn is in the 2- to 10-leaf stage and broadleaf weeds are in the 2- to 3-leaf stage for best results. Use a directed spray if corn size prevents adequate spray coverage of weeds.
- COC should be included when Resource is applied alone. Use 1 pint/A for broadcast application and 1 quart/A for directed application. UAN or AMS can be added to improve control of large velvetleaf. Adjuvant recommendations vary with the other herbicides in the mixture. See the label for more information.
- Apply in a spray volume of at least 10 gpa with a spray pressure of 30 to 60 psi.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

Corn: Postemergence Herbicides — Systemic

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Armezon PRO	**5.35EC**	**14 - 24 oz**	**14 - 24 oz**

- Armezon PRO is a premix of topramezone (Impact/Armezon) and dimethenamid (Outlook) for control of emerged broadleaf weeds and residual control of grasses and pigweeds. See Impact/Armezon and Outlook descriptions for more information.
- Site of action: group 27 (topramezone); group 15 (dimethenamid). See pages 22-23.
- Can be applied postemergence on field corn and seed corn up to the V8 stage or 30-inch corn, whichever occurs first, and not within 45 days of harvest for forage or grain. Check with seed supplier for information on tolerance prior to use on inbreds grown for seed production.
- Apply with MSO, COC, or HSOC (0.5 to 1.0% v/v) plus either UAN (1.25 to 2.5% v/v) or AMS (8.5 to 17 lbs/100 gallons of water). NIS can be used instead of MSO, COC, or HSOC if required in mixtures with other herbicides.
- Armezon PRO should not be relied upon to provide complete control of grasses, but can control small (less than 3-inch) grasses that escape preemergence herbicides.

Armezon PRO Use Rates (floz/A)		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	14 to 16	16 to 20
Medium and fine	16 to 20	20 to 24

Herbicide	Formulation	Product Rate Range	With Glyphosate
Beacon	**75DF**	**3/8 - 3/4 oz**	**3/8 - 3/4 oz**

- Beacon (primisulfuron) is a systemic sulfonylurea herbicide that controls or suppresses annual and perennial grasses and controls annual broadleaf weeds. Beacon provides only partial control of foxtail species and may be less effective than Accent for rhizome johnsongrass and quackgrass control, but is generally more effective than Accent for broadleaf weed control. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Mixtures of Beacon plus dicamba or 2,4-D will suppress a number of perennial broadleaf weeds.
- Beacon is labeled for use on field corn, popcorn, and seed corn. Popcorn and inbred lines grown for seed may be severely injured by Beacon and should be thoroughly tested for potential sensitivity to Beacon before treating large acreage. Do not use Beacon on sweet corn.
- Apply broadcast or as a directed spray when field corn is between 4 and 20 inches tall, and as a directed spray after corn is 20 inches tall and before tassel emergence. All applications to inbred lines and popcorn should be made post-directed or semi-directed (nozzles positioned to avoid placing spray in whorl) after corn is 10 inches tall but before tassel emergence.
- Apply with NIS (0.25% v/v) or COC (1 to 4 pints per acre); COC is generally the preferred additive. Liquid nitrogen fertilizer (2 to 4 quarts/A) or AMS (2 to 4 lbs/A) may be added, but should not substitute for surfactant or oil concentrate. COC plus nitrogen fertilizer can be use when mixing with atrazine, Accent, or 2 oz/A or less of dicamba. Mixtures with most other herbicides should be applied with NIS. See label for detailed information on mixtures with other herbicides.
- Apply when grasses are at the following heights: shattercane and seedling johnsongrass — 4 to 12 inches; rhizome johnsongrass — 8 to 16 inches; quackgrass — 4 to 8 inches; fall panicum — less than 2 inches. Beacon will control common and giant ragweed that are 2 to 9 inches tall. Most other broadleaf weeds should be 1 to 4 inches tall when Beacon is applied.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Corn: Postemergence Herbicides — Systemic

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Bestow	**25DF**	**0.5 - 2.0 oz**	**Gly - 1.0 oz; Lib -0.75 oz**

- Bestow (rimsulfuron) controls or suppresses small (1 to 2 inch) annual grass and broadleaf weeds, including foxtails, lambsquarters, and pigweed. When mixed with glyphosate in postemergence treatments to glyphosate-resistant corn, Bestow provides residual control of annual grasses and some small-seeded broadleaf weeds The 1.0 oz rate is recommended for most situations. .
- Site of action: group 2 (see pages 22-23).
- Can be applied broadcast to field corn with up to 5 collars, or up to 12 inches tall (whichever is more restrictive).
- Apply with NIS (0.25% v/v) plus UAN (2 qt/A) or AMS (2 lb/A). No additional adjuvants are needed when applying with glufosinate or a glyphosate product that contains surfactant.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Callisto	**4L**	**3 oz**	**2.5 - 3 oz**

- Callisto (mesotrione) is a systemic herbicide that controls annual broadleaf weeds. The addition of atrazine (1/2 pint) improves control of a number of weeds, and is required for consistent control of common ragweed and morning-glory. Where corn is more than 12 inches tall and atrazine cannot be used, a mixture of Callisto plus bromoxynil can improve control of ragweeds.
- Site of action: group 27 (see pages 22-23).
- Apply when weeds are less than 5 inches tall for best results. Apply with atrazine (1/2 pint) if weeds are more than 5 inches tall.
- Callisto can be applied to field corn and seed corn up to 30 inches tall or the 8-leaf stage. Callisto plus atrazine can be applied to corn up to 12 inches tall.
- Apply with COC (1% v/v) plus UAN (2.5% v/v) or AMS (8.5 lb/100 gallons). Do not use MSO (MSO) or MSO blend adjuvants.
- Callisto can be applied at the rate of 2.5 oz/A when weeds are less than 5 inches tall and it is mixed with either atrazine (0.5 lbs ai/A) or glyphosate.
- Apply in a spray volume of 10 to 30 gpa, but use a volume of at least 20 gpa if weed foliage is dense.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.
- Do not apply Callisto postemergence in a mixture with emulsifiable concentrate grass herbicides, unless specifically addressed under one of the mixture sections of the label, or crop injury may occur.
- Do not use COC when mixing with glufosinate. Do not use UAN, COC or MSO when mixing with glyphosate. If glyphosate has an adjuvant system, add AMS (8.5 - 17 lb/100 gal). If the glyphosate does not contain adjuvants, add NIS (0.25% v/v) and AMS.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Callisto Xtra	**3.7L**	**20 to 24 oz**	**20 to 24 oz**

- Callisto Xtra is a premix of mesotrione (Callisto) and atrazine that controls annual broadleaf weeds.
- Site of action: group 27 (mesotrione); group 5 (atrazine). See pages 22-23.
- Apply when weeds are less than 5 inches tall for best results. Can be applied to field corn, seed corn, and yellow popcorn from emergence up to 12 inches tall.
- Apply with COC (1% v/v) or NIS (0.25% v/v) plus UAN (2.5% v/v) or AMS (8.5 lb/100 gallons). COC is the preferred adjuvant to maximize activity. Do not use MSO (MSO) or MSO blend adjuvants.
- Apply in a spray volume of 10 to 30 gpa, but use a volume of at least 15 gpa if weed foliage is dense.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Corn: Postemergence Herbicides — Systemic

- Do not apply Callisto Xtra postemergence in a mixture with emulsifiable concentrate grass herbicides, unless specifically addressed under one of the mixture sections of the label, or crop injury might occur.
- Do not use COC or UAN when mixing with glufosinate. Do not use UAN, COC or MSO when mixing with glyphosate. If glyphosate has an adjuvant system, add AMS (8.5 - 17 lb/100 gal). If the glyphosate does not contain adjuvants, add NIS (0.25% v/v) and AMS.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Capreno	**3.45SC**	**3 oz**	**Glyphosate - 3 oz** **Glufosinate - 2 oz**

- Capreno is a premix of tembotrione (Laudis) and thiencarbazone-methyl that controls annual grass and broadleaf weeds in field corn and seed corn. This product will provide residual control of grasses also. The addition of atrazine (0.5 lb/A) will generally improve the speed and effectiveness of control.
- Site of action: group 27 (tembotrione), group 2 (thiencarbazone). See pages 22-23.
- Apply with COC (1% v/v, minimum of 1.25 pt/A) and 28% UAN (1.5 qts/A) or AMS (8.5 lbs/100 gallons, minimum of 1.5 lbs/A). High surfactant oil blends at their recommended rates can replace COC, but do not use NIS or MSO.
- Can be applied broadcast from the V1 to V6 stage of corn, and as a directed spray up to V7. Capreno is most effective when broadleaf weeds are less than 4 to 6 inches tall, and grasses are less than 3 inches tall and not tillering.
- Apply in a minimum spray volume of 10 gpa, but use a volume of 15 to 20 gpa if weed foliage is dense.
- Consult seed company for information on inbred tolerance before using Capreno on seed corn inbreds.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.
- Use 2 oz/A of Capreno and 22 oz/A of glufosinate when mixing in LibertyLink corn. Do not use any adjuvants except AMS.
- Use 3 oz/A of Capreno when mixing with glyphosate in glyphosate-resistant corn. AMS should always be included with this combination. The addition of a glyphosate-compatible high surfactant oil blend is also recommended, and required if the glyphosate does not contain adjuvants.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Dicamba	**4L**	**1/2 - 1 pt**	**Not addressed on label**

- Dicamba is sold under a number of trade names, including Banvel, Clarity, Sterling Blue, and Oracle. Dicamba is a translocated herbicide that controls many annual broadleaf weeds, including pigweeds, ragweeds, eastern black nightshade, cocklebur, and Pennsylvania smartweed. Control of velvetleaf can be variable. Dicamba will control or suppress perennial broadleaf weeds, especially when applied with group 2 herbicides.
- Site of action: group 4 (see pages 22-23).
- Apply 1/2 to 1 pint when corn is in the spike to five-leaf stage, or until corn is 8 inches tall, whichever occurs first. Do not apply more than 1/2 pint on coarse-textured soils. If the 6th true leaf is emerging from the whorl, or corn is more than 8 inches tall, a rate of 1/2 pint can be applied until corn is 36 inches tall, or until 15 days before tassel emergence. Apply as a directed spray when corn leaves prevent proper spray coverage, or sensitive crops are growing nearby.
- The 1 pint rate provides limited residual broadleaf weed control.
- Apply with 1/2 to 1 gallon per acre of UAN (28%) when velvetleaf is a target weed. Can be applied with surfactant or crop oil to improve control in dry growing conditions. Do not apply with crop oil when corn exceeds 5 inches in height.
- With any dicamba product, risk of corn injury increases when corn exceeds 8 to 10 inches in height. To reduce risk of injury, make sure nozzle spacing and spray boom height are set to minimize interception of spray by the corn plants.
- Soybeans and vegetables are extremely susceptible to dicamba. Apply in a spray volume of 20 gpa at a pressure of less than 20 psi to reduce drift. Do not apply where sensitive crops are growing nearby if winds over 5 MPH are moving in the direction of sensitive crops, corn is more than 24 inches tall, soybeans are more than 10 inches tall, or

soybeans have begun to bloom. Most dicamba products should not be applied when air temperatures on the day of application will exceed 85 degrees.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Dicamba + atrazine premix	**3.2L**	**3 1/2 pt**	**Not addressed on label**

- Dicamba plus atrazine is sold under a number of trade names, including Marksman, Sterling Plus, Banvel-K+atrazine, and Stratos. These products control most annual broadleaf weeds, and suppress or control perennial broadleaf weeds.
- Site of action: group 5 (atrazine), group 4 (dicamba). See pages 22-23.
- Apply when corn is in the spike to five-leaf stage, or until corn is 8 inches tall, whichever comes first. The rate is 3 1/2 pints on medium- or fine-textured soils with at least 2 percent organic matter, and 2 pints on coarse-textured soils. Provides some residual broadleaf weed control.
- The addition of crop oil, surfactant, or liquid nitrogen fertilizer may improve control, especially when weeds are drought-stressed. Apply with UAN if velvetleaf is a target weed. Application with crop oils may cause crop injury. Do not apply with crop oil after corn exceeds 5 inches in height.
- Precautions on spray drift, volatility, and corn injury are the same as for dicamba. See dicamba description for more information.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
DiFlexx	**4L**	**1/2 - 1 pt**	**Not addressed on label**

- DiFlexx is a premix of dicamba and cyprosulfamide, a safener that reduces the risk of injury to corn. See dicamba description for more information also.
- Site of action: group 4 (see pages 22-23).
- Apply 1/2 to 1 pint when corn is in the spike to V6 stage, or up to 36 inches tall, whichever occurs first. Apply as a directed spray when corn is in the V7 to V10 stage and less than 36 inches tall, or up to 15 days before tassel, whichever occurs first. Directed spray should be used also when corn leaves prevent proper spray coverage, sensitive crops are growing nearby, or if mixed with 2,4-D.
- Can be applied with and adjuvant and nitrogen source, especially under dry growing conditions. Apply with NIS (0.25% v/v) or COC/MSO (1% v/v) plus either UAN (2 to 4 qt/A) or AMS (8.5 to 17 lbs/100 gallons of water).

Herbicide	Formulation	Product Rate Range	With Glyphosate
Hornet	**68.5WDG**	**2 - 5 oz**	**2 - 4 oz**

- Hornet is a premix of flumetsulam (Python) and clopyralid (Stinger) that controls annual broadleaf weeds, and suppresses certain perennial broadleaf weeds. Hornet controls ragweeds, velvetleaf, cocklebur, Pennsylvania smartweed, and small marestail, but is not effective for control of lambsquarters, pigweeds, eastern black nightshade, and annual morningglory. The higher rates can suppress or control some perennial weeds, including dandelion and Jerusalem artichoke.
- Site of action: group 2 (flumetsulam), group 4 (clopyralid). See pages 22-23.
- Hornet will control the above-ground growth of Canada thistle, but may be less effective than labeled rates of Stinger for long-term control of thistle. Mixing Hornet with Stinger will improve long-term control. Apply before thistle plants are in the bud stage for best results.
- Apply broadcast when weeds are 2 to 8 inches tall and field corn is up to 20 inches tall or at the 6-collar stage, whichever occurs first. Hornet can be applied as a directed postemergence application using drop nozzles to corn that is 20 to 36 inches tall.
- Apply with NIS (1 quart/100 gallons) or COC (1 gallon/100 gallons). Under dry conditions, the addition of UAN (2 1/2 gallons/100 gallons) may improve control.
- Apply in a spray volume of 10 to 40 gpa with a spray pressure of 20 to 40 psi.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

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- Do not apply to corn that shows symptoms of injury from previously applied herbicides. Corn inbred lines may be injured by Hornet.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Impact/Armezon	**2.8L**	**0.75 - 1 oz**	**0.5 - 0.75 oz**

- Impact/Armezon (topramezone) controls many broadleaf weeds, including biotypes resistant to group 2 herbicides, glyphosate, and triazines. Impact controls or suppress small annual grasses. Impact/Armezon is most effective when applied in combination with 0.25 to 1.5 lbs ai/A of atrazine. The higher atrazine rates will provide residual weed control.
- Site of action: group 27 (see pages 22-23).
- Can be applied to field corn, seed corn, popcorn, and sweet corn. Check with seed supplier for information on tolerance prior to use on inbreds grown for seed production.
- Apply when most broadleaf weeds are emerged and less than 6 inches tall.
- Impact can be applied postemergence up to 45 days before crop harvest. Apply with drop nozzles if the crop canopy prevents adequate spray coverage on weeds.
- For best results, apply with a MSO (1 to 1.5% v/v) plus either UAN (1.25 to 2.5% v/v) or AMS (8.5 to 17 lbs/100 gallons of water). NIS can be used instead of methylated seed soil if required in mixtures with other herbicides.
- Apply in a minimum spray volume of 10 gpa, and apply in 15 gpa when treating large weeds or high-density weed infestations.
- Impact/Armezon should not be relied upon to provide complete control of grasses, but can control small (less than 3-inch) grasses that escape preemergence herbicides.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Laudis	**3.5L**	**3 oz**	**Glyphosate: 3 oz** **Glufosinate: 2 - 3 oz**

- Laudis (tembotrione) controls many broadleaf weeds, including biotypes resistant to groups 2, 5, and 9. Laudis controls or suppresses small annual grasses.
- Laudis is most effective when applied in combination with 0.5 lbs ai/A of atrazine. Bromoxynil (6 to 12 oz/A) can be substituted for atrazine when corn is more than 12 inches tall.
- Site of action: group 27 (see pages 22-23).
- Can be applied to field corn, seed corn, popcorn, and sweet corn. Check with seed supplier for information on tolerance prior to use on popcorn, sweet corn, or inbreds grown for seed production.
- Apply when broadleaf weeds are less than 6 inches tall. Most grass species should be less than 3 inches tall at time of application.
- Apply broadcast up to the V8 stage of field corn.
- Apply with MSO (1% v/v, minimum of 1.25 pt/A) plus either UAN (1.5 qt/A) or AMS (1.5 lb/A).
- Apply in a minimum spray volume of 10 gpa, and apply in 15 to 20 gpa in dense weed populations or under adverse environmental conditions. Use nozzles and pressure that result in medium spray droplets, and increase application volume when using nozzles that produce coarse spray droplets. Flat fan nozzles of 80 or 110 degrees will provide optimum postemergence spray coverage.
- Laudis should not be relied upon to provide complete control of grasses, but can control small (less than 3-inch) grasses that escape preemergence herbicides.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not for-

mulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

Herbicide	Formulation	Product Rate Range
Nicosulfuron (active ingredient)		
Accent Q	**54.5WDG**	**0.9 oz**
NIC-IT	**2L**	**2 oz**

- These products contain nicosulfuron, a translocated sulfonylurea herbicide. Accent Q contains nicosulfuron plus isoxadifen, a safener to reduce the risk of corn injury. Nicosulfuron controls annual and perennial grasses and a few annual broadleaf weeds. Does not control crabgrass.
- Site of action: group 2 (see pages 22-23).
- Accent Q and NIC-IT are labeled for use on field corn, popcorn, seed corn, and some sweet corn hybrids grown for processing and fresh market. Growers should contact seed suppliers for recommendations and information on hybrid tolerance, and use of soil-applied organophosphate insecticides, prior to application to popcorn or seed corn. Accent and NIC-IT can be used on high-lysine, waxy, white or other food grade hybrids.
- Can be applied broadcast or as a directed spray to field corn that is up to 20 inches tall or up to 6 collars (whichever occurs first). Apply as a directed spray when corn is 20 to 36 inches tall. Do not apply to corn that is at or past the 10-collar stage or more than 36 inches tall. Best results occur when corn is less than 12 inches tall and weeds are small.
- Can be applied broadcast to seed corn that is less than 20 inches tall or up to 5 collars (whichever occurs first).
- For best results, apply with COC (1 gallon/100 gallons spray) plus UAN (2 to 4 quarts/A) or AMS (2 to 4 lbs/A). Substituting a MSO for COC can improve control under drought-stressed conditions. NIS (1 to 2 qts/100 gallons spray) can be used instead of crop oil if required in a mixture with another herbicide.
- Apply in a spray volume of at least 10 gpa with a pressure of 20 to 40 psi. Increase volume to at least 15 gpa in heavy weed pressure. Avoid spraying excessive amounts of herbicide directly into the corn whorl.
- Apply when grasses are at the following heights: foxtails and fall panicum — 2 to 4 inches; quackgrass — 4 to 10 inches; shattercane and seedling johnsongrass — 4 to 12 inches; rhizome johnsongrass — 8 to 18 inches.
- Control of yellow and green foxtail may be reduced in mixture with some broadleaf herbicides. Consult the label for spray additive recommendations when mixing with broadleaf herbicides, and follow the most restrictive label with regard to maximum corn size at the time of application.
- Control may be reduced if applied during conditions of drought stress, abnormally hot or cold weather, when daytime temperatures do not exceed 50 degrees, or following periods of large day/night temperature fluctuations.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range	With Glyphosate
NorthStar	**47.4DF**	**5 oz**	**2.5 - 5 oz**

- NorthStar is a premix of primisulfuron (Beacon) plus dicamba (Banvel) for control of annual broadleaf weeds and suppression or control of annual and perennial grasses. NorthStar will suppress a number of perennial broadleaf weeds. See Beacon and dicamba descriptions for more information and precautions on use.
- Site of action: group 2 (primisulfuron), group 4 (dicamba). See pages 22-23.
- Can be applied broadcast or directed to field corn that is between 4 and 20 inches tall. Apply using drop nozzles when corn is 20 inches (V6) up to 36 inches tall or 15 days before tassel emergence, whichever occurs first.
- For seed corn inbreds, apply as a directed spray using drop nozzles when corn is between 10 and 36 inches tall or 15 days before tassel emergence, whichever occurs first. Inbred lines should be thoroughly tested for sensitivity to NorthStar before treating large acreages.
- Apply with NIS (0.25% v/v) or COC (1 to 4 pints/A), but do not use COC if corn is more than 12 inches tall. UAN (2 to 4 qts/A) or AMS (2 to 4 lbs/A) may also be added.

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- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.
- When mixing with glyphosate, add AMS if the glyphosate contains adjuvants. Otherwise, add adjuvants specified on the glyphosate product label.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Peak	**57DF**	**0.25 - 0.5 oz**	**0.25 - 0.5 oz**

- Peak (prosulfuron) can be mixed with other broadleaf herbicides to improve control of emerged weeds and provide residual control of burcucumber and other weeds in field corn.
- Site of action: group 2 (see pages 22-23).
- Peak can be applied to corn up to 30 inches tall, but should be applied as a directed spray using drop nozzles when corn is past the 6-collar stage or more than 20 inches tall.
- When mixing Peak with a herbicide that contains a fully loaded adjuvant system (e.g. Touchdown Total), no additional adjuvant is needed. All other herbicide mixtures should be applied with COC (1% v/v).
- Check label for recrop information prior to use. Recrop to soybeans and other crops varies with rate applied, whether mixed with Spirit, area of the state, and soil pH. The recrop interval for soybeans can be 18 months for some rates and mixtures.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Permit/Sandea/Halomax	**75DF**	**2/3 to 1 1/3 oz**	**Not addressed on label**

- These products contain halosulfuron, a translocated sulfonylurea herbicide that controls yellow nutsedge and annual broadleaf weeds, including velvetleaf, ragweeds, cocklebur, and redroot pigweed. Halosulfuron is weak on lambsquarters and annual morningglory. A combination of halosulfuron plus dicamba will improve control of these weeds and control or suppress perennial broadleaf weeds. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Apply when field corn is in the spike through layby stage and most annual weeds are 1 to 6 inches tall for best results. When corn is more than 24 inches tall, mixtures of halosulfuron with other postemergence corn herbicides should be applied with drop nozzles to ensure weed coverage and avoid spraying directly into the whorl. Follow the most restrictive label with regard to maximum corn size when mixing with other herbicides..
- For control of yellow nutsedge, apply 1 to 1 1/3 ounces/A when nutsedge is 4 to 12 inches tall. Dense populations of nutsedge may require a second application.
- Apply in a minimum spray volume of 10 gpa with NIS (1 to 2 quarts/100 gallons) or COC (1 gallon/100 gallons). Include UAN (2 to 4 quarts/A) or AMS (2 to 4 lbs/A) when velvetleaf or redroot pigweed is present.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Realm Q	**38.75WDG**	**4 oz**	**4 oz**

- Realm Q is a premix of rimsulfuron (Resolve) and mesotrione (Callisto). It also contains a safener, isoxadifen, that reduces risk of corn injury and broadens the application window, compared with other rimsulfuron products.
- Realm Q controls or suppresses small annual grass (1 to 2 inches) and broadleaf (less than 5 inches) weeds, and provides limited residual control. Can be mixed with glyphosate (glyphosate-resistant corn), glufosinate (LibertyLink corn), and other herbicides to broaden the spectrum of control, or for control of larger weeds, or to extend residual control.
- Site of action: group 2 (rimsulfuron); group 27 (mesotrione). See pages 22-23.
- Can be applied broadcast to field corn up to 20 inches tall and prior to the 7-collar stage (whichever is more restrictive).
- The preferred adjuvant system for Realm Q is COC or MSO (1% v/v) plus UAN (2 qt/A) or AMS (2 lb/A). NIS can be used instead of COC/MSO. Do not use spray additives that adjust the spray solution pH below 5 or above 9 as

rapid product degradation can occur.

- Use a minimum spray volume of of 15 gpa for best performance. Volume of 10 gpa can be used for light, scattered stands of weeds. To minimize drift, apply using nozzles that deliver coarse spray or larger spray droplets.
- When applied in a tank-mix with a glyphosate that contains a built-in adjuvant, ensure the total adjuvant load is equivalent to the recommendations on the Realm Q label.
- Do not mix with Basagran. See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Resolve Q	**22.4 WDG**	**1.25 oz**	**1.25 oz**
Harrow	**75 DF**	**0.33 oz**	**0.33 oz**

- Resolve Q and Harrow are premixes of rimsulfuron and thifensulfuron. Resolve Q also contains a safener, isoxadifen, that reduces risk of corn injury and broadens the application window, compared with other rimsulfuron products.
- Controls or suppresses small (1 to 2 inch) annual grass and broadleaf weeds, including foxtails, lambsquarters, and pigweed. When mixed with glyphosate in postemergence treatments to glyphosate-resistant corn, Resolve/Harrow provides residual control of annual grasses and some small-seeded broadleaf weeds.
- Site of action: group 2 (see pages 22-23).
- Resolve Q can be applied broadcast to field corn with up to 6 collars, or up to 20 inches tall (whichever is more restrictive). Harrow can be applied to corn in the spike to 2-collar stage; do not apply to corn over 6 inches tall.
- Resolve Q should be applied with NIS (0.25% v/v) plus UAN (2 qt/A) or AMS (2 lb/A). Harrow should be applied with COC (1% v/v) or NIS (0.25% v/v) plus UAN (2 qt/A) or AMS (2 lb/A). No additional adjuvants are needed when applying with glufosinate or a glyphosate product that contains surfactant.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Revulin Q	**51.2WDG**	**3.4 - 4 oz**	**3.4 - 4 oz**

- Revulin Q is a premix of nicosulfuron (Accent Q) and mesotrione (Callisto). It also contains a safener, isoxadifen, that reduces risk of corn injury and broadens the application window, compared with non-safened nicosulfuron products. See nicosulfuron and Callisto descriptions for more information also.
- Controls small (less than 4 to 5 inches) annual grass and broadleaf weeds, and provides limited residual control. Can be mixed with glyphosate (glyphosate-resistant corn), glufosinate (LibertyLink corn), and other herbicides to broaden the spectrum of control, or for control of larger weeds, or to extend residual control.
- Site of action: group 2 (nicosulfuron); group 27 (mesotrione). See pages 22-23.
- Can be applied broadcast to field corn or seed corn up to 20 inches tall and prior to the V5 stage (whichever is more restrictive). Can be applied as a directed spray with drop nozzles when field corn (not seed corn) is 20 to 30 inches tall, and prior to the V8 stage. Apply when corn is less than 12 inches tall for best results.
- The preferred adjuvant system for Revulin Q is COC (1% v/v) or HSOC (0.5% v/v) plus UAN (2 qt/A) or AMS (2 lb/A). NIS (0.25% v/v) can be used instead of COC/HSOC but weed control may be reduced. Do not use MSO or MSO blend adjuvants. Do not use spray additives that adjust the spray solution pH below 5 or above 9 as rapid product degradation can occur.
- Use a minimum spray volume of of 15 gpa for best performance. Volume of 10 gpa can be used for light, scattered stands of weeds. To minimize drift, apply using nozzles that deliver coarse spray or larger spray droplets.
- When applied in a tank-mix with a glyphosate that contains a built-in adjuvant, ensure the total adjuvant load is equivalent to the recommendations on the Revulin Q label.
- Do not mix with Basagran. See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

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Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Shotgun	**3.25L**	**2 - 3 pints**	**Not addressed on label**

- Shotgun is a premix of atrazine plus 2,4-D for postemergence control of many broadleaf weeds in corn.
- Site of action: group 5 (atrazine), group 4 (2,4-D). See pages 22-23.
- Apply broadcast in a minimum spray volume of 10 gpa when corn is spike to 8 inches tall, and as a directed spray when corn is 8 to 12 inches tall. Treated corn may be brittle and subject to breakage by wind during the 2 weeks following application.
- Follow precautions to prevent drift and volatility of 2,4-D, which will injure nearby broadleaf plants. Volatility is more likely at air temperatures greater than 85 degrees.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Solstice	**4L**	**2.5 - 3.15 oz**	**Not addressed on label**

- Solstice is a premix of fluthiacet-methyl (Cadet) and mesotrione (Callisto) for control of many annual broadleaf weeds less than 5 inches tall. Mix with atrazine for improved control of ragweeds or larger weeds.
- Site of action: group 14 (fluthiacet); group 27 (mesotrione). See pages 22-23.
- Can be applied to field and seed corn up to 30 inches tall, or the V8 stage, whichever occurs first. Consult seed company for recommendations before using on inbred lines.
- Apply with COC (1% v/v) or NIS (0.25% v/v) plus UAN (2.5% v/v) or AMS (8.5 lb/100 gallons). COC is the preferred adjuvant. Do not apply with MSO or MSO blends. Do not apply in a mixture with emulsifiable concentrate grass herbicides.
- Apply in a spray volume of 10-30 gpa, and minimum of 15 gpa in dense foliage. Use spray nozzles that provide medium droplet size, and pressure of 35-40 psi at the nozzle. Flat fan nozzles are recommended for optimum coverage.
- Solstice can cause bleaching and speckling of leaves, which is typically short-lived. Spray boom should be kept a minimum of 18 inches above the crop canopy to ensure uniform spray distribution and to avoid concentrating spray in corn whorls.
- See label and Table 10 for information about possible interactions between Solstice and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Spirit	**57DF**	**1 oz (1 packet per 4 acres)**	**0.75 - 1 oz**

- Spirit is a premix of prosulfuron (Peak) plus primisulfuron (Beacon), translocated sulfonylurea herbicides. Broadleaf weed control is similar to Beacon, although Spirit is more effective on a few broadleaf weeds. Mixing with dicamba, 2,4-D, or bromoxynil will improve annual weed control. Most effective control/suppression of perennial broadleaf weeds will occur when mixed with 2,4-D or dicamba. Spirit is weak on annual morningglories and yellow nutsedge. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Follow these guidelines to avoid carryover of Spirit to subsequent crops: 1) Avoid use where soil pH is greater than 7.8. If used where soil pH is greater than 7.8, plant only field corn or small grains the following year; 2) where less than one inch of rain occurs within one month of application, or less than 12 inches of rain occurs within 5 months after application, plant only corn, small grains, or STS soybeans the following year ; 2) north of Interstate 80, do not plant soybeans within 18 months of application; 3) south of I-80, soybeans can be planted 10 months after application where soil pH is less than 7.8; and 4) do not apply after June 30. See label for guidelines on rotation to other crops.
- Apply broadcast or directed when field corn is 4 to 24 inches tall. To avoid injury and improve spray coverage on weeds, apply as a directed spray using drop nozzles when corn is more than 20 inches tall.
- For seed corn inbreds, Spirit can be applied broadcast when corn is between 4 and 20 inches tall, or until the 6-collar stage, whichever occur first. Use drop nozzles when seed corn inbreds are 20 to 24 inches tall and before tassel emergence. Inbred lines should be thoroughly tested for sensitivity to Spirit before treating large acreages.

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- Apply in a minimum spray volume of 10 gpa. Increasing the volume to at least 20 gpa can improve control in dense weed infestations.
- Apply with COC (1 to 4 pints/A) or NIS (1 to 2 quarts/100 gallons). UAN (2 to 4 quarts/A) or AMS (2 lbs/A) may be added to improve control of velvetleaf and other weeds. COC is generally more effective than NIS. Use of a MSO (Meth Oil, Priority MSO, Sun-It II, for example) may improve control when weeds are large or drought-stressed.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Starane	**1.5L**	**2/3 pt**	**Not addressed on label**

- Starane (fluroxypyr) is a translocated herbicide that controls hemp dogbane, kochia, common ragweed and a few other broadleaf weeds. Due to a relatively narrow spectrum of activity, Starane should be mixed with other herbicides to improve control of specific problem weeds.
- Site of action: group 4 (see pages 22-23).
- Apply broadcast up to the V5 stage of field corn and when weeds are less than 8 inches tall. Applications when corn is past the V5 stage should be made as a directed spray using drop nozzles.
- Crop injury, including stem curvature, stunting, and brace root injury can occur with some corn hybrids when Starane is applied as a broadcast treatment. Hybrids susceptible to phenoxy injury may also be susceptible to injury from Starane.
- When mixing with other herbicides, use adjuvants specified on the label of the partner herbicides.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Status	**56 WDG**	**2.5 - 10 oz**	**2.5 - 5 oz**

- Status is a premix of dicamba plus diflufenzopyr plus a safener, for control of most annual broadleaf weeds in corn. Addition of the safener results in reduced risk of injury to corn, compared with other dicamba products. Status can be weak on velvetleaf, although it is more effective than dicamba alone.
- Site of action: group 4 (dicamba), group 19 (diflufenzopyr). See pages 22-23.
- Status can control or suppress small annual grasses that have escaped premergence herbicide treatments. Effectiveness on grasses is variable, and can be reduced under dry conditions.
- Status is generally more effective than other dicamba products on perennial broadleaf weeds, and has provided excellent control of Canada thistle and hedge bindweed in OSU research.
- Apply when corn is 4 to 36 inches tall, or from V2 to V10. The 5 oz rate should be used when Status is applied postemergence following preemergence herbicides. The 2.5 oz rate can be used to improve control in mixtures with glyphosate, or glufosinate, but rate should be increased to 5 oz where weeds are resistant to any of these herbicides.
- Status can be applied with NIS (0.25% v/v), COC (1 to 2 pt/A), or a methylated seed soil (1 to 2 pt/A) plus UAN (1.25% v/v) or AMS (5 to 17 lbs/100 gallons). To avoid mixing problems, add Status to spray tank first, and make sure it is fully suspended in water before adding AMS.
- Take precautions to avoid contact of Status with sensitive plants via drift or volatility. Exposure of soybeans to Status via sprayer contamination or spray particle drift will result in more severe injury compared with other dicamba products. Thoroughly clean spray equipment, including tank, hoses, and screens, to make sure it is free of Status prior to using the same equipment in soybeans.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

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Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Steadfast Q	**37.7 WDG**	**1.5 oz**	**Not addressed on label**

- Steadfast Q is a 2:1 premix of nicosulfuron (Accent) and rimsulfuron , translocated sulfonylurea herbicides, that controls annual and perennial grasses, including foxtails, fall panicum, quackgrass, and shattercane. Will control large crabgrass up to one inch tall. Controls small annual morningglory, pigweed, Pennsylvania smartweed, and sunflower. Steadfast Q contains isoaxadifen, a safener that reduces the risk of crop injury.
- Site of action: group 2 (see pages 22-23).
- Can be applied broadcast or as a directed spray to field corn that is up to 20 inches tall or up to 6 collars (whichever comes first). Best overall performance will occur when applied to corn less than 12 inches tall. Do not apply to seed corn seed inbreds.
- For best results, apply with COC (1 gallon/100 gallons spray) plus UAN (28% - 2 quarts/A) or AMS (2 lbs/A). Substituting a MSO (Meth Oil, Priority MSO, Sun-It II, for example) for COC can improve control under drought-stressed conditions. NIS (1 to 2 qts/100 gallons spray) can be used instead of crop oil if required in a mixture with another herbicide, but grass control may be reduced.
- Apply in a spray volume of at least 15 gpa with a pressure of 20 to 40 psi. Avoid spraying excessive amounts of herbicide directly into the corn whorl.
- Apply when grasses are at the following heights: foxtails, fall panicum, and barnyardgrass — up to 4 inches; quackgrass — 4 to 8 inches; shattercane — up to 6 inches; seedling johnsongrass — up to 8 inches.
- Control may be reduced if applied during conditions of drought stress, abnormally hot or cold weather, when nighttime temperatures are less than 40 degrees, or following periods of large day/night temperature fluctuations.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Stinger	**3L**	**1/4 - 2/3 pt**	**Not addressed on label**

- Stinger (clopyralid) is a translocated herbicide that controls ragweeds, cocklebur, jimsonweed, and Canada thistle. Controls or suppresses Jerusalem artichoke and suppresses sowthistle.
- Site of action: group 4 (see pages 22-23).
- Apply after corn emergence until corn is 24 inches tall, and us a spray volume of at least 10 gallons per acre.
- For annual weed and Jerusalem artichoke control, apply 1/4 to 1/2 pint when weeds have 5 or fewer leaves.
- For Canada thistle control, apply 1/3 to 2/3 pint when thistles are at least 4 inches tall or across, but before the bud stage. The higher rate provides more complete plant kill and better control of dense patches. Do not cultivate prior to or for 14 to 20 days following application. Although control of thistle with Stinger during the season of application may appear similar to that from other corn herbicides, Stinger provides more complete kill of the entire plant (at a greater cost).

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
WideMatch	**1.5L**	**1.3 pts**	**Not addressed on label**

- WideMatch is a premix of clopyralid (Stinger) plus fluroxypyr (Starane) for control of broadleaf weeds in corn, including hemp dogbane, ragweeds, Canada thistle, marestail, and cocklebur.
- Site of action: group 4 (see pages 22-23).
- Apply broadcast up to the V5 stage of field corn and when weeds are less than 8 inches tall. Applications when corn is past the V5 stage should be made as a directed spray using drop nozzles.
- Crop injury, including stem curvature, stunting, and brace root injury can occur with some corn hybrids when WideMatch is applied as a broadcast treatment. Hybrids susceptible to phenoxy injury may also be susceptible to injury from WideMatch.
- For most effective Canada thistle control, apply after the majority of the basal leaves have emerged and before bud stage.

Corn: Postemergence Herbicides — Systemic

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Yukon	**67.5WG**	**4 - 8 oz**	**2 - 8 oz**

- Yukon is a premix of halosulfuron (Permit) plus dicamba for control of most annual broadleaf weeds and yellow nutsedge. Yukon will also suppress/control some perennial broadleaf weeds, primarily during the growing season of application.
- Site of action: group 2 (halosulfuron); group 4 (dicamba). See pages 22-23.
- Can be applied broadcast or with drop nozzles from the spike stage through 36 inch-tall corn. Weeds should generally be less than 6 inches tall for best results. Use a rate of 6 to 8 oz for yellow nutsedge control.
- Apply with NIS (1 to 2 quarts/100 gallons) or COC (1 gallon/100 gallons). COC may cause injury at the higher Yukon rates. UAN (28% UAN, etc. - 2 to 4 quarts/A) or AMS (2 to 4 lbs/A) can be added to improve control of certain weeds or if required for another herbicide in the spray mix. Apply in a spray volume of at least 10 gpa.
- Most of the precautions and restrictions on use of Permit and dicamba apply to Yukon also. See Permit and dicamba descriptions for more information.
- When mixing with glyphosate, add NIS at 0.25% v/v if glyphosate product used does not contain adjuvants. Use of AMS at 8.5 - 17 lb/100 gal is required. When mixing with glufosinate, the addition of AMS is required.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
2,4-D LV ester	**Various**	**0.17 - 0.25 lb ai/A**	**Not addressed on label**
2,4-D amine	**Various**	**0.34 - 0.5 lb ai/A**	
2,4-D acid	**1.74L**	**0.5 - 2.25 pts**	

- Site of action: group 4 (see pages 22-23).
- Controls many annual broadleaf weeds, including ragweeds, cocklebur, lambsquarters, and pigweed. Will control or suppress perennial broadleaf weeds, especially when applied with Beacon, Spirit, or Permit.
- For best results, apply when weeds are small.
- If corn is more than 8 inches tall, use drop nozzles to reduce the risk of crop injury. Do not apply from tasseling to the dough stage.
- Use precautions to prevent drift. The ester forms of 2,4-D can volatilize and injure nearby susceptible plants, including soybeans and vegetable crops. Amine and acid formulations are less volatile than ester formulations, and should generally be used for postemergence applications in corn.
- Injury may result when applied to corn growing rapidly under high temperatures and high humidity. Corn may be brittle for 7 to 10 days after application, and is susceptible to stalk breakage from high winds or cultivation.

LibertyLink Corn — Postemergence Herbicides

Herbicide	Formulation	Product Rate Range
Glufosinate		
Liberty/Cheetah/Interline	**2.34L**	**22 oz**

- Glufosinate is a contact, broad-spectrum herbicide for postemergence use only on LibertyLink (glufosinate-resistant) corn.
- Site of action: group 10 (see pages 22-23).
- Glufosinate controls many annual grass and broadleaf weeds up to 3 to 6 inches tall when applied at a rate of 22 oz per acre. Mixing with atrazine improves control of many weeds, including pigweeds, waterhemp, velvetleaf, annual morningglories, and lambsquarters, and can provide residual control. Maximum total amount of glufosinate that can be applied per season (burndown + POST) is 44 oz.
- Ohio State and Purdue University research indicates that glufosinate is most effective in a combined preemergence plus postemergence program, where the preemergence herbicide will provide control of grass and broadleaf weeds for several weeks to a month after corn planting. Postemergence applications of glufosinate in this program should include atrazine, Capreno, or Laudis where possible. Glufosinate is weak on yellow foxtail, barnyardgrass, and lambsquarters, and the other PRE or POST herbicides used with glufosinate should provide substantial control of these weeds.
- Maximum height for grass weeds at the 22 oz/A rate: barnyardgrass, crabgrass, yellow foxtail, fall panicum - 3 inches; woolly cupgrass, shattercane, and green, giant, and robust foxtails - 6 inches; volunteer corn - 10 inches. Yellow foxtail and crabgrass should be treated prior to tiller initiation for best results. Glufosinate is most effective on volunteer corn (including glyphosate-resistant) that is 6 to 12 inches tall.
- Maximum height for broadleaf weeds at the 22 oz/A rate: velvetleaf, pigweeds - 3 inches; lambsquarters, waterhemp - 4 inches; burcucumber, cocklebur, annual morningglories, eastern black nightshade, ragweeds, and Pennsylvania smartweed - 6 inches.
- Glufosinate plus atrazine (1 lb ai/A) will control or suppress some perennial weeds, including dandelion, Canada thistle, Jerusalem artichoke, and wirestem muhly. Glufosinate has activity on above-ground growth only, so regrowth of perennials may occur and retreatment may be necessary.
- Apply with AMS at the rate of 3 lbs/A, or 17 lbs/100 gallons. When air temperatures are above 85 degrees, the rate can be reduced to 1.5 lbs/A, or 8.5 lbs/100 gallons, to reduce the risk of leaf burn. Applying with surfactants or crop oils may increase the risk of crop injury.
- Apply broadcast from corn emergence through the V7 stage (7 collars), and as a directed spray up to 36-inch corn.
- Apply in a minimum spray volume of 15 gpa. Use a volume of 20 to 40 gpa in dense weed/crop canopies. Glufosinate should be applied with a nozzle type and spray pressure that results in medium spray droplets (250 to 350 microns).
- Glufosinate is most effective when applied under warm, sunny conditions. Effectiveness may be reduced if applied when heavy dew, fog and mist/rain are present, or if weeds are under stress due to drought, cool temperatures, or extended periods of cloudiness. To avoid reduced weed control, apply between dawn and two hours before sunset.

Glyphosate-Resistant Corn — Postemergence Herbicides

Herbicide	Formulation	Product Rate Range
Callisto GT	**4.18L**	**2 pt**

- Callisto GT is a premix of glyphosate and mesotrione (Callisto) that controls emerged grass and broadleaf weeds in glyphosate-resistant corn, and provides residual control of broadleaf weeds. See descriptions of glyphosate and Callisto for more information on these herbicides.
- Site of action: group 9 (glyphosate), group 27 (mesotrione). See pages 22-23.
- Use rate provides the equivalent of 3 oz of Callisto and 0.85 lb ae glyphosate.
- Apply before corn exceeds 30 inches in height, and prior to the V8 stage.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.
- Apply with NIS (0.25 to 0.5% v/v) and AMS (8.5 to 17 lbs/100 gallons). NIS can be replaced with COC (1% v/v) but risk of crop injury increases. Do not use MSO or MSO-based adjuvants.

Herbicide	Formulation
Expert	**4.88L**

- Expert is a premix of glyphosate, S-metolachlor (Dual II Magnum), and atrazine that can be applied early postemergence to glyphosate-resistant corn. See descriptions of glyphosate and metolachlor/S-metolachlor plus atrazine for more information on these herbicides.
- Site of action: group 9 (glyphosate), group 5 (atrazine), group 15 (S-metolachlor). See pages 22-23.
- Use rates provide the equivalent of 0.4 to 0.75 lbs of glyphosate acid and 1.75 to 2.6 quarts/A of Bicep II Magnum. Use rate ranges from 2.5 to 3.75 qts/A on coarse-textured soils with less than 3% organic matter, and from 3 to 3.75 on all other soils.
- Apply before corn exceeds 12 inches in height.
- Use water as the spray carrier for postemergence applications. Do not mix other products with Expert when applying to emerged corn. Can cause minor corn leaf burn.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**0.56 - 1.12 lb ae/A**

- Glyphosate is a translocated herbicide that controls emerged annual and perennial grass and broadleaf weeds. Variations in the formulation may result in differences in product rate and adjuvant recommendations, and specified rainfast intervals. Users should consult labels and local product use guides for more specific information.
- Apply postemergence only to glyphosate-resistant corn hybrids (Roundup Ready, Agrisure GT, etc.).
- Site of action: group 9 (see pages 22-23).
- The general recommendation on most labels for the initial postemergence glyphosate application is a rate of 0.56 to 0.75 lbs of glyphosate acid per acre (lbs ae/A) when weeds are less than 4 inches tall, or before weeds become competitive with the crop. Rates should be increased to 1.1 lbs ae/A where weeds are more than 6 inches tall. Multiple postemergence applications of glyphosate are allowed. The maximum rate per application is 1.1 lbs ae/A of glyphosate and the total amount that can be applied postemergence in one season should not exceed 2.25 lbs ae/A. There are exceptions to this depending upon the glyphosate product used and the type of glyphosate-resistant corn planted, and in some situations the maximum rate and amount that can be applied may be lower. Consult seed supplier and glyphosate product label prior to use.
- University research has shown that postemergence glyphosate treatments should be applied when weeds are no more than 2 to 4 inches tall in order to avoid corn yield loss from early-season weed competition. Where preemergence herbicides are applied, there may be more flexibility in the timing of postemergence glyphosate treatments.
- The following management practices are most effective for minimizing the risk of glyphosate resistance in weeds, maintaining adequate weed control, and preserving maximum crop yield: 1) start weed free at planting through use of tillage or a preplant burndown herbicide application; 2) Apply preplant/preemergence herbicides at rates that provide 4 to 6 weeks of residual weed control; 3) make the first postemergence glyphosate application when weeds are less than about 4 inches tall, and consider adding a herbicide with another site of action to help prevent the development of resistance and control glyphosate-resistant weeds.

Glyphosate-Resistant Corn — Postemergence Herbicides

- A total postemergence approach can be effective in glyphosate-resistant corn, but only when: 1) the field is weed free at the time of crop planting through use of tillage or preplant burndown herbicides; 2) the postemergence treatment is applied soon enough after planting to small weeds (less than 2 to 4 inches tall), in order to avoid yield loss from weed interference; and 3) when the postemergence treatment includes not only glyphosate, but also residual herbicides that will control later-emerging weeds for several weeks to a month.
- For Roundup Ready Corn 2, most glyphosate products can be applied broadcast or as a directed spray using drop nozzles from corn emergence through the 8-collar stage or until corn is 30 inches tall, whichever occurs first. When corn is 24 to 30 inches tall, use of drop nozzles will generally improve spray coverage on weeds. Drop nozzles can be used to apply glyphosate to Roundup Ready Corn 2 up to 48 inches tall, but should be adjusted to keep spray out of corn whorls. Similar guidelines apply to the use of Touchdown on Agrisure GT corn. However, not all glyphosate products are labeled similarly with regard to use on Agrisure GT corn. Consult seed supplier and glyphosate product label prior to use.
- Glyphosate resistance has developed in populations of marestail, Palmer amaranth, waterhemp, and common and giant ragweed in Ohio, Indiana, and Illinois, and some lambsquarters populations appear to have become less sensitive to glyphosate. Consider use of a preemergence herbicide that provides residual control of these weeds, and avoid use of herbicide programs consisting solely of multiple glyphosate applications. In fields with a history of poor glyphosate performance on lambsquarters and giant and common ragweed, include another postemergence herbicide (Status, Callisto, etc.) with the glyphosate to improve control.
- Control of perennial weeds will require higher rates than annual weeds. Application when perennials are in the bud to bloom stage (or boot to seedhead for grasses) will provide the most complete control of the entire plant. Minimum size of various perennial weeds for most effective control through the growing season: quackgrass, Canada thistle, wirestem muhly, and yellow nutsedge - 6 inches; field bindweed and common milkweed -12 inches; johnsongrass and hemp dogbane - 18 inches.
- Apply in a spray volume of 5 to 20 gpa. Take precautions to reduce spray drift, since corn, soybeans, and other sensitive crops are likely to be growing in areas surrounding treated fields. The risk of spray drift can be reduced by using a volume of 15 to 20 gpa, selecting the appropriate nozzles, and reducing spray pressure.

Herbicide	Formulation	Product Rate Range
Halex GT	**4.38L**	**3.6 - 4 pts**

- Halex GT is a premix of glyphosate, mesotrione (Callisto), and S-metolachlor (Dual II Magnum) for postemergence use in glyphosate-resistant corn (Agrisure GT, Roundup Ready 2, etc.). This product controls emerged grass and broadleaf weeds, and can provide approximately 4 weeks of residual weed control.
- Site of action: group 9 (glyphosate); group 27 (mesotrione); group 15 (S-metolachlor). See pages 22-23.
- Weeds should be less than 2 to 4 inches tall at the time of application to minimize risk of yield loss from early-season weed interference. Apply with atrazine if weeds are more than 4 inches tall, or where weeds are resistant to glyphosate.
- Apply to glyphosate-resistant corn up to 30 inches tall or the 8-leaf stage, whichever occurs first. When mixed with atrazine, apply to corn up to 12 inches tall.
- Apply with NIS (1 to 2 qts/100 gallons) and AMS (8.5 to 17 lbs/100 gallons), using water as the spray carrier.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation
Sequence	**5.25L**

- Sequence is a premix of glyphosate plus S-metolachlor (Dual II Magnum) that can be applied postemergence to glyphosate-resistant corn to provide control of emerged weeds and residual control of annual grasses, eastern black nightshade, pigweed, Palmer amaranth, and waterhemp.
- Apply 2.5 to 3.5 pints/A up to the V8 stage or 30-inch corn (broadcast), or up to 48 inches tall (with drop nozzles). Avoid application into whorls of corn plants.
- Add AMS (8.5 to 17 lbs/100 gallons) where concentration of Ca, Mg, and Mn in water exceeds 150 ppm, and to generally improve control of some weeds.

Corn: Harvest Aid

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**1 - 2 oz**

- Aim (carfentrazone) can be applied prior to harvest of corn for dessication of velvetleaf, morningglory, pigweeds, and other weeds. Apply at least 3 days before harvest when the crop is mature and grain has begun to dry down.
- Site of action: group 14 (see pages 22-23).
- The total amount of Aim that can be applied to small grains in one season, including postemergence and harvest aid treatments, cannot exceed 2 oz/A. UAN or AMS can be added.
- Use a spray volume that results in complete coverage of foliage. Apply with NIS (0.25% v/v) or a COC (1 to 2% v/v). UAN or AMS may also be added.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**See labels.**

- Many glyphosate products can be applied as a preharvest treatment to control perennial and annual weeds in corn. Application rate varies with glyphosate product, type of application (ground vs aerial), type of corn (glyphosate-resistant corn vs other), and amount of glyphosate previously applied. Consult labels for specific recommendations.
- Preharvest applications of glyphosate may provide a good opportunity to control perennial weeds, such as pokeweed, because their growth is undisturbed compared to postharvest applications.
- Site of action: group 9 (see pages 22-23).
- Apply when grain moisture is 35 percent or less. Corn should be physiologically mature (black layer formed) with maximum kernel fill complete. Apply at least 7 days before harvest.
- Depending upon the glyphosate product, the label prohibits or recommends avoiding preharvest application to corn grown for seed, due to the potential for a reduction in germination or vigor.

Herbicide	Formulation	Product Rate Range
Gramoxone SL	**2L**	**1.2 - 2 pt**
Parazone	**3SL**	**0.8 - 1.3 pt**

- Gramoxone and Parazone (paraquat) may be used for drying weeds in field corn, seed corn, and popcorn just before harvest. Apply when corn is mature - after the black layer has formed at the base of the kernels.
- Site of action: group 22 (see pages 22-23).
- Mature cocklebur and lambsquarters are tolerant of paraquat and may not desiccate completely.
- For aerial application, use a spray volume of 5 gallons per acre; for ground application, use 20 gallons per acre. Add NIS (0.25% v/v) or COC (1% v/v).
- Apply at least 7 days before harvest.

Table 7. Grazing and Forage (Silage, Hay, etc.) Intervals for Herbicide-Treated Corn

This table is a guide for grazing and feeding herbicide-treated corn, and shows the time that should occur between herbicide application and grazing or harvest for silage. For premixes or combinations not listed below, the minimum interval equals the longer of the two intervals for each individual product in the mix. Always consult herbicide labels for specific limitations.

Herbicide	Grazing	Forage (silage, etc.)
2,4-D	7 days	7 days
Acuron	45	60
Aim	None	None
Anthem	70	30
Anthem ATZ	70	60
Atrazine	60 days	60 days
Balance Flexx	None	None
Basagran	12 days	None
Beacon	30 days	45 days
Bestow	30 days	30 days
Bicep II Magnum/Cinch ATZ	30 days	30 days
Breakfree NXT/Breakfree NXT ATZ	21 days	21 days
Bromoxynil	30 days	30 days
Cadet	90 days	30 days
Callisto	Do not graze	45 days
Callisto GT	45 days	45 days
Callisto Xtra	Do not graze	60 days
Capreno	45 days	45 days
Corvus	45 days	45 days
Degree Xtra	60 days	60 days
Dicamba	Past “milk” stage	Past “milk” stage
Dicamba+atrazine	Past “milk” stage	Past “milk” stage
DiFlexx	45 days	45 days
Distinct	32 days	32 days
Dual II Magnum/Cinch	30 days	30 days
Expert	60 days	60 days
Fierce	None	None
Flumioxazin (Valor/Outflank/Panther)	None	None
FulTime NXT	21 days	21 days
Glufosinate (Liberty/Interline/Cheetah)	70 days	60 days
Glyphosate	50 days	50 days
Gramoxone SL (at planting)	None	None
Harness	21 days	21 days
Harness Xtra	60 days	60 days
Harrow	30 days	30 days
Hornet	85 days	45 days
Impact/Armezon/Armezon PRO	45 days	45 days

Table 7. Grazing and Forage (Silage, Hay, etc.) Intervals for Herbicide-Treated Corn (continued)

Herbicide	Grazing	Forage (silage, etc.)
Instigate	45 days	45 days
Keystone NXT	21 days	21 days
Laddok	21 days	21 days
Laudis	45 days	45 days
Lumax/Lexar	45 days	45 days
Metribuzin	60 days	60 days
Nicosulfuron	30 days	30 days
Northstar	30 days	45 days
Outlook	60 days	60 days
Parallel	30 days	30 days
Peak	30 days	40 days
Pendimethalin	21 days	21 days
Permit/Sandea/Halomax/Permit Plus	30 days	30 days
Prequel	30 days	30 days
Princep/simazine	Do not graze	None
Python	85 days	85 days
Radius	None	None
Realm Q	45 days	45 days
Resolve Q/Crusher	30 days	30 days
Resource	28 days	28 days
Revulin Q	45 days	70 days
Sharpen	80 days	80 days
Shotgun	21 days	21 days
Spirit	30 days	40 days
Stalwart C, Stalwart Xtra	30 days	30 days
Solstice	30 days	30 days
Starane	47 days	47 days
Status	32 days	32 days
Steadfast	30 days	30 day
SureStart II/TripleFlex II	45 days	45 days
Surpass NXT	21 days	21 days
Stinger	40 days	40 days
Touchdown	50 days	50 days
Verdict	80 days	80 days
Volley/Volley ATZ	21 days	21 days
WideMatch	47 days	47 days
Yukon	30 days and past “milk” stage	30 days and past “milk” stage
Zemax	45 days	45 days
Zidua	No restriction	No restriction

Table 8. Rainfast Intervals, Spray Additives, and Crop Size for Postemergence Corn Herbicides

This table shows the required time interval between herbicide application and rainfall and summarizes label recommendations for spray additives and maximum crop stage. Check herbicide labels for additive rates. Information in this table applies to field corn only.

Herbicide	Rainfast Interval (hours)	Spray additives/Maximum Crop Size (field corn)
2,4-D Amine	6-8	No additives. Broadcast up to 8-inch corn; directed spray before tassel stage.
2,4-D Ester	2-3	No additives. Broadcast up to 8-inch corn; directed spray before tassel stage.
Accent Q, NIC-IT	4	MSO, COC or SURF (Addition of UAN or AMS is recommended). Broadcast up to 6 collars or 20-inch corn; directed spray up to 10 collars or 36-inch field corn.
Aim	1	SURF. AMS or UAN may be added if required by tank-mix partner. Do not use COC or tank-mix with EC formulations of other crop protection chemicals except as specifically directed by label. Apply up to 8-collar corn.
Armezon PRO	1	MSO or COC plus UAN or AMS. Can use SURF in mixtures. Up to the V8 stage or 30-inch corn, whichever occurs first.
Atrazine	2	MSO or COC. Apply before corn is 12 inches tall.
Basagran	8	COC, MSO, UAN, or AMS or COC or MSO + UAN or AMS, depending on weed species present.
Beacon	4	MSO, COC, or SURF (UAN or AMS may be added). Broadcast 4 to 20-inch corn; directed spray before tassel emergence.
Bestow	4	NIS + UAN or AMS. Broadcast up to 12 inches or 5-collar stage.
Bromoxynil	1	No additives. Apply before tassel emergence.
Bromoxynil+atrazine	2	No additives. Apply before corn is 12 inches tall.
Cadet	4	NIS, COC, or MSO. UAN or AMS can be added. Preplant up to 48 inches tall, and before tassel emergence.
Callisto	1	COC + UAN or AMS. Apply up to 30-inch or 8-leaf corn.
Callisto GT	-	NIS + AMS. COC can be used instead of NIS but increases risk of crop injury. Broadcast up to 30-inch or V8 corn.
Callisto Xtra	-	COC or NIS + UAN or AMS. Apply up to 12-inch corn.
Capreno	1	COC + UAN or AMS. Apply broadcast from V1 to V6 corn; directed spray up to V7 corn.
Dicamba	6-8	Add UAN if velvetleaf is present. SURF, COC, or UAN may be added under dry conditions. Do not apply with COC when corn height exceeds 5 inches. Broadcast up to 5th-leaf stage or 8-inch corn; directed spray up to 36-inch corn.
Dicamba/atrazine	6-8	Add UAN if velvetleaf is present. SURF, COC, or UAN may be added under dry conditions. Do not apply with COC when corn height exceeds 5 inches. Apply broadcast up to 5-leaf stage or 8-inch corn.
DiFlexx	6-8	Can add SURF, COC, or MSO + UAN or AMS. Broadcast up to V6 or 36 inches tall; directed spray up to V10 or 36 inches tall, or 15 days prior to tassel, whichever occurs first.
Glufosinate	4	AMS. Broadcast or directed up to 24-inch or V7 corn. Directed spray up to 36-inch corn.
Halex GT	2	SURF + AMS. Broadcast up to 30-inch or 8-leaf corn.
Harrow	4	SURF, COC, or MSO plus UAN or AMS. Broadcast from spike to 2-collar stage, and not more than 6 inches tall.
Hornet	2	SURF, COC, or MSO. UAN or AMS may be added under extremely dry conditions. Broadcast up to 20-inch corn or 6 collars; directed spray up to 36-inch corn.
Impact/Armezon	1	MSO or COC + UAN or AMS. SURF can be used in combinations with other broadleaf herbicides. Apply broadcast or directed up to 45 days before harvest.
Laddok	8	MSO, COC, UAN, AMS, DASH, or combinations of these. Apply before corn is 12 inches tall.
Laudis	1	MSO + UAN or AMS. Broadcast up to V8 corn.
Laudis + atrazine	2	COC + UAN or AMS. Broadcast up to 12-inch corn
Northstar	4	SURF, COC or MSO up to 12-inch corn. Only SURF between 12 and 36-inch corn. UAN or AMS may be added. Broadcast 4 to 20-inch corn; directed spray up to 36-inch corn.
Peak	4	COC unless mixed with glyphosate. Broadcast up to V6 or 20-inch corn; directed spray up to 30 inches.
Permit/Sandea/ Halomax	4	SURF, MSO, or COC. UAN or AMS may be added. Apply through layby stage of corn.
Realm Q	4	SURF or COC + UAN or AMS. Broadcast or directed up to 20 inches and prior to the 7-collar stage.
Revulin Q	4	COC or HSOC + UAN or AMS. Broadcast up to V5 stage or 20 inches tall, whichever occurs first.
Resolve Q	4	NIS + UAN or AMS, unless mixed with a glyphosate product or Ignite. Broadcast up to 20-inch or 6 collar corn.
Resource	1	COC. UAN or AMS may be added to improve control of certain species. Apply up to the 10-leaf stage.
Shotgun	6	No additives. Apply before 12-inch corn.
Solstice	1	COC or NIS + UAN or AMS. COC is preferred adjuvant. Do not use MSO. Up to V8 or 30-inch corn.
Spirit	4	COC, MSO or SURF.UAN or AMS may be added. Broadcast 4 to 20-inch corn; directed spray up to 24-inch corn or after 6 collar corn.
Starane	1	An adjuvant can be used if required by tank-mix partner. Broadcast up to the V5 stage; directed spray after the V5 stage.
Status	4	SURF, COC, or MSO + UAN or AMS. Broadcast from 4 to 36-inch corn (rates up to 5 oz/A)
Steadfast Q	4	COC, MSO, or SURF + UAN or AMS. COC or MSO is preferred over SURF. Broadcast up to and including 6 collars or 20-inch corn
Stinger	6-8	No additives. Up to 24-inch corn.
WideMatch	6	No additives. Broadcast up to the V5 stage; directed spray after the V5 stage.
Yukon	4	SURF or COC. UAN or AMS may be added. Apply broadcast or directed up to 36-inch corn.
Zemax	1	SURF or COC. Apply up to 30-inch or 8-leaf corn.

Table 9. Herbicides Labeled for Use on Field Corn, Seed Corn, Popcorn, and Sweet Corn

	Field Corn	Field Corn Grown for Seed	Popcorn	Sweet Corn
2,4-D	Y	Y[5]	Y[5]	Y
Accent Q/NIC-IT	Y	Y[5, 8]	Y[1, 5, 8]	Y[5, 8]
Acuron	Y	Y	Y[10]	Y
Aim	Y	Y[9]	Y	Y[5]
Anthem/Anthem ATZ	Y	Y[5]	Y[5]	Y[5]
Armezon PRO	Y	Y	Y	Y
Atrazine	Y	Y	Y	Y
Balance Flexx	Y	Y[5]	N	N
Basagran	Y	Y	Y	Y
Basis	Y	N	N	N
Beacon	Y[5]	Y[5, 7]	Y[5, 7]	N
Bestow	Y	N	N	N
Bicep II Magnum/Cinch ATZ	Y	Y	Y	Y
Breakfree NXT/Breakfree NXT ATZ	Y	Y	Y	Y
Bromoxynil	Y	Y[2, 5]	Y[2]	N
Cadet	Y	Y	Y	Y
Callisto, Callisto Xtra	Y	Y	Y[10]	Y
Capreno	Y	Y[5]	N	N
Corvus	Y	Y[5]	N	N
Degree	Y	Y	Y	Y
Degree Xtra	Y	Y	Y	Y
Dicamba	Y	Y[5]	Y[5]	N
Dicamba+atrazine	Y	Y[5]	Y[5]	N
DiFlexx	Y	Y	Y	N
Dual II Magnum/Cinch	Y	Y	Y	Y
Expert	Y	Y	Y	Y
Fierce	Y	N	N	N
Flumioxazin (Valor/Outflank,etc.)	Y	N	N	N
FulTime NXT	Y	Y	Y	Y
Harness/Harness Xtra	Y	Y	Y	Y
Harrow	Y	N	N	N
Hornet	Y	Y[5]	N	N
Impact/Armezon	Y	Y[5]	Y[5]	Y[5]
Instigate	Y	N	N	N
Keystone NXT	Y	Y[3]	Y	Y
Laddok	Y	Y	Y	Y
Laudis	Y	Y[5]	Y[5]	Y[5]
Lumax/Lexar EZ	Y	Y	Y[10]	Y
Metribuzin	Y	N	N	N
Northstar	Y[5]	Y[5, 7]	Y[5, 7]	N
Outlook	Y	Y	Y	Y[5]
Parallel/Parallel Plus	Y	Y	Y	N
Peak	Y	N	N	N
Pendimethalin	Y	Y	Y	Y
Permit/Sandea/Halomax	Y	Y	Y	Y[5]
Prequel	Y	N	N	N
Princep/simazine	Y	N	N	N
Python	Y	Y[5]	N	N
Realm Q	Y	N	N	N
Resolve Q/Crusher	Y	N	N	N

Table 9. Herbicides Labeled for Use on Field Corn, Seed Corn, Popcorn, and Sweet Corn (continued)

	Field Corn	Field Corn Grown for Seed	Popcorn	Sweet Corn
Resource	Y	Y[5]	N	N
Revulin Q	Y	Y[5]	Y[5,10]	Y[5]
Sharpen	Y	Y	Y[5]	N
Shotgun	Y	N	N	N
Solstice	Y	Y	Y	Y
Spirit	Y[5]	Y[5, 7]	Y[5, 7]	N
Stalwart C/Stalwart Xtra	Y	Y	Y	Y
Starane	Y	N	N	Y
Status	Y	Y	Y	N
Steadfast Q	Y	N	N	N
Stinger	Y	Y[5]	N	N
SureStart II/TripleFlex II	Y	N	N	N
Surpass NXT	Y	Y	Y	Y
Verdict	Y	Y	Y[5]	N
Volley/Volley ATZ	Y	Y	Y	Y
Warrant	Y	Y	N	N
WideMatch	Y	N	N	Y
Yukon	Y	Y	N	N
Zemax	Y	Y	Y[10]	Y
Zidua	Y	Y[5]	Y[5]	Y[5]

[1]Do not apply to any white popcorn inbred or hybrid unless approved by seed supplier.
[2]Do not apply prior to 3-leaf corn stage.
[3]Do not use on corn seed stock such as “Breeders,” “Foundation,” or “Increase.”
[4]Do not make postemergence application of Partner or Microtech to sweet corn.
[5]Check with seed supplier or chemical representative for sensitivity of inbreds/hybrids prior to use.
[6]Injury may occur on field corn hybrids with a Relative Maturity (RM) rating of less than 88 days or on waxy, Hi-Lysine, or food grade corn.
[7]Can be used if spray is directed using drop nozzles when seed corn is between 4 and 20 and 4 and 30 inches tall for Spirit and Exceed, respectively, when popcorn is between 10 and 24 and 10 and 30 inches tall for Spirit and Exceed respectively, and when seed corn and popcorn are between 10 and 36 and 10 and 48 inches tall for Northstar and Beacon, respectively. All products must be applied before tassel emergence.
[8]Do not apply if corn is greater than 20 inches tall or exhibits 5 collars.
[9]Apply as directed spray only. Avoid herbicide application into the corn whorl.
[10]Yellow popcorn only.

Table 10. Herbicide and Soil Insecticide Use Precautions

This table is a guide to using herbicides on field corn where an organophosphate (OP) insecticide is used at planting. Do not mix an OP insecticide with the herbicides shown below, as severe injury will occur. Read the herbicide label before applying OP insecticides postemergence when using any of these herbicides. For herbicides not listed here, use of an OP insecticide should not increase risk of injury.

Definitions and Abbreviations:

Do not use = do not apply the herbicide if corn has been previously treated with soil insecticide.

NR = not recommended to apply the herbicide if corn has been previously treated with soil insecticide.

TI = Temporary injury may occur if the herbicide is applied to corn previously treated with soil insecticide.

Y = The herbicide can be used with nearly no risk of injury when applied to corn previously treated with soil insecticide.

Herbicide	Soil-applied Organophosphate Insecticides						
	Counter 20CR (in furrow)	Counter 20CR (banded)	Thimet/ phorate	Lorsban	Aztec	Fortress	Capture LFR
Acuron (POST)	NR	NR	TI	TI	TI	TI	Y
Beacon	Do not use	NR	TI	TI	TI	TI	Y
Bestow	45 days	45 days	45 days	45 days	NR	NR	Y
Callisto, Callisto Xtra (POST)	NR	NR	See label	NR	See label	See label	Y
Callisto GT	Do not use	Do not use	Do no use	Do not use	See label	See label	Y
Capreno	Do not use	Do not use	Do not use	Do not use	Y	Do not use	Y
Crusher	60 days[3]	60 days[3]	NR	NR	Y	Y	Y
Corvus	Do not use	Do not use	Y	Y	Y	Y	Y
Halex GT	NR	NR	NR	NR	NR	NR	Y
Harrow (POST)	45 days	45 days	TI	TI	NR	NR	Y
Hornet (PRE)	Do not use	Do not use	Do not use	TI[1]	TI[1]	TI[1]	Y
Hornet (POST)	Do not use	Do not use	Do not use	TI	TI	TI	Y
Instigate (PRE)	Do not use	Do not use	Do not use	Do not use	Y	Y	Y
Instigate (POST)	Do not use	Do not use	TI	TI	Y	Y	Y
Lexar EZ/Lumax EZ (POST)	NR	NR	TI	TI	TI	TI	Y
Nicosulfuron	Do not use	NR	TI	TI	Y	Y	Y
NorthStar	Do not use	NR	TI	TI	TI	TI	Y
Peak	Do not use	Do not use	TI	TI	TI	TI	Y
Prequel	Do not use	TI	TI[2]	TI[2]	Y	Y	Y
Python	Do not use	Do not use	Do not use	TI[1]	TI[1]	TI[1]	Y
Realm Q	NR	NR	NR	NR	Y	Y	Y
Resolve Q	Do not use	NR	NR	NR	60 days[3]	60 days[3]	Y
Revulin Q	NR	NR	NR	NR	Y	Y	Y
Solstice	Do not use	Do not use	Do not use	Do not use	Y	Y	Y
Spirit	Do not use	NR	TI	TI	TI	TI	Y
Steadfast Q	Do not use	NR	NR	TI	Y	Y	Y
SureStart II/TripleFLEX II	Do not use	Do not use	Do not use	TI[1]	TI[1]	TI[1]	Y
Verdict, Sharpen	Do not use	Do not use	Do not use	Do not use	Y	Y	Y
Zemax (POST)	NR	NR	NR	NR	NR	NR	Y

[1]Apply the soil insecticide in a T-band or a band to reduce risk of crop injury.

[2]Do not use herbicide if soil insecticide is applied in furrow. Herbicide may be used if soil insecticide is applied in a band, but temporary corn injury may still occur.

[3]Do not apply herbicide within 60 days of insecticide application.

Popcorn and Sweet Corn Weed Management

Weed management in popcorn and sweet corn is similar to field corn in many respects. However, there are a few important points to keep in mind when planning a weed management strategy for these specialty crops. First, not every product labeled in field corn is labeled in popcorn or sweet corn. Second, the sensitivity of popcorn and sweet corn inbreds and hybrids to herbicides varies. Popcorn and sweet corn inbreds and hybrids are generally selected based on their performance, but the selection can determine which herbicides can be used.

White popcorn lines are often more sensitive to herbicides than yellow corn lines. Tolerance of sweet corn to herbicides has been intensively studied, but the sensitivity of the many new varieties introduced every year is often uncertain. Labels for several new herbicides contain statements that limit the herbicide manufacturer's liability should sweet corn be damaged. Many sweet corn varieties are sensitive to mesotrione and sulfonyl urea herbicides. A few varieties are sensitive to Laudis while nearly all varieties tolerate Impact. For more information on sweet corn varietal response to herbicides visit the web sites listed below. It is always a good idea to address this issue with your seed supplier before selecting herbicides to use in popcorn or sweet corn. Finally, most popcorn and some sweet corn is grown under contract, and seed company contracts may specify herbicide programs to be used on their varieties.

- Ranking of sweet corn variety tolerance to nicosulfuron and Callisto:
  http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/656/Sweet-Corn-Tolerance-Results-from-2008.aspx
  http://ag.udel.edu/rec/WeedScience/Research_reports/Sweet%20Corn%20Hybrid%20Tolerance%20Rating%202007.pdf

- Response of sweet corn varieties to Impact and Laudis:
  http://ag.udel.edu/rec/WeedScience/Research_reports/Sweet_Corn_Tolerance_laudis_impact_07.pdf

The number of broad-spectrum postemergence herbicides labeled for popcorn and sweet corn is somewhat limited. Annual grasses should be controlled with preemergence herbicides, such as acetochlor (Degree, Harness, Surpass, and Topnotch), metolachlor, (Dual II Magnum), and dimethenamid-P (Outlook). Accent can be applied for postemergence grass control in popcorn, but it cannot be used on some hybrids and inbreds. Impact is much less likely to cause injury to popcorn than Accent, and it can be applied postemergence for control of small grasses and many broadleaf weeds. Shattercane, johnsongrass, and quackgrass can be particularly difficult to manage in these speciality crops. Fields infested with these weeds should probably not be planted to popcorn or sweet corn.

Many of the broadleaf herbicides labeled for field corn can also be used in popcorn and sweet corn. Atrazine is probably the most commonly used herbicide, and has activity on many broadleaf weeds such as black nightshade, common ragweed, and lambsquarters. It is somewhat less effective on giant ragweed, annual morningglories, and velvetleaf. Atrazine premix products, such as Degree Xtra, Bicep II Magnum, Keystone, Guardsman Max, are commonly used broad spectrum herbicides for popcorn and sweet corn, although not all premixes are labeled for both types of corn. Application of a three-way premix, such as Lumax or Lexar, will improve control of the broadleaf weeds that atrazine premix products fail to adequately control.

Table 11. Weed Response to Herbicides in Popcorn and Sweet Corn—Grasses

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables. See pages 22-23 for additional information on site of action classification.

Weed control rating:
9 = 90% to 100%
8 = 80% to 90%
7 = 70% to 80%
6 = 60% to 70%
- = less than 60% control, not recommended.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

Crop injury of 1 or less is rarely significant.

		Grasses											
	Site of action	Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Giant foxtail	Yellow foxtail	Shattercane	Seedling johnsongrasss	Rhizome johnsongrass	Quackgrass	Woolly cupgrass	Yellow nutsedge
Preplant or Preemergence													
Acetochlor	15	9	9	8	7	9	9	-	-	-	-	7+	8+
Acetochlor+atrazine	5/15	9	9	8	7	9	9	-	-	-	6	7+	8+
Acuron	5/27/15	9	9	8	6	8+	8+	-	-	-	6	7	8
Anthem	14/15	8	8	8	6	9	8	-	-	-	-	6	-
Anthem ATZ	5/15	8	8	8	6	9	8	-	-	-	6	6	6
Atrazine	5	8	-	-	6	7	7	-	-	-	8	-	7
Callisto	27	-	6	-	-	-	-	-	-	-	-	-	-
Lumax / Lexar EZ	5/27/15	9	9	8	6	9	9	-	-	-	6	7	8
Metolachlor	15	8	9	8+	6	9	9	-	-	-	-	7	8+
Metolachlor + atrazine	5/15	9	9	8	6	9	9	-	-	-	6	7	8
Outlook	15	8	8+	8	6	8+	8+	-	-	-	-	7	8
Pendimethalin[1]	3	8	8	8	7	8	8	6	6	-	-	8	-
Sharpen (popcorn only)	14	-	-	-	-	-	-	-	-	-	-	-	-
Verdict (popcorn only)	14/15	8	8	8	6	8	8	-	-	-	-	7	8
Zemaz	14/27	8	9	8+	6	9	9	-	-	-	-	7	8+
Zidua	15	8	8	8	6	9	8	-	-	-	-	6	-
Postemergence													
2,4-D (popcorn only)	4	-	-	-	-	-	-	-	-	-	-	-	-
Aim	14	-	-	-	-	-	-	-	-	-	-	-	-
Atrazine	5	7	-	-	-	8	8	-	-	-	7	-	7
Basagran/Broadloom	6	-	-	-	-	-	-	-	-	-	-	-	8
Beacon (popcorn only)	2	-	-	8	6	7	7	9	9	7	8	-	6
Bromoxynil	6	-	-	-	-	-	-	-	-	-	-	-	-
Cadet	14	-	-	-	-	-	-	-	-	-	-	-	-
Callisto	27	-	7*	-	-	-	-	-	-	-	-	-	-
Callisto Xtra	5/27	-	7*	-	-	-	-	-	-	-	-	-	-
Dicamba (popcorn only)	4	-	-	-	-	-	-	-	-	-	-	-	-
Glyphosate[2]	9	8	8	8	8	9	9	9	9	9	9	9	7
Impact/Armezon/Armezon PRO	27	7	7	6	-	7+	7	6	7	-	-	6	-
Impact /Armezon + atrazine	5/27	8	8	6	-	8	7+	6	7	-	-	6	-
Laddok	5/6	-	-	-	-	-	-	-	-	-	-	-	8+
Laudis	27	8	8	-	6	7	9	8	8	7	7	7+	-
Laudis + atrazine	5/27	8	8	-	6	8	9	8	8	7	7	7+	-
Liberty[2]	10	6	8	8	7	8	6	8	8	7	6	8+	-
Nicosulfuron	2	8	-	8	8	9	9	9	9	9	9	8	6
NorthStar (popcorn only)	2/4	-	-	7	6	6	6	9	9	6	7	-	-
Permit/Sandea/Halomax	2	-	-	-	-	-	-	-	-	-	-	-	9
Revulin Q	2/27	8	7*	8	8	9	9	9	9	9	9	8	6
Solstice	14/27	-	7*	-	-	-	-	-	-	-	-	-	-
Spirit (popcorn only)	2	-	-	7	-	6	6	9	9	6	7	-	-
Status (popcorn only)	4/19	6	6	6	-	6	6	-	-	-	-	-	-
Stinger	4	-	-	-	-	-	-	-	-	-	-	-	-
Yukon (popcorn only)	2/4	-	-	-	-	-	-	-	-	-	-	-	9

[1]Popcorn—apply pendimethalin after planting or postemergence; sweet corn—apply pendimethalin postemergence only. Provides residual weed control only, not control of emerged weeds.
[2]Apply glyphosate only to Roundup Ready sweet corn hybrids, and Liberty only to Attribute Bt11 (glufosinate-resistant) sweet corn hybrids.
*Large crabgrass only.

Table 12. Weed Response to Herbicides in Popcorn and Sweet Corn—Broadleaf Weeds

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables. See pages 22-23 for additional information on site of action classification.

Weed control rating:
9 = 90% to 100%
8 = 80% to 90%
7 = 70% to 80%
6 = 60% to 70%
- = less than 60% control, not recommended.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

Crop injury of 1 or less is rarely significant.

	Broadleaf Weeds																			
	Annual morningglory	Black nightshade	Burcucumber	Cocklebur	Common ragweed	Common ragweed (group 2-R)	Giant ragweed	Giant ragweed (group 2-R)	Jimsonweed	Kochia	Lambsquarter	Lambsquarter (group 5-R)	Palmer amaranth (group 2-R)	Palmer amaranth (group 2+9-R)	Pigweed (redroot/smooth)	Smartweed	Velvetleaf	Waterhemp (group 2-R)	Waterhemp (group 2+9-R)	Waterhemp (group 2+9+14-R)
Preplant or Preemergence																				
Acetochlor	-	8+	-	-	7	7	-	-	-	-	7+	7+	8	8	8+	-	-	8	8	8
Acetochlor+atrazine	8	9	6	8	9	9	8	8	9	9	9	7+	9	9	9	9	8	9	9	9
Acuron	8	9	7	8+	9	9	8+	8+	9	9	9	9	9	9	9	9	9	9	9	9
Anthem	-	8	-	-	7	7	-	-	-	7+	8	8	8	8	8	-	7	8	8	8
Anthem ATZ	7	9	6	7	9	9	6	6	7	8	9	8	8+	8+	9	9	8	8+	8+	8+
Atrazine	8	9	6	8	9	9	8	8	9	9	9	-	8	8	9	9	8	8	8	8
Callisto	6	9	7	-	7	7	6	6	-	9	9	9	7	7	9	9	9	7	7	7
Lumax / Lexar EZ	8	9	7	8	9	9	8	8	9	9	9	9	9	9	9	9	9	9	9	9
Metolachlor	-	8	-	-	-	-	-	-	-	-	6	6	7	7	8	-	-	7	7	7
Metolachlor + atrazine	8	9	6	8	9	9	8	8	9	9	9	6	8+	8+	9	9	8	8+	8+	8+
Outlook	-	8+	-	-	-	-	-	-	-	-	6	6	7+	7+	8	-	-	7+	7+	7+
Pendimethalin[1]	-	-	-	-	-	-	-	-	-	7	8	8	7	7	9	-	-	7	7	7
Sharpen (popcorn only)	8	9	-	8	9	9	8	8	8	8	9	9	8	8	9	9	8	8	8	8
Verdict (popcorn only)	8	9	?	8	9	9	8	8	8	8	9	9	9	9	9	9	8	9	9	9
Zemaz	6	9	7	7	7	7	6	6	-	8	9	9	8	8	9	9	9	8	8	8
Zidua	-	8	-	-	7	7	-	-	-	7+	8	8	8	8	8	-	7	8	8	8
Postemergence																				
2,4-D (popcorn only)	9	7	-	9	9	9	9	9	7	7+	9	9	8	8	9	6	8	8	8	8
Aim	8	8	-	-	6	6	-	-	-	7+	7	7	-	-	8	-	9	-	-	-
Atrazine	9	9	8	9	9	9	8	8	9	9	9	-	8+	8+	9	9	8	8+	8+	8+
Basagran/Broadloom	-	-	-	9	7	7	6	6	9	7	6	6	-	-	-	9	8+	-	-	-
Beacon (popcorn only)	6	8	9	9	9	-	9	-	9	8	-	-	-	-	9	8	8	-	-	-
Bromoxynil	8	9	7	9	9	9	8	8	9	9	9	9	-	-	7	8	8	-	-	-
Cadet	7	-	-	-	-	-	-	-	-	8	7	7	-	-	8	-	9	-	-	-
Callisto	7	9	8	7+	7+	7+	8	8	9	8	9	9	8	8	8	9	9	8	8	8
Callisto Xtra	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Dicamba (popcorn only)	9	8	7	9	9	9	9	9	9	8	9	9	8	8	9	8	7	8	8	8
Glyphosate[2]	6	8	8	9	8+	8+	8+	8+	9	8	8+	8+	8	-	9	8	8	9	-	-
Impact/Armezon/Armezon PRO	7	9	7+	8	7	7	7	7	9	8+	9	9	8	8	9	8	9	8	8	8
Impact /Armezon + atrazine	8	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Laddok	8	8	6	9	9	9	9	9	9	9	9	5	7+	7+	9	9	9	7+	7+	7+
Laudis	7	9	7	8	8	8	8	8	9	8	9	9	8	8	9	8	9	8	8	8
Laudis + atrazine	8	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Liberty[2]	8	9	8	9	9	9	9	9	9	8	7	7	8	8	8	9	8	8	8	8
Nicosulfuron	8	-	8	-	-	-	-	-	8	-	-	-	-	-	9	8	-	-	-	-
NorthStar (popcorn only)	8	9	9	9	9	7	9	6	9	8	9	9	7	7	9	9	8	7	7	7
Permit/Sandea/Halomax	6	-	-	9	8	-	8	-	8	7	-	-	-	-	9	7	8	-	-	-
Revulin Q	8	9	8	7+	7+	7+	8	8	9	8	9	9	8	8	9	9	9	8	8	8
Solstice	8	9	8	8	7	7	8	8	9	8	9	9	9	9	9	9	9	9	9	8
Spirit (popcorn only)	7	8	9	9	9	-	9	-	9	8	6	6	-	-	9	8	8	-	-	-
Status (popcorn only)	9	8	7	9	9	9	9	9	9	8	9	9	8	8	9	8+	8	8	8	8
Stinger	-	8	-	9	9	9	9	9	8	-	-	-	-	-	-	-	-	-	-	-
Yukon (popcorn only)	8	7	7	9	9	7	9	7	9	8	8	8	7+	7+	9	9	9	7+	7+	7+

[1]Popcorn—apply pendimethalin after planting or postemergence; sweet corn—apply pendimethalin postemergence only. Provides residual weed control only, not control of emerged weeds.
[2]Apply glyphosate only to Roundup Ready sweet corn hybrids, and Liberty only to Attribute Bt11 (glufosinate-resistant) sweet corn hybrids.
*Large crabgrass only.

Popcorn and Sweet Corn: Soil-Applied Herbicides—Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
AAtrex/atrazine	**4L**	**2 - 4 pt**
	90DF	**1.1 - 2.2 lb**

- Site of action: group 5 (see pages 22-23).
- Atrazine is generally applied at a rate of 1.4 to 2 pounds active ingredient per acre to control broadleaf weeds.
- Rates approaching 2 pounds active ingredient will improve control of velvetleaf, cocklebur, giant ragweed, and morningglory. Atrazine will not control fall panicum, regardless of rate.
- Maximum soil-applied rate on soils not highly erodible is 2 pounds of active ingredient per acre. Maximum rate on highly erodible soils is 2 pounds active ingredient on fields with at least 30% crop residue, and 1.6 pounds active ingredient on fields with less than 30% crop residue. Soil applications may be followed with a postemergence application of atrazine, but total of all treatments cannot exceed 2.5 pounds active ingredient per acre per year.
- Plant only corn or sorghum the year of atrazine application.
- Where oats, forage legumes, or forage grasses will be planted the following spring, do not apply more than 0.8 pounds active ingredient per acre.

Herbicide	Formulation	Product Rate Range
Acetochlor	**various**	

- Acetochlor (plus safener) is sold under various trade names, including Harness, Breakfree NXT, Surpass NXT, Degree, Confidence, and Volley. Check label to make sure the product is labeled for sweet corn.
- Acetochlor controls annual grasses, pigweed, and black nightshade, and controls or suppresses yellow nutsedge, lambsquarters, and common ragweed. Control of lambsquarters and common ragweed will generally be less effective compared to most broadleaf herbicides, but more effective than other acetamide herbicides.
- Site of action: group 15 (see pages 22-23).
- Degree is an encapsulated product that can provide a longer period of annual grass control compared to other acetochlor products.
- Acetochlor products can be applied after planting but prior to weed emergence, and before corn height exceeds 11 inches. All acetochlor products except Degree must be applied using water as the spray carrier after the corn has emerged.
- Degree and Degree plus atrazine can be applied to emerged popcorn in water or UAN, but popcorn should not exceed 6 inches in height if fertilizer solution is used as the carrier. Do not apply in fertilizer solution when air temperatures exceed 85 degrees. Mixtures with products other than atrazine should be applied only in water if corn has emerged. Leaf burn may occur when acetachlor is applied to emerged corn.
- Do not apply postemergence to sweet corn.

Degree 3.8L Use Rates (pts/A)

Soil Texture	Less than 3% OM	3% or more OM*
Coarse	2.25 to 3.25	3.25
Medium	3.25 to 4.25	3.25 to 4.25
Fine	3.25 to 4.25	4.25 to 5.0

*On soils with 6 to 10% organic matter (OM) use 4.25 to 6.25.

Harness/Confidence 7EC Use Rates (pts/A)[a]

Soil Texture	Less than 3% OM	3% or more OM[b]
Coarse	1.25 to 1.75	1.75
Medium	1.75 to 2.25	1.75 to 2.25
Fine	1.75 to 2.25	2.25 to 2.75

[a]Use higher rate in recommended rage in areas of high weed infestations.
[b]On soils with 6 to 10% OM use 2.5 to 3.4 pt/A.

Breakfree NXT/Surpass/Volley 6.4EC Use Rates (pt/A) in Conventional Tillage Systems When Applied within 14 Days Before Planting[a]

Soil Texture	Less than 3% OM	3% or more OM[b]
Coarse	1.5 to 2.25	1.5 to 2.5
Medium	1.5 to 2.5	1.5 to 2.5
Fine	1.5 to 2.75	2 to 3

[a]Use higher rate in recommended range in areas of high weed infestations.

Surpass/Volley 6.4EC Use Rates (pt/A) in Reduced or No-Till systems or Conventional Systems When Applied More Than 14 Days Before Planting

Soil Texture	Less than 3% OM	3% or more OM
Coarse	2	2
Medium	2 to 2.5	2.5
Fine	3	3

Popcorn and Sweet Corn: Soil-Applied Herbicides—Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
Acetochlor + atrazine	**Various**	

- Acetochlor plus atrazine (plus safener) is sold under various trade names, including Harness Xtra, Degree Xtra, Fultime, Keystone, Breakfree ATZ, Confidence Xtra, and Volley ATZ. These premix products control annual broadleaves and grasses in popcorn. The ratio of atrazine to acetochlor varies with product, and some products require the addition of atrazine or another broadleaf herbicide for the effective control of some broadleaf weeds. Check label to make sure the product is labeled for sweet corn.
- Degree Xtra and Fultime are encapsulated formulations that can provide a longer period of annual grass control compared to other acetochlor products.
- Site of action: group 5 (atrazine), group 15 (acetochlor). See pages 22-23.
- Can be applied after planting and before corn height exceeds 11 inches and before weeds reach the 2 leaf-stage. When mixing with postemergence herbicides to control larger weeds, follow the most restrictive label with regard to maximum popcorn size.
- All acetochlor products except Degree Xtra should be applied using water as the spray carrier after the popcorn has emerged.
- Degree Xtra can be applied in water or UAN, but popcorn should not exceed 6 inches in height if fertilizer solution is the carrier. Do not apply in fertilizer solution when temperature exceeds 85 degrees. Mixtures with products other than atrazine should be applied only in water if the corn has emerged. Leaf burn may occur when applied to emerged corn.
- Do not apply postemergence to sweet corn.

Degree Xtra 4L Use Rates (qt/A)

Soil Texture	
Coarse	2.9
Medium*	2.9 to 3.7
Fine*	3.2 to 3.7

*In areas of heavy weed pressure rates can be increased to 4.3 qts/A.

FulTime 4L Use Rates (qt/A) in Conventional Tillage Systems When Applied Within 14 Days Before Planting

Soil Texture	Less than 3% OM	3% OM or more
Coarse	2.5 to 2.7	2.7 to 3
Medium	2.7 to 3.3	3 to 3.3
Fine	3 to 3.5	3 to 5

FulTime 4L Use Rates (qt/A) in Reduced or No-Till Systems or Conventional Systems When Applied More Than 14 Days Before Planting

	Time From Application		
Soil Texture	**Greater than 10 days before planting**	**Less than 10 days before or after planting**	**After planting and/or emergence**
Coarse	Do not apply more than 14 days before planting	2.5 to 3	2.5 to 3
Medium	2.7 to 4	2.7 to 3.3	2.7 to 3.3
Fine	3.3 to 5	3 to 5	3 to 4

Harness Xtra/Confidence Xtra 5.6L Broadcast Rate (qt/A)*

Soil Texture	Less than 3% OM	3% or more OM
Coarse	1.4	1.7
Medium	1.7 to 2.4	2.3 to 2.6
Fine	2.3 to 2.6	2.3 to 3.0

* In areas of heavy infestations use up to 2.3 qt/A on coarse-textured soils and 2.3 to 3.0 qt/A on medium- and fine-textured soils, but do not exceed 2.5 qt/A on highly erodible soils with less than 30% plant residue.

Breakfree ATZ/Keystone/Volley ATZ 5.25: Use Rate in Conventional Tillage (qt/A)

Soil Texture	Less than 3% OM	3% or more OM
Coarse	2.2 to 2.4	2.4 to 2.6
Medium	2.4 to 2.8	2.6 to 2.8
Fine	2.6 to 3.0	2.6 to 3.4

Herbicide	Formulation	Product Rate Range
Callisto	**4L**	**6 - 7.7 fl oz**

- Yellow popcorn and sweet corn only. Do not apply to white popcorn.
- Callisto (mesotrione) can be applied preplant or preemergence for control of annual broadleaf weeds. Callisto can help control giant ragweed, cocklebur, and morningglory in mixtures with atrazine.
- Site of action: group 27 (see pages 22-23).
- Callisto does not control grass weeds, and should be applied in combination with Harness, Dual II Magnum, Top-Notch, or another acetamide grass herbicide, or an acetamide/atrazine premix (Bicep II Magnum, Degree Xtra, etc.).

Popcorn and Sweet Corn: Soil-Applied Herbicides—Preplant or Preemergence

Herbicide	Formulation
Acuron	**3.44L**

- Acuron is a premix of atrazine, S-metolachlor (Dual II Magnum), mesotrione (Callisto), and bicyclopyrone for control of grass and broadleaf weeds in corn. This product is overall similar to Lexar and Lumax for residual control and control of emerged weeds, but can be slightly better on large-seeded broadleaf weeds such as giant ragweed and cocklebur.
- Site of action: group 5 (atrazine); group 15 (S-metolachlor); group 27 (mesotrione, bicyclopyrone). See pages 22-23.
- Apply preplant or preemergence to yellow popcorn and sweet corn. Do not apply to white popcorn.
- Acuron use rates: soils with less than 3% organic matter - 2.5 qts/A; soils with more than 3% organic matter - 3.0 qts/A.

Herbicide	Formulation
Anthem	**2.15L**
Anthem ATZ	**4.5L**

- Anthem (pyroxasulfone + fluthiacet-methyl) and Anthem ATZ (atrazine + pyroxasulfone + fluthiacet) can be applied pre-plant, preemergence, or early postemergence in field corn, seed corn, popcorn, and sweet corn for residual control of annual grasses and broadleaf weeds. These products should be combined with other preemergence corn herbicide(s) to improve the longevity and spectrum of weed control, or followed with a postemergence herbicide treatment.
- Site of action: Anthem - group 14/15; Anthem ATZ - group 5/14/15 (see pages 22-23).
- Corn seed must be planted a minimum of one inch deep.
- Anthem will not generally provide adequate control of emerged weeds when applied early postemergence. The addition of atrazine in Anthem ATZ improves activity on emerged weeds but will generally still require the addition of glyphosate or other postemergence herbicide.

Anthem Broadcast Rates (oz/A)[a]		
Soil Texture Group	Less than 3% OM	3% or Greater OM
Coarse	7 to 8	7 to 8
Medium	8 to 10	8 to 11
Fine	9 to 11	10 to 13

a. Rates may increase when applied more than 14 days prior to planting, and decrease when used postemergence - see label.

Anthem ATZ Broadcast Rates (pt/A)[a]		
Soil Texture Group	Less than 3% OM	3% or Greater OM
Coarse	1.75 to 2	1.75 to 2
Medium	2 to 2.5	2 to 2.75
Fine	2.25 to 3	2.5 to 4

a. Rates may increase when applied more than 14 days prior to planting, and decrease when used postemergence - see label.

Herbicide	Formulation	
Lumax EZ	**3.67L**	**2.7 - 3.25 qts**
Lexar EZ	**3.7L**	**3 - 3.5 qts**

- Lumax and Lexar are premixes of atrazine plus s-metolachlor (Dual II Magnum) plus mesotrione (Callisto) for control of grass and broadleaf weeds in corn. See descriptions for these products for more information.
- Site of action: group 5 (atrazine); group 15 (s-metolachlor); group 27 (mesotrione).
- Control most annual broadleaf weeds, but expect partial control of giant ragweed, cocklebur, and annual morningglory.
- Can be applied preplant or preemergence to yellow popcorn and sweet corn. Do not apply postemergence to popcorn or sweet corn. Do not use on white popcorn.

Herbicide	Formulation
s-metolachlor	**7.64E**
metolachlor	**7.8E**

- S-metolachlor (Dual II Magnum, Cinch) and metolachlor (Stalwart C, Parallel) control annual grasses and pigweed, and control or suppress waterhemp, black nighshade, and yellow nutsedge.
- Site of action: group 15 (see pages 22-23).
- Can be applied preplant or preemergence before corn and weeds emerge. Can be applied postemergence with

Popcorn and Sweet Corn: Soil-Applied Herbicides—Preplant or Preemergence

atrazine up to 5-inch corn or as a directed spray up to 12-inch corn, and before grass and broadleaf weeds exceed the 2-leaf stage. Do not apply using fertilizer solution as the spray carrier after the corn has emerged.

- May be applied up to 30 days before planting as a single application.
- Incorporation to a depth of 2 inches will improve yellow nutsedge cotnrol and reduce dependence on rainfall.
- Allow 30 days between application and harvest of sweet corn.

Use rates for Dual II Magnum, Cinch, Parallel, and Stalwart (pt/A)

Soil Texture	Less than 3% OM	3% or more OM
Coarse	1.0 to 1.33	1.33
Medium	1.33 to 1.67	1.33 to 1.67
Fine	1.33 to 1.67	1.67 to 2.0

Herbicide	Formulation	Product Rate Range
S-metolachlor + atrazine	**5.5L**	
metolachlor + atrazine	**5.5L**	

- S-metolachlor plus atrazine (Bicep II Magnum, Brawl II ATZ, Cinch ATZ) and metolachlor plus atrazine (Stalwart Xtra, Parallel Plus, Trizmet) control annual grass and broadleaf weeds in corn.
- Site of action: group 5 (atrazine), group 15 (S-metolachlor/metolachlor). See pages 22-23.
- Can be applied preplant, preemergence, and after corn emergence until corn plants are 5 inches tall and before weeds exceed the 2-leaf stage. Do not apply using fertilizer solution as the spray carrier after crop emergence.
- Allow 30 days between application and harvest of sweet corn.

Bicep II Magnum/Cinch ATZ Use Rates (qt/A)

Soil Texture	Less than 3% OM	3% or more OM
Coarse	1.3	1.6
Medium	1.6	2.1
Fine	2.1	2.1[a] 2.1 to 2.6[b]
Muck or Peat	Do not use	Do not use

[a] Do not exceed this rate on highly erodible land with less than 30% plant residue cover.
[b] For cocklebur, yellow nutsedge, and velvetleaf control on fine-textured soils above 3% OM, apply 3.0 qt/A Bicep II.

Stalwart Xtra Use Rates (qt/A)

Soil Texture	Less than 3% OM	3% or more OM
Coarse	1.3	1.6
Medium	1.6	2.1
Fine	2.1	2.1

Herbicide	Formulation	Product Rate Range
Outlook	**6EC**	

- Outlook (dimethenamid-P) controls annual grasses and pigweed, and controls or suppresses yellow nutsedge and black nightshade.
- Site of action: group 15 (see pages 22-23).
- Can be applied preplant, preemergence, but must be applied before weed emergence, or in a mixture with herbicides that control emerged weeds. Do not apply to corn that is more than 12 inches tall.
- Can be applied after corn has emerged with surfactant or low rates of liquid fertilizer. Do not use fertilizer solution as the spray carrier after crop has emerged. COC should not be added after the crop has emerged unless specified for a particular tank mixture.
- Consult your seed company regarding hybrid tolerance to Outlook. Do not harvest sweet corn for 50 days after application. Do not make any layby applications to sweet corn.

Outlook Use Rates (fl oz/A)

Soil Texture	Less than 3% OM	3% or more OM
Coarse	10 to 14	14 to 18
Medium	14 to 16	16 to 20
Fine	16 to 18	18 to 21

Popcorn and Sweet Corn: Soil-Applied Herbicides—Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
Pendimethalin/Pendimax/ Pendant/etc	**3.3EC**	
Prowl H2O/Satellite Hydrocap	**3.8CS**	

- Apply in conventional systems only, do not apply in minimum or no-till systems. Apply only after planting. Do not incorporate or severe injury may result.
- The active ingredient in these products, pendimethalin controls annual grasses, pigweed, and lambsquarters (including triazine-resistant biotypes), and helps control smartweed, velvetleaf, and seedling johnsongrass. Pendimethalin is often combined with atrazine for control of grass and broadleaf weeds where triazine-resistant pigweed and lambsquarters are a problem.
- Site of action: group 3 (see pages 22-23).
- Do not apply preplant or preemergence on sweet corn.
- Can be applied postemergence until popcorn and sweet corn are 20 to 24 inches tall. Where the corn canopy prevents spray particles from reaching the soil, use drop nozzles and apply as a directed spray. Postemergence applications provide residual control only, not control of emerged weeds.
- To reduce the risk of corn injury, plant at least 1.5 inches deep and ensure seed to soil contact. Combining pendimethalin with dicamba may increase the potential for crop injury, especially when corn is under stress from cool, wet conditions.

Prowl/Pendimax Use Rates (pt/A)

Soil Texture	Soil Organic Matter Content		
	Less than 1.5%	1.5 to 3%	More than 3%
Coarse	1.8 to 2.4	2.4 to 3.6	3.6
Medium	2.4 to 3.6	3.6	3.6 to 4.8
Fine	2.4 to 3.6	3.6 to 4.8	3.6 to 4.8

Prowl H2O/Satellite Hydrocap Use Rates (pt/A)

Soil Texture	Soil Organic Matter Content		
	Less than 1.5%	1.5 to 3%	More than 3%
Coarse	2	3	3
Medium	3	3	4
Fine	3	4	4

Herbicide	Formulation
Sharpen	**2.85SC**

- Sharpen (saflufenacil) controls or suppresses annual broadleaf weeds in popcorn. Check with seed supplier for information on varietal tolerance to Sharpen before using. Do not use on sweet corn.
- The addition of atrazine will improve control of large-seeded broadleaf weeds such as giant ragweed, morningglory, and cocklebur. Sharpen can also be added to other preemergence corn products to improve residual control of broadleaf weeds. Do not apply Sharpen after corn has emerged.
- Site of action: group 14. See pages 22-23.
- This product is intended for use in a planned preemergence followed by postemergence program, and the product rates are not intended to provide full-season weed control. Preemergence or preplant application of Sharpen should be followed by application of postemergence herbicides as needed.
- Sharpen rates are based on soil texture as follows: coarse - 2 to 2.5 oz; medium - 2.5 to 3 oz; fine - 3 to 3.5 oz.
- Do not apply Sharpen where an at-planting application of an organophosphate or carbamate insecticide us planned or has occurred or severe injury can occur. See product label and Table 10 for more information on herbicide-insecticide interactions.
- Preplant application of Sharpen and atrazine can control small, emerged weeds in no-till, including marestail. Glyphosate should be added when weeds are more than about 4 inches tall and for weeds Sharpen does not control (see label). For control of emerged weeds, apply with MSO (1% v/v) and AMS (8.5 to 17 lbs/100 gallons) or UAN (1.25 to 2.5% v/v). Use a spray volume of 15 to 20 gpa in no-till burndown situations, or where emerged weeds are present. Flat fan nozzles are recommended for burndown applications.

Popcorn and Sweet Corn: Soil-Applied Herbicides—Preplant or Preemergence

Herbicide	Formulation
Verdict	**5.57EC**

- Verdict is a premix of dimethenamid-P (Outlook) and saflufenacil (Sharpen) that controls annual grass and broadleaf weeds in popcorn. Check with seed supplier for information on varietal tolerance to Verdict before use.
- The addition of atrazine will improve control of large-seeded broadleaf weeds such as giant ragweed, morningglory, and cocklebur.
- Site of action: Group 15 (dimethenamid-P); group 14 (Saflufenacil). See pages 22-23.
- This product is intended for use in a planned preemergence followed by postemergence program, and the product rates are not intended to provide full-season weed control. Preemergence or preplant application of Verdict should be followed by application of postemergence herbicides as needed.
- Verdict rates are based on soil texture as follows: coarse - 10 to 12 oz; medium - 13 to 15 oz; fine - 16 to 18 oz.
- Do not apply Verdict where an at-planting application of an organophosphate or carbamate insecticide us planned or has occurred or severe injury can occur. See product label and Table 10 for more information on herbicide-insecticide interactions.
- Preplant application of verdict can control small, emerged weeds in no-till, especially when combined with atrazine. Glyphosate should be added when weeds are more than about 4 inches tall, and for weeds Verdict does not control (see label). For control of emerged weeds, apply with MSO (1% v/v) and AMS (8.5 to 17 lbs/100 gallons) or UAN (1.25 to 2.5% v/v). Do not apply Verdict after corn has emerged. Use a spray volume of 15 to 20 gpa in no-till burndown situations, or where emerged weeds are present. Flat fan nozzles are recommended for burndown applications.

Herbicide	Formulation	Product Rate Range
Zemax	**3.76ZC**	**2 to 2.4 qt**

- Zemax is a premix of mesotrione (Callisto) and s-metolachor (Dual II Magnum) that controls annual grass and broadleaf weeds in corn. The addition of atrazine will improve control of large-seeded broadleaf weeds. See Callisto and s-metolachlor descriptions for more information.
- Site of action: group 14 (s-metolachlor); 27 (mesotrione). See pages 22-23.
- Can be applied preemergence to most types of corn, including popcorn (yellow only), sweet corn, and corn grown for seed. Do not apply postemergence to popcorn or sweet corn.
- Application rates: 2 qts/A - less than 3% soil OM; 2.4 qts/A - 3% or greater soil OM.

Herbicide	Formulation
Zidua	**85WDG**

- Zidua (pyroxasulfone) can be applied preplant, preemergence, or early postemergence in field corn, seed corn, popcorn, and sweet corn for residual control of annual grasses and small-seeded broadleaf weeds. This product should generally be combined with other preemergence corn herbicide(s) to improve broadleaf weed control, or followed with a postemergence herbciide treatment.
- Site of action: group 15 (see pages 22-23).
- Application rates based on soil texture: coarse - 1.5 to 2.75 oz; medium - 2 to 3 oz; fine - 2.5 to 4 oz. The label allows rates lower than those listed here when applied postemergence or used in a planned sequential (PRE + POST) program.
- Corn seed must be planted a minimum of one inch deep.
- Early postemergence applications will not control emerged weeds.

Popcorn and Sweet Corn: Postemergence Herbicides—Contact

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**0.5 -1 oz**

- Aim (carfentrazone-ethyl) is a contact herbicide that controls black nightshade, velvetleaf, redroot pigweed, and small annual morninglories and lambsquarters. Aim is often mixed with other broadleaf herbicides to improve control of velvetleaf.
- Site of action: group 14 (see pages 22-23).
- Apply when weeds are 1 to 4 inches tall for best results. Velvetleaf can be controlled up to 36 inches tall. Apply before corn exceeds the 8-collar stage.
- Apply with NIS (0.25% v/v). UAN (2 to 4 gallons/100 gallons) or AMS (2 to 4 lbs/A) can be added if recommended for use with other herbicides in a mix with aim. In general, Aim should not be mixed with COC or EC formulations of other herbicides in order to avoid excessive crop injury. The label does allow use of COC under dry conditions and in specific mixtures. Add Aim to the spray tank first, before adding other products.
- Apply in a spray volume of 10 to 20 gpa with a pressure of 20 to 40 psi. Flat fan nozzles are recommended for adequate spray coverage.
- Aim usually causes leaf speckling and necrosis. The severity of injury varies with environmental conditions, adjuvants, tank-mix partner. To reduce injury, 1) do not apply within 6 to 8 hours of rain, 2) make sure spray nozzles are positioned at least 18 inches above the crop, and 3) avoid direction of excessive amounts of herbicide into the corn whorls.
- Not all sweet corn hybrids have been tested for their tolerance to Aim. The user assumes all liability for crop injury when Aim is applied to sweet corn.

Herbicide	Formulation	Product Rate Range
AAtrex / atrazine	**4L**	**1.5 - 2 qt**
	90DF	**1.67 - 2.22 lb**

- Site of action: group 5 (see pages 22-23).
- Maximum rate for postemergence application to fields without soil-applied atrazine in the same year is 2 pounds active ingredient/A. When applied postemergence to fields with soil-applied atrazine the same year, total amount of atrazine applied may not exceed 2.5 pounds of active ingredient.
- For annual grass control, apply 2 lba ai/A when grasses are no more than 1.5 inches tall. Atrazine will not control fall panicum.
- For control of broadleaf weeds, rates of 1.2 pounds of active ingredient may be sufficient. Apply until broadleaf weeds are 4 inches tall.
- Apply with COC (1% v/v) for best results. Mix atrazine with water first, and add oil last.
- Apply when popcorn or sweet corn is less then 12 inches tall.

Herbicide	Formulation	Product Rate Range
Basagran/Broadloom	**4L**	**1.5 to 2 pt**

- Basagran/Broadloom (bentazon) is a contact herbicide that controls many annual broadleaf weeds, including cocklebur, velvetleaf, and Pennsylvania smartweed. Controls or suppresses Canada thistle and yellow nutsedge.
- Site of action: group 6 (see pages 22-23).
- For best results, apply with COC when weeds are in the 2- to 6-leaf stage.
- Apply in combination with atrazine for control of pigweed, lambsquarters, and ragweed.
- Consult your seed company regarding sweet corn hybrid tolerance to Basagran.

Popcorn and Sweet Corn: Postemergence Herbicides—Contact

Herbicide	Formulation	Product Rate Range
Bromoxynil	**2S**	**1 - 1.5 pt**

- Do not apply to popcorn prior to the 3-leaf stage. Not labeled for sweet corn.
- Bromoxynil is sold under various trade names, including Buctril, Moxy, and Broclean. Bromoxynil is a contact herbicide that controls annual broadleaf weeds, including black nightshade, cocklebur, ragweeds, lambsquarters, and smartweeds, but is weak on pigweed and large velvetleaf.
- Site of action: group 6 (see pages 22-23).
- Do not apply until the 3-leaf popcorn stage. Can be applied until tassel emergence. The 1.5-pint rate may be applied after corn reaches the 4-leaf stage and before tassel emergence. Maximum corn size at the time varies with tank-mix partner.
- Do not use surfactant or crop oil when applying bromxynil alone or with most other herbicides. NIS and fertilizer solution are allowed in some tank mixtures.
- Apply in a minimum volume of 10 gpa at a minimum pressure of 30 psi using flat fan nozzles. May cause leaf burn, but effect are usually temporary.

Herbicide	Formulation	Product Rate Range
Cadet	**0.91EC**	**0.4 - 0.9 oz**

- Cadet (fluthiacet-methyl) is a contact herbicide that controls velvetleaf, and controls or suppresses small lambsquarters, pigweeds, black nightshade, and annual morningglory at the 0.9 oz rate.
- Site of action: group 14 (see pages 22-23).
- Can be applied to field corn, popcorn, seed corn, and sweet corn (processing only) from the 2-collar stage up to 48 inches tall. Apply before tassel emergence. Not labeled for freash market sweet corn.
- Apply with NIS (0.25% v/v), or a COC or MSO (1 to 2 pts/A). UAN (1 to 2 qts/A) or AMS can be added. When combined with other herbicides, Cadet can generally be applied with any adjuvants required for those herbicides.
- Apply in a minimum spray volume of 15 gpa and pressure of 20-40 psi. Increase volume and pressure in dense crop and weed canopies.
- Allow 40 days between application and harvest of sweet corn.

Herbicide	Formulation	Product Rate Range
Laddok S-12	**5L**	**1.3 - 2.3 pt**

- Do not apply to popcorn seed production fields.
- Laddok/Headline is a 1:1 premix of bentazon (Basagran) plus atrazine for control of most broadleaf weeds, and suppression or control of yellow nutsedge, Canada thistle, and some perennial vines.
- Site of action: group 5 (atrazine); group 6 (bentazon). See pages 22-23.
- Application rate with species and size. Apply with UAN solution, AMS, nonphytotoxic oil concentrate, or Dash. The label allows combinations of spray additives, which vary with the weed species present. UAN or AMS should be added when velvetleaf is the target weed, and may also increase control of cocklebur and Pennsylvania smartweed. COC should also be added when common lambsquarters, common ragweed, Canada thistle, yellow nutsedge, or field bindweed is present.
- Apply in a spray volume of at least 10 gpa with a minimum pressure of 40 psi. Increasing the spray volume (up to 50 gpa) will improve control when the crop and weed foliage is dense.
- To suppress Canada thistle, apply 2.3 pints when thistle plants are 8 to 10 inches tall until the bud stage.
- A single application of 2.3 pints of Laddok can suppress yellow nutsedge that is 1 to 4 inches tall.
- Provides more effective control of velvetleaf, annual morningglory, lambsquarters, and pigweed than Basagran alone, but is no more effective on triazine-resistant lambsquarters.

Popcorn and Sweet Corn: Postemergence Herbicides—Systemic

Herbicide	Formulation	Product Rate Range
Armezon PRO	**5.35EC**	**14 - 24 oz**

- Armezon PRO is a premix of topramezone (Impact/Armezon) and dimethenamid (Outlook) for control of emerged broadleaf weeds and residual control of grasses and pigweeds. See Impact/Armezon and Outlook descriptions for more information
- Site of action: group 27 (topramezone); group 15 (dimethenamid). See pages 22-23.
- Can be applied postemergence on popcorn up to the V8 stage or 30-inch corn, whichever occurs first, and not within 45 days of harvest for forage or grain. Can be applied postemergence on sweet corn from emergence up to 12 inches tall, and not within 50 days of harvest.
- Apply with MSO, COC, or HSOC (0.5 to 1.0% v/v) plus either UAN (1.25 to 2.5% v/v) or AMS (8.5 to 17 lbs/100 gallons of water). NIS can be used instead of MSO, COC, or HSOC if required in mixtures with other herbicides.
- Armezon PRO should not be relied upon to provide complete control of grasses, but can control small (less than 3-inch) grasses that escape preemergence herbicides.

Armezon PRO Use Rates (floz/A)		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	14 to 16	16 to 20
Medium and fine	16 to 20	20 to 24

Herbicide	Formulation	Product Rate Range
Beacon	**75DF**	**3/8 -3/4 oz**

- Risk of severe injury - check with popcorn seed supplier or chemical representative for sensitivity of inbreds/hybrids. Not labeled for sweet corn.
- Can be applied only as a directed spray using drop nozzles, when popcorn is between 10 and 48 inches tall. Nozzles should be positioned to avoid placing herbicide in whorl. Must be applied before tassel.
- Beacon (primsulfuron) is a translocated sulfonylurea that controls or suppresses annual and perennial grasses and controls annual broadleaf weeds. Beacon provides partial control of foxtail species and may be less effective than Accent for rhizome johnsongrass and quackgrass control, but is generally more effective than Accent on broadleaf weed control. Does not control ALS resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Apply NIS (0.25% v/v) or COC (1 to 4 pints per acre); COC is generally the preferred additive. COC plus UAN or AMS can be used when tank-mixing with atrazine, Accent, or dicamba. Most other tank-mixures should be applied with NIS. See specific label for details.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range
Callisto	**4L**	**3 fl oz**

- Apply only to yellow popcorn or sweet corn up to 30 inches tall or the 8-leaf stage. Apply when weeds are less than 5 inches tall for best results.
- Callisto (mesotrione) is a systemic herbicide that controls annual broadleaf weeds, including cocklebur, atriplex, lambsquarters (including triazine-resistant), giant ragweed, Pennsylvania smartweed, pigweeds, waterhemp, velvetleaf, and black nightshade. Callisto alone does not provide consistent control of common ragweed or morningglory, and can be variable on giant ragweed.
- Site of action: group 27 (see pages 22-23).
- Apply with COC (1% v/v). Do not use MSO (MSO), MSO blend adjuvants, AMS, or UAN.
- To avoid crop injury, do not apply Callisto postemergence in a tank-mix with emulsifiable concentrate grass herbi-

Popcorn and Sweet Corn: Postemergence Herbicides—Systemic

cides (Dual II Magnum, etc.). See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

- Herbicide sensitivity in sweet corn and yellow popcorn varies widely, and not all sweet corn and yellow popcorn hybrids have been tested. Contact your sweet corn or popcorn company or agronomist about hybrid recommendations before making a postemergence application of Callisto to sweet corn or yellow popcorn.

Herbicide	Formulation	Product Rate Range
Callisto Xtra	**3.7L**	**20 to 24 oz**

- Callisto Xtra is a premix of mesotrione (Callisto) and atrazine that controls annual broadleaf weeds. See Callisto description for more information.
- Site of action: group 27 (mesotrione); group 5 (atrazine). See pages 22-23.
- Apply when weeds are less than 5 inches tall for best results. Can be applied to sweet corn and yellow popcorn from emergence up to 12 inches tall.
- Apply with COC (1% v/v) or NIS (0.25% v/v). COC is the preferred adjuvant to maximize activity, but increases the risk of crop injury. Applying when weeds are less than 5 inches tall will minimize the need for COC. Do not use MSO (MSO) or MSO blend adjuvants, UAN or AMS.
- Apply in a spray volume of 10 to 30 gpa, but use a volume of at least 15 gpa if weed foliage is dense.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides. Do not apply Callisto Xtra postemergence in a mixture with emulsifiable concentrate grass herbicides.

Herbicide	Formulation	Product Rate Range
Dicamba	**4L**	**1/2 - 1 pt**

- Risk of injury - check with popcorn seed supplier or chemical representative for sensitivity of selected inbreds/hybrids. Not labeled for sweet corn.
- Dicamba is sold under several trade names such as Banvel, Clarity, Sterling Blue, and Oracle. Dicamba is a translocated herbicide that controls many annual broadleaf weeds, including pigweed, black nightshade, cocklebur, and Pennsylvania smartweed. Control of velvetleaf can be variable. Dicamba will control or suppress perennial weeds, especially when mixed with an ALS herbicide.
- Site of action: group 4 (see pages 22-23).
- Apply 1/2 to 1 pint when corn is in the spike to 5-leaf stage, or until corn is 8 inches tall, whichever occurs first. Do not apply more than 1/2 to 1 pint on coarse-textured soils. If the 6th true leaf is emerging from the whorl, or corn is more than 8 inches tall, a rate of 1/2 pint can be applied until corn is 36 inches tall, or until 15 days before tassel emergence. Apply as a directed spray when corn leaves prevent proper spray coverage, or sensitive crops are growing nearby.
- The 1 pint rate provides limited residual broadleaf weed control.
- Apply with 1/2 to 1 gallon per acre of UAN (28%) when velvetleaf is a target weed. Can be applied with surfactant or crop oil to improve control in dry growing conditions. Do not apply with crop oil when corn exceeds 5 inches in height.
- With any dicamba product, risk of corn injury increases when corn exceeds 8 to 10 inches in height. To reduce risk of injury, make sure nozzle spacing and boom height are set to minimize interception of spray by the corn plants.
- Soybean and vegetables are extremely susceptible to dicamba drift and vapors. Apply in a spray volume of 20 gpa at a pressure of less than 20 psi to reduce drift. Do not apply where sensitive crops are present if winds over 5 MPH are moving in the direction of the sensitive crops, corn is more than 24 inches tall, soybeans are more than 10 inches tall, or soybeans have begun to bloom. Most dicamba products should not be applied when air temperatures on the day of application will exceed 85 degrees.

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Herbicide	Formulation	Product Rate Range
Dicamba + atrazine	**3.2L**	**3.5 pt**

- Risk of injury - check with popcorn seed supplier or chemical representative for sensitivity of selected inbreds/hybrids. Not labeled for sweet corn.
- Dicamba + atrazine is sold under several trade names, including Marksman, Sterling Plus, Banvel-K + atrazine, and Stratos. These products control most annual broadleaf weeds, and suppress or control perennial broadleaf weeds.
- Site of action: group 4 (dicamba), group 5 (atrazine). See pages 22-23.
- Apply when corn is in the spike to five-leaf stage, or until corn is 8 inches tall, whichever comes first. The rate is 3.5 on medium- or fine textured soils with at least 2.5 percent organic matter, and 2 pints on coarse-textured soils. Provides some residual broadleaf weed control.
- The addition of crop oil, surfactant, or liquid nitrogen fertilizer may improve control, especially when weeds are drought-stressed. Apply with UAN if velvetleaf is a target weed. Application with crop oils may cause crop injury. Do not apply with crop oil after corn exceeds 5 inches in height.
- Precautions on spray drift, volatility, and corn injury are the same as for dicamba. See dicamba description above for more information.

Herbicide	Formulation	Product Rate Range
DiFlexx	**4L**	**1/2 - 1 pt**

- DiFlexx is a premix of dicamba and cyprosulfamide, a safener that reduces the risk of injury to corn. See dicamba description for more information also.
- Site of action: group 4 (see pages 22-23).
- Can be applied to popcorn only, not sweet corn. Apply 1/2 to 1 pint when corn is in the spike to V6 stage, or up to 36 inches tall, whichever occurs first. Apply as a directed spray when corn is in the V7 to V10 stage and less than 36 inches tall, or up to 15 days before tassel, whichever occurs first. Directed spray should be used also when corn leaves prevent proper spray coverage, sensitive crops are growing nearby, or if mixed with 2,4-D.
- Can be applied with and adjuvant and nitrogen source, especially under dry growing conditions. Apply with NIS (0.25% v/v) or COC/MSO (1% v/v) plus either UAN (2 to 4 qt/A) or AMS (8.5 to 17 lbs/100 gallons of water).

Herbicide	Formulation	Product Rate Range
Impact/Armezon	**2.8L**	**0.75 oz**

- Impact/Armezon (topramezone) controls annual broadleaf weeds, including biotypes resistant to ALS inhibitors, glyphosate, and triazines. Impact controls or suppress small annual grasses. Impact/Armezon is most effective when applied in combination with 0.25 to 1.5 lbs active ingredient /A of atrazine. The higher atrazine rates will provide residual weed control and more effective control of grasses.
- Site of action: group 27 (see pages 22-23).
- Popcorn inbreds and sweet corn hybrids vary in their tolerance to Impact. Users should check with seed supplier for information on tolerance prior to use in seed production fields.
- Apply when most broadleaf weeds are emerged and less than 6 inches tall.
- Impact can be applied postemergence up to 45 days before crop harvest. Apply with drop nozzles if the crop canopy prevents adequate spray coverage on weeds.
- For best results, apply with a MSO (1 to 1.5% v/v) plus either UAN (1.25 to 2.5% v/v) or AMS (8.5 to 17 lbs/100 gallons of water). NIS can be used instead of methylated seed soil if required in tank-mixes with other herbicides.
- Apply in a minimum spray volume of 10 gpa, and apply in 15 gpa when treating large weeds or high-density weed infestations.
- Impact/Armezon should not be relied upon to provide complete control of grasses, but can control small grasses (less than 2 inches) that escape preemergence herbicides.

Popcorn and Sweet Corn: Postemergence Herbicides—Systemic

Herbicide	Formulation	Product Rate Range
Laudis	**3.5L**	**3 oz**

- Laudis (tembotrione) controls many broadleaf weeds, including biotypes resistant to ALS inhibitors, glyphosate, and triazines. Impact controls or suppress small annual grasses.
- Laudis is most effective when applied in combination with 0.5 lbs active ingredient /A of atrazine. Bromoxynil (6 to 12 oz/A) can be substituted for atrazine when corn is more than 12 inches tall.
- Site of action: group 27 (see pages 22-23).
- Check with seed supplier for information on hybrid tolerance prior to use on sweet corn or popcorn.
- Apply when broadleaf weeds are less than 6 inches tall. For most grass species, grasses should be less than 3 inches tall at time of application.
- Apply broadcast up to the V8 stage of popcorn and the V7 stage for sweet corn. Maximum of two applications on popcorn and one on sweet corn.
- Apply with a MSO (1% v/v, minimum of 1.25 pt/A) plus either UAN (1.5 qt/A) or AMS (1.5 lb/A).
- Apply in a minimum spray volume of 10 gpa, and apply in 15 to 20 gpa in dense weed populations or under adverse environmental conditions. Use nozzles and pressure that result in medium spray droplets, and increase application volume when using nozzles that produce coarse spray droplets. Flat fan nozzles of 80 or 110 degrees will provide optimum postemergence spray coverage.
- Laudis should not be relied upon to provide complete control of grasses, but can control small (less than 2 inches) grasses that escape preemergence herbicides.

Herbicide	Formulation	Product Rate Range
Nicosulfuron (active ingredient)		
Accent Q	**54.5DF**	**0.9 oz**
NIC-IT	**2L**	**2 oz**

- Accent Q and NIC-IT are labeled for use on popcorn and some sweet corn hybrids grown for processing and fresh market. Growers should contact seed suppliers for recommendations and information on crop tolerance, and use of soil-applied organophosphate insecticides, prior to application. Do not apply to any white popcorn inbred or hybrid unless approved by the seed supplier. Accent and NIC-IT can be used on High Lysine, Waxy, White or other Food Grade hybrids. A list of approved processing sweet corn hybrids is available from DuPont. With regard to use of Accent on fresh market sweet corn, the user assumes all risk based on recommendations from university or seed company personnel, or other experts.
- Can be applied broadcast to popcorn that is less than 20 inches tall or has up to 5 collars (whichever occurs first). Do not apply broadcast to sweet corn more than 12 inches tall. Drop nozzles can be used up to 18 inches or V6 corn stage.
- Nicosulfuron is a translocated sulfonylurea herbicide that controls annual and perennial grasses and some annual broadleaf weeds, including Pennsylvania smartweed, pigweed, and annual morningglory. Does not control crabgrass.
- Site of action: group 2 (see pages 22-23).
- Accent Q contains nicosulfuron plus isoxadifen, a safener to reduce the risk of corn injury.
- Apply in a spray volume of at least 15 gpa with a spray pressure of 20 to 40 psi. Increase spray volume and pressure as weed density and size increase. Flat fan or Turbo Floodjet nozzles are recommended.
- To avoid a reduction in grass control or crop injury, do not mix with 2,4-D, Basagran, or Laddok. See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range
NorthStar	**47DF**	**5 oz**

- Not labeled for sweet corn.

Popcorn and Sweet Corn: Postemergence Herbicides—Systemic

- Risk of injury - check with your popcorn seed supplier or chemical representative for sensitivity of inbred/hybrid. Inbred lines and popcorn hybrids should be thoroughly tested for sensitivity to NorthStar before treating large acreages.
- Apply as a directed spray using drop nozzles when popcorn is between 10 and 30 inches tall. Must be applied before tassel emergence.
- NorthStar is a premix of primisulfuron (Beacon) plus dicamba (Banvel) for control of most annual broadleaf weeds and suppression or control of annual and perennial grasses. NorthStar will suppress a number of perennial broadleaf weeds. See Beacon and dicamba descriptions for more information and precautions on use.
- Site of action: group 2 (primisulfuron), group 4 (dicamba). See pages 22-23.
- Apply with NIS (0.25% v/v) or COC (1 to 4 pints/A), but do not use COC if corn is more than 12 inches tall. UAN (2 to 4 quarts/A) or AMS (2 to 4 lbs/A) may also be added.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range
Permit/Sandea/Halomax	**75DF**	**2/3 oz**

- These products contain halosulfuron, a translocated sulfonylurea herbicide that controls yellow nutsedge and annual broadleaf weeds, including velvetleaf, ragweeds, cocklebur, and redroot pigweed. Halosulfuron is weak on lambsquarters and annual morninglories. Does not control ALS-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Can be applied broadcast to popcorn and sweet corn in the spike through layby stage. Two applications are allowed per year, but the second should be applied with drop nozzles. Popcorn and sweet corn hybrids should be thoroughly tested for sensitivity to halosulfuron before treating large acreages. Do not apply when corn is under stress from environmental conditions.
- For control of yellow nutsedge, apply 1 to 1 1/3 ounces/A when nutsedge is 4 to 12 inches tall. Dense populations of nutsedge may require a second application.
- Apply in a minimum spray volume of 10 gpa with NIS (1 to 2 quarts/100 gallons) or COC (1 gallon/ 100 gallons). Include UAN (2 to 4 quarts/A) or AMS (2 to 4 lbs/A) when velvetleaf or redroot pigweed is present.
- Tank mixtures may cause temporary crop injury, especially when the tank-mix partner is Accent or Beacon. Do not apply in a mixture if the crop is under stress due to drought, water saturated soils, low fertility, hail, frost, insects, or when the maximum daytime temperature is above 92 degrees.
- Allow 30 days after application before harvesting for forage or grazing.

Herbicide	Formulation	Product Rate Range
Revulin Q	**51.2WDG**	**3.4 - 4 oz**

- Revulin Q is a premix of nicosulfuron (Accent Q) and mesotrione (Callisto). It also contains a safener, isoxadifen, that reduces risk of corn injury and broadens the application window, compared with non-safened nicosulfuron products. See nicosulfuron and Callisto descriptions for more information also.
- Controls small (less than 4 to 5 inches) annual grass and broadleaf weeds, and provides limited residual control. Can be mixed with other herbicides to broaden the spectrum of control, for control of larger weeds, or to extend residual control.
- Site of action: group 2 (nicosulfuron); group 27 (mesotrione). See pages 22-23.
- Can be applied broadcast to yellow popcorn less than 20 inches tall (free standing) and prior to the V5 stage (whichever is more restrictive). Apply when corn is less than 12 inches tall for best results.
- Can be applied broadcast to sweet corn up to 12 inches tall, or up to and including 5 leaf collars (V5), whichever occurs first. Can be applied as a directed spray using drop nozzles to sweet corn up to 18 inches tall, and prior to the V6 stage.

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- Apply with NIS (0.25% v/v). Use of COC can improve control, especially under dry conditions, but risk of crop injury is substantially increased in some environments. Do not use UAN, AMS, MSO or MSO blend adjuvants. Do not use spray additives that adjust the spray solution pH below 5 or above 9 as rapid product degradation can occur.
- Use a minimum spray volume of 15 gpa for best performance. Volume of 10 gpa can be used for light, scattered stands of weeds. To minimize drift, apply using nozzles that deliver coarse spray or larger spray droplets.
- Do not mix with Basagran. See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range
Solstice	**4L**	**2.5 - 3.15 oz**

- Solstice is a premix of fluthiacet-methyl (Cadet) and mesotrione (Callisto) for control of most annual broadleaf weeds less than 5 inches tall. Solstice should be applied with atrazine whenever possible based on crop size or other atrazine restrictions.
- Site of action: group 14 (fluthiacet); group 27 (mesotrione). See pages 22-23.
- Can be applied to yellow popcorn and sweet corn up to 30 inches tall, or the V8 stage, whichever occurs first. Sensitivity of popcorn sweet corn hybrids varies widely - check with seed company for information about tolerance of specific hybrids to Solstice.
- Do not apply to white popcorn or ornamental corn. Allow 40 days between application and harvest of sweet corn ears or forage.
- Apply with NIS (0.25% v/v). COC can be used instead of NIS to improve control, under dry conditions especially, but increases the risk of injury. Do not apply with nitrogen-based adjuvants (UAN or AMS), or MSO or MSO blends.
- Apply in a spray volume of 10-30 gpa, and minimum of 15 gpa in dense foliage. Use spray nozzles that provide medium droplet size, and pressure of 35-40 psi at the nozzle. Flat fan nozzles are recommended for optimum coverage.
- Solstice can cause bleaching and speckling of leaves, which is typically short-lived. Spray boom should be kept a minimum of 18 inches above the crop canopy to ensure uniform spray distribution and to avoid concentrating spray in corn whorls.
- Do not apply in a mixture with emulsifiable concentrate grass herbicides. See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range
Spirit	**57DF**	**1 oz (1 packet per 4 acres)**

- Not labeled for sweet corn.
- Risk of injury - check with your seed supplier or chemical representative for sensitivity of popcorn inbred/hybrid.
- Apply as a directed spray using drop nozzles when popcorn is between 10 and 30 inches tall. Must be applied before tassel emergence.
- Spirit is a premix of prosulfuron (Peak) plus primisulfuron (Beacon). Mixing with dicamba, 2,4-D, or Buctril/Moxy will improve lambsquarters control. Most effective control/suppression of perennial broadleaf weeds will occur when mixed with 2,4-D or dicamba. Spirit is weak on annual morningglories and yellow nutsedge. Does not control ALS-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Follow these guidelines to avoid carryover of Spirit to subsequent crops: 1) Avoid use where soil pH is greater than 7.8. If used where soil pH is greater than 7.8, plant only field corn or small grains the following year; 2) where less than one inch of rain occurs within one month of application, or less than 12 inches of rain occurs within 5 months after application, plant only corn, small grains, or STS soybean the following year; 2) north of Interstate 80, do not plant soybeans within 18 months of application; 3) south of interstate 80, soybean can be planted 10 months after application where soil pH is less than 7.8; and 4) do not apply after June 30. See label for guidelines on rotation to other crops.

Popcorn and Sweet Corn: Postemergence Herbicides—Systemic

- Apply in a minimum spray volume of 10 gpa. Increasing the volume to at least 20 gpa can improve control in dense weed infestations.
- Apply with COC (1 to 4 pints/A) or NIS (1 to 2 quarts/100 gallons). UAN (2 to 4 quarts/A) or AMS (2 lbs/A) may be added to improve control of velvetleaf and other weeds. COC is generally more effective than NIS. Use of a MSO (Meth Oil, Priority MSO, Sun-It II, for example) may improve control when weeds are large or drought-stressed.
- See label and Table 10 for information about possible interactions between this herbicide and soil-applied/foliar insecticides.

Herbicide	Formulation	Product Rate Range
Status	**56WDG**	**5 - 10 oz**

- Risk of injury - check with your popcorn seed supplier for sensitivity of inbred/hybrid. Not labeled for use on sweet corn.
- Status is a premix of dicamba plus diflufenzopyr plus a safener, for control of most annual broadleaf weeds. Status can be weak on velvetleaf, although it is more effective than dicamba alone.
- Site of action: group 4 (dicamba), group 19 (diflufenzopyr). See pages 22-23.
- Status is generally more effective than other dicamba products on perennial broadleaf weeds, and has provided excellent control of Canada thistle and hedge bindweed in OSU research.
- Apply 5 oz/A when corn is 4 to 36 inches tall, or from V2 to V10. As with any dicamba product, risk of corn injury increases when corn exceeds 8 to 10 inches in height. To reduce risk of injury, make sure nozzle spacing and spray boom height are set to minimize interception of spray by the corn plants.
- Apply with NIS (0.25% v/v), COC (1 to 2 pts/A), or MSO (1 to 2 pts/A), plus UAN (at least 1.25% v/v) or AMS (5 -17 lb/100 gallons). To avoid mixing problems, add Status to spray tank before adding AMS.
- Volatility of Status is similar to Clarity. Take precautions to avoid contact of herbicide with sensitive plants via drift or volatility. Exposure of soybeans to Status via sprayer contamination of spray particle drift with result in more severe injury compared to other dicamba products.

Herbicide	Formulation	Product Rate Range
Stinger	**3L**	**1/4 - 2/3 pt**

- Stinger (clopyralid) is a translocated herbicide that controls ragweeds, cocklebur, jimsonweed, and Canada thistle. Controls or suppresses Jerusalem artichoke and suppresses sowthistle.
- Site of action: group 4 (see pages 22-23).
- Apply after corn emergence until popcorn is 24 inches tall or sweet corn is 18 inches tall. Use a spray volume of at least 10 gallons per acre.
- For annual weed and Jerusalem artichoke control, apply 1/4 to 1/2 pint when weeds have 5 or fewer leaves.
- For Canada thistle control, apply 1/3 to 2/3 pint when thistles are at least 4 inches tall or across, but before the bud stage. The higher rate provides more complete plant kill and better control of dense patches. Do not cultivate prior to or for 14 to 20 days following application.

Popcorn: Harvest Aid

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**1 - 2 oz**

- Aim (carfentrazone) can be applied prior to harvest of corn for dessication of velvetleaf, morningglory, pigweeds, and other weeds. Apply at least 3 days before harvest when the crop is mature and grain has begun to dry down.
- Site of action: group 14 (see pages 22-23).
- Use a spray volume that results in complete coverage of foliage. Apply with NIS (0.25% v/v) or COC (1 to 2% v/v). UAN or AMS may also be added.

Attribute Bt11 Sweet Corn (glufosinate-resistant)

Herbicide	Formulation	Product Rate Range
Liberty 280SL	**2.34L**	**20 oz**

- Liberty (glufosinate) is a contact, broad-spectrum herbicide for postemergence use only on Attribute Bt11 (glufosinate-resistant) sweet corn hybrids.
- Site of action: group 10 (see pages 22-23).
- Apply broadcast from corn emergence through 24-inch corn or the V7 stage (7 collars), whichever occurs first. Can be applied twice during the same season, for a maximum total of 40 oz/A. Allow at least 10 days between applioca-tions, and 50 days between the last application and harvest of ears.
- Liberty should be used in a combined preemergence plus postemergence program, where the preemergence herbicide will provide control of grass and broadleaf weeds for several weeks to a month after corn planting. Postemergence applications of Liberty in this program should include atrazine or Laudis where possible. Liberty is weak on yellow foxtail, barnyardgrass, and lambsquarters, and the other PRE or POST herbicides used with Liberty should provide substantial control of these weeds.
- Maximum height for grass weeds: barnyardgrass, crabgrass, yellow foxtail, fall panicum - 3 inches; woolly cupgrass, shattercane, and green, giant, and robust foxtails - 6 inches; volunteer corn - 10 inches. Yellow foxtail and crabgrass should be treated prior to tiller initiation for best results. Liberty is most effective on volunteer corn (including glyphosate-resistant) that is 6 to 12 inches tall.
- Maximum height for broadleaf weeds: velvetleaf, pigweeds - 3 inches; lambsquarters, waterhemp - 4 inches; burcucumber, cocklebur, annual morningglories, black nightshade, ragweeds, and Pennsylvania smartweed - 6 inches.
- Apply with AMS at the rate of 3 lbs/A, or 17 lbs/100 gallons. When air temperatures are above 85 degrees, the rate can be reduced to 1.5 lbs/A, or 8.5 lbs/100 gallons, to reduce the risk of leaf burn. Applying with surfactants or crop oils may increase the risk of crop injury.
- Apply in a spray volume of 15 to 20 gpa. Liberty should be applied with a nozzle type and spray pressure that results in medium spray droplets (250 to 350 microns).
- Liberty is most effective when applied under warm, sunny conditions. Effectiveness may be reduced if applied when heavy dew, fog and mist/rain are present, or if weeds are under stress due to drought, cool temperatures, or extended periods of cloudiness. To avoid reduced weed control, apply between dawn and two hours before sunset.

Roundup Ready Sweet Corn (glyphosate-resistant)

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**0.55 - 1.5 lb ae/A**

- Glyphosate is a translocated herbicide that controls emerged annual and perennial grass and broadleaf weeds. Variations in the formulation may result in differences in product rate and adjuvant recommendations, and specified rainfast intervals. Users should consult labels and local product use guides for more specific information.
- Apply postemergence only to glyphosate-resistant sweet corn hybrids (Roundup Ready).
- Site of action: group 9 (see pages 22-23).
- The rate in a single application should not exceed 1.5 lb ae/A, and the total applied between emergence and 48 inches should not exceed 4.5 lbs ae/A. The general recommendation on most labels for the initial postemergence glyphosate application is a rate of 0.56 to 0.75 lbs of glyphosate acid per acre (lbs ae/A) when weeds are less than 4 inches tall, or before weeds become competitive with the crop. Rates should be increased to 1.1 to 1.5 lbs ae/A where weeds are more than 6 inches tall.
- Apply from corn emergence through the 8-collar stage or until corn is 30 inches tall, whichever occurs first. When corn is 24 to 30 inches tall, use of drop nozzles will generally improve spray coverage on weeds. For sweet corn heights of 30 to 48 inches, avoid treating if corn has reached the reproductive stage, and apply only with drop nozzles adjusted to keep spray out of corn whorls.
- Glyphosate resistance has developed in populations of marestail, Palmer amaranth, waterhemp, and common and giant ragweed in Ohio, Indiana, and Illinois. Consider use of a preemergence herbicide that provides residual control of these weeds, avoid use of herbicide programs consisting solely of multiple glyphosate applications, and include another postemergence herbicide where necessary to improve control.
- Control of perennial weeds will require higher rates than annual weeds. Application when perennials are in the bud to bloom stage (or boot to seedhead for grasses) will provide the most complete control of the entire plant. Minimum size of various perennial weeds for most effective control through the growing season: quackgrass, Canada thistle, wirestem muhly, and yellow nutsedge - 6 inches; field bindweed and common milkweed -12 inches; johnsongrass and hemp dogbane - 18 inches.
- Apply in a spray volume of 5 to 20 gpa. Allow 30 days between application and harvest.

Soybean Herbicide Management Strategies

A number of broad-spectrum preemergence (PRE) and postemergence (POST) herbicides are available for use in soybeans. In OSU research, almost any type of approach to herbicide management can be used in fields with low weed pressure with little risk of crop yield loss. These approaches include: total PRE, PRE followed by POST, and total POST. However, the biology of some weeds that occur in soybean fields, in addition to the slow early development of no-till soybeans, can make it difficult to achieve effective weed control with a single application of PRE or POST herbicides. For this reason, a PRE followed by POST program or a two-pass POST program often provides the most consistent control.

Weeds that are especially problematic in a total PRE herbicide program, depending upon their population, include annual grasses, giant ragweed, ALS-resistant common ragweed, marestail, annual morningglory, cocklebur, waterhemp, and most perennial weeds. Another major drawback to PRE herbicides applied at planting is the narrow window of time in which at least 0.5 to 1 inch of rain must occur to move herbicide into the soil. In early May when soybeans are often planted, weeds will typically start to emerge within 8 to 10 days after tillage or an application of glyphosate or paraquat. Rain is needed before these weeds emerge in order for PRE herbicides to be effective. Applying herbicides several weeks or more before planting of no-till soybeans often results in more consistent weed control initially, although herbicide activity may not last as long after planting, compared to application at the time of planting.

Weeds that can be problematic in a one-pass, total POST herbicide program, depending upon their population, include annual grasses, giant ragweed, waterhemp, lambsquarters, marestail, and some perennials (because they may be too small at the time of an early POST application). Most POST soybean herbicides should be applied before weeds exceed 3 to 6 inches in height for consistent control and to avoid crop yield loss. Glyphosate application can be timed for weed heights of 4 to 8 inches, although velvetleaf, lambsquarters and some other weeds are more easily controlled when less than 6 inches tall. Problems with proper timing of a single postemergence application include: 1) giant ragweed grows at approximately twice the rate of most annual weeds, and is likely to be 8 to 12 inches tall when other weeds are 3 to 6 inches tall; 2) wet and/or cold weather can prevent timely application and result in the need to treat many acres within a short period of time once favorable weather returns, and 3) when weed populations continue to emerge after the POST application and are not suppressed by the soybean leaf canopy, a second POST application may be needed.

A planned PRE plus POST approach will provide more consistent weed control than any one-pass approach in many fields, and help solve some of the problems in management of glyphosate and other POST herbicides. The most complete PRE plus POST program includes use of a PRE herbicide with activity on key broadleaf weeds that also provides at least some early-season control of grasses, followed by glyphosate in Rounudp Ready soybeans, or another POST treatment with activity on grass and broadleaf weeds in non-Roundup Ready soybeans. The PRE herbicide can control or reduce the population of some problem broadleaf weeds, such as lambsquarters, waterhemp, and giant ragweed, making it relatively easy to control any later-emerging weeds with the POST treatment. A major advantage of the PRE plus POST approach, compared to total POST, is that the PRE herbicide will often provide enough weed control to prevent major problems if weather delays the POST application. The PRE plus POST approach can allow for a slightly delayed POST application, resulting in more consistent control of late-emerging weeds such as foxtails, giant ragweed, black nightshade, waterhemp, and perennials.

Preemergence (PRE) Soybean Herbicide Programs

Total PRE herbicide programs fit fields with:

- low annual grass populations
- low to moderate populations of annual broadleaf weeds, including common ragweed, smartweed, pigweed, and velvetleaf
- most populations of lambsquarters

Total PRE programs do not fit fields with:

- moderate to high annual grass populations
- giant ragweed, Palmer amaranth, cocklebur, burcucumber, annual morningglory, or waterhemp
- biennial and perennial weeds

Advantages:

- one-pass, can apply while planting
- with adequate rain, provides control through the first 6 weeks, and later-emerging weeds have much reduced impact on soybean yields

Disadvantages:

- dependence upon adequate rain within narrow period of time
- not effective enough on tough broadleaf or perennial weeds or in moderate to high grass populations
- soybeans need to be competitive earlier in season compared to PRE plus POST programs

Approaches:

The most broad-spectrum programs include mixtures of a grass herbicide (Command, metolachlor, Outlook, pendimethalin, etc.) with Canopy, Surveil, Envive, Valor XLT, Sonic, or Authority First. Python, Valor, and metribuzin have less activity on giant ragweed and other tough broadleaf weeds compared to the previously listed products.

Preemergence (PRE) plus Postemergence (POST) Soybean Herbicide Programs

PRE plus POST herbicide programs fit any field, but are especially well-suited for fields with:

- moderate to high annual grass populations
- moderate to high giant ragweed, cocklebur, and annual morningglory populations
- Palmer amaranth and waterhemp
- biennial and perennial weeds
- burcucumber
- no-tillage

Advantages:

- very consistent, as long as some rain on PRE
- creates wider window for POST application, compared to total POST programs
- good on many tough weeds
- best approach to control of herbicide-resistant weeds

Disadvantages:

- dependence upon rain for PRE activity (although have planned POST backup)
- two-pass

Approaches:

In fields with low grass populations, using PRE grass or grass plus broadleaf herbicides followed by POST broadleaf herbicide is one approach. Examples:

- Dual II Magnum followed by Flexstar + thifensulfuron
- Prowl followed by Pursuit + Cobra

In fields with moderate to high grass populations, using a PRE broadleaf herbicide that also has some grass activity followed by a POST grass or grass plus broadleaf herbicide treatment is another approach. Choice of PRE herbicide would vary with type of broadleaf weeds present – problem weeds such as giant ragweed require PRE use of Canopy EX, Synchrony XP, FirstRate, or Surveil. Examples:

- Canopy followed by Flexstar + Fusion
- Valor XLT followed by glyphosate (RR soybeans)
- Matador followed by Liberty (LibertyLink soybean)

Total Postemergence (POST) Soybean Herbicide Programs

Total POST herbicide programs (one application) can be used in fields with:

- low to moderate populations of most annual weeds
- low populations of giant ragweed

Avoid use in fields with:

- moderate to high lambsquarters or grass populations
- high giant ragweed populations
- marestail
- late-season perennials such as hemp dogbane

Advantages:

- one-pass, can plant first and apply later (except for burndown in no-till soybeans)
- not dependent upon rainfall for postemergence activity (although soil moisture status affects weed response to herbicides)
- consistent control of low to moderate annual weed populations

Disadvantages:

- narrow window of application depending upon weather should be applied before weeds exceed about 6 inches in height to avoid yield loss
- a second POST application may be needed for late-emerging weeds that are not suppressed by the soybean leaf canopy
- application may be too early for best perennial weed control
- Difficult to control herbicide-resistant weeds without the use of PRE herbicides

Approaches:

Apply a POST herbicide treatment with activity on grass and broadleaf weeds before weeds exceed 3 to 6 inches in height (4 to 8 inches for Roundup Ready soybean program). Make a second POST application as necessary for late-emerging weeds.Examples:

Glyphosate (Roundup Ready soybeans)
Flexstar + Harmony GT + Fusion
Raptor

Table 13. Weed Response to Preplant/Preemergence Herbicides in Soybeans—Grasses

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables. See pages 22-23 for more information on herbicide site of action classification and description of site of action groups.

Weed control rating:
9 = 90% to 100% control
8 = 80% to 90% control
7 = 70% to 80% control
6 = 60% to 70% control
- = less than 60% control, not recommended.
Crop injury of 1 or less is rarely significant.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

	Grasses											
	Site of Action	Crop Tolerance	Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Giant foxtail	Yellow foxtail	Shattercane	Seedling johnsongrass	Woolly cupgrass	Yellow nutsedge
Preplant Incorporated Only												
Trifluralin	3	1	9	9	9	8+	9	9	7	7	8+	-
Preplant or Preemergence												
Authority Assist	2/14	2	6	7	7	-	7	7	6	6	-	8
Authority First/Sonic	2/14	2	-	7	-	-	-	-	-	-	-	-
Authority MTZ	5/14	2	-	-	-	-	-	-	-	-	-	6
Authority MAXX/XL	2/14	2	-	-	-	-	-	-	-	-	-	8
Boundary/Ledger/Tailwind	5/15	1	8	9	8+	6	8+	8+	-	-	7	8
BroadAxe XC	14/15	2	8	9	8	6	8+	8+	-	-	7	8
Canopy DF/Cloak DF	2/5	2	-	-	-	-	-	-	-	-	-	-
Canopy/Cloak EX, Fallout	2	2	-	-	-	-	-	-	-	-	-	-
Command	13	0	9	9	9	7	9	9	6	6	7	-
Envive/Enlite	2/14	2	-	-	-	-	-	-	-	-	-	-
Fierce[3]		2	8	8	8	6	8	8	-	-	6	-
Fierce XLT	2/14/15	2	8	8	8	6	8	8	-	-	6	-
FirstRate	2	0	-	-	-	-	-	-	-	-	-	-
Flumioxazin	14	2	-	-	-	-	-	-	-	-	-	-
Intimidator	5/14/15	1	8	9	8+	6	8+	8+	-	-	7	8
Latir/Militia	2/14	2	6	7	7	-	7	7	6	6	-	-
Lorox	7	2	-	-	-	-	-	-	-	-	-	-
Matador	2/5/15	1	9	9	8+	6	8+	8+	-	-	7	8
Metolachlor/s-metolachlor[1]	15	1	8	9	8+	6	8+	8+	-	-	7	8
Metribuzin	5	2	6	5	6	-	6	6	-	-	-	-
Optill PRO	2/14/15	2	8	8	8	-	8	8	6	6	-	6
Outlook	15	1	8	9	8	6	8	8	-	-	7	8
Pendimethalin	3	2	8	9	9	8	8	8	7	7	8+	-
Prefix/Vise/Statement[3]	14/15	1	8	8	8	6	8	8	-	-	7	-
Pursuit	2	1	6	7	7	-	7	7	6	6	-	-
Pummel	2/15	1	9	9	9	6	9	9	-	-	7	8
Python	2	1	-	-	-	-	-	-	-	-	-	-
Ransom	5/14	2	6	5	6	-	6	6	-	-	-	-
Spartan	14	2	7	7	7	-	7	7	-	-	-	8
Surveil	2/14	2	-	-	-	-	-	-	-	-	-	-
Torment	2/14	1	6	7	7	-	7	7	6	6	-	-
Trivence	2/5/14	2	-	-	-	-	-	-	-	-	-	-
Valor XLT/Rowel FX	2/14	2	-	-	-	-	-	-	-	-	-	-
Warrant	15	1	8	8	8	7	8	8	-	-	7	7
Warrant Ultra	15/14	1	8	8	8	7	8	8	-	-	7	7
Zidua, Anthem	15	1	8	8	8	6	9	8	-	-	6	-

[2]Marestail ratings are for residual control only (not burndown), and are based on a weedfree start at planting through use of an effective burndown treatment.
[3]PRE rates are not intended to provide season-long control. Should be used only where it will be followed with a broad-spectrum POST herbicide treatment (such as glyphosate in Roundup Ready soybeans or Ignite on Liberty Link soybeans).

Table 14. Weed Response to Preplant/Preemergence Herbicides in Soybeans—Broadleaf Weeds

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables. See pages 22-23 for more information on herbicide site of action classification and description of site of action groups.

Weed control rating:
9 = 90% to 100% control
8 = 80% to 90% control
7 = 70% to 80% control
6 = 60% to 70% control
- = less than 60% control, not recommended.
Crop injury of 1 or less is rarely significant.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

	Broadleaf Weeds																				
	Annual Morningglory	Black nightshade	Burcucumber	Cocklebur	Common ragweed	Common ragweed (group 2-R)	Common ragweed (group 2+9-R)	Giant ragweed	Giant ragweed (group 2-R)	Jimsonweed	Kochia	Lambsquarters	Lambsquarters (group 5-R)	Marestail (group 9-R)[2]	Marestail (group 2+9-R)[2]	Palmer amaranth (group 2-R)	Pigweed (redroot/smooth)	Smartweed	Velvetleaf	Waterhemp (group 2-R)	Waterhemp (group 2+14-R)
Preplant Incorporated Only																					
Trifluralin	-	-	-	-	-	-	-	-	-	-	7+	8+	8+	-	-	8	9	-	-	8	8
Preplant or Preemergence																					
Authority Assist	8+	9	-	7	6	-	-	-	-	8	9	9	9	8	8	8+	9	9	8	8+	-
Authority First/Sonic	8+	8	-	8	9	-	-	7	-	8	9	9	9	9	8	8+	9	9	8	8+	-
Authority MTZ	7	8	-	-	-	-	-	-	-	6	9	9	8	8	8	8	9	9	7	8	6
Authority MAXX/XL	8+	8	-	8	9	-	-	7	-	9	9	9	9	9	8	8+	9	9	8+	8+	-
Boundary/Ledger/Tailwind	3	8	-	-	6	6	6	-	-	6	-	8	6	6	6	7+	9	8	6	7+	7+
BroadAxe XC	8	9	-	-	-	-	-	-	-	-	8+	9	9	8	8	9	9	8	7	8+	8
Canopy DF/Cloak DF	7+	-	6	8	9	-	-	7	-	9	7	9	9	9	6	6	9	9	8+	6	6
Canopy/Cloak EX, Fallout	7+	-	6	8	9	-	-	7	-	9	7	9	9	9	-	-	9	9	8+	-	-
Command	-	6	-	6	7	7	-	-	-	8	9	9	9	-	-	-	-	8	9	-	-
Envive/Enlite	8	9	6	8	9	7	-	7	-	9	8	9	9	9	8	8+	9	9	8+	8+	-
Fierce[3]	7	9	-	-	8	8	6	-	-	-	7+	9	9	8	8	9	9	7	7	9	7
Fierce XLT	8	9	6	8	9	7	-	7	-	9	7+	9	9	9	8	9	9	9	8+	9	7
FirstRate	7+	-	-	8	9	-	-	7	-	-	-	9	9	9	-	-	9	8	8+	-	-
Flumioxazin	7+	9	-	-	7	7	7	-	-	-	7+	9	9	8	8	8+	9	7	7	8+	-
Intimidator	-	9	-	-	8	8	-	-	-	-	7+	9	7	6	6	8	9	9	6	8	7
Latir/Militia	8	9	-	7	8	7	-	6	-	8	9	9	9	8	8	8+	9	9	9	8+	-
Lorox	-	7	-	6	8	8	8	-	-	6	6	9	9	-	-	7	9	9	6	7	7
Matador	7	9	-	7	7	-	-	-	-	8	8	9	9	6	-	7	9	9	8	7	7
Metolachlor/s-metolachlor	-	8	-	-	-	-	-	-	-	-	-	6	6	-	-	7	8	-	-	7	7
Metribuzin	-	-	-	-	6	6	6	-	-	7	8	9	-	8	8	7+	9	9	7	7+	7+
Optill PRO	7	9	-	7	7	-	-	-	-	8	8	9	9	7	-	7	9	9	9	7	-
Outlook	-	8	-	-	-	-	-	-	-	-	-	6	6	-	-	7+	8	-	-	7+	7+
Pendimethalin	-	-	-	-	-	-	-	-	-	-	7+	8+	8+	-	-	7	9	-	-	7	7
Prefix/Vise/Statement[3]	-	8	-	-	8	8	-	-	-	-	-	7	7	-	-	8	8	-	-	8	7
Pursuit	7	9	-	7	6	-	-	6	-	8	8	9	9	-	-	-	9	9	8	-	-
Pummel	7	9	-	7	6	-	-	6	-	8	8	9	9	-	-	7	9	9	8	7	7
Python	-	8	-	7	7	-	-	-	-	7	8	9	9	9	-	-	8	8+	-	-	-
Ransom	6	9	-	-	7	7	7	-	-	7	8	9	9	8+	8+	8+	9	9	7	8	7
Spartan	8	9	-	-	-	-	-	-	-	-	8+	9	9	8	8	8+	9	8	7	8+	-
Surveil	8	9	-	8	9	7	-	7	-	9	8	9	9	9	8	8+	9	9	8+	8+	-
Torment	7	9	-	7	8	8	-	6	-	8	8	9	9	-	-	6	9	9	8	6	6
Trivence	8	9	6	8	9	7	-	7	-	9	8+	9	9	9	8	9	9	9	8+	9	6
Valor XLT/Rowel FX	8	9	6	8	9	7	-	7	-	9	7+	9	9	9	8	8+	9	9	8+	8+	-
Warrant	-	8	-	-	-	-	-	-	-	-	-	8	8	-	-	8	8	6	-	8	8
Warrant Ultra	-	8	-	-	8	8	-	-	-	-	-	8	8	-	-	8	8	-	-	8	7
Zidua, Anthem	-	8	-	-	7	7	7	-	-	-	8	8	8	-	-	8	8	-	7	8	8

[2]Marestail ratings are for residual control only (not burndown), and are based on a weedfree start at planting through use of an effective burndown treatment.
[3]PRE rates are not intended to provide season-long control. Should be used only where it will be followed with a broad-spectrum POST herbicide treatment (such as glyphosate in Roundup Ready soybeans or Ignite on Liberty Link soybeans).

Table 15. Grasses and Nutsedge—Response to Postemergence Herbicides in Soybeans

This table compares the relative effectiveness of herbicides on individual weeds. Ratings indicate the level of control of weeds present at the time of application, and are based on labeled rate and weed size or growth stage. Postemergence soybean herbicides not listed on the grass or broadleaf section of this table lack significant activity on those weeds. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables.

Weed control rating:
9 = 90% to 100% control
8 = 80% to 90% control
7 = 70% to 80% control
6 = 60% to 70% control
- = less than 60% control, not recommended.
Crop injury of 1 or less is rarely significant.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

	Site of Action	Crop Tolerance	Barnyardgrass	Crabgrass	Fall panicum	Field sandbur	Giant foxtail	Yellow foxtail	Shattercane	Seedling johnsongrass	Rhizome johnsongrass	Quackgrass	Volunteer corn	Vol Corn (glyphosate-resistant)	Wirestem muhly	Yellow nutsedge	Woolly cupgrass
Postemergence																	
Basagran/Broadloom	6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	8+	-
Cheetah Max[3]	10/14	2	6	8	8	8	8+	6	8	8	7	6	7	7	6	-	6
Classic	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-
Extreme/Tackle[2]	2/9	1	9	8+	9	9	9	9	9	9	8+	8+	9	-	8	7	9
Flexstar GT[2]	9/14	2	9	9	9	9	9	9	8	9	9	9	9	-	8+	8	9
Glufosinate[3]	10	0	6	8	8	6	8	6	8	8	7	6	7	7	6	-	8
Glyphosate 0.75 lb ae/A[2]	9	0	8+	8+	8+	9	9	9	8	9	9	9	9	-	8+	7	9
Glyphosate 1.5 lb ae/A[2]	9	0	9	9	9	9	9	9	8	9	9	9	9	-	9	8	9
Pursuit/Torment	2	1	6	7	7	-	8	7	8	8	-	-	-	-	-	-	-
Raptor	2	2	6	7	7	7	8+	7	-	-	-	-	8	8	-	-	-
Storm	6/14	2	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-
Synchrony XP[1]	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-
Assure II/Targa	1	0	8+	8+	9	9	9	8	9	9	9	9	9	9	6	-	8
Clethodim	1	0	9	8+	9	9	9	9	9	9	9	9	9	9	8+	-	9
Fusilade DX	1	0	8	8	8	8	8	8	9	9	9	9	9	9	8+	-	8
Fusion	1	0	9	8+	9	8+	9	9	9	9	9	9	9	9	8+	-	8
Poast	1	0	9	8	9	9	9	9	8	8	7	7+	8	8	-	-	9

[1]Ratings are for 0.75 oz/A applied to STS soybeans.
[2]Apply to Roundup Ready soybeans only.
[3]Apply to LibertyLink soybeans only

Table 16. Broadleaf Weeds—Response to Postemergence Herbicides in Soybeans

This table compares the relative effectiveness of herbicides on individual weeds. Ratings indicate the level of control of weeds present at the time of application, and are based on labeled rate and weed size or growth stage. Performance may be better or worse than indicated in the table, due to weather or soil conditions or other variables.

Weed control rating:
9 = 90% to 100% control
8 = 80% to 90% control
7 = 70% to 80% control
6 = 60% to 70% control
- = less than 60% control, not recommended.

Crop tolerance rating:
0 = Excellent
1 = Good
2 = Fair
3 = Poor

Crop injury of 1 or less is rarely significant.

	Site of Action	Crop Tolerance	Annual morningglory	eastern black nightshade	Burcucumber	Cocklebur	Common ragweed	Common ragweed (group 2-R)	Common ragweed (group 9-R)	Com ragweed (group 2+9-R)	Common ragweed (group 2+14-R)	Giant ragweed	Giant ragweed (group 2-R)	Giant ragweed (group 9-R)	Giant ragweed (group 2+9-R)	Jimsonweed	Kochia	Lambsquarters	Lambsquarters (group 5-R)	Palmer amaranth (group 2-R)	Palmer amaranth (group 2+9-R)	Pigweed (redroot/smooth)	Marestial (group 9-R)	Mareastail (group 2+9-R)	Smartweed	Velvetleaf	Waterhemp (group 2-R)	Waterhemp (group 2+9-R)	Waterhemp (group 2+9+14-R)
Postemergence																													
Aim	14	2	8	8	-	-	6	6	6	6	-	-	-	-	-	-	7+	7	7	-	-	8	-	-	-	9	-	-	-
Basagran/ Broadloom	6	1	-	-	-	9	7	7	7	7	7	6	6	6	6	9	7	7	7	-	-	-	-	-	9	8+	-	-	-
Cadet, Anthem	14	2	7	-	-	-	-	-	-	-	-	-	-	-	-	-	8	7	7	-	-	8	-	-	-	9	-	-	-
Cheetah Max[3]	10/14	2	9	9	8	9	9	9	9	9	9	9	9	9	9	9	8+	7	7	8+	8+	9	8	8	9	9	8+	8+	8
Classic	2	2	7	-	8+	9	8	-	8	-	-	7+	-	7+	-	8+	-	-	-	-	-	9	8	-	8	8	-	-	-
Cobra/Phoenix	14	3	7	8+	7	8	9	9	9	9	-	8	8	8	8	9	7	-		8	8	9	-	-	6	7	8	8	-
Extreme/Tackle[2]	2/9	1	8	9	8	9	8+	8+	7	-	8+	8+	8+	6	-	9	8	8+	8+	8	-	9	-	-	9	9	8	-	-
FirstRate	2	1	8	-	8+	9	9	-	9	-	-	9	-	9	-	8	-	-	-	-	-	-	8	-	8	9	-	-	-
Flexstar GT[2]	9/14	2	9	9	8	9	9	9	9	9	9	9	9	8	8	9	8	8+	8+	9	8	9	-	-	9	9	9	8	-
Fomesafen	14	2	8	9	7	8+	9	9	9	9	-	8	8	8	8	9	6	6	7	8	8	9	-	-	9	8	8	8	-
Glufosinate[3]	10	0	8	9	8	9	9	9	9	9	9	8+	8+	8+	8+	9	8	7	7	8	8	8	8	8	9	8	8	8	8
Glyphosate 0.75 lb[2]	9	0	6	8	8	9	8+	8+	-	-	8+	8	8	-	-	9	8	8	8	8	-	9	-	-	8	8	8	-	-
Glyphosate 1.5lb[2]	9	0	7	9	8	9	9	9	-	-	9	8+	8+	-	-	9	8+	8+	8+	9	-	9	-	-	9	9	9	-	-
Marvel	14	2+	9	7	-	7	7	7	7	7	-	6	6	6	6	8	7	7	7	7	7	9	-	-	8	9	7	7	-
Prefix/Vise	14/15	2	8	8	6	8+	8+	8+	8+	8+	-	8	8	8	8	9	-	-	-	8	8	9	-	-	7	6	8	8	-
Pursuit	2	1	7	9	6	9	6	-	6	-	-	7	-	7	-	8+	7+	6	6	-	-	9	-	-	9	9	-	-	-
Raptor	2	2	7	9	6	8	7	-	7	-	-	8	-	8	-	8	7+	8	8	-	-	9	-	-	8	9	-	-	-
Resource	14	2	6	-	6	7	7	7	7	7	-	-	-	-	-	7	-	7	7	-	-	7	-	-	-	9	-	-	-
Storm	6/14	2	8+	7	6	8+	9	9	9	9	5	7+	7+	7+	7+	9	6	6	6	7	7	9	-	-	9	8	7	7	-
Synchrony XP[1]	2	0	8	-	8+	9	8	-	8	-	-	7+	-	7+	-	9	-	8	8	-	-	9	8	-	9	9	-	-	-
Thifensulfuron	2	2+	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	8	8	-	-	9	-	-	8	9	-	-	-
Torment	2/14	2	8	9	7	8+	9	8+	9	8+	-	8	8	8	8	9	7+	6	6	8	8	9	-	-	9	9	8	8	-
Ultra Blazer	14	2	8	8	6	7	9	9	9	9	-	7	7	7	7	9	6	-	-	8	8	9	-	-	9	6	8	8	-

[1]Ratings are for 0.75 oz/A applied to STS soybeans.
[2]Apply to Roundup Ready soybeans only.
[3]Apply to Liberty Link soybeans only.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
Afforia	**50.8DG**	**2.5 to 3.75 oz**

- Afforia is a premix of flumioxazin, tribenuron (Express), and thifensulfuron (Harmony) for control of broadleaf weeds, including lambsquarters, pigweeds, eastern black nightshade, and marestail, and partial control/suppression of Pennsylvania smartweed, waterhemp, Palmer amaranth and velvetleaf. This product does not control giant ragweed. The tribenuron and thifensulfuron have activity on emerged weeds,but the residual control is due to the flumioxazin.
- Site of action: group 14 (flumioxazin); group 2 (tribenuron, thifensulfuron). See pages 22-23.
- Can be applied in fall or spring, with following restriction: the 2.5 oz rate should be applied at least 1 day before planting; rates greater than 2.5 oz should be applied at least 7 days before planting. When used on coarse-textured soils or high pH (>7.9) soil, extend time between application and planting by another 7 days.
- Do not apply to frozen or snow-covered ground. Do not till after fall applications.
- Soybean stunting may occur when rainfall results in prolonged wet soil conditions following application. Excessive rainfall shortly after soybean emergence can result in minor leaf necrosis or crinkling, or loss of lower leaves. Risk of injury can be minimized by not using this product on poorly-drained soils, ensuring that seeds are completely covered with soil, and applying a week or more prior to planting.

Herbicide	Formulation	Product Rate Range
Authority Assist	**4L**	**4 to 12 oz**

- Authority Assist is a premix of imazethapyr (Pursuit) and sulfentrazone (Spartan) for control or suppression of broadleaf weeds, including lambsquarters, pigweeds, eastern black nightshade, Pennsylvania smartweed, velvetleaf, annual morningglory, and waterhemp. Provides partial control of annual grasses, but a follow up postemergence herbicide will be necessary for complete grass control. This product does not control common or giant ragweed.
- Site of action: group 14 (sulfentrazone); group 2 (imazethapyr). See pages 22-23.
- Application rates when used in standard PRE or PRE + POST programs, on soils with 2 to 4% OM: coarse-textured - 8 to 10 oz; medium-textured - 10 to 12 oz; fine-textured - 12 oz. Application rate when followed by a POST application of glyphosate in Roundup Ready soybeans, on soils with 2 to 4% OM: coarse-textured - 4 to 5 oz; medium-textured - 5 to 6 oz; fine-textured - 6 oz. Within a rate range, use higher rates where soil pH is less than 7, and lower rates where soil pH is greater than 7.
- Can be applied from 45 days before planting through 3 days after planting. To minimize risk of crop injury, apply a week or more prior to planting. When applied after planting, apply prior to soybean seed germination to prevent injury to emerging soybean seedlings.
- Do not use on coarse soils with less than 1% organic matter, or to soils with pH greater than 7.5. Do not incorporate deeper than 2 inches.

Herbicide	Formulation
Authority MTZ	**45DG**

- Authority MTZ is a premix of metribuzin and sulfentrazone (Spartan) for control or suppression of broadleaf weeds, including lambsquarters, pigweeds, eastern black nightshade, Pennsylvania smartweed, velvetleaf, and waterhemp. This product does not control giant or common ragweed or cocklebur.
- Site of action: group 14 (sulfentrazone); group 5 (metribuzin). See pages 22-23.
- Application rates when used in standard PRE or PRE + POST programs, on soils with 2 to 4% OM: coarse-textured - 14 to 16 oz; medium-textured - 16 to 18 oz; fine-textured - 18 to 20 oz. Application rate when followed by a POST application of glyphosate in Roundup Ready soybeans, on soils with 2 to 4% OM: coarse-textured - 8 to 10 oz; medium-textured - 10 to 12 oz; fine-textured - 12 to 14 oz.
- Can be applied from 30 days before planting through 3 days after planting. To minimize risk of crop injury, apply a week or more prior to planting. When applied after planting, apply prior to soybean seed germination to prevent injury to emerging soybean seedlings.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

- Do not apply to sandy soils with less than 1% organic matter, or to soils with pH greater than 7.5. Do not apply to frozen soil or incorporate deeper than 2 inches.

Herbicide	Formulation
Authority XL	**70DF**
Authority MAXX	**66DF**

- Authority XL and MAXX are premixes of chlorimuron (Classic) and sulfentrazone (Spartan) for control or suppression of most annual broadleaf weeds. This product does not control group 2-resistant ragweeds, but does provide residual control of group 2-resistant marestail, waterhemp, and Palmer amaranth. The ratio of sulfentrazone to chlorimuron is higher in Authority MAXX compared with Authority XL.
- Site of action: group 14 (sulfentrazone); group 2 (chlorimuron). See pages 22-23.
- Can be applied in fall, or in spring from 60 days before through 3 days after soybean planting, but before emergence. To minimize risk of crop injury, apply a week or more prior to planting. When applied after planting, apply prior to soybean seed germination to reduce injury to emerging soybean seedlings.
- Authority XL/MAXX application rates on soils with 2 to 4% OM: coarse-textured - 6 to 7 oz; medium-textured - 7 to 8 oz; fine-textured - 8 to 9.6 oz. Authority XL application rate when followed by a POST application of glyphosate in Roundup Ready soybeans or glufosinate in LibertyLink soybeans, on soils with 2 to 4% OM: coarse-textured - 3.2 to 4 oz; medium-textured - 3.2 to 4.8 oz; fine-textured - 4 to 5 oz.
- Do not apply Authority XL on soils with pH greater than 7.6. Authority XL rates are not pH-dependent, but rotation intervals for all crops except small grains are extended to at least 18 months for soil pH between 7.2 and 7.6, regardless of rate. Authority MAXX rotation intervals are not pH-dependent.

Herbicide	Formulation	Product Rate Range
Boundary/Ledger/Tailwind	**6.5E**	**1.5 to 3 pts**

- Premix of S-metolachlor plus metribuzin for annual grass and broadleaf control in soybeans. Controls most annual grasses, lambsquarters, pigweeds, waterhemp, eastern black nightshade, and Pennsylvania smartweed. See metribuzin and S-metolachlor descriptions for guidelines on use.
- Site of action: group 5 (metribuzin), group 15 (S-metolachlor). See pages 22-23.
- Application rates can be reduced to 1.5 to 1.8 pts/A when part of a planned preemergence followed by postemergence program.

Herbicide	Formulation	Product Rate Range
BroadAxe XC	**7L**	**3 - 8 oz**

- BroadAxe XC is a premix of sulfentrazone (Spartan) and S-metolachlor that controls annual grass and broadleaf weeds, including lambsquarters, eastern black nightshade, pigweed, waterhemp, and Palmer amaranth. Has essentially no activity on common and giant ragweed. See Spartan and S-metolachlor descriptions also for more information.
- Site of action: group 14 (sulfentrazone); group 15 (S-metolachlor). See pages 22-23.
- Apply preplant, preplant incorporated, or preemergence, up to 3 days after soybean planting and prior to emergence. To minimize risk of crop injury, apply a week or more prior to planting.

BroadAxe XC use rates (oz/A)			
% organic matter	Soil texture		
	Coarse	Medium	Fine
< 1.5%	19 - 25	25 - 32	25 - 32
1.5 to 3%	25	25 - 32	25 - 32
> 3%	25	25 - 32	32 - 38.7

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
Canopy EX/Cloak EX/Fallout	**29.5DF**	**1.1 to 3.3 oz**
Synchrony XP	**28.4WDG**	**1 to 3 oz**
Canopy/Cloak DF	**75DF**	**2.25 to 7 oz**

- Canopy EX is a premix of chlorimuron (Classic) plus tribenuron (Express), also available as Cloak EX and Fallout; Synchrony XP is a premix of chlorimuron plus thifensulfuron (Harmony GT); and Canopy/Cloak DF is a premix of chlorimuron plus metribuzin. These herbicides provide residual control of ragweeds, annual morningglory, cocklebur, velvetleaf, Pennsylvania smartweed, pigweeds, and lambsquarters. Control of cocklebur, morningglory, and giant ragweed varies with rainfall and population. Early preplant application will provide most effective control of giant ragweed.
- Canopy EX and Synchrony XP do not control group 2-resistant weeds. High rates of Canopy/Cloak DF can provide limited residual control of group 2-resistant waterhemp, pigweed, and marestail, but additional metribuzin will usually be needed for acceptable control of these weeds.
- Site of action: group 2 (chlorimuron, tribenuron, thifensulfuron); group 5 (metribuzin). See pages 22-23.
- Canopy EX can be applied in fall or spring, with following restriction: rates of 2.2 oz or less should be applied at least 7 days before planting; rates of 2.2 to 3.3 oz should be applied at least 14 days before planting. Canopy/Cloak DF can be applied in fall or spring (no more than 45 days before planting). Synchrony can be applied preplant or preemergence in the spring, no more than 45 days before planting.
- Maximum rate on soils where the composite pH exceeds 7.0: Canopy EX - 1.1 oz/A; Canopy/Cloak DF - 2.25 oz/A; Synchrony XP - 1 oz/A.
- The chlorimuron component helps control many emerged no-till weeds in mixtures with 2,4-D and glyphosate in spring preplant burndown treatments. Canopy/Cloak products can be applied to no-till or conservation tillage fields in the fall for burndown of existing vegetation and limited residual control into the following growing season. 2,4-D should be included with all fall-applied treatments. Do not apply to frozen ground.
- Apply with COC (1 gallon/100 gallons spray) for best control of emerged weeds, unless glyphosate is included in the treatment.
- Soybean stunting may occur when rainfall results in prolonged wet soil conditions following application.

Herbicide	Formulation	Product Rate Range
Command	**3ME**	**1 1/3 - 2 2/3 pt**

- Command (clomazone) controls annual grasses, velvetleaf, lambsquarters, and smartweed, and controls or suppresses jimsonweed and common ragweed. The lower rates control velvetleaf and suppress grasses and some broadleaf weeds.
- Site of action: group 13 (see pages 22-23).
- Many ornamental, vegetable, and agronomic crops are sensitive to Command spray drift and vapors moving outside the target area. Chlorosis or bleaching of sensitive plants may occur. Do not apply within 1200 feet of the following areas: towns and housing developments, commercial fruit or vegetable production, commercial greenhouses or nurseries. Do not apply within 300 feet of other desirable plants. Do not apply in winds greater than 10 mph, do not exceed a spray pressure of 30 psi, and do not rinse spray equipment near desirable plants. Do not apply to fence rows, waterways, ditches and roadsides.

Herbicide	Formulation	Product Rate Range
Envive	**41.3 DG**	**2.5 - 5.3 oz**
Enlite	**47.9 DG**	**2.8 - 4.25 oz**

- Envive and Enlite are premixes of chlorimuron (Classic) plus thifensulfuron (Harmony GT) plus flumioxazin for residual control of most annual broadleaf weeds. The ratio of chlorimuron to the other ingredients is lower in Enlite than Envive, allowing use of Enlite over a broader range of soil pH levels. Maximum Envive rate on soils where the composite pH exceeds 7.0 is 2.5 oz. The Enlite rate is not pH-dependent.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

- Control of cocklebur, morningglory, and giant ragweed varies with rainfall and population. Early preplant application will provide most effective control of giant ragweed.
- Will not control group 2-resistant giant ragweed, but will provide partial control of group 2-resistant common ragweed. The higher rates will provide the most effective control of group 2-resistant pigweed, waterhemp, and common ragweed.
- Site of action: group 2 (chlorimuron, thifensulfuron); group 14 (flumioxazin). See pages 22-23.
- Can be applied anytime in fall or spring, but must be applied before soybean emergence and no later than 3 days after planting. Do not apply to frozen or snow-covered ground.
- Apply with COC or modified seed oil (1% v/v) or NIS (0.25% v/v) for control of emerged weeds. Mixtures with glyphosate or glyphosate plus 2,4-D have been among the most effective spring treatments for dandelion control in Ohio State and Purdue University research.
- Soybean stunting may occur when rainfall results in prolonged wet soil conditions following application. Excessive rainfall shortly after soybean emergence can result in minor leaf necrosis or crinkling, or loss of lower leaves. Risk of injury can be minimized by not using this product on poorly-drained soils, planting seeds at least 1.5 inches deep, ensuring that seeds are completely covered with soil, and applying a week or more prior to planting.
- Envive and Enlite can be mixed with pyroxasulfone with no added restrictions. Do not mix with products containing alachlor, metolachlor, S-metolachlor, flufenacet, or dimethenamid when applied within 14 days of planting, unless soybeans are planted under no-tillage or minimum tillage conditions in wheat stubble or no-till field corn stubble.

Herbicide	Formulation	Product Rate Range
Fierce	**76WDG**	**3 - 3.75 oz**

- Fierce is a premix of flumioxazin (Valor) and pyroxasulfone (Zidua) that controls or suppresses annual grass and broadleaf weeds. See Valor and Zidua descriptions for more information.
- The application rates are intended to provide early-season control only. Preplant application of Fierce should be followed with a broad-spectrum postemergence herbicide treatment.
- Site of action: group 14 (flomioxazin), group 15 (pyroxasulfone). See pages 22-23.
- Apply no later than 3 days after soybean planting, and prior to soybean emergence. Do not incorporate into the soil following application.
- Do not apply in a mixture with any of the following herbicides unless following directions on a Valent supplemental label: flufenacet, metolachlor or S-metolachlor, alachlor, dimethenamid-p, or acetochlor.

Herbicide	Formulation	Product Rate Range
Fierce XLT	**62.4WDG**	**3.75 - 5.25 oz**

- Fierce XLT is a premix of chlorimuron, flumioxazin (Valor) and pyroxasulfone (Zidua) that controls or suppresses annual grass and broadleaf weeds. Do not use a rate higher than 3.75 oz/A where composite soil pH is 6.8 or greater. See Valor XLT and Zidua descriptions for more information.
- Site of action: group 14 (flomioxazin), group 15 (pyroxasulfone); group 2 (chlorimuron). See pages 22-23.
- Apply no later than 3 days after soybean planting, and prior to soybean emergence. Do not incorporate into the soil following application. Risk of injury can be minimized by not using this product on poorly-drained soils, planting seeds at least 1.5 inches deep, ensuring that seeds are completely covered with soil, and applying a week or more prior to planting.
- Do not apply with products containing any of the following herbicides: flufenacet, metolachlor or S-metolachlor, alachlor, dimethenamid, or acetochlor.

Fierce XLT Use Rates (oz/A)

Soil Texture	0.5-3% OM	3-5% OM
Coarse	3.75	3.75 - 4.5
Medium	3.75 - 4.5	3.75 - 5.25
Fine	4.5 - 5.25	4.5 - 5.25

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation
FirstRate	**84DF**

- FirstRate (cloransulam-methyl) controls many annual broadleaf weeds, including ragweeds, velvetleaf, lambsquarters, pigweed, and cocklebur. Control of waterhemp is usually inadequate. Does not control group 2-resistant weeds.
- Control of giant ragweed, morningglory, and cocklebur varies with rainfall, population, and application method. Moderate to high population densities of giant ragweed will require an additional application of a postemergence herbicide.
- Site of action: group 2 (see pages 22-23).
- Application rates in Ohio and north of I-64 in Indiana: and Illinois 3% or less soil organic matter - 0.6 oz; greater than 3% organic matter - 0.75 oz. The rate is 0.75 oz south of I-64 in Indiana and Illinois.
- For best results, apply within 2 weeks before planting. Do not apply earlier than 4 weeks before planting.
- Preplant applications with COC plus UAN or AMS can control small emerged annual broadleaf weeds, including ragweeds and annual smartweeds. Mixing with 2,4-D ester or other burndown herbicides will improve control of most annual weeds.

Herbicide	Formulation
Flumioxazin (active ingredient)	
Valor/Encompass/Outflank/Panther/Rowel	**51WDG**
Panther SC	**4SC**

- Flumioxazin can be applied preplant or preemergence for control of lambsquarters (including triazine-resistant), eastern black nightshade, pigweeds, waterhemp, and marestail (emerging from seed). Suppresses or provides partial control of common ragweed, morningglory, velvetleaf, smartweed, and some annual grasses.
- Site of action: group 14 (see pages 22-23).
- Use rates: all coarse or medium-textured soils, and fine-textured soils with less than 3% OM - 2 to 2.5 oz; fine-textured soils with greater than 3% OM - 2 to 3 oz.
- Apply no later than 3 days after soybean planting. Do not incorporate into the soil following application. To minimize risk of crop injury, apply a week or more prior to planting.
- In university research, flumioxazin has occasionally stunted and slowed the growth of soybeans when high rainfall conditions occur following soybean planting. The label states that risk of crop injury can be minimized by avoiding use on poorly drained soils, planting at least 1½ inches deep, and completely covering seeds with soil.
- Do not mix with products containing alachlor, metolachlor, S-metolachlor, flufenacet, or dimethenamid when applied within 14 days of planting, unless soybeans are planted under no-tillage or minimum tillage conditions in wheat stubble or no-till field corn stubble.

Herbicide	Formulation
Intimidator	**4.81L**

- Intimidator is a premix of fomesafen, metribuzin, and S-metolachlor for preplant and preemergence control of annual grass and broadleaf weeds. Controls many broadleaf weeds but is weak on giant ragweed, morninglory, and cocklebur. For residual control of marestail, add enough metribuzin to attain the equivalent of 8 oz of metribuzin 75DF.
- Site of action: group 15 - S-metolachlor; group 5 - metribuzin; group 14 - fomesafen. See pages 22-23.
- Intimidator use rates for reduced or no-tillage soybeans: coarse-textured soils - 1.9 to 3.2 pts; medium-textured soils - 3.2 to 4.48 pts; fine-textured soils - 4.48 pts. Within a rate range, use the lower rates where soil OM is less than 3%, and the higher rares where soil OM is greater than 3%.
- The total amount of fomesafen that should be used within the same season should not exceed 0.375 lb ai/A in southern OH and IN, or 0.313 lb ai/A in northern OH or IN. Other products containing fomesafen: Flexstar, Flexstar GT, and Prefix.
- Injury to soybeans may occur where soil pH is 7.5 or greater, when heavy rains occur soon after application, or when soybeans are planted less than 1.5 inches deep.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation
Latir/Militia	**55 WDG**

- Latir/Militia is a premix of imazethapyr (Pursuit) and flumioxazin for preplant and preemergence control of annual broadleaf weeds, and early-season suppression of annual grasses. Has no activity on group 2-resistant giant ragweed, but provides control/suppression of group 2-resistant common ragweed.
- Site of action: group 2 - imazethapyr; group 14 - flumioxazin. See pages 22-23.
- Apply within 3 days after planting, and prior to cracking or soybean emergence.
- Use rates: all soils with 0.5 to 2.5% organic matter - 3.2 to 3.8 oz; coarse- or medium-textured soils with 2.5 to 5% organic matter - 4.25 oz. When applied more than 30 days before planting, use higher labeled rates for soil type.
- Crop injury can occur when applied to poorly drained soils under cool, wet conditions. Excessive rainfall shortly after soybean emergence can result in minor leaf necrosis or crinkling, or loss of lower leaves. Risk of injury can be minimized by not using this product on poorly drained soils, planting seeds at least 1.5 inches deep, ensuring that seeds are completely covered with soil, and applying a week or more prior to planting.
- Do not mix with products containing any of the following: flufenacet, metolachlor, dimethenemid, acetochlor, or alachlor. Do not apply to frozen or snow-covered ground.

Herbicide	Formulation	Product Rate Range
Lorox	**50DF**	**2/3 - 1 2/3 lb**
	4L	**2/3 -1 2/3 pt**

- Lorox (linuron) controls many annual broadleaf weeds, including Pennsylvania smartweed, pigweeds, lambsquarters, and common ragweed. Helps suppress eastern black nightshade and cocklebur, but does not control giant ragweed or annual morningglory.
- Site of action: group 7 (see pages 22-23).
- Best-suited for use on medium-textured soils with 1 percent to 3 percent organic matter. Do not use on very sandy soils.
- Can provide burndown of small, emerged annual weeds present at application when mixed with 2,4-D ester.
- Apply to the soil surface only. Do not incorporate following application. May occasionally injure soybeans. Accurate application of the correct rate based on soil type is important to reduce the risk of injury.

Herbicide	Formulation
Matador	**4.7L**

- Matador is a premix of imazethapyr (Pursuit), metribuzin, and metolachlor for preplant and preemergence control of annual grass and broadleaf weeds. Controls many broadleaf weeds but is weak on giant ragweed, morninglories, common ragweed, and cocklebur. For residual control of marestail, add enough metribuzin to attain the equivalent of 8 oz of metribuzin 75DF.
- Site of action: group 2 - imazethapyr; group 5 - metribuzin; group 15 - metolachlor. See pages 22-23.
- Matador use rates for reduced or no-tillage soybeans: coarse-textured soils - 1.6 to 2.7 pts; medium-textured soils - 2.7 to 4 pts; fine-textured soils - 4 pts. Within a rate range, use the lower rates where soil OM is less than 3%, and the higher rates where soil OM is greater than 3%.
- Injury to soybeans may occur where soil pH is 7.5 or greater, when heavy rains occur soon after application, or when soybeans are planted less than 1.5 inches deep.

Herbicide	Formulation
S-metolachlor	**7.64E**
Metolachlor	**7.8E**

- S-metolachlor (Dual II Magnum/Cinch) and metolachlor (Parallel/Stalwart) control annual grasses and pigweed, and control or suppress yellow nutsedge and black nightshade.
- Site of action: group 15 (see pages 22-23).

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

- Use rates for most products are similar: coarse-textured soils - 1 to 1.33 pt/A; all medium-textured soils, and fine-textured soils with less than 3% OM - 1.33 to 1.67 pt/A; fine-textured soils, less than 3% - 1.67 to 2 pt/A.
- May be applied up to 30 days before planting as a single application.
- Can be applied postemergence (up to 90 days before harvest), for residual control of weeds only. Mix with herbicides with postemergence activity to control emerged weeds.
- Incorporation to a depth of 2 inches will improve yellow nutsedge control and reduce dependence upon rainfall.

Dual II Magnum, Parallel, and Stalwart Use Rates (pts/A)		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	1 to 1.33	1.33
Medium	1.33 to 1.67	1.33 to 1.67
Fine	1.33 to 1.67	1.67 to 2

Herbicide	Formulation
Metribuzin	**4F**
	75DF

- Metribuzin (Dimetric, Tricor, Glory) controls annual broadleaf weeds, including Pennsylvania smartweed, pigweeds, waterhemp, lambsquarters, and marestail (emerging from seed). Control of common ragweed and velvetleaf is variable. Metribuzin does not control annual morningglory, giant ragweed, cocklebur, or eastern black nightshade.
- Site of action: group 5 (see pages 22-23).
- Preplant applications of metribuzin, paraquat, and 2,4-D ester can provide effective burndown in many no-till situations.
- May injure soybeans when applied at high rates. Injury may be greater where soil pH is over 7.5, and where seedling diseases, weather stress, or atrazine carryover occur. Soybean varieties vary in tolerance to metribuzin. Selection of a variety with above-normal tolerance to metribuzin will reduce the risk of crop injury.
- To avoid soybean injury, accurately apply the correct rate based on soil type. Do not use on sandy soil that is low in organic matter.
- Can be applied in the fall with 2,4-D ester for control of winter annual weeds, including marestail, mustards, purple deadnettle, and common chickweed.

Metribuzin 75 DF Use Rates (lb/A)			
Soil Texture Group	**Soil Organic Matter Content**		
	Less than 2%	**2% to 4%**	**More than 4%**
Coarse	Do not use	0.5	0.75
Medium	0.5 to 0.75	0.75 to 0.83	0.83 to 1
Fine	0.75 to 0.83	0.83 to 1	1 to 1.17

Metribuzin 4F DF Use Rates (pints/A)			
Soil Texture Group	**Soil Organic Matter Content**		
	Less than 2%	**2% to 4%**	**More than 4%**
Coarse	Do not use	3/4	0.75
Medium	3/4 to 1	1 to 1-1/4	1-1/4 to 1-1/2
Fine	1 to 1-1/4	1-3/4	2

Herbicide	Formulation	Product Rate Range
Optill PRO	**co-pack**	

- Optill PRO is a co-pack of Outlook (dimethenamid) with a dispersible dry premix of saflufenacil (Sharpen) and imazethapyr (Pursuit). Outlook PRO provides residual control of grass and broadleaf weeds, and can help burndown emerged weeds in no-till, especially marestail. It should generally be combined with glyphosate or glufosinate for burndown.
- Site of action: group 14 (saflufenacil); group 2 (imazethapyr); group 15 (dimethenamid). See pages 22-23.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

- Apply prior to soybean cracking or emergence. On coarse-textured soils with 2% organic matter or less, apply at least 30 days before planting.
- Salfufenacil products used in soybeans cannot be mixed with or applied within 30 days of products containing flumioxazin (Valor products, Envive, and Surveil), sulfentrazone (Authority products), or fomesafen (Prefix, Intimidator).
- Burndown activity requires the addition of MSO (1% v/v) plus either AMS (8.5 to 17 lbs/100 gallons) or UAN (1.25 to 2.5% v/v).
- Ensure that the seed furrow is closed and seed row sufficiently covered with soil to avoid washing and concentration of saflufenacil in the seed zone.

Herbicide	Formulation
Outlook	**6EC**

- Outlook (dimethenamid) controls annual grasses and pigweeds, and controls or suppress yellow nutsedge and eastern black nightshade.
- Site of action: group 15 (see pages 22-23).
- Application rates vary with soil texture, organic matter content, and CEC. Can be applied early postemergence on soybeans up to the 5th trifoliate stage, but will not control emerged grasses.
- Can be incorporated into the upper 1 to 2 inches of soil up to 2 weeks before planting. Incorporation will improve yellow nutsedge control.
- Can be applied up to 30 days before planting as a single application.

Outlook Use Rates (floz/A)[a]		
Soil Texture Group	**Less than 3% OM**	**3% or Greater OM**
Coarse	12 to 14	14 to 18
Medium and Fine	14 to 18	18 to 21

a. Not recommended on soils with CEC values less than 5 or coarse soils with less than 1.5% organic matter.

Herbicide	Formulation
Pendimethalin/Pendant/etc.	**3.3EC**
Prowl H2O/Satellite HydroCap	**3.8CS**

- The active ingredient in these products, pendimethalin, controls annual grasses, pigweed, and lambsquarters and helps control smartweed and velvetleaf.
- Site of action: group 3 (see pages 22-23).
- Preplant applications should be incorporated within 7 days after application. Incorporation may not be necessary if sufficient rainfall occurs.
- When applied without incorporation, apply from 15 days before planting through 2 days after planting.
- Application close to or after planting may result in soybean injury, including stem swelling and brittleness. To reduce the risk of injury, apply early preplant or incorporate prior to planting.

Prowl H2O/Satellite Hydrocap Use Rates (pt/A)		
Soil Texture	**Soil Organic Matter Content**	
	Less than 3%	**More than 3%**
Coarse	1.5	1.5 to 2
Medium	2 to 2.5	2 to 3
Fine	2 to 3	2.5 to 3

Pendimethalin 3.3EC Use Rates (pt/A)		
Soil Texture	**Soil Organic Matter Content**	
	Less than 3%	**More than 3%**
Coarse	1.8	1.8 to 2.4
Medium	2.4 to 3	2.4 to 3.6
Fine	2.4 to 3.6	3 to 3.6

The high rates for each soil texture above should be used if heavy weed populations are anticipated, extensive crop residues were present prior to seedbed preparation, or in no-till.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
Pummel	**5.25L**	**1.6 - 2 pts**

- Pummel is a premix of imazethapyr (Pursuit) and metolachlor that controls annual grass and broadleaf weeds. Pursuit is weak on common ragweed, and less effective than several other group 2 herbicides on giant ragweed. This product will be variable for residual control of marestail and will not control group 2-resistant populations of marestail or ragweeds. See Pursuit and metolachlor descriptions for more information.
- Site of action: group 2 (imazethapyr); group 15 (metolachlor). See pages 22-23.
- Can be applied preplant (up to 30 days before planting), preemergence, or postemergence prior to the V3 soybean stage. NIS (0.25% v/v) plus UAN (1-2 qt/A) or AMS (4 lbs/A) should be included in postemergence applications for control of emerged weeds.
- Application rates: 2 pts - medium and fine-textured soils; 1.6 pts - coarse-textured soils with at least 3% organic matter. DO not use on coarse-textured soils with less than 3% organic matter.

Herbicide	Formulation	Product Rate Range
Pursuit	**2S**	**4 oz**

- Pursuit (imazethapyr) controls annual broadleaf weeds and controls or suppresses annual grasses. Pursuit is weak on common and giant ragweed. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Pursuit may be applied preplant (up to 45 days before planting), preplant incorporated, preemergence, or postemergence. Postemergence applications provide more consistent control than soil-applied treatments.

Herbicide	Formulation	Product Rate Range
Python	**80WDG**	**0.8-1.33 oz.**

- Python (flumetsulam) controls annual broadleaf weeds, including velvetleaf, lambsquarters (including triazine-resistant), and pigweeds. Control of common ragweed is variable. Python does not adequately control cocklebur, giant ragweed, or annual morningglory. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Python use rates range from 0.8 to 1 oz/A on coarse-textured soils, and 0.9 to 1.33 oz/A in medium or fine-textured soils.
- May by applied up to 30 days before planting. Rates increase when applied early, compared to application at planting. Preplant application of Python will control small mustards and field pennycress when applied with COC and 2,4-D.
- Do not apply to soils with the combination of pH less than 5.9 and organic matter content greater than 5%. Do not apply where soil pH is greater than 7.8.

Herbicide	Formulation
Ransom	**68.9WDG**

- Ransom is a premix of metribuzin plus flumioxazin for control of annual broadleaf weeds, including lambsquarters, eastern black nightshade, pigweeds, waterhemp, Palmer amaranth, and marestail (emerging from seed). Suppresses or provides partial control of common ragweed, morningglory, velvetleaf, and some annual grasses.
- Site of action: group 14 (flumioxazin); group 5 (metribuzin). See pages 22-23.
- Use rates: all coarse or medium-textured soils, and fine-textured soils with less than 3% OM - 2 to 2.5 oz; fine-textured soils with greater than 3% OM - 2 to 3 oz.
- Apply no later than 3 days after soybean planting and prior to cracking or soybean emergence.
- Flumioxazin has occasionally stunted and slowed the growth of soybeans when high rainfall conditions occur following soybean planting. Risk of crop injury can be minimized by avoiding use on poorly drained soils, planting at least 1½ inches deep, and completely covering seeds with soil, and allowing at least a week between application and planting.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

- Mixing Ransom with products containing flufenacet, S-metolachlor, metolachlor, dimethenamid-P, acetochlor, or alachlor may result in severe injury to soybeans when application is followed by prolonged periods of cool, wet weather. Do not mix with these products unless directed by state 2(ee) or 24(c) labeling.

Ransom Use Rates (oz/A)		
Soil Texture	Soil Organic Matter Content	
	Less than 2%	2 to 4%
Coarse	Do not use	6.5
Medium	8	8 - 10
Fine	10	10 - 12

Herbicide	Formulation
Sequence	**5.25L**

- Sequence is a premix of glyphosate plus S-metolachlor for preplant or preemergence application. See glyphosate and S-metolachlor descriptions for more information.
- Can be applied at reduced rates when followed by a postmergence herbicide treatment.
- Can be applied postemergence to Roundup Ready soybeans to provide control of emerged weeds and residual control of annual grasses, eastern black nightshade, pigweeds, and waterhemp. Apply between cracking and the 3rd trifoliate soybean stage.

Sequence Use Rates (pt/A)		
Soil Texture Group	Less than 3% OM	3% or Greater OM
Coarse	2.5 to 3.5	3.5
Medium	3.5 to 4	3.5 to 4
Fine	3.5 to 4	4

Herbicide	Formulation	Product Rate Range
Sharpen	**2.85SC**	**1 to 2 oz**
Verdict	**5.57EC**	**5 to 10 oz**

- Sharpen (saflufenacil) can help burndown emerged weeds in no-till, especially marestail. It provides a low level (40 to 60%)of residual control of broadleaf weeds at the 1 oz rate, and residual control improves with increasing rate. The 1.5 and 2 oz rates have provided substantial residual control of marestail in OSU research, especially when mixed with other residual herbicides. It should be combined with glyphosate or glufosinate for burndown, and with other residual herbicide(s) for broad-spectrum residual control.
- Verdict is a premix of salflufenacil and dimethenamid (Outlook), which improves residual control of grasses and a few small-seeded broadleaf weeds, compared with Sharpen. The 5 oz rate of Verdict provides the equivalent amount of saflufenacil in 1 oz/A of Sharpen.
- Site of action: Sharpen - group 14; Verdict - group 14 (saflufenacil) and group 15 (dimethenamid). See pages 22-23.
- Apply prior to crop emergence. Rates vary based on soil texture and timing of application - see rate tables.
- Salfufenacil products used in soybeans cannot be mixed with or applied within 30 days of group 14 products containing flumioxazin (Valor products, Envive, Surveil, etc.), sulfentrazone (Sonic, Authority products), or fomesafen (Prefix, Intimidator, etc.), with the following exception: Sharpen can be applied 14 days before planting when mixed with these herbicides except on coarse-textured soils with less than 2% organic matter.
- Burndown activity requires the addition of MSO (1% v/v) plus either AMS (8.5 to 17 lbs/100 gallons) or UAN (1.25 to 2.5% v/v).
- Ensure that the seed furrow is closed and seed row sufficiently covered with soil to avoid washing and concentration of saflufenacil in the seed zone.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

Minimum preplant interval (days) required between Sharpen application and soybean planting. Numbers in ( ) are for tank-mix with group 14 herbicides		
Use rate (oz)	Soil texture	
	Coarse soils with 2% or less OM	All other soils
1.0	30 (30)	0 (14)
1.5	30 (30)	14 (30)
2.0	44 (44)	30 (30)

Minimum preplant interval (days) required between Verdict application and soybean planting		
Use rate (oz)	Soil texture	
	Coarse soils with 2% or less OM	All other soils
5.0	30	0
7.5	30	14
10	44	30

Herbicide	Formulation	Product Rate Range
Sonic/Authority First	**70 WDG**	**3 - 8 oz**

- Sonic/Authority First is a premix of sulfentrazone (Spartan) and cloransulam (FirstRate) that controls many broadleaf weeds.
- Site of action: group 14 (sulfentrazone); group 2 (cloransulam). See pages 22-23.
- Can be applied at rates as low as 3 oz/A in Roundup Ready soybeans, when followed with a postemergence glyphosate application. Use rates in non-Roundup Ready soybeans: 3% or less OM - 6.5 oz; greater than 3% OM - 8 oz.
- Apply preplant or preemergence, up to 3 days after soybean planting. To minimize risk of crop injury, apply a week or more prior to planting.

Herbicide	Formulation
Spartan	**4F**
Spartan Advance	**4.6L**

- Spartan (sulfentrazone) controls eastern black nightshade, marestail (emerging from seed), pigweeds, lambsquarters, kochia, and waterhemp, and can suppress annual grasses and annual morningglory. Spartan Advance is a premix of sulfentrazone and glyphosate.
- Site of action: group 14 (see pages 22-23).
- May cause stunting of soybeans if excessive rain occurs between application and soybean emergence. Soybeans generally outgrow this injury, but some soybean varieties are more sensitive to this herbicide and can be severely injured. Check with seed supplier for varietal tolerance information prior to use.

Spartan use rates (oz/A)			
% organic matter	Soil texture		
	Coarse	Medium	Fine
< 1.0%	4.5 to 6	6 to 8	8
1 to 3%	6 to 8	8 to 10.1	10.1
> 3%	8 to 10.1	10.1 to 12	12

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

Herbicide	Formulation	Product Rate Range
Surveil	**48% WDG**	**2.1 - 4.2 oz**

- Surveil is a premix of flumioxazin (Valor) plus cloransulam (FirstRate) for annual broadleaf weed control and limited grass suppression in soybeans. Does not control group 2-resistant giant ragweed, and provides partial control of group 2-resistant common ragweed. See Valor and FirstRate descriptions for guidelines and precautions on use.
- Site of action: group 14 (flumioxazin), group 2 (cloransulam). See pages 22-23.
- Apply no later than 3 days after soybean planting. To minimize risk of crop injury, apply a week or more prior to planting.
- Do not mix with products containing alachlor, metolachlor, S-metolachlor, flufenacet, or dimethenamid when applied within 14 days of planting, unless soybeans are planted under no-tillage or minimum tillage conditions in wheat stubble or no-till field corn stubble.

Herbicide	Formulation
Treflan/Trifluralin	**4EC, HFP, HF**
	10G

- Treflan (trifluralin) controls annual grasses, pigweed, waterhemp, and lambsquarters and helps control smartweed, morningglory, and johnsongrass.
- Site of action: group 3 (see pages 22-23).
- Treflan HFP rates: coarse-textured soils, less than 2% OM - 1 pt/A; coarse-textured soils with 2 to 5% OM and medium-textured soils - 1.5 pts/A; fine-textured soils - 2 pts/A.
- Must be incorporated into the soil (depth of 2 to 3 inches) within 24 hours after application. For best results, make two incorporation passes in different directions.

Herbicide	Formulation	Product Rate Range
Trivence	**61.3 WDG**	**6 - 10 oz**

- Trivence is premix of chlorimuron (Classic), flumioxazin, and metribuzin for residual control of most annual broadleaf weeds, including group 2-resistant marestail, waterhemp, and Palmer amaranth. Control of cocklebur, morningglory, and giant ragweed varies with rainfall and population. Early preplant application will provide most effective control of giant ragweed. See descriptions of Envive and metribuzin for more information.
- Trivence will not control group 2-resistant giant ragweed, but will provide partial control of group 2-resistant common ragweed.
- Site of action: group 2 (chlorimuron); group 14 (flumioxazin); group 5 (metribuzin). See pages 22-23.
- Trivence can be applied anytime in fall or spring, but must be applied before soybean emergence and no later than 3 days after planting. Do not apply to frozen or snow-covered ground.
- Maximum rate on soils where the composite pH exceeds 7.0 is 6 oz.
- Soybean stunting may occur when rainfall results in prolonged wet soil conditions following application. Excessive rainfall shortly after soybean emergence can result in minor leaf necrosis or crinkling, or loss of lower leaves. Risk of injury can be minimized by not using this product on poorly-drained soils, planting seeds at least 1.5 inches deep, ensuring that seeds are completely covered with soil, and applying a week or more prior to planting.
- Trivenece can be mixed with pyroxasulfone with no added restrictions. Mixtures of Trivence with products containing S-metolachlor, metolachlor, alachlor, dimethenamid, or flufenacet should be applied at least 14 days prior to planting to avoid crop injury.

Herbicide	Formulation	Product Rate Range
Valor XLT/Rowel FX	**40 WDG**	**2.5 to 5 oz**

- Valor XLT/Rowel FX is premix of chlorimuron (Classic) plus flumioxazin for residual control of most annual broadleaf weeds. Control of cocklebur, morningglory, and giant ragweed varies with rainfall and population. Early preplant application will provide most effective control of giant ragweed.

Soybeans: Soil-Applied Herbicides — Preplant or Preemergence

- Will not control group 2-resistant giant ragweed, but will provide partial control of group 2-resistant common ragweed. The 5 oz rate will provide the most effective control of group 2-resistant pigweed, waterhemp, and common ragweed.
- Site of action: group 2 (chlorimuron); group 14 (flumioxazin). See pages 22-23.
- Can be applied in fall or spring, but must be applied before soybean emergence and no later than 3 days after planting. Do not apply to frozen or snow-covered ground. Fall applications should be made after October 15, or when soil temperature is less than 50°F.
- Apply 3 to 4 oz to soils with 0.5 to 3% OM, and 3 to 5 oz to soils with 3 to 5% OM. Rates of 3 to 3.5 oz/A can be used when followed by postemergence application of glyphosate in Roundup Ready soybeans. Maximum rate on soils where the composite pH exceeds 6.8 is 2.5 oz.
- Mixtures of Valor XLT/Rowel FX with glyphosate or glyphosate plus 2,4-D have been among the most effective spring treatments for dandelion control in Ohio State and Purdue University research.
- Soybean stunting may occur when rainfall results in prolonged wet soil conditions following application. Risk of injury can be minimized by not using this product on poorly-drained soils, planting seeds at least 1.5 inches deep, ensuring that seeds are completely covered with soil, and applying a week or more prior to planting.
- Do not mix with products containing alachlor, metolachlor, S-metolachlor, flufenacet, or dimethenamid when applied within 14 days of planting, unless soybeans are planted under no-tillage or minimum tillage conditions in wheat stubble or no-till field corn stubble.

Herbicide	Formulation
Warrant	**3L**

- Warrant (acetochlor) can be applied preplant, preemergence, or early postemergence to soybeans for residual control of annual grasses, lambsquarters, pigweed, waterhemp, and eastern black nightshade. Warrant applied alone does not control emerged weeds, but a postemergence mixture of glyphosate and Warrant will control emerged weeds and provide residual control.
- Site of action: group 15 (see pages 22-23).
- Rates for preplant/preemergence application on soils with more than 1.5% OM, based on soil texture: coarse - 1.25 to 1.7 qts; medium - 1.25 to 1.9 qts; fine - 1.25 to 2.0 qts.
- Postemergence applications should be prior to the R2 stage, and prior to weed emergence or in combination with glyphosate to control emerged weeds.
- Optimum timing and rate of application (when applied postemergence with glyphosate) is 1.5 qts/A when weeds are 2 to 4 inches tall, and soybeans are at V2 to V3. Labeled rates range from 1.25 to 2 qts/A depending upon soil texture and organic matter content.

Herbicide	Formulation
Zidua	**85WDG**

- Zidua (pyroxasulfone) can be applied preplant, preemergence, or early postemergence in soybeans for residual control of annual grasses and small-seeded broadleaf weeds. This product should generally be combined with other preemergence soybean herbicide(s) to improve broadleaf weed control, or followed with a postemergence herbicide treatment.
- Site of action: group 15 (see pages 22-23).
- Application rates based on soil texture: Preemergence - coarse - 1.5 to 2.1 oz; medium - 2 to 3 oz; fine - 2.5 to 3.5 oz; postemergence - coarse - 1.0 to 2.1 oz; medium - 1.5 to 3 oz; fine - 2.0 to 3.5 oz.
- Check with seed supplier for information on soybean variety tolerance to Zidua.
- Early postemergence applications will not control emerged weeds. Apply when soybeans are in the first to third trifoliate stage. May cause temporary leaf burn and stunting to soybeans when applied postemergence. Do not apply from the cracking through unifoliate stage of soybean growth.

Soybeans: Postemergence/Residual Premixes

Herbicide	Formulation
Anthem	**2.15SE**

- Anthem is a premix of pyroxasulfone (Zidua) and fluthiacet (Cadet) that can be applied preplant, preemergence, or early postemergence in soybeans for residual control of annual grasses and small-seeded broadleaf weeds. Residual control is provided solely by the pyroxasulfone.
- Site of action: group 15 (pyroxasulfone); group 14 (fluthiacet). See pages 22-23.
- When applied early postemergence, the fluthiacet component can control or help control some broadleaf weeds, but should be mixed with other postemergence herbicides. Apply when soybeans are up to the third trifoliate stage (V3). May couse temporary leaf burn and stunting to soybeans when applied postemergence.
- Include NIS (0.25% v/v) or COC/MSO (1 to 2 pts/A) with postemergence applications. Follow adjuvant recommendations for partner herbicides in tank mixes. Additional adjuvants are not needed when mixing with glufosinate or glyphosate products that already contain surfactant.

Anthem PRE/POST use rates (oz/A)

% organic matter	Soil texture		
	Coarse	Medium	Fine
PRE < 3%	5 to 6.5	6.5 to 9.5	8.5 to 11
PRE > 3%	6.5	8 to 9.5	10 to 11
POST - any	4 to 6.5	5 to 9	6.5 to 11

Herbicide	Formulation	Product Rate Range
Prefix	**5.29L**	**2 - 3 pts**
Vise	**5.4L**	**2 - 3 pts**
Statement	**5.24L**	**2 - 3 pts**

- These products are premixes of S-metolachlor or metolachlor plus fomesafen that can be applied preplant, preemergence or early postemergence. Preplant/preemergence applications provide early-season control of annual grasses and small-seeded broadleaf weeds, including eastern black nightshade, pigweeds, common ragweed, and waterhemp, and should be followed by a postemergence herbicide program. See S-metolachlor and fomesafen descriptions for more information.
- Prefix and Vise can be applied early postemergence (Prefix - up to 90 days before harvest; Vise - through the 3rd trifoliate stage) at rates of 2 - 2.33 pts/A to control emerged weeds and provide residual control of grasses and some broadleaf weeds, including waterhemp and Palmer amaranth. Should generally be mixed with glyphosate to broaden the spectrum of control. Include NIS (0.25% v/v) in postemergence applications unless mixing with a glyphosate product that contains surfactant. Do not apply with COC or MSO. Statement did not have a POST label yet at time of publication.
- Site of action: group 15 (S-metolachlor), group 14 (fomesafen). See pages 22-23.
- Maximum preplant/preemergence use rates: north of I-70 - 2.5 pts; south of I-70 - 3 pts. See labels for more information on rates north and south of I-70.
- Do not apply postemergence to fields that have received a preplant/preemergence treatement of S-metolachlor.

Herbicide	Formulation	Product Rate Range
Torment	**2.5L**	**3/4 - 1 pt**

- Torment is a premix of imazethapyr (Pursuit) and fomesafen (Reflex) that can be applied preplant, preemergence, or early postemergence for residual control and control of emerged weeds. This product will be less effective for residual control of waterhemp and Palmer amaranth compared with Prefix/Vise. See Pursuit and Reflex descriptions for more information.
- Site of action: group 2 (imazethapyr); group 14 (fomesafen). See pages 22-23.

Soybeans: Postemergence/Residual Premixes

- Postemergence applications should occur when weeds are less than 3 inches tall, approximately 14 to 28 days after planting in the absence of a prior residual herbicide treatment. Include COC or MSO (0.5 to 1% v/v) or NIS (0.25 to 0.5% v/v) in postemergence applications, plus either UAN (1 to 2.5% v/v) or AMS (at least 8.5 lbs/100 gal).
- Apply in a spray volume of at least 15 gpa with a pressure of 30 to 60 psi. When weed foliage is dense use a spray volume of at least 20 gpa with a pressure of 60 psi.

Herbicide	Formulation	Product Rate Range
Warrant Ultra	**3.45L**	**48 - 70 oz**

- Warrant Ultra is a premix of acetochlor and fomesafen that can be applied preplant, preemergence or early postemergence. Preplant/preemergence applications provide early-season control of annual grasses and small-seeded broadleaf weeds, including eastern black nightshade, lambsquarters, pigweed, Palmer amaranth, common ragweed, and waterhemp, and should be followed by a postemergence herbicide program. See Warrant and fomesafen descriptions for more information.
- Can be applied postemergence anytime before soybeans reach the R2 stage. Optimum timing of application is when soybeans are in the V2 to V3 stage to control small emerged weeds and provide residual control of grasses and some broadleaf weeds, including waterhemp and Palmer amaranth. Should generally be mixed with glyphosate to broaden the spectrum of control.
- For postemergence applications, apply with NIS (0.25 to5% v/v) or COC/MSO (0.5 to 1% v/v).
- Site of action: group 15 (acetochlor), group 14 (fomesafen). See pages 22-23.
- Do not exceed the maximum annual total acetochlor rate of 3 lbs ai/A. Do not exceed the following maximum rates of Warrant Ultra, which can be applied every other year: north of I-70 - 60 oz; south of I-70 - 70 oz.

Warrant Ultra POST Use Rates (oz/A)		
Soil Texture	**Soil Organic Matter Content**	
	Less than 1.5%	**1.5% or higher**
Coarse	48	48 - 60
Medium	48 - 55	48 - 65
Fine	48 - 60	48 - 70

Soybeans: Postemergence Herbicides — Contact

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Aim	**2EW**	**0.25 oz**	**Not addressed on label**

- Aim (carfentrazone) is a contact herbicide that controls primarily velvetleaf at 0.25 oz rate.
- Site of action: group 14 (see pages 22-23).
- Apply when soybeans are in the V3 to V10 stage. Do not use on soybeans with maturity less than 2.0. Maximum broadcast rate: 0.25 oz/A for 2.1 to 3.4 maturity; 0.5 oz for maturity of 3.5 or higher.
- Apply with NIS (0.25% v/v) in a spray volume of 10 to 20 gpa.
- Always add Aim to the spray tank first when mixing with other herbicides.
- Application of Aim is likely to cause soybean leaf burn.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Basagran/Broadloom	**4L**	**1 - 2 pt**	**1 - 2 pt**

- Basagran/Broadloom (bentazon) is a contact herbicide that controls many annual broadleaf weeds, but is weak on pigweed, ragweeds, and annual morninglories. At higher rates, controls or suppresses yellow nutsedge and Canada thistle.
- Site of action: group 6 (see pages 22-23).
- Apply with COC (1.25% v/v) and/or nitrogen fertilizer (UAN or AMS). The label suggests the use of UAN (1/2 to 1 gallon/A) or AMS (2.5 pound/A) in place of COC where velvetleaf is the primary target weed. COC must also be used if common ragweed and lambsquarters are present. Additive recommendations vary when mixing with other herbicides; see the label for additional information.
- Apply in a spray volume of at least 20 gpa with a minimum pressure of 40 psi. Increasing spray volume (up to 50 gpa) will improve control when crop and weed foliage is dense.
- Application with Flexstar will improve control of morningglory, giant ragweed, and pigweed.
- The addition of 2 fluid ounces of 2,4-DB will improve morningglory control. Do not add crop oil or UAN when applying with 2,4-DB.
- May cause temporary soybean leaf burn, but is less injurious to soybeans than most other postemergence herbicides.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, or if mixing with glufosinate, just add AMS.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Cadet	**0.91EC**	**0.4 - 0.9 oz**	**0.4 - 0.6 oz**

- Cadet (fluthiacet-methyl) is a contact herbicide that controls velvetleaf, and controls or suppresses small lambsquarters, pigweeds, eastern black nightshade, and annual morningglory at the 0.9 oz rate.
- Site of action: group 14 (see pages 22-23).
- Apply from first trifoliate stage through flowering, but at least 60 days before harvest.
- Apply with NIS (0.25% v/v), or a COC or MSO (1 to 2 pts/A). UAN (1 to 2 qts/A) or AMS can be added. When combined with other herbicides, Cadet can generally be applied with any adjuvants required for those herbicides.
- Apply in a minimum spray volume of 15 gpa and pressure of 20 to 40 psi. Increase volume and pressure in dense crop and weed canopies.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Cobra/Phoenix	**2L**	**8 - 12.5 oz**	**8 - 12.5 oz**

- Cobra/Phoenix (lactofen) is a contact herbicide that is similar to Flexstar in weeds controlled. In OSU research, Flexstar has been more consistently effective than Cobra on giant and common ragweed and annual morningglory. Cobra can suppress some perennial vines, including climbing milkweed and bigroot morningglory.

Soybeans: Postemergence Herbicides — Contact

- Site of action: group 14 (see pages 22-23).
- For best results, apply with COC (0.25 to 1%, v/v) up to the 4- to 6-leaf stage of weeds. Surfactant, UAN, or AMS may be substituted for COC when weeds are actively growing under high temperature, high humidity, and high soil moisture conditions. Do not use surfactant when relative humidity is less than 80 percent.
- Apply at least 45 days prior to harvest.
- Apply in a spray volume of 20 to 30 gallons per acre at a spray pressure of 40 to 60 psi using flat fan or hollow cone nozzles.
- Cobra causes more severe soybean leaf burn than other postemergence herbicides. Phoenix causes less injury to soybeans than Cobra.
- When mixing with glyphosate, add AMS (2.5 to 4.5 lb/A). University research has shown that where these products are mixed with glyphosate in order to control glyphosate resistance weeds, the Cobra/Phoenix rate and adjuvants used must be appropriate to optimize the lactofen activity.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Fomesafen			
Flexstar, Rhythm, etc	**1.88L**	**1 - 1.6 pints**	**6 - 12 oz**
Reflex, Shafen, etc	**2LC**	**1 - 1.5 pts**	**6 - 12 oz**
Sinister	**2.87L**	**0.52 - 1.05 pts**	**4.2 - 8.3 oz**

- Fomesafen controls annual broadleaf weeds, including ragweeds, cocklebur, pigweeds, waterhemp, annual morninglories, velvetleaf, Pennsylvania smartweed, and black nightshade. Can suppress Canada thistle, bindweeds, and climbing milkweed, but does not control lambsquarters.
- Site of action: group 14 (see pages 22-23).
- Maximum rates: 1.88L - north of I-70 - 1.3 pints, south of I-70 - 1.6 pints; 2LC - north of I-70 - 1.25 pints, south of I-70 - 1.5 pints; 2.87L - north of I-70 - 0.87 pints, south of I-70 - 1.05 pints.
- Labels allow a minimum spray volume of 10 (2L and 2.87L) or 15 gpa (1.88L). In general, apply in a spray volume of 15 to 20 gpa (use 20 gpa in dense foliage) with a spray pressure of 30 to 60 psi.
- Adjuvants - 1.88L. Apply with COC or MSO (0.5 to 1% v/v) or NIS (0.25 to 0.5%), plus UAN (minimum of 1% v/v) or AMS (minimum of 4 lbs/100 gallons). MSO is the preferred adjuvant for effectiveness on weeds, but can cause more soybean leaf burn than COC.
- Adjuvants - 2LC. Apply with COC (0.5 to 1% v/v) or NIS (0.25 to 0.5% v/v). UAN can be added to the spray mixture along with COC or NIS, which may improve control of velvetleaf and other weeds. Do not substitute UAN for COC or NIS.
- Adjuvants - 2.87L. Apply with COC (0.5 to 1% v/v) or NIS (0.25 to 0.5% v/v). UAN (2.5% v/v) or AMS (at least 10 lbs/100 gallons) can be added to the spray mixture along with COC or NIS.
- Fomesafen can reduce the activity of postemergence grass herbicides mixtures, especially under drought-stress conditions. To avoid a reduction in grass control, apply fomesafen 2 to 3 days after the postemergence grass herbicide is applied, or wait about 7 days after fomesafen is applied before applying the grass herbicide. See labels for more information.
- Often causes temporary soybean leaf burn. This will typically be more severe when applied with MSO and/or UAN, compared with other adjuvants.
- Do not apply more than once every two years.
- When mixing the 1.88L or 2LC with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS. For the 2.87L, consult glyphosate label for information on adjuvants in mixtures.
- University research has shown that where fomesafen is mixed with glyphosate in order to control glyphosate resistance weeds, the fomesafen rate and adjuvants used must be appropriate to optimize the fomesafen activity. This will often require maximum fomesafen rates and use of COC or MSO.

Soybeans: Postemergence Herbicides — Contact

Herbicide	Formulation	Product Rate Range	With Glyphosate
Marvel	**3L**	**5 - 7.5 oz**	**5 - 7.5 oz**

- Marvel is a premix of fomesafen (Reflex) and fluthiacet methyl (Cadet) that controls small annual broadleaf weeds. See Reflex and Cadet descriptions for more information.
- Site of action: group 14 (see pages 22-23).
- This product often causes temporary soybean leaf burn, which will be more severe when applied with COC.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system or mixing with glufosinate, just add AMS.
- Apply with NIS (0.25 to 0.5% v/v), or COC/MSO (0.5 percent to 1 percent v/v). UAN or AMS can be added to the spray mixture along with one of these adjuvants. Use of COC or MSO is recommended under dry conditions or low relative humidity.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Resource	**0.86EC**	**4 - 12 oz**	**2 - 4 fl oz**

- Resource (flumiclorac) is a contact herbicide that controls velvetleaf and pigweeds. Control of lambsquarters is variable, and some other broadleaf weeds will be suppressed.
- Site of action: group 14 (see pages 22-23).
- Apply 4 to 8 ounces/A when broadleaf weeds are in the 2- to 3-leaf stage for best results. The 8 ounce rate will control velvetleaf up to 24 inches tall. Use 12 oz/A for velvetleaf up to 30 inches tall.
- Apply in a spray volume of at least 10 gpa with a spray pressure of 30 to 60 psi.
- Resource applied alone and in mixtures with most other herbicides requires the use of COC (1 quart/A) . The addition of liquid nitrogen fertilizer may enhance control of tall velvetleaf and is required in some mixtures. See the label for more information.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Rezult	**Co-pack**	**3.25 pts**	**Not addressed on label**

- Rezult is a co-pack of Poast Plus (premix of sethoxydim plus Dash) plus Basagran (bentazon). The use rate contains the equivalent of 1.6 pints of Poast Plus and 1.6 pints of Basagran. See Poast Plus and Basagran descriptions and product labels for more information.
- Site of action: group 6 (bentazon), group 1 (sethoxydim). See pages 22-23.
- Apply when most weeds are 2 to 4 inches tall in a spray volume of 10 to 20 gpa with a spray pressure of at least 40 psi (60 psi where foliage is dense).
- Include UAN (28, 30, or 32% - 2 quarts/A) in the spray mix when applied alone or in combination with Classic. Apply with a silicon adjuvant (1 to 2 pints/100 gallons spray) when applied with Blazer or Reflex.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Storm	**4S**	**1.5 pt**	**1.5 pt**

- Storm is a 2:1 premix of bentazon (Basagran) plus acifluorfen (Ultra Blazer) for control of broadleaf weeds. The recommended rate of Storm (1½ pt) is equivalent to 1 pint of Basagran and 1 pint of Ultra Blazer.
- Site of action: group 14 (acifluorfen), group 6 (bentazon). See pages 22-23.
- Apply Storm in a spray volume of 10 to 20 gpa. Use a minimum pressure of 40 psi. Increasing the spray volume (up to 50 gpa) will improve control when crop and weed foliage is dense.
- Apply Storm with COC (1 to 2 pints/A), UAN (1/2 to 1 gallon/A), or NIS (1 to 2 pints/100 gallons), depending upon weed species present and other herbicide in the mixture. See label for specific directions.
- Apply early when weeds are small (2 to 4 inches) for best results. Control is reduced when weeds exceed maximum size stated on the label.

Soybeans: Postemergence Herbicides — Contact

- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Ultra Blazer	**2L**	**0.5 - 1.5 pt**	**0.5 - 1.5 pt**

- Ultra Blazer (acifluorfen) is a contact herbicide that controls annual broadleaf weeds, including pigweed, waterhemp, annual morningglory, common ragweed, and black nightshade. Control of giant ragweed is variable. Cocklebur, velvetleaf, and lambsquarters are not adequately controlled.
- Site of action: group 14 (see pages 22-23).
- Apply when weeds are in the 2- to 4-inch stage and actively growing.
- Standard adjuvant recommendation is NIS (1 to 2 pints per 100 gallons spray). Various rates and combinations of surfactant or COC and UAN are allowed depending upon weed species and environmental conditions. Application with COC will increase crop injury.
- Apply in a spray volume of at least 20 gpa with a minimum pressure of 40 psi. Increasing spray volume (up to 50 gpa) will improve control when crop and weed foliage is dense.
- Application in combination with Basagran will improve control of velvetleaf, cocklebur, giant ragweed and some other weeds.
- The addition of 2 fluid ounces of 2,4-DB will improve morningglory, giant ragweed, and cocklebur control.
- Often causes soybean leaf burn. Soybeans usually recover within a few weeks.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Soybeans: Postemergence Herbicides — Systemic

Herbicide	Formulation	Product Rate Range	With Glyphosate
Assure II/Targa	**0.88EC**	**5 - 10 oz**	**5 - 10 oz**

- Assure II/Targa (quizalofop) is a translocated herbicide that controls many annual and perennial grasses, including giant foxtail, johnsongrass, shattercane, quackgrass, and volunteer corn. Quizalofop is often less effective than other postemergence grass herbicides for control of yellow foxtail, barnyardgrass, and crabgrass, especially in mixtures with broadleaf herbicides.
- Site of action: group 1 (see pages 22-23).
- Apply 7 to 8 ounces per acre for control of foxtails (2 to 8 inches tall), and fall panicum, barnyardgrass, and crabgrass (2 to 6 inches tall). Lower rates may be used for control of shattercane, seedling johnsongrass, volunteer corn, and small giant foxtail.
- For perennial grass control, application is delayed until grass reaches a height of at least 4 to 10 inches, depending upon the target weed. Two applications may be needed for perennial grass control.
- Apply with COC (1 to 2 gallons/100 gallons spray) for best results. NIS (2 pints/100 gallons spray) may be used instead of COC if required in a mixture with other herbicides. Petroleum-based COCs are preferred over MSOs.
- For control of volunteer glyphosate-resistant corn in Roundup Ready soybeans in mixtures with glyphosate, apply the following rates based on corn size: up to 12 inches - 4 oz; 12-18 inches - 5 oz; 18 to 30 inches - 8 oz. The addition of NIS at the rate of 2 pints per 100 gallons spray is recommended in this mixture. If the glyphosate product contains a surfactant package, add NIS at the rate of 1 pint per 100 gallons.
- Apply in a spray volume of 10 to 40 gpa with a pressure of 25 to 60 psi.
- A reduction in the control of grasses may occur when quizalifop is applied to moisture-stressed plants or mixed with Classic, Harmony GT, or Basagran. The reduction due to mixing is not usually observed for volunteer corn, giant foxtail, shattercane, and johnsongrass control, and no increase in Assure II/Targa rate is required for control of these grasses in mixtures. To maintain control of other grasses, increase the Assure II/Targa rate by 2 ounces in mixtures. Do not mix Assure II/Targa with Basagran, Classic, or Harmony GT when the target grass is barnyardgrass, quackgrass, crabgrass, yellow foxtail, or wirestem muhly.
- For sequential applications of Assure II/Targa and broadleaf herbicides, wait at least 24 hours after Assure II/Targa application before applying the broadleaf herbicide. If the broadleaf herbicide is applied first, do not apply Assure II/Targa until grass plants begin to develop new leaves.
- When mixing with glyphosate products without an adjuvant, use NIS or COC at above rates. If glyphosate product has an adjuvant, use NIS (1 pint/100 gallons). If conditions are dry, use COC (1 gallon/100 gallons).

Herbicide	Formulation	Product Rate Range	With Glyphosate
Classic	**25DF**	**0.25 - 0.75 oz**	**0.25 - 0.33 oz**

- Classic (chlorimuron) is a translocated sulfonylurea herbicide that controls many annual broadleaf weeds, including velvetleaf, annual morningglory, burcucumber, pigweed, cocklebur, Pennsylvania smartweed, yellow nutsedge, and ragweeds. Classic does not control lambsquarters or eastern black nightshade, and control of giant ragweed that are 4 to 8 inches tall is variable. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Apply with NIS (0.125% v/v or greater) or COC (1% v/v) plus UAN (2 - 4 quarts/A) or AMS (2 - 4 lbs/A). COC provides better control than surfactant under hot, dry conditions and is suggested for control of pigweed and giant ragweed.
- Most weeds up to 2 inches tall can be controlled with a rate of 1/2 ounce per acre. Rate increases with weed size and leaf stage. Velvetleaf and common ragweed control require a minimum rate of 2/3 ounce per acre, and the minimum rate for large giant ragweed and Jerusalem artichoke is 3/4 ounce per acre. Classic will control cocklebur up to 12 inches tall at the rate of 3/4 ounce per acre.
- Split applications of Classic 14 to 21 days apart will improve control of morningglory, giant ragweed, burcucumber, and Jerusalem artichoke.
- Apply in a minimum spray volume of 10 gallons per acre at a minimum pressure of 25 psi.
- May cause temporary yellowing and stunting of soybeans, especially when applied with COC.

Soybeans: Postemergence Herbicides — Systemic

- Apply any time after the first trifoliate has opened, but no later than 60 days before soybean maturity.
- Treating weeds under stress from abnormally cold or hot weather or dry soil conditions may result in only partial control. To maintain effective control, delay application until stress passes and weeds resume active growth.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (4.25 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Clethodim	**Various**	**See comments**	**Select Max 6 - 12 fl oz** **Others 6 - 8 fl oz**

- Clethodim is a translocated herbicide for control of annual and perennial grasses, including foxtails, barnyardgrass, fall panicum, johnsongrass, shattercane, quackgrass, and volunteer corn.
- Clethodim is sold under various trade names, including Select, Arrow, Section, Tapout, and Select Max.
- Site of action: group 1 (see pages 22-23).
- Most clethodim products are 2 lb/gal formulations, and the rates are as follows: 6 oz/A when giant foxtail is 2 to 12 inches tall, shattercane and seedling johnsongrass are 4 to 10 inches tall, volunteer corn is 12 to 18 inches tall, and most other annual grasses are 2 to 6 inches tall. A rate of 4 ounces per acre may be used to control volunteer corn that is 4 to 12 inches tall. Lower rates may be used for control of small giant foxtail that are actively growing under favorable environmental conditions.
- Select Max should be applied at a rate of 9 to 12 oz/A for control of annual grasses less then 6 inches tall. Rate should be increased to 14 to 16 oz/A for annual grasses more than 6 inches tall and perennial grasses.
- Control of volunteer corn with Select Max when mixed with glyphosate: 6 oz/A for volunteer corn that is less than 12 inches tall, and 9 oz/A for corn that is 12 to 24 inches tall. Apply with AMS (8.5 to 17 lbs/100 gallons). Add surfactant if required by the glyphosate product label. Other clethodim products will not usually adequately control volunteer corn when mixed with glyphosate unless applied with COC or MSO. Consult labels and local use guides for more information on adjuvant types and rates.
- Control of perennial grasses requires higher rates and possibly sequential applications. Application should be delayed until perennial grasses are at least 4 to 12 inches tall, depending upon the target weed.
- Labels for most clethodim products (excluding Select Max) specify application with COC or MSO (1% v/v and not less than 1 pint/A) in a spray volume of 10 to 40 gpa at a pressure of 30 to 60 psi. Do not apply with flood nozzles. UAN or AMS can be added, and may improve control of some grasses.
- When applied alone, the preferred adjuvants for Select Max are NIS (0.25%) and AMS (2.5 lbs/A). COC (1% v/v or 1 qt/A) can be substituted for NIS if required for other herbicides mixed with Select Max.
- Mixing clethodim with broadleaf herbicides may reduce grass control, especially under dry conditions. Increasing the clethodim rate can help maintain grass control in mixtures with broadleaf herbicides. When making separate applications of grass and broadleaf herbicides, allow at least one day between applications if the grass herbicide is applied first.
- When mixing with glyphosate, adjuvants are handled differently on different labels. Add AMS (2.5 to 4 lb/A) when using any clethodim product and glyphosate. Select Max - add NIS (0.25% v/v). Arrow or Section - add NIS (0.125% v/v) or COC (0.5 - 1% v/v). If mixing with a loaded glyphosate product, see glyphosate label also.

Herbicide	Formulation	Product Rate Range	With Glyphosate
FirstRate	**84DF**	**0.3 - 0.6 oz**	**0.3 - 0.6 oz**

- FirstRate (cloransulam-methyl) is a translocated sulfonamide herbicide than controls ragweeds, velvetleaf, annual morningglory, and cocklebur. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Apply with NIS (0.125 to 0.25% v/v) plus 28% UAN (2.5% v/v) or AMS (2 lbs/A); or with COC or MSO (1.2% v/v). COC or MSO plus UAN or AMS can increase crop injury and should only be used under adverse weed control conditions. The spray mix should include UAN or AMS if velvetleaf is a target weed.

Soybeans: Postemergence Herbicides — Systemic

- Control of giant ragweed may be reduced when air temperature remains below 55 degrees for significant periods within 2 days before or after application.
- Apply up to R2 stage, in a spray volume of 10 to 40 gpa with a pressure of 20 to 40 psi.
- Mixing FirstRate with a grass herbicide, especially Assure II or Fusion, may result in reduced grass control. Increase the grass herbicide rate or apply separately to avoid this problem.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Fusilade DX	**2E**	**6 - 12 oz**	**4 - 6 oz**

- Fusilade DX (fluazifop) is a translocated herbicide that controls annual and perennial grasses.
- Site of action: group 1 (see pages 22-23).
- Mixtures with Pursuit and Classic are labeled for control of volunteer corn and shattercane only.
- For sequential applications of Fusilade and broadleaf herbicides, the minimum time interval that must occur between applications varies with the herbicides sprayed and the order of application. See the label for additional information.
- Apply 12 oz per acre to actively growing giant foxtail (2 to 6 inches tall) or other annual grasses (2 to 4 inches tall) before grass has tillered. The rate for shattercane is 6 to 8 ounces per acre, and the rate is 4 to 6 oz/A for volunteer corn. Apply with COC (0.5 - 1.0% v/v) or NIS (0.25 - 0.5% v/v) in a minimum spray volume of 5 gallons per acre. UAN can also be added.
- The Fusilade DX rate is 4 to 6 oz/A for control of volunteer glyphosate-resistant corn in Roundup Ready soybeans in mixtures with glyphosate. The 4 oz rate can be used only under the following conditions: favorable soil moisture and humidity; volunteer corn is less than 12 inches tall; and COC (0.25% v/v) is used as the spray adjuvant. In mixtures with glyphosate products that are formulated with a surfactant package, where COC is not used, apply 6 oz of Fusilade DX.
- For perennial grass control, use 12 oz and delay application until grass reaches a height of at least 4 to 8 inches, depending upon the target weed. A second application of 8 ounces/A may be needed for complete control.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Fusion	**2.66E**	**6 - 14 oz**	**6 - 12 oz**

- Fusion is a premix of fluazifop-P (Fusilade) plus fenoxaprop-ethyl, translocated herbicides that control annual and perennial grasses, including foxtails, barnyardgrass, johnsongrass, shattercane, volunteer corn, and quackgrass.
- Site of action: group 1 (see pages 22-23).
- Mixtures with Pursuit are labeled for control of volunteer corn and shattercane only.
- When applied alone, the rate is 6 to 8 ounces per acre for control of foxtails, fall panicum, and many other annual grasses, 6 ounces per acre for control of seedling johnsongrass and shattercane, and 4 to 6 ounces for volunteer corn. The lower rates may be used when grasses are actively growing and are at the earliest growth stages indicated on the label, soybeans are planted in narrow rows or cultivation is planned, weed densities are light to moderate, and COC is used. The Fusion rate may need to be increased to 12 ounces when mixed with broadleaf herbicides, depending upon grass size and environmental conditions at the time of application.
- The Fusion rate is 4 to 6 oz/A for control of volunteer glyphosate-resistant corn in Roundup Ready soybeans in mixtures with glyphosate. The 4 oz rate can be used only under the following conditions: favorable soil moisture and humidity; volunteer corn is less than 12 inches tall; and COC (0.25% v/v) is used as the spray adjuvant. In mixtures with glyphosate products that are formulated with a surfactant package, where COC is not used, apply the 6 oz Fusion rate.
- Can be applied at 8 to 14 ounces/A as a rescue treatment for control of giant foxtail up to 16 inches tall. Use 12 to 14 ounces/A if grass is drought-or temperature-stressed. Do not mix with broadleaf herbicides when applying rescue treatments.

Soybeans: Postemergence Herbicides — Systemic

- Do not mix with Classic, Harmony GT, or Synchrony STS if conditions are dry and target grasses include yellow foxtail, barnyardgrass, or crabgrass.
- For perennial grass control, application is delayed until grass reaches a height of at least 4 to 6 inches, depending upon the target weed. Two applications may be needed for perennial grass control.
- For sequential applications of Fusion and broadleaf herbicides, the minimum time interval that must occur between applications varies with the herbicides sprayed and the order of application. See the label for additional information on sequential applications.
- Apply with COC (2 to 4 quarts/100 gallons spray) for best results. NIS (1 to 2 quarts/100 gallons spray) may be used instead of COC if required in a mixture with other herbicides. Liquid nitrogen fertilizer can be added to the spray mixture, but should not be used as a substitute for COC or surfactant.
- Apply in 5 to 40 gpa at a spray pressure of 40 to 60 psi. Use 60 psi and a minimum volume of 20 gpa where grass foliage is dense.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Poast	**1.5E**	**12 - 24 oz**	**12 - 24 oz**

- Poast (sethoxydim) controls annual grasses and controls or suppresses perennial grasses.
- Site of action: group 1 (see pages 22-23).
- For control of most annual grasses, apply 16 ounces before weeds are 8 inches tall. Control of volunteer cereals (prior to overwintering) requires higher rates. The label allows for reductions in rate when applied to small actively growing grass. Reduced-rate recommendations apply only to barnyardgrass, fall panicum, giant and green foxtails, and volunteer corn. See label for more information.
- Apply with 2 COC (2 pts/A). Include UAN (1/2 to 1 gallon/A) or AMS (2 1/2 lb/A) for control of crabgrass, volunteer corn, or volunteer wheat. When mixing with Basagran, include UAN or AMS in the spray mix. Rates and additive recommendations vary when mixing with Basagran, depending upon the target grasses. See label for more information.
- A 24 oz/A rate can be used as a rescue treatment for control of foxtails up to 16 inches tall, barnyardgrass and fall panicum up to 12 inches tall, and crabgrass up to 8 inches tall. Add UAN or AMS for control of crabgrass.
- Poast is generally less effective than other postemergence grass herbicides for perennial grass control. Two applications may be necessary for perennial grass control.
- Optimum spray volume is 10 gallons per acre, but spray volumes of 5 to 20 gallons per acre may be used. Apply with a spray pressure of 40 to 60 psi.
- Poor control may result when applied to weeds under stress from hot, dry conditions or herbicide injury.
- When applied in mixture with a glyphosate product not loaded with an adjuvant system follow recomendations above, but do not use MSO. If glyphosate product is loaded with an adjuvant system, see glyphosate label for adjuvant recommendations.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Pursuit	**2S**	**4 oz**	**4 oz**

- Pursuit (imazethapyr) is a translocated imidazolinone herbicide that controls annual broadleaf weeds and controls or suppresses grasses. Pursuit also provides some residual control of grass and broadleaf weeds. Control of common and giant ragweeds and lambsquarters is variable. Mixtures with reduced rates of Flexstar or Cobra will improve control of ragweeds. Pursuit does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Apply with NIS (2 pints/100 gallons spray) or a COC (1½ to 2 pints/A) plus UAN (1 to 2 quarts per acre). AMS (2 1/2 pounds/A) may be substituted for liquid fertilizer in the spray mix. Control of large or drought-stressed weeds will be maximized when the higher rates of fertilizer are used in combination with a seed oil-based COC (Meth Oil or Sun-It II, for example).
- For control of most annual grass and broadleaf weeds, apply before weeds are 3 inches tall and before soybeans bloom. Pursuit should be applied before lambsquarters and morningglory are 2 inches tall. Cocklebur, pigweed,

shattercane, and seedling johnsongrass can be controlled up to 8 inches tall. For control or suppression of Jerusalem artichoke, apply when artichokes are 6 to 10 inches tall.

- Control may be reduced when weeds are growing slowly under cold or dry conditions. If possible, wait for rain and resumption of active weed growth before applying Pursuit. If air temperatures reach or stay below 50 F for 10 or more hours, delay application for 48 hours from the time temperatures increase above 50 F.
- Combinations of Pursuit plus thifensulfuron can cause severe injury and yield loss under environmental conditions that predispose soybeans to herbicide injury.
- Apply in a spray volume of at least 10 gallons per acre with a spray pressure of 20 to 40 psi. Flat fan spray nozzles are recommended for adequate plant coverage. Allow 1 hour between application and rainfall.
- Mixtures of Pursuit with postemergence grass herbicides are generally labeled for control of volunteer corn and shattercane only.
- When mixing with glyphosate, add NIS (0.25% v/v) and AMS (8.5 to 17 lb/100 gallons) if the glyphosate is not formulated with its own adjuvant. If the glyphosate has its own adjuvant system, just add AMS.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Raptor	**1AS**	**4 - 5 oz**	**4 - 5 oz**

- Raptor (imazamox) is a translocated imidazolinone herbicide that controls annual broadleaf and grass weeds. Raptor generally provides better control of lambsquarters and annual grasses than Pursuit. Control of common and giant ragweeds and waterhemp is variable. Raptor provides a shorter period of residual control compared to Pursuit. Raptor does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Apply with NIS (2 pints/100 gallons spray) or a COC (1% v/v) plus UAN (1 to 2 quarts per acre) or AMS (2 1/2 pounds/A). AMS is generally the preferred nitrogen source over UAN or 10-34-0. Control of large or drought- or temperature-stressed weeds will be maximized when the higher rates of fertilizer are used in combination with a seed oil-based COC (Meth Oil or Sun-It II, for example).
- For control of most annual grass and broadleaf weeds, apply before weeds are 4 to 5 inches tall and before soybeans bloom.
- Control may be reduced when weeds are growing slowly under cold or dry conditions. If possible, wait for rain and resumption of active weed growth before applying Raptor. If air temperatures reach or stay below 50 F for 10 or more hours, delay application for 48 hours from the time temperatures increase above 50 F.
- Raptor is more injurious to soybeans than Pursuit. Internode shortening and/or temporary yellowing of plants may occur following application, especially when applied with a COC or MSO.
- Apply in a spray volume of at least 10 gallons per acre with a spray pressure of 20 to 40 psi. Flat fan spray nozzles are recommended for adequate plant coverage.
- When applied in mixture with glyphosate, always include AMS (4.5 - 17 lb/100 gal). Include NIS (0.25% v/v) if glyphosate product does not contain an adjuvant.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Synchrony XP			
NonSTS or nonBolt soybeans	**28.4%WDG**	**0.375 oz**	**0.375 oz**
STS soybeans		**0.375 - 0.75 oz**	
Bolt soybeans		**0.375 - 1.125 oz**	

- Synchrony XP is a premix of chlorimuron (Classic) plus thifensulfuron (Harmony GT).
- Site of action: group 2 (see pages 22-23).
- Synchrony applied at 0.75 to 1.125 oz/A controls many annual broadleaf weeds, including lambsquarters, velvetleaf, cocklebur, morningglory, burcucumber, pigweed, Pennsylvania smartweed, yellow nutsedge, and ragweeds. Control of giant ragweed that are 4 to 8 inches tall is variable. Black nightshade is not controlled. Synchrony will suppress or control small perennial sowthistle, dandelion, common milkweed, pokeweed, and Jerusalem artichoke. Does not control group 2-resistant weeds.

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- Mixing with Cobra or fomesafen will improve control of giant ragweed, common ragweed, eastern black nightshade, and waterhemp.
- Apply after the first trifoliate soybean leaves have opened but no later than 60 days before soybean maturity. Weeds should be 2 to 4 inches tall and actively growing for best results. Cocklebur, pigweed, velvetleaf, and smartweed can be controlled up to 8 inches tall.
- Apply with COC (1% v/v) plus an ammonium nitrogen fertilizer at the following rates: 28% - 2 to 4 quarts/A; 10-34-0 - 1 to 2 quarts/A; or ammonum sulfate - 2 to 4 pounds/A. Use the lower fertilizer rates for spray volumes of less than 15 gpa.
- At a reduced rate of 0.375 oz/A, Synchrony STS can be applied to non-STS soybeans for control of small cocklebur, pigweed, and sunflower and suppression of other weeds. Use NIS instead of COC on non-STS soybeans. This Synchrony rate can be used on mixtures with fomesafen, FirstRate, or Harmony GT.
- Apply in a minimum spray volume of 10 gpa at a pressure of at least 25 psi using flat fan nozzles.
- Synchrony STS may reduce the activity of a grass herbicide in mixtures. Increase the rate of the grass herbicide or apply separately to maintain effective control.
- When mixing with glyphosate, add AMS (4.25 - 17 lb/100 gal). If allowed by the glyphosate label, the use of NIS (0.25% v/v) may improve efficacy.

Herbicide	Formulation	Product Rate Range	With Glyphosate
Thifensulfuron (active ingredient)			
Harmony SG - non Bolt soybeans	**50DF**	**0.12 oz**	**Not labeled**
Harmony SG - Bolt soybeans		**0.125 - 0.5 oz**	
Harass, Treaty	**75DF**	**0.08 oz**	

- Thifensulfuron is a translocated sulfonylurea herbicide that controls velvetleaf, pigweed, lambsquarters, and Pennsylvania smartweed. Thifensulfuron is often included in mixtures with other broadleaf herbicides to improve lambsquarter and velvetleaf control. Does not control group 2-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Treating weeds under stress from abnormally cold or hot weather or dry soil conditions may result in only partial control. To maintain effective control, delay application until stress passes and weeds resume active growth.
- Apply with 0.125 to 0.25 percent NIS (v/v) when weeds are less than 4 inches tall and actively growing. Liquid nitrogen fertilizer or AMS should also be included in the spray mix at the following rates: 28% - 2 to 4 quarts/A; 10-34-0 - 2 to 4 pints/A; or AMS - 2 to 4 pounds/A. Under dry conditions, thifensulfuron can be applied with COC, but soybean injury is likely to be more severe. To avoid injury when mixing with other products, follow label directions closely regarding spray additives.
- Apply with flat fan nozzles in a spray volume of 10 to 25 gpa at a pressure of 25 to 60 psi.
- Apply after the first trifoliate soybean leaf has fully expanded up to 60 days before harvest.
- Application of thifensulfuron on non-Bolt soybeans may cause temporary wilting, leaf yellowing, and/or growth retardation (shortened internode spacing). These symptoms are most likely to occur when applied during periods of hot and humid weather.

LibertyLink Soybeans — Postemergence Herbicides

Herbicide	Formulation	Product Rate Range
Glufosinate		
Liberty/Cheetah/Interline	**2.34L**	**29 - 36 oz**

- Glufosinate is a contact, broad-spectrum herbicide for postemergence use only on LibertyLink (glufosinate-resistant) soybeans.
- Site of action: group 10 (see pages 22-23).
- Controls many annual grass and broadleaf weeds up to 3 to 6 inches tall when applied at a rate of 29 oz/A. Two postemergence applications are allowed, but the total amount of glufosinate per season (burndown + POST) should not exceed 65 oz/A.
- Glufosinate is most effective in a combined preemergence plus postemergence program, where the preemergence herbicide will provide control of grass and broadleaf weeds for several weeks to a month after soybean planting. The preemergence herbicide should have substantial activity on lambsquarters, giant ragweed, waterhemp, marestail, and velvetleaf. Glufosinate is weak on barnyardgrass, crabgrass, and yellow foxtail, and these weeds should be controlled by the PRE herbicides or with the addition of a POST grass herbicide (clethodim, Fusion, etc.).
- Controls ragweed and marestail resistant to group 2 and/or 9. For most effective control, apply when weeds are 4 to 6 inches tall. A second application (approximately 3 weeks later) will be necessary in dense giant ragweed infestations, where the preemergence herbicide fails to substantially reduce the weed population, or for control of large marestail that were present at the time of soybean planting and escaped prior herbicide treatment.
- Suppresses some perennial weeds, but has activity on above-ground growth only. Regrowth of perennials may require a second application.
- Activity on certain weeds is enhanced by the addition of AMS. The glufosinate labels do not mention AMS with regard to LibertyLink soybeans, but specifies the use of AMS (3 lbs/A, or 17 lbs/100 gallons) in postemergence applications to LibertyLink corn. Glufosinate has typically been applied with AMS (8.5 lbs/100 gallons) in university research trials.
- Apply after soybean emergence and prior to soybean bloom.
- Apply in a minimum spray volume of 15 gpa. Use a volume of 20 to 40 gpa in dense weed/crop canopies. Apply with a nozzle type and spray pressure that results in medium spray droplets (250 to 350 microns).
- Glufosinate is most effective when applied under warm, sunny conditions. Effectiveness may be reduced if applied when heavy dew, fog and mist/rain are present, or if weeds are under stress due to drought, cool temperatures, or extended periods of cloudiness. To avoid reduced weed control, apply between dawn and two hours before sunset.

Herbicide	Formulation	Product Rate Range
Cheetah Max	**3L**	**26 - 42 oz**

- Cheetah Max is a premix of glufosinate and fomesafen for postemergence use only on LibertyLink (glufosinate-resistant) soybeans. The addition of fomesafen to glufosinate can improve control of emerged waterhemp and Palmer amaranth, and provide some residual control of these weeds.
- Site of action: group 10 (glufosinate); group 14 (fomesafen). See pages 22-23.
- Controls many annual grass and broadleaf weeds up to 3 to 6 inches tall. Use rates: north of I-70 - 26 to 40 oz; south of I-70 - 26 to 42 oz. Apply in a minimum spray volume of 15 gpa, and increase to 20 to 40 gpa in dense weed/crop canopies.
- Cheetah Max is most effective in a combined preemergence plus postemergence program, where the preemergence herbicide will provide control of grass and broadleaf weeds for several weeks to a month after soybean planting. Cheetah Max is weak on barnyardgrass, crabgrass, and yellow foxtail, and these weeds should be controlled by the PRE herbicides or with the addition of a POST grass herbicide (clethodim, Fusion, etc.).
- Often causes temporary soybean leaf burn. Cheetah Max contains adjuvants, and use of additional adjuvant will increase the risk of crop injury.
- Apply prior to bloom stage.

Roundup Ready Soybeans: Postemergence Herbicides

Herbicide	Formulation	Product Rate Range
Extreme/Thunder Master	**2.17L**	**3 pints**
Tackle	**4.128SL**	**1 quart**

- These products are premixes of imazethapyr (Pursuit) and glyphosate for postemergence plus residual grass and broadleaf weed control in Roundup Ready soybeans. They do not provide residual control of group 2-resistant weeds. See Pursuit and glyphosate description for guidelines and restrictions on use.
- Site of action: group 2 (imazethapyr); group 9 (glyphosate) (see pages 22-23).
- Can be more effective than glyphosate on eastern black nightshade, due to the residual control of later-emerging nightshade plants.
- Apply when weeds are less than 8 inches tall, with NIS (1 pint/100 gallons) plus AMS (2.5 lbs/A) or UAN (1 to 2 qts/A).
- This herbicide mixture occasionally causes unacceptable crop injury. Do not apply more than once per growing season.

Herbicide	Formulation	Product Rate Range
Flexstar GT	**3.29L**	**3 - 4.5 pts/A**

- Flexstar GT is a premix of glyphosate and fomesafen (Flexstar) for postemergence application to Roundup Ready soybeans. Can also be applied prior to soybean emergence for no-till burndown.
- Site of action: group 9 (glyphosate); group 14 (fomesafen). See pages 22-23.
- Use rates: north of I-70 - 3 to 3.75 pts/A; south of I-70 - 3 to 4.5 pts. Rates of 3.75 to 4.5 pints will provide the most consistent control of glyphosate-resistant common or giant ragweed. The label allows a reduction of rate to 2.375 pts/A in fields without glyphosate-resistant weeds, as long as weeds are less than 4 inches tall.
- Flexstar GT contains adjuvants, and requires only the addition of AMS (8.5 to 17 lbs/100 gallons) in areas where weeds are not resistant to glyphosate. The addition of COC or MSO (0.5 - 1% v/v) can improve control but also increases leaf burn and other injury symptoms. Based on Ohio State research, the addition of COC or MSO is required for effective control of glyphosate-resistant ragweeds or in other situations where it is necessary to maximize the activity of fomesafen.
- Apply in a spray volume of 15 to 20 gpa with a pressure of 30 to 60 psi. Flat fan nozzles will result in the most effective control. Do not use air induction of other nozzles that deliver large spray droplets.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**0.56 - 1.5 lbs acid/A**

- Glyphosate is a nonselective, translocated herbicide that controls emerged annual and perennial grass and broadleaf weeds. Application rates, adjuvant recommendations, rainfast intervals, and other guidelines for use vary among glyphosate products, and users should consult labels and local product use guides for more specific information.
- Site of action: group 9 (see pages 22-23).
- Glyphosate can be applied broadcast to Roundup Ready soybeans before, during, or after planting and crop emergence. The postemergence application window, per most glyphosate labels, is from emergence (cracking) through flowering, or the R2 stage of soybean development. Soybean development exceeds the R2 stage, or begins the R3 stage, when a pod at least 3/16 inch long appears at one of the four uppermost nodes on the main stem with a fully developed leaf. Crop injury and reduced pod formation has been observed where glyphosate was applied in late summer to soybeans that were past the R2 stage of growth.
- The following management practices are most effective for minimizing the risk of glyphosate resistance in weeds, maintaining adequate weed control, and preserving maximum crop yield: (1) start weed free at planting through use of tillage or a preplant burndown herbicide application, which should include 2,4-D ester; (2) include residual herbicides in the preplant application to reduce weed populations and help control tough weeds; (3) make the first postemergence glyphosate application when weeds are less than about 6 inches tall, and add a herbicide with another site of action to help prevent the development of resistance or control glyphosate-resistant weeds; and (4) make a second postemergence application of the appropriate herbicide (based on response to the first POST)

Roundup Ready Soybeans: Postemergence Herbicides

about 3 weeks later as needed to control late-emerging weeds and weeds that were not completely killed by the initial application.

- The general recommendation on most labels for the initial postemergence application is a rate of 0.75 lbs of glyphosate acid per acre (lbs a.e./A) when weeds are less than 4 to 8 inches tall. University research indicates that weeds should be no larger than 6 to 8 inches tall at the time of postemergence glyphosate application to avoid yield loss from weed interference. Rate should be increased to 1.1 to 1.5 lbs ae/A for larger weeds or in fields with a history of poor glyphosate performance. Additional postemergence applications are permitted, but the total glyphosate in all postemergence applications should not exceed 2.25 lbs ae/A.
- For control of volunteer glyphosate-resistant corn in Roundup Ready soybeans, apply glyphosate with Assure II, Targa, Fusion, Fusilade DX, or clethodim. Consult labels and local recommendation guides for information on adjuvants and rates when mixing glyphosate with postemergence grass herbicides.
- Glyphosate resistance has developed in populations of marestail, Palmer amaranth, waterhemp, and common and giant ragweed in Ohio, Indiana, and Illinois, and some lambsquarters populations appear to have become less sensitive to glyphosate. Consider use of a preemergence herbicide that provides residual control of these weeds, in order to avoid use of herbicide programs consisting solely of multiple glyphosate applications. Applying a glyphosate rate of 1.5 lbs a.e./A when plants are small (less than 6 inches tall) can result in more consistently effective control of populations that have developed a low level of resistance, especially when followed by another application of glyphosate 3 weeks later. Alternative approaches will be necessary where the population has a higher level of glyphsoate resistance, and in populations with resistance to both groups 2 and 9. For more detailed recommendations for control of these weeds, see the “Control of Problem Weeds” section in this guide.
- In Ohio State and Purdue University research, use of all of the following strategies has resulted in most effective control of dense giant ragweed populations: (1) apply a preplant herbicide that includes 2,4-D ester, glyphosate, and a residual herbicide with activity on giant ragweed; (2) make the first postmergence application of glyphosate at 1.5 lbs ae/A when giant ragweed are not more than 10 inches tall, and (3) follow with a second application of glyphosate at 0.75 lb ae/A approximately 3 weeks later.
- Application of a combination of glyphosate plus FirstRate can improve control of marestail and giant ragweed. However, university research indicates that many marestail populations in Ohio, Indiana, and Illinois are resistant to group 2, and FirstRate will not improve control of these populations.
- Annual morningglory, groundcherry, ladysthumb, velvetleaf, marestail, and Pennsylvania smartweed should be less than 6 inches tall at the time of application.
- Best control of perennials will occur at higher labeled rates. Application when perennials are in the bud to bloom stage (or boot to seedhead for grasses) will provide the most complete control of the entire plant. Minimum size of various perennial weeds for most effective control through the growing season: quackgrass, Canada thistle, wirestem muhly, and yellow nutsedge - 6 inches; field bindweed and common milkweed - 12 inches; johnsongrass and hemp dogbane - 18 inches.
- Apply in a spray volume of 5 to 20 gpa. Take precautions to reduce spray drift. Corn, soybeans, and other sensitive crops are likely to be growing in areas surrounding treated fields. Using 15 to 20 gpa and drift-control nozzles at low pressure will reduce the potential for spray drift.
- The addition of AMS will improve control of velvetleaf and some other weeds. AMS will also improve control when using hard water or when daytime air temperatures are 55 degrees or less.

Herbicide	Formulation
Sequence	**5.25L**

- Sequence is a premix of glyphosate plus S-metolachlor that can be applied postemergence to Roundup Ready soybeans to provide control of emerged weeds and residual control of annual grasses, eastern black nightshade, pigweed, Palmer amaranth, and waterhemp.
- Apply 2.5 to 3.5 pints/A when soybeans are between cracking and the 3rd trifoliate stage. Add AMS (8.5 to 17 lbs/100 gallons) where concentration of Ca, Mg, and Mn in water exceeds 150 ppm, and to generally improve control of some weeds.

Soybeans: Selective Application of Glyphosate

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**See comments**

- Glyphosate can be applied to weeds growing above the soybean canopy through selective applicators such as rope-wicks or sponge wipers. This application is useful for control of volunteer corn, shattercane, johnsongrass, hemp dogbane, and common milkweed.
- Site of action: group 9 (see pages 22-23).
- Weeds should be at least 6 inches taller than the soybeans. Avoid contact of herbicide with the crop. Adjust equipment so that the lowest wiper contact is at least 2 inches above the soybeans.
- For mixing instructions and equipment calibration, refer to directions on labels.

Soybeans: Harvest Aid

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**1 - 1.5 oz**

- Aim (carfentrazone) can be applied prior to harvest of mature soybeans for dessication of velvetleaf, morningglory, pigweeds, and other weeds. Apply at least 3 days before harvest.
- Site of action: group 14 (see pages 22-23).
- The total amount of Aim that can be applied to soybeans in one season, including preplant, postemergence, and harvest aid treatments, cannot exceed 1.5 oz/A.
- Use a spray volume that results in complete coverage of foliage. Apply with NIS (0.25% v/v) or a COC (1 to 2% v/v). UAN or AMS may also be added.

Herbicide	Formulation	Product Rate Range
Gramoxone SL	**2L**	**8 to 16 oz**
Parazone	**3SL**	**5.4 to 10.7 oz**

- Gramoxone SL and Parazone (paraquat) may be used for dessicating weeds in soybeans just before harvest. For indeterminate soybean varieties, apply when 65 percent of the seed pods have reached a mature brown color or when seed moisture is 30 percent or less. For determinate varieties, apply when at least one-half of the leaves have dropped and the rest of the leaves are turning yellow.
- Site of action: group 22 (see pages 22-23).
- Mature cocklebur and lambsquarters are tolerant of paraquat and may not desiccate completely.
- For aerial application, use a spray volume of 5 gallons per acre; for ground application, use 20 gallons per acre. Add NIS (0.25% v/v) or COC (1% v/v).
- Apply at least 15 days before harvest. Do not graze or harvest for forage or hay.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**up to 1.5 lb acid/A (aerial application)** **up to 3.7 lbs acid/A (ground application)**

- Application rates, adjuvant recommendations, rainfast intervals, application parameters, and other guidelines for use vary among glyphosate products, and users should consult labels and local product use guides for more specific information. The following comments are meant as general guidelines for the use of glyphosate except where a product name is listed.
- Can be applied as a preharvest treatment to control perennial and annual weeds in soybeans. Dessication from glyphosate is less rapid compared with Gramoxone. Preharvest applications of glyphosate may provide a good opportunity to control perennial weeds because their growth is undisturbed compared to postharvest applications.

Soybeans: Harvest Aid

- Site of action: group 9 (see pages 22-23).
- Apply after pods have lost all green color, and at least 7 or 14 days before harvest, depending upon the product used. Do not graze or harvest the treated crop for livestock feed (Roundup brand labels allow use of soybeans for livestock feed when harvested 14 to 25 days, depending upon rate, after the last preharvest application).
- Do not use glyphosate preharvest in soybeans grown for seed, due to the potential for a reduction in viability or vigor.

Herbicide	Formulation
Sharpen	**2.85SC**

- Sharpen (saflufenacil) can be applied broadcast at rates of 1 to 2 oz/A to soybeans that have reached physiological maturity. Indeterminate varieties should have greater than 65% brown pods and greater than 70% leaf drop with seed moisture of 30% or less. Determinate varieties should have greater than 50% leaf drop with the rest of the leaves yellowing.
- Site of action: group 14 (see pages 22-23).
- Allow 3 days between application and harvest. Optimum dessication can require up to 10 days.
- Do not apply to soybeans grown for seed production. Do not graze or feed treated hay or straw.
- Use a spray volume of at least 10 gpa (ground) or 5 gpa (aerial). Apply with MSO ((1% v/v) plus either AMS (8.5 to 15 lbs/100 gallons) or 28% (1.25 to 2.5% v/v). Increase volume as necessary to ensure adequate coverage.

Table 17. Rainfast Intervals and Spray Additive Recommendations for Postemergence Soybean Herbicides

This table shows the required time interval between herbicide application and rainfall and summarizes label recommendations for spray additives. Check herbicide labels for additive rates. Adjuvant key: NIS + nonionic surfactant; COC = crop oil concentrate; MSO = methylated seed oil; UAN = urea ammonium nitrate solution; AMS = ammonium sulfate.

Herbicide	Rainfast Interval (hours)	Spray additives
Aim	1	NIS
Assure II/Targa	1	NIS, COC, OR MSO. COC is preferred.
Basagran	8	MSO, COC, UAN or AMS; or COC or MSO + UAN or AMS
Cadet	1	NIS, COC, or MSO. UAN or AMS can be added.
Cheetah Max	4	None specified on label
Classic	1	NIS, COC, MSO or NIS + UAN or 10-34-0
Clethodim	1	COC or MSO. UAN, AMS, or 10-34-0 may be added.
Cobra	1/2	MSO, COC or UAN. NIS may be used under conditions of high humidity.
Cobra + Classic	1	NIS
Extreme/Tackle/Thunder Master	1	NIS + UAN, 10-34-0 or AMS.
FirstRate	2	NIS, COC, or MSO, + UAN or AMS, or COC or MSO alone.
Fomesafen 1.88L	1	MSO, COC, or NIS + UAN or AMS
Fomesafen 2LC	1	MSO, NIS or COC. UAN or 10-34-0 may be added.
Fusilade DX	1	MSO, NIS or COC. UAN or 10-34-0 may be added.
Fusion	1	MSO, NIS or COC. UAN or AMS may be added.
Glufosinate	4	None specified on label.
Marvel	1	NIS, COC or MSO. UAN or AMS may be added.
Poast/Poast Plus	1	MSO, COC or Dash. UAN or AMS may be added.
Prefix	1	NIS
Pursuit	1	MSO, NIS or COC, + UAN, 10-34-0, or AMS.
Raptor	1	COC, MSO, or NIS + UAN, 10-34-0, or AMS
Resource	1	MSO or COC. UAN OR AMS may be added to improve control of certain weeds.
Select Max	1	NIS + AMS. COC can be used instead of NIS in mixtures with broadleaf herbicides.
Sinister	1	NIS or COC. UAN or 10-34-0 may be added.
Storm	8	MSO, NIS, COC, or UAN.
Synchrony XP	1	MSO or COC + UAN, 10-34-0, or AMS.
Synchrony XP + Cobra	1	COC or MSO + UAN, 10-34-0, or AMS.
Thifensulfuron	1	NIS + UAN, 10-34-0, or AMS. COC may be used instead of NIS under dry conditions.
Torment	1	NIS, COC, or MSO + UAN or AMS
Ultra Blazer	4	NIS or COC. UAN or 10-34-0 may be added to improve control of certain weeds.
Vise	1	NIS
Warrant Ultra	1	NIS, COC, or MSO

Table 18. Harvest and Feeding Intervals for Soybean Herbicides

Soybean Herbicides	Days to Harvest	
	Grain	Forage
Aim	Apply up to third trifoliate	Do not feed
Assure II/Targa	80	Do not feed
Basagran	30	30
Basagran + 2,4-DB	60	60
Basagran + thifensulfuron	60	Do not feed
Basagran + Reflex	Apply prior to bloom	Do not feed
Basagran + Cobra	90	Do not feed
Cadet	60	Do not feed
Cheetah Max	70	Do not feed
Classic	Apply 60 days before maturity	Do not feed
Clethodim	60	Do not feed
Cobra	45	Do not feed
Extreme/Tackle/Thunder Master	Apply prior to bloom and 85 days before harvest	Do not feed
FirstRate	70	25
Fomesafen	45	Do not feed
Fusilade DX	Apply prior to bloom	Do not feed
Fusion	Apply prior to bloom	Do not feed
Liberty/Cheetah	Apply prior to bloom.	Do not feed
Poast/Poast Plus	75	Do not feed[1]
Previx/Vise	90	Do not feed
Pursuit	85	Do not feed
Raptor	85 and apply prior to bloom	Do not feed
Resource	60	Do not feed
Storm	50	Do not feed
Synchrony XP	Apply 60 days before maturity	Do not feed
Thifensulfuron	60	Do not feed
Torment	85	Do not feed
Ultra Blazer	50	Do not feed
Warrant Ultra	45	Do not feed

[1]Soybean hay may be fed.

Weed Management Strategies for Wheat

A healthy wheat crop competes well with weeds, especially when production techniques result in an initial uniform stand and when loss of stand due to winter injury is minimal. Effective weed control and prevention of weed seed production in prior crops will reduce the risk of weed problems in wheat. Wheat should be planted into a weedfree seedbed accomplished with tillage or burndown herbicides. Gramoxone, glyphosate, and Sharpen are labeled for burndown application in wheat anytime prior to wheat emergence. Sharpen can control emerged marestail and provide residual control following planting, but should be mixed with glyphosate or Garmoxone for control of most other emerged weeds. Some wheat fields can benefit greatly from herbicide application in late fall or spring, and failure to scout fields and take the appropriate measure can result in yield loss and harvesting problems in these fields. The weeds that appear above the wheat canopy late in the season, such as ragweeds and Canada thistle, can often be easily controlled with a spring herbicide treatment. The most common weed problems in wheat include:

- winter annual weeds, such as common chickweed, purple deadnettle, shepherd's-purse, and field pennycress. These weeds become established in the fall along with the wheat, and can interfere with the early development of wheat in spring. Dense populations of winter annual weeds should be controlled in late fall or early spring to minimize interference with wheat growth. Many of these weeds have emerged by the time of no-till wheat planting, and can be controlled with glyphosate before wheat emerges.
- wild garlic, due to the contamination of harvested grain with its bulblets. Several herbicides are effective if applied in the spring after garlic has several inches of new growth.
- Canada thistle, which can greatly suppress wheat growth due to its tendency to occur in dense patches. many wheat herbicides have some activity on thistle, and can suppress it adequately through harvest if not applied too early in spring.
- dandelion, which can interfere with wheat establishment in the fall and wheat growth in the spring. Emerged dandelion should be controlled prior to wheat planting with tillage or glyphosate.
- summer annual broadleaf weeds, such as common and giant ragweed, which can begin to emerge in late March. A healthy wheat crop can adequately suppress these weeds but herbicide application is occasionally warranted.
- It is essential to apply herbicides at the correct stage of wheat growth to avoid crop injury. When wheat has not yet reached the jointing stage, any herbicide labeled can be safely applied. As wheat growth stage advances past jointing and approaches the boot stage, herbicide choices become much more limited. Most herbicides can be applied in UAN when the wheat is top-dressed. This may increase crop injury somewhat, and some labels recommend adjusting surfactant rates to minimize injury.

Table 19. Weed Response to Postemergence Herbicides in Small Grains

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may vary due to weather and soil conditions, or other variables. See pages 22-23 for more information on herbicide site of action and a description of site of action groups.

Weed control rating:

9 = 90% to 100%; 8 = 80% to 90%; 7 = 70% to 80%; 6 = 60% to70%; - = less than 60% control.

		Winter annual													Summer annual						Perennial	
	Site of action	Bluegrass, annual	Cheat	Brome, downy	Ryegrass, annual	Chickweed, common	Deadnettle, purple	Henbit	Lettuce, wild or prickly	Marestail	Marestail (group 2-R)	Mustard species	Pennycress, field	Shepherdspurse	Buckwheat, wild	Lambsquarters, common	Pigweed	Ragweed, common	Ragweed, giant	Smartweed, ladysthumb	Garlic, wild	Thistle, Canada
Aim	14	-	-	-	-	-	6	6	6	-	-	6	7	6	6	7	8	6	-	-	-	-
Anthem Flex	14/15	8	6	6	8	-	6	6	6	-	-	6	7	6	-	-	-	-	-	-	-	-
Axial Star	1/4	-	-	-	9	-	-	-	6	-	-	7	-	-	6	-	-	8	8	6	-	-
Axial TBC	1/2	-	-	-	9	9	-	-	6	-	-	9	6	9	6	-	6	-	-	-	-	-
Axial XL	1	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Axiom	5/15	-	-	7	8	7	7	7	-	-	-	8	8	8	-	-	-	-	-	-	-	-
Bromoxynil	6	-	-	-	-	6	-	8	6	6	6	9	8	8	9	9	7	9	8	9	-	6
Cleansweep D or M	4/6	-	-	-	-	6	6	8	7	8	8	9	9	9	9	9	9	9	9	9	-	8
Curtail	4	-	-	-	-	-	-	-	9	8	8	9	9	9	9	9	9	9	9	8	-	9
Dicamba	4	-	-	-	-	6	-	6	8	8	8	6	6	8	9	9	9	9	9	9	-	6
Finesse/Report Extra	4	9	-	-	-	9	9	9	8	8	-	9	9	9	8	9	9	8	-	7	6	7
Huskie	6/27	-	-	-	-	8	9	9	9	9	9	9	9	9	8+	9	9	9	9	8+	-	6
Maverick	2	-	8	8	-	-	7	7	8	7	-	8	8	8	-	6	8	-	-	-	7	-
MCPA	4	-	-	-	-	-	-	-	9	8	8	9	9	9	8	9	9	9	9	7	-	-
Olympus	2	-	9	8	-	9	9	9	-	8	-	9	8	9	6	-	6	-	-	-	-	-
Orion	2/4	-	-	-	-	9	-	-	9	-	-	9	9	9	8	9	9	9	8	9	-	6
Peak	2	-	-	-	-	7	7	7	8	-	-	9	9	8	8	7	9	9	7	7	8	6
PowerFlex	2	-	9	8	9	9	7	7	6	6	-	9	9	8	7	8	9	-	-	7	-	-
Pulsar + MCPA	4	-	-	-	-	8	8	8	9	8	8	9	9	9	9	9	9	9	9	8	-	-
Starane	4	-	-	-	-	-	-	-	6	-	-	7	-	-	7	-	-	9	9	7	-	-
Stinger	4	-	-	-	-	-	-	-	8	9	9	-	-	-	9	-	-	9	9	8	-	9
Tribenuron	2	-	-	-	-	9	9	9	9	-	-	9	9	8	8	9	9	-	-	8	6	8
Tribenuron + thifensulfuron	2	-	-	-	-	9	8	9	8	7	-	9	9	9	8	9	9	-	-	9	9	7
WideMatch	4	-	-	-	-	-	-	-	8	9	9	7	-	-	9	-	-	9	9	7	-	8
2,4-D	4	-	-	-	-	-	-	-	9	8	8	9	9	9	-	9	9	9	9	6	7	7

Small Grains: Wheat Only

Herbicide	Formulation	Product Rate Range
Anthem Flex	**4 SE**	**2 - 4.5 oz**

- Anthem Flex is a premix of pyroxasulfone (Zidua) and carfentrazone (Aim) that controls annual ryegrass, foxtails, and barnyardgrass, and a few broadleaf weeds in wheat. Provides only residual control of grasses.
- Site of action: group 15 - pyroxasulfone; group 14 - carfentrazone (see pages 22-23).
- Apply delayed preemergence (80% of germinated wheat seeds with at least 1/2 inch shoot through wheat spiking) or early postemergence (spiking up to 4th tiller growth stage). See label for rates based on timing and soil type.
- Wheat seed should be planted between 1 and 1.5 inches deep. Avoid preeemergence application if 0.25 inches of rain or more is expected within 48 hours of application. Do not incorporate.
- Do not apply preplant or preemergence to broadcast seeded wheat.

Herbicide	Formulation	Product Rate Range
Axial Star	**1.15L**	**16.4 oz**

- Axial Star is a premix of pinoxaden (Axial) and fluroxypyr (Starane) that controls annual ryegrass, foxtails, and barnyardgrass, and a few broadleaf weeds in wheat. Mix with other broadleaf herbicides to expand the spectrum of broadleaf weed control.
- Site of action: group 1 - pinoxaden); group 4 - fluroxypyr (see pages 22-23).
- Apply when wheat is in the 2-leaf to pre-boot stage, and when grass weeds have 1 to 5 leaves and less than 3 tillers.
- Do not plant soybeans and other crops within 4 months after application.
- Can be mixed with most other broadleaf herbicides used in wheat. See label for more information.

Herbicide	Formulation	Product Rate Range
Axial XL	**0.42L**	**16.4 oz**

- Axial XL (pinoxaden) controls annual ryegrass, foxtails, and barnyardgrass in wheat.
- Site of action: group 1 (see pages 22-23).
- Apply when wheat is in the 2-leaf to pre-boot stage, and when grass weeds have 1 to 5 leaves and less than 3 tillers.
- Do not plant soybeans and most other crops for 120 days after application.
- Can be mixed with most other broadleaf herbicides used in wheat. See label for more information.

Herbicide	Formulation	Product Rate Range
Axial TBC	**0.84L**	**8.85 oz**

- Axial TBC is a premix of florasulam and pinoxaden that controls annual ryegrass, foxtails, barnyardgrass, and some broadleaf weeds in wheat and barley. The label specifies the addition of MCPA or other herbicide to improve broadleaf weed control.
- Site of action: group 1 (pinoxaden); group 2 (florasulam). See pages 22-23.
- Apply when wheat is in the 3-leaf to boot stage, and when grass weeds have 1 to 5 leaves and less than 3 tillers.
- Apply with Adigor Adjuvant at the rate of 9.6 oz/A. Can be applied in a spray solution containing up to 50% UAN or other nitrogen fertilizer.
- Allow 9 months between application and soybean planting.

Herbicide	Formulation	Product Rate Range
Axiom	**68DF**	**4 - 10 oz**

- Axiom is a premix of metribuzin and flufenacet that can be applied early postemergence in wheat to control small winter annual grass and broadleaf weeds. Axiom provides limited residual weed control also.
- Site of action: group 5/15 (see pages 22-23).

Small Grains: Wheat Only

- Apply in the fall from spike to 3-leaf stage of wheat, and prior to the 1-leaf stage of weeds. For best results, use tillage or burndown herbicides to ensure that wheat is weedfree at the time of planting.
- Some wheat varieties are sensitive to Axiom. Check the label and with seed supplier for information on tolerance prior to using.

Herbicide	Formulation	Product Rate Range
Curtail	**2.38L**	**1 - 2 2/3 pts**

- Curtail is a premix of clopyralid (Stinger) plus 2,4-D amine that controls many annual weeds in wheat, including ragweeds, lambsquarters, mustard species, field pennycress, and shepherd's-purse.
- Curtail controls Canada thistle, but will be less effective than Stinger for long-term thistle control. For best thistle control, apply after the majority of the weed's basal leaves have emerged from the soil, but before bud stage. Other perennials controlled or suppressed include sowthistle, dandelion, and curly dock.
- Site of action: group 4 (see pages 22-23).
- Apply in the spring to actively growing wheat after 4 leaves have unfolded on the main stem. Maximum rates based on wheat growth stage and weed size are as follows: 2 2/3 pints - before jointing, weeds up to 12 inches tall; 1.5 pints - before boot stage, weeds up to 10 inches tall; and 1 pint - before boot stage, weeds less than 6 inches tall.
- Apply in a spray volume of at least 10 gpa and increase volume where the weed/crop canopy is dense.
- Curtail can be applied in UAN.
- Allow 6 to 8 hours between application and rainfall.
- Do not apply Curtail where double-crop soybeans will be planted after wheat harvest or a legume will be seeded into standing wheat.
- Do not harvest hay from treated fields.
- Crop rotation restrictions: grasses - 30 days after application; alfalfa, soybeans - 10 1/2 months; clovers - 18 months.

Herbicide	Formulation	Product Rate Range
Dicamba + 2,4-D premix	**3.87L**	**0.5 - 1 pt**

- This product is available from various manufacturers, and product names and rates vary. Controls broadleaf weeds in wheat.
- Site of action: group 4 (see pages 22-23).
- Apply 0.5 to 1 pint per acre in the spring after tillering and prior to the joint stage.
- Rates up to 1 1/3 pints per acre can be applied in the fall after wheat begins to tiller for suppression of perennial weeds such as dandelion. Apply following a frost but before a killing freeze. Periods of extended stress such as cold and wet weather may increase the risk of crop injury. Do not apply in the fall unless the user is willing to accept the risk of of crop injury.
- Apply in a spray volume of at least 5 gpa, and increase spray volume in dense or tall vegetation.

Herbicide	Formulation	Product Rate Range
Maverick	**75DF**	**2/3 oz**

- Maverick (sulfosulfuron) can be applied in the fall or spring, from preemergence up to jointing, to suppress or control grass weeds.
- Site of action: group 2 (see pages 22-23).
- Maverick will suppress or control downy bromegrass and cheat, which are winter annual grasses. Most effective application timing is postemergence in the fall when these grasses are in the 2- to 3-leaf stage. This treatment will also suppress quackgrass. Maverick provides residual control of some winter annual broadleaf weeds, but may not adequately control emerged broadleaf weeds.
- Apply with NIS (2 qts/100 gallons).
- The optimum pH of the spray solution is 6.0 to 8.0 when using Maverick.
- Ohio State recommends the use of an STS soybean variety where double-crop soybeans will be planted after

wheat harvest. The label specifies the following with regard to rotation to soybean: (1) STS soybeans can be planted 3 months after application where soil pH is less than 6.5 and at least 30 inches of rain has occurred between application and soybean planting; (2) non-STS soybeans can be planted 5 months after application where soil pH is less than 6.5 and at least 30 inches of rain has occurred; and (3) non-STS soybeans can be planted 12 months after application where soil pH is less than 7.5 and at least 24 inches of rain has occurred.

- Any crop other than soybeans or wheat should be planted no sooner than 3 months after Maverick application and only after the completion of a successful field bioassay.

Herbicide	Formulation	Product Rate Range
Metribuzin	**75DF**	**0.75 - 2 oz**

- Metribuzin (Dimetric, Tricor) can be applied in the fall to emerged wheat to help control winter annual weeds.
- Site of action: group 5 (see pages 22-23).
- Wheat should be in the 2-leaf to 2-tiller stage and actively growing at the time of application. Rate varies with soil type.
- Wheat varieties vary in their tolerance to metribuzin. Consult the label for a list of varieties that are approved for use with metribuzin.
- Can be applied with other herbicides labeled for fall application, including Harmony Extra. Consult labels for all precautions before application of any herbicide combination.
- Do not apply with fertilizer solution.
- Crop injury may occur if metribuzin is applied: 1) when the crop is under stress from frost damage, drought, or excessive moisture; 2) to soils with pH greater than 7.7, or 3) to fields where wheat is planted less than 1 inch deep.

Herbicide	Formulation	Product Rate Range
Olympus	**70WDG**	**0.6 - 0.9 oz**

- Olympus (propoxycarbazone-sodium) controls downy brome, cheat, and mustard species. Olympus should be mixed with other herbicide(s) to control a broader spectrum of broadleaf weeds.
- Site of action: group 2 (see pages 22-23).
- Can be applied from preemergence in the fall through the spring before jointing.
- Apply with NIS (0.25 to 0.5% v/v). When applied using UAN as the carrier, the NIS rate is 0.25% v/v. Temporary crop injury, including reduced growth, discoloration, and leaf burn, may occur when fertilizer is the carrier. Do not use adjuvants that result in a spray solution pH of less than 5.
- Can be mixed with Huskie, Axiom, Harmony GT, Harmony Extra, dicamba, or bromoxynil.
- Do not plant crops other than wheat within 4 months after application. Conduct field bioassay before rotating to any other crop - see label for guidelines.

Herbicide	Formulation	Product Rate Range
PowerFlex	**7.5DF**	**3.5 oz**

- PowerFlex (pyroxsulam) controls downy brome, cheat, and Italian ryegrass, and some winter annual broadleaf weeds.
- Site of action: group 2 (see pages 22-23).
- Apply in the fall or spring, when wheat is in the 3-leaf to jointing stage. Most effective control results from treatment of winter annual grasses in the fall at the 2-leaf to 2-tiller stage of growth, and when broadleaf weeds are no more than 2 inches tall or in diameter.
- Apply with NIS (0.25% to 0.50% v/v) or COC (1 to 1.25% v/v). When using NIS, UAN (1-2 qt/A) or AMS (3 lbs/acre) may be added to enhance control. Potential for crop injury is increased with the use COC. Do not use additives that lower the spray solution below a pH of 6.0.
- PowerFlex may be applied in spray solutions containing nitrogen fertilizer solution (UAN). The spray solution should not consist of more than 50% UAN and should not exceed 30 pounds of actual nitrogen per acre. When PowerFlex

is applied in spray solutions containing UAN, use NIS at a maximum of 0.25% v/v, instead of COC or MSO. Temporary crop injury may result when liquid nitrogen is used as the spray carrier.

- A separate application of nitrogen fertilizer solution made 7 days before or after a PowerFlex application may result in transient leaf burn or stunting. Do not make a liquid fertilizer application during this period unless the risk of crop response is acceptable.
- Grass control can be reduced if PowerFlex is mixed with dicamba or amine formulations of 2,4-D or MCPA.
- Allow 3 months between application and soybean planting. Where Powerflex is applied in fall or anytime prior to February, do not plant soybeans until after April 30.

Herbicide	Formulation	Product Rate Range
Pulsar	**1.67L**	**8.3 - 12.5 oz**

- Pulsar is a premix of fluroxypyr (Starane) and dicamba for control of broadleaf weeds in wheat and barley. Pulsar applied alone has a fairly narrow spectrum of control, and should generally be mixed with MCPA ester or another broadleaf herbicide.
- Site of action: group 4 (see pages 22-23).
- Apply before the jointing stage of wheat (label does not specify whether fall application is allowed).
- Pulsar can be applied with NIS (0.125% to 0.25% v/v) to improve control under less than optimum environmental conditions. Can be applied in a spray solution containing up to 50% nitrogen fertilizer solution.
- Allow 9 months between application and soybean planting.

Herbicide	Formulation	Product Rate Range
Tribenuron methyl (active ingredient)		
Express TotalSol	**50DF**	**0.25 - 0.5 oz**
Nuance, Victory	**75WDG**	**1/6 - 1/3 oz**

- Tribenuron methyl controls annual broadleaf weeds, including common chickweed, lambsquarters, and field pennycress, and provides partial control of Canada thistle, dandelion, shepherdspurse, and other mustard species.
- Site of action: group 2 (see pages 22-23).
- Can be mixed with bromoxynil, 2,4-D or MCPA for improved control of Canada thistle, ragweeds, dandelion, and other broadleaf weeds. Ester formulations have provided better results than amines.
- Apply after wheat is in the 2-leaf stage but before the flag leaf is visible. Apply when annual weeds are less than 4 inches tall or wide (rosettes). Allow 45 days between application and harvest.
- To reduce the risk of crop injury, mix tribenuron with 2,4-D and apply after crop has reached the tillering stage of growth.
- To control or suppress Canada thistle, apply the higher rate to actively growing thistle plants that are 4 to 8 inches tall with 2 to 6 inches of new growth.
- When applying in water, add 0.06 to 0.50% v/v NIS (1/2 to 4 pints per 100 gallons of water). When applying in liquid fertilizer, add 0.06 to 0.25% NIS. Temporary crop yellowing and stunting may occur when applied in liquid fertilizer. This injury is occasionally severe, and risk of severe injury may increase under saturated soil conditions.
- For flat-fan nozzles, apply in a spray volume of at least 5 gallons per acre. For flood nozzles on spacings of 30, 40, or 60 inches, maintain minimum spray volumes of 10, 13, or 20 gallons per acre, respectively.
- Forage legumes, grasses, and soybeans may be planted 45 days after application.
- Allow at least 7 days between application and grazing of treated forage. In addition, allow at least 7 days between application and feeding of forage (green chop) from treated areas to livestock. Allow at least 30 days between application and feeding of hay from treated areas to livestock. Allow at least 45 days between application and harvesting of grain. Harvested straw may be used for bedding and/or feed.

Small Grains: Oats and Wheat

Herbicide	Formulation	Product Rate Range
2,4-D Amine	**Various**	**0.25 - 1 lb ai/A**
2,4-D Ester		
2,4-D acid	**1.74L**	**1 - 3.25 pts**
MCPA Amine	**4 lb/gal**	**1/2 - 2 pt**
MCPA Ester		**1/2 - 1½ pt**

- Site of action: group 4 (see pages 22-23).
- Apply in the spring after full tiller. Labels vary with regard to the wheat stage when 2,4-D should no longer be applied. Weedar and Weedone labels specify application before wheat is forming joints in the stem. Labels of some other 2,4-D products allow application after jointing but before early boot. The risk of injury and yield loss increases when applied after jointing. Amine formulations are less likely to injure the crop than ester formulations, and use of fertilizer solution as the spray carrier may increase the risk of injury. To minimize the risk of injury after jointing, use water as the carrier and do not apply more than 0.25 lb ai/A of ester or 0.5 lb ai/A of amine.
- Application prior to wheat emergence can cause crop injury and stand loss.
- MCPA is less likely than 2,4-D to injure oats. Do not apply 2,4-D ester to oats.
- 2,4-D and MCPA are translocated herbicides that control many winter and summer annual weeds, but are weak on chickweed, henbit, and purple deadnettle. Expect some suppression of early-emerging perennial broadleaf weeds.
- 2,4-D may provide some suppression of wild garlic, especially the ester formulation. Apply 0.75 lb ai/A of 2,4-D ester when wild garlic plants are small.
- In wheat, 2,4-D or MCPA may be applied with 1/4 pint of dicamba (4 lb/gallon formulations) for improved control of some weeds.
- To control problem weeds at harvest, apply 0.5 to 1.0 lb ai/A per acre of 2,4-D during the hard dough stage.
- Do not forage or graze within 7 days (MCPA) or 2 weeks (2,4-D) of treatment. Do not feed treated straw to livestock when 2,4-D is applied as a preharvest treatment.

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**0.5 - 2 oz**

- Aim (carfentrazone-ethyl) is a contact herbicide that controls a limited number of small summer and winter annual weeds. Aim is not effective on biennial or perennial weeds.
- Site of action: group 14 (see pages 22-23).
- Apply Aim in the fall or spring before jointing when weeds are less than 4 inches tall and rosettes are less than 3 inches across.
- Apply with NIS (0.25% v/v). UAN (2 to 4 gallons/100 gallons) or AMS (2 to 4 lbs/A) can be added if recommended for use with other herbicides in a mix with Aim.
- Apply Aim in a spray volume of 10 to 20 gpa with a pressure of 20 to 40 psi. Flat fan nozzles are recommended for adequate spray coverage.
- Add Aim to the spray tank before adding other products.

Herbicide	Formulation	Product Rate Range
Bromoxynil	**2S**	**1 - 2 pt**

- Bromoxynil is a contact herbicide that controls annual broadleaf weeds. Product names include Buctril, Moxy, Broclean, and Bronate among others.
- Site of action: group 6 (see pages 22-23).
- In fall-seeded small grains, apply in the fall or spring, but before the boot stage.
- In spring-seeded oats, apply from emergence up to the boot stage.
- For best results, apply before weeds are in the 4-leaf stage or are 2 inches tall, or before rosettes exceed 1 inch in diameter.
- Very safe on small grains, but slight leaf burn may occur occasionally.

Small Grains: Oats and Wheat

- May be applied with dicamba, 2,4-D, MCPA, Express, or Harmony Extra. Maximum growth stage at the time of application and spray additive recommendations vary with the other herbicide in the mixture. Follow label directions to avoid injury to the crop.
- UAN may be used as the spray carrier early in the spring, but this will increase leaf burn. Do not use fertilizer as the carrier after jointing.
- Do not graze treated fields for 30 days after application.

Herbicide	Formulation	Product Rate Range
Callisto	**4L**	**6 oz (preemergence)** **3 oz (postemergence)**

- Callisto (mesotrione) can be applied preemergence or postemergence in oats for control of broadleaf weeds. Do not apply to wheat or other small grains.
- Site of action: group 27 (see pages 22-23).
- Apply when weeds are less than 5 inches tall.
- Control of emerged weeds requires the addition of COC (1% v/v) or NIS (0.25% v/v). UAN (2.5% v/v) or AMS (8.5 lbs/100 gallons) may be added, but increases the risk of injury.
- Postemergence applications may cause temporary crop injury, including leaf bleaching and burn, and stunting if injury is extreme.

Herbicide	Formulation	Product Rate Range
Cleansweep D	**4.25L**	**1 - 1.5 pts**
Cleansweep M	**4L**	**1 - 1.5 pts**

- These products are mixtures of bromoxynil, fluroxypyr, and either 2,4-D (Cleansweep D) or MCPA (CleansweepM) for control of annual broadleaf weeds in wheat, oats, and barley. Supression of some perennial broadleaf weeds is also possible.
- Site of action: group 6 (bromxynil), group 4 (fluroxypyr, 2,4-D, MCPA. See pages 22-23.
- Cleansweep D: apply from the fully-tillered stage of growth until (but not including) the jointing stage.
- Cleansweep M: apply from the 2-leaf crop stage up to and including flag leaf emergence.
- Weed control is maximized by application when air temperatures are between 55 and 75 degrees, and reduced activity can occur below 45 or above 85 degrees. Weed control and crop tolerance may be reduced if frost occurs within 3 days before or after application.
- Allow 1 hour between application and rainfall.
- Labels for these products do not indicate whether product can be applied in the fall or applied using 28% UAN as the spray carrier. An adjuvant can be added, but labels do not otherwise specify rate or type of adjuvant.
- Allow 4 months between application and planting soybeans or crops other than small grains.

Herbicide	Formulation	Product Rate Range
Dicamba	**4L**	**2 - 4 oz**

- Dicamba is sold under various trade names, including Banvel, Oracle, and Sterling Blue. Dicamba is a translocated herbicide that controls annual and winter annual broadleaf weeds, and helps suppress perennial broadleaf weeds.
- Site of action: group 4 (see pages 22-23).
- Can be applied in the fall or spring after emergence of fall-seeded wheat, but before jointing. Application prior to wheat emergence can cause crop injury and stand loss. Can be applied prior to planting, but allow 10 days between application and planting for each 0.25 lb active ingredient dicamba applied.
- In spring oats, apply a maximum of 0.12 lb ai/A before oats exceed the 5-leaf stage.
- For best results, apply when weeds are small and actively growing.
- Dicamba is more effective on Canada thistle and smartweed than 2,4-D or MCPA. For better control of some weeds, Banvel may be mixed with up to 2 pints of 2,4-D amine or 1½ pints of 2,4-D ester.
- Do not graze or harvest for dairy feed before ensilage (milk) stage.

Small Grains: Oats and Wheat

Herbicide	Formulation	Product Rate Range
Finesse/Report Extra	**75WDG**	**0.2 - 0.5 oz**

- Finesse/Report Extra is a premix of chlorsulfuron and metsulfuron methyl that can be applied preplant, preemergence or postemergence for control or suppression of downy brome, cheat, and annual ryegrass. Postemergence applications control or suppress these same grasses and also annual annual bluegrass, along with a number of winter annual broadleaf weeds.
- Postemergence applications should be made in the fall for most effective control of grasses, and to avoid crop rotation problems. Apply after the majority of the weeds have emerged, when the crop is in at least the 1-leaf stage.
- Chlorsulfuron is a long-residual sulfonylurea herbicide. Consider rotation guidelines prior to using this product. STS soybeans can be planted 6 months after application. Field corn and non-STS soybeans can be planted 18 months after application.
- Apply with flat fan (at least 3 gpa) or low-volume flood nozzles (at least 10 gpa) for optimum distribution and coverage. Include a NIS (0.125 to 0.5% v/v).
- Can be applied using UAN as the spray carrier, and the rate of UAN determines the rate of surfactant. Consult the label for more information.
- The field can be grazed anytime after herbicide application.

Herbicide	Formulation	Product Rate Range
Huskie	**2.47L**	**13.5 - 15 oz**

- Huskie (bromoxynil plus pyrasulfotole) controls winter and summer annual broadleaf weeds in wheat, oats, barley, rye, and triticale.
- Site of action: group 6 (bromoxynil); group 27 (pyrasulfotole). See pages 22-23.
- Apply in fall or spring after the crop reaches the 1-leaf stage, and up to flag leaf emergence. Weeds should be no larger than the 4- to 6-leaf stage, or 4 inches in diameter, depending upon species.
- Apply with NIS (0.125% v/v) plus AMS (0.5 to 1 lb/A) or UAN (1 to 2 qts/A) for most consistently effective weed control. Can be applied using nitrogen fertilizer solution as the spray carrier. The fertilizer solution should not exceed 50% nitrogen, and the nitrogen rate should not exceed 30 lbs/A.
- Add the lowest rate of thifensulfuron for control of wild garlic in the spring.
- Should generally be applied in a spray volume of at least 10 gpa, but this can be reduced to as low as 5 gpa when conditions are ideal for weed control (small weeds, favorable environment). Use nozzles and spray pressure that result in medium spray droplets. Do not apply with floodjet or cone nozzles.
- Allow 1 hour between application and rainfall.
- Do not graze or harvest forage within 25 days after application. Grain and straw can be harvested 60 days after application.
- Allow 4 months between application and planting soybeans.

Herbicide	Formulation	Product Rate Range
Orion	**2.37L**	**17 oz**

- Orion (MCPA plus florasulam) controls annual broadleaf weeds in wheat, oats, rye, and triticale. Weeds controlled include chickweed, mustard species, common ragweed, and lambsquarters.
- Site of action: group 2 (florasulam); group 4 (MCPA). See pages 22-23.
- Apply early postemergence when the crop is in the 3-leaf to joint stage. Weeds will be most effectively controlled when in the seedling stage and actively growing.
- This product does not require use of an adjuvant. Apply in a spray volume of at least 10 gpa. Increasing the spray volume may improve control where the crop and weed canopy is dense.
- Allow 4 hours between application and rainfall.
- Do not graze for 7 days after application. Apply at least 60 days before harvest.
- Crop rotation restrictions: grasses - 0.5 months; corn - 3 months; alfalfa, soybeans - 9 months; clovers - 12 months.

Small Grains: Oats and Wheat

Herbicide	Formulation	Product Rate Range
Peak	**57DF**	**1/2 oz (1 packet per 6 acres)**

- Peak (prosulfuron) controls annual broadleaf weeds in wheat, oats, rye, and some other small grains. Weeds controlled include chickweed, wild garlic, mustard species, and common ragweed (except group 2-resistant biotypes). Peak will suppress Canada thistle.
- Site of action: group 2 (see pages 22-23).
- May be mixed with 2,4-D, dicamba, Buctril, or MCPA to improve control of Canada thistle, giant ragweed, lambsquarters and other broadleaf weeds. Follow restrictions on all labels with regard to growth stage and adjuvants in mixtures.
- Apply in fall or spring after crop emergence and before the second node is detectable in stem elongation (Feeke's Growth Stage 7). Weeds should be 1 to 3 inches tall and actively growing for best results.
- COC (1 to 4 pints/A) is the preferred adjuvant when Peak is applied alone using water as the carrier. Apply with NIS (1 to 2 quarts per 100 gallons of spray) if fluid fertilizer is used as the spray carrier, or if mixing with any other herbicide.
- Apply in a spray volume of at least 10 gpa. Increasing the spray volume may improve control where the crop and weed canopy is dense.
- Do not apply when the crop is under stress due to drought, cold weather, or other factors, or if cold, wet conditions are expected within one week after application.
- Allow 4 hours between application and rainfall.
- Do not graze or feed treated crops to livestock until 30 days after application.
- Crop rotation restrictions: soybeans - 10 months; forage grasses, alfalfa, clovers - 22 months.

Herbicide	Formulation	Product Rate Range
Sharpen	**2.85SC**	**1 to 2 oz/A**

- Sharpen (saflufenacil) can be applied preplant or preemergence to wheat, oats, or barley. Sharpen controls mareatail, and mixtures with glyphosate can provide more effective control of emerged weeds in no-till, compared with glyphosate alone. Sharpen provides residual control of marestail and other broadleaf weeds at rates of 1.5 to 2 oz.

Herbicide	Formulation	Product Rate Range
Starane	**1.5L**	**1/2 - 2/3 pt**

- Starane (fluroxypyr) controls hemp dogbane, common ragweed and a few other broadleaf weeds. Due to a relatively narrow spectrum of activity, Starane should generally be mixed with other herbicides to improve control of specific weeds.
- Site of action: group 4 (see pages 22-23).
- Apply from the 2-leaf growth stage of wheat or oats up to and including flag leaf emergence, and when weeds are less than 4 (1/2 pt/A) to 8 (2/3 pt/A) inches tall.
- Do not plant soybeans within 4 months following Starane application.

Herbicide	Formulation	Product Rate Range
Stinger	**3L**	**1/4 - 1/3 pt**

- Stinger (clopyralid) controls ragweeds, wild buckwheat, and Canada thistle, and suppresses sowthistle and dandelion.
- Site of action: group 4 (see pages 22-23).
- Apply from the 3-leaf stage up to early-boot stage of oat or wheat growth. Annual broadleaf weeds should have no more than 5 leaves at the time of application.
- For Canada thistle control, apply 1/3 pint when thistle plants are in the rosette (at least 4 inches tall or across) to prebud stage.
- Can be mixed with most other wheat herbicides for improved control of broadleaf weeds. See label for more information.

Small Grains: Oats and Wheat

- Do not harvest hay from treated fields.
- Crop rotation restrictions: grasses - anytime; alfalfa, soybeans - 10 1/2 months after application; clovers - 18 months.

Herbicide	Formulation	Product Rate Range
Thifensulfuron + tribenuron methyl (active ingredients)		
Harmony Extra TotalSol	**50DF**	**Wheat 0.45 - 0.9 oz**
		Oats 0.45 - 0.6 oz
Nimble, Treaty Extra	**75WDG**	**Wheat 0.3 - 0.6 oz**
		Oats 0.3 - 0.4 oz
Rapport BroadSpec	**75DF**	**Wheat 0.4 - 1 oz**
Rapport Tank Mix	**75DF**	**Wheat 0.6 - 1 oz**

- Controls wild garlic and annual broadleaf weeds, including common lambsquarters, mustard species, Pennsylvania smartweed, field pennycress, shepherd's purse, common chickweed, purple deadnettle, and henbit.
- Site of action: group 2 (see pages 22-23).
- Does not control ragweeds. Can be mixed with bromoxynil, 2,4-D or MCPA for improved control of Canada thistle, ragweeds, and some other weeds. Ester formulations have provided better results than amines. Mixing with dicamba may result in reduced control of some broadleaf weeds.
- Apply in fall or spring after wheat is in the 2-leaf stage, but before the flag leaf is visible. Annual broadleaf weeds should be past the cotyledon stage, actively growing, and less than 4 inches tall or across at the time of application.
- Apply when spring oats are in at least the 3-leaf stage, and before jointing. Do not apply to oats more than once per season. Do not use on Ogle, Premier, or Porter varieties. Rapport products are not labeled for use on oats.
- To control wild garlic, apply higher rates when garlic plants are less than 12 inches tall with 2 to 4 inches of new growth. Control will be better if applied during warm weather (60 F or more) to actively growing garlic plants.
- To suppress Canada thistle, apply higher rates when all thistles have emerged, are actively growing, and are 4 to 8 inches tall with 2 to 6 inches of new growth. Application with 2,4-D will improve thistle control.
- The following adjuvant recommednations pertain to all products listed except Rapport BroadSpec and Tank Mix - see Rapport product labels for adjuvant recommendations. If water is the spray carrier, apply with 0.25 to 0.5% v/v NIS (1 to 2 quarts per 100 gallons). If the spray solution contains consists of no more than 50% UAN (and the other 50% is water), apply with 0.06 to 0.25% v/v surfactant (1/2 to 2 pints per 100 gallons). If the spray solution consists of more than 50% nitrogen fertilizer, consult dealer or Dupont representative before adding an adjuvant. Temporary crop injury may occur when applied with surfactant, when fertilizer is used as the spray carrier. This injury is occasionally severe, and risk of severe injury may increase under saturated soil conditions.
- May be applied with flat fan or low-volume flood nozzles. Minimum spray volume is dependent upon nozzle type and size. See label for additional information.
- Most other crops can be planted 45 days after application (60 days for Rapport BroadSpec).
- Allow at least 7 days between application and grazing of treated forage. In addition, allow at least 7 days between application and feeding of forage (green chop) from treated areas to livestock. Allow at least 30 days between application and feeding of hay from treated areas to livestock. Allow at least 45 days between application and harvesting of grain. Harvested straw may be used for bedding and/or feed.

Herbicide	Formulation	Product Rate Range
WideMatch	**1.5L**	**1.0 - 1.3 pts**

- WideMatch is a premix of clopyralid (Stinger) plus fluroxypyr (Starane) for control of broadleaf weeds, including hemp dogbane, ragweeds, Canada thistle, marestail, and cocklebur. WideMatch should be mixed with other wheat herbicide(s) for control of most winter annual weeds.
- Site of action: group 4 (see pages 22-23).
- Apply from the 3-leaf growth stage of wheat or oats up to and including flag leaf emergence, and before weeds are 4 inches tall.
- For most effective Canada thistle control, apply after the majority of the basal leaves have emerged and before bud stage.

Oats and Wheat — Underseeded With Legumes

Herbicide	Formulation	Product Rate Range
2,4-D Amine	**4 lb/gal**	**1/4 - 1/2 pt**
MCPA Amine	**4 lb/gal**	**1/2 pt**

- Site of action: group 4 (see pages 22-23).
- Use low pressure (30 psi or less), and apply before jointing, but after the small grain and weeds have formed a canopy over the legumes. Do not apply 2,4-D until the grain is 8 inches tall.
- Controls most annual broadleaf weeds.
- For best results, apply when weeds are small and actively growing.
- MCPA is less likely to injure the legumes than 2,4-D, but both will cause some injury and stand loss. Red and ladino clovers are more tolerant than other legumes. Do not apply MCPA to vetch or sweet clover. Do not apply 2,4-D to sweet clover or alfalfa unless the weed infestation is severe and crop injury can be tolerated.
- To minimize injury, do not use more than 6 gallons of water per acre when applying MCPA amine.
- Do not forage or graze for 7 days (MCPA) or 14 days (2,4-D) after treatment.

Herbicide	Formulation	Product Rate Range
Bromoxynil	**2S**	**1 - 1½ pt**

- Can be applied to wheat, oats, barley, rye, and triticale underseeded with alfalfa only.
- Site of action: group 6 (see pages 22-23).
- Apply to small grains from emergence up to boot stage and when seedling alfalfa has 2 to 4 trifoliate leaves.
- Apply when weeds have less than 4 leaves or are less than 2 inches tall, or before rosettes are 1 inch in diameter.
- Apply in a minimum spray volume of 20 gpa with a minimum pressure of 30 psi.
- Some crop leaf burn can result from application, especially under warm, humid conditions. Do not apply when temperatures will exceed 70 F the day of and for 3 days following application. Do not apply when alfalfa is under stress by moisture, temperature, insect, or disease.
- Do not graze or harvest for 30 days following treatment.

Wheat: Harvest Aid

Herbicide	Formulation	Product Rate Range
2,4-D Amine	**Various**	**1.5 lbs ai/A**
2,4-D Ester		**0.5 - 1.0 lb ai/A**

- Various formulations of 2,4-D can be applied with aerial or ground equipment after wheat has reached the hard dough stage.
- Site of action: group 4 (see pages 22-23).
- The Weedar 64 label advises that crop injury can occur, and spot treatment is recommended to minimize the extent of injury.
- Do not feed wheat straw to livestock if a harvest-aid treatment of 2,4-D has been applied.
- Take precautions to reduce spray drift. Corn, soybeans and other sensitive crops are likely to be growing in areas surrounding treated wheat fields. Amine formulations of 2,4-D have less potential than ester formulations to move off-target through volatilization and injure other plants.

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**1 - 2 oz**

- Aim (carfentrazone) can be applied prior to harvest of mature small grains for dessication of velvetleaf, morning-glory, pigweeds, and other weeds. Apply at least 3 days before harvest.
- Site of action: group 14 (see pages 22-23).
- The total amount of Aim that can be applied to small grains in one season, including postemergence and harvest aid treatments, cannot exceed 2 oz/A.
- Use a spray volume that results in complete coverage of foliage. Apply with NIS (0.25% v/v) or a COC (1 to 2% v/v). UAN or AMS may also be added.

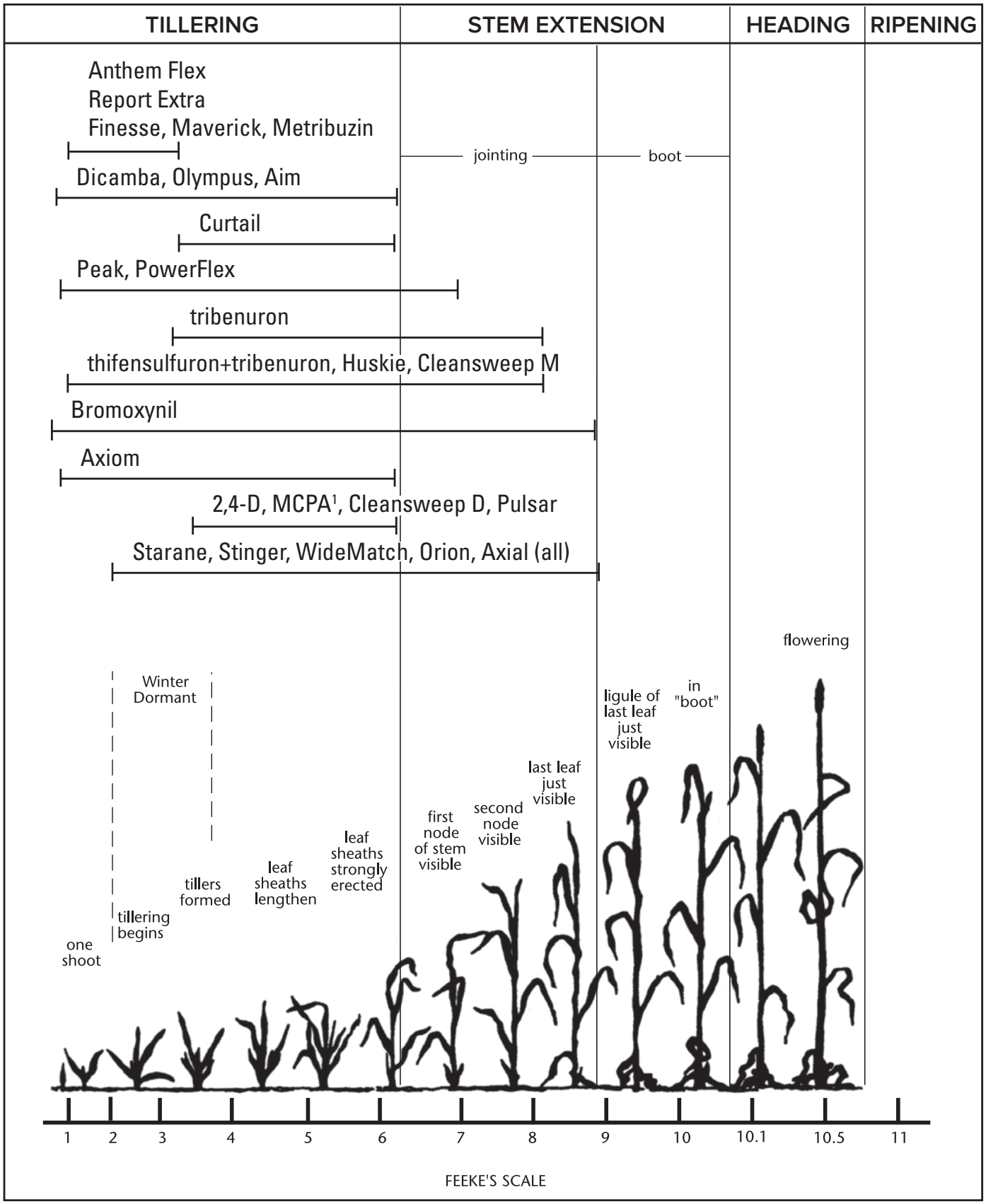
Herbicide	Formulation	Product Rate Range
Dicamba + 2,4-D premix	**3.87L**	**2 pints**

- This product is available from various manufacturers, and product names and rates vary.
- Apply when wheat is in the hard dough stage and the green color has disappeared from the nodes of the wheat stem. Apply at least 7 days before harvest.
- Can be mixed with glyphosate products registered for this use.
- Do not use treated wheat for seed unless a germination test is performed on the seed.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**0.75 lb acid/A**

- Glyphosate can be applied as a preharvest treatment in wheat to control annual and perennial weeds. See labels for specific information on preharvest application.
- Site of action: group 9 (see pages 22-23).
- Apply after the hard dough stage when grain moisture is 30% or less, and at least 7 days prior to harvest.
- Some glyphosate products can be mixed with 2,4-D (0.5 to 1.0 lb ai/A) to broaden the spectrum of control.
- Apply with ground or aerial application equipment using a spray volume of 3 to 10 gpa.
- Wheat grown for seed should not be treated with glyphosate as reduction of germination and vigor may occur.
- Take precautions to reduce spray drift. Corn, soybeans and other sensitive crops are likely to be growing in areas surrounding treated wheat fields.

Figure 1. Wheat Growth Stages and Herbicide Application



[1] Labels of some 2,4-D products allow application after jointing but before early boot. (See text for more information.)

Managing Weeds in Legumes

Managing weeds in forages requires a different approach than weed management in row crops. Over 95% of the weed control in a healthy forage crop comes from the competition provided by the forage. However, to maintain a relatively weed-free forage, proper fertilization, cutting management, insect control, the use of disease-resistant varieties, and selective herbicide use are necessary to keep the forage stand competitive.

If weeds become a problem, they can compete or interfere for light, nutrients, water, and space, directly influencing yield and standability. Common chickweed infestations in alfalfa have been reported to reduce forage stand by more than 30%. Common chickweed emerges in the fall and winter, and spring develops a thick lush mat by early spring that can compete with the first forage cutting. Once the chickweed dies in early summer, summer annual weeds such as foxtails, lambsquarters, and pigweed or perennial weeds such as dandelion can replace the dead or dying winter annual weeds and continue to reduce forage yield and quality.

Unlike most grain or fiber crops from which weeds are separated at harvest, weeds are often harvested along with the forage crop, potentially reducing quality. Reductions in quality are often in the form of lower protein content and feed digestibility. Although weeds do have some feed value, this value differs among species. Dandelions come close to equaling alfalfa in protein and total digestible nutrients (TDN). Control of dandelion may not necessarily improve the quality of hay, but it may be of some value in reducing the time necessary to dry the hay, since dandelion dries more slowly than alfalfa. Increased drying time may mean greater harvest losses due to untimely rainfall. Some weeds are toxic to livestock, while others become toxic under certain environmental conditions. For information regarding plants that are toxic to live stock see the following web sites: http://www.vet.purdue.edu/depts/addl/toxic/cover1.htm or http://www.ansci.cornell.edu/plants/index.html.

Grassy weed quality can be similar to that of the forage. In general, weedy grasses have about 75% of the quality of alfalfa. However, controlling quackgrass in alfalfa can increase forage protein levels 4% to 7%. Weeds with woody stems or flower stalks, such as yellow rocket, white cockle, rough fleabane, curly dock, and broadleaved dock, have lower protein levels (about 50% of the quality of alfalfa), so controlling them is even more important.

When weeds are present or persist in spite of good management, herbicides can help improve yield and quality. Weed control at establishment or in the seedling year is most critical for maintaining a healthy forage stand. When weeds are controlled the seedling year, the forage crop seldom requires additional herbicide treatments for at least the first two years of the stand.

Weed management in forages can be divided into two phases: control in the establishment or seedling year and control in an established stand.

Control before and during establishment

Managing weeds in forages begins long before crop establishment. Certain types of weeds are potentially serious problems for forages, so it is important to eliminate them in advance. In particular, perennial broadleafs and grasses such as dandelion, curly dock, Canada thistle, and quackgrass are much easier to manage prior to planting a forage crop. In addition, biennial weeds such as musk thistle, wild carrot, and burdock should be eliminated before establishing forage. If these weeds are not removed before the seeding is made, they commonly persist throughout the life of the forage. The cost of controlling weeds before or at the time of seeding should be considered an investment that will be returned for the life of the stand.

Below are some general rules for managing weeds at establishment or in the seedling year:

1. Weeds that emerge with the crop are generally more destructive.
2. Maintain the forage relatively weed-free for the first 60 days.
3. Weeds that emerge beyond 60 days will not influence that year's forage yield.
4. Later-emerging weeds may still influence forage quality.
5. Winter annual weed competition in early spring is most damaging to forages.
6. Broadleaved weeds are generally more competitive against legumes than grassy weeds.

Herbicides are needed most often during establishment, and several options exist for managing weeds in pure legume seedings. In no-till seedings, adequately controlling the existing vegetation prior to planting is very important, especially perennials. Weed control is also very important while the forage is young and prone to competition from invading species.

Control in established alfalfa

The best weed control in an established forage stand is achieved by maintaining a dense healthy stand through proper fertilization, cutting management, and insect control. Controlling weeds in established forages is normally of greatest benefit in the first cutting. Weeds generally cause less yield loss in the second and succeeding harvests. Before using a herbicide in established stands, evaluate the forage to ensure it is worth the cost of the herbicide.

Below are some general rules to follow before using a herbicide in established forage stands:

1. Thin or irregular stands will not thicken once weeds are removed. Be sure there are sufficient desirable species to fill in the gaps. Use the following guidelines to evaluate stands.

Stems per square foot	**Effect on Yield**
55	Stem density not limiting yield
40-55	Some yield reduction expected
<40	Significant yield reduction

Year	**Minimum number of plants/square foot**
Fall of seeding year	25-30
2nd	10-15
3rd or older	5-6

2. Weeds tolerant of the herbicide may invade the space left by susceptible species, ultimately creating a more severe weed problem.
3. Only well-established vigorous stands should be treated with herbicides.
4. If the forage stand is at least two years old and 25% to 30% are weeds, removing them with an herbicide application is of questionable value.
5. If 50% or greater of the stand are weeds, it is time to rotate to a different crop.
6. Weed control in established stands is most effective when herbicides are applied in the fall or early spring. Application of metribuzin or Velpar in winter when established alfalfa is dormant is the most effective method of broadleaf weed control.

If weeds become a problem in established forages, several herbicide options are available. Chemical control in established forage legumes is often limited to late fall or early spring applications. Also, many products have harvesting, feeding, or grazing restrictions following their use.

Adapted with modifications from the Penn State Field Crop Pest Management/Agronomy Guide.

Table 20. Weed Response to Herbicides in Alfalfa

This table compares the tolerance of forages to herbicides and the relative effectiveness of herbicides on weeds. Ratings are based on labeled application rate and weed size or growth stage. Performance may vary due to weather and soil conditions or other variables.

Forage crop tolerance rating:

0 = Excellent Tolerance; 1 = Good Tolerance; 2 = Fair Tolerance; 3 or greater = Poor Tolerance; and N = No Information.

Weed control rating:

9 = 90% to 100%; 8 = 80% to 90%; 7 = 70% to 80%; 6 = 60% to70%; - = less than 60% control, not recommended.

	Forage Crop Tolerance			Grasses									Broadleaf Weeds																
	Alfalfa	Red Clover	BFT	Barnyardgrass	Crabgrass	Downy Brome	Fall Panicum	Foxtails	Orchardgrass	Quackgrass	Volunteer Grain	Yellow Nutsedge	Canada Thistle	Chickweed	Dandelion	Dock, Curly	Field Pennycress	Henbit	Lambsquarters	Mustard, Wild	Nightshade	Pigweed	Plantain	Ragweed, Common	Ragweed, Giant	Shepherd's purse	Smartweed	Wild Radish	Yellow Rocket
Balan	1	1	1	9	9	9	9	9	-	-	8	-	-	8	-	-	-	-	9	-	-	9	-	-	-	-	-	-	-
Eptam	1	1	1	9	9	9	9	9	6	8	8	8	-	7	-	-	6	9	9	6	8	9	-	-	-	7	-	-	7
Aim	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	6	7	6	8	8	-	6	-	6	-	-	-
Bromoxynil	2	N	N	-	-	-	-	-	-	-	-	-	6	6	-	-	8	8	9	8	9	8	-	9	8	9	9	-	7
Butyrac	1	1	1	-	-	-	-	-	-	-	-	-	-	6	8	-	9	6	8	9	-	8	-	9	9	9	6	-	8
Chateau	1	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	8	9	9	9	9	9	-	7	-	9	7	-	-
Clethodim	0	0	0	9	8+	9	9	9	6	9	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Extreme[1]	1	N	N	9	9	9	9	9	8	9	8	7	9	9	8														
Glyphosate[1]	6	9	9	9	9	9	9	9	8	9	9	7	9	9	8	8	9	9	9	9	9	9	9	9	9	9	9	8	9
Kerb	1	1	1	8	8	9	6	8	7	8	9	-	-	8	-	-	-	8	6	-	6	6	-	-	-	-	-	-	-
Metribuzin	1	N	N	6	5	9	6	6	-	-	-	-	-	9	7	6	9	9	9	9	-	9	8	8	-	9	9	5	9
Paraquat	1	N	N	8	7	9	9	9	-	-	6	-	-	8	-	-	9	9	8	9	9	9	-	9	9	9	9	8	8
Poast	0	0	0	9	9	9	9	9	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prowl H2O	1	N	N	8	9	7	9	8	-	-	-	-	-	6-	-	-	-	8+	8	-	-	9	-	-	-	6	6	-	-
Pursuit	1	N	N	6	7	-	7	8	-	-	-	-	6	8	-	-	8	8	6	9	9	9	-	6	7	9	9	9	8
Raptor	2	N	N	6	7	-	7	8+	-	-	-	-	6	8	-	-	8	8	8	9	9	9	-	7	8	9	8	9	8
Sinbar	1	N	N	6	7	9	6	7	-	-	-	-	-	9	6	6	9	9	9	9	6	8	7	8	-	9	8	9	7
Velpar/Velossa	1	N	N	7	7	8	6	7	6	-	-	-	-	9	8	6	9	8	9	9	6	9	8	8	-	9	8	7	9

[1]Use in Roundup Ready alfalfa only, unless loss of stand is acceptable where spot treating with glyphosate.

Forage Legumes

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**0.5 - 2.5 oz**

- Aim (carfentrazone) is a contact herbicide that controls or suppresses several small annual broadleaf weeds in established stands of alfalfa, clover, and other legumes. Aim is labeled for use in legume stands that do not contain grasses.
- Apply in winter when legumes are dormant or between cuttings during the growing season. In-season applications should be made as soon as possible after hay removal, and prior to significant regrowth of stems and crowns (up to 6 inches of new growth).
- Apply with NIS (0.25% v/v), or with COC (0.5 - 1% v/v) for increased activity. Weeds should be less than 4 inches tall, and rosettes less than 3 inches across at time of application.
- Temporary leaf speckling and necrosis may occur with in-season treatments, and this is enhanced by use of COC and the presence of moisture on foliage.

Herbicide	Formulation	Product Rate Range
Butyrac 200 (2,4-DB)	**2L**	**1 - 3 qt**

- Site of action: group 4 (see pages 22-23).
- Controls annual broadleaf weeds in seedling forage legumes (alfalfa, clovers, and birdsfoot trefoil) and established alfalfa. Do not use on sweet clover.
- Apply in spring or fall when legumes have 2 to 4 trifoliate leaves. Annual weed seedlings should be no more than 2 to 3 inches tall. Rosettes should be no more than 2 inches across and not bolting. Weeds that emerge in the fall and overwinter in the rosette stage (mustards, field pennycress) may be more easily controlled in late fall than in spring.
- Apply 1 to 2 quarts/A when weeds are less than 1 inch tall, and 2 to 3 quarts when weeds are 1 to 3 inches tall. Use the 3-quart rate for smartweed or curly dock.
- Do not harvest or graze for 60 days following treatment.
- Butyrac 200 can be mixed with Poast for control of a mixed population of grass and broadleaf weeds in alfalfa.

Herbicide	Formulation	Product Rate Range
Bromoxynil	**2S**	**1 - 1½ pt**

- Site of action: group 6 (see pages 22-23).
- Apply in the fall or spring to seedling alfalfa with 4 trifoliate leaves when weeds have less than 4 leaves or are less than 2 inches tall, or before rosettes are 1 inch in diameter. Do not apply to established alfalfa
- Apply in a minimum spray volume of 20 gpa with a minimum spray pressure of 30 psi.
- For improved control of pigweed, mix 1 pint of bromoxynil with 1 quart of Butyrac 200.
- Crop leaf burn often occurs from bromoxynil application and is increased by warm, humid conditions. To avoid serious crop injury, do not treat when temperatures will exceed 70 F on the day of and for 3 days following application. Injury can be more severe in mixtures with Butyrac 200.
- Do not apply when alfalfa is under stress from moisture, temperature, insects, or disease.
- Do not graze or harvest for 30 days following treatment.

Herbicide	Formulation	Product Rate Range
Chateau	**51 WDG**	**up to 4 oz**

- Chateau (flumioxazin) provides residual control of annual broadleaf weeds in established alfalfa. Does not control emerged weeds.
- Apply when alfalfa has 6 inches of growth or less.
- Site of action: group 14 (see pages 22-23).
- Do not harvest or graze for 25 days after application.
- Do not apply with adjuvants or mix with products formulated as emusifiable concentrates (EC), unless applying after the last alfalfa cutting for the year.

Forage Legumes

Herbicide	Formulation	Product Rate Range
Clethodim	**Various**	**See labels**

- Clethodim controls annual and perennial grasses in alfalfa. Clethodim is sold under various trade names, including Select, Arrow, Section, Tapout, and Select Max.
- Site of action: group 1 (see pages 22-23).
- Most clethodim products are 2 lb/gal formulations, and should be applied at a rate of 6 to 8 ounces per acre for control of annual grasses up to 8 inches tall. Perennial grasses will generally require higher rates and may require more than one application. Application should be delayed until perennial weeds are at least 4 to 12 inches tall for best results. These products should generally be applied with COC (1% v/v) for best results. UAN or AMS can be added.
- Select Max should be applied at a rate of 9 to 12 oz/A for annual grasses less than 6 inches tall, and 12 to 32 oz/A for larger annual grasses or perennial grasses. Apply with NIS (1 qt/100 gallons) plus AMS (2.5 to 4 lbs/A). COC or MSO can be used instead of surfactant under hot,dry conditions.
- Clethodim can be mixed with other herbicides for control of a mixed population of grass and broadleaf weeds. See labels for more information.
- Allow 15 days between application and grazing, feeding, or harvesting of alfalfa.
- Allow 1 hour between application and rainfall.

Herbicide	Formulation	Product Rate Range
Eptam	**7E**	**3 1/2 - 4 1/2 pt**
	10G	**30 lb**
Balan	**1.5EC**	**3 - 4 qt**

- Site of action: group 3 (Balan), group 8 (Eptam). See pages 22-23.
- Control annual grasses and some broadleaf weeds in alfalfa, clovers, and birdsfoot trefoil. High rates of Eptam provide some control of yellow nutsedge and quackgrass.
- Apply to prepared seedbed shortly before seeding, and incorporate 2 to 3 inches deep immediately following application.
- Do not use when a companion crop of grain or forage grass is in the seeding mixture.
- Do not use Eptam on white Dutch clover.
- Do not use Balan on soils high in organic matter.

Herbicide	Formulation	Product Rate Range
Gramoxone SL	**2L**	**1 pt (between cuttings)** **1 - 2 pts (seedling - dormant)** **2 - 3 pts (established - dormant)**
Parazone	**3SL**	**0.7 pt (between cuttings)** **0.7 to 1.3 pts (seedling - dormant)** **1.3 - 2 pts (established - dormant)**

- Paraquat is the active ingredient in these products.
- Site of action: group 22 (see pages 22-23).
- Controls or suppresses small emerged grass and broadleaf weeds in dormant stands or between cuttings. Weeds beyond the seedling stage may not be controlled. Paraquat provides effective control of henbit, but control of common chickweed is variable.
- Apply with NIS (0.125 to 0.25% v/v) in a minimum spray volume of at least 10 gpa. Increase spray volume to 15 to 20 gpa where foliage is dense.
- When using between cuttings, apply no later than 5 days after alfalfa has been removed. Injury to first-year alfalfa will be more severe than to established stands. Stand and yield may be reduced if alfalfa is allowed to regrow more than 2 inches between cutting and application. Do not make more than 2 applications during the first growing season.

Forage Legumes

- When using on dormant alfalfa, apply during winter or early spring before alfalfa starts new growth. Early-spring application is usually most effective. Do not cut or harvest within 42 days after application. Do not apply more than once during the first growing season.

Herbicide	Formulation	Product Rate Range
Kerb	**50W**	**1 - 3 lb**

- Site of action: group 3 (see pages 22-23).
- Apply in the fall after the soil temperature is below 60F and until the ground freezes. Alfalfa plants must have reached the first trifoliate leaf stage. Can be applied to seedling alfalfa and established stands of alfalfa, clover, birdsfoot trefoil, and crown vetch, as long as there are no desirable grasses.
- Controls many perennial grasses, volunteer grains, downy brome, and chickweed.
- Use 1 to 1½ pounds per acre to control volunteer grains, downy brome, and chickweed, and 2 to 3 pounds to control quackgrass.
- Do not graze or harvest for 120 days following application.

Herbicide	Formulation	Product Rate Range
Poast	**1.5E**	**12 - 24 oz**

- Poast (sethoxydim) controls annual and perennial grasses in alfalfa and clover.
- Site of action: group 1 (see pages 22-23).
- Apply with COC (2 pints/A). For best control of crabgrass, volunteer cereals, and quackgrass, also include UAN (1/2 to 1 gallon/A) or AMS (2 1/2 lbs/A).
- For control of volunteer wheat in summer seedings, apply 24 ounces /A of Poast with COC plus UAN or AMS. Apply in the fall before wheat is 4 inches tall and prior to tillering.
- Apply in spray volume of 5 to 20 gpa with a pressure of 40 to 60 psi. Adjust spray pressure, spray volume, and boom height to ensure penetration of canopy and coverage of grasses.
- The rate is 16 oz/A of Poast per acre for control of most annual grasses up to 8 inches tall. The rate may be reduced for control of barnyardgrass, giant and green foxtails, and fall panicum that are up to 4 inches tall and actively growing.
- Quackgrass and other perennial grasses require higher rates and often two applications. Apply 24 oz/A of Poast when quackgrass is 6 to 8 inches tall, and make a second application at 2/3 the initial rate when regrowth reaches the same height.
- Oats inter-seeded with alfalfa may be killed with a rate of 16 oz/A of Poast before oats exceed 10 inches in height.
- Not recommended for control of cereals planted the previous fall.
- May be mixed with Butyrac 200 for control of a mixed population of grass and broadleaf weeds. Apply this mixture with COC only, and observe feeding, grazing, and harvesting restrictions for Butyrac.
- Mixing Poast with Pursuit often results in reduced grass control.
- Allow 1 hour between application and rainfall.
- Do not apply to grasses under stress from lack of moisture, herbicide injury, or low temperatures.
- Do not feed, graze, or harvest forage for 7 days following application. Do not feed or harvest dry hay for 14 days following application.

Herbicide	Formulation	Product Rate Range
Prowl H2O/Satellite Hydrocap	**3.8 CS**	**New stands: 1.1 - 2.1 pts** **Established: 1.1 to 4.2 qts**

- Site of action: group 3 (see pages 22-23).
- Provides residual control of most annual grasses and certain broadleaf weeds.
- Seedling alfalfa: apply prior to weed emergence. Seedling alfalfa must be in at least the 2nd trifoliate stage of growth but not more than 6 inches tall at the time of application.

Forage Legumes

- Provides residual control of most annual grasses and certain broadleaf weeds.
- Established alfalfa (mowed at least once): apply prior to weed emergence in the fall after last cutting, in the spring, or between cuttings. Alfalfa should have less than 6 inches of regrowth at time of application.
- Some stunting and chlorosis of alfalfa may occur with postemergence applications.
- Apply rates less than 2.1 pts at least 28 days prior to harvest, and wait 50 days for higher rates.

Herbicide	Formulation	Product Rate Range
Pursuit	**2S**	**3 - 6 oz**

- Pursuit (imazethapyr) is a translocated imidazolinone herbicide that controls annual broadleaf weeds and controls or suppresses grasses. Control of ragweeds and lambsquarters is variable. Does not control ALS-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Can be applied postemergence to seedling or established alfalfa. Apply in spring or fall when seedling alfalfa is in the 2nd trifoliate stage or larger. For established alfalfa, Pursuit can be applied in the fall after the last cutting, in the spring before or after alfalfa breaks dormancy, or between cuttings. Apply spring treatments before alfalfa growth exceeds 3 inches to allow adequate spray coverage on weeds.
- Pursuit application may cause a temporary yellowing or reduction in alfalfa height.
- Apply in a spray volume of at least 10 gpa with NIS (1 qt/100 gallons) or COC (1½ to 2 pints/A) plus UAN (1 to 2 quarts/A) or spray grade AMS (2 1/2 lbs/A). Control of large or drought-stressed weeds will be maximized when the higher rates of fertilizer are used in combination with a seed-oil based COC (Meth Oil, Priority MSO, or Sun-It II, for example).
- Can be mixed with Buctril/Moxy, 2,4-DB, or Poast to control additional weeds. Control of some grasses may be reduced when mixed with Poast.
- Apply when annual weeds are 1 to 3 inches tall. For low growing weeds such as mustards, apply before the rosette exceeds 3 inches in diameter.
- If replanting is necessary in a field treated with Pursuit, do not replant to alfalfa for 4 months following application. See label for other recrop restrictions.

Herbicide	Formulation	Product Rate Range
Raptor	**1AS**	**4 - 6 oz**

- Raptor (imazamox) is a translocated imidazolinone herbicide that controls annual broadleaf and grass weeds. Raptor generally provides better control of lambsquarters and annual grasses than Pursuit. Control of common and giant ragweeds and waterhemp is variable. Raptor provides a shorter period of residual control compared to Pursuit. Does not control ALS-resistant weeds.
- Site of action: group 2 (see pages 22-23).
- Seedling year: apply when alfalfa is in the 2nd trifoliate stage or larger, and when weeds are 1 to 3 inches tall or when rosettes are 1 to 3 inches wide.
- In established stands, Raptor can be applied: 1) in early spring when alfalfa is dormant and winter annual weeds are emerging; 2) before the first cutting; 3) between cuttings; or 4) in the fall after the last cutting. Apply before alfalfa growth exceeds 3 inches to allow adequate spray coverage on weeds. Weeds should be no more than 1 to 3 inches tall or 1 to 3 inches wide (for rosettes) at the time of application.
- Raptor application may cause a temporary yellowing or reduction in alfalfa height.
- Raptor should be applied with NIS (1 to 2 quarts/100 gallons spray) or a COC (1 to 2 gallons/100 gallons) plus UAN (2.5 gallons/100 gallons) or AMS (12 to 15 pounds/100 gallons). AMS is generally the preferred nitrogen source over UAN or 10-34-0. Control of large or drought- or temperature-stressed weeds will be maximized when the higher rates of fertilizer are used in combination with a seed oil-based COC (Meth Oil or Sun-It II, for example).
- Apply in a spray volume of 10 to 20 gpa with a pressure of 20 to 40 psi. Flat fan spray nozzles are recommended for adequate plant coverage. Allow 1 hour between application and rainfall.

Forage Legumes

- Control may be reduced when weeds are growing slowly under cold or dry conditions. If possible, wait for rain and resumption of active weed growth before applying Raptor. If air temperatures reach or stay below 50 F for 10 or more hours, delay application for 48 hours from the time temperatures increase above 50 F.
- Can be mixed with one or more of the following: bromoxynil, Poast/Poast Plus, clethodim, or 2,4-DB.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**2% v/v solution**

- See labels for more information on this type of application.
- Site of action: group 9 (see pages 22-23).
- Apply as a spot treatment in established stands to control problem weeds that cannot be controlled by any other means.
- Apply to actively growing, susceptible weeds.
- To avoid crop injury, avoid contact with desirable, nontarget vegetation (forage).
- For maximum effectiveness on target vegetation, refer to label for recommended timing of application.
- Treat no more than 1/10 of an acre at one time. Further applications may be made to the same area at 30-day intervals.
- Do not graze or harvest for 14 days following application.

Herbicide	Formulation	Product Rate Range
Metribuzin (Tricor, Glory)	**4F**	**1/2 - 2 pt**
	75DF	**1/3 - 1 1/3 lb**

- Site of action: group 5 (see pages 22-23).
- Use in established alfalfa only. Apply once in the fall or spring to dormant alfalfa (before new growth starts).
- Application rate varies with target weed, and soil texture and organic matter content.
- Controls downy brome and most winter annual weeds, including chickweed, henbit, mustards, and yellow rocket. High rates will suppress dandelion, curly dock, and quackgrass. The 1/3 lb/A rate is for control of chickweed only.
- Do not use on sandy soils or soils with pH greater than 7.5.
- Do not graze or harvest for 28 days following application.

Herbicide	Formulation	Product Rate Range
Sinbar	**80W**	**1/2 - 1½ lb**

- Site of action: group 5 (see pages 22-23).
- Use in established alfalfa only. Apply once in the fall or spring to dormant alfalfa (before new growth starts).
- Application rate varies with soil type. Use lower rates for coarser soils. Do not use on soils with less than 1 percent organic matter.
- Do not apply to snow-covered or frozen ground.
- Controls chickweed, henbit, mustards, and yellow rocket. Suppresses dandelion and quackgrass.
- Do not plant any other crop for 2 years after Sinbar application.

Herbicide	Formulation	Product Rate Range
Treflan/Trifluralin	**TR-10/10G**	**20 lb**

- Site of action: group 3 (see pages 22-23).
- Controls annual grasses in established alfalfa.
- Apply in the spring before weed emergence.
- A single rainfall or overhead irrigation of 1/2 inches or more within 3 days of application is required for this treatment to be effective.
- The year following Treflan application, plant only crops for which Treflan may be applied as a preplant incorporated treatment or injury may result.

Forage Legumes

Herbicide	Formulation	Product Rate Range
Velpar/Velossa	**2L**	**1 - 3 qt**

- Site of action: group 5 (see pages 22-23).
- Use in established alfalfa only. Apply in the fall or spring when alfalfa is dormant or before new growth exceeds 2 inches in height. Can also be applied to stubble after hay crop removal, but before regrowth exceeds 2 inches.
- Application rate varies with soil type.
- For best results, apply when weeds are less than 2 inches tall and rosettes are less than 2 inches across.
- Controls most winter annual broadleaf weeds, including chickweed, mustards, and yellow rocket. Controls dandelion and downy brome.
- Do not plant any crop except corn within 2 years of treatment. Corn may be planted 12 months after treatment where deep tillage is used.
- Do not graze or harvest for 30 days following treatment.

Alfalfa: Preharvest Glyphosate Application

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**See labels**

- Some glyphosate products can be used in declining alfalfa stands where crop destruction is desirable or acceptable.
- Site of action: group 9 (see pages 22-23).
- A preharvest application will control annual and perennial weeds, and greatly improve control of alfalfa and perennial grasses compared to application after harvest.
- Apply in a spray volume of 3 to 10 gpa just prior to alfalfa harvest in spring or fall.
- Allow a minimum of 36 hours between application and harvest. Optimum harvest time is 3 to 7 days after application to maintain hay quality and maximize perennial control.
- The treated alfalfa can be fed to any livestock including lactating animals.
- If the field is planted to corn following alfalfa harvest, including atrazine in the preplant/preemergence herbicide program will aid in control of perennial grasses. Postemergence application of dicamba or dicamba + 2,4-D may be required for complete control of alfalfa in the corn.

Mixed Grass-Legume Forages: Established Stands Only

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**2% solution (spot treatment)**

- See labels for more information on this type of application.
- Apply as a spot treatment to problem weeds not controlled by any other means.
- Site of action: group 9 (see pages 22-23).
- Apply to actively growing, susceptible weeds.
- To avoid crop injury, avoid contact with desirable, nontarget vegetation (forage).
- For maximum effectiveness on target vegetation, refer to label for recommended adjuvants and timing of application.
- Treat no more than 1/10 of an acre at one time. Further applications may be made to the same area at 30-day intervals.
- Do not graze or harvest for 14 days following application.

Herbicide	Formulation	Product Rate Range
Metribuzin	**4F**	**3/4 - 1½ pt**
	75DF	**1/2 - 1 lb**

- Can be used in alfalfa-grass mixtures.
- Apply once in the fall or spring when plants are dormant (before new growth starts).
- Site of action: group 5 (see pages 22-23).
- Application rate varies with soil texture and organic matter content.
- Higher rates may injure grass component.
- Do not use on sandy soils or soils with pH greater than 7.5.
- Do not graze or harvest for 28 days following application.

Roundup Ready Alfalfa

Herbicide	Formulation	Product Rate Range
Extreme	**2.17L**	**2.2 to 4.4 pts**

- Extreme is a premix of imazethapyr (Pursuit) and glyphosate for postemergence control of annual and perennial weeds in seedling or established Roundup Ready alfalfa. Pursuit provides residual control of some grass and broadleaf weeds also. See Pursuit and glyphosate descriptions for additional information.
- Site of action: group 2 (imazethapyr); group 9 (glyphosate). See pages 22-23.
- Extreme can be applied to seedling alfalfa that is in the second trifoliate stage or larger. For low-growing weeds, apply before the rosette exceeds 3 inches in diameter. New seedings of Roundup Ready alfalfa should be treated with glyphosate or Extreme at or before the 3 to 4 trifoliate stage, to eliminate the seedlings that may not be resistant to glyphosate.
- Extreme can be applied to established Roundup Ready alfalfa in the fall, in the spring to dormant or semi-dormant alfalfa (less than 3 inches of new growth), or between cuttings.
- Avoid application during periods of unusually cool weather (temperatures less than 50 degrees). Allow one hour between application and rain.
- Allow at least 30 days after application before grazing, cutting, or feeding of Roundup Ready alfalfa forage or hay.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**0.75 lb acid/A (new seedings)** **0.75 to 1.5 lb acid/A (established)**

- Glyphosate can be applied to established stands of Roundup Ready alfalfa for control of annual and perennial weeds. Not all glyphosate products are approved for this use – see labels for more information.
- Site of action: group 9 (see pages 22-23).
- Glyphosate should be applied after weeds have emerged but before alfalfa growth or regrowth interferes with spray coverage on weeds. New seedings of Roundup Ready alfalfa should be treated with glyphosate or Extreme at or before the 3 to 4 trifoliate stage, to eliminate the seedlings that may not be resistant to glyphosate.
- Application when annual weeds are less than 6 inches tall will result in most effective control and allow use of lower rates. Perennial weeds should be larger for most effective control. Application in the late fall may be the most effective strategy on cool-season perennials such as dandelion and Canada thistle, when there is adequate time after the last cutting for considerable regrowth of weeds. Multiple applications may be necessary to control some perennials.
- The rate of glyphosate in any single application should not exceed 1.5 lbs a.e./A. Sequential applications should be at least 7 days apart. The combined total per year for all in-crop applications should not exceed 4.5 lbs a.e./A.
- Remove livestock before application and wait a minimum of 5 days after last application before grazing, cutting, or feeding of Roundup Ready alfalfa forage or hay.

Management Strategies for Permanent Grass Pastures/CRP/Grass Hay

Long-term management of weeds in pasture and CRP areas is necessary to maximize pasture productivity and the growth of desirable species established in CRP areas, control weeds that are poisonous to livestock, and to prevent the encroachment of weeds into adjacent crop production fields. Some weed species are considered noxious weeds under state law and must be controlled, or the landowner can be subject to fines.

Many forage and grass species used in pastures and CRP have prolific growth characteristics and are effective at suppressing weeds. Effective establishment and maintenance of these species can greatly minimize weed problems. Factors in establishment include starting weed-free through tillage or the application of glyphosate or other non-selective herbicides, fertilization or liming as necessary based on soil testing, use of the proper seeding rate, and proper maintenance of over-grazed areas. Soil fertility should be periodically monitored and supplemented to maintain a healthy pasture or cover crop that is competitive with weeds. This should include testing the nitrogen level for grass species and pH for legume growth. Where phosphorous and potassium are at proper levels initially, these nutrients should cycle through the residue unless hay harvest is allowed. If the area is harvested for hay, then soil in the area may need to be tested, and nutrients applied to maintain further health of the pasture or CRP cover. Use grazing practices that prevent deterioration of desirable species, since weeds will rapidly infest areas devoid of a competitive stand of grasses and legumes.

Weeds are controlled in pastures and CRP land primarily by mechanical or chemical methods. Mowing is a viable option, depending upon the species to be controlled. Mowing is more effective for control when it can be used several times in the same year. Custom rates for rotary mowing in recent years averaged about $13 per acre, with a range of $6 to $19, based on information from The Ohio State University and Purdue University.

Annual weeds should be mowed prior to or soon after flowering to prevent the production of viable seed. Seed production may occur earlier than the timing of mowing allowed by CRP contracts. Biennial weeds have a two-year cycle. Emergence of plants from seed occurs in the first year, and the plants remain in the vegetative stage as a low-growing rosette with short internodes that grow close to the ground. Mowing is typically not effective for control of plants in this stage, because not enough leaf area can be removed to affect the plant growth. Elongation of the stem and development of a large plant occurs in the second year, as well as flowering and seed production. Mowing can be used in year two to control biennial plant growth and reduce seed production. Perennial weeds reproduce by both seed and plant parts such as stems, tubers and roots. Perennials should be mowed in the early bud stage. This is the point in the life cycle when carbohydrate movement from roots is at the lowest levels. Mowing at this time can help reduce the viability of the plant parts used to produce new plants and prevent seed production, but mowing rarely controls perennials completely. The bottom line - mowing can be used to prevent seed production, and it can effective for weed control when used at plant growth stages when the plant is most vulnerable or least likely to regrow.

A combination of mowing and herbicide applications may be most effective for the control of perennial weeds. Mowing in mid-summer removes weed growth from the first half of the season, and prevents seed production by many annuals and biennials. The initial growth of cool-season perennials is also removed, followed by their regrowth into the fall, when herbicides can be most effective. Mowing CRP areas before the first week of August will allow for maximum regrowth of perennial weeds. Applying herbicide in July or August will prevent seed production by annual weeds, but this is not the most effective timing for control of cool-season perennial weeds.

The most effective herbicide application timing for perennial weed control is generally mid-September through late October depending upon the species. Herbicide effectiveness at that time will be maximized by applying after several days of warm weather when perennial weeds are fairly large and/or in the bud to flower stage. Perennial weeds should be at least 8 to 12 inches tall in order to obtain maximum control of the roots or rhizomes for next year. For warm-season perennials such as johnsongrass, hemp dogbane, milkweeds, common pokeweed, and bindweeds, applications in mid- to late September should provide the most effective control. This strategy can prove effective in controlling perennial weeds, which are not well controlled by mowing alone.

Herbicides can effectively control many weeds in pastures and CRP, and can be a less expensive alternative to mowing. Herbicide effectiveness, similar to

mowing, also varies by weed life cycle and timing of application. A primary disadvantage of herbicide application – most herbicides that can be used for control of broadleaf weeds in CRP will injure or kill desirable legumes in the cover. Exceptions to this are bromoxynil, Butyrac, and Plateau, which can be applied to mixed stands of grasses and legumes. These herbicides can be used to control weeds during CRP cover establishment, depending upon the species planted and herbicide. Herbicide selection should take into account the weed species, CRP cover species, application method, and the presence of water in nearby ditches. Most herbicides can be applied to dry ditchbanks, but only some dicamba, 2,4-D, and glyphosate products are labeled for application directly to water. See product labels for more information.

CRP contracts are written with maintenance provisions that include the control of weeds through mowing or herbicides. The CRP contract usually limits mowing to a certain time of the year, so as"not to disturb the acreage under contract during the primary nesting and brood rearing seasons for wildlife except as approved by the CCC." This limitation may reduce the overall effectiveness of mowing as a weed control method, especially for certain perennial species. CRP contracts may allow more frequent mowing for control of noxious weeds such as Canada thistle. Weed management practices and the herbicides approved for use in CRP can vary among states, and also within a state. Landowners should consult contracts and local NRCS offices for more information on approved weed management practices (see below). Labels for some products specify application timing and rate based on the grasses that are being established or are present in a CRP area. This may include recommendations for cool-season vs warm-season grasses, which are categorized in the following table. The tolerance of many native forbs and grasses has not been characterized for some herbicides. Labels for some products warn of this and state that the manufacturer is not responsible for injury to native forbs and grasses.

See the following website for information on CRP contract requirements and management practices:
http://www.nrcs.usda.gov/programs/crp/

Cool Season Grasses		Warm Season Grasses	
Annual Ryegrass (I)[1]	Bluegrass, Rough (I)	Bahia (N)	Buffalo (N)
Bentgrass (I and N)	Canada wildrye (N)	Bermuda (I)	Eastern gramagrass (N)
Bluegrass, Kentucky (N)	Orchardgrass (I)	Big bluestem (N)	Foxtail millet (I)
Perennial ryegrass (I)	Smooth brome (N)	Bluestem yellow (caucasian) (I)	Indiangrass (N)
Tall fescue (I)	Timothy (I)	Little bluestem (N)	Pearl millet (I)
Virginia wildrye (N)		Broomsedge (N)	Swithgrass (N)

[1]I = introduced species, N = Native species. CRP guidelines require the use of native species.

Permanent Grass Pastures/CRP/Grass Hay

Herbicide	Formulation	Product Rate Range
2,4-D Amine	**Various**	**1 - 2 lbs ai/A**
2,4-D Ester		

- 2,4-D is labeled for use in grass pastures, CRP, and fallow land.
- Site of action: group 4 (see pages 22-23).
- Apply 2 pints/A when annual weeds are small and actively growing. Rates of 1.5 to 2 lbs ai/A may be needed for less susceptible annual weeds, and biennial and perennial weeds.
- Spray bull or musk thistles or other biennial weeds in the rosette stage (spring or fall) while they are actively growing. Spray perennials such as Canada thistle in the bud to flower stage or in the fall regrowth stage. Spray susceptible woody species in the spring when leaves are fully expanded.
- The ester formulation is more effective on wild garlic and onion than the amine formulation.
- Do not graze dairy cattle for 7 days after treatment. Remove livestock from treated fields at least 3 days before slaughter.
- Do not apply to newly seeded areas or after heading begins. Do not apply to grass when it is in the boot to milk stage if grass seed production is desired.
- Will injure or kill desirable broadleaf plants in grass/forb mixtures. Do not reseed legumes or rotate to other crops for 3 months or until chemical has disappeared from soil.

Herbicide	Formulation	Product Rate Range
Aim	**2EC**	**0.5 - 2 oz**

- Aim (carfentrazone) is a contact herbicide that will control velvetleaf, pigweeds, lambsquarters, and a few other annual broadleaf weeds up to 4 inches tall in grass pastures. Aim will not control biennial or perennial weeds.
- Site of action: group 14 (see pages 22-23).
- Can be used in grass pastures, CRP areas, and grasses grown for hay or silage. There is no waiting interval between application of Aim and harvest or grazing.
- Use a spray volume that results in complete coverage of foliage. Apply with NIS (0.25% v/v) or a COC (1 to 2% v/v). UAN or AMS may also be added.

Herbicide	Formulation	Product Rate Range
Bromoxynil	**2S**	**1 - 2 pt**

- Controls small winter and summer annual weeds in new CRP seedings. Can be applied during CRP cover establishment, after grasses have emerged. Bromoxynil can be applied to alfalfa, but will injure other legumes.
- Apply when annual weeds have less than 4 leaves or are less than 2 inches tall, or before rosettes are 1 inch in diameter.
- Apply in a minimum spray volume of 20 gpa with a minimum spray pressure of 30 psi.
- For improved control of pigweed, mix 1 pint of Buctril/Moxy with 1 quart of Butyrac 200.

Herbicide	Formulation	Product Rate Range
Butyrac 200 (2,4-DB)	**2L**	**1 - 3 qt**

- Controls annual broadleaf weeds in CRP stands of grass, alfalfa, clovers, and/or birdsfoot trefoil. Do not use on sweet clover. Can be used during establishment, but legumes should have emerged and grasses should be tillering or have a minimum of 6 leaves at the time of application.
- Annual weed seedlings should be no more than 2 to 3 inches tall at the time of application, and rosettes should be no more than 2 inches across and not bolting. Weeds that emerge in the fall and overwinter in the rosette stage (mustards, field pennycress) may be more easily controlled in late fall than in spring.
- Apply 1 to 2 quarts/A when weeds are less than 1 inch tall, and 2 to 3 quarts when weeds are 1 to 3 inches tall. Use the 3-quart rate for suppression of smartweed or curly dock.

Permanent Grass Pastures/CRP/Grass Hay

Herbicide	Formulation	Product Rate Range
Chaparral	**71.6 WDG**	**1.5 - 3.3 oz**

- Chaparral is labeled for use on grass pastures, established CRP areas, and natural areas.
- Cimarron Max is a premix of metsulfuron methyl plus aminopyralid (Milestone). These are translocated herbicides for control of primarily broadleaf weeds and brushy plants.
- Site of action: group 2 (metsulfuron); group 4 (aminopyralid). See pages 22-23.
- The standard rate is 2 oz/A when applied early-season for control of most pasture weeds. Increase rate if annuals are more than 6 inches tall. Biennials should be treated as seedlings in the fall ideally, or in the spring/early summer when still small. Perennials should be treated prior to bloom.
- For control of Canada thistle, apply 2 to 3.3 oz/A in fall before a killing frost, or in the spring after all plants have fully emerged and up until the oldest plants are in flower stage.
- Apply with COC/MSO (1% v/v) or NIS (0.25% v/v). AMS (2 lbs/A) or UAN (2 qts/A) can also be added.
- Do not rotate to any other crop within one year following application. Do not use on soils with pH greater than 7.9.
- Can be applied to many native and other grass species planted the previous season and fully tillered. Can be applied in spring or early summer to grass planted at least 4 months prior to application. If applied in the fall, do not plant grasses the following spring.
- Can cause stunting, yellowing, and seed head suppression on tall fescue. See label for precautions on this grass.
- Animals grazing on treated pasture should be grazed on nontreated forage for 3 days before moving to areas where sensitive broadleaf crops will be planted in the future. Manure in treated areas should be left on the pasture or spread only on pasture grasses, wheat or corn. Do not use aminopyralid-treated plant residues, including hay or straw from treated areas, or manure from animals that have grazed forage or eaten hay harvested from treated areas within the previous 3 days, in compost or mulch that will be spread to areas where broadleaf plants may be grown.

Herbicide	Formulation	Product Rate Range
Cimarron Max	**co-pack**	**See labels**

- Cimarron Max is labeled for use on grass pastures, established CRP areas, and warm and cool season native grasses.
- Cimarron Max is a co-pack of metsulfuron methyl plus a premix of dicamba and 2,4-D. These are translocated herbicides for control of broadleaf weeds and brushy plants.
- Site of action: group 2 (metsulfuron); group 4 (2,4-D, dicamba). See pages 22-23.
- Do not apply to timothy until 12 months after establishment. Lowest labeled rate should be applied to timothy in late summer or fall.
- Do not apply to bluegrass, bromegrass, or orchardgrass until 6 months after establishment, timothy until 12 months after establishment, and fescue until 24 months after establishment. Lowest labeled rate should be applied late in spring after 5 to 6 inches of new fescue growth, or in the fall.
- On timothy and fescue, use NIS rather than crop oil to minimize injury. Do not use additional surfactants if UAN is used as the spray carrier. Timothy should be at least 6 inches tall prior to application.
- The metsulfuron component is a long-residual herbicide and is labeled with extensive restrictions on over-seeding with legumes, pasture renovation, and crop rotation. Cautionary statements on the pasture label should be read and understood by the user prior to use. See label for list of established CRP grasses that are tolerant to Cimarron Max.
- Allow 4 hours between application and rainfall.
- Do not graze lactating animals within 7 days of treatment. There is no waiting period for non-lactating animals, but meat animals should be removed from treated areas 30 days prior to slaughter. Treated grasses may be harvested for dry hay, but do not harvest within 37 days of treatment.

Permanent Grass Pastures/CRP/Grass Hay

Herbicide	Formulation	Product Rate Range
Crossbow/Crossroad/Candor	**3L**	**Annuals - 1 - 2 qt** **Biennials - 2 - 4 qt** **Perennials - 2 - 4 qt** **Woody brush - 6 qt**

- Crossbow/Crossroad is a premix of 2,4-D plus triclopyr for use in grass pastures and CRP. Can be used in cut-stump, dormant stem, and basal applications.
- Site of action: group 4 (see pages 22-23).
- In CRP areas, apply only to established native grasses (not seedlings). Will injury or kill broadleaf forbs and legumes.
- Apply to foliage during warm weather when brush and broadleaf weeds are actively growing. When applying as a spot spray, thoroughly wet all foliage.
- Be cautious of vapor and particle drift, as Crossbow may injure susceptible crops growing nearby.
- Crossbow is effective for control of small ironweed and poison hemlock plants. For ironweed, apply 2 qt/A in early summer before evidence of leaf rust is seen on the ironweed leaves. Apply when poison hemlock is small for best results.
- A foliar application of a 1½ percent Crossbow solution applied in late April to early June has proven effective for multiflora rose control. Dormant season (late winter to early spring) basal bark applications of a 4 to 5 percent solution will also control multiflora rose. See herbicide label for more specific rate recommendations.
- Grazing restrictions for rates of 2 gallons per acre or less: Do not graze dairy animals for 14 days after treatment. Other livestock: no waiting period between application and grazing, but remove animals from treated areas at least 3 days before slaughter.

Herbicide	Formulation	Product Rate Range
Curtail	**2.38L**	**2 - 4 qt**

- Curtail is a premix of clopyralid (Stinger) plus 2,4-D for use on grass pastures and CRP areas.
- Site of action: group 4 (see pages 22-23).
- Apply when annual weeds are small and actively growing. Treat bull or musk thistles in the spring or fall when they are actively growing and in the rosette stage. Treat susceptible woody species in the spring when fully leafed out.
- Apply in the fall for most effective CRP site preparation. Allow at least 30 days after application before seeding native grasses. Where CRP areas will be seeded in the fall, apply Curtail in spring or early summer. Do not exceed 4 qts/A in areas to be seeded.
- Use higher rates for Canada thistle, and treat prior to the bud stage.
- Do not treat pastures containing legumes unless injury can be tolerated. Established grasses are tolerant, but new seedlings may be injured.
- Do not graze lactating dairy cattle in treated areas for 14 days after application. Meat animals should be removed from treated areas 7 days before slaughter (this is not necessary if at least 12 weeks have elapsed since application. Do not cut treated grass for hay for 30 days after application.
- Do not transfer livestock from treated grazing areas (or if fed treated hay) to sensitive broadleaf crops without first allowing 7 days of grazing on an untreated pasture (or feeding untreated hay). If livestock are transferred within less than 7 days of grazing untreated pasture or hay, urine or manure may contain enough clopyralid to injure sensitive broadleaf plants.

Permanent Grass Pastures/CRP/Grass Hay

Herbicide	Formulation	Product Rate Range
Dicamba	**4L**	**Annuals - 1/4 - 1½ pt**
		Biennials - 1/2 - 3 pt
		Perennials - 1 - 6 qt
		Woody brush - 1 - 8 qt
Distinct	**76.4DF**	**Annuals - 4 - 8 oz**

- Dicamba is sold under various trade names, including Banvel, Clarity, Sterling, and Oracle. Dicamba is a translocated herbicide labeled for use in grass pastures and CRP.
- Dicamba can be applied when seedling grasses are in at least the 3-leaf stage, and can be applied to established grasses. Rates higher than 1 pt/A may severely injure seedling grasses. Dicamba will injure of kill desirable broadleaf plants in grass/forb mixtures.
- Site of action: group 4 (see pages 22-23).
- Use lower rates for susceptible annuals when they are small and actively growing and for susceptible biennials in the early rosette stage. Use higher rates for larger weeds, for less susceptible weeds, for established perennials in dense stands, and for certain woody brush species.
- Remove livestock from treated fields at least 30 days before slaughter. There is no waiting period between application and grazing for non-lactating animals. Do not graze lactating dairy animals for 7 to 60 days after application, depending upon rate applied.
- Allow 6 to 8 hours between application and rainfall.
- Distinct is a premix of dicamba and diflufenzopyr that is more effective than the same rates of dicamba on many weeds, especially Canada thistle and bindweeds. Apply with NIS or MSO, plus AMS.
- Be cautious of spray drift and volatility.

Herbicide	Formulation	Product Rate Range
Dicamba + 2,4-D premix	**3.87L**	**1 - 4 pts**

- This product is available from various manufacturers, and product names and rates vary. Controls broadleaf weeds in pastures.
- Site of action: group 4 (see pages 22-23).
- When applied as a spot treatment, rates up to 8 pints/A can be used.
- Apply with NIS (2 to 4 pts/100 gallons) using a spray volume of at least 5 gpa. Increase volume where in dense or tall vegetation.
- Allow 37 days between application and harvesting of grasses for hay or silage.
- Allow 7 days between application and grazing of lactating animals. There is not waiting period between application and grazing of non-lactating animals, but remove animals from treated areas at least 30 days before slaughter.

Herbicide	Formulation	Product Rate Range
Forefront	**3L**	**1.5 - 2.6 pts**

- Forefront is a premix of aminopyralid (Milestone) plus 2,4-D that controls annual, biennial and perennial broadleaf weeds, including bull, musk, and Canada thistle.
- Site of action: group 4 (see pages 22-23).
- Forefront should generally be applied when perennial weeds are in the bud or early-flower stage. Most effective control of biennial species will result from application at the end of the first year of growth, or in the following spring when plants are still relatively small.
- The addition of NIS (0.25 to 0.5% v/v) is recommended for control of weeds with pubescent leaf surfaces or advanced in growth stage, or under adverse environmental conditions (too hot, too dry, etc.).
- Forefront can be used in permanent grass pastures and CRP acres. Do not rotate to any other crop within one year following application. Animals grazing on treated pasture should be grazed on nontreated forage for 3 days before

moving to areas where sensitive broadleaf crops will be planted in the future. Manure should be left on the pasture or, if collected at a central location such as a barn, spread on pastures, not cropland. Do not use aminopyralid-treated plant residues, including hay or straw from treated areas, or manure from animals that have grazed forage or eaten hay harvested from treated areas within the previous 3 days, in compost or mulch that will be spread to areas where broadleaf plants may be grown.

Herbicide	Formulation	Product Rate Range
Glyphosate	**Various**	**2% v/v (spot treatment only)**

- Glyphosate can be used as a spot treatment to control a variety of herbaceous and woody brush species such as multiflora rose, brambles, poison ivy, and quackgrass. Glyphosate should generally be applied when perennial weeds are in the bud to flower stage, and woody perennials are fully leafed out. Consult label for recommended timing of application for maximum effectiveness on target species.
- Glyphosate can be used for site preparation before planting in CRP, postemergence control when grasses are dormant, and selectively with the use of wiper application equipment. Apply 5 to 8 floz/A in the spring during dormancy. Grasses and forbs that have broken dormancy will be injured.
- Site of action: group 9 (see pages 22-23).
- Spray foliage of target vegetation completely and uniformly, but not to the point of runoff.
- Glyphosate is very effective for the selective killing of multiflora rose near desirable trees, due to the lack of soil activity. However, avoid contact with foliage of desirable nontarget vegetation. Apply in late spring or summer when multiflora rose are fully leafed out.
- No more than one tenth of an acre of pasture should be treated at one time. Further applications in the same area may be made at 30-day intervals.
- Do not graze or harvest for 14 days after application.

Herbicide	Formulation	Product Rate Range
Metsulfuron methyl (active ingredient)		
Accurate/Patriot	**60DF**	**1/10 - 1.0 oz**

- Accurate and Patriot are labeled for use in pastures and fallow areas.
- Metsulfuron-methyl is a translocated herbicide for control of broadleaf weeds and brushy plants.
- Site of action: group 2 (see pages 22-23).
- Apply to foliage when weeds and brush are actively growing. For annual weeds, apply in spring or early summer before weeds are 4 inches tall. Apply when brushy plants are fully leafed out.
- In OSU trials, metsulfuron-methyl has been highly effective for multiflora rose control; foliar applications provide best control of rose. Apply in late spring or summer when rose plants are fully leafed out. For spot treatment of multiflora rose, blackberry, or Canada thistle, use 1 ounce of Accurate/Valuron per 100 gallons of water. Metsulfuron-methyl is less effective than Stinger or glyphosate for long-term control of Canada thistle.
- Apply with NIS at a rate of 1 to 2 pints per 100 gallons water (1/2 to 1 pint for tall fescue).
- The maximum use rate for fescue pastures is 2/10 ounce/A. Application to fescue may cause stunting, temporary discoloration, and seed head suppression. To minimize injury to fescue, apply later in the spring or fall and/or tank mix with 2,4-D. Bluegrass, orchardgrass, timothy, bromegrass, and bermudagrass pastures have demonstrated good tolerance. Ryegrass is highly sensitive to metsulfuron-methyl. Grasses should be well-established at time of application.
- Metsulfuron-methyl is a long-residual herbicide and is labeled with extensive restrictions on over-seeding with legumes, pasture renovation, and crop rotation (34 months to most crops). Cautionary and other restrictive statements on the pasture label should be read and understood by the user prior to use.
- Allow 4 hours between application and rainfall.
- There is no grazing restriction on the Accurate or Patriot label.

Permanent Grass Pastures/CRP/Grass Hay

Herbicide	Formulation	Product Rate Range
Milestone	**2L**	**3 - 7 oz**

- Milestone (aminopyralid) controls annual, biennial and perennial broadleaf weeds, including bull, musk, and Canada thistle.
- Site of action: group 4 (see pages 22-23).
- Milstone should generally be applied when perennial weeds are in the bud or early-flower stage. For Canada thistle control, apply 5 to 7 oz/A in the spring to plants in the prebud stage, or apply in the fall to plants that have regrown to a size of at least 8 inches. For control of bull or musk thistle, apply 3 to 5 oz/A in spring or early summer to rosette or bolting plants, or apply 4 to 5 oz/A in fall to plants in the late bolt through early-flowering stage.
- The addition of NIS (0.25 to 0.5% v/v) is recommended for control of weeds with pubescent leaf surfaces or advanced in growth stage, or under adverse environmental conditions (too hot, too dry, etc.).
- Milestone can be used in permanent grass pastures, CRP acres, wildlife areas, and other non-cropland areas. Do not rotate to any other crop within one year following application. Animals grazing on treated pasture should be grazed on nontreated forage for 3 days before moving to areas where sensitive broadleaf crops will be planted in the future. Manure should be left on the pasture or, if collected at a central location such as a barn, spread on pastures, not cropland. Do not use aminopyralid-treated plant residues, including hay or straw from treated areas, or manure from animals that have grazed forage or eaten hay harvested from treated areas within the previous 3 days, in compost or mulch that will be spread to areas where broadleaf plants may be grown.

Herbicide	Formulation	Product Rate Range
PastureGard	**2 EL**	**2 - 8 pt (broadcast)** **50% v/v (basal or cut stump)**

- Pasture Guard is premix of triclopyr and fluroxypr for use on permanent pastures, CRP, and other non-crop areas.
- Site of action: group 4 (see pages 22-23).
- Can be applied as a foliar spray, or as a basal bark or cut stump application for woody species. Basal and cut stump applications must use diesel, kerosene, or other commercial carrier.
- Apply as a basal application to control trumpetcreeper and Virginia creeper.
- There are no grazing restrictions for non-lactating animals. Do not let lactating animals graze treated areas until the following season after application. Allow 14 days between application and harvest for hay. Animals grazing on treated forage must be removed from treated forage 3 days before slaughter.

Herbicide	Formulation	Product Rate Range
Plateau	**2L**	**4 to 12 oz**

- Controls small annual grass and broadleaf weeds at rates of 4 to 6 oz/A, while rates of 8 to 12 oz/A will control a number of biennial and perennial weeds. The lower rates should be used for CRP cover that contains legumes.
- Apply with nonionic surfactant (1 qt/100 gallons). Plateau can be more effective when applied with methylated seed oil (1.5 to 2 pts/A) instead of surfactant, but will be more injurious to the CRP cover. The addition of nitrogen fertilizer solution may improve control of certain weeds, but will also increase risk of injury to CRP cover crops.
- Plateau can be used during the establishment of CRP cover. To minimize injury to grasses, delay application until they have reached the 5-leaf stage.
- See the Plateau label for information on tolerance of grass and legume species.

Herbicide	Formulation	Product Rate Range
Remedy Ultra/Relegate	**4L**	**1 - 3 pt (broadcast)**

- Remedy Ultra (triclopyr) is a translocated herbicide for control of herbaceous broadleaf and woody weeds in permanent grass pastures, CRP, and other non-crop areas.
- Site of action: group 4 (see pages 22-23).
- Can be applied as a foliar spray, or basal bark or cut stump application for woody species.
- Controls only emerged herbaceous weeds that are fully leafed out at the time of application.

- Will injure desirable broadleaf forbs.
- There are no grazing restrictions for non-lactating animals. Do not let lactating animals graze treated areas until the following season after application. Allow 14 days between application and harvest for hay. Animals grazing on treated forage must be removed from treated forage 3 days before slaughter.

Herbicide	Formulation	Product Rate Range
Spike	**20P**	**10 - 20 lb**

- Spike (tebuthiuron) controls brush and woody plants, including multiflora rose, in rangeland and grass pastures. Requires sufficient rainfall to move herbicide into root zone. See label for rates on specific species.
- Site of action: group 7 (see pages 22-23).
- Apply anytime throughout the year except when soil is frozen or saturated with moisture. For best results, apply prior to the resumption of active seasonal growth in the spring.
- There are no grazing restrictions following the application of Spike.
- May kill or injure desirable legumes and grasses where contact is made. Apply as a spot treatment or when grasses are dormant to minimize injury.
- Do not apply on or near field crops or other desirable vegetation. Do not apply where soil movement is likely. Refer to label for additional restrictions.

Herbicide	Formulation	Product Rate Range
Stinger/Clean Slate	**3L**	**2/3 - 1 1/3 pt**

- Stinger (clopyralid) is a translocated herbicide for use in grass pastures and set-aside land.
- Site of action: group 4 (see pages 22-23).
- Controls a limited number of broadleaf weeds, including cocklebur, ragweeds, and nightshade. Controls Canada thistle at higher rates. Suppresses sowthistle and buffalobur.
- Apply when weeds are young and actively growing. Canada thistle should be at least 4 inches tall or across (rosette), but apply before the bud stage.
- Established grasses are tolerant, but new grass seedings may be injured. Some forages, especially legumes, are especially sensitive to Stinger. Do not spray pastures containing legumes unless injury can be tolerated.
- Allow 6 to 8 hours between application and rainfall.
- There is no waiting period between application and grazing. Do not use hay, straw, or manure from treated areas for composting or mulching on susceptible broadleaf crops. Do not transfer animals from treated grazing areas onto sensitive broadleaf crop areas without first allowing 7 days of grazing on an untreated pasture. Otherwise, urine may contain enough Stinger to injure sensitive broadleaf plants.
- Apply only once per 12 month period. Wheat, grasses, field corn, or sugar beets may be planted anytime after treatment. Check the label for recrop intervals on other broadleaf crops.

Herbicide	Formulation	Product Rate Range	With glyphosate/glufosinate
Yukon	**67.5WG**	**4 - 8 oz**	**2 - 8 oz**

- Yukon is a premix of halosulfuron (Permit) plus dicamba for control of most annual broadleaf weeds and yellow nutsedge. Yukon will also suppress some perennial broadleaf weeds, primarily during the growing season of application.
- Site of action: group 2 (halosulfuron); group 4 (dicamba). See pages 22-23.
- There is no waiting period between application and grazing. Allow 37 days between application and harvest for hay.
- Weeds should generally be less than 6 inches tall for best results. Use a rate of 6 to 8 oz for yellow nutsedge control.
- Apply with NIS (1 to 2 quarts/100 gallons) or COC (1 gallon/100 gallons). UAN (28% UAN, etc. - 2 to 4 quarts/A) or AMS (2 to 4 lbs/A) can be added to improve control of certain weeds or if required for another herbicide in the spray mix. Apply in a spray volume of at least 10 gpa.

Table 21. Weed Response to Herbicides in Grass Pastures/CRP/Grass Hay

This table compares the relative effectiveness of herbicides on weeds. Ratings are based on labeled application rate and weed size or growth stage. Control of perennial weeds may require more than one application. Performance may be better or worse than indicated in the table, due to weather or soil conditions, or other variables.

Weed control rating:
9 = 90% to 100% control
8 = 80% to 90% control
7 = 70% to 80% control
6 = 60% to 70% control
- = not recommended or insufficient information

		2,4-D	Chaparral	Cimarron Max	Crossbow	Curtail	Dicamba	Forefront	Glyphosate	Metsulfuron	Milestone	PastureGard	Remedy Ultra	Stinger
	Site of action	4	2/4	2/4	4	4	4	4	9	2	4	4	4	4
Winter annual														
	Chamomile, mayweed	7	8	9	7	9	8	7	9	9	-	-	-	9
	Chickweed, common	-	9	9	8	6	9	8	9	9	7	8	8	6
	Cockle, corn	7	-	9	8	7	9	6	9	-	-	-	-	-
	Cockle, cow	7	-	9	8	7	9	6	9	-	-			-
	Horseweed (marestail)	9	9	9	9	9	9	9	9	9	8	6	7	9
	Mustard spp.	9	8	9	9	9	7	9	9	9	-	-	9	6
	Pennycress, field	9	8	9	9	9	8	9	9	9	-	-	-	6
	Pepper weed spp.	9	8	9	9	9	7	9	9	9	-	-	-	6
	Shepherd's purse	8	8	9	9	8	7	8	9	9	-	-	-	6
Summer annual														
	Cocklebur, common	8	9	9	9	9	9	9	9	9	9	8	8	9
	Lambsquarters, common	8	9	9	9	8	9	9	9	9	9	9	9	6
	Nightshade, black	7	9	8	8	7	8	9	8	7	9	-	-	-
	Pigweed spp.	8	9	9	8	8	9	8	9	9	8	9	-	6
	Ragweed, common	9	9	9	9	9	9	9	9	-	9	9	9	9
	Ragweed, giant	9	9	9	9	9	9	9	9	-	9	9	9	9
	Velvetleaf	8	7	9	8	8	9	8	8	8	-	9	-	-
Biennial														
	Burdock, common	9	9	9	9	8	7	9	9	9	9	9	9	8
	Carrot, wild	8	9	9	9	8	7	8	8	9	-	7	8	6
	Evening primrose, common	8	8	8	9	7	7	9	9	-	8	-	8	-
	Hemlock, poison	7	-	8	9	8	8	7	8	-	-	-	9	-
	Lettuce, wild	9	9	9	8	9	8	9	8	9	-	-	-	9
	Parsnip, wild	8	9	8	9	8	8	8	8	8	-	-	-	-
	Teasel	7	9	9	8	9	8	8	8	9	-	-	-	8
	Thistle, bull	8	9	9	9	9	9	9	9	9	9	6	6	9
	Thistle, musk	9	9	9	9	9	9	9	9	9	9	6	7	9
	Yellow rocket	8	8	9	9	8	8	8	8	9	-	-	-	-

Table 21. (continued)

		2,4-D	CHaparral	Cimarron Max	Crossbow	Curtail	Dicamba	Forefront	Glyphosate	Metsulfuron	Milestone	PastureGard	Remedy Ultra	Stinger
Herbaceaous perennials														
	Aster spp.	8	-	8	8	9	8	8	8	6	-	-	-	9
	Bedstraw spp.	6	9	6	9	7	-	9	8	-	9	-	-	7
	Bindweed, field	7	-	7	8	7	8	7	8	-	-	7	7	-
	Bindweed, hedge	8	-	8	8	8	8	7	8	-	-	7	8	-
	Buttercup spp.	8	8	9	9	8	7	8	8	9	8	7	8	9
	Chickweed, mouseear	6	9	9	8	1	7	6	8	9	-	8	8	6
	Chicory	8	9	9	7	8	7	9	8	9	9	9	8	8
	Clover spp.	6	9	9	8	9	8	9	8	9	9	8	9	9
	Cockle, white	6	-	6	8	8	8	6	9	-	-	-	-	8
	Daisy, oxeye	8	8	8	9	9	9	9	8	-	8	-	-	9
	Dandelion	9	9	9	9	9	8	8	7	9	9	8	8	8
	Dock spp.	7	9	8	8	8	7	9	8	8	9	7	-	8
	Dogbane, hemp	8	6	8	6	8	7	5	8	7	-	6	9	6
	Garlic or onion, wild	7	8	9	7	7	6	6	8	9	-	-	-	-
	Goldenrod spp.	8	7	8	7	8	9	8	9	7	6	7	8	7
	Groundcherry spp.	6	8	6	7	6	6	6	7	-	-	-	-	-
	Hemlock, spotted water	7	-	7	9	7	7	7	8	-	-	-	-	-
	Horsenettle	6	9	9	8	6	7	8	7	9	9	6	6	-
	Ironweed	7	8	7	9	7	7	8	9	-	8	6	7	-
	Knotweed, Japanese	6	-	6	6	7	7	-	7	-	-	-	-	7
	Milkweed, common	6	-	6	7	6	7	-	8	-	-	-	7	-
	Nettle, stinging	7	8	7	8	7	7	9	8	-	9	-	9	-
	Plaintain spp.	9	8	9	9	6	7	9	8	7	-	9	5	6
	Pokeweed, common	6	6	6	8	9	-	8	8	-	8	-	-	-
	Snakeroot, white	7	-	7	8	7	8	6	8	-	-	-	-	7
	Sorrel, red	-	8	9	9	7	8	-	8	9	-	-	-	7
	Sowthistle, perenniel	7	8	8	9	7	8	9	8	8	9	-	-	7
	Thistle, Canada	7	9	7	7	9	8	9	9	7	9	-	6	9
	Yarrow, common	6		6	-	7	8	9	8	-	9	-	-	7
Woody Perennials														
	Blackberry spp.	6	6	8	7	6	6	-	7	8	-	-	7	6
	Dewberry spp.	6	6	8	7	6	6	-	6	8	-	-	-	6
	Grape, wild	7	6	7	8	7	7	-	7	7	-	-	-	-
	Honeysuckle spp.	6	6	9	8	6	-	-	7	9	-	-	-	-
	Locust, black	6	8	6	7	6	7	8	7	6	8	-	8	-
	Multiflora rose	6	8	9	8	6	6	7	9	9	7	-	8	-
	Nightshade, bittersweet	6	-	6	-	6	6	-	8	-	-	-	-	7
	Olive, autumn	6	-	6	7	6	7	-	7	-	-	-	-	-
	Poison ivy, oak	6	-	6	8	6	7	-	7	6	-	-	8	-
	Sumac spp.	6	-	6	8	6	7	-	7	-	-	-	8	6
	Trumpetcreeper	6	-	6	7	6	6	-	6	-	-	-	6	-
	Virginia creeper	6	-	6	8	6	7	-	7	6	-	-	6	-

Control of Problem Weeds

The following section outlines strategies and herbicide treatments for management of weeds that are especially problematic in crop production. For annual weeds, this usually involves selection of the proper herbicides and application method. Perennial weeds require other strategies, such as application of translocated herbicides (glyphosate, dicamba, 2,4-D) in the fall following wheat harvest when perennials are in an advanced stage of growth. This allows movement of herbicide into the roots or other underground plant parts. Perennial weeds can be present in any tillage system, but tend to be more of a problem in minimum tillage, due to the lack of disturbance of underground plant parts. Root systems, rhizomes, tubers, and similar underground parts of perennial plants are a source of reinfestation even when above ground growth is controlled. It is extremely difficult to eliminate perennial weeds with a single herbicide application, and effective management will require attention every year. The following general strategies should be considered for management of perennial weeds.

1. Perennial weeds often occur first at the edges of crop fields, near fencerows and wooded areas. Taking steps to control perennial weeds in these areas when infestations are light will prevent further spread into the rest of the field. This can be accomplished by tillage or herbicide application in the infested area, without having to treat the rest of the field.
2. Apply glyphosate, or combinations of glyphosate with dicamba or 2,4-D, in the fall when perennial broadleaf weeds are in the bud to flower stage, or as late as possible before a hard frost. Add AMS (17 lb/100 gallon water) to glyphosate for maximum effectiveness on perennial weeds. Perennial grasses should have at least 10 to 14 inches of growth at the time of treatment. The best opportunity for this treatment is in wheat stubble. If the wheat stubble is mowed in summer to control seed production by annual weeds, mow before early August to allow time for regrowth of perennial weeds. It may be possible to apply herbicide after corn or soybean harvest in the fall, but allow time for perennials to recover from damage by harvest equipment.
3. Preplant application of glyphosate, 2,4-D, dicamba or combinations of these can help reduce the population of early emerging perennial weeds such as quackgrass and dandelion.
4. Postemergence herbicides can suppress or control perennial weeds, but this is often limited to suppression through the growing season. In corn, dicamba, 2,4-D, Stinger, and many ALS inhibitors (Hornet, Beacon, Permit, nicosulfuron) have activity on perennial broadleaf weeds when applied postemergence. Combinations of an ALS inhibitor with 2,4-D or dicamba have generally provided the most effective control, especially for hemp dogbane and perennial vines. In soybeans, ACCase inhibitors (clethodim, Fusilade, Fusion, and Assure II) will control or suppress many perennial grasses, including johnsongrass, quackgrass, and wirestem muhly. Synchrony STS and Classic/Harmony GT combinations can suppress common milkweed, pokeweed, and perennial sowthistle, and Basagran can control the above-ground growth of Canada thistle. Blazer, Cobra, and fomesafen can burn back the above-ground growth of vines, such as bindweeds and honeyvine milkweed.
5. Postemergence application of glyphosate in glyphosate-resistant soybeans and corn can be a very effective tool for reducing perennial weed populations. Late postemergence application, when perennial weeds are in the bud to flower or boot to seedhead stage, will provide the most effective and complete plant control. When applied early postemergence, a second application may be required to control regrowth.
6. Glyphosate can be selectively applied to weeds in soybeans with a ropewick or sponge applicator. Weeds should be substantially taller than the soybeans, and herbicide applied in mid- to late-season for best results. This can be an effective method of managing hemp dogbane and common milkweed.
7. A preharvest application of approved glyphosate products in soybeans, corn, or wheat may help control perennial weeds, since their above-ground growth is still intact. In wheat and corn, 2,4-D is also labeled as a preharvest treatment. This treatment may have to be applied with aerial or high-clearance ground equipment.
8. Tillage can aid greatly in control of biennial and perennial weeds, but mainly is effective at removing those with a single deep taproot, such as pokeweed, dandelion, and wild carrot. Tillage with a chisel plow, disk, or field cultivator may actually help spread perennials with creeping root systems, such as Canada thistle and hemp dogbane.

Jerusalem Artichoke

Jerusalem artichoke is a perennial broadleaf weed that spreads by seed, rhizomes, and tubers. The tubers overwinter in the soil and may become as large as a small potato. Jerusalem artichoke is extremely competi-

tive with all crops and may reach a height of 6 to 8 feet. The flowers of Jerusalem artichoke resemble those of annual sunflower, but are much smaller.

Noncrop/Fallow Areas. A 2 percent solution of glyphosate as a spot treatment provides fair to good control. For broadcast applications, use 2.25 lbs ae of glyphosate/A. This treatment will be most effective when plants are close to or in the bud stage.

Corn. Postemergence application of Spirit (1 oz/A), NorthStar (5 oz/A), Stinger (1/2 pt/A), WideMatch (1.3 pts/A), or Hornet (3 to 5 oz/A) will control or suppress small (3 to 6 inch) artichoke plants. These herbicides are most effective when mixed with dicamba (NorthStar is a premix of Beacon and dicamba). Marksman (3.5 pints/A), dicamba (1/2 to 1 pint/A), Status (5 oz/A), 2,4-D amine (0.5 lb ai/A), or dicamba + 2,4-D (1/2 pint + 1/4 pint/A) applied when artichoke are at least 6 inches tall provides fair to good control. Glyphosate (glyphosate-resistant corn) applied at 0.75 lbs ae/A will suppress or control Jerusalem artichoke, but a second application may be necessary. Glufosinate (LibertyLink corn only) applied postemergence will often suppress artichoke through the growing season.

Soybeans. Glyphosate (Roundup Ready soybeans) will suppress or control Jerusalem artichoke. A second application may be necessary. Late post applications, when plants are in the early bud stage, will provide the most complete control of underground plant parts. A single postemergence application of Classic (3/4 oz/A), Synchrony XP (0.75 oz/A), Raptor (4 to 5 oz/A), Pursuit (1.44 ounces/A), or glufosinate (29 oz/A - LibertyLink soybeans only) will control or suppress artichoke. Split applications of Classic (1/2 oz/A followed by 1/2 oz/A) will provide more effective control than a single application. The first Classic application should be made when artichokes are less than 8 inches tall and have fewer than 8 leaves, and followed with a second application 14 to 21 days later.

Atriplex

Atriplex is a summer annual weed in the lambsquarters family that is increasing in prevalence throughout Ohio and eastern Indiana, although most is found north of Interstate 70. Atriplex resembles common lambsquarters, but often has narrower leaves and emerges earlier in the season. Orientation of leaves at the base of the stem is a key difference between lambsquarters and Atriplex. Atriplex has opposite leaf orientation at the lowest 4 to 8 nodes and leaves are usually alternate at all higher nodes. Lambsquarters can have opposite leaf orientation at the lowest one or two nodes, and all higher nodes are alternate. Atriplex usually reaches a maximum height of 3 feet, while lambsquarters can exceed this height. Atriplex has been a problem primarily in soybeans, where it has survived preplant glyphosate and 2,4-D application and postemergence Harmony GT application.

Soybeans. Controlling emerged Atriplex prior to planting with burndown herbicides is important. Because it emerges early in the spring, Atriplex may have considerable size at the time of burndown herbicide application. Burndown herbicides seem to be most effective on small plants, while larger plants can be difficult to control. University research indicates that low rates of glyphosate mixed with 2,4-D ester are effective on small plants, and herbicide rates should be increased with increasing plant size or cold temperatures. Gramoxone plus 2,4-D ester can also be effective on small plants, especially when mixed with Synchrony XP. Chlorimuron-containing products or Python can provide residual control of later-emerging plants, but most other soil-applied herbicides are variable in effectiveness. Postemergence application of glyphosate (0.75 to 1.5 lbs ae/A - Roundup Ready soybeans) will control small Atriplex and help control plants that escape burndown treatments. Increase glyphosate rates as Atriplex size increases. Most other postemergence soybean herbicides are ineffective for Atriplex control.

Field and Hedge Bindweed

Field and hedge bindweed are perennial vines that are similar in appearance. Both are often mistaken for annual morningglory. However, they are much more difficult to control than annual morningglory because of their deep, overwintering rootstocks. Tillage and crop rotation, in combination with selected herbicide use, helps reduce infestations. Chemical controls are the same for both types of bindweed.

Noncrop/Fallow Areas. To control bindweeds in wheat stubble or after corn or soybean harvest, apply glyphosate (2.25 to 3 lbs ae/A or 2% solution for spot treatment), glyphosate + 2,4-D (1.5 lbs ae/A + 0.5 lb ai/A), or glyphosate + dicamba (1.5 lbs ae/A + 1 pint/A) when plants are at or past the full-bloom stage. Apply fall treatments before a killing frost, and do not till for at least 7 days following application. Do not treat weeds under stress from drought.

Corn. Status (5 oz/A) has provided excellent bindweed control in university research. Application of NorthStar (5 oz/A), Yukon (6 to 8 oz/A), or combinations of Spirit (1 ounce/A) or nicosulfuron with dicamba will suppress bindweed plants less than 6 inches tall. Starane (2/3 pt/A) and WideMatch (1.33 pts/A) suppress bindweeds. Glyphosate (glyphosate-resistant corn) applied at 1.1 lb ae/A will suppress bindweed, but a second application may be necessary.

Soybeans. Glyphosate (1.5 lbs ae/A - Roundup Ready soybeans) will suppress or control bindweeds. A second application may be necessary. Late postemergence applications, when plants are in the bloom stage, will provide the most complete control of underground plant parts. Postemergence application of Ultra Blazer (2 pints/A), Cobra/Phoenix (12.5 ounces/A), or a fomesafen product, or combinations of Basagran/Broadloom with these products may burn back the above-ground foliage of bindweeds under favorable conditions. Results are best with high temperature, high humidity, and good soil moisture. Apply when bindweeds are from 12 to 18 inches long.

Burcucumber

Burcucumber is an annual broadleaf weed that reproduces by seed. It is more prevalent than wild cucumber and distinguished from this weed by its white flowers and flat, egg-shaped pods. The pods, which are in clusters, bear single seeds and are covered with barbed, prickly bristles. Burcucumber is extremely competitive, and vines may spread as far as 25 feet from a single plant. Seed may germinate throughout the spring and summer, making season-long control difficult. The vines cover soybeans and twine around corn, hindering harvest operations.

Corn. Products that contain high rates of isoxaflutole (Balance Flexx, Corvus) or mesotrione (Acuron, Lumax, Lexar, Instigate) applied preemergence can provide early-season control of burcucumber, but a postemergence treatment is also required. While many postemergence herbicides are effective on small plants, the later-emerging burcucumber plants often grow rapidly enough to cause problems. A successful burcucumber control program often involves preemergence herbicides that provide early-season control, followed by late postemergence applications when corn is about 25 to 35 inches tall (sometimes with high-clearance sprayers) to control late-emerging plants. Most effective control results from use of postemergence herbicides that have foliar and residual activity on burcucumber, such as Callisto, Spirit, Zemax, Realm Q, Revulin Q, Solstice, or Halex GT (some of these must be applied when corn is no more than 20 inches tall). Other herbicides with effective activity on emerged burcucumber include nicosulfuron, Beacon, Impact/Armezon, Northstar, Status, dicamba, bromoxynil, Yukon, glyphosate (glyphosate-resistant corn), or glufosinate (LibertyLink corn). Use drop nozzles where directed by the label to avoid crop injury in late postemergence applications.

Soybeans. Classic (2/3 to 3/4 ounce/A) and Synchrony XP (0.75 ounce/A) are the most effective postemergence herbicides for control of burcucumber in soybeans.Glyphosate (Roundup Ready soybeans) and glufosinate (LibertyLink soybeans) will control small burcucumber. For all of these products, a split application may be more effective than a single application at a higher rate where late-emerging burcucumber are a frequent problem.

Wild Carrot

Wild carrot (also called Queen Anne's lace) is a biennial weed that is a frequent problem in continuous no-tillage cropping systems. Infestations often first appear at the borders of fields and the seed is spread throughout the field by the combine during corn and soybean harvest. It can be distinguished by its finely divided or lacy leaf shape, a white flower head, and its carrot-like odor. Wild carrot spreads by seed. The ultimate goal of controlling wild carrot, regardless of the method, should be to prevent seed production. A dense population of wild carrot can cause severe yield losses in corn and soybeans. Some wild carrot populations in Ohio are resistant to 2,4-D.

Wheat Stubble. Mow the wheat stubble before early August. Apply glyphosate (1.1 to 1.5 lbs ae/A) or glyphosate + 2,4-D (0.75 lb ae/A + 0.5 lb ai/A) in October. This fall application is targeted at the plants that will flower and produce seed the following year.

Fall/preplant control. Wild carrot is most effectively controlled by fall application of glyphosate + 2,4-D (0.75 lbs ae/A + 0.5 lb ai/A) or combinations of glyphosate or 2,4-D plus Autumn products or Basis. Apply from early October into mid November. For best results in spring, apply glyphosate plus 2,4-D (0.75 to 1.5 lbs ae/A + 0.5 lb ai/A) as an early preplant treatment soon after the plants begin to green up. Tillage is the most effective tool for control of wild carrot in the spring.

Corn. Wild carrot can be controlled or suppressed with postemergence corn herbicides. The most effective postemergence treatments include atrazine (2 pounds active ingredient/A), Spirit (1 ounce/A), Beacon (3/4 ounce/A), NorthStar, Permit (1 to 1.3 ounces/A), Yukon, or nicosulfuron. These should be applied with COC or MSO. Application of any of these herbicides with dicamba will generally improve control, and the addition of 28% nitrogen may increase effectiveness. Any postemergence treatment containing at least 1.5 pounds active ingredient/A of atrazine will provide fair to good control. Glyphosate (1.1 lb ae/A - glyphosate-resistant corn) will suppress or control wild carrot.

Soybeans. Most effective control in spring results from preplant application of glyphosate plus 2,4-D ester plus a chlorimuron-containing product. Follow fall or

spring preplant treatments with a postemergence application of Classic (3/4 ounce/A), Synchrony XP (3/4 ounce/A), or glyphosate (1.1 lb ae/A - Roundup Ready soybeans). Use COC or MSO with Classic and Synchrony to maximize control.

Dandelion

Dandelion is a perennial weed that occurs primarily in no-till fields. Reproduction is by seed and sprouting from a thick, fleshy root or root segments. Dandelion stems do not elongate but produce a rosette of leaves. This weed can become extremely problematic in corn, soybean, and wheat fields.

Fall herbicide treatments. Dandelion is most effectively controlled with fall herbicide treatments, especially mixtures of 2,4-D plus a chlorimuron-containing herbicide (Canopy/Cloak DF/EX), Basis, or Autumn Super. Soybeans must be planted the following year where chlorimuron is used. Corn or soybeans can be planted following Autumn Super and Basis (varies by rate and area for Basis). Other effective treatments include glyphosate (1.1 lbs ae/A), and a combination of glyphosate (0.75 lb ae/A) plus 2,4-D (0.5 to 1 lb ai/A). The mixture of 2,4-D and dicamha has activity on dandelion but has been less effective than the previously listed treatments. These treatments can be applied in the fall prior to corn or soybeans. Apply when plants are at least 4 inches in diameter and after a light frost for best results. Mid-October to mid-November may be the best period for application, as long as plants are mostly green.

Corn. The most effective spring preplant treatments have been Lumax or Lexar plus 2,4-D ester in Ohio State and Purdue University research. Acuron or a combination of Instigate and an atrazine premix should have similar activity. Expert + 2,4-D, Balance/Corvus + atrazine + 2,4-D, or other treatments containing glyphosate and 2,4-D can be effective, but control has been more variable. Expert or combinations of glyphosate with other preplant herbicides (without the 2,4-D) can also be effective, but may be more variable across a range of weather conditions and dandelion sizes. For best results, do not apply spring treatments before about April 7 and use water as the spray carrier. The most effective postemergence treatments include Status, Laudis/Corvus + atrazine, and atrazine plus Callisto (or another herbicide containing mesotrione). Postmergence application of glyphosate (Roundup Ready soybeans) or glufosinate + atrazine (LibertyLink corn) can control or suppress seedling dandelion and plants that have been injured by preplant herbicides. Postemergence herbicides are best suited for control of plants that regrow after a relatively effective fall or spring burndown treatment, and not for control of plants that were previously untreated.

Soybeans. Preplant application of glyphosate plus 2,4-D ester plus a chlorimuron-containing or a cloransulam-containing herbicide has generally been the most effective treatment in university research (chlorimuron can be more effective than cloransulam). Glyphosate plus 2,4-D ester has been consistently less effective than treatments containing chlorimuron or cloransulam. Apply after about April 7 for best results. Postemergence application of Classic (3/4 ounce/A) or Synchrony XP (3/4 ounce/A) can suppress dandelion plants that regrow after preplant treatment. Postmergence application of glyphosate (Roundup Ready soybeans) can control or suppress seedling dandelion and plants that have been injured by preplant herbicides. Postemergence combinations of glyphosate plus Classic or FirstRate can be more effective than glyphosate alone.

Wheat. OSU research results indicate that application of tribenuron (Express/Nuance) plus dicamba to emerged wheat in early November may be the most effective approach to dandelion control in wheat. Fall-applied Huskie also has activity on dandelion. Preplant or preemergence application of glyphosate has the potential to provide some control or suppression, but will be most effective when glyphosate application can be delayed until at least mid-November, or after a frost. Several wheat herbicides can have activity on dandelion when applied in the spring, but control can vary greatly with dandelion growth stage and weather. Herbicides with activity in the spring include Express + 2,4-D, and combinations of Curtail, Stinger, or WideMatch plus Express/Nuance or 2,4-D (see labels for information on approved mixtures).

Hemp Dogbane

Hemp dogbane is a tall-growing, perennial broadleaf weed often mistaken for common milkweed. It spreads by seed and overwintering rootstock. Hemp dogbane tends to appear in areas that have not been tilled for a number of years.

Noncrop/Fallow Areas. Glyphosate (3 lbs ae/A or 2% solution for spot treatment) or glyphosate + 2,4-D (1.1 lb ae/A + 0.5 lb ai/A) can be applied when dogbane are in the late-bud to flower stage of growth. Treatments following crop harvest or mowing should be delayed until weeds regrow to a mature stage.

Corn. Glyphosate (glyphosate-resistant corn) applied at 1.1 lb ae/A will suppress or control dogbane, but a second application may be necessary. Most effective postemergence treatments include Starane (2/3 pt/A),

WideMatch (1.33 pts/A), or combinations of Spirit (1 ounce/A) or Beacon (3/4 ounce/A) plus 1/2 pint/A of 2,4-D. Other postemergence treatments with activity include NorthStar, Yukon, and combinations of dicamba (1/4 to 1/2 pint/A) with Spirit or nicosulfuron. Dicamba (1/2 to 1 pint/A) applied alone will suppress dogbane, with best results if dogbane plants are at least 8 inches tall. If corn is less than 8 inches tall, the higher rate can be applied. Use drop nozzles where directed by the label to avoid crop injury in late postemergence applications.

Soybeans. Glyphosate (1.5 lb ae/A - Roundup Ready soybeans) is the only effective postemergence treatment. A second application may be necessary. Late postemergence applications, when plants are in the bud to flower stage, will provide the most complete control of underground plant parts.

Wild Garlic

Wild garlic is a perennial plant that produces underground and aerial bulblets. The leaves are hollow, nearly round, and attached to the lower half of the stem. The aerial bulblets of wild garlic contaminate harvested small grains, especially wheat. Price dockage for garlic-tainted grain can be substantial, depending on the degree of contamination. Wild garlic can also cause off-flavor in milk from animals grazing infested pastures. Wild garlic is found throughout Ohio, Illinois, and Indiana, but creates the most problems in the wheat-growing areas of the state.

Wheat. Postemergence application of the higher rates of a thifensulfuron/tribenuron premix product in the spring provides good to excellent control. Apply with surfactant when wild garlic plants are less than 12 inches tall, with 2 to 4 inches of new growth. For best results, apply when wild garlic is actively growing under temperatures of 60 degrees or higher. These products can be applied using 28% UAN as the carrier, but surfactant recommendations may change. Refer to the label for more information on application in liquid fertilizer. Peak (1/4 to 1/2 ounce/A) is also labeled for control of garlic up to 8 inches tall. The higher rate provides more effective control of underground bulblets.

Postemergence application of the high rate of tribenuron or 2,4-D ester (0.75 to 1.0 lb ai/A) can prevent formation of the aerial bulblets of wild garlic, but will not control other parts of the plant. Tribenuron application timing is similar to that described for thifensulfuron/tribenuron products. Apply 2,4-D ester from mid-March to early April when the air temperatures are 60 degrees or higher.

Soybeans. Wild garlic infestations in soybeans sometimes require control measures. Effective treatments include fall or early-spring application of a chlorimuron-containing product, or preplant application of Synchrony XP (plus 0.5 lb ai/A of 2,4-D, if at least 7 days before planting). Postemergence application of Classic, chlorimuron/thifensulfuron combinations, or Synchrony XP can also be used. Harmony Extra can be applied 14 or more days before soybean planting for control of emerged wild garlic plants in early spring.

Horsenettle

Horsenettle is a perennial that spreads through creeping rootstocks, in addition to reproduction by seed. A distinguishing feature of horsenettle is the bristly stem, which is covered with hairs and spines. Leaves are alternate, oblong, and lobed, with yellow prickles on the petioles, midrib and veins. The plant produces juicy, yellow berries that are about 1/2 inch in diameter and contain the seeds. Horsnettle is found mainly in no-till fields, and is difficult to control. It typically emerges after crop planting, and postemergence herbcides are only marginally effective.

Noncrop/Fallow Areas. Application of glyphosate (3 lbs ae/A or 2% solution for spot treatment), dicamba (2 quarts/A), or 2,4-D ester (2.0 lbs ai/A) when horsenettle is in the late-bud to flowering stage are most effective. Control ranges from fair to good with these treatments. Milestone and and Forefront are effective for horsenettle control in permanent grass pastures and other noncrop areas that will not be rotated into field crops.

Corn. Preplant herbicides are not effective for control of horsenettle. Most effective suppression/control results from postemergence application of Laudis, Capreno, NorthStar (5 oz), Yukon (6 to 8 oz), or combinations of Spirit (1 ounce/A) or nicosulfuron with 1/4 to 1/2 pint/A of dicamba. Other treatments with activity include glyphosate (1.1 lb ae/A - glyphosate-resistant corn), dicamba (1/2 to 1 pint/A), and Marksman (3.5 pints/A).

Soybeans. Postemergence application of Classic (3/4 ounce/A), Synchrony XP (3/4 ounce/A), Pursuit (1.44 ounce/A), or glyphosate (Roundup Ready soybeans) can suppress horsenettle.

Horsetail (Equisetum)

Horsetail is a perennial weed that reproduces through spores (instead of seeds) and rhizomes. It is typically found in wet areas and in no-till production, and long-term management of horsetail should involve drainage and tillage where possible. Several herbicides have activity on emerged horsetail, but the lack of leaf tissue to intercept spray particles reduces herbicide effectiveness. Considerable variation occurs among Equisetum species with regard to their response to herbicides,

and the following treatments may not be effective in all populations.

Corn. Flumetsulam (Python, Hornet) is the most effective herbicide on emerged plants. Plants can be treated with a preplant application of Python or Hornet, or a postemergence application of Hornet depending upon the emergence pattern and date of crop planting. Postemergence application of Steadfast plus Status can suppress horsetail.

Soybeans. Preplant application of glyphosate plus Python can control plants during the season of application and help reduce the severity of future infestations.

Wheat. MCPA can control or suppress horsetail.

Johnsongrass

Johnsongrass is an extremely competitive perennial grass prevalent in the southern half of Ohio and Indiana, although it has been observed as far north as Wood County in northwestern Ohio and Lake and Allen Counties in Indiana. It reproduces both by seed and overwintering rhizomes (large, white, scaly, underground stems). Control of rhizome johnsongrass is an ongoing process that should include both cultural and chemical methods.

Most rhizome production occurs when johnsongrass plants reach 2 or more feet in height and begin producing seed heads. Close grazing or mowing to keep johnsongrass less than a foot tall will greatly reduce rhizome production.

Noncrop/Fallow Areas. Glyphosate provides excellent control of johnsongrass that is in the boot to head stage or anytime prior to frost. For spot treatment, use a 2% solution. For broadcast application, apply 0.75 lb ae/A glyphosate plus AMS (17 lbs/100 gallons of water) in a spray volume of 5 to 10 gpa.

Corn. Postemergence application of nicosulfuron, Beacon, NorthStar, or Steadfast Q provides the most effective control of established johnsongrass infestations. Rhizome johnsongrass plants should be at least 8 inches tall at the time of application. Glyphosate (Roundup Ready soybeans) will control seedling and rhizome johnsongrass. For most effective control of rhizome johnsongrass, apply after plants are in the boot stage. Glufosinate (22 ounces/A - LibertyLink corn), Corvus, and Laudis can also control seedling johnsongrass, but will be less effective than the other herbicides listed here in established johnsongrass infestations.

Soybeans. Postemergence application of Assure II / Targa (10 ounces/A), Fusilade DX (12 ounces/A), Fusion (12 ounces/A), or clethodim provides good to excellent control. Application should be delayed until johnsongrass reaches a height of about 10 to 20 inches (labels vary with regard to minimum height at the time of application — consult individual labels for more information). Glyphosate (Roundup Ready soybeans) will control seedling and rhizome johnsongrass. For most effective control of rhizome johnsongrass, apply after plants are in the boot stage. For any of these herbicides, a second application may be necessary to control regrowth. Postemergence application of glufosinate (LibertyLink soybeans) can suppress seedling johnsongrass.

Lambsquarters (triazine-resistant)

Triazine-resistant weeds have developed in areas where triazine herbicides (atrazine, simazine) have been used for many years, primarily in continuous corn areas. The predominant triazine-resistant weed in Ohio is lambsquarters, although some triazine-resistant pigweed also occurs. Triazine-resistant weeds are not controlled by atrazine, simazine, or metribuzin, regardless of the rate applied. Preemergence herbicides should be used in lambsquarters control programs, because postemergence herbicides are variable in their effectiveness.

Corn. Preplant or preemergence application of products containing isoxaflutole (Balance Flexx, Corvus), flumetsulam (Python, SureStart/TripleFlex, Hornet), mesotrione (Acuron, Lumax, Instigate, Lexar), or saflufenacil (Verdict, Sharpen) will control triazine-resistant lambsquarters. Preemergence applications of pendimethalin will also provide control, but may be more variable than the others. Pyroxasulfone (Zidua, Anthem) and acetochlor products (Surpass, Harness, etc.) provide fair to good control of triazine-resistant lambsquarters, but a tank-mix partner or follow-up postemergence treatment will generally be required for complete control.

Many postemergence corn herbicides can effectively control triazine-resistant lambsquarters, especially when used primarily to control plants that escape effective preemergence herbicide. Using postemergence herbicides as the sole method of control is likely to result in more variable results. See Tables 5 and 6 for postemergence herbicide ratings.

Soybeans. Metribuzin will not control triazine-resistant lambsquarters, but most other preplant/preemergence broadleaf soybean herbicides provide adequate control. Lambsquarters can be extremely difficult to control with postemergence soybean herbicides, especially when they are large or well-established. Best control results from application of glyphosate (Roundup Ready soybeans), Harmony GT (1/12 ounce/A), Synchrony STS (3/4 ounce/A), or Raptor (4 to 5 ounces/A) when plants are less than 4 inches tall. Use of crop oil instead of surfactant will improve control with Harmony GT or

Synchrony, but may increase soybean injury on non-STS soybeans. Use of MSO can improve Raptor activity, but also increases soybean injury. Some lambsquarters populations have become less sensitive to glyphosate. Postemergence glyphosate rates of 1.1 to 1.5 lbs a.e./A can provide more consistent control than lower rates.

Common Milkweed

Common milkweed, like hemp dogbane, is a problem primarily in continuous no-till fields. It may grow 4 to 5 feet tall and reproduces by seed and deep, creeping roots that overwinter and form new plants the following spring.

Noncrop/Fallow Areas. Apply glyphosate (2.25 lbs ae/A or 2% solution for spot treatment) when milkweed are in the late-bud to flower stage of growth. Glyphosate (1.5 lb ae/A) plus 2,4-D ester (0.75 lb ai/A can provide good control. Following small-grain harvest or mowing, allow milkweed to regrow to a mature stage prior to treatment.

Corn. Postemergence application of glyphosate (1.1 lb ae/A - glyphosate-resistant corn) will control or suppress milkweed. A second application may be necessary. Late post applications, when plants are in the bloom stage, will provide the most complete control of underground plant parts. Products containing dicamba provide some control or suppression. Apply when milkweed is at least 8 inches tall. Application of Yukon, NorthStar, or a combination of Spirit (1 ounce/A) with dicamba may provide better control than dicamba alone.

Soybeans. Postemergence application of glyphosate (Roundup Ready soybeans) applied at high rates will control or suppress milkweed. A second application may be necessary. Late post applications, when plants are in the bloom stage, will provide the most complete control of underground plant parts. Classic (3/4 ounce/A) and Synchrony STS (3/4 ounce/A) can suppress milkweed through the growing season.

Honeyvine Milkweed

Honeyvine milkweed is a vining perennial that spreads by seeds and long, creeping roots. It is more of a problem in long-term no-till fields. Control is made difficult by the late emergence and limited leaf area on young plants.

Noncrop/Fallow Areas. High rates of glyphosate, or combinations of glyphosate plus 2,4-D ester will provide some control when applied in fall. Apply when plants are in the bud to bloom stage or before a light frost.

Corn. Postemergence application of glyphosate (0.75 lb ae/A - glyphosate-resistant corn) will control or suppress honeyvine milkweed, but results have been variable. Make a second application if necessary. Best control may result from late postemergence application when plants are flowering. Other postemergence treatments with activity include Starane (2/3 pt/A), WideMatch (1.33 pt/A), 2,4-D ester (0.25 to 0.38 lb ai/A), dicamba (1/2 to 1 pint/A), Status (5 oz/A), and dicamba + 2,4-D (half rates of each). Beacon (3/4 ounce/A), nicosulfuron, Spirit (1 ounce/A), and Permit (1 to 1.3 ounce/A) will suppress small (1 to 6 inch) plants, but these products are likely to be more effective when combined with 2,4-D or dicamba (1/4 to 1/2 pint/A) where allowed by the label.

Soybeans. Postemergence application of glyphosate (Roundup Ready soybeans) will control or suppress honeyvine milkweed, but results have been variable. Apply higher labeled rates and make a second application if necessary. Best control may result from late postemergence application when plants are flowering. Other treatments with activity include fomesafen 1.88L (1.3 pints/A), fomesafen 2L (1.25 pints/A), Ultra Blazer (1.5 pints/A), and Cobra (12.5 ounces/A) or combinations of any of these with Basagran. These treatments can burn back the above-ground foliage under favorable conditions, but will not affect the roots.

Bigroot Morningglory

Bigroot morningglory (also called wild sweet potato) is a vining perennial that reproduces from seed and from roots. The roots are yellowish white and may be several feet long and weigh over 30 pounds. The bulk of the root system is often below the plow line. The stems grow to a length of 10 feet or more, and cause problems by twining on crops.

Noncrop/Fallow Areas. Application of high rates of glyphosate (or a 2% solution for spot treatment) in late August or when plants are in the bud stage can provide some long-term control.

Corn. Postemergence application of glyphosate (glyphosate-resistant corn) will control or suppress bigroot morningglory. Apply 1.1 lb ae/A and make a second application if necessary. Postemergence application of 2,4-D amine (0.5 lb ai/A), 2,4-D ester (0.25 to 0.38 lb ai/A), or mixtures of these with dicamba and suppress plants through the season. Status has similar activity. Applications later in the season when plants are in the bud stage will result in reduction of the morningglory population, but these can be difficult to implement without injuring corn.

Soybeans. Postemergence application of glyphosate (Roundup Ready soybeans) will control or suppress bigroot morningglory. Apply higher labeled rates and make a second application if necessary. Best control may

result from late postemergence application when plants are in the bud stage. Cobra (12.5 ounces) can provide limited suppression of vines.

Wirestem Muhly

Wirestem muhly is a perennial grass that spreads by seed and short, scaly rhizomes. The rhizomes, like those of johnsongrass or quackgrass, can be moved from farm to farm by tillage equipment. Wirestem muhly does not begin growth until late spring after the crop has emerged, making it more difficult to control than quackgrass.

Noncrop/Fallow Areas. Glyphosate can be used as a preplant treatment in early June where crop planting is delayed, or it can be applied after harvest when wirestem muhly is at least 8 inches tall and actively growing. For best results, apply at least 0.75 lb ae/A of glyphosate plus AMS (17 pounds/100 gallons water) in a spray volume of 5 to 10 gpa. For spot treatments, use a 2% solution.

Corn. Glyphosate (0.75 lb ae/A - glyphosate-resistant corn) is the most effective herbicide for wirestem muhly. Plants should be at least 8 inches tall at the time of application.

Soybeans. Postemergence application of Assure II/ Targa (8 ounces/A), Fusilade DX (12 ounces/A), Fusion (8 ounces/A), or clethodim provides good to excellent control. Apply Assure II or clethodim when wirestem muhly is 4 to 8 inches tall. Apply Fusilade or Fusion when plants are 4 to 12 inches tall. Glyphosate (Roundup Ready soybeans) will control wirestem muhly. Plants should be at least 8 inches tall at the time of application. For any of these treatments, a second application may be necessary to control regrowth.

Eastern Black Nightshade

Eastern black nightshade, a summer annual weed, develops late in the growing season and produces purple berries that stain harvested grain. Nightshade can be identified by the purple color on the underside of the older leaves. It is a shade-tolerant plant that can survive underneath the crop canopy. In addition to reducing yields and crop quality, the succulent plant and berries can “gum up” a combine so badly that it will not clear grain properly. Nightshade is a problem in soybeans primarily. Most effective control results from a combination of preemergence and postemergence herbicides.

Soybeans. Preplant or preemergence applications of many preplant/preemergence soybean herbicides will control black nightshde, but products that contain only chlorimuron and/or metribuzin will not. A follow up postemergence treatment may be necessary to control plants that emerge in mid-season. Several postemergence products are effective on eastern black nightshade if applied when weeds are small. These include Ultra Blazer (1.5 pints/A), Cobra (12.5 ounces/A), fomesafen, Pursuit (1.44 ounce/A), Raptor (4 to 5 ounces/A), glyphosate (0.75 lb ae/A - Roundup Ready soybeans), and glufosinate (29 oz/A - LibertyLink soybeans). Pursuit provides residual nightshade control, while most other postemergence herbicides have little to no residual activity.

Yellow Nutsedge

Yellow nutsedge is a perennial sedge that reproduces mainly by small, overwintering tubers located at the ends of rhizomes. The tubers begin sprouting about May 1 in Ohio. The plant looks like a grass, but has a triangular stem. It is more of a problem in wet areas and during wet years.

Corn. Acetochlor, metolachlor/s-metolachlor, and Outlook can provide good control, but surface applications are variable in activity. Preplant incorporation (2 to 3 inches deep) of these materials will provide more consistent nutsedge control than preemergence application. Control also is enhanced by combining atrazine with these herbicides.

Postemergence application of Permit (1 to 1.3 ounces/A) or Yukon (6 to 8 oz/A) when nutsedge is 4 to 12 inches tall provides the most effective control. Basagran (1.5 to 2 pints/A) or Laddok (2.3 pints/A) applied postemergence when nutsedge is 6 inches tall also suppresses or controls nutsedge, but is less effective than Permit for reduction of nutsedge populations. Atrazine plus COC may be used as a postemergence spray to control emerged yellow nutsedge when small. Postemergence applications of glyphosate can control nutsedge, but activity is usually slow.

Soybeans. Metolachlor/S-metolachlor and Outlook can provide good control, but surface applications are variable in activity. Preplant incorporation (2 to 3 inches deep) of these materials will provide more consistent nutsedge control than preemergence application.

Postemergence application of Basagran (1½ to 2 pints/A) when plants are at least 6 inches tall provides good nutsedge control. Classic (1/2 to 3/4 ounce/A) or Synchrony STS (3/4 ounce/A) provides good control of yellow nutsedge plants with 4 to 6 leaves. Postemergence application of glyphosate can control nutsedge, but activity is usually slow.

Common Pokeweed

Common pokeweed is a perennial broadleaf weed that reproduces by seed and also has an enlarged tap-

root that over-winters to provide a source of new growth the following spring. This plant is becoming more prevalent as no-tillage continues to increase. Common pokeweed can be identified by its pinkish-red colored stem and its fleshy appearance and alternate leaf pattern. The plant produces many purple berries that can stain soybeans at harvest.

Noncrop/Fallow Areas. Apply glyphosate at 1.1 to 1.5 lbs ae/A, or at 0.75 lb ae/A in combination with 2,4-D ester (0.5 to 0.75 lb ai/A) in late September or early October when plants are 8 to 24 inches tall, but before frost. For spot treatment, apply glyphosate in a 2% solution.

Cut Stump Treatments. Application of undiluted glyphosate directly to the freshly cut stump of pokeweed can provide effective control. Plants should be several feet tall at the time of cutting for best results.

Corn. Glyphosate (1.1 lb ae/A - glyphosate-resistant corn) applied postemergence when plants are at least 8 inches tall will control or suppress pokeweed. Make a second application if necessary. Other effective postemergence treatments include NorthStar, Yukon, Callisto, dicamba (1 pint/A), Status (5 oz/A), or a combination of dicamba with Spirit (1 ounce/A). Apply when plants are less than 12 inches tall.

Soybeans. Glyphosate (1.1 to 1.5 lb ae/A - Roundup Ready soybeans) applied postemergence when plants are at least 8 inches tall will control or suppress pokeweed. Control will be reduced where glyphosate is applied to very small plants, or too late in the season when plants are extremely large. Make a second application if necessary. Synchrony STS (3/4 ounce/A) and Classic/Harmony GT combinations will often suppress pokeweed through the growing season. Thorough spray coverage on the foliage of larger plants is essential to maximize herbicide activity.

Quackgrass

Quackgrass is a cool season perennial grass reproducing from seed and a dense network of small rhizomes. Weed growth often begins in early March if there are a few successive warm days. It tends to be the biggest problem where grass or grass/legume forage mixtures are grown or in areas where continuous no-till corn is grown. Growth of quackgrass is most vigorous during the spring, while temperatures are relatively cool.

Noncrop/Fallow Areas. Apply glyphosate in the spring or fall when quackgrass is at least 6 to 8 inches tall and actively growing. Apply at a rate of 0.75 lb ae/A plus AMS (17 pounds/100 gallons water) in spray volume of 5 to 10 gpa. For spot-treatment, use a 2% solution.

Corn. Atrazine provides some suppression or control of quackgrass when split-applied at high rates, but the current atrazine label allows a maximum of only 2.5 pounds per year. This rate may not be sufficient in many fields, and additional herbicides or applications will usually be necessary.

Glyphosate (0.75 lb ae/A - glyphosate-resistant corn) will control quackgrass that is at least 8 inches tall. Postemergence application of nicosulfuron, Steadfast Q (3/4 ounce/A), or Beacon (3/4 ounce/A) will provide good to excellent control of quackgrass up to 8 or 10 inches tall. Capreno and Laudis have activity on quackgrass also.

Soybeans. Postemergence application of Assure II/Targa (10 ounces/A), Fusilade DX (12 ounces/A), Fusion (12 ounces/A), or clethodim provides good to excellent control. These products should be applied when quackgrass is about 6 to 10 inches tall. Glyphosate (Roundup Ready soybeans) will control quackgrass that is at least 8 inches tall. For any of these herbicides, a second application at a lower rate may be necessary to control regrowth.

Common Ragweed (herbicide-resistant)

Many common ragweed populations in Ohio and Indiana are resistant to group 2 herbicides (Classic, FirstRate, Beacon, etc.), especially in fields with a history of non-GMO soybeans. Populations with multiple herbicide resistance, to both group 2 and 9 or group 2 and 14 herbicides (fomesafen, Cobra, flumioxazin) have also been indentified. In the populations investigated so far, all of the group 9-resistant populations have also been resistant to group 2. Common ragweed with resistance to both group 2 and 14 herbicides can be controlled by postemergence application of glyphosate in Roundup Ready soybeans. Likewise, populations with resistance to both group 2 and 9 herbicides can still be controlled by fomesafen or Cobra. However, the most effective management strategy for multiple-resistant populations may be to plant corn, in order to take advantage of the effectiveness of corn herbicides on herbicide-resistant ragweed. Use of glufosinate in LibertyLink soybeans can also be an effective tool to manage populations that have been poorly controlled by other types of herbicides.

Corn. Herbicide-resistant common ragweed populations should not be difficult to control in corn, due to the effectiveness of triazines, dicamba, and other corn herbicides. Preemergence corn herbicides can provide season-long control of common ragweed, when used at recommended rates. In glyphosate-resistant corn fields with history of poor performance of glyphosate on common ragweed, postemergence herbicide treatments should include other herbicides along with glyphosate if

the preemergence herbicides fail to adequately control the ragweed. Most effective partners for glyphosate in these mixtures include Status, Impact, Callisto, Laudis, and dicamba. The rate of the partner herbicide should be high enough to control common ragweed that appears to be resistant to glyphosate. In LibertyLink corn, postemergence application of glufosinate or glufosinate plus atrazine effectively controls ragweed plants that escape residual herbicides.

Soybeans. It is essential that no-till soybean fields with resistant populations receive an effective burndown treatment with 2,4-D ester to ensure that that the field is weedfree at the time of planting. A combination of preemergence and postemergence herbicides will provide the most effective control of populations resistant to group 2 and/or group 9 (there are no effective preemergence herbicides where the ragweed is resistant to both group 2 and 14). Where the population is known to still be sensitive to group 2, any of the following preemergence herbicides can provide effective control: Canopy/Cloak, FirstRate, Surveil, Valor XLT, Envive, Sonic, Authority First/XL/MAXX, or Trivence. Where the population is group 2 -resistant, but still sensitive to group 14, flumioxazin products, Trivence, Ransom, Prefix, Intimidator, or metribuzin can provide fair to good control.

Postemergence application of glyphosate (Roundup Ready soybeans) should control any common ragweed population that is not glyphosate-resistant. Glufosinate (29 oz/A - LibertyLink soybeans) will control common ragweed that is resistant to group 2, 9, or 14 herbicides. Fomesafen 1.88L (1.3 pts) or Cobra/Phoenix (12.5 oz) will control populations that are resistant to both group 2 and 9, although fomesafen has been more effective in OSU research. Apply postemergence herbicides when ragweed plants are no more than 6 inches tall for most effective control. Where it is necessary to mix fomesafen or Cobra with glyphosate to control glyphosate-resistant plants, apply with the adjuvants specified on the labels for these products. This is likely to result in the use of MSO or COC. Similarly, Flexstar GT should be applied with COC or MSO in glyphosate-resistant populations.

Giant Ragweed

This annual weed emerges as early as March and will continue to germinate through the spring and early summer. Giant ragweed is extremely competitive and is most difficult to control in soybeans and other broadleaf crops. Its ability to germinate and emerge from deep in the soil allows it to escape many soil-applied herbicides. The most dense populations occur in tilled soil. Populations can decrease in long-term no-till with proper management. Many populations of giant ragweed in Ohio and Indiana are resistant to group 2 herbicides (Classic, FirstRate, Beacon, etc.), especially in fields with a history of non-GMO soybeans. Populations with resistance to glyphosate (group 9) have also been identified, and some of these have multiple-resistance, to both group 2 and 9.

Corn. Early-emerging giant ragweed plants should be removed prior to planting with tillage or a preplant herbicide treatment. A preplant application of 2,4-D ester (0.5 lb ai/A) plus atrazine provides effective control of giant ragweed plants that emerge early in the spring before planting. For preplant control of large plants, the addition of glyphosate or Gramoxone may be necessary.

A combination of preemergence followed by postemergence herbicides provides the most effective giant ragweed control, and this approach should be used in any field where control of giant ragweed has been inadequate in previous years. Most effective preemergence treatments are those that contain atrazine and another broadleaf herbicide with activity on giant ragweed. These include Acuron, Lumax, Lexar, or a combination of atrazine and one of the following: SureStart/TripleFlex, Instigate, Hornet, Balance Flexx, Corvus, or Verdict/Sharpen.

A follow up postemergence treatment is usually necessary in fields infested with giant ragweed, and some preemergence products are intended for use only in preemergence plus postemergence programs. Many postemergence corn herbicides will control giant ragweed, especially if they contain atrazine or dicamba (see Tables 5 and 6 - corn herbicide effectiveness ratings). In glyphosate-resistant corn fields with a history of poor performance of glyphosate on giant ragweed, postemergence herbicide treatments should include other herbicides along with glyphosate. Most effective partners for glyphosate in these mixtures include Status, Impact/Armezon, mesotrione products, Laudis, and dicamba. The rate of the partner herbicide should be high enough to control giant ragweed that appears to be resistant to glyphosate. In LibertyLink corn, postemergence application of glufosinate or glufosinate plus atrazine effectively controls ragweed plants that escape residual herbicides.

Soybeans. A combination of preemergence followed by postemergence herbicides provides the most effective giant ragweed control, and this approach should be used in any field where control of giant ragweed has been inadequate in prior years. Early-emerging giant ragweed plants should be removed prior to planting with tillage or a preplant herbicide treatment. While 2,4-D ester alone can control small plants, it should be combined with glyphosate or Gramoxone when plants are more than a few inches tall. Where the use of 2,4-D is not possible, application of saflufenacil (Sharpen, Op-

till PRO, or Verdict) plus either glyphosate or glufosinate, or a combination of glufosinate and metribuzin should be effective. Glyphosate is somewhat variable for burndown of early-emerging giant ragweed plants, and use of the appropriate rate based on plant size is important. The addition of 2,4-D ester or saflufenacil is also recommended for consistently effective control, especially in fields with a prior history of poor glyphosate performance on giant ragweed.

Include herbicide(s) with residual activity in the preplant burndown treatment (or apply these after planting where tillage is used), which involves the use of a product containing chlorimuron or cloransulam. These herbicides will reduce the giant ragweed population and slow the growth of remaining plants to build more flexibility in the postemergence application window. None of these herbicides will control group-2 giant ragweed, however. Prefix and Intimidator can provide some residual group 2 -resistant giant ragweed control, but their activity is variable, and the field cannot be treated POST with any fomesafen products where these PRE herbicides are used.

Where residual herbicides have been applied and are effective, or the giant ragweed population is very low, it may be possible to obtain adequate control with a single postemergence application. However, where ragweed populations are moderate to dense, early postemergence herbicide applications need to be followed by a second application to control late-emerging plants. The most effective postemergence treatments for control of giant ragweed (4 to 8 inches tall), that are not herbicide-resistant, in non-GMO soybeans include: FirstRate (0.3 ounce/A), fomesafen 1.88L (1.3 pints/A), or FirstRate + fomesafen 1.88L (0.3 ounces + 1 pint/A). Results with Classic and Synchrony XP have been more variable than with FirstRate. In STS soybeans, combinations of Synchrony XP plus Cobra will provide more consistent control than Synchrony alone. FirstRate, Classic, Synchrony, and Pursuit do not control group 2-resistant ragweed.

In Roundup Ready soybeans, make an initial postemergence application of glyphosate when ragweed are about 6 to 10 inches tall. Glyphosate rate for this application should be 1.1 to 1.5 lbs ae/A (use the higher rate in fields where giant ragweed has not been adequately controlled in the past). Make a second application of glyphosate (0.75 lbs ae/A) three to four weeks later as needed to control later-emerging plants or to improve control of plants that survive the first application. In continuous Roundup Ready soybean fields and fields with a history of giant ragweed control problems (but where glyphosste still has substantial activity), it is essential to make two postemergence glyphosate applications at the rates and timings indicated here (in addition to the use of a burndown with 2,4-D and residual herbicides as described above). Failure to do so is likely to result in giant ragweed escapes later in the season, and these plants will be extremely difficult to control.

Use of glufosinate in LibertyLink soybeans and can be an excellent tool to manage giant ragweed, especially those populations that have become resistant to ALS inhibitors or glyphosate. Apply glufosinate (29 oz/A) postemergence initially when ragweed plants are about 4 to 8 inches tall. Make a second application (22 oz/A) about three weeks later as needed to control later-emerging plants or to improve control of plants that survive the first application.

Herbicide-resistant giant ragweed. Giant ragweed populations with group 9 resistance occur in Ohio and Indiana, and some populations have resistance to both group 2 and 9. Postemergence control of these populations in soybeans can be extremely difficult, and the most effective management strategy may be to plant corn, in order to take advantage of the effectiveness of corn herbicides on resistant ragweed. It is essential that no-till soybean fields with resistant populations receive a preplant treatment of 2,4-D ester, to ensure that that the field is weedfree at the time of planting. Preemergence soybean herbicides listed in the previous section can be included in the preplant herbicide treatment, although they will not control plants that are group 2-resistant (they may still have activity on the plants in the population that are not resistant).

Use of glufosinate in LibertyLink soybeans is the most effective tool for management of glyphosate-resistant giant ragweed populations. Apply glufosinate (29 oz/A) postemergence initially when ragweed plants are about 4 to 6 inches tall. Make a second application (22 oz/A) about three weeks later as needed to control later-emerging plants or to improve control of plants that survive the first application. Ohio State and Purdue research has shown that resistant populations can also be managed with multiple applications of group 14 herbicides (fomesafen, Cobra), although this approach may lead to the development of resistance to these herbicides as well. The best approach is to make an initial application of fomesafen 1.88L (1.3 to 1.6 pts/A) or Flexstar GT when plants are 4 to 8 inches tall. This should be followed with postemergence application of Cobra (10 oz/A) three to four weeks later. Where a PPO inhibitor is mixed with glyphosate to control glyphosate-resistant plants, apply with the adjuvants specified on the labels for the fomesafen or Cobra in order to optimize their activity. This is likely to result in the use of MSO (fomesafen) or COC (Cobra), and one of these adjuvants should be added to Flexstar GT in this situation also.

Perennial Sowthistle

Perennial sowthistle is a perennial broadleaf weed that spreads by seed and creeping roots. Identifying characteristics are a smooth stem with milky juice and a whitish coating on the surface, long lobed leaves with spiny edges, and yellow flower that is about 1½ inches across.

Noncrop/Fallow Areas. Apply glyphosate (2.25 lbs ae/A or a 2% solution for spot treatment) when plants are in the full-rosette stage for fair to good control. Effective control can be obtained using dicamba (2 quarts/A) or 2,4-D ester (2 lb ai/A) when plants are in the bud to flower stage. Avoid tillage for 7 days after application.

Corn. Atrazine applied preplant/preemergence (1.5 pounds/A) or postemergence (2 pounds/A) can provide good control of sowthistle. Dicamba (1/2 to 1 pint/A), Status (5 oz/A), or Marksman (3.5 pints/A) provide fair control when applied to sowthistle at least 6 inches tall. Apply dicamba with drop nozzles if corn is more than 8 inches tall to avoid crop injury. Stinger (1/3 to 2/3 pint/A) or Hornet (3 to 5 oz/A) provides fair control when applied at the rosette to bud stage. Postemergence application of glyphosate (1.1 lb ae/A - glyphosate-resistant corn) will control or suppress sowthistle.

Soybeans. Preplant or premeergence applications of a chlorimuron-containing product provides fair to good control. Postemergence application of Classic (3/4 ounce/A) or Synchrony XP (3/4 ounce/A) when sowthistle are in the early- to mid-rosette stage provides suppression to fair control. Postemergence application of glyphosate (Roundup Ready soybeans) will control or suppress sowthistle.

Wheat. Application of high rates of tribenuron or a thifensulfuron/tribenuron premix product when sowthistle are 4 to 8 inches tall provides fair control. Stinger (1/3 pint/A) or Curtail (2 to 2 2/3 pints/A) provides fair control when applied at the rosette to bud stage.

Star-of-Bethlehem

Star-of-Bethlehem is a bulbous perennial emerging in early spring and maturing in late spring or early summer. The leaves of this weed appear grass-like, and are green and fleshy with a prominent whitish midrib. The leaves originate from a central bulb. Flowers have 6 white petals with a green stripe on the underside of each petal. Star-of-Bethlehem has been most problematic in no-till soybean fields, but is also found in no-till corn. The thick vegetation and bulb density of this plant can interfere with crop establishment and reduce crop vigor.

All Crops. The most effective preplant treatment is Gramoxone SL applied at 2 to 3 pts/A. This treatment will provide control during the season of application and also reduce the severity of future infestations.

Corn. Preplant application of atrazine provides fair control during the season of application, but will not reduce the population.

Soybeans. Preplant application of a flumioxazin product can suppress star-of-Bethlehem during the season of application, but will not reduce the population.

Canada Thistle

Canada thistle is a perennial weed that spreads both by seed and creeping roots. Canada thistle plants emerge early in the spring and tend to grow in dense, spreading patches. This weed is extremely competitive and can be a problem in all crops.

Noncrop/Fallow Areas. The most effective treatment for control of Canada thistle is glyphosate applied in late spring or early fall when thistles are in the bud-to-flower stage. Fall treatment will be most successful when thistles have been mowed or clipped off earlier in the season and allowed to regrow to the bud stage (or to a height of at least 10 to 14 inches). This method may be used in noncrop areas and fallow fields, or following small-grain harvest.

For fall treatment, apply 0.75 lb ae/A of glyphosate plus AMS (17 lbs per 100 gallons water) in a spray volume of 5 to 10 gallons per acre, or 1.5 lb ae/A of glyphosate in spray volumes greater than 10 gallons per acre. For most effective control of thistle, do not mix other herbicides with glyphosate. High rates (1 to 2 quarts/A) of dicamba or 2,4-D are generally less effective than glyphosate, but a low-cost application of 2,4-D will provide some long-term control of thistle. Alternatively, any of these herbicides may be applied as a spot treatment using a 2 percent solution. Treatment with glyphosate, dicamba, or 2,4-D in this manner should be delayed until thistles regrow enough to begin producing buds, or applied as late in the fall as possible. Thistle plants will survive a few light frosts, but apply before the first freeze.

Wheat. Stinger (1/3 pint/A), Curtail (2 to 2 2/3 pts/A), and combinations of 2,4-D with high rates of Express/Nuance controls or suppresses Canada thistle, preventing harvest problems. Stinger provides the most complete thistle kill, but is more expensive than the other three herbicides. Huskie, or dicamba + 2,4-D will also often suppress Canada thistle to the point that it does not interfere with harvest.

Corn. Most effective postemergence control of the entire plant results from application of Stinger (2/3 pint/A), Hornet (4 to 5 ounces/A) plus a few ounces of Stinger, or glyphosate (1.1 lb ae/A - glyphosate-resistant corn). Apply Stinger/Hornet when thistles are at least 4

inches tall and before the bud stage. Glyphosate should be applied when thistles are in at least the bud stage for best results; earlier applications will control thistle through the growing season.

Status (5 oz/A) or Hornet (4 to 5 ounces/A) will effectively control the above-ground part of the plant. Postemergence application of Basagran/Broadloom (1 quart/A), Laddok (2.3 pints/A), or glufosinate plus atrazine (LibertyLink corn) will control above-ground growth of actively growing Canada thistle in the 8-inch to bud stage. Other treatments with activity on thistle include bromoxynil/atrazine, Marksman, dicamba, dicamba + 2,4-D, NorthStar, Yukon, and combinations of Spirit, Steadfast, or nicosulfuron with dicamba. Most of these treatments will control or suppress the above-ground part of the plant, which will help prevent further spread.

Soybeans. Glyphosate (1.1 lb ae/A - Roundup Ready soybeans) is the most effective postemergence treatment. Late post applications, when plants are in the bud to flower stage, will provide the most complete control of underground plant parts. To prevent yield loss where thistle populations are high, apply when thistles are small and retreat regrowth as necessary. Postemergence applications of Basagran (2 pints/A) will control above-ground parts of the plant or suppress growth of Canada thistle. Regrowth usually occurs, but this treatment will reduce competition from Canada thistle in soybeans and help prevent production of more rootstock. Apply when thistle plants are from 8 inches tall to the bud stage. COC should be included in the spray mixture. A second application at the same rate may be made 7 to 10 days later, if necessary. Other products and mixtures with activity on thistle include fomesafen and mixtures of Basagran with fomesafen, Ultra Blazer, or Cobra. Postemergence application of Pursuit (1.44 ounces/A), Classic (2/3 to 3/4 ounce/A), FirstRate (0.3 oz/A), and Synchrony XP (3/4 ounce/A) may also suppress thistle growth, but results have been variable.

Waterhemp

Waterhemp is an annual weed that closely resembles smooth and redroot pigweeds that is abundant in Illinois and indiana, and starting to spread throughout Ohio. Waterhemp has no hair on the stem or leaves, while most other pigweeds have some hair. It often has a long and narrow leaf shape with wavy leaf margins and a shiny or glossy appearance. While a number of herbicides are effective for control of waterhemp, this weed's ability to germinate and emerge late in the season make it difficult to control with one herbicide application. The increase in population of this weed seems to also be due to its greater tolerance to herbicides in general, compared to other pigweeds,and especially to group 2 and 9 herbicides. Waterhemp populations across the north central region have developed resistance to herbicides in groups 2, 5, 9, 14, and 27 and many are resistant to multiple sites of action.

Corn. Many preplant/preemergence corn herbicides provide effective control of waterhemp, especially when mixed with atrazine (see Table 7 - corn herbicide effectiveness ratings). A follow-up postemergence treatment may be necessary in dense populations or if rainfall promotes emergence later in the season. Postemergence treatments containing atrazine, 2,4-D, dicamba, Status, mesorione products, Laudis, Corvus, Impact, and glyphosate (glyphosate-resistant corn) are effective. Glufosinate plus atrazine (LibertyLink corn) will control small waterhemp.

Soybean. For best results, start with a preplant or preemergence herbicide with activity on waterhemp (See Table 18 - soybean herbicide effectiveness ratings). Preemergence herbicides will greatly reduce the waterhemp population, and provide more flexibility in the postemergence application window. A postemergence treatment will usually be required to control late-emerging plants. Effective postemergence treatments include Ultra Blazer, Cobra, fomesafen, and glufosinate (LibertyLink soybeans), which should be applied when waterhemp plants are less than 4 inches tall. Glyphosate (Roundup Ready soybean) can be effective where the waterhemp population is not resistant to glyphosate.

Volunteer corn

The risk of volunteer corn varies from year to year, depending upon the severity of problems with stalk breakage and unharvested ears in the previous fall. Much of the volunteer corn is now resistant to glyphosate or glufosinate, and some has resistance to both herbicides. As a result, volunteer corn will often not be controlled in soybeans by postemergence application of glyphosate or glufosinate, and the addition of a postemergence grass herbicide will be required. These herbicides should be added to the first postemergence application in a Roundup Ready soybean field, which will ensure effective control of small volunteer corn.

Soybeans. In non-GMO soybeans, any type of volunteer corn can be controlled by inclusion of Assure II/Targa, Select Max, Fusion, Fusilade or clethodim in postemergence herbicide programs. Activity of most of these herbicides is maximized by use of COC or MSO, plus AMS (NIS + AMS should be used with Select Max). Control can be more variable when applied in a mixture with a glyphosate product that contains surfactant, in the absence of COC or MSO. Follow local recommenda-

tions and product literature that can specify use of COC or MSO in mixtures with glyphosate.

Corn. Volunteer corn can be impossible to control in continuous corn, especially when the volunteer plants have resistance to both glyphosate and glufosinate. Several scenarios can occur in continuous corn, as follows: 1) where non-GMO corn was planted in 2010, glyphosate-resistant or LibertyLink corn can be planted in 2011, and treated with glyphosate or glufosinate; 2) where LibertyLink corn was planted in 2010, glyphosate-resistant corn can be planted in 2011, and treated with glyphosate; or 3) where glyphosate-resistant corn was planted in 2010, LibertyLink corn can be planted in 2011, and treated with glufosinate. Glufosinate can be somewhat variable for control of volunteer corn, but has the potential to at least suppress it to the point of being non-competitive. There are no options for control of volunteer corn where the previous year's corn had both glyphosate resistance and LibertyLink traits.

Table 22. Corn and Soybean Herbicide Premix Information

Liquid Premixes for Corn			
Name	**Active Ingredients (lbs active/gallon)**	**Formulation Equivalents**	
Acuron 3.44L	atraxine (1) S-metolachlor (2.14) mesotrione (0.24)	3 qts =	0.75 lb ai atrazine + 1.7 pts Dual II Magnum 7.64EC + 5.76 oz Callisto 4L
Anthem 2.15L	pyroxasulfone (2.09) fluthiacet-methyl (0.063)	10 oz =	3 oz Zidua 85DF + 0.7 oz Cadet 0.91L
Anthem ATZ 4.5L	atrazine (4) pyroxasulfone (0.485) fluthiacet-methyl (0.014)	2.5 pts =	1.25 lb ai atrazine + 2.85 oz Zidua 85DF + 0.61 oz Cadet 0.91L
Armezon PRO 5.35L	topramezone (0.1) dimethenamid (5.25)	16 oz =	0.57 oz Armezon 2.8L + 14 oz Outlook 6EC
Bicep II Magnum 5.5L/ Cinch ATZ/Charger Max ATZ	S-metolachlor (2.4) atrazine (3.1)	2.1 qts =	1.3 pts Dual II Magnum 7.64EC + 1.6 lbs ai atrazine
Buctril/atrazine 3L or Moxy/atrazine 3L	bromoxynil (1.0) atrazine (2.0)	2 pts =	1 pt bromoxynil 2S + 0.5 lb ai atrazine
Callisto GT 4.18L	mesotrione (0.38) glyphosate (3.8)	2 pts =	3 oz Callisto 4L + 0.95 lb glyphosate acid
Callisto Xtra 3.7L	mesotrione (0.5) atrazine (3.2)	24 oz =	3 oz Callisto 4L + 0.6 lbs ai atrazine
Capreno 3.45L	tembotrione (2.88) thiencarbazone-methyl (0.57)	3 oz =	2.5 ox Laudis 3.5L + 0.21 oz ai thiencarbazone
Corvus 2.63SC	isoxaflutole (1.88) thiencarbazone-methyl (0.75)	5.6 oz =	5.3 oz Balance Flexx 2L + 0.52 oz ai thiencarbazone
Degree Xtra 4L	acetochlor (2.69) atrazine (1.35)	3 qts =	1.9 lbs ai acetochlor + 1 lb ai atrazine
Expert 4.88L	s-metolachlor (1.74) atrazine (2.14) glyphosate (1.0)	3 qts =	1.36 pts Dual II Magnum 7.64 EC + 1.6 lbs ai atrazine + 0.56 lbs glyphosate acid
FulTime 4L	acetochlor (2.4) atrazine (1.6)	3.0 qts =	1.8 lbs ai acetochlor + 1.2 lbs ai atrazine
Halex GT 4.38L	s-metolachlor (2.09) mesotrione (0.209) glyphosate (2.09)	3.6 pts =	1 pt Dual II Magnum 7.68EC + 3 oz Callisto 4L + 0.94 lbs glyphosate acid
Harness Xtra 5.6L/ Confidence Xtra 5.6L	acetochlor (3.1) atrazine (2.5)	2.4 qts =	1.86 lb ai acetochlor + 1.5 lbs ai atrazine
Harness Xtra 6L/ Confidence Xtra 6L	acetochlor (4.3) atrazine (1.7)	2.4 qts =	2.6 lb ai acetochlor + 1 lb ai atrazine
Keystone 5.25L	acetochlor (3.0) atrazine (2.25)	2.6 qts =	1.95 lb ai acetochlor + 1.5 lbs ai atrazine
Laddok S-12 5L	bentazon (2.5) atrazine (2.5)	1.67 pts =	1 pt Basagran 4L + 0.5 lb ai atrazine
Lumax EZ 3.67L	s-metolachlor (2.49) atrazine (0.935) mesotrione (0.249)	3 qts =	1.94 pts Dual II Magnum 7.68EC + 0.7 lb ai atrazine + 6 oz Callisto 4L
Lexar EZ 3.7L	s-metolachlor (1.74) atrazine (1.74) mesotrione (0.224)	3 qts =	1.35 pts Dual II Magnum 7.68EC + 1.3 lbs ai atrazine + 5.3 oz Callisto 4L
Marksman/Sterling Plus/ Banvel-K+atrazine 3.2L	dicamba (1.1) atrazine (2.1)	3.5 pts =	1 pt dicamba 4L + 0.9 lb ai atrazine
Shotgun 3.25L	atrazine (2.25) 2,4-D (1.0)	3 pts =	0.85 lb ai atrazine + 0.75 pt 2,4-D 4L
Solstice 4L	mesotrione (3.784) fluthiacet methyl (0.216)	3 oz =	3 oz Callisto 4L + 0.7 oz Cadet 0.91L
SureStart/TripleFLEX/TripleFLEX II 4.25L	acetochlor (3.75) clopyralid (0.38) flumetsulam (0.12)	1.75 pts =	0.82 lb ai acetochlor + 3.5 oz Stinger 3L + 0.5 oz Python 80%WDG
Stalwart Xtra 5.5L	atrazine (3.1) metolachlor (2.4)	2.1 qts =	1.6 lbs ai atrazine + 1.3 pts Stalwart C 7.8EC
Volley/Breakfree ATZ 5.25L	atrazine (2.25) acetochlor (3.0)	2.8 qts =	1.6 lb ai atrazine + 2.1 lb ai acetochlor
Verdict 5.57EC	dimethenamid-P (5.0) saflufenacil (0.57)	13 oz =	11 oz Outlook 6EC + 2.6 oz Sharpen 2.85L
WideMatch 1.5L	clopyralid (0.75) fluroxypyr (0.75)	1.3 pts =	5 oz Stinger 3L + 10 oz Starane 1.5L
Zemax 3.67L	mesotrione (0.33) s-metolachlor (3.34)	2 qts =	5.3 oz Callisto 4L + 1.7 pts Dual II Magnum 7.68EC

Table 22. Continued

Liquid Premixes for Soybeans			
Name	**Active Ingredients (lbs active/gallon)**	**Formulation Equivalents**	
Authority Assist 4L	sulfentrazone (3.33) imazethapyr (0.67)	6 oz =	5 oz Spartan 4L + 2 oz Pursuit 2L
Boundary/Ledger/Tailwind 6.5EC	metribuzin (1.25) s-metolachlor (5.25)	2.1 pts =	0.43 lb metribuzin 75DF 1.4 pts Dual II Magnum 7.64EC
BroadAxe 7L	S-metolachlor (6.3) sulfentrazone (0.7)	25 oz =	1.3 pts Dual II Magnum 7.64EC + 4.4 oz Spartan 4L
Cheetah Max 3L	glufosinate (2) fomesafen (1)	34 oz =	29 oz Liberty/Cheetah + 18 oz Flexstar
Extreme 2.17L	imazethapyr (0.17) glyphosate (2)	3 pts =	4 oz Pursuit 2L + 0.56 lb glyphosate acid
Flexstar GT	fomesafen (0.66) glyphosate (2.63)	3.75 pts =	1.3 pts fomesafen 1.88L + 1.2 lbs glyphosate acid
Fusion 2.66EC	fluazifop (2.0) fenoxaprop (0.66)	8 oz =	8 oz Fusilade DX 2L + 8 oz Option II 0.67L
Intimidator 4.81L	s-metolachlor (3.39) metribuzin (0.75) fomesafen (0.67)	2.8 pts =	1.24 pts Dual II Magnum 7.64EC 5.6 oz metribuzin 75DF 0.93 pts fomesafen 2L
Marvel 3L	fomesafen (2.88) fluthoacet methyl (0.12)	7.25 oz =	10.4 oz fomesafen 2L 0.95 oz Cadet 0.91L
Matador 4.7L	metolachlor (4.01) metribuzin (0.56) imazethapyr (0.13)	2 pts =	1 lb ai/A metolachlor 3 oz metribuzin 75DF 2 oz Pursuit 2L
Prefix/Statement	s-metolachlor (4.34) fomesafen (0.95)	2 pts =	1.1 pts Dual Magnum 7.62EC + 0.95 pt fomesafen 2L
Pummel 5.25L	metolachlor (5) imazethapyr (0.25)	2 pt =	1.25 lb ai metolachlor + 4 oz Pursuit 2L
Sequence 5.25L	glyphosate (2.25) s-metolachlor (3)	3.5 pts =	1 lb glyphosate acid + 1.3 pts Dual II Magnum
Storm 4S	bentazon (2.67) acifluorfen (1.33)	1.5 pts =	1 pt Basagran 4L + 1 pint Blazer 2S
Spartan Advance	sulfentrazone (0.56) glyphosate acid (3.0)	30 oz =	4.2 oz Spartan 4L + 0.7 lbs glyphosate acid
Tackle 4.128SL	imazethapyr (0.128) glyphosate (3)	32 oz =	2 oz Pursuit 2L + 0.75 lb glyphosate acid
Torment 2.5L	fomesafen (2) imazethapyr (0.5)	1 pt =	16 oz fomesafen 2L + 4 oz Pursuit 2L
Warrant Ultra 3.45L	acetochlor (2.82) fomesafen (0.63)	60 oz =	56 oz acetochlor 3L + 19 oz Reflex 2L
Verdict 5.57EC	dimethenamid-P (5.0) saflufenacil (0.57)	5 oz =	4.2 oz Outlook 6EC + 1 oz Sharpen 2.85L
Vise 5.4L	metolachlor (4.45) fomesafen (0.95)	2.5 pt =	1.4 lb ai metolachlor + 19 oz fomesafen 2L

Table 22. Continued

Dry Premixes for Corn			
Name	**Active Ingredients (percentage active)**	**Formulation Equivalents**	
Basis Blend 30DF	rimsulfuron (20%) thifensulfuron (10%)	0.825 oz =	0.16 oz ai rimsulfuron + 0.16 oz HarmonySG
Crusher 50DF	rimsufuron (25%) thifensulfuron-methyl (25%)	1 oz =	0.25 oz ai rimsulfuron + 0.5 oz HarmonySG
Distinct 70DF	dicamba (48.6%) diflufenzopyr (21.4%)	4 oz =	4 oz dicamba 4L + 0.9 oz ai diflufenzopyr
Fierce 76WDG	flumioxazin (33.5%) pyroxasulfone (42.5%)	3 oz =	2 oz flumioxazin 51WDG + 1.5 oz Zidua 85WDG
Harrow 75DF	rimsulfuron (25%) thifensulfuron (75%)	0.5 oz =	0.25 oz ai rimsulfuron + 0.125 oz Harrass
Hornet 78.5WDG	flumetsulam (18.5%) clopyralid (60%)	5.0 oz =	1.16 oz Python 80 DG + 6.7 oz Stinger 3L
Instigate 45.8%WDG	rimsulfuron (4.17%) mesotrione (41.67%)	6 oz =	0.35 oz ai rimsulfuron + 5 oz Callisto 4L
Northstar 47.4DF	primisulfuron (7.5%) dicamba (39.9%)	5.0 oz =	0.5 oz Beacon 75DF + 4.0 oz dicamba 4L
Prequel 45WDG	rimsulfuron (15%) isoxaflutole (30%)	1.66 oz =	0.25 oz ai rimsulfuron + 0.66 oz isoxaflutole 75WDG
Realm Q 38.75WDG	rimsulfuron (7.5%) mesotrione (31.25%)	4 oz =	0.3 oz ai rimsulfuron + 2.5 oz Callisto 4L
Resolve Q 22.4WDG	rimsulfuron (18.4%) thifensulfuron (4%)	1.25 oz =	0.23 oz ai rimsulfuron + 0.1 oz Harmony SG
Revulin Q 51.2WDG	nicosulfuron (14.4%) mesotrione (36.8%)	4 oz =	1.06 oz Accent Q 54.5WDG + 2.9 oz Callisto 4L
Spirit 57DF	prosulfuron (14.2%) primisulfuron (42.8%)	1.0 oz =	0.25 oz Peak 57DF + 0.57 oz Beacon 75DF
Status 56DF	dicamba (40%) diflufenzopyr (16%)	5 oz =	4 oz dicamba 4L + 0.8 oz ai diflufenzopyr
Steadfast Q 37.7WDG	rimsulfuron (12.5%) nicosulfuron (25.2%)	1.5 oz =	0.19 oz ai rimsulfuron 0.7 oz Accent Q 54.5WDG
Yukon 67.5DF	halosulfuron dicamba	4 oz =	0.67 oz Permit 75DF 4.4 oz dicamba 4L

Table 22. Continued

Dry Premixes for Soybeans			
Name	**Active Ingredients (percentage active)**	**Formulation Equivalents**	
Afforia 50.8 WDG	flumioxazin (40.8%) tribenuron (5%) thifensulfuron (5%)	2.5 oz =	2 oz flumioxazin 51WDG + 0.25 oz Express 50DF + 0.25 oz Harmony 50DF
Authority First 70WDG	sulfentrazone (62.1%) cloransulam (7.9%)	3 oz =	2.5 oz Spartan 75DF + 0.28 oz FirstRate 84DF
Authority MAXX	sulfentrazone (62.1%) chlorimuron (3.9%)	6 oz =	5 oz Spartan 75DF 0.94 oz Classic 25DF
Authority MTZ 45WDG	sulfentrazone (18%) metribuzin (27%)	10 oz =	2.4 oz Spartan 75DF + 0.17 lb ai metribuzin
Authority XL	sulfentrazone (62.2%) chlorimuron (7.8%)	4 oz =	3.3 oz Spartan 75DF + 1.24 oz Classic 25DF
Canopy/Cloak 75DF	chlorimuron (10.7%) metribuzin (64.3%)	4 oz =	1.7 oz Classic 25DF + 0.16 lb ai metribuzin
Canopy EX/Cloak EX/Fallout 29.5DF	chlorimuron (22.7%) tribenuron (6.8%)	1.5 oz =	1.4 oz Classic 25DF + 0.2 oz Express 50DF
Enlite 47.9 WDG	chlorimuron (2.85%) flumioxazin (36.21%) thifensulfuron (8.8%)	3.5 oz =	0.4 oz Classic 25DF + 2.5 oz flumioxazin 51WDG + 0.62 oz Harmony SG 50DF
Envive 41.3 DG	chlorimuron (9.2%) thifensulfuron (2.9%) flumioxazin (29.2%)	3 oz =	1.1 oz Classic 25DF + 0.17 oz Harmony SG 50DF + 1.7 oz flumioxazin 51WDG
Fierce 76WDG	flumioxazin (33.5%) pyroxasulfone (42.5%)	3 oz =	2 oz flumioxazin 51WDG + 1.5 oz Zidua 85WDG
Fierce XLT 62.4WDG	chlorimuron (6.7%) flumioxazin (24.6%) pyroxasulfone (31.2%)	4.5 oz =	1.2 oz Classic 25DF + 2.2 oz flumioxazin 51WDG + 1.65 oz Zidua 85WDG
Latir/Militia 55WDG	flumioxazin (31.5%) imazethapyr (23.5%)	4.25 oz =	2.6 oz flumioxazin 51WDG + 4 oz Pursuit 2L
Optill PRO Optill PRO WDG component	Co-pack of 68WDG component with Outlook imazethapyr (50.2%) saflufenacil (17.8%)	2 oz =	4 oz Pursuit 2L + 1.0 oz Sharpen 2.85L
Ransom 68.9WDG	metribuzin (56%) flumioxazin (12.9%)	10 oz =	0.47 oz metribuzin 75DF + 0.16 oz flumioxazin 51WDG
Sonic 70WDG	sulfentrazone (62.1%) cloransulam (7.9%)	3 oz =	2.5 oz Spartan 75DF + 0.28 oz FirstRate 84DF
Surveil 48WDG	flumioxazin (36%) cloransulam (12%)	2.8 oz =	2 oz flumioxazin 51WDG + 0.4 oz FirstRate 84DF
Synchrony XP 28.4WDG	chlorimuron (21.5%) thifensufuron (6.9%)	0.75 oz =	0.64 oz Classic 25DF + 0.069 oz Harmony GT 75DF
Trivence 61.3%WDG	chlorimuron (3.9%) flumioxazin (12.8%) metribuzin (44.6%)	8 oz =	1.2 oz Classic 25DF + 2 oz flumioxazin 51WDG + 4.75 oz metribuzin 75DF
Valor XLT/Rowel FX 40.3WDG	chlorimuron (10.3%) flumioxazin (30%)	3 oz =	1.23 oz Classic 25DF + 1.76 oz flumioxazin 51WDG

Table 23. Restrictions on Crop Rotation

This table gives the recrop intervals for the planting of rotational crops following the application of corn and soybean herbicides. If a herbicide is not listed on the table, there are no restrictions on rotation, provided the crop on which that herbicide is applied is grown to full maturity and harvested. Refer to the following scale:

NR = No restriction, assuming that the corn or soybean crop is taken to harvest. Where the corn crop fails and soybeans will be planted within 1 to 2 months of corn herbicide application, consult the label for further precautions.

BA = Conduct a field bioassay prior to rotating to this crop; consult the label for more information. Where products containing atrazine or Princep are used, see the footnote below for precautions on rotation to soybeans and other crops. **Consult herbicide labels for precautions regarding rotation to seed corn or specialty corn.**

Herbicide	Months Before Planting								
	Corn	Wheat	Oats	Alfalfa	Clover	Soybeans	Tomatoes	Popcorn	Sweet Corn
Acuron	NR	4	18	18	18	10	18	NR	NR
Afforia	0.5-1	2	5-10	5-10	5-10	1-7 days	6-12+BA	4	4
Anthem/AnthemATZ	NR	18	18	18	18	18	18	18	18
Armezon PRO	NR	4	4	9	18	9	18	NR	NR
Atrazine[a]	NR	14	21	21	21	10	21	NR	NR
Authority Assist	10	4	18	12	40	NR	40	18	18
Authority First	10[v]	4	12	12	30+BA	NR	30+BA	10[v]	10[v]
AuthorityMAXX	10	4	12	12	18	NR	15	10	18
Authority MTZ	10	4	18	12	18	NR	NR[b]	10	18
Authority XL[l]	10	4	12	12	18	NR	12[b]	10	18
Autumn	1	4	9	18	18	9	18	1	1
Balance Flexx	NR	4	18	10	18	6	18	6	6
Basis/Harrow	NR	3	9	10	10	2-10[w]	1	10	10
Beacon	14 days[i]	3	8	8	18	8	18	8	8
Bestow - 1 oz/2 oz	NR	3/4	9	10/18	10/18	1/10	1	10	10
Bicep/Cinch ATZ[a]	NR	15	15	18	18	10	18	NR	NR
Boundary/Ledger/Tailwind	4	4.5	12	4.5	12	NR	12	12	12
BroadAxe XC	10	4.5	12	12	12+BA	NR	4	18	18
Buctril/atrazine[a]	NR	15	15	21	21	10	21	1	1
Callisto/Callisto GT	NR	4	4	10	18	10	18	NR	NR
Callisto Xtra	NR	8	18	8	18	8	18	NR	NR
Canopy/Cloak DF[k]	10	4	30	10	12	NR	10[b]	10	18
Canopy/Cloak EX/Fallout[k]	10	4	4	10	12	1.5	10[b]	10	18
Capreno	NR	4	18	18	18	10	18	10	10
Cheetah Max	10	4	4	18	18	NR	6-18	10-12	10
Classic	9[n]	3	3	12[n]	12[n]	NR	9[bn]	9[n]	18
Command/Commit	9	12[cd]	16[cd]	16[cd]	16[cd]	NR	9-12[f]	9	9
Corvus	NR	4	17	17	17	9	17	9	9
Crusher 1/1.8 oz	NR	3/4	9	10/18	10/18	1/10	1	10	10
Curtail	1	1	1	10.5	18	10.5[i]	18	10.5	10.5
Degree	NR	4	18	9	9	9	18	NR	NR
Degree Xtra[a]	NR	4	21	21	21	10	21	NR	NR
Enlite	9	3	10	12	12	NR	9	9	9
Envivek	10	4	10	10	18	NR	12[b]	10	18
Expert[a]	NR	15	15	18	18	10	18	NR	NR
Extreme/Tackle	8.5	3	18	4	40	NR	40	18	18
Fierce	0.25-1	1-2	18	10	18	NR	18	18	18
Fierce XLT	10	10	30	18	18	NR	18[b]	10	18
FirstRate	9	4	18	9	18	NR	18	9	18

Table 23. Continued

Herbicide	Months Before Planting								
	Corn	Wheat	Oats	Alfalfa	Clover	Soybeans	Tomatoes	Popcorn	Sweet Corn
Flumioxazin	0.5-1	1	12+BA	12+BA	12+BA	NR	12+BA	12+BA	4
Fomesafen	10	4	4	18	18	NR	18	12	12
FulTime NXT[a]	NR	15	15	15	18	10	18	NR	NR
Halex GT	NR	4	4	10	18	10	18	NR	NR
Harness	NR	4	18	9	9	9	8	NR	NR
Harness Xtra[a]	NR	4	21	21	21	10	21	NR	NR
Hornet	NR	4	4	10.5	26+BA	10.5	26+BA	10.5	18/10.5[u]
Impact/Armezon	NR	3	3	9	18	9	18	NR	NR
Instigate	NR	4	9	10	18	10	18	10	10
Intimidator	10	4.5	18	18	18	NR	18	12	10
Keystone[a]	NR	15	15	15	21	10	21	NR	NR
Laddok[a]	NR	9	9	9	9	9	15	NR	NR
Latir/Militia	8.5	4	18	4-12	4-12	NR	40	18	18
Laudis	NR	4	4	10	18	8	10	NR	NR
Lumax/Lexar[a]	NR	4.5/10	10	18	18	10	18	NR	NR
Marksman[a]	NR	10	18	18	18	10	18	NR	NR
Marvel	10	4	18	18	18	NR	4	10	18
Matador	8.5	4.5	18	4.5	12	NR	40	18	18
Metribuzin	4	4	12	4	12	NR	4	4	4
Nicosulfuron	NR	4	8	12	12	0.5	10/18[h]	10	10[j]
Northstar	14 days[i]	3	8	8	18	8	18	8	8
Optill PRO	8.5	4	18	9	9	0 to 1	40+BA	18	18
Peak[q]	1	NR	NR	22	22	10	22	10	10
Permit	NR	2	2	9	9	9	8	3	3
Princep[a]	NR	14	21	21	21	10	18	10	10
Prefix/Vise/Statement	10	4.5	4.5	18	18	NR	18	12	10
Prequel	NR	4	18	10	18	10	18	10	10
Prowl/Pendimax	NR	4	8	8	8	NR	8	8	8
Pummel	9.5	4.5	18	4.5	18	NR	40	9.5	18
Pursuit	8.5	3	18	4	40	NR	40	18	18
Python	NR	4	4	4	26+BA	NR	26+BA	9	18
Ransom	4	4	18	5/10[x]	18	NR	18	4	4
Raptor	8.5	3	9	3	18	NR	9	8.5	8.5
Realm Q	NR	4	9	10	18	10	18	10	10
Resolve Q	NR	3	9	10	10	10	18	10	10
Revulin Q	NR	4	10	10	18	10	18	10	10
Shotgun[a]	NR	14	21	21	21	10	21	NR	NR
Solstice	NR	18	18	18	18	10	18	NR	18
Sonic	10[v]	4	12	12	30+BA	NR	30+BA	10[v]	10[v]
Spartan	10	4	30	12	18	NR	30	10	18
Spirit[p]	1	3	3	18	18	10[s]	10	8	8
Stalwart Xtra[a]	NR	14	21	21	21	10	21	NR	NR
Steadfast	NR	4	8	12	12	0.5	10/18[h]	10	10
Stinger	NR	NR	NR	10.5	18	10.5	18	10.5	10.5
SureStart/TripleFLEX/TripleFLEX II	NR	4	9	9	9	9	26+BA	9	10.5 - 18

Table 23. Continued

Herbicide	Months Before Planting								
	Corn	Wheat	Oats	Alfalfa	Clover	Soybeans	Tomatoes	Popcorn	Sweet Corn
Surpass NXT	NR	4	9	9	9	9	18	NR	NR
Surveil	9	3	9	10	30+BA	NR	30+BA	9	18
Synchronyk (PRE)	10	4	4	10	12	NR	10[b]	10	18
Synchronyk (POST)	9[n]	3	3	12[n]	12[n]	NR	9[bn]	9	18
Torment	10	4	4	18	18	NR	40	10	18
Trivence[k]	10	4	18	10	18	NR	12[b]	10	18
Valor XLT/Rowel FX[k]	10	4	30	12	18	NR	12[b]	10	18
Verdict (>10 oz)	NR	4	9	9	9	9	9	NR	9
Volley	NR	4	21	21	21	10	21	NR	10
Volley ATZ[a]	NR	15	21	21	21	10	21	NR	NR
Warrant	NR	4	10	9	9	NR	18	NR	NR
Warrant Ultra	10	4	4	18	18	NR	18	12	12
WideMatch	NR	NR	NR	10.5	BA	10.5	BA	4	4
Yukon	1	2	2	9	9	9	8[b]	3	3
Zemax	NR	4.5	4.5	18	18	9	18	NR	NR
Zidua	NR	4	18	10	18	0	18	0	0

[a]Restrictions on rotation following the application of products containing atrazine or Princep will vary, depending on the product. There are a few general guidelines to follow to reduce the potential for injury to crops planted where these products are used. Plant only corn or sorghum the year (including fall) of application. Where oats, forage legumes, or forage grasses will be planted the following spring, do not apply more than 0.8 pounds active ingredient. Do not plant sugar beets, tobacco, or vegetable crops the year following application.

[b]Transplant tomatoes only.

[c]Do not plant in the fall of year of application or the spring of the following year.

[d]Cover crops may be planted prior to 12 months, but stand reduction may occur. Do not graze or harvest these cover crops for feed or food.

[e]Moldboard plow to a depth of 12 inches before planting sugar beets in the spring. Recrop interval to sugar beets is extended to 13 months if less than 20 inches of rain falls during the growing season of application.

[f]9 months for transplant tomatoes; 12 months for all tomatoes.

[g]Corn can be planted 9.5 months after application if at least 15 inches of rainfall is received from 2 weeks prior to last application through November 15 of the same year. If this requirement is not met, plant only a Clearfield corn hybrid the following spring.

[h]Rotation interval for Accent is 10 months where soil pH is 6.5 or less, and 18 months where soil pH is greater than 6.5.

[i]Refer to Syngenta literature for a list of hybrids that have tolerance to Beacon before planting.

[j]Except the sweet corn varieties "merit", "carnival", and "sweet success", for which the minimum rotational interval is 15 months.

[k]For rates higher than 1 oz/A (Synchrony), 1.1 oz/A (Canopy EX), 2.2 oz/A (Canopy DF), 6 oz (Trivence), 3.75 oz (Fierce XLT), or 2.5 oz (Envive, Valor XLT), plant only soybeans the following year where composite soil pH is greater than 7.0 (or greater than 6.8 for Valor XLT and Fierce XLT).

[l]Where soil pH is greater than 7.2, rotation intervals increase to at least 18 months for all crops except small grains.

[m]If applied after July 1st, do not plant soybeans the season following application.

[n]If applied after August 1, extend recrop interval by 2 months.

[o]If soil pH is less than 6.2, allow 26 months to rotation of sugarbeets.

[p]If soil pH is 7.8 or greater and/or less than 12 inches of rainfall occurs within the first 5 months and/or less than 1.0 inch within the first 4 weeks following application, then only plant corn or small grain cereals the following spring. STS soybeans can be planted the following spring after a drought if Spirit was used.

[r]Allow 12 months to rotation of sweet corn if 2-2/3 pt of Command is used.

[s]Do not plant soybeans the following season if herbicide is applied after June 30.

[t]Soybeans and tomatoes should not be planted until 18 months after application north of Interstate 70, but can be planted 10 months after application south of Interstate 70. STS soybeans can be planted the following spring in areas north of Interstate 70.

[u]Only certain sweet corn varieties may be grown 10.5 months after application; check herbicide label for those varieties. Otherwise wait 18 months.

[v]Rotation interval extends to 18 months if applied to soil with 1.5% organic matter or less and pH above 7.0.

[w]Harrow: 10 months. Basis up to 1.25 oz: 60 days south of I70, and 10 months north of I70. Soybeans can be planted 15 days after use of the 0.825 oz Basis rate.

[x]5 months for tilled ground; 10 months for no-till alfalfa.

Table 24. Glossary of Chemical Names and Manufacturers

Trade Name	Common Name	Formulations	Restricted Use	Ground Water Advisory	Surface Water Advisory	Manufacturer
AAtrex, Atrazine	atrazine	4 lb/gal L, 90% DF, 80% WP	Y	Y	Y	Syngenta, others
Accurate	metsulfuron	60% DF	N	N	N	Cheminova
Acuron	S-metolachlor + atrazine + mesotrione + bicyclopyrone	3.44 lb/gal L	Y	Y	Y	Syngenta
Aim	carfentrazone-ethyl	2 lb/gal L	N	N	N	FMC
Accent Q	nicosulfuron + isoxadifen	54.5% WDG	N	N	N	DuPont
Afforia	flumioxazin + tribenuron + thifensulfuron	50.8% WDG	N	N	N	DuPont
Anthem	pyroxasulfone + fluthiacet-methyl	2.15 lb/gal L	N	Y	Y	FMC
Anthem ATZ	pyroxasulfone + atrazine + fluthiacet-methyl	4.5 lb/gal L	Y	Y	Y	FMC
Anthem Flex	pyroxasulfone + carfentrazone	4 lb/gal L	N	Y	Y	FMC
Armezon	topramezone	2.8 lb/gal L	N	N	N	BASF
Armezon PRO	topramezone + dimethenamid	5.35 lb/gal L	N	Y	Y	BASF
Arrow	clethodim	2 lb/gal L	N	N	N	ADAMA
Assure II	quizalofop	0.88 lb/gal L	N	N	N	DuPont
Authority Assist	sulfentrazone + imazethapyr	4 lb/gal L	Y	Y	Y	FMC
Authority First	sulfentrazone + cloransulam-methyl	70% WDG	Y	Y	Y	FMC
Authority MAXX	sulfentrazone + chlorimuron-ethyl	66% WDG	N	Y	Y	FMC
Authority MTZ	sulfentrazone + metribuzin	45% WDG	Y	Y	Y	FMC
Authority XL	sulfentrazone + chlorimuron-ethyl	70% DF	Y	Y	Y	FMC
Autumn Super	iodosulfuron-methyl + thiencarbazone	51% WDG	N	Y	Y	Bayer
Axial Star	pinoxaden + fluroxypyr	1.15 lb/gal L	N	N	N	Syngenta
Axial TBC	pinoxaden + florasulam	0.83 lb/gal L	N	N	N	Syngenta
Axial XL	pinoxaden	0.42 lb/gal L	N	N	N	Syngenta
Axiom DF	metribuzin + flufenacet	68% DF	N	Y	Y	Bayer
Balance Flexx	isoxaflutole + cyprosulfamide	2 lb/gal L	Y	Y	Y	Bayer
Banvel	dicamba	4 lb/gal L	N	N	N	MicroFlo
Banvel-K+atrazine	dicamba+atrazine	3.2 lb/gal L	Y	Y	Y	MicroFlo
Banvel SGF	dicamba	2 lb/gal L	N	N	N	MicroFlo
Basagran	bentazon	4 lb/gal L	N	N	N	various
Basis Blend	rimsulfuron + thifensulfuron	30 DF	N	N	N	DuPont
Battle Star	fomesafen	1.88 lb/gal L	N	N	N	Albaugh
Beacon	primisulfuron	75% DF	N	N	N	Syngenta
Bestow	rimsulfuron	25% DF	N	N	N	Cheminova
Bicep II Magnum	s-metolachlor + atrazine + safener	5.5 lb/gal L	Y	Y	Y	Syngenta
Boundary	s-metolachlor + metribuzin	6.5 lb/gal L	N	Y	N	Syngenta
Brash	dicamba + 2,4-D	3.87 lb/gal L	N	N	N	Winfield Solutions
Brawl II	s-metolachlor + safener	7.64 lb/gal L	N	Y	N	Tenkoz
Brawl II ATZ	s-metolachlor + atrazine + safener	5.5 lb/gal L	Y	Y	Y	Tenkoz
Breakfree NXT	acetochlor	7 lb/gal L	N	Y	Y	DuPont
Breakfree NXT ATZ	acetochlor + atrazine	5.6 lb/gal L	Y	Y	Y	DuPont
BroadAxe XC	sulfentrazone + S-metolachlor	7 lb/gal L	N	Y	Y	Syngenta
Broadloom	bentazon	4 lb/gal L	N	N	N	Uniphos
Broclean	bromoxynil	2 lb/gal L	N	N	N	UAP-Platte
Brozine	bromoxynil + atrazine	3 lb/gal L	Y	Y	Y	UAP-Platte
Buctril	bromoxynil	2 lb/gal L	N	N	N	Bayer
Buctril/atrazine	bromoxynil + atrazine	3 lb/gal L	Y	Y	Y	Bayer
Butoxone 200	2,4-DB	2 lb/gal L	N	N	N	Cedar
Butyrac 200	2,4-DB	2 lb/gal L	N	N	N	Albaugh

Table 24. Glossary of Chemical Names and Manufacturers—Continued

Trade Name	Common Name	Formulations	Restricted Use	Ground Water Advisory	Surface Water Advisory	Manufacturer
Cadence	acetochlor + safener	6.4 lb/gal L	N	Y	N	UAP Loveland
Cadence ATZ	atrazine + acetochlor + safener	5.25 lb/gal L	Y	Y	Y	UAP Loveland
Cadet	fluthiacet-methyl	0.91 lb/gal L	N	N	N	FMC
Callisto	mesotrione	4 lb/gal L	N	N	Y	Syngenta
Callisto GT	mesotrione + glyphosate	4.18 lb/gal L	Y	Y	Y	Syngenta
Callisto Xtra	mesotrione + atrazine	3.7 lb/gal L	Y	Y	Y	Syngenta
Candor	triclopyr + 2,4-D	3 lb/gal L	N	N	N	Nufarm
Canopy	chlorimuron-ethyl + metribuzin	75% DF	N	Y	N	DuPont
Canopy EX	chlorimuron-ethyl + tribenuron	29.5% DF	N	N	N	DuPont
Capreno	tembotrione + thiencarbazone-methyl	3.45 lb/gal L	N	Y	N	Bayer
Charger Max	s-metolachlor + safener	7.64 lb/gal L	N	Y	N	Winfield Solutions
Charger Max ATZ	s-metolachlor + atrazine + safener	5.5 lb/gal L	Y	Y	Y	Agriliance
Chateau	flumioxazin	51% WDG	N	N	N	Valent
Chaparral	metsulfuron + aminopyralid	71.6% WDG	N	Y	N	Dow AgroSciences
Cheetah	glufosinate	2.34 lb/gal L	N	N	N	Nufarm
Cheetah Max	glufosinate + fomesafen	3 lb/gal L	N	N	N	Nufarm
Cimarron Max	metsulfuron methyl + dicamba + 2,4-D	co-pack	N	N	N	DuPont
Cinch	s-metolachlor + safener	7.64 lb/gal L	N	Y	N	DuPont
Cinch ATZ	s-metolachlor + atrazine + safener	5.5 lb/gal L	Y	Y	Y	DuPont
Clarity	dicamba	4 lb/gal L	N	N	N	BASF
Clash	dicamba	4 lb/gal L	N	N	N	Nufarm
Classic	chlorimuron-ethyl	25% DF	N	N	N	DuPont
Clean Slate	clopyralid	3 lb/gal L	N	Y	N	Nufarm
Cleansweep D	bromoxynil + fluroxypyr + 2,4-D	4.25 lb/gal L	N	Y	N	Nufarm
Cleansweep M	bromoxynil + fluroxypyr + MCPA	4 lb/gal L	N	Y	N	Nufarm
Cloak	chlorimuron-ethyl + metribuzin	75% DF	N	Y	N	Nufarm
Cloak EX	chlorimuron-ethyl + tribenuron	29.5% DF	N	N	N	Nufarm
Cobra	lactofen	2 lb/gal L	N	N	N	Valent USA
Colt	fluroxypyr + clopyralid	1.5 lb/gal L	N	Y	N	UAP Loveland
Command	clomazone	3 lb/gal L (ME)	N	N	N	FMC, others
Confidence	acetochlor + safener	7 lb/gal L	N	Y	Y	Winfield Solutions
Confidence Xtra 5.6	atrazine + acetochlor + safener	5.6 lb/gal L	Y	Y	Y	Winfield Solutions
Corvus	isoxaflutole + thiencarbazone+ cyprosulfamide	2.63 lb/gal L	Y	Y	Y	Bayer
Crossbow	triclopyr + 2,4-D	3 lb/gal L	N	N	N	Various
Crossroad	triclopyr + 2,4-D	3 lb/gal L	N	N	N	Albaugh
Crusher	rimsulfuron + thifensulfuron-methyl	50% DF	N	N	N	Cheminova
Curio	chlorimuron-ethyl	25% DF	N	N	N	Nufarm
Curtail	clopyralid + 2,4-D	2.38 lb/gal L	N	Y	N	Dow AgroSciences
Dawn	fomesafen	2 lb/gal L	N	N	N	Cheminova
Degree	acetochlor + safener	3.8 lb/gal L	Y	Y	N	Monsanto
Degree Xtra	acetochlor + atrazine + safener	4.04 lb/gal L	Y	Y	Y	Monsanto
Diablo	dicamba	4 lb/gal L	N	N	N	Nufarm
DiFlexx	dicamba + cyprosulfamide	4 lb/gal L	N	N	N	Bayer
Distinct	dicamba + diflufenzopyr	76.4% DF	N	Y	Y	BASF
Dual II Magnum	s-metolachlor + safener	7.64 lb/gal L, 16% G	N	Y	N	Syngenta
Encompass	flumioxazin	51% WDG	N	N	N	Valent
Enlite	flumioxazin + chlorimuron + thifensulfuron	47.8% WDG	N	Y	N	DuPont
Envive	flumioxazin + chlorimuron + thifensulfuron	41.3% DG	N	Y	N	DuPont

Table 24. Glossary of Chemical Names and Manufacturers—Continued

Trade Name	Common Name	Formulations	Restricted Use	Ground Water Advisory	Surface Water Advisory	Manufacturer
Eptam	EPTC	7 lb/gal L, 10% G	N	N	N	Syngenta
Expert	atrazine + glyphosate + s-metolachlor + safener	4.88 lb/gal L	Y	Y	Y	Syngenta
Express TotalSol	tribenuron methyl	50% DF	N	N	N	DuPont
Extreme	imazethapyr + glyphosate	2.17 lb/gal L	N	N	N	BASF
Fallout	chlorimuron-ethyl + tribenuron	29.5% DF	N	N	N	Agsurf
Fierce	pyroxasulfone + flumioxazin	76% WDG	N	Y	Y	Valent
Fierce XLT	pyroxasulfone + flumioxazin + chlorimuron	62.4% WDG	N	Y	Y	Valent
Finesse	chlorsulfuron + metsulfuron methyl	75% DF	N	N	N	DuPont
FirstRate	cloransulam-methyl	84% DF	N	Y	Y	Dow AgroSciences
Flexstar	fomesafen	1.88 lb/gal L	N	N	N	Syngenta
Flexstar GT	fomesafen + glyphosate	3.29 lb/gal L	N	N	N	Syngenta
Forefront	aminopyralid + 2,4-D	3 lb/gal L	N	N	N	Dow AgroSciences
FulTime NXT	acetochlor + atrazine + safener	4.0 lb/gal L (ME)	Y	Y	Y	Dow AgroSciences
Fusilade DX	fluazifop	2 lb/gal L	N	N	N	Syngenta
Fusion	fluazifop + fenoxaprop	2.66 lb/gal L	N	N	N	Syngenta
Glory	metribuzin	75% DF	N	Y	N	ADAMA
Gramoxone SL	paraquat	2 lb/gal L	Y	N	N	Syngenta
Halex GT	glyphosate + s-metolachlor + mesotrione	4.38 lb/gal L	N	Y	Y	Syngenta
Halomax	halosulfuron	75% WDG	N	Y	N	Aceto
Harass	thifensulfuron	75% WDG	N	N	N	Cheminova
Harmony Extra TotalSol	thifensulfuron + tribenuron methyl	50% DF	N	N	N	DuPont
Harmony SG	thifensulfuron	50% DF	N	N	N	DuPont
Harness	acetochlor + safener	7 lb/gal L, 20% G	N	Y	Y	Monsanto
Harness Xtra 5.6L	acetochlor+atrazine+safener	5.6 lb/gal L	Y	Y	Y	Monsanto
Harrow	rimsulfuron + thifensulfuron	75% DF	N	N	N	Cheminova
Hornet	flumetsulam + clopyralid	78.5% WDG	N	Y	N	Dow AgroSciences
Huskie	pyrasulfotole + bromoxynil	2.47 lb/gal L	N	Y	Y	Bayer
Impact	topramezone	2.8 lb/gal L	N	N	N	AMVAC
Instigate	rimsulfuron + mesotrione	45.8%WDG	N	N	Y	DuPont
Intensity	clethodim	2 lb/gal L	N	N	N	UAP-Platte
Intensity One	clethodim	1 lb/gal L	N	N	N	UAP-Platte
Interline	glufosinate-ammonium	2.34 lb/gal L	N	N	N	UPI
Intimidator	s-metolachlor + metribuzin + fomesafen	4.81 lb/gal L	N	Y	Y	Loveland
Kerb	pronamide	50% WP	N	N	N	Dow AgroSciences
Keystone NXT	atrazine + acetochlor + safener	5.25 lb/gal L	Y	Y	Y	Dow AgroSciences
Laddok S-12	bentazon + atrazine	5 lb/gal L	Y	Y	Y	MicroFlo
Latigo	dicamba + 2,4-D	4.2 lb/gal L	N	N	N	Helena
Latir	flumioxazin + imazethapyr	55% WDG	N	N	N	ADAMA
Laudis	tembotrione	3.5 lb/gal L	N	Y	Y	Bayer
Ledger	s-metolachlor + metribuzin	6.5 lb/gal L	N	Y	N	Tenkoz
Lexar EZ	s-metolachlor+atrazine+mesotrione	3.7 lb/gal L	Y	Y	Y	Syngenta
Liberty 280 SL	glufosinate	2.34 lb/gal L	N	N	N	Bayer
Lorox/Linex	linuron	50% DF, 4 lb/gal L	N	N	N	Griffin LLC
Lumax EZ	s-metolachlor + atrazine + mesotrione	3.67 lb/gal L	Y	Y	Y	Syngenta
Maestro	bromoxynil	2 or 4 lb/gal L	N	N	N	Nufarm
Marksman	dicamba + atrazine	3.2 lb/gal L	Y	Y	Y	BASF
Marvel	fomesafen + fluthiacet methyl	3 lb/gal L	N	Y	Y	FMC
Matador	metolachlor + metribuzin + imazethapyr	4.7 lb/gal L	N	Y	Y	Loveland

Table 24. Glossary of Chemical Names and Manufacturers—Continued

Trade Name	Common Name	Formulations	Restricted Use	Ground Water Advisory	Surface Water Advisory	Manufacturer
Matador-S	metolachlor + metribuzin + imazethapyr	4.3 lb/gal L	N	Y	Y	Loveland
Maverick	sulfosulfuron	75% DF	N	Y	N	Monsanto
Metribuzin	metribuzin	75% DF	N	Y	N	ADAMA
Me-Too-Lachlor II	metolachlor + pcr	7.8 lb/gal L	N	Y	Y	Drexel
Milestone	aminopyralid	2 lb/gal L	N	N	N	Dow AgroSciences
Militia	flumioxazin + imazethapyr	55% WDG	N	N	N	ADAMA
Moxy	bromoxynil	2 lb/gal L	N	N	N	Riverside
NIC-IT	nicosulfuron	2 lb/gal L	N	N	N	Cheminova
Nimble	thifensulfuron + tribenuron	75% WDG	N	N	N	Cheminova
NorthStar	dicamba + primisulfuron	47.4% WDG	N	N	N	Syngenta
Nuance	tribenuron	75% WDG	N	N	N	Cheminova
Olympus	propoxycarbazone-sodium	70% WDG	N	N	N	Bayer
Optill PRO	saflufenacil + dimehenamid-p + imazethapyr	co-pack	N	Y	Y	BASF
Oracle	dicamba	4 lb/gal L	N	N	N	Gharda USA
Orion	MCPA + florasulam	2.37 lb/gal L	N	N	N	Syngenta
Outflank	flumioxazin	51% WDG	N	N	N	ADAMA
Outlaw	dicamba + 2,4-D	2.54 lb/gal L	N	N	N	Helena
Outlook	dimethenamid-P	6.0 lb/gal L	N	Y	N	BASF
Panoflex	tribenuron methyl + thifensulfuron-methyl	50% SG	N	N	N	DuPont
Panther	flumioxazin	51% WDG, 4 lb/gal L	N	N	N	Nufarm
Parallel	metolachlor + benoxacor	7.8 lb/gal L	N	Y	Y	ADAMA
Parallel PCS	metolachlor	8 lb/gal L	N	Y	Y	ADAMA
Parallel Plus	metolachlor + atrazine	5.5 lb/gal L	Y	Y	Y	ADAMA
Parazone	paraquat	3 lb/gal L	Y	N	N	Makhteshim Agan
PastureGard	triclopyr and fluroxypyr	2 lb/gal L	N	N	N	Dow AgroSciences
Patriot	metsulfuron-methyl	60% WDG	N	N	N	Nufarm
Peak	prosulfuron	57 DF	N	N	N	Syngenta
Pendant	pendimethalin	3.3 lb/gal L	N	N	N	BASF
Pendimax	pendimathalin	3.3 lb/gal L	N	N	N	Dow AgroSciences
Permit	halosulfuron	75% DF	N	Y	N	Gowan
Phoenix	lactofen	2 lb/gal L	N	Y	N	Valent USA
Plateau	imazapic	2 lb/gal L	N	N	N	BASF
Poast	sethoxydim	1.5 lb/gal L	N	N	N	MicroFlo
PowerFlex	pyroxsulam	7.5% DF	N	N	Y	Dow AgroSciences
Prequel	rimsulfuron + isoxaflutole	45% WDG	Y	Y	Y	DuPont
Prefix	fomesafen + s-metolachlor	5.3 lb/gal L	N	Y	N	Syngenta
Princep, Simazine	simazine	4 lb/gal L, 90% DF	N	Y	N	Syngenta, others
Prowl	pendimethalin	3.3 lb/gal L	N	N	N	BASF
Prowl H2O	pendimethalin	3.8 lb/gal L	N	N	N	BASF
Pulsar	dicamba + fluroxypyr	1.67 lb/gal L	N	Y	N	Syngenta
Pummel	metolachlor + imazethapyr	5.25 lb/gal L	N	Y	Y	ADAMA
Pursuit	imazethapyr	2 lb/gal L	N	N	N	BASF
Python	flumetsulam	80% WDG	N	Y	N	Dow AgroSciences
Ransom	metribuzin + flumioxazin	68.9% WDG	N	Y	N	ADAMA
Rapport BroadSpec	thifensulfuron + tribenuron methyl	50% DF	N	N	N	Nufarm
Rapport Tankmix	thifensulfuron + tribenuron methyl	50% DF	N	N	N	Nufarm
Raptor	imazamox	1.0 lb/gal L	N	N	N	BASF
Realm Q	rimsulfuron + mesotrione + isoxadifen	38.75%WDG	N	N	Y	DuPont

Table 24. Glossary of Chemical Names and Manufacturers—Continued

Trade Name	Common Name	Formulations	Restricted Use	Ground Water Advisory	Surface Water Advisory	Manufacturer
Reflex	fomesafen	2 lb/gal L	N	N	N	Syngenta
Reglone	diquat dibromide	3.73 lb/gal L	N	N	N	Syngenta
Relegate	triclopyr	4 lb/gal L	N	N	N	Nufarm
Remedy Ultra	triclopyr	4 lb/gal L	N	N	N	Dow AgroSciences
Report Extra	chlorsulfuron + metsulfuron methyl	75% DF	N	N	N	Cheminova
Resolve Q	rimsulfuron + thifensulfuron + isoxadifen	22.4% WDG	N	N	N	DuPont
Resource	flumiclorac-pentyl	0.86 lb/gal L	N	N	N	Valent
Revulin Q	nicosulfuron + mesotrione + isoxadifen	51.2% WDG	N	N	Y	DuPont
Rezult	bentazon + sethoxydim + Dash	Co-Pack	N	N	N	BASF
Rhythm	fomesafen	1.88 lb/gal L	N	N	N	Cheminova
Rifle	dicamba	4 lb/gal L	N	N	N	UAP Loveland
Rifle-D	dicamba + 2,4-D	3.87 lb/gal L	N	N	N	UAP Loveland
Rifle Plus	dicamba + atrazine	3.2 lb/gal L	Y	Y	Y	UAP Loveland
Ringside	fomesafen	2 lb/gal L	N	N	N	Tenkoz
Rowel	flumioxazin	51% WDG	N	N	N	Monsanto
Rowel FX	flumioxazin + chlorimuron	40.3% WDG	N	N	N	Monsanto
Rumble	fomesafen	1.88 lb/gal L	N	N	N	ADAMA
Sandea	halosulfuron	75 DF	N	Y	N	Gowan
Satellite Hydrocap	pendimethalin	3.8 lb/gal L	N	N	N	Uniphos
Section	clethodim	2.0 lb/ gal L	N	N	N	Winfield Solutions
Select	clethodim	2.0 lb/ gal L	N	N	N	Valent
Select Max	clethodim	1 lb/gal L	N	N	N	Valent
Sequence	s-metolachlor + glyphosate	5.25 lb/gal L	N	Y	N	Syngenta
Shafen	fomesafen	2 lb/gal L	N	N	N	Sharda
Shafen Star	fomesafen	1.88 lb/gal L	N	N	N	Sharda
Sharpen	saflufenacil	2.85 lb/gal L	N	Y	Y	BASF
Shotgun	atrazine +2,4-D	3.25 lb/gal L	Y	Y	Y	United Ag Products
Sinbar	terbacil	80% WP	N	Y	Y	DuPont
Sinister	fomesafen	2.87 lb/gal L	N	Y	Y	Helena
Sonic	sulfentrazone + cloransulam-methyl	70% WDG	N	Y	Y	Dow AgroSciences
Solstice	mesotrione + fluthiacet methyl	4 lb/gal L	N	Y	Y	FMC
Spartan	sulfentrazone	4 lb/gal L	Y	Y	Y	FMC
Spartan Advance	glyphosate + sulfentrazone	4.6 lb/gal L	Y	Y	Y	FMC
Spike	tebuthiuron	20% P	N	Y	N	Dow AgroSciences
Spirit	primisulfuron + prosulfuron	57% DF	N	N	N	Syngenta
Spitfire	2,4-D ester + dicamba	3.57 lb/gal L	N	N	N	Nufarm
Stalwart	metolachlor	8 lb/gal L	N	Y	N	Sipcam Agro USA
Stalwart C	metolachlor + safener	7.8 lb/gal L	N	Y	N	Sipcam Agro USA
Stalwart Xtra	metolachlor + atrazine + safener	5.5 lb/gal L	Y	Y	Y	Sipcam Agro USA
Starane	fluroxypyr	1.5 lb/gal L	N	N	N	Dow AgroSciences
Statement	metolachlor + fomesafen	5.24 lb/gal L	N	Y	Y	Cheminova
Status	dicamba + diflufenzopyr + safener	56% WDG	N	Y	Y	BASF
Steadfast Q	nicosulfuron + rimsulfuron + isoxadifen	27.7% DF	N	N	N	DuPont
Stealth	pendimethalin	3.3 lb/gal L	N	N	N	UAP Loveland
Sterling Blue	dicamba	4 lb/gal L	N	N	N	Winfield Solutions
Sterling Plus	dicamba + atrazine	3.2 lb/gal L	Y	Y	Y	Winfield Solutions
Stinger	clopyralid	3 lb/gal L	N	Y	N	Dow AgroSciences
Storm	bentazon + acifluorfen	4 lb/gal L	N	N	N	United Phosphorus

Table 24. Glossary of Chemical Names and Manufacturers—Continued

Trade Name	Common Name	Formulations	Restricted Use	Ground Water Advisory	Surface Water Advisory	Manufacturer
Stratos	dicamba + atrazine	3.2 lb/gal L	Y	Y	Y	Gharda USA
Strut	dicamba	4 lb/gal L	N	N	N	UAP
SureStart	acetochlor + flumetsulam + clopyralid	4.25 lb/gal L	N	Y	Y	Dow AgroSciences
Surpass NXT	acetochlor + safener	6.4 lb/gal L	Y	Y	Y	Dow AgroSciences
Surveil	flumioxazin + cloransulam	48% WDG	N	Y	Y	Dow AgroSciences
Synchrony XP	chlorimuron-ethyl + thifensulfuron	28.4% DF	N	N	N	DuPont
Tackle	imazethapyr + glyphosate	4.128 lb/gal L	N	N	N	Cheminova
Tailwind	s-metolachlor + metribuzin	6.5 lb/gal L	N	Y	N	ADAMA
Tapout	clethodim	0.97 lb/gal L	N	N	N	Helena
Targa	quizalifop	0.88 lb/gal L	N	N	N	Gowan
Thunder Master	imazethapyr + glyphosate	2.17 lb/gal L	N	N	N	Albaugh
Topgun	fomesafen	2 lb/gal L	N	N	N	Loveland
Torment	fomesafen + imazethapyr	2.5 lb/gal L	N	Y	N	ADAMA
Treaty	thifensulfuron methyl	75% DF	N	M	N	Nufarm
Treaty Extra	thifensulfuron + tribenuron methyl	75% DF	N	N	N	Nufarm
Treflan, Trifluralin	trifluralin	4 lb/gal L, 10% G	N	N	N	Dow AgroSciences, others
TriCor	metribuzin	75% DF	N	Y	N	United Phosphorus
TripleFLEX/TripleFLEX II	acetochlor + flumetsulam + clopyralid	4.25 lb/gal L	N	Y	Y	Monsanto
Trivence	chlorimuron + flumioxazin + metribuzin	61.3% WDG	N	Y	Y	DuPont
Trizmet II	metolachlor + atrazine + safener	5.5 lb/gal L	Y	Y	Y	Rosens
Trycera	tricolpyr	2.87 lb/gal L	N	N	N	Helena
Ultra Blazer	acifluorfen	2 lb/gal L	N	N	N	United Phosphorous
Valor	flumioxazin	51% WDG	N	N	N	Valent
Valor XLT	flumioxazin + chlorimuron-ethyl	40.3% WDG	N	N	N	Valent
Velossa	hexazinone	2 lb/gal L	N	Y	N	Helena
Velpar	hexazinone	2 lb/gal L, 90% WP	N	Y	N	DuPont
Verdict	saflufenacil + dimethenamid-P	5.57 lb/gal L	N	Y	Y	BASF
Victory	tribenuron methyl	75% DF	N	N	N	Nufarm
Vida	pyraflufen ethyl	0.208 lb/gal L	N	N	N	Gowan
Vise	metolachlor + fomesafen	5.4 lb/gal L	N	Y	Y	ADAMA
Vision	dicamba	3.8 lb/gal L	N	N	N	Helena
Volley	acetochlor + safener	6.4 lb/gal L	N	Y	Y	Tenkoz
Volley ATZ	acetochlor + atrazine	5.25 lb/gal L	Y	Y	Y	Tenkoz
Volunteer	clethodim	2 lb/gal L	N	N	N	Tenkoz
Warrant	acetochlor	3 lb/gal L	N	Y	Y	Monsanto
Warrant Ultra	acetochlor + fomesafen	3.45 lb/gal L	N	Y	Y	Monsanto
Weedmaster	2,4-D + dicamba	3.87 lb/gal L	N	N	N	BASF
WideMatch	clopyralid + fluroxypyr	1.5 lb/gal L	N	Y	N	Dow AgroSciences
Yukon	halosulfuron + dicamba	67.5% WDG	N	Y	N	Gowan
Zemax	mesotrione + s-metolachlor	3.67 lb/gal L	N	Y	Y	Syngenta
Zidua	pyroxasulfone	85% WG	N	Y	Y	BASF

Control of Marestail in No-till Soybeans

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Find Herbicide Labels at:

cdms.net
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Marestail Biology

- Marestail (aka horseweed) has two primary periods of emergence - from late summer into fall, and from late March through June.
- Marestail plants overwinter in the rosette stage, and remain in this low-growing stage through late April, followed by stem elongation (bolting) and growth to an eventual height of 3 to 6 feet. Plants that emerge the previous fall will start stem elongation earlier than spring-emerging plants.
- Marestail is most easily controlled when in the seedling or rosette stage
- Marestail competes with the soybeans throughout the growing season, and reduces crop yield. Marestail matures in late summer or early fall, and large mature plants can interfere with soybean harvest.
- Marestail plants can produce up to 200,000 seed that are transported by wind, providing for effective spread of herbicide-resistant populations.

Soybean yield loss due to marestail

- Herbicide programs should consist of: 1) fall and spring burndown treatments (or two spring treatments - early spring and at plant) to ensure that the field is free of marestail at the time of soybean planting, and 2) spring-applied residual (PRE) herbicides to control marestail for another 6 to 8 weeks after planting.
- Failure to follow these guidelines can result in poor control and reduced soybean yield. We observed the following soybean yields in a 2010 OSU marestail study:

  51 bu/A - the burndown treatment failed to control emerged plants
  57 bu/A - the burndown treatment was effective, but there was no residual herbicide
  65 bu/A - the burndown was effective and included residual herbicides

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Herbicide resistance in marestail

- Most populations of marestail in Ohio and Indiana are resistant to glyphosate (group 9), and will not be controlled by burndown or postemergence applications of glyphosate alone.
- Many marestail populations are now also resistant to group 2 (ALS-inhibiting - e.g Classic, FirstRate) herbicides Growers should therefore not expect to obtain effective POST control in soybeans with combinations of glyphosate plus Classic, Synchrony, or FirstRate. Postemergence group 14 herbicides, such as Flexstar, Cobra, and Cadet, also do not control marestail.

Photos: multiple-resistant marestail surviving treatment with (from left to right): glyphosate alone, ALS inhbitor alone, and a combination of ALS inhibitor and glyphosate

Other impacts of multiple resistance (group 2 + 9)

- Fall-applied Canopy or other chlorimuron- or cloransulam-containing herbicides will not provide residual control of group 2-resistant marestail into spring. Activity of other residual herbicides does not persist from fall into spring, and their use should be reserved for spring applications
- The ALS component of residual premix products will not contribute to marestail control when applied in spring. Spring-applied residuals should include active rates of non-ALS herbicides - metribuzin, flumioxazin (Valor), sulfentrazone (Authority), or higher rates of saflufenacil (Sharpen).
- In burndown applications, there will be no added effectiveness on emerged marestail from products that contain chlorimuron or cloransulam, which makes selection of the other herbicides in the mix more important.

LibertyLink soybeans - the most effective marestail control strategy

- LibertyLink soybeans are the most effective tool for management of herbicide-resistant marestail, especially in fields with high marestail populations.
- Use burndown and residual herbicides as outlined on the next two pages. Apply glufosinate POST (29 oz/A) before marestail plants exceed 6 inches in height. Glufosinate can be applied POST at rates up to 36 oz/A for taller plants or plants that have survived previous herbicide treatments, but control may be variable. Follow with a second POST application of glufosinate as necessary.

Steps for effective management of marestail

1. **Use fall herbicide treatments** in fields with a history of problems or where marestail seedlings are observed in fall. Consider using 2,4-D as the base herbicide to control marestail, and combining it with one of the following to ensure control of other winter weeds:

- glyphosate; dicamba (dicamba/2,4-D premixes - Brash, WeedMaster, Outlaw, Rifle); Basis/Crusher/Harrow; Express/Nuance; a low rate of Canopy/Cloak EX or DF; or metribuzin
- can add Canopy/Cloak to other herbicide combinations to obtain residual control of weeds into spring, but do not expect residual from fall-applied Canopy/Cloak to adequately control spring-emerging marestail. We do not recommend the use of other residual herbicides in the fall due to cost and lack of residual control into spring.
- Do not overspend on fall treatments. Keep the cost of herbicides in the $6 to $15 range.

2. **Apply effective burndown herbicides in spring**. Do not plant into existing stands of marestail. Start weedfree at the time of planting by using one of the following preplant herbicide treatments, applied when marestail plants are still in the rosette stage. Note - tillage close to time of planting also effectively removes marestail, but must thoroughly mix the upper few inches of soil and uproot existing plants.

  - 2,4-D ester plus glyphosate (1.5 lb ae/A)
  - Saflufenacil product (Sharpen/Verdict) plus MSO (1% v/v) plus either glyphosate or Liberty
  - 2,4-D ester plus glyphosate plus Sharpen/Verdict plus MSO (1% v/v)
  - 2,4-D ester plus Gramoxone (3 to 4 pts/A) plus a metribuzin-containing herbicide
  - glufosinate - 29 to 36 oz/A (addition of 2,4-D and/or metribuzin can improve control)

- The mixture of glyphosate and 2,4-D ester applied in the spring has become variable for control of marestail over time, especially in fields that were not treated the previous fall. Plants should be newly emerged/small rosettes at the time of application for best results. In fields where this mixture has previously failed to provide effective control, add metribuzin and/or Sharpen or use one of the other burndown treatments listed above.
- Control can be improved by using the highest rate of a 2,4-D ester product that is allowed, based on the interval between application and soybean planting. For all 2,4-D ester products, rates up to 0.5 lb active ingredient/A must be applied at least 7 days before planting. Rates between 0.5 and 1.0 lb/A should be applied at least 30 days before planting, with the the exception of several products (E-99, Salvo, and Weedone 650) that allow 1 lb/A to be applied 15 days before planting.
- Mixtures of Sharpen with herbicides containing other group 14 herbicides (flumioxazin, sulfentrazone, fomesafen) must be applied 14 days prior to soybean planting on most soils, and 30 days prior to planting on coarse-textured soils with less than 2% organic matter.
- The addition of dicamba to early spring burndown treatments can improve control or emerged marestail, especially plants that have overwintered. Dicamba can be more effective than 2,4-D on marestail in the spring, but has more potential to injure soybeans if the recrop guidelines are not followed. Following dicamba application, soybeans can be planted 14 to 28 days **after an inch of rain has occurred** (in total). For example, the Clarity label states the following - “following application of Clarity and a minimum accumulation of one inch of rain, a waiting interval of 14 days is required for rates of 8 oz/A or less, and 28 days for rates up to 16 oz/A”.

Steps for effective management of marestail (continued)

3. **Include non-ALS residual herbicides** with the burndown treatment, for control of marestail until the soybean leaf canopy develops.

   - flumioxazin - Valor/Encompass/Outflank/Panther, Valor XLT, Envive/Enlite, Fierce, Fierce XLT, Surveil
   - sulfentrazone - Authority First, Sonic, Authority XL/Maxx, Authority, Authority Assist, BroadAxe
   - Metribuzin - Metri DF, Tricor, Glory (at least 8 oz/A, and preferably 10 to 12 oz/A), but do not exceed recommended rate for soil type
   - Increase rate or add metribuzin to bring total rate to 0.38 to 0.5 lbs ai/A, for premix products that contain metribuzin, such as Boundary/Ledger, Canopy/Cloak DF, Intimidator, Matador, Authority MTZ, Ransom
   - In OSU research, most effective residual control has occurred with mixtures that contain two non-ALS residual herbicide components. Examples: mixture of a flumioxazin or sulfentrazone product with metribuzin; mixture of a metribuzin product with Sharpen (1.5 to 2 oz). Trivence and Ransom are examples of premixes that contain flumioxazin and metribuzin.
   - Residual control of marestail with Sharpen occurs primarily at the 1.5 to 2 oz rate, which must be applied 14 to 30 days prior to planting - see label for specific information on application timing.
   - Where early spring application is needed due to lack of a treatment the previous fall, it is especially important to increase herbicide rates and use more complex mixtures (or consider split spring approach).

4. **No fall treatment? - consider split-spring applications**. Failing to treat fields in the fall can result in a population of overwintered marestail plants the following spring, which should be controlled early in spring to ensure effective burndown. Applying all of the burndown and residual herbicide early can result in poor control of plants that emerge mid-season. An alternative approach is to apply burndown herbicides with some of the residual herbicide in early spring, and then when soybeans are planted, apply the rest of the residual herbicide. The second application may require some additional burndown herbicide. Examples here include:

   - early spring - glyphosate + 2,4-D + Sonic (2.5 oz/A); at plant - Sonic (2.5 oz) + Gramoxone
   - early spring - glyphosate + 2,4-D + metribuzin (4 oz); at plant - Canopy DF (4 oz) + metribuzin (2 oz) + Sharpen (1 oz)
   - early spring - glyphosate + 2,4-D + metribuzin (6 oz); 7 days preplant - Envive (4 oz) + 2,4-D ester

5. **So this all seems really involved. Can't I just do it all with one spring preplant treatment?**

   Maybe - but this is not an approach that has consistently worked well (see photos below). It can be difficult to accomplish unless the marestail population in the field has been well managed for several years and the population is generally low. Growers should use their own previous experiences here as guidance, and plan on increasing the complexity and rates of the herbicide program. Problems with skipping the fall treatment, and applying everything at once in spring include the following: 1) applying early in spring when plants are small can result in poor control of plants that are emerging in mid-season if the residual herbicide runs out; and 2) applying closer to planting to maximize the length of residual often results in less effective control of larger, older marestail plants, especially those that have overwintered.

Left photo - spring application of glyphosate + 2,4-D + residual herbicides (no fall herbicide treatment)

Right photo - fall application of glyphosate + 2,4-D followed by spring application of glyphosate + 2,4-D + residual herbicides

Fall application = early November

Spring application = April 21 (7 days preplant)

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Palmer Amaranth Biology, Identification, and Management

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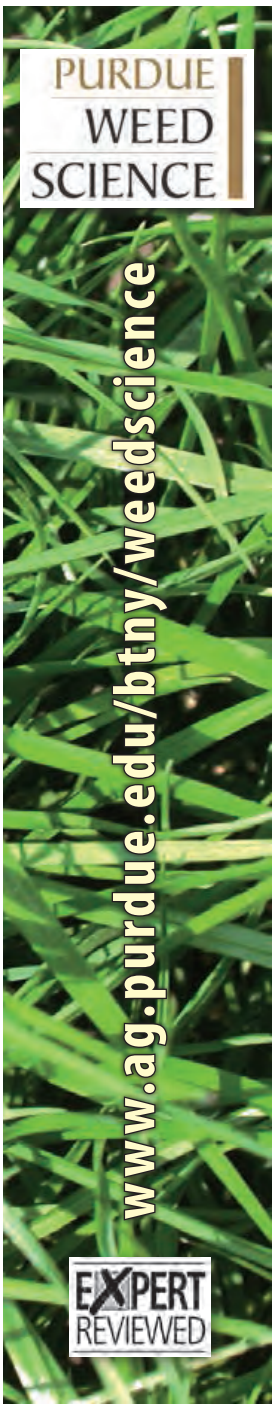


Palmer amaranth (*Amaranthus palmeri*) is an aggressive, invasive weed native to the desert regions of the southwest United States and northern Mexico. It slowly infiltrated the southeast United States and has become one of the most significant weed pests of cotton and soybean producers. What makes Palmer amaranth such a problem is that most populations are resistant to glyphosate and ALS herbicides.

Recently, Palmer amaranth has been confirmed in Indiana (particularly in the northwest), Michigan, Ohio, and Illinois. This means Palmer amaranth could potentially become a major agronomic weed in Indiana and the Midwest.

This publication indicates where Palmer amaranth has been found in Indiana, describes the plant's biology, provides ways to properly identify it, and offers management strategies.

Palmer Amaranth in Indiana

In Indiana, Palmer amaranth was first confirmed in the river bottoms of Posey and Vanderburgh counties. Purdue University researchers collected Palmer amaranth seed from one of the river bottom fields. In greenhouse settings, the plants from this seed survived applications of 20 lbs. ae/acre glyphosate (equivalent of 7 gallons/acre of generic glyphosate).

In the fall of 2012, 51 fields across five northwest Indiana counties were confirmed to have Palmer amaranth plant populations that were not controlled by management tactics used during that growing season. The majority of fields (and the heaviest infestations) were confirmed in Jasper County. Many of the observed fields received multiple applications of glyphosate and attempted rescue applications of PPO-inhibiting herbicides (Flexstar®, Cobra®, Ultra Blazer®, etc.).

Researchers believe Palmer amaranth was introduced to northern Indiana in dairy or beef manure from animals that were fed cotton seed hulls or other feed stocks that came from the South that were contaminated with Palmer seed. The exact timing of the initial event is unknown, but researchers estimate that it happened at least two or three years ago due to the severity of infestation in multiple fields.

Farm equipment, specifically combines, has and will spread Palmer amaranth seed. Wildlife can also spread the seed into new, previously uninfested fields. As of fall 2013, Purdue Weed Science confirmed the presence of Palmer amaranth in 27 Indiana counties.

Photos by Travis Legleiter, except Figures 10 and 11 by Tom Sinnot, Superior Ag Resources.

Biology and Impact

Palmer amaranth is adaptable and invasive. Evidence of its adaptability is the success of populations in Michigan and northern Indiana where average temperatures are below the preferred temperatures of native Palmer populations.

The biological distinctions that highlight Palmer amaranth's success as a weed are described below.

Adapts Quickly

Palmer amaranth has dioecious reproduction, so individual plants are either male or female, which forces outcrossing and genetic diversity. This gives Palmer amaranth the ability to adapt and quickly spread herbicide resistance genes when selection pressure is applied (as when producers repeatedly apply single mode of action herbicides).

Produces Lots of Seed

Palmer amaranth is a prolific seed producer. Each plant can produce at least 100,000 seeds when they compete with a crop. In noncompetitive scenarios they can produce nearly a half million seeds.

Distributes Small Seed

Palmer amaranth seeds are rather small and thrive in no-till or minimum tillage fields. In those situations, seeds are allowed to stay in their ideal emergence zone: the top inch of soil. Humans easily transport the small seeds through grain, seed, or feed contamination; or on equipment such as combines.

Competes Aggressively

Palmer exhibits aggressive growth and competitiveness with crops. Under ideal conditions, Palmer amaranth plants can grow 2 or 3 inches per day. Within two months, Palmer amaranth plants that emerged on May 29, 2013, were more than 6 feet tall at the Purdue Palmer amaranth research site. When allowed to compete throughout the growing season, Palmer amaranth can create yield losses up to 91 percent in corn (Massinga, et al.) and up to 79 percent in soybean (Bensch, et al.).

Herbicide Resistance

Palmer populations have evolved resistance to multiple herbicide modes of action, including ALS inhibitors, triazines, HPPD inhibitors, dinitroanilines, and glyphosate. The majority of populations in the South are ALS-inhibitor- and glyphosate-resistant.

Emerges for an Extended Period

Palmer amaranth's emergence period extends well into the typical crop season and can, at times, occur after crop harvest. During the 2013 Indiana growing season, researchers observed Palmer amaranth emergence from early May until mid-September. This emergence period forces producers to manage the weed throughout the year, unlike other summer annual weeds that are typically managed only through early summer.

Amaranth Identification

The first, and often critical, step to managing Palmer amaranth (or any weed) is to scout and identify the species that exist in each agronomic field. It is easy to misidentify Palmer amaranth because it looks similar to three other common amaranth species: redroot pigweed (*Amaranthus retroflexus*), smooth pigweed (*Amaranthus hybridus*), and common waterhemp (*Amaranthus rudis*). The resemblance is especially strong during the seedling stages of growth.

All too often, the amaranths are all called "pigweed" and not identified properly by species. The populations in northwest Indiana were misidentified as waterhemp for at least the last couple of years and were not managed as aggressively as the situation demanded.

To correctly identify the amaranth species in your field, note the characteristics described below. While these characteristics help differentiate the species, remember that the characteristics also can be variable within a species even within the same population or field. Due to this variability, always assess multiple plants within the field and remember that more than one amaranth species may exist in the field.

There are several characteristics that differentiate the three amaranth species:

- The presence of hair
- Leaf shape
- Petiole length
- Apical meristem growth pattern
- Seed head structures
- Leaf blade watermark
- The presence of a leaf tip hair

Understanding these characteristics will help producers correctly identify amaranth species, and then determine the proper management strategies.

Presence of Hair

Only redroot and smooth pigweeds have hairs (pubescence) on their stems and leaf surfaces (Figure 1). The fine hairs will be most noticeable on the stems towards the newest growth. Palmer amaranth and common waterhemp do not have hair on any surface. Looking for pubescence is a quick and easy way to differentiate redroot and smooth pigweeds from the other two amaranths.

Figure 1. Redroot and smooth pigweeds have hairs on their stems and leaf surfaces. These hairs distinguish them from common waterhemp and Palmer amaranth.

Leaf Shape

The leaf shapes of amaranths can vary quite a bit within a single species; however, there are general shapes that distinguish the species (Figures 2-5).

Common waterhemp leaves are generally long, linear, and lanceolate.

Palmer amaranth leaves are wider and ovate to diamond-shaped.

Redroot and smooth pigweed leaves are similar to Palmer leaves and have a round to ovate shape — redroot and smooth pigweed leaves, however, have hairs while Palmer and common waterhemp leaves do not.

Plants that have been sprayed and survived multiple herbicide applications (especially PPO-inhibitors) can exhibit variable leaf shapes that may not correctly represent the species.

Petiole Length

The petiole is the stem-like structure that connects the leaf blade to the main stem. In Palmer amaranth the petioles (especially on older leaves) will be as long (or longer) than the leaf blade itself (Figures 2, 7, and 8). The petioles of waterhemp, on the other hand, will be shorter than their long, lance-shaped leaves (Figure 4).

A quick way to determine the petiole length is to simply pull a leaf and petiole off a plant and bend the petiole back over the leaf blade to compare the petiole and leaf blade lengths (Figures 3, 5, and 9).

This is the most consistent and reliable characteristic that differentiates Palmer amaranth from common waterhemp, and it is most evident on the oldest leaves of plant (lowest on the stem). Leaf shape, leaf watermark, and leaf tip hair characteristics will help confirm the identity of Palmer amaranth; however, these characteristics are much more variable within species and can make correct identification difficult and frustrating if used alone.

Figure 2. A Palmer amaranth leaf blade with extended petiole.

Figure 3. A Palmer amaranth petiole bent back over the leaf blade, demonstrating the length of its petiole.

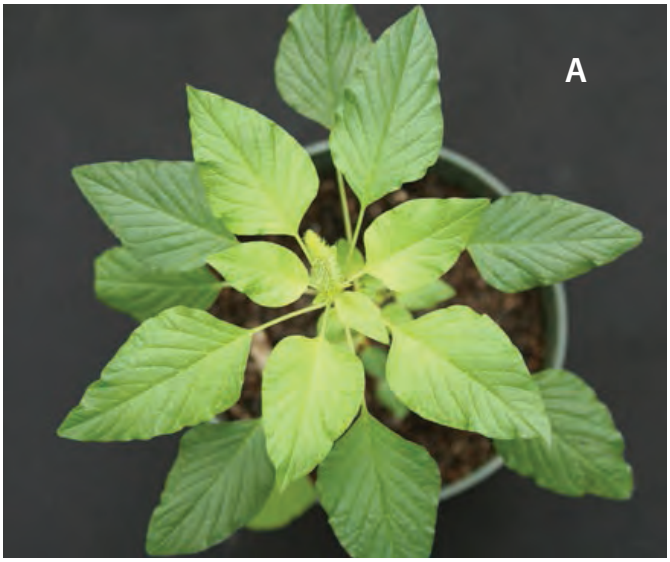
Figure 4. The linear, lance-shaped leaf blade and short petiole characteristic of common waterhemp.

Figure 5. A common waterhemp petiole bent back over the leaf blade, illustrating the length of its petiole.

Apical Meristem Growth Pattern

Palmer amaranth's leaf shape and petiole lengths are the result of the growth pattern of the apical meristem, which grows to capture as much light as possible. This results in a rosette-like appearance as you look directly down from the top of the plant (Figure 6A). This growth pattern and rosette appearance is often compared to that of a poinsettia.

The short petioles and long linear leaves of common waterhemp form a less patterned rosette appearance when observed from above (Figure 6B).



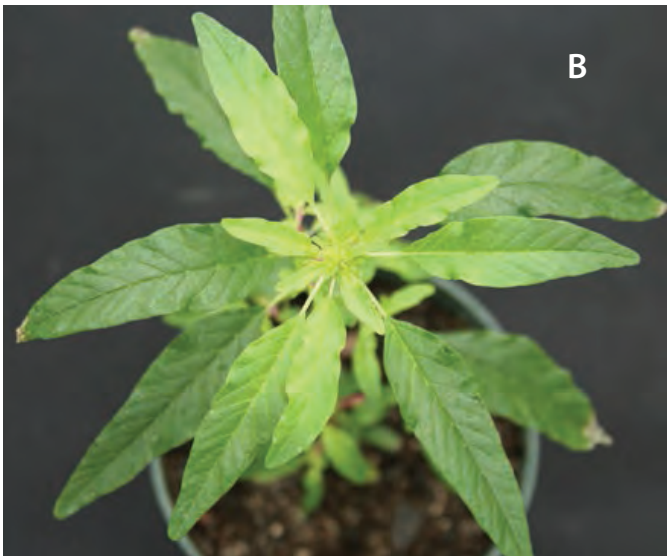


Figure 6. These photos show the leaf shapes and apical meristem growth patterns of Palmer amaranth (A) and common waterhemp (B). Also note the long petioles of the Palmer amaranth plant, which extend the lower leaves out from the shadow of the upper leaves.

Figure 7. Young Palmer amaranth seedlings exhibit an extended petiole on the first true leaves.

Figure 8. A Palmer amaranth seedling. Note the extended petiole on the first true leaves.

Figure 9. Note the petiole of this Palmer amaranth seedling is longer than the leaf blade when bend back over the blade.

Seed Head Structures

Although one should identify weeds before the plants reach reproductive stage, it can be useful to look at seed head structures of escaped weeds to help identify the species.

Palmer amaranth females have a long main terminal seed head that can reach up to 3 feet long (Figures 10 and 11). Palmer amaranth female seed heads also have stiff, sharp bracts that give the seed heads a prickly feeling when touched.

Common waterhemp has multiple branched seed heads that are similar in length and lack the stiff, prickly bracts.

Leaf Blade Watermark

The leaves of some (but not all) Palmer amaranth plants have a white watermark shaped like a chevron or V (Figure 12). This mark is not present on common waterhemp, but use this mark only to verify an identification of Palmer amaranth since not all Palmer plants will express this characteristic.

Leaf Tip Hair

You can use the presence or lack of a singular hair in the leaf tip notch to help distinguish Palmer amaranth and common waterhemp (Figure 13), although waterhemp in the western Corn Belt sometimes has the leaf tip hair. To date, researchers have observed Palmer amaranth plants in Indiana have this single leaf tip hair, while common waterhemp plants do not.

It's important to note that the single hair does not appear on all Palmer plants or Palmer plant leaves, but can typically be found on the first two or three true leaves. Because this characteristic is so variable, use it only to help confirm the identity of Palmer amaranth along with the other characteristics, particularly petiole length.

Spiny Amaranth: A Common Misidentification

The presence of stiff, pointy bracts on the female seed head and leaf axils can lead to confusing Palmer amaranth with spiny amaranth or spiny pigweed (*Amaranthus spinosus*). Spiny amaranth is predominantly a weed of pastures, livestock holding pens, and feeding areas; it is rare in agronomic fields. Spiny amaranth has a bushy growth pattern and exhibits the spiny bracts throughout its life cycle, whereas Palmer amaranth exhibits the bracts only at maturity and during reproductive stages.

Figure 10. A Palmer amaranth plant growing in soybean with multiple terminal seed heads.

Figure 11. A Palmer amaranth seed head measuring close to 30 inches long.

Figure 12. Some Palmer amaranth leaves have white chevron or V-shaped watermarks.

Figure 13. Some Palmer amaranth plants have a single hair in the leaf tip notch.

Palmer Amaranth Management

Once Palmer amaranth has been properly identified in a field, the next step is to develop a proactive management plan. The main management goals should be to reduce early-season competition with crop plants *and* prevent *all* plants from producing seed and to avoid spreading the weed to other areas.

Indiana producers who encounter Palmer amaranth should treat the population as if it is ALS- and glyphosate-resistant — that's because the original transplanted seed likely came from the South, where the majority of Palmer populations *are* resistant to these herbicides. Again, the most crucial step is to scout fields dilligently and properly identify Palmer amaranth when it first appears.

Palmer amaranth has only recently been confirmed in Indiana. Purdue Weed Science has conducted limited research on its management. The recommendations provided here are based on the short-term research of Purdue and recommendations from researchers in the South and Michigan.

Consider combining cultural practices and herbicide programs for the most effective Palmer amaranth management. Palmer is a very aggressive and adaptive weed, and management programs that rely on a single mode of action (such as glyphosate as the only post herbicide) will typically be ineffective at completely controlling the weed.

Cultural Practices

Rotate Crops

Although it's not a new concept to rotate corn and soybean, rotating fields to corn allows producers to use herbicides with additional modes of action that will control Palmer amaranth. Rotation also helps slow further resistance issues and preserves current herbicide tools. In highly infested fields, consider growing corn for at least two years to maximize Palmer control. Although, as noted below, exercise caution to prevent resistance to corn herbicides.

Practice Deep Tillage

Deep tillage (moldboard plow) will bury the small Palmer amaranth seed below its preferred emergence depth. Deep tillage will not provide complete control, but will reduce the number of seeds that can emerge from the top 1 inch of soil.

In a heavily infested field, this practice can reduce the Palmer amaranth population up to 50 percent. Deep till only once, because the buried seed will remain viable up to five years and will redeposit in the top layer of soil if you deep till again within that time. Long-term no-till producers must weigh the weed control benefits of tillage against the economic and soil-structure benefits of their no-till system.

Plant a Cereal Rye Cover Crop

A properly managed and crimped cereal rye cover crop can provide a mulch that will suppress Palmer amaranth emergence. The majority of research on crimped cereal rye cover crop suppression on Palmer amaranth has been combined with deep tillage; hence, the cover crop is used for its weed suppression capabilities and not the soil health benefits that cover crop advocates often promote. No other cover crops have been extensively studied for use to suppress Palmer amaranth.

Hand Weed

In severe infestations in southern U.S. cotton fields and some Indiana soybean fields, producers have resorted to hiring hand weeding crews to remove Palmer amaranth. It is important to note that weeds should be pulled and taken out of the field and composted or burned. Plants that are laid on the soil in the field will reroot and continue to grow and produce viable seed.

Monitor Ditches and Borders

Take care to control Palmer amaranth plants in ditches and field edges. In fall 2012, Purdue weed scientists identified Palmer amaranth scattered along multiple roadside ditches in northwest Indiana. Although these plants did not compete with field crops, they still help spread of the population through pollen and seed.

Harvest Heavily Infested Fields Last

Because it is so small, Palmer amaranth seed disperses and spreads quickly, especially in machinery. Since combines are one of the largest contributors to the spread of Palmer amaranth seed, consider harvesting fields or field sections that have heavy Palmer amaranth infestations last.

Doing so will help keep the seed in these areas. After harvest, clean the combine as best as possible to assure seed will not be spread during the next harvest (this will be a meticulous and difficult process).

Table 1. Herbicides that provide pre-emergence control of Palmer amaranth in corn.

Trade Name(s)	Active Ingredient	Site of Action	Site of Action Group #[a]
Aatrex® and others[b]	atrazine	PSII-inhibitor	5
Anthem®	pyroxasulfone	Long chain fatty acid-inhibitor	15
	fluthiacet-methyl	PPO-inhibitor	14
Anthem ATZ®	pyroxasulfone	Long chain fatty acid-inhibitor	15
	fluthiacet-methyl	PPO-inhibitor	14
	atrazine	PSII-inhibitor	5
Balance Flexx®	isoxaflutole	HPPD-inhibitor	27
Bicep II Magnum®, Brawl II ATZ®, and Cinch ATZ®	atrazine	PSII-inhibitor	5
	S-metolachlor	Long chain fatty acid-inhibitor	15
Degree Xtra®, Fultime®, Harness Xtra®, and Keystone®	atrazine	PSII-inhibitor	5
	acetochlor	Long chain fatty acid-inhibitor	15
Corvus®	isoxaflutole	HPPD-inhibitor	27
	thiencarbazone	ALS-inhibitor	2
Dual II Magnum® and Cinch®	S-metolachlor	Long chain fatty acid-inhibitor	15
Fierce®	pyroxasulfone	Long chain fatty acid-inhibitor	15
	flumioxazin	PPO-inhibitor	14
Guardsman Max® and G-Max Lite®	atrazine	PSII-inhibitor	5
	dimethenamid-P	Long chain fatty acid-inhibitor	15
Outlook®	dimethenamid-P	Long chain fatty acid-inhibitor	15
Lexar and Lumax®	atrazine	PSII-Inhibitor	5
	S-metolachlor	Long chain fatty acid-Inhibitor	15
	mesotrione	HPPD-Inhibitor	27
Verdict®	saflufenacil	PPO-Inhibitor	14
	dimethenamid-P	Long chain fatty acid-Inhibitor	15
Zidua®	pyroxasulfone	Long chain fatty acid-Inhibitor	15

[a]Classification system using numbers for each specific site of action developed by the Weed Science Society of America.
[b]Maximum of 2 lbs. ai/A per application and 2.5 lbs. ai/A total for all applications per season.

Table 2. Corn herbicides that provide post-emergence control of Palmer amaranth.

Trade Name(s)	Active Ingredient	Site of Action	Site of Action Group #[a]
various	2,4-D	Growth regulator	4
Aatrex® and others[b]	atrazine	PSII-inhibitor	5
Callisto®	mesotrione	HPPD-inhibitor	27
Banvel®, Clarity®, Sterling Blue®, and others	dicamba	Growth regulator	4
Callisto Xtra®	atrazine	PSII-inhibitor	5
	mesotrione	HPPD-inhibitor	27
Capreno®	tembotrione	HPPD-inhibitor	27
	thiencarbazone-methyl	ALS-inhibitor	2
Expert®[c]	glyphosate	EPSPS-inhibitor	9
	S-metolachlor	Long chain fatty acid-inhibitor	15
	atrazine	PSII-inhibitor	5
Halex GT®[c]	glyphosate	EPSPS-inhibitor	9
	S-metolachlor	Long chain fatty acid-inhibitor	15
	mesotrione	HPPD-inhibitor	27
Impact® and Armezon®	topramezone	HPPD-inhibitor	27
Laudis®	tembotrione	HPPD-inhibitor	27
Liberty®[d]	glufosinate	Glutamine synthesis inhibitor	10
Status®	dicamba	Growth regulator	4
	diflufenzopyr	Auxin transport	19

[a]Classification system using numbers for each specific site of action developed by the Weed Science Society of America.
[b]Maximum of 2 lbs. ai/A per application and 2.5 lbs. ai/A total for all applications per season.
[c]Roundup Ready® corn hybrids only.
[d]Liberty Link® corn hybrids only.

Herbicide Control in Corn

There are a number of herbicides available in corn that effectively control Palmer amaranth and offer alternate modes of action to incorporate into your herbicide rotations. In highly infested fields, growing corn for multiple years can be effective in reducing Palmer populations. However, when growing corn for multiple years, take care to not rely heavily on single modes of action because atrazine- and HPPD-resistant Palmer amaranth populations have previously been confirmed.

Tables 1 and 2 outline the products available for pre-emergence and post-emergence use in corn. The tables also provide the active ingredients and sites of action for these products. Use these tables (along with knowledge of other weeds present) to formulate an effective herbicide program that maximizes the number of sites of action to delay resistance. Also, be aware that a maximum application of atrazine is 2 lbs./acre of active ingredient (ai) and the total of all applications cannot exceed 2.5 lbs. ai/acre.

Herbicide Control in Soybean

In soybean the number of herbicides available to replace glyphosate for Palmer amaranth control is limited. Furthermore, the herbicides must be applied at appropriate weed sizes for consistent control. The major herbicide limitation occurs with post-emergence products, so producers must take advantage of the available burndown and residual products.

Start With a Clean Field

Start with a clean field (either with tillage or an herbicide burndown) as the first key to successful Palmer amaranth management in soybean (see Table 3). Burndown treatments of glyphosate + 2,4-D or glyphosate + dicamba can be inconsistent on Palmer larger than four inches. Researchers in Tennessee have found that gramoxone + metribuzin is the most consistent burndown, even on large Palmer plants. Producers may have to consider a two-pass burndown because gramoxone + metribuzin can be weak on winter annuals that may also exist in the field.

Table 3. Herbicide products and tank mixes for burndown of Palmer amaranth prior to soybean planting.

Trade Name(s) or Tank Mix	Active Ingredient	Site of Action	Site of Action Group #[a]
glyphosate + 2,4-D[b,c,d]	glyphosate	EPSPS-inhibitor	9
	2,4-D	Growth regulator	4
glyphosate + Clarity®[b,c,d]	glyphosate	EPSPS-inhibitor	9
	dicamba	Growth regulator	4
Gramoxone® + Dimetric®[b]	paraquat	PSI-electron diverter	22
	metribuzin	PSII-inhibitor	5
Liberty®[d]	glufosinate	Glutamine synthesis inhibitor	10
Sharpen®/OpTill®/OpTill PRO®/Veridct +® glyphosate, Liberty®, Gramaxone®[d,e]	saflufenacil	PPO-inhibitor	14
	glyphosate or glufosinate or paraquat	EPSPS-inhibitor or glutamine synthesis inhibitor or PSI-electron diverter	9 or 10 or 22

[a] Classification system using numbers for each specific site of action developed by the Weed Science Society of America.
[b] Specific trades names are used only for clarification. Multiple glyphosate, 2,4-D, dicamba, and metribuzin products are available for use and are equally effective on Palmer amaranth.
[c] Burndown applications containing 2,4-D or dicamba must be applied 7-28 days before planting depending on product and rate. Refer to labels for specific pre-plant intervals
[d] Must be applied to Palmer amaranth that is 4 inches tall or shorter to achieve maximum consistent control.
[e] Do not apply saflufenacil products with sulfentrazone or flumioxazin as a tank mix or sequential application within 30 days of planting.

Table 4. Herbicides that provide pre-emergence control of Palmer amaranth in soybean.

Trade Name(s)	Active Ingredient	Site of Action	Site of Action Group #[a]
Authority Assist®/XL®/First®/ Maxx®, and Sonic®	sulfentrazone	PPO-inhibitor	14
	various	ALS-inhibitor	2
Authority MTZ®	sulfentrazone	PPO-inhibitor	14
	metribuzin	PSII-inhibitor	5
Boundary®	S-metolachlor	Long chain fatty acid-inhibitor	15
	metribuzin	PSII-inhibitor	5
Canopy®	chlorimuron	ALS-inhibitor	2
	metribuzin	PSII-inhibitor	5
Dual II Magnum® and Cinch®	S-metolachlor	Long chain fatty acid-inhibitor	15
Dimetric®, TriCor®, and others	metribuzin	PSII-inhibitor	5
Fierce®	pyroxasulfone	Long chain fatty acid-inhibitor	15
	flumioxazin	PPO-inhibitor	14
Intimidator®	fomesafenb	PPO-inhibitor	14
	metribuzin	PSII-inhibitor	5
	S-metolachlor	Long chain fatty acid-inhibitor	15
Intrro®, Lasso®, and Micro-Tech®	alachlor	Long chain fatty acid-inhibitor	15
Matador®	imazethapyr	ALS-inhibitor	2
	metribuzin	PSII-inhibitor	5
	S-metolachlor	Long chain fatty acid-inhibitor	15
Outlook®	dimethenamid-P	Long chain fatty acid-inhibitor	15
Optill PRO®	dimethenamid-P	Long chain fatty acid-inhibitor	15
	saflufenacil	PPO-inhibitor	14
	imazethapyr	ALS-inhibitor	2
Prefix®	S-metolachlor	Long chain fatty acid-inhibitor	15
	fomesafen[b]	PPO-inhibitor	14
Prowl®	pendimethalin	Microtubule inhibitor	3
Valor®	flumioxazin	PPO-inhibitor	14
Valor XLT®, Gangster®, Enlite®, and Envive®	flumioxazin	PPO-inhibitor	14
	various	ALS-inhibitor	2
Zidua®	pyroxasulfone	Long chain fatty acid-inhibitor	15

[a]Classification system using numbers for each specific site of action developed by the Weed Science Society of America.
[b]A total of 0.313 lb./A (north of I-70) or 0.375 lb./A (South of I-70) of fomesafen is allowed to be applied per season.

Producers also need to be aware of the planting restrictions that come with several burndown programs. Burndowns containing 2,4-D or dicamba require a pre-plant interval of seven to 28 days, depending on the product, rate, and for dicamba, when the first precipitation event occurs after application.

Saflufenacil products (Sharpen®, OpTill®, OpTill PRO®, Verdict®) for Palmer or winter annual burndown require a 30-day pre-plant window if the producer will use a PPO-inhibiting residual (such as flumioxazin or sulfentrazone).

With these restrictions, it may mean you will have to make multiple passes over a field in the spring to effectively burn down existing Palmer, and then apply a residual herbicide as close to planting as possible.

Residual Herbicides

Residual herbicides should be the foundation of all Palmer amaranth herbicide control programs in soybean (see Table 4). There are a variety of residual soybean herbicides that will control Palmer amaranth at its weakest point (emergence) and substantially reduce the number of plants requiring a post-emergence application. Using residual herbicides to manage Palmer will reduce the selection pressure of the few post-emergence herbicide options.

Apply residual herbicides as close to soybean planting as possible to maximize product activity in the crop. Fall or early spring residual herbicide applications provide very little to no Palmer amaranth control.

Table 4 lists all the soybean products that provide Palmer amaranth control or suppression — although the level of suppression varies by product. Purdue Weed Science research has shown that products with the active ingredients flumioxazin or sulfentrazone provide the highest level of control when applied alone; however, even these herbicides will begin to break down two to three weeks after application.

Products that contain metribuzin, S-metolachlor, pyroxasulfone, and dimethenamid-P will provide marginal suppression of Palmer amaranth; however, these products will strengthen a residual program when applied in combination with flumioxazin or sulfentrazone.

Research indicated that the most robust residual programs combined two or three of these active ingredients either in tank mixes or premixes. Product labels may restrict tank mixes; always refer to product

Table 5. Soybean herbicides that provide post-emergence control of Palmer amaranth that is 4 inches tall or less.

Trade Name(s)	Active Ingredient	Site of Action	Site of Action Group #[a]
Prefix®[b]	S-metolachlor	Long chain fatty acid-inhibitor	15
	fomesafen[c]	PPO-inhibitor	14
Reflex®/Dawn® and Flexstar®/Rhythm®	fomesafen[c]	PPO-inhibitor	14
Flexstar GT®[d]	fomesafen[c]	PPO-inhibitor	14
	glyphosate	EPSPS-inhibitor	9
Cobra® and Phoenix®	lactofen	PPO-inhibitor	14
Liberty[e]	glufosinate	Glutamine synthesis inhibitor	10

[a]Classification system using numbers for each specific site of action developed by the Weed Science Society of America.
[b]Prefix® has both post-emergence control and residual activity.
[c]A total of 0.313 lb./A (North of I-70) or 0.375 lb./A (South of I-70) of fomesafen is allowed per season.
[d]Roundup Ready® soybean varieties only.
[e]Liberty Link® soybean varieties only.

labels before tank mixing products. Remember, many of these active ingredients and combinations pose crop injury risk — weigh the potential risk for injury against the risk of Palmer amaranth escapes.

Post-emergence Herbicide Timing

Post-emergence herbicides in soybean are limited (see Table 5) to PPO-inhibiting herbicides and Liberty® (Liberty Link® beans only). The timing of these products is key for effective Palmer amaranth control. The consistency and overall control of the PPO-inhibitors and Liberty® is dramatically decreased once Palmer amaranth plants are taller than 4 inches. Soybean producers in the South often plow under and replant soybean once Palmer is taller than 4 inches without an effective post-emerge herbicide application.

Liberty Link® Considerations

In heavily infested fields consider planting Liberty Link® soybean because Liberty® offers consistent control of small Palmer amaranth and adds post-emergence options and another site of action to your rotation (thus reducing pressures on the PPO-inhibiting herbicides). Keep a pre-emergence residual as the foundation of all Palmer amaranth herbicide programs, even in Liberty Link® soybean.

A Liberty Link® system will also require a layby residual product to achieve maximum control.

Post-emergence (Layby) Residuals

Although pre-emergence residuals are the foundation of Palmer amaranth herbicide programs, these products will not last the entire season — so Palmer plants will continue to emerge. Add a residual herbicide (such as Dual II Magnum®, Warrant®, or Outlook®, or Zidua®) to your post-emergence application to add residual activity into the latter parts of the season (see Table 6). Remember, pre-emergence products do not control emerged plants and must be tank mixed with one of the post-emergence options mentioned above.

Multiple Applications and Sites of Action (SOA)

The days of one- and two-pass single mode of action soybean programs are gone. Producers should accept this fact when managing a Palmer amaranth-infested field. Producers will have to make multiple applications before and after planting. Producers should also avoid applying any single herbicide product or multiple products with the same mode of action more than twice in a growing season to avoid conferring resistance to the few remaining products left to control Palmer amaranth in soybean.

Tables 3-6 outline the products available for effective control of Palmer amaranth at burndown, pre-emergence, and post-emergence, and provide the sites of action of each product. Use these tables (and the information in

Table 6. Soybean herbicides that can be tank mixed with post-emergence the products listed in Table 5 for additional residual activity in the crop.

Trade Name(s)	Active Ingredient	Site of Action	Site of Action Group #[a]
Dual II Magnum®	S-metolachlor	Long chain fatty acid-inhibitor	15
Outlook®	dimethenamid-P	Long chain fatty acid-inhibitor	15
Warrant®	acetochlor	Long chain fatty acid-inhibitor	15
Sequence®[b]	S-metolachlor	Long chain fatty acid-inhibitor	15
	glyphosate	EPSPS-inhibitor	9
Zidua®[c]	pyroxasulfone	Long chain fatty acid-inhibitor	15

[a]Classification system using numbers for each specific site of action developed by the Weed Science Society of America.
[b]Roundup Ready® soybean varieties only.
[c]Pending label approval for use in soybean — expected in early 2013. Check label to confirm status.

this publication) to formulate a multiple-pass herbicide program for Palmer amaranth control that maximizes the number of herbicide sites of action to delay development of future resistance.

It may be worthwhile to discuss product and program options with your chemical representative, crop consultant, or weed science specialist. Pre-plant and tank mix label restrictions are intricate and these experts may be able to help you more than can be briefly discussed in this publication.

Sources

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Ohio Poison Information Centers

National Poison Control Center—1-800-222-1222

This number will automatically connect you to the center closest to you.

Cincinnati: 45627-0144	Cleveland: 44106	Columbus: 43205
Drug and Poison Information Center University of Cincinnati Medical Center, Room 7701 3333 Burnet Ave., ML 9004 513-558-5111 800-872-5111	Greater Cleveland Poison Center 11100 Euclid Avenue 216-231-4455 1-888-231-4455	Children's Hospital 700 Children's Drive 614-228-1323 800-682-7625 614-228-2272 (TTY)*

*Phone number for the deaf.

Emergency Contacts

In the event of gross environmental contamination by pesticides, such as a spill or fire, contact:

Ohio Environmental Protection Agency	Ohio Department of Agriculture
24-Hour Emergency Response Group 1800 Watermark Dr. Columbus 43266 1-800-282-9378 (in Ohio) 614-224-2260 (outside Ohio)	Pesticide Regulation Section 8995 East Main Street Reynoldsburg 43068 1-800-282-1955 8:00 a.m. to 4:30 p.m., Monday through Friday

In event of chemical fire, spill, leak, exposure or accident on a highway, railway or waterway, contact:

Chemtrec
Washington, D.C. 800-424-9300 24 hours a day; 7 days a week

Indiana Poison Control Centers

Indiana Poison Center
I-65 at 21st Street
P.O. box 1367
Indianapolis, IN 46206-1367
(800) 382-9097

Environmental Emergencies (chemical spills)
Indiana Department of Environmental Management
Indiana Government Center North
100 North Center Drive
P.O. Box 6015
Indianapolis, IN 46206-6015
24 hours: (317) 233-7745 (emergencies only)
Nonemergencies: 800-451-6027

Chem Trek (800) 424-9300

Indiana Pesticide Regulatory Official
(including information on Worker Protection Standard WPS)
Office of the Indiana State Chemist
Dept. of Biochemistry
Purdue University
West Lafayette, IN 47907
(765) 494-1492
or for WPS information (765) 494-1589

Illinois Poison Control Information

National Poison Control Center
1-800-222-1222

This number will automatically connect you to the center closest to you.

Spill Assistance: For major spills, Illinois law requires that emergency notification be made to the Illinois Emergency Management Agency (IEMA). They in turn notify the appropriate agencies for response. Their 24-hour emergency hotline number is:

Illinois Emergency Management Agency
1-800-782-7860

Tables