2017 Mid-Atlantic Field Crop Weed Management Guide

Produced by Penn State Extension in cooperation with University of Delaware, University of Maryland, Rutgers University, Virginia Tech, and West Virginia University

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Weeds and Their Impacts

There are numerous definitions of a weed. The following are some common definitions:

- A plant that is out of place and not intentionally sown
- A plant that grows where it is not wanted or welcomed
- A plant whose virtues have not yet been discovered
- A plant that is competitive, persistent, pernicious, and interferes negatively with human activity

No matter which definition is used, weeds are plants whose undesirable qualities outweigh their good points, at least according to humans. Human activities create weed problems since no plant is a weed in nature. Though we may try to manipulate nature for our own good, nature is persistent. Through manipulation we control certain weeds, while other, more serious weeds may thrive due to favorable growing conditions. Weeds are naturally strong competitors, and those weeds that can best compete always tend to dominate.

Both humans and nature are involved in plant-breeding programs. The main difference between the two programs is that humans breed plants for yield and/or aesthetic qualities, while nature breeds plants for survival.

Characteristics of Weeds

There are approximately 250,000 species of plants worldwide; of those, about 3 percent, or 8,000 species, behave as weeds. Of those 8,000, only 200 to 250 are major problems in worldwide cropping systems. A plant is considered a weed if it has certain characteristics that set it apart from other plant species. Weeds possess one or more of the following characteristics that allow them to survive and increase in nature:

- Abundant seed production
- Rapid population establishment
- Seed dormancy
- Long-term survival of buried seed
- Adaptation for spread
- Presence of vegetative reproductive structures
- Ability to occupy sites disturbed by humans

Abundant Seed Production

Weeds can produce tens or hundreds of thousands of seeds per plant, while most crop plants only produce several hundred seeds per plant. Below are some examples of approximate numbers of seeds produced per weed:

- Giant foxtail: 10,000
- Common ragweed: 15,000
- Purslane: 52,000
- Lambsquarters: 72,000
- Pigweed (Fig. 1-1): 117,000

Figure 1-1. Pigweed.

Since most weeds deposit their seed back to the soil, seed numbers in the soil increase rapidly from year to year if the weeds are not managed. Despite the fact that many weed seeds are either not viable, eaten by animals or insects, or decompose within several months after they are deposited, hundreds of millions of viable weed seeds per acre can still be present and waiting to germinate.

Rapid Population Establishment

Most weeds can germinate and become established relatively quickly. They also produce viable seed even under environmental and soil conditions that are not favorable for most crop plants. Under ideal conditions, dense weed populations can thrive and easily outcompete a crop if left unchecked. Under poor conditions, certain weeds can adapt and produce some viable seed in a relatively short time period (6 to 8 weeks).

Seed Dormancy

Dormancy is basically a resting stage or a temporary state in which the weed seed does not germinate because of certain factors. Seed dormancy allows the weed to disperse itself in time. Dormancy is a survival mechanism that prevents germination when conditions for survival are poor. For example, seeds of summer annual weeds will generally not germinate in the fall, preventing them from being killed by cold winter conditions. The various factors that affect dormancy are temperature, moisture, oxygen, light, the presence of chemical inhibitors, tough seed coat, and immature embryos.

Long-term Survival of Buried Seed

Most crop, turf, and ornamental plant seeds lose their viability after a few years and will usually rot if they don't germinate soon after planting. Weed seeds tend to resist decay for longer periods and remain dormant. If conditions are adequate, buried weed seeds have the potential to remain viable for 40 years or more. Broadleaf weed seeds tend to last longer in the soil than grassy weed seeds since they usually have tougher seed coats. In most cases, the majority of seeds only exist in the soil for a few years due to germination, decomposition, predator feeding, or other factors. However, with the large number of seeds produced, a small percentage may remain viable for long-term survival.

Adaptation for Spread

Weeds have certain mechanisms for easy dispersal of seeds. Most seeds or seed pods have special structures allowing them to cling, fly, or float. Common cocklebur and burdock seed pods have hooks that attach to animal fur or feathers; curly dock seeds have bladderlike structures that allow them to float; and milkweed, dandelion, and thistle seeds have a feathery pappus that allows them to be carried by the wind. Other weeds, such as jewelweed or snapweed, have pods that "explode" when the seeds are mature, projecting them several feet from the parent plant. Weeds also can be spread when animals or birds eat their fruit and deposit the seeds with their droppings. Weed seed can be widely spread through crop seeds, feed grains, hay, straw, manure, and mulch, to name a few. These and other human activities (e.g., interstate and worldwide freight transport and travel) probably account for the long-distance spread of weeds.

Vegetative Reproductive Structures

Many weeds have two means of reproduction: by seed and vegetatively. Most perennial weeds possess special vegetative structures that allow them to reproduce asexually and survive. These structures contain carbohydrates (food reserves, sugars) and have numerous buds in which new plants can arise. Most of these underground parts grow rapidly (many feet per year) and can penetrate and emerge from deep (2 to 5 feet or more) in the soil. Such perennial structures include the following:

- **Stolons:** aboveground, horizontal stems that root at the nodes (e.g., crabgrass, bermudagrass, ground ivy)
- **Rhizomes:** belowground, thickened stems that grow horizontally in the upper soil layers (e.g., quackgrass, Johnsongrass, wirestem muhly, Canada thistle)
- **Tubers:** enlarged rhizomes with compressed internodes located at the ends of rhizomes (e.g., yellow nutsedge, Jerusalem artichoke, potato)
- **Bulbs:** modified leaf tissues for carbohydrate storage that are located at the base of the stem or below the soil line (e.g., wild garlic, onion, Star-of-Bethlehem)
- **Budding roots:** modified roots that can store carbohydrates and grow both vertically and horizontally (e.g., hemp dogbane, Canada thistle)

Despite these vegetative reproductive structures, many perennials also reproduce by seed. Some depend heavily on reproduction by seed (e.g., dandelion), while for others it is less important (e.g., yellow nutsedge).

Ability to Occupy Disturbed Sites

Weeds are very opportunistic and capable of growing under adverse conditions. When conditions are adequate, weed seeds germinate and colonize if left unchecked. When a site is disturbed, weeds are usually the first to emerge. If a weed becomes established first, it has the competitive advantage over crop plants or desirable vegetation.

Problems with Weeds

Weeds are troublesome in many ways. Primarily, they reduce crop yield by competing for:

- Water
- Light

- Soil nutrients
- Space
- CO_2 (carbon dioxide)

Other problems associated with weeds include:

- Reducing crop quality by contaminating the commodity
- Interfering with harvest
- Serving as hosts for crop diseases or providing shelter for insects to overwinter
- Limiting the choice of crop rotation sequences and cultural practices
- Producing chemical substances that cause allergies or toxins to humans, animals, or crop plants (allelopathy)
- Producing thorns and woody stems that cause irritations and abrasions to skin, mouths, or hooves of livestock
- Being unsightly, dominant, or aggressive
- Obstructing visibility along roadways, interfering with delivery of public utilities (power lines, telephone wires), obstructing the flow of water in waterways, and creating fire hazards
- Accelerating deterioration of recreational areas, parking lots, buildings, and equipment
- Invading exotic weed species that can displace native species in stabilized natural areas

Cost of Weeds

Weeds are common on all 485 million acres of U.S. cropland and almost one billion acres of range and pasture. Weeds are one of the most significant threats to crop production in North America with losses in crop yield and quality along with the costs of control having a significant economic impact for many farmers. In 1992, it was estimated that weeds caused a 1 to 15 percent loss in corn yield and a 2 to 20 percent loss in soybean yield even with the use of herbicides and nonchemical control tactics. In 2003, it was estimated that without herbicides and the substitution of alternatives (e.g., cultivation, hand-weeding) a loss of $13.3 billion would result in food and fiber production. The total impact of herbicide nonuse would be an income loss of $21 billion, which includes $7.7 billion in increased costs for weed control and $13.3 billion in yield losses. The most recent survey conducted by scientist members of the Weed Science Society of America considered corn and soybean yield performance in university weed control trials in the United States from 2007 to 2013 in the absence of herbicides. They estimated that without effective herbicides, weeds would cause a 52 percent corn and 49 percent soybean yield loss.

Weed control and other input costs (e.g., seed, fertilizer, other pesticides, and fuel) vary with the crop. In Pennsylvania in 2015, herbicide costs for corn grain production were estimated to be about $42 per acre for reduced till and $45 for no-till with total variable costs of about $440 per acre. For full-season soybean, costs of herbicide averaged $13 per acre without a burndown application, with a total variable cost of about $200 per acre. For winter wheat, herbicide costs averaged about $6 per acre, with a total variable cost of about $260. The cost of herbicides for weed control remains 10 percent or less of the total variable cost for all agronomic crops grown in Pennsylvania. Several factors help determine the relative costs of weed control from one crop to another, including the competitive ability of the crop, the weeds present, the contribution of nonchemical control practices, tillage method, management decisions, the type of crop seed used (i.e., normal versus resistant GMO variety) and the value of the crop. Weeds not only cause losses in crops but also can affect livestock production if poisonous weeds are present or weeds invade and reduce the carrying capacity of or render the pasture useless.

Benefits of Weeds

Despite the negative impacts of weeds, some plants usually thought of as weeds may actually provide some benefits, such as:

- Stabilizing and adding organic matter to soils
- Providing habitat and feed for wildlife
- Providing nectar for bees and other pollinator species
- Offering aesthetic qualities
- Serving as a genetic reservoir for improved crops
- Providing products for human consumption and medicinal use
- Creating employment opportunities

Weeds have a controversial nature. But, to the agriculturist, they are plants that need to be managed, in an economical and practical way, in order to produce food, feed, fiber, and ornamental and vegetative cover for humans and animals. In this context, the negative impacts of weeds indirectly affect all living beings.

Weed Ecology and Biology

Origins of Weeds

Weeds are found throughout the world. However, all are not common in every region. Since weeds can be easily spread, more and more are being disseminated to places where they were not originally found. Only about 40 percent of the weeds found in the United States are native, while the remaining 60 percent are considered exotic or imported. Below are some examples of weeds and their origins:

- **United States:** common and giant ragweed, common milkweed, hemp dogbane, fall panicum, common cocklebur, poison ivy, marestail (horseweed), nightshade, wild or common sunflower, wild onion, Joepyeweed, ironweed, smooth sumac, spotted waterhemlock, goldenrod, hedge bindweed, burcucumber, dodder, wild four-o'clock, devil's

claw, common pokeweed, reed canarygrass, jimsonweed, groundcherry, eastern black nightshade, horsenettle, common cattail, stinging nettle

- **South America:** pigweed species, prickly sida, giant salvinia, and parrot feather watermilfoil
- **Europe:** quackgrass, chickweed, dandelion, Canada thistle, common lambsquarters, common purslane, wild garlic, yellow foxtail, common burdock, garlic mustard, purple loosestrife, poison hemlock, wild carrot, chicory, bull thistle, St. Johnswort, yellow nutsedge, ground ivy, downy brome, smooth and large crabgrass, annual bluegrass, Johnsongrass
- **Asia or Africa:** Johnsongrass, wild carrot, giant foxtail, velvetleaf, shattercane, kudzu, Japanese knotweed, spotted knapweed, multiflora rose, tree of heaven, mile-a-minute, Japanese stiltgrass, witchweed, hydrilla, Eurasian watermilfoil, autumn olive, bush honeysuckles, Bradford pear

Weeds not native to an area tend to become invasive and spread rapidly. In some cases, these alien species have displaced natural populations of native vegetation. Alien species distribute so rapidly not only because their natural enemies were not brought with them but also because they may easily adapt to areas disturbed by people.

Classification of Weeds

Almost all plants are categorized by some sort of plant classification system and given a scientific name to identify them anywhere in the world. Keep in mind that the scientific name (i.e., genus and species) is universal, but the common name of a weed may differ from region to region. For example, velvetleaf is also known as buttonweed and butter print; common lambsquarters can be referred to as pigweed, goosefoot, fathen, or bacon-weed; and wild carrot is known as Queen Anne's lace. Weeds are also classified by other means. In general, they can be classified by their structure and appearance (e.g., dicots [broadleaves] and monocots [grasses and sedges]), habitat, or physiology. A common categorization system groups them according to their life cycle (how long they live). The three major life cycle groups are annuals, biennials, and perennials.

Annuals

Annuals are generally divided further into summer annual and winter annual weeds. Summer annuals germinate in the spring, mature, produce seed, and die in one growing season. Large crabgrass, giant foxtail, smooth pigweed, common lambsquarters, common ragweed, velvetleaf, hairy galinsoga, and common purslane are examples of troublesome summer annuals.

Winter annual weeds germinate in late summer or fall, mature, produce seed, and then die the following spring or summer. Examples of winter annuals include common chickweed (Fig. 1-2), henbit, shepherdspurse, downy brome, and annual bluegrass. (Some annual bluegrass subspecies can occasionally function as perennials.)

Biennials

Biennial weeds grow from seed any time during the growing season. They normally produce a rosette of leaves close to the soil surface the first year, and then flower, mature, and die during the second year. A true biennial never produces flowers or seeds the first year. There are relatively few biennial weeds. Some examples include wild carrot, common burdock, bull and musk thistle (Fig. 1-3), and poison hemlock.

Perennials

Perennial weeds live for more than two years and can be divided into two groups: simple and creeping. Simple perennials form a deep taproot and spread primarily by seed dispersal. Some examples of simple perennials include dandelion (Fig. 1-4), broadleaf plantain, curly/broadleaf dock, autumn olive, and common pokeweed. Creeping perennials may be either herbaceous or woody, and can spread by both vegetative structures as well as seed. Some common herbaceous perennials include Canada thistle, common milkweed, hemp dogbane, creeping buttercup, slender speedwell, ground ivy, quackgrass (Fig. 1-5), and yellow nutsedge. Some examples of woody perennials include poison ivy, multiflora rose, Japanese knotweed/bamboo, brambles, wild grape, and Virginia creeper. Creeping perennials become established by seed or by vegetative parts. Since perennial weeds live indefinitely, their persistence and spread are not as dependent on seed as the other two weed groups.

Figure 1-2.
Common chickweed.

Figure 1-3.
Bull thistle.

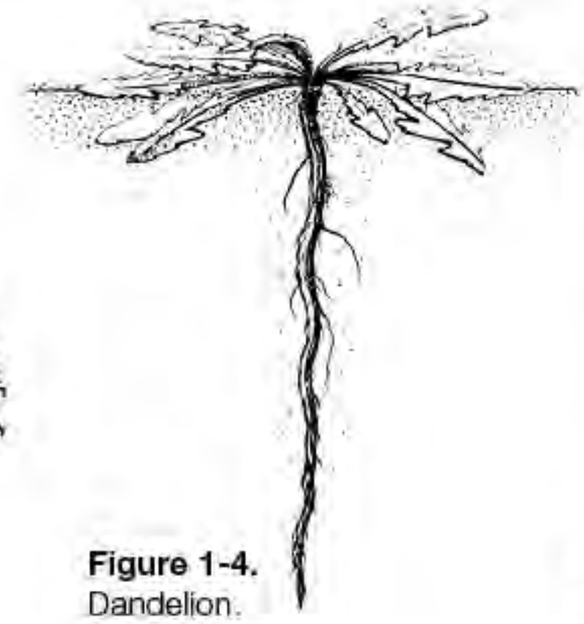

Figure 1-4.
Dandelion.

Figure 1-5.
Quackgrass.

Weed Management Techniques

Over the past decade or so there have been a number of rapid changes in weed management techniques and ideologies. New directions in weed management include shifting crop management practices, continuously changing weed control technologies, increasing concern for the environment, and using computer software and electronic information technology for decision making, record keeping, and data managing. Environmental concerns have resulted in more no-till, cover crop, and organic crop production systems. Advancements in technology have allowed the development of lower-use-rate herbicides with less soil persistence, biotechnology that produces genetically modified crops, and computers that allow us to develop predictive models for weed and crop development, while weed mapping and GPS units enhance more precise herbicide application on specific weed patches and at various herbicide rates. However, despite all these advances, mechanical and chemical tactics still provide the majority of weed control in many settings. Regardless of the weed control tactic or setting, knowledgeable and experienced field consultants and technicians will be necessary to diagnose problems, interpret information and results, and provide practical advice about weed management.

Since weeds are so prevalent in many areas of the landscape, management techniques are necessary to maintain order. Weed management is most successful when it involves an integrated approach using a variety of methods. The common methods used to manage weeds include prevention and cultural, mechanical, biological, and chemical means. Relying on any single tactic can lead to severe problems, such as high costs and crop failure. In planning a weed management strategy, keep in mind the available equipment and time, land characteristics, weed spectrum, and yield objective. Management inputs such as herbicides sometimes can be reduced, but alternative approaches must be substituted if the production level is to be maintained.

Integrated Weed Management

Corn and soybean fields that are weed free for the first 4 to 6 weeks after planting will often yield the same as fields that are weed free for the entire growing season. This approach relies on a residual soil-applied herbicide program. Weeds that germinate with the crop but are controlled in a timely fashion (3 to 4 weeks after planting) will not impact final yields. This approach relies on effective and timely postemergence weed control. In addition, if weeds are kept out of the field for 4 to 6 weeks after crop emergence, any weeds that invade later will not reduce yield significantly, although they may produce seeds, cause harvesting problems, or reduce crop quality. Also, it is not necessary to control all weeds in a field to achieve maximum yield. Weed populations of 10 to 20 weeds per 10 square yards are sufficient to cause severe yield loss. However, weed populations at 1 plant per 10 square yards will have no impact on final yield. The impact of weed populations between 1 and 10 per yard is difficult to predict. The decision to treat the field depends on the weed species present, crop vigor, weather conditions, and herbicide cost.

Prevention

Preventative methods are used to stop the spread of weeds. It is usually easier to prevent the introduction of weeds than it is to control them after establishment. Preventive practices include cleaning tillage and harvesting or mowing equipment of weed seeds and vegetative structures; planting certified, weed-free crop seed or sod; and controlling weeds in barnyards, around structures, and along fencerows, roadways, and ditch banks. Scouting areas to assess weed populations and controlling them before they spread farther is another means for preventing additional weed problems.

Early Season Weed Scouting

The first key to weed management is proper weed identification. The best method for timely identification is through field scouting. The first reports on weed conditions in a field are needed within 2 weeks after crop emergence to evaluate herbicide performance and determine if there is a need for rotary hoeing, cultivation, or postemergence herbicides. Earlier scouting will be needed in no-till fields where a knockdown or early preplant herbicide may be applied. Identify and record all weed species found. Determine the severity of the infestation by counting the number of weeds found per 10 feet of row for large infestations or per 100 feet of row for smaller infestations in all areas sampled. Sample areas should represent no more than 5 acres, so sample enough areas to get an accurate count of the different weeds present in the field or on the farm. The approximate height and growth stage of both weeds and crop should be recorded. Along with weed reports, early soil moisture observations are important. They serve as indicators of herbicide effectiveness. Adequate moisture is necessary for effective weed control with all soil-applied herbicides. Too little rainfall can mean there is not enough moisture to allow adequate mobilization of the herbicide; too much rain can cause more soluble herbicides to move downward below the zone where they are most effective. Postemergence herbicides usually are most effective when weeds are young and actively growing. The degree of control with these herbicides will vary due to differences in weed species, growth stages, weather conditions, and herbicide application method. To select the best possible herbicide and apply it at the optimum time to maximize control, the manager needs to be able to identify weed seedlings when they are small.

Cultural Techniques

Cultural crop management techniques provide a healthy crop to best compete with weeds. Competition from crop, turf, or desirable vegetative cover can be an inexpensive and effec-

tive aid to weed management if used to its fullest advantage. Examples of cultural techniques include following soil test recommendations for fertilizer and lime; selecting the best varieties for the environmental conditions; planting dense populations at the proper timing; proper mowing practices; scouting fields or areas regularly for weeds, insects, and diseases, and controlling them when necessary; and including crop rotations and cover crops in the system. Composting, ensiling, or feeding weeds or weed-infested crops to livestock can destroy the viability of weed seeds. The heat and/or digestive acids break down the majority of weed seeds. However, some seeds pass through livestock or the composting process unharmed and can germinate if spread back onto the land.

Cover Crops

Cover crops provide important benefits to the Mid-Atlantic region, including soil and water conservation and nutrient retention. Some growers are also finding that cover crops can help reduce weed problems, especially winter annuals like horseweed. The following management factors should be considered to enhance weed suppression with your cover crops.

Species selection. Choose cover crops based on your objectives. If weed suppression is an objective, select an aggressive species that will cover the ground quickly. If you desire a cover crop that will protect the soil through the fall and winter and suppress winter annual weeds, plant a winter cereal in late summer or early fall.

Establishment date. Establishing a hardy winter cover, such as cereal rye, as early in the fall as possible will result in greater cover crop biomass over the winter and rapid growth during the spring. Other establishment dates may be preferable for different cover crops depending on the species and your objectives.

Seeding rate, row spacing, and planting arrangement. The seeding rate and arrangement of the cover crop can influence weed suppression. Planting at higher-than-normal seeding rates and in narrow rows can influence the amount of soil cover, particularly in the first several weeks after seeding. Thick, dense cover crop stands can help reduce the establishment of weeds.

Soil fertility. It is important to provide adequate soil fertility to cover crops to ensure they are competitive and successful. This is particularly true for small grains like cereal rye and wheat and forage radish, which require adequate nitrogen. Lime may be necessary to maintain or raise the soil pH for legumes like hairy vetch and red clover. Regular soil tests will help you determine how best to manage your cover crops so as to maximize their beneficial effects on weed suppression and soil quality.

Termination timing. Allowing a cover crop to grow as long as possible before controlling it reduces weed populations through competition for light, nutrients, and moisture. In no-till, letting the cover crop achieve maximum dry matter production (often at flowering or beyond) will increase weed suppression. This may mean delaying termination and cash crop planting until the cover crop has achieved sufficient growth to suppress weeds (weed suppression may require dry matter production of at least 4,000 pounds per acre). Keep in mind, however, that high-biomass cover crops can be more challenging to manage, may need shorter-season cash crops to allow for adequate cover crop growth, and may require specialized planting equipment or may increase the potential for some insect pest problems.

Cover crops can be terminated mechanically or with herbicides. Each method has advantages and disadvantages. Mowing can be effective for some annual cover crops, but the mulch may degrade quite rapidly because it has been chopped. Plowing can be an effective physical control for cover crops, but the benefit of the weed-suppressive mulch in the subsequent cash crop is lost. The roller-crimper offers effective physical control of some annual cover crops, but without any accompanying herbicides, control is delayed until the winter annual cover crops are flowering and can be inconsistent. Rolling creates a longer-lived mulch layer than mowing. Herbicides can effectively control most cover crops, but product selection and application timing are important.

Mechanical Techniques

Mechanical or physical techniques either destroy weeds or make the environment less favorable for seed germination and weed survival. These techniques include hand-pulling, hoeing, mowing, plowing, disking, cultivating, and digging. If adequate weed control is obtained from other methods such as herbicides, tillage or cultivation may not be necessary, which in turn may avoid soil crusting and soil erosion that can occur when soils are routinely tilled. Mowing removes the seed heads of most weeds and reduces the amount of spread of seed in an area. Mowing is used primarily for weed control in lawns, meadows, pastures, waste areas, and along roadsides. Digging or pulling is an effective method of controlling a limited number of weeds. Smaller weeds can be easily hand-pulled or hoed in small garden areas or flower beds; however, the use of heavy machinery may be necessary to remove large woody weeds such as multiflora rose, tree of heaven, and autumn olive. Mulching (straw, wood chips, compost, gravel, plastic, landscape fabric, etc.) can also be considered a mechanical control means since it uses a physical barrier to block light and impede weed growth. In landscaping and vegetable production, it usually helps to reduce the need for other weed management tactics.

Biological Techniques

Biological weed control involves the use of other living organisms, such as insects, diseases, or livestock, for the management of certain weeds. In theory, biological control is well suited for an integrated weed management program. However, the limitations of biological control are that it is a long-term undertaking, its effects are neither immediate nor always adequate, only certain weeds are potential candidates, and the rate of failure for past biological control efforts has been fairly high. There have been a few success stories of weed species (e.g., St. Johnswort, prickly pear, multiflora rose, purple loosestrife, thistles) being managed or affected by insect or disease biocontrol agents. Herbivores such as sheep and goats can provide successful control of some common pasture weeds. Finally, conservation biological control may improve our ability to manage weeds and use less herbicide. This involves enhancing populations of natural enemies by manipulating field habitats to create more favorable environments for predator insects and rodents. Ground beetles, crickets, ants, and mice are some of the more common weed seed predators. In general, providing cover in the form of living or dead crops, causing less soil disturbance, and avoiding the use of toxic pesticides can encourage these biocontrol agents. Research continues in this area of weed management.

Chemical Techniques

Chemicals used for the control of weeds are called herbicides. Herbicides can be defined as crop (or desirable plant) protecting chemicals used to kill weedy plants or interrupt normal plant growth. Herbicides provide a convenient, economical, and effective way to help manage weeds. They allow fields to be planted with less tillage, allow earlier planting dates, and provide additional time to perform the other tasks that farm or personal life require. Due to reduced tillage, soil erosion has been reduced from about 3.5 billion tons in 1938 to one billion tons in 1997, thus reducing soil from entering waterways and decreasing the quality of the nation's surface water. Without herbicide use, no-till agriculture becomes impossible. However, herbicide use also carries risks that include environmental, ecological, and human health effects. It is important to understand both the benefits and disadvantages associated with chemical weed control before selecting the appropriate control.

Herbicides may not be a necessity on some farms or landscape settings, but without the use of chemical weed control, mechanical and cultural control methods become that much more important. There are many kinds of herbicides from which to choose. Many factors determine when, where, and how a particular herbicide can be used most effectively. Understanding some of these factors enables you to use herbicides to their maximum advantage.

No-till Weed Management

Successful production of no-till crops requires control of existing vegetation at planting (cover crops and weeds) and broadleaf and grass weeds that emerge after planting. A diversity of herbicides and cover crop and residue situations makes it impossible to utilize a single program to efficiently control weeds and grasses in all situations. Herbicide selection based on weed identification histories of each field is necessary to achieve maximum yield potential. Fields with heavy crop residues may require the maximum labeled rate of residual herbicides for acceptable performance. Encapsulated formulations, when available, may be less readily absorbed by heavy crop residues and may perform more consistently.

Cultivation and mechanical weed control are very difficult or impossible and generally not considered an option in most no-till production systems. However, some companies manufacture high-residue cultivators that are designed for use in no-till/reduced-till systems. We have had a number of trials examining their effectiveness and generally two passes will provide about a 50 percent reduction in weed dry matter. Combining these tools with herbicides can provide a more integrated approach to weed management.

Existing vegetation is traditionally controlled by the non-selective herbicides, which are often tank-mixed with residual herbicides. Burndown herbicide options include paraquat or glyphosate and perhaps a growth regulator herbicide. No-till crop production tends to favor perennial weed populations because their root systems are not disrupted by tillage. No-till also favors small-seeded broadleaf weeds and grasses (small-seeded broadleaves include lambsquarters and pigweed) rather than large-seeded weeds, such as velvetleaf.

Escalating herbicide costs and interest in keeping herbicide use to a minimum encourage many people to consider the use of postemergence herbicide programs. Experience leads us to suggest that existing vegetation should always be controlled prior to planting. In the Mid-Atlantic region, soil moisture is often the factor most limiting yield. The decision to apply burndown herbicides early preplant, at planting, or as a delayed preemergence (spike) treatment to control existing emerged vegetation should always be made with consideration to the impact of the existing vegetation on the availability of soil moisture. Preemergence or postemergence herbicides that can provide residual weed control can then be selected that will control weeds that emerge after planting. Reducing or eliminating all or some of the residual preemergence herbicides can reduce costs in fields that historically have required postemergence herbicide applications.

Herbicides

Herbicides can be classified several ways, including by weed control spectrum, labeled crop usage, chemical families, mode of action, application timing/method, and others. For this publication, herbicides will be grouped according to mode and site of action, which are also important in understanding herbicide resistance in weeds.

Some Considerations When Using Herbicides

The perfect herbicide does not exist. No single herbicide is capable of controlling all weeds that can develop in a crop or planting. Since every herbicide has advantages and disadvantages, selecting the correct herbicide(s) is crucial. Consider these points before you choose or apply any herbicide:

- Is it registered for use on the crop or area you want to treat? If it is, the directions for use and rate of application will appear on the label. Recommended rates for soil-applied herbicides may vary according to the soil texture and the amount of organic matter in the soil. Labels usually give a range of rates because soil types differ in the amount of herbicide that binds to soil particles. The application for postemergence treatments varies with weed size and climatic conditions. Weeds that are growing under dry conditions or during prolonged cool weather will not actively translocate a systemic herbicide. A higher herbicide rate may be needed than the rate used on weeds that are actively growing.
- Will it control the weeds that are causing the biggest problem, and does it take into account methods for managing herbicide resistance? Many weed control measures fail because the chosen herbicide will not control the weeds that are present.
- Can it be used effectively at the current stage of crop or weed growth? Very few herbicides can be applied at any stage during the growth cycle of a plant. Pendimethalin and metolachlor are good examples of how growth stage affects herbicide performance. They are excellent herbicides for annual grasses when applied before the grass weeds emerge. However, they are useless if applied after the weeds have emerged.
- Can the herbicide be used effectively and safely under the current conditions? Soil-applied herbicides must move into the soil to be taken up by roots and shoots of weed seedlings and perennial plant parts. Rainfall is usually adequate to provide soil incorporation of soil-applied herbicides, but in the absence of rainfall, weed control may be poor. The effectiveness of soil-applied herbicides can be reduced if the chemical is intercepted by debris from a previous crop, a prior application of livestock manure, thatch, or other barrier. Reduced-tillage cropping systems may require higher application rates of soil-applied herbicides than are required by conventional systems, depending on the amount of crop residue. Vegetation remaining on the soil surface binds some of the herbicide and prevents even distribution of the herbicide. Herbicides can also be lost to runoff, leaching, or volatilization.
- Will the herbicide(s) interact negatively with other pesticides, fertilizers, or other inputs being used on the crop or area? Because of such interactions, injury or death to desirable plants may occur.
- Is the herbicide being applied to a "normal" or a genetically modified crop? Since genetically modified crops look similar to normal crops once growing, misapplication can occur and the crop can be unintentionally killed or severely injured. Make sure to record the type of crop that was planted in each field.
- Will carryover of the herbicide result in a residue that might affect the crop or cover crop you want to plant next in rotation? Herbicide carryover is a problem with chemicals that persist in sufficient quantity to injure succeeding plantings. Some examples of herbicides prone to carryover include the triazines (atrazine and simazine), dinitroanilines (Treflan, Curbit, Barricade, Prowl), ALS inhibitors (Classic, Cimarron, Steadfast, Outrider, Spirit, Pursuit, Python), and pigment inhibitors (Command, Balance, Callisto, Impact). These herbicides can provide season-long control of certain weeds. However, if an excessive rate was applied, the soil pH was above 7.0, or the weather during the growing season was cool and dry, natural breakdown of the chemicals may not occur and carryover may result. Read labels carefully for warnings about carryover and rotation. See Tables 1-5 through 1-7 for rotation restrictions.
- What is the appropriate method of application (i.e., broadcast, band, directed, spot)? Is it convenient to use such as ready-to-use (RTU) products or does it require special equipment or need to be mixed with water before application? Are there other characteristics, such as compatibility with other herbicides when tank-mixing or staining, that make it difficult to use?
- Does the herbicide label recommend that a surfactant, crop oil, or other additive be used to improve leaf coverage or herbicide performance? Many postemergence herbicides require the use of an adjuvant in the mixture (see the herbicide spray additives section later in this chapter).
- Can this product be used safely on the intended planting? What is required to handle, mix, and apply it safely during and after use? Is it a restricted-use pesticide (RUP)?
- Can the herbicide injure non-target plants in adjacent areas? Exercise caution to avoid drift, runoff, leaching to groundwater, and cross-contamination of other materials. Be especially alert to the potential for residues left in sprayers when spraying a different crop. This is discussed in more detail in a later chapter.

Classification of Chemical Weed Control

Timing of Application: Preemergence or Postemergence

Preemergence or soil-applied herbicides control weeds at the seed germination stage, or as they are emerging from the soil. Postemergence or foliar herbicides control emerged weeds. Combinations of preemergence and postemergence herbicides may be necessary to control the various types of weeds in an area.

Contact or Translocated

Contact herbicides kill or injure only the part of the plant with which the spray droplets come into contact, so adequate spray coverage is very important. Annual weeds may be killed, but regrowth of perennial weeds from belowground parts usually occurs following application of a contact herbicide. (On a side note, sometimes the term "contact" is used to describe an herbicide that is applied postemergence or sprayed directly on the weed and thus "contacts" the foliage of the plant. When used in this context, it may have a different meaning and the herbicide could have systemic activity throughout the plant, depending on the product.) Translocated (or systemic) herbicides are absorbed by the leaves or roots of the plants and move within the plant. They are needed to kill underground parts of perennial weeds.

Selective or Non-selective

Non-selective herbicides kill or injure almost all plants, while selective herbicides kill some plants but do little or no damage to others (Fig. 1-6). Were it not for the fact that most herbicides can be applied just before crop planting or emergence, and even over the top after crop emergence, without excessive injury, herbicides would be of little value. Most of the herbicides labeled for use today will selectively remove most of the weeds without injuring the crop or planting. Selectivity is accomplished primarily by two methods: selectivity by placement and true selectivity. Selectivity accomplished by avoiding or minimizing contact between the herbicide and the desired crop is called selectivity by placement. An example is wiping or directing an herbicide, such as glyphosate, on a weed without exposing the desired plant. Selectivity by this means is as good as any, as long as the excess herbicide is not washed off the weeds and leached into the root zone where it might be absorbed by the root. Selectivity by placement also is accomplished when an herbicide that does not readily leach is applied to the soil surface for control of shallow-rooted weeds but does not leach into the root zone of a more deeply rooted crop such as fruit trees or established alfalfa. Selectivity that is true tolerance as a result of some morphological, physiological, or biochemical means is referred to as true selectivity. The herbicide can be applied to the foliage of the crop or to the soil in which the crop is growing without danger of injury. Although true tolerance may be the best type of selectivity, it is not perfect. Such things as crop growth stage, cuticle thickness, hairiness of the leaf surface, location of the growing point, air temperature and humidity, spray droplet size, and the surface tension of spray droplets all can influence herbicide activity. When conditions are ideal for herbicide activity, even true selectivity may not adequately prevent some crop injury.

Fumigants

Fumigants may kill all living things in the soil, including weeds, weed seeds, insects, and disease organisms.

Herbicide Mode and Site of Action

To be effective, herbicides must (1) adequately contact plants, (2) be absorbed by plants, (3) move within the plants to the site of action without being deactivated, and (4) reach toxic levels at the site of action. The term "mode of action" refers to the sequence of events from absorption into plants to plant death, or in other words, how an herbicide works to injure or kill the plant. The specific site the herbicide affects is referred to as the site or mechanism of action. Understanding herbicide mode of action is helpful in knowing what groups of weeds are killed, specifying application techniques, diagnosing herbicide injury problems, and preventing herbicide-resistant weeds.

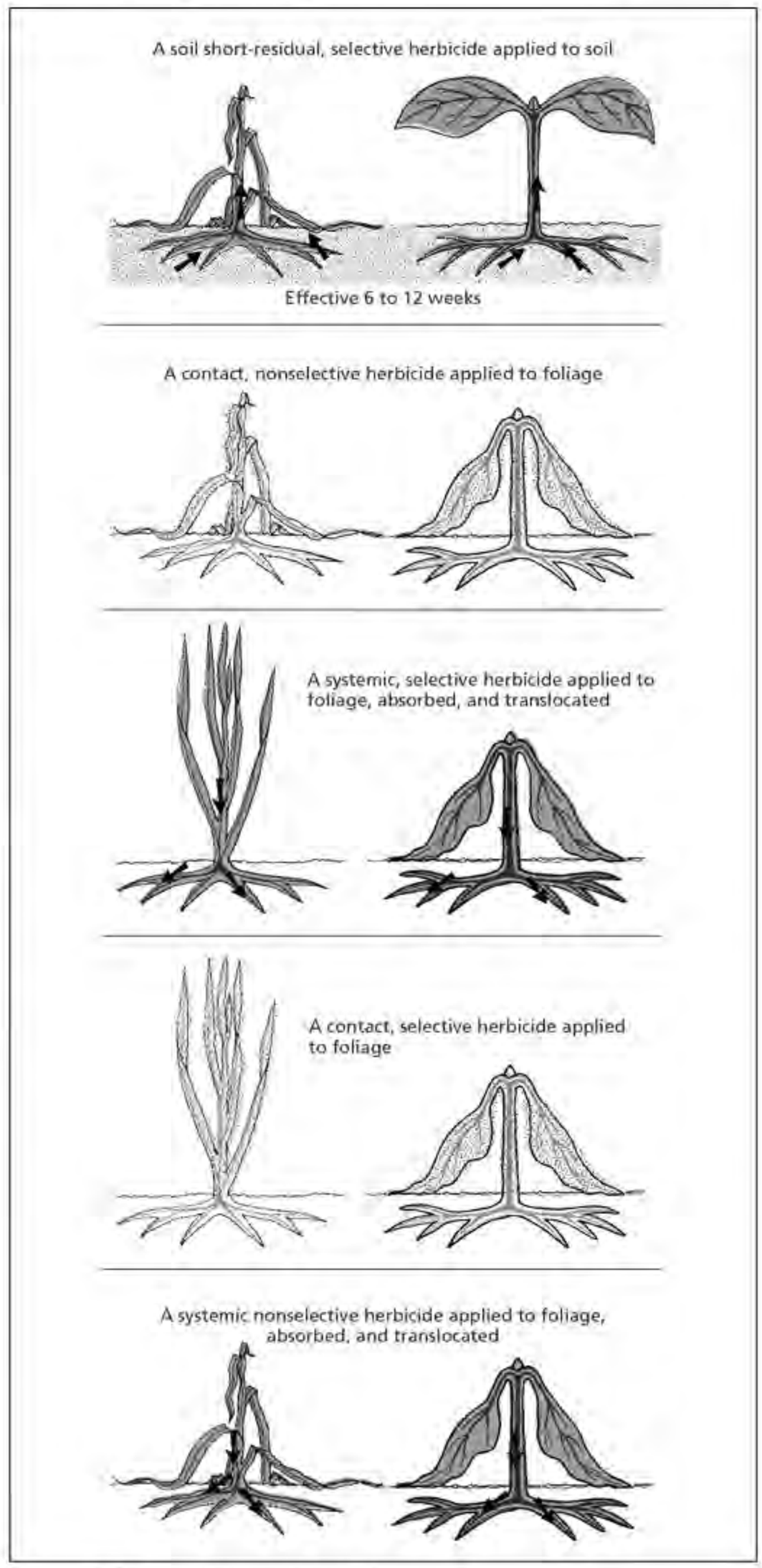

Figure 1-6. Chemical weed control.

A common method of grouping herbicides is by their mode of action. Although a large number of herbicides are available in the marketplace, several have similar chemical properties and herbicidal activity. Herbicides with a common chemistry are grouped into families. Also, two or more families may have the same mode of action and can thus be grouped into classes. Table 1-1 lists several groups of herbicides and information related to their mode of action.

The following section provides a brief overview of herbicide functions in the plant and associated injury symptoms for each of the herbicide classes found in Table 1-1.

Plant Growth Regulators (PGRs)—Groups 4 and 19

These herbicides are effective on annual and perennial broadleaf plants and usually have no activity on grasses or sedges, except at high application rates. They produce responses similar to those of natural growth-regulating substances called auxins. Application of artificial auxins, such as 2,4-D, upsets normal growth as follows:

- Cells of leaf veins rapidly divide and elongate, while cells between veins cease to divide. This results in long, narrow, straplike young leaves.
- Water content increases, making treated plants brittle and easily broken.
- Cell division and respiration rates increase, and photosynthesis decreases. Food supply of treated plants is nearly exhausted at their death.
- Roots of treated plants lose their ability to take up soil nutrients, and stem tissues fail to move food effectively through the plant.

The killing action of growth-regulating chemicals is not caused by any single factor but results from the effects of multiple disturbances in the treated plant.

Injury symptoms: Broadleaf plant leaves become crinkled, puckered, strap shaped, stunted, and malformed; leaf veins appear parallel rather than netted; and stems become crooked, twisted, and brittle, with shortened internodes. If injury occurs in grasses (e.g., corn), new leaves do not unfurl but remain tightly rolled in an onionlike fashion, and stems become brittle, curved, or crooked, with short internodes. A lesser effect in corn is the fusion of brace roots, noticed later in the season.

Amino Acid Biosynthesis Inhibitors—Groups 2 and 9

These herbicides are effective mostly on annual broadleaves, while a few in this large group have activity on grasses, nutsedge, and/or perennial plants. (Glyphosate [Roundup], for example, is a broad-spectrum herbicide and has activity on all types of plants. See Table 1-2.) These herbicides work by interfering with one or more key enzymes that catalyze the production of specific amino acids in the plant. When a key amino acid is not produced, the plant's metabolic processes begin to shut down. The effect is like that of an assembly line worker not doing his or her job. Different herbicides affect different enzymes that catalyze the production of various amino acids, but the result is generally the same—the shutdown of metabolic activity with eventual death of the plant.

Injury symptoms: Plants that are sensitive to these herbicides stop growth almost immediately after foliar treatment; seedlings die in 2 to 4 days, established perennials in 2 to 4 weeks. Plants become straw colored several days or weeks after treatment, gradually turn brown, and die.

Fatty Acid (Lipid) Biosynthesis Inhibitors—Group 1

These herbicides are rapidly absorbed by grasses and translocated to the growing points, where they inhibit meristematic activity, stopping growth almost immediately. They have no activity on broadleaf plants and are most effective on warm-season grasses such as Johnsongrass, shattercane, corn, fall panicum, giant foxtail, and crabgrass. Cool-season grasses like quackgrass, annual and perennial ryegrass, orchardgrass, timothy, and small grains are not as sensitive as warm-season grasses. Some of these herbicides are weaker on perennial species than other products. They are frequently referred to as "postgrass" herbicides.

Injury symptoms: Growing points are killed first, resulting in the death of the leaves' inner whorl. Older, outer leaves of seedlings appear healthy for a few days, and those of perennials for a couple of weeks, but eventually they also wither and die. After several weeks, the growing points begin to rot, allowing the inner leaves to be pulled out of the whorl. Sensitive grasses commonly turn a purplish color before dying.

Seedling Growth Inhibitors (Root and Shoot)—Groups 3 and 8

Herbicides in this group prevent cell division primarily in developing root tips and are effective only on germinating small-seeded annual grasses and some broadleaves.

Injury symptoms: Seeds of treated broadleaved plants germinate, but they either fail to emerge or emerge as severely stunted seedlings that have thickened, shortened lower stems, small leaves, and short, club-shaped roots. Seedlings of taprooted plants, such as soybeans and alfalfa, usually are not affected, nor are established plants with roots more than a couple inches deep.

Grass seeds germinate but generally fail to emerge. Injured seedlings have short, club-shaped roots and thickened, brittle stem tissue. Seedlings die from lack of moisture and nutrients because of the restricted root system.

Seedling Growth Inhibitors (Shoot)—Group 15

Herbicides in this class are most effective on annual grasses and yellow nutsedge. Depending on the product, some will control small-seeded annual broadleaves. These herbicides cause abnormal cell development or prevent cell division in

germinating seedlings. They stop the plant from growing by inhibiting cell division in the shoot and root tips while permitting other cell duplication processes to continue. Then follows a slow decline in plant vigor.

Injury symptoms: Germinating grasses normally do not emerge. If they do, young leaves fail to unfold, resulting in leaf looping and an onionlike appearance. The tip of the terminal leaf becomes rigid, not free flapping (flaglike). The leaves of broadleaved plants turn dark green, become wrinkled, and fail to unfold from the bud. The roots become shortened, thickened, brittle, and clublike.

Photosynthesis Inhibitors (Mobile)—Groups 5 and 7

These herbicides are effective primarily on annual broadleaves, while some provide control of grasses as well. Photosynthesis-inhibiting herbicides block the photosynthetic process so captured light cannot be used to produce sugars. In the presence of light, green plants produce sugar from carbon dioxide and water. Energy is needed for carbon, hydrogen, and oxygen atoms to rearrange and form sugar. To supply this necessary energy, electrons are borrowed from chlorophyll (the green material in leaves) and replaced by electrons split from water. If chlorophyll electrons are not replaced, the chlorophyll is destroyed and the plant's food-manufacturing system breaks down. The plant slowly starves to death due to lack of energy.

As soil-applied treatments, these herbicides permit normal seed germination and seedling emergence but cause seedlings to lose their green color soon afterward. With the seeds' food supply gone, the seedlings die. These herbicides are more effective on seedling weeds than on established perennial weeds. Herbicides such as prometon (Primitol) and tebuthiuron (Spike) are considered soil sterilants. Soil sterilants are non-selective chemicals that can kill existing vegetation and keep the soil free from vegetation for one or more years.

Injury symptoms: In broadleaved plants, early seedling growth appears normal, but shortly after emergence (when energy reserves in cotyledons are depleted), leaves become mottled, turn yellow to brown, and die. In most cases, the oldest leaves turn yellow on the leaf margins first, the veins remain green, and eventually the plant turns brown and dies. Herbaceous and woody perennials starve very slowly because they have large energy reserves in roots or rhizomes to live on while photosynthesis is inhibited. The herbicide may have to effectively inhibit photosynthesis for a full growing season to kill trees or brush. This kind of death may be slow, but it is certain.

Photosynthesis Inhibitors (Nonmobile, "Rapid-Acting")—Group 6

Herbicides in this group have activity primarily on annual and some perennial broadleaves and are applied to the plant foliage. The mode of action is the same as the mobile photosynthesis inhibitors.

Injury symptoms: Their activity within the plant is similar to that of the mobile photosynthesis inhibitors, except the injury occurs at the site of contact, causing "leaf burning" and eventual death of the plant.

Cell Membrane Disrupters—Groups 14 and 22

These herbicides control mostly broadleaves. Certain products have some activity on grasses, and paraquat (Gramoxone) provides broad-spectrum control of many different species.

These herbicides are referred to as contact herbicides and they kill weeds by destroying cell membranes. They appear to burn plant tissues within hours or days of application. Good coverage of the plant tissue and bright sunlight are necessary for maximum activity. The activity of these herbicides is delayed in the absence of light.

Injury symptoms: All contact herbicides cause cellular breakdown by destroying cell membranes, allowing cell sap to leak out. Affected plants initially have a "water-soaked" appearance, followed by rapid wilting and "burning" or leaf speckling and browning. Plant death occurs within a few days.

Pigment Inhibitors—Groups 12, 13, and 27

These herbicides provide control of many annual broadleaves and some grasses. These products are referred to as "bleachers" because they inhibit carotenoid biosynthesis or the HPPD enzyme by interfering with normal chlorophyll formation.

Injury symptoms: Symptoms are very evident and easy to identify. Affected plants either do not emerge or emerge white or bleached and eventually die. Older leaf tissue is affected first.

Phosphorylated Amino Acid (Nitrogen Metabolism) Disrupters—Group 10

This herbicide provides broad-spectrum control of most annual grasses and broadleaves and some perennials. It affects growth by disrupting nitrogen metabolism, thus interfering with other plant processes. It is a contact herbicide with slight translocation throughout the plant. Good spray coverage and sunlight are important for maximum efficacy.

Injury symptoms: Injury is similar to that of the cell-membrane-disrupter herbicides. Sensitive plants show "leaf burning," yellowing and browning, and eventual death after a week or so. Perennials generally take longer for symptoms and death to occur.

Unknown Herbicides

This category contains miscellaneous products for which the mode of action and family are unknown. Dazomet (Basamid) and metam (Vapam) are considered soil fumigants. These products are applied to the soil and covered with a gas-tight tarp, where they are converted to gases and penetrate the soil to kill weeds, diseases, and nematodes. Endothall (Aquathol)

Table 1-1. Important herbicide groups for corn, soybean, small grain, commercial vegetable, and forage.

	Herbicide Class/MOA				
WSSA Group[1]	Site of Action	No. Resistant in U.S.	Family	Common Name	Trade Name
	Lipid Synthesis Inhibitors				
1	ACCase Inhibitors (acetyl CoA carboxylase)	15	Aryloxyphenoxy-propionate (fops)	diclofop	Hoelon
				fenoxaprop	Puma, Tacoma
				fluazifop	Fusilade
				quizalofop	Assure II, Targa
			Cyclohexanedione (dims)	clethodim	Select Max
				sethoxydim	Poast
			Phenylpyrazolin	pinoxaden	Axial XL
	Amino Acid Synthesis Inhibitors				
2	ALS Inhibitors (acetolactate synthase)	48	Imidazolinone	imaxamox	Beyond, Raptor
				imazapic	Plateau
				imazapyr	Arsenal
				imazethapyr	Pursuit
				pyrithiobac	Staple
			Pyrimidinylthio-benzoic acid	flucarbazone	Everest, Pre-Pare
			Sulfonylaminocarb-onyltriazolinone	propoxycarb-azone	Olympus
				thiencarbazone	*component of Capreno, Corvus*
			Sulfonylurea	chlorimuron	Classic
				chlorsulfuron	Glean
				foramsulfuron	Option
				halosulfuron	Permit, Sandea
				imazosulfuron	League
				iodosulfuron	Autumn
				mesosulfuron	Osprey
				metsulfuron	Cimarron, *others*
				nicosulfuron	Accent Q
				primisulfuron	Beacon
				prosulfuron	Peak
				rimsulfuron	Matrix, Resolve
				sulfosulfuron	Maverick
				thifensulfuron	Harmony
				tribenuron	Express
				triflusulfuron	UpBeet
			Triazolopyrimidine	cloransulam	FirstRate
				flumetsulam	Python
				pyroxsulam	PowerFlex
9	EPSP Synthase Inhibitor (5-enolpyruvyl-shikimate-3-phosphate)	15	Organophosphorus	glyphosate	Roundup, Touchdown, *others*

(continued)

	Herbicide Class/MOA				
WSSA Group[1]	Site of Action	No. Resistant in U.S.	Family	Common Name	Trade Name
	Growth Regulators				
4	T1R1 Auxin Receptors (synthetic auxins)	8	Benzoic acid	dicamba	Banvel, Clarity
			Carboxylic acid	aminopyralid	Milestone
				clopyralid	Stinger
				fluroxypyr	Starane, Vista
				picloram	Tordon
				quinclorac	Facet
				triclopyr	Garlon, Remedy
			Phenoxy	2-4-D	*various*
				2,4-DB	Butyrac, *various*
				MCPA	*various*
19	Auxin Transport Inhibitor	0	Semicarbazone	diflufenzopyr	*component of Status*
	Photosynthesis Inhibitors				
5	Photosystem II Inhibitors (mobile) different binding than 6 and 7	26	Phenylcarbamate	phenmedipham	Spin-Aid
			Triazine	atrazine	Atrazine
				prometon	Pramitol
				simazine	Princep
			Triazinone	hexazinone	Velpar
				metribuzin	Glory, Metribuzin, TriCor
			Uracil	terbacil	Sinbar
6	Photosystem II Inhibitors (non-mobile) different binding than 5 and 7	1	Benzothiadiazole	bentazon	Basagran
			Nitrile	bromoxynil	Buctril/Maestro
7	Photosystem II Inhibitors (mobile) different binding than 5 and 6	11	Urea	diuron	Direx, Karmex
				linuron	Linex, Lorox
				tebuthiuron	Spike
	Nitrogen Metabolism Inhibitor				
10	Glutamine Synthetase Inhibitor	1	Amino acid derivative	glufosinate	Finale, Liberty, Rely
	Pigment Inhibitors				
12	Phytoene Desaturase Biosynthesis Inhibitor	1	Pyridazinone	norflurazon	Solicam
13	DOXP Synthase Inhibitor (1-deoxy-D-xyulose 5-phosphate)	1	Isoxazolidinone	clomazone	Command
27	HPPD Inhibitors (4-hydroxy-phenyl-pyruvate-dioxygenase)	2	Isoxazole	isoxaflutole	Balance Flexx
				mesotrione	Callisto
			Pyrazole	pyrasulfotole	*component of Huskie*
			Pyrazolone	topramezone	Armezon, Impact
			Triketone	tembotrione	Laudis

	Herbicide Class/MOA				
WSSA Group[1]	Site of Action	No. Resistant in U.S.	Family	Common Name	Trade Name
	Cell Membrane Disrupters				
14	PPO Inhibitors (protoporphyringogen oxidase)	2	Aryl triazolinone	carfentrazone	Aim
				fluthiacet	Cadet
				sulfentrazone	Authority, Spartan
			Diphenyl ether	acifluorfen	Ultra Blazer
				fomesafen	Reflex
				lactofen	Cobra, Phoenix
				oxyfluorfen	Goal
			N-phenylphthalimide	flumiclorac	Resource
				flumioxazin	Château, Valor
			Oxadiazole	oxadiazon	Ronstar
			Pyrimidinedione	saflufenacil	Kixor, Sharpen
22	Photosystem I Electron Diverter	5	Bipyridylium	diquat	Reglone
				paraquat	Gramoxone
	Seedling Root Growth Inhibitors				
3	Microtubule Inhibitors	6	Benzamide	pronamide	Kerb
			Dinitroaniline	ethalfluralin	Curbit, Sonalan
				oryzalin	Surflan
				pendimethalin	Pendulum, Prowl, *others*
				prodiamine	Barricade
				trifluralin	Treflan, *others*
			Phthalic acid	DCPA	Dacthal
			Pyridazine	dithiopyr	Dimension
	Seedling Shoot Growth Inhibitors				
8	Lipid Synthesis Inhibitors (not ACCase)	5	Phosphorodithioate	bensulide	Prefar
			Thiocarbamate	butylate	Sutan+
				cycloate	Ro-Neet
				EPTC	Eptam, Eradicane
15	Long-chain Fatty Acid Inhibitors	1	Acetamide	napropamide	Devrinol
			Chloroacetamide	acetochlor	Breakfree, Degree, Harness Topnotch, Warrant, *others*
				alachlor	Intrro, Micro-Tech
				dimethenamid	Outlook
				metolachlor	Dual, Cinch, *others*
			Oxyacetamide	flufenacet	Define
			Pyrazole	pyroxasulfone	Zidua
16	Specific Site Unknown	0	Benzofurane	ethofumesate	Nortron
	Cell Wall Synthesis Inhibitors				
20	Cellulose Inhibitor (Site A)	0	Nitrile	dichlobenil	Casoron, Norosac, *others*
21	Cellulose Inhibitor (Site B)	0	Benzamide	isoxaben	Gallery
29	Cellulose Inhibitor (unspecified site)	0	Alkylazaine	indaziflam	Alion

[1] WSSA group is a system of classifying herbicides, based on site of action, developed by the Weed Science Society of America.

Table 1-2. Selected glyphosate (Group 9) products and premixes for agronomic use.

Currently, numerous products contain glyphosate. Most of them are labeled for burndown/preemergence and/or spot applications. The majority, but not necessarily all, of the products below are labeled for over-the-top application in Roundup Ready crops (namely, RR corn and RR soybean). Refer to the product label for additional information on crop use, formulation, application rates, and other use restrictions. Other glyphosate-containing products may be available in your area. Contact your local dealer for more details.

Product and Amount of Glyphosate per Gallon[1]	Company	Product Rate (fl oz) Equivalent to:				Formulation	
		0.375 lb ae	0.56 lb ae	0.75 lb ae	1.13 lb ae	Salt[2]	Adjuvant Load[3]
5 lb ae/5.5 lb ai							
Touchdown HiTech	Syngenta	10	14	19	29	Potassium	minimal
4.5 lb ae/5.5 lb ai							
Abundit Edge	DuPont	11	16	22	32	Potassium	fully loaded
Credit Xtreme	Nufarm	11	16	22	32	IPA + potassium	fully loaded
Gly Star K-Plus	Albaugh/Agri Star	11	16	22	32	Potassium	fully loaded
Roundup WeatherMAX	Monsanto	11	16	22	32	Potassium	fully loaded
Roundup PowerMAX	Monsanto	11	16	22	32	Potassium	fully loaded
4 lb ae/5 lb ai							
Cinco (5.4 ai)	Loveland	12	18	24	36	IPA	partial
Cornerstone 5 Plus	WinField	12	18	24	36	IPA	fully loaded
Durango DMA/Duramax (5.4 ai)	Dow AgroSciences	12	18	24	36	DMA	fully loaded
Extra Credit 5	Nufarm	12	18	24	36	IPA	fully loaded
Gly Star 5 Extra	Albaugh/Agri Star	12	18	24	36	IPA	fully loaded
Touchdown Total	Syngenta	12	18	24	36	Potassium	fully loaded
Traxion (4.17 ae)	Syngenta	12	18	24	36	Potassium	fully loaded
3 lb ae/4 lb ai							
Abundit Extra	DuPont	16	24	32	48	IPA	fully loaded
Buccaneer	Tenkoz	16	24	32	48	IPA	partial
Buccaneer Plus	Tenkoz	16	24	32	48	IPA	fully loaded
Cornerstone Plus	WinField	16	24	32	48	IPA	fully loaded
Credit	Nufarm	16	24	32	48	IPA	partial
Credit Extra	Nufarm	16	24	32	48	IPA	fully loaded
Envy	Innvictis	16	24	32	48	IPA	partial
Glyfine Plus	Aceto	16	24	32	48	IPA	fully loaded
Glyfos Xtra	Cheminova	16	24	32	48	IPA	fully loaded
Gly Star Original	Albaugh/Agri Star	16	24	32	48	IPA	partial
Gly Star Plus	Albaugh/Agri Star	16	24	32	48	IPA	fully loaded
Glyphogan Plus	ADAMA	16	24	32	48	IPA	partial
Helosate Plus Advanced	Helm Agro	16	24	32	48	IPA	fully loaded
Honcho	Monsanto	16	24	32	48	IPA	minimal
Honcho Plus	Monsanto	16	24	32	48	IPA	fully loaded
Hoss Ultra	Helena	16	24	32	48	IPA	fully loaded
Mad Dog	Loveland	16	24	32	48	IPA	partial
Mad Dog Plus	Loveland	16	24	32	48	IPA	fully loaded
Makaze	Loveland	16	24	32	48	IPA	fully loaded
Mirage	Loveland	16	24	32	48	IPA	partial
Mirage Plus	Loveland	16	24	32	48	IPA	fully loaded
Rascal	WinField	16	24	32	48	IPA	partial
Rascal Plus	WinField	16	24	32	48	IPA	fully loaded
Showdown	Helena	16	24	32	48	IPA + monoammonium	fully loaded

1 Glyphosate products can be formulated to have different concentrations of glyphosate acid per gallon of product. To improve handling, performance, and concentration, the glyphosate acid is formulated as a salt compound. Acid equivalent (ae) is only the weight of the glyphosate acid, which is herbicidally active. Active ingredient (ai) is the weight of the glyphosate acid plus the salt. It is best to refer to ae when comparing glyphosate products and rates.

2 Glyphosate can be formulated as different salts: isopropylamine (IPA), monoammonium, diammonium, or potassium.

3 Some glyphosate products contain all the necessary adjuvants (i.e., fully loaded). Others contain only a limited amount and additional surfactants must be added to the tank before application. All brands of glyphosate recommend adding ammonium sulfate (AMS) if using hard water as a carrier or under other challenging conditions. If using AMS, always add it to the spray solution before glyphosate. Refer to product label for more information.

is used for aquatic weed control. Fosamine (Krenite) is used in noncrop areas to control perennial weeds and brush.

Other compounds such as pelargonic acid (Scythe), fatty-acid herbicides, and clove oil and vinegar are contact, non-selective, broad-spectrum, foliar-applied products that are sometimes used for weed control in organic crop production settings. However, because they basically "burn" only the plant tissue they contact, there is potential for plant regrowth.

Trade Name, Formulation Notations, and Premixes

In certain publications, many herbicides are listed by trade name (or product name) and formulation—for example, Roundup 4S or Permit 75WDG. Roundup is the trade name and 4S stands for 4 pounds of active ingredient (glyphosate) per gallon of product in a soluble (S) formulation. Permit is formulated as a water-dispersible granule with each granule (or certain unit) containing 75 percent active ingredient (halosulfuron). The remaining parts of the formulation contain inert ingredients, which have no effect on weed control. Additional information about formulation and ingredients can be found in another part of this publication and on the product's label and MSDS (material safety data sheet).

Premixes contain two or more herbicide active ingredients mixed into one product by the manufacturer. The actual premix formulation can vary but commonly contains two or more herbicides that are already used together. The primary reason for using premixes is convenience. Many herbicide products are now marketed as premixes.

Herbicide Safeners

Herbicide safeners, also called antidotes or protectants, are chemicals that help prevent injury to crops without reducing weed control. Early discovery of compounds capable of safening herbicides started in the late 1940s with the phenoxy herbicides, but commercialization really started with seed treatments and soil-active safeners in the 1970s and early 1980s. In general, herbicide safeners allow crops with fair tolerance to an herbicide to metabolize or detoxify the herbicide more quickly, thus providing increased crop safety. To date, safeners have only been developed for grass crops such as corn and wheat with few advances in dicot or broadleaf crops. Some of the more notable of these safeners includes dichlormid (Eradicane, Sutan, and some acetochlor formulations), benoxacor (Dual II), and the seed treatment Concept (fluxofenim), which allows chloroacetamide herbicide use in sorghum. More recently, a number of Group 2 (ALS) and other herbicides use isoxadifen (Accent Q, Resolve Q, Status, Steadfast Q, etc.), which provides increased safety from foliar applications. The most recently launched safener is cyprosulfamide, which provides preemergence and foliar safening with several herbicides. Cyprosulfamide is used in a number of Bayer CropScience products, including Balance Flexx, Corvus, Capreno, and Diflexx. See Table 1-3 for common herbicide safeners used as commercial products.

Generic or Post-patent Products

The pace of novel herbicide active ingredient commercialization has greatly slowed over the last 15 years and many herbicides are going off patent. Also, several new manufacturers have entered the herbicide market and are reintroducing older active ingredients. Most original brands still dominate, but the post-patent product market is growing. It can be challenging to find all post-patent herbicides sold in our region, but we have tried to summarize some of the more common ones in Table 1-4. Other generic herbicide products may be available in your area. Be cautious and consider all factors when looking at generic herbicide alternatives, especially guarantees for resprays on product failures. Contact your local dealer for details.

Herbicide Spray Additives (Adjuvants)

Additives, or adjuvants, are substances in herbicide formulations or that are added to the spray mixture to improve herbicidal activity or application characteristics. Over 70 percent of all herbicides recommend the use of one or more adjuvants in the spray mixture. In general, there are two types of adjuvants: formulation and spray. Formulation adjuvants are "already in the container" from the manufacturing process. These help with mixing, handling, effectiveness, and providing consistent performance.

Spray adjuvants can be divided into special-purpose adjuvants and activator adjuvants. Special-purpose adjuvants include compatibility agents, buffering agents, antifoam agents, drift retardants, and others that widen the range of conditions for herbicide use. Activator adjuvants are commonly used to enhance postemergence herbicide performance by increasing herbicide activity, absorption, and rainfastness and decreasing photodegradation. These include surfactants (i.e., "surface active agents," Fig. 1-7), crop oil concentrates, vegetable oil

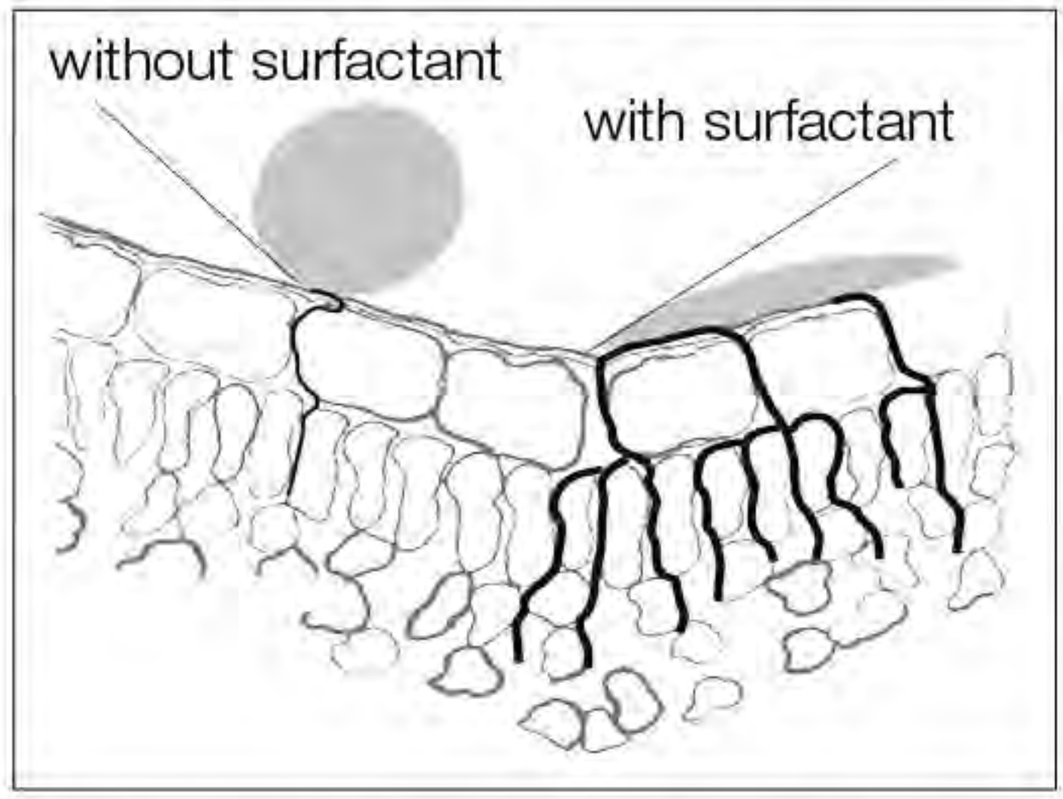

Figure 1-7. The surfactant reduces surface tension and helps the spray droplet spread, providing better contact with the leaf surface.

Table 1-3. Common herbicide safeners used as commercial products.

Safener	Approximate Date of Introduction	Herbicide(s)	Crop	Other
1,8-naphthalic anhydride (NA)	1971	EPTC and butylate	corn	seed treatment
Benoxacor	1985	metolachlor	corn	premixed with herbicide
Cloquintocet-methyl	2006	pinoxaden	wheat, cereals	premixed with herbicide
Cyposulfamide	2009	numerous (Groups 4 and 27)	corn	premixed with herbicide
Dichlormid	1972	EPTC, butylate, acetochlor	corn	premixed with herbicide
Fenchlorazole-ethyl	1992	fenoxaprop	wheat, cereals	premixed with herbicide
Fluxofenim	1986	alachlor, metolachlor	sorghum	seed treatment
Furilazole	1991	acetochlor	corn	premixed with herbicide
Isoxadifen	2001	numerous (Groups 2 and 4)	corn	premixed with herbicide
Mefenpyr-diethyl	1989	pyrosulfotole	wheat	premixed with herbicide

concentrates, wetting agents, stickers-spreaders, N-fertilizers, penetrants, and others. Commonly used surfactants are non-ionic surfactants and organosilicones, which are typically used at a rate of 1 quart per 100 gallons (0.25 percent v/v) of spray mixture. Crop oil concentrates are 80 to 85 percent petroleum based plus 15 to 20 percent surfactant, while vegetable oil concentrates contain vegetable or seed oil in place of petroleum oil. Oil concentrates are typically included at a rate of 1 gallon per 100 gallons (1 percent v/v) of spray mixture. In general, oil concentrates are "hotter" than surfactants, so they provide better herbicide penetration into weeds under hot/dry conditions, but they are more likely to cause greater crop injury under normal growing conditions. Nitrogen fertilizers, such as UAN (a mixture of ammonium nitrate, urea, and water) or AMS (ammonium sulfate), are used in combination with surfactants or oil concentrates to increase herbicide activity and reduce problems with hard water. Many blended adjuvants are available that include various combinations of special purpose adjuvants or activator adjuvants.

Be sure to include the proper adjuvant(s) for the herbicide being used. Most herbicide labels specify the type and amount of additive to use. Failure to follow the recommendations can result in poor weed control or excessive crop injury.

Managing Herbicides

Environmental Hazard Warnings

Some herbicide labels carry "Environmental Hazard Warnings" on the label. The environmental hazard may specify a "water-quality advisory," which requires special precautions for coarse-textured (sandy) soils, soils with a shallow water table, and soils with other potential water-contamination risks. Herbicides with water-quality advisories have been detected in small amounts in water supplies after normal agricultural use. Additional environmental dangers include toxicity to fish and wildlife and hazards to endangered species. Check the label or specific hazard warning information before using a product.

Herbicide Use Rate

The recommended use rates of soil-applied herbicides often vary with soil texture, organic matter content, and tillage systems. The use of soil-applied herbicide rates that are incorrect for the soil texture, pH, and organic matter may result in poor weed control or crop injury. Consult the herbicide label for the proper herbicide rate for your soils.

Most of the herbicides recommended in this publication are selective. At the recommended rate of application, they will selectively control or injure weeds but not seriously damage the crop in which these weeds are growing. In using selective herbicides, you should carefully follow the recommended application rate and follow instructions related to the use of surfactants and other additives. Using higher herbicide rates or additives that are not recommended may result in severe crop injury. You must accept the responsibility if you use an herbicide in a manner other than that directed on the herbicide label.

Herbicide Persistence and Crop Rotation Intervals

Herbicides are applied to the soil to manage weeds. It is desirable for the chemicals to control weeds during the season of application, but they should not persist and affect subsequent crop growth. The length of time that an herbicide remains active in the soil is called "soil persistence" or "soil residual life." With some herbicides, there may be a fine line between controlling the weeds for the entire growing season and then planting a sensitive rotation crop. Anything that affects the disappearance or breakdown of herbicides will affect per-

Table 1-4. Selected generic (or post-patent) alternative herbicides for agronomic use.

Labeled crops:
A = alfalfa C = corn
P = pasture Sb = soybean
SG = small grain Sr = sorghum

Common Name	Trade Name	Manufacturer	Labeled Crops*	Generic Alternative to:
Acetochlor + atrazine	Cadence ATZ (NXT)	Loveland	C	Harness Xtra, Degree Xtra, Keystone (NXT)
	Confidence Xtra	WinField		
	Overtime ATZ (NXT)	Helena		
	Volley ATZ (NXT)	Tenkoz		
Acetochlor + flumetsulam + clopyralid	Staunch (II)	Tenkoz	C	SureStart, SureStart II
	Trisidual	WinField		
Acifluorfen	Avalanche Ultra	WinField	Sb	Ultra Blazer
	Levity	Innvictis		
Chlorimuron	Curio	Nufarm	Sb	Classic
Chlorimuron + metribuzin	Cedock	AgSurf	Sb	Canopy DF
	Cloak DF	Nufarm		
	Resist	Tenkoz		
Chlorimuron + tribenuron	Cloak EX	Nufarm	Sb	Canopy EX
	FallOut	AgSurf		
Clethodim	Arrow	ADAMA	Sb, A	Select, (Select Max), Prism
	Avatar	Innvictis		
	Clethodim 2EC	Albaugh/Agri Star		
	Clethodim 2EC	Willowood		
	Dakota	Rotam North America		
	Intensity	Loveland		
	(Intensity One)	Loveland		
	Section	WinField		
	Shadow	Arysta LifeScience		
	TapOut	Helena		
	Volunteer	Tenkoz		
Clopyralid	Spur	Albaugh/Agri Star	C, P, SG	Stinger
Dimethenamid-P + atrazine	Establish ATZ	Tenkoz	C, Sr	Guardsman Max
	Slider ATZ	Loveland		
	Sortie ATZ	Helena		

(continued)

Common Name	Trade Name	Manufacturer	Labeled Crops*	Generic Alternative to:
Flumioxazin	Outflank	ADAMA	Sb	Valor SX
	Panther	Nufarm		
	Varsity WDG	Innvictis		
Fluroxypyr	Comet	Nufarm	SG	Starane
Fomesafen	Andros 1.88/2.0	Rotam North America	Sb	Reflex, Flexstar
	Battle Star	Albaugh/Agri Star		
	Dawn	FMC (Cheminova)		
	Foma 1.88/2SL	Drexel		
	Fomesafen 1.88/2SL	Willowood		
	Rhythm	FMC (Cheminova)		
	Rumble	ADAMA		
	Shafen	Sharda		
	Sinister	Helena		
	TopGun	Loveland		
Fomesafen + imazethapyr	Camo	Albaugh/Agri Star	Sb	—
	Torment	ADAMA		
Fomesafen + metolachlor	Statement	FMC (Cheminova)	Sb	Prefix
	Vise	ADAMA		
	UP-Front	Drexel		
Glufosinate	Cheetah	Nufarm	LibertyLink C and Sb, other	Liberty 280
	Forfeit 280	Loveland		
	Glufosinate 280SL (OT)	Willowood		
	Interline	UPI		
Halosulfuron	Halomax 75	Aceto	C	Permit, Sandea
	Profine 75	Aceto		
Imazethapyr	Thunder	Albaugh/Agri Star	Sb, A	Pursuit
Imazethapyr + glyphosate	Tackle	FMC (Cheminova)	Sb	Extreme
	ThunderMaster	Albaugh/Agri Star		
Mesotrione	Mesotrione 4SC	Willowood	C, Sr	Callisto
Mesotrione + S-metolachlor	Palace	Tenkoz	C, Sr	Zemax
Metolachlor	Me-Too-Lachlor	Drexel	C, Sb, Sr	Dual, Dual II
	Me-Too-Lachlor II	Drexel		
	Parallel	ADAMA		
	Stalwart	Sipcam		

Common Name	Trade Name	Manufacturer	Labeled Crops*	Generic Alternative to:
Metolachlor + atrazine	Parallel Plus	ADAMA	C, Sr	Bicep II
	Stalwart Xtra	Sipcam		
	Triangle	Tenkoz		
	Trizmet II	Drexel		
	Visor ATZ	Innvictis		
Metolachlor + imazethapyr	Pummel	ADAMA	Sb	—
Metolachlor + metribuzin	Galvan	Innvictis	Sb	Boundary
	Ledger	Tenkoz		
	PREsidual	WinField		
	Tailwind	ADAMA		
Metribuzin	Derive 75DF	Innvictis	Sb, C, A	formerly Sencor
	Dimetric 75DF	WinField		
	Glory	ADAMA		
	Metribuzin 75	Loveland		
	Metribuzin 75DF	ADAMA		
	Metrixx	Sharda		
	TriCor 75DF/4F	UPI		
Metsulfuron-methyl	Accurate	FMC (Cheminova)	P	Cimarron 60DF (DuPont no longer sells the single-ai product for pastures)
	Ciramet	AgSurf		
	Metsulfuron 60EG AG	Arysta LifeScience		
	Plotter	Rotam North America		
	PureStand	Nufarm		
	Rometsol	Rotam North America		
Metsulfuron-methyl + chlorsulfuron	Chisum	FMC (Cheminova)	P	Cimarron Plus
Nicosulfuron	Primero 75DF and 40SC	Rotam North America	C	Accent (not Accent Q)
Paraquat	Devour	Innvictis	All	Gramoxone
	Helmquat	Helm		
	Para-SHOT 3.0	Sharda		
	Paraquat 3SL	Willowood		
	Parazone	ADAMA		
	Quik-Quat 300	Drexel		

(continued)

Common Name	Trade Name	Manufacturer	Labeled Crops*	Generic Alternative to:
Pendimethalin	Acumen	Tenkoz	C, Sb	Prowl 3.3EC, (Prowl H2O)
	Framework	WinField		
	Pavilion	Innvictis		
	(Satellite HydroCap)	UPI		
	Stealth	Loveland		
Quinclorac	Quinstar 4L or GT	Albaugh/Agri Star	P	Paramount/Facet
Rimsulfuron	Bestow	FMC (Cheminova)	C	Resolve, Matrix
	Pruvin	ADAMA		
	Solida	FMC (Cheminova)		
Rimsulfuron + thifensulfuron	Crusher	FMC (Cheminova)	C, Sb	—
	Harrow	FMC (Cheminova)		
S-metolachlor	Brawl	Tenkoz	C, Sb, Sr	Dual Magnum, Dual II Magnum
	Brawl II	Tenkoz		
S-metolachlor + atrazine	Brawl II ATZ	Tenkoz	C, Sr	Bicep II Magnum
	Charger MAX ATZ	WinField		
	Visor S-MOC II	Innvictis		
Sulfentrazone	Blanket	Tenkoz	Sb	Authority 75DF, Spartan
	Sulfentrazone 4SC	Willowood		
	Vandal	Innvictis		
Thifensulfuron	Harass	FMC (Cheminova)	C, Sb, SG	Harmony GT 75DF (not Harmony SG 50WDG)
	Treaty	Nufarm		
	Volta	Rotam North America		
Thifensulfuron + tribenuron	Edition	FMC (Cheminova)	C, Sb, SG	Harmony Extra 75DF (not Harmony Extra SG 50WDG)
	Nimble	FMC (Cheminova)		
	Rapport	Nufarm		
	Treaty Extra	Nufarm		
	T-Square	AgSurf		
	Volta Extra	Rotam North America		
Triclopyr	Triclopyr 4E	Albaugh/Agri Star	P	Remedy Ultra
	Trycera	Helena		
Triclopyr + 2,4-D	Candor	Nufarm	P	Crossbow
	Crossbow L	Loveland		
	Crossroad	Albaugh/Agri Star		

*A = alfalfa; C = corn; P = pasture; Sb = soybean ; SG = small grain; Sr = sorghum.

sistence. Herbicides vary in their potential to persist in the soil. Some herbicide families that have persistent members include the triazines, uracils, phenylureas, sulfonylureas, dinitroanilines, isoxazolidinones, imidazolinones, and certain plant growth regulators belonging to the pyridine family. Several factors determine the length of time herbicides to persist. These factors fall into three categories: soil factors, climatic conditions, and herbicidal properties. The factors within each of these categories can strongly interact with one another.

Soil Factors

The soil factors affecting herbicide persistence include soil composition, soil chemistry, and microbial activity. Soil composition is a physical factor that is determined by relative amounts of sand, silt, and clay (the soil texture) and the organic-matter content. An important chemical property of the soil that can influence herbicide persistence is pH. The microbial aspects of the soil environment include the type and abundance of soil microorganisms present. Soils containing more clay and organic matter (heavier) tend to bind herbicides more strongly and they will persist longer. Also, higher soil pH (>7) can be more problematic for some herbicides.

Climatic Factors

The climatic variables involved in herbicide breakdown are moisture, temperature, and sunlight. Herbicide degradation rates generally increase as temperature and soil moisture increase because both chemical and microbial decomposition rates increase with higher temperatures and moisture levels. Cool, dry conditions slow down herbicide degradation. Carryover problems are always greater the year following a drought. If winter and spring conditions are wet and mild following a previously dry summer, the likelihood of herbicide carryover is lower.

Herbicide Properties

An herbicide's chemical properties affects its persistence. Properties include water solubility, vapor pressure, and susceptibility of the molecule to chemical or microbial alteration or degradation. Much of this boils down to the herbicide half-life, or the time it takes for 50 percent of the active ingredient to dissipate. Several factors influence the rate of dissipation such as rainfall, soil texture, and soil pH, among others. The basic manufacturers, along with universities and some other research organizations, have evaluated the persistence of herbicides in soil for local conditions, and it can vary widely.

Avoiding Herbicide Persistence in Subsequent Crops

There are several ways to avoid herbicide carryover problems. First, check the recrop statement on the herbicide label and do not plant a sensitive crop prior to the specified time. Second, always apply the correct rate of any pesticide for your specific soil type and weed problem. This means applying the lowest rate of the chemical consistent with obtaining the desired effect. Higher rates of more persistent products certainly carry more risk of injury to following crops. Accurate acreage determination, chemical measurement, proper sprayer calibration, and uniform application are essential for avoiding misapplication problems. **Always read the label before applying any herbicide.**

In summary, the first step in avoiding herbicide persistence problems is choosing less persistent products. Check the herbicide label for recrop statements before selecting any material. With all pesticides, use the appropriate rates and application timings. The use of selective tillage, herbicide combinations, and tolerant crops and varieties will also help reduce the risk of carryover crop injury. Wise herbicide use will ensure the continued availability of these important weed management tools for the future. Table 1-5 provides the cash crop rotation restrictions for common herbicides that are used in multiple crops. These restrictions are the label guidelines and may be due to concerns about herbicide residues accumulating in forage or feed or carryover injury.

Herbicide Persistence and Rotation to Cover Crops

The question about whether corn or soybean herbicide programs will pose a problem for establishing fall cover crops has become a common one, particularly in areas of severe drought where corn is harvested earlier than normal and the desire to plant a cover/forage crop is strong. If you look at the rotation crop restrictions for corn and soybean herbicides in this guide, you will see that many products limit rotation to alfalfa and/or the clovers as well as some of the small grains. This is a good place to start when thinking about rotation to fall cover crops. However, these tables are inadequate because these cash crop rotation restrictions may be due to the concern for herbicide residues accumulating in forage or feed rather than carryover injury. If the crop is not going to be harvested and consumed by livestock or humans, then the primary concern is carryover injury and achieving an acceptable stand that provides the benefits of a fall or winter cover. Cover crops that are not harvested can be planted after any herbicide program, but the grower assumes the risk of crop failure.

Two factors become important when trying to predict the potential for carryover injury to rotation crops: (1) how long does the herbicide last or persist in the soil, assuming that it has soil activity, and (2) how sensitive is the rotation crop to potential herbicide residues? Herbicides with shorter half-lives (the time it takes for 50 percent of the active ingredient to dissipate) are always less of a concern. Of course, several factors influence the rate of dissipation such as rainfall, soil texture and soil pH, etc.; however, most guidelines are generally for "normal" conditions (e.g., not severe drought). In general, products with a 4-month or less rotation restriction for the species of interest, close relative, or sensitive species (e.g., clovers) should pose little problem. These products typically have half-lives of less than 30 days. Species sensitivity can play

Table 1-5. Herbicide rotation restrictions for cash crops.

The information listed in this rotation restriction table is our interpretation of label statements or a "best guess" estimate. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

AH = after harvest
B = bioassay of soil recommended before planting
NI = no information
NR = no restrictions
NY = next year
SY = second year following application

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
2,4-D	AH	3	AH	1	AH	NR	AH	3	3	3	1	AH	AH	AH	AH	0.25–1[1]	AH	3	NR	NY	AH	3	AH	AH	AH	AH
Accent/ Accent Q	10	10[2]	10	10	10[2]	NR	10	12	10[2]	10[2]	10[2]	10	10[2]	10[2]	10	0.5	8	10[2]	10	10[2]	10[2]	10[2]	10[2]	4	4	4
Acuron	18	18	18	10	18	NR	10	18	18	18	10	18	18	18	18	10	18	18	NR	18	18	18	10	4	4	4
Acuron Flexi	10[24]	18	18	10[24]	18	NR	10[24]	18	18	18	10[24]	18	18	18	18	10[24]	18	18	NR	18	18	18	10[24]	4	4	4
Afforia (2.5 oz)	4[25]	4[25]	4[25]	1	4[25]	0.5[25]	1	4[25]	4[25]	4[25]	1.5	3	4[25]	4[25]	3	NR[25]	4[25]	4[25]	3	1.5	4[25]	4[25]	4[25]	3	3	1[25]
Aim	12	1	12	NR	12	NR	NR	1	1	1	NR	12	12	12	12	NR	NR	1	NR	12	12	1	1	NR	NR	NR
Anthem	10	18	18	4	18	NR	18	18	18	18	4	6	18	18	11	NR	11	18	NR	18	18	18	4	11	11	4
Anthem ATZ	SY	18	SY	NY	SY	NR	SY	18	18	18	NY	SY	SY	SY	SY	NY	SY	18	NR	SY	SY	18	SY	NY	NY	NY
Anthem Maxx (4.875 oz)	10	18	18	4	18	NR	11[26]	18	18	18	4	11[26]	18	18	18	NR	11[26]	18	NR	18	18	18	4	11[26]	11[26]	4[26]
Armezon (0.75 oz)	9	18	18	9	18	NR	9	18	18	18	9	9	18	18	9	9	3	18	NR	18	18	18	9	3	3	3
Armezon PRO (16–20 fl oz/A)	9	18	18	9	18	NR	9	18	18	18	9	9[3]	18	18	9[3]	9	4	18	NR	18	18	18	9	4	4	4
Assure II	4	4	4	NR	4	4	4	4	4	4	4	NR	4	4	NR	NR	4	4	4	4	4	4	4	4	4	4
Atrazine	SY	SY	SY	NY	SY	NR	NR	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NR	SY	SY	SY	SY	NY	NY	NY
Authority Elite/ BroadAxe	12	2	12	18[4]	12	10	10	12	12	12	4	12	12	12	12	NR	12	12	18	10	4	12	4	4.5	4.5	4.5
Authority MTZ	12	18	18	18[4]	18	10	12	18	18	18	12	18	18	18	18	NR	18	18	18	12	NR	18	12	4	4	4

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Authority XL	18	18	18	18	18	10	10	36	36	36	12	36	36	36	36	NR	18	36	18	36	36	18	36	4	4	4
Autumn	18	18	18	2[1]	18	1	1	18	18	18	18	10[1]	18	18	10[1]	2	1	18	2	18	18	18	10[1]	1	1	1
Axial XL	3	1	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	NR	3	NR
Axiom	12	12	12	8	12	NR	12	12	12	18	12	12	12	12	12	NR	12	NY	12	12	12	12	1	12	12	0.33–4
Balance Flexx/Pro	10	18	18	10	18	NR	6	18	18	18	11	18	18	18	18	6	18	18	6	18	18	18	6	6	4	4
Banvel	AH	AH	AH	0.75–1.5[5]	AH	NR	NR	AH	AH	AH	AH	AH	AH	AH	AH	1[5]	1[5]	AH	AH	NY	AH	AH	AH	1[5]	1[5]	1[5]
Basagran	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basis[6]	10	18	10	1[6]	10	NR	10[6]	18	18	18	18	10	18	18	10	0.5[6]	9	18	10	18	1	18	NR	3	3	3
Basis Blend[6]	10[1]	18	18	1[6]	10	NR	10[6]	18	18	18	10	10	18	18	10	0.5[6]	9	18	10	10	1	18	NR	3	3	3
Beacon/ NorthStar	8	18	18	8	18	0.5[7]	8	18	18	18	8	8	18	18	18[7]	8	8	18	8	8	18	18	18[7]	3	3	3
Beyond	3	9	18	9	9	8.5[8]	9	NR	9	9	9	9	9	9	NR	NR	9	9	8.5	9	9	9	9	9	4	3[8]
Bicep products/ Cinch ATZ	SY	SY	SY	NY	SY	NR	NR[10]	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Boundary	4.5	12	12	12	12	8	12	12	12	18	12	8	12	12	12	NR	12	12	8	12	12	12	8	4.5	12	4.5
Breakfree	NY	NI	NY	NY	NI	NR	NY	NI	NI	NI	NY	NY	NI	NI	NI	NY	NY	NI	NR	NY	NI	NI	NY	NY	NY	4
Buctril/ Maestro	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bullet	NY	SY	NY	NY	SY	NR	NR[10]	NY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Cadet	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Callisto	10	18	18	10	18	NR	NR	18	18	18	10	18	18	18	18	10	NR	18	NR	10	18	18	10	4	4	4
Callisto Xtra	NY	18	18	NY	18	NR	NR	18	18	18	NY	18	18	18	18	NY	18	18	NR	NY	18	18	NY	NY	18	NY
Canopy[1]	10	18	12	10	18	10	12	30	30	30	18	12	30	18	12	NR	30	30	18	10[9]	10[9]	18	30	4	4	4
Canopy Blend	10	18	30	18	18	10[27]	18	30	30	30	18	12	30	18	18	NR	4	30	18	10[9]	10[9]	18	30	4	4	4
Canopy EX[1]	10	18	12	9	18	10	10	12	30	18	15	12	18	18	12	NR	4	30	18	10[9]	10[9]	18	30	4	4	4
Caparol	12	5	12	5	12	5	12	12	12	8	12	5	12	12	12	12	12	12	5	12	12	12	12	12	12	12

(continued)

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Capreno	10	18	18	10	18	NR	10	18	18	18	11	18	18	18	18	10	10	18	10	18	18	18	18	10	18	4
Chateau (up to 3 oz)[11]	5[11]	12	5[11]	2[11]	12	1	1	12B	12B	12B	NR	12B	12B	12B	4	NR	5[11]	NR	4	2	12B	12B	NR[11]	4	4	2
Cimarron Plus	4	B	4	B	B	12	B	B	B	B	B	B	B	B	B	12	10	B	B	B	B	B	B	10	4	1
Celebrity Plus[1]	10	10	10[1]	10	10[1]	0.25	10	10	10	10	10[1]	10	10[1]	10[1]	10	4	8	10	10	10[1]	10[1]	10	10[1]	4	4	4
Clarity	4	4	4	0.75–1.5[5]	4	NR	NR	4	4	4	4	4	4	4	4	0.5–1[5]	0.5–1.5[5]	4	4	4	4	4	4	0.5–1.5[5]	0.5–1.5[5]	0.5–1.5[5]
Classic[1]	12	18	12	10	18	9	9	30	30	30	8	9	30	18	9	NR	3	30	18	9[1]	9[1]	18	30	3	3	3
Cobra	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Command	16	12	16	NR[12]	9	9	9	16	9	16	9	NR	NR	NR	9	NR	16	NR	9	NR	9	9	9	16	16	12
Corvus	17	17	17	10	17	NR	17	17	17	17	11	17	17	17	17	9	17	17	9	17	17	17	17	9	17	4
Curbit	NR	NR	NI	NI	NR	NR	NR	AH	NR	AH	NI	NR	NR	NR	NR	NR	8	NR	NR	NI	NR	NR	NR	NR	NR	NR
Curtail	10.5	10.5	18	18	18	NR	10.5	18	18	10.5	18	18	18	18	18	10.5	1	18	10.5	18	18	18	18	1	1	1
Dacthal	8	NR	8	8	AH	8	8	8	8	NR	8	8	8	8	8	8	8	8	8	8	AH	AH	8	8	8	8
Define	12	4	12	4	12	NR	12	12	12	12	12	12	4	12	12	NR	12	12	12	12	12	12	1	12	12	12
Degree	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NR	NY	SY	SY	NY	AH	AH	AH
Degree Xtra	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	NY	SY	SY	SY	SY	SY	AH
Devrinol	12	NR	12	12	12	12	12	12	12	12	12	12	NR	12	12	12	6	12	12	NR	NR	12	12	6	6	6
DiFlexx	4	4	4	2	4	NR	2	4	4	4	4	4	4	4	4	2	2	4	4	4	4	4	4	2	4	2
DiFlexx Duo	10	18[8]	18[8]	10	18	NR	10	18[8]	18	18[28]	11	10	18[8]	18	10	8	4	18[8]	4	12	10	18	10	4	4	4
Distinct	1	4	4	1	4	0.25	1	4	4	4	4	4	4	4	4	1	1	1	4	4	4	4	4	1	1	1
Dual products/ Cinch	4	2[1]	9	NR	12	NR	NR[10]	NR	12	12	NR	NR	2	2[1]	NR	NR	4.5	12	NR	NY	2[1]	12	2[1]	4.5	4.5	4.5
Envive	12	18	18	10	18	10	10	18	18	18	8	12	30	18	12	NR	30	18	18	10[9]	12[9]	18	30	4	4	4
Eptam	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH
Eradicane	AH	AH	AH	AH	AH	NR	NY	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	NY	AH	AH	AH	AH	AH	AH
Evik	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	AH	NY	NY	NY	NY	NY	NY	AH	AH	AH
Expert	SY	SY	SY	NY	SY	NR	NR[10]	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY

Trade Name	Rotation Crops (months after application)																									
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Extreme	4	40B	40B	18	40B	8.5[13]	18	NR	40B	40B	NR	4	40B	40B	4	NR	18	40B	18	9.5	40B	40B	18	4	4	3
Facet L	24B	10	24B	10	10	10	NR	10	10	10	10	24B	10	10	10	10	10	10	10	24B	24B	10	24B	10	10	NR
Fierce[14]	10	18	18	1–2[14]	18	1[14]	18	18	18	18	4	11[14]	18	18	11	NR	11–12[14]	18	18	18	18	18	18	11–12[14]	11–12[14]	1–2[14]
Fierce XLT[1]	18	18	18	18	18	10	18	18	18	18	18	18	30	18	18	NR	30	18	18	18	18	18	30	18	18	10
Finesse Cereal and Fallow (0.4 oz)	B	B	B	18	B	18	18	B	B	B	B	B	B	B	B	18[15]	10	B	B	B	B	B	10	B	NR	NR
FirstRate	9	30B	18	9	18	9	9	30B	30B	30B	9	9	18	18	9	NR	9	30B	18	18[16]	18	30B	18B	12	18	4
Flexstar	18	18	18	NR	12	10	18	4	12	18	4	4	10	10	NR	NR	18	12	10	18	10	10	NR	4	4	4
Flexstar GT	18	18	18	NR	12	10	18	4	12	18	4	4	10	10	NR	NR	18	12	10	18	10	10	NR	4	4	4
FulTime/ Keystone/ Breakfree ATZ	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	SY	SY	SY	SY	SY	SY	SY	15
Fusilade/ Fusion	NR	NR	NR	NR	NR	2	2	NR	NR	NR	NR	NR	NR	NR	NR	NR	2	NR	2	NR	NR	NR	NR	2	2	2
Galigan	2	2 (NR[10])	2	2	2	10	10	2	2	2	2	2	2	2	2	NR	10	2	10	2	2	2	2	10	10	10
Glyphosate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Goal/ GoalTender	2	2 (NR[10])	2	2	2	10	10	2	2	2	2	2	2	2	2	NR	10	2	10	2	2	2	1	10	10	10
Gramoxone	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
GrazonNext HL	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	12	24B	24B	24B	24B	12	12	12
Guardsman Max	SY	SY	SY	NY	SY	NR	NR[10]	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Halex GT	10	18	18	10	18	NR	NR[10]	18	18	18	10	10[1]	18	18	10[1]	10	4.5	18	NR	10	18	18	10	4.5	4.5	4.5
Harmony Extra SG	1.5	1.5	1.5	0.75	1.5	0.75	0.75	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	NR	1.5	NR
Harmony SG	1.5	1.5	1.5	0.25	1.5	NR	NR	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	NR	NR	1.5	1.5	1.5	1.5	1.5	1.5	NR	1.5	NR
Harness	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NR	NY	SY	SY	NY	AH	AH	AH
Harness Xtra	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	SY	SY	NY

(continued)

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Hornet/ Stanza[17]	10.5	26	26B	18	26B	NR	12	26	26	26	18	18[17]	26B	26B	18[17]	10.5	4	26	18[17]	18	26B	26B	18	4	4	4
Huskie	4	1B	1B	1B	1B	4	0.25	1B	1B	9	1B	9	1B	1B	9	4	1	1B	1B	1B	1B	1B	9	0.25	1	0.25
Impact (0.75 oz)	9	18	18	9	18	NR	9	18	18	18	9	18	18	18	9	9	3	18	NR	18	18	18	9	3	3	3
Instigate	10	18	18	10	18	NR	10	18	18	18	18	18	18	18	18	10	9	18	10	18	18	18	10	4	4	4
Intrro	AH	NI	AH	NY	NY	NR	NR[10]	NI	NI	NI	NR	NY	NY	NY	NY	NR	AH	NI	NR	NY	NY	NI	NY	AH	AH	AH
Karmex	24	24	24	NR	24	NY	NY	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	12
Kerb	NR	7	NR	5	7	5	5	5	7	7	NI	12	12	7	5	5	12	7	5	NI	7	7	12	12	12	12
Keystone NXT	15	18	SY	NY	18	NR	NY	18	18	18	SY	18	18	18	18	NY	SY	18	NY	SY	18	18	15	15	15	15
Laudis	10	18	18	10	18	NR	10	18	18	8	11	10	18	18	10	8	4	18	NR	12	10	18	10	4	4	4
Liberty/ Interline/ Rely 280	6	2.3	6	NR	6	NR	6	6	6	2.3	6	6	6	6	6	NR	2.3	6	6	6	6	18	2.3	2.3	2.3	2.3
Lexar/Lexar EZ	18	18	18	NY	18	NR	NR[10]	18	18	18	NY	18	18	18	18	NY	NY	18	NR	18	18	6	18	NY	NY	NY
Lightning	9.5	40B	40B	40B	40B	8.5[8]	18	40	40	40	9.5	9.5	40B	40B	9.5	9	18	40	18	9.5	40B	40B	26	9.5	4	4
Lorox/Linex	4	4	4	4	4	NR	4	4	4	4	4	4	4	4	4	NR	4	4	4	4	4	4	NR	4	4	4
Lumax/Lumax EZ	18	18	18	NY	18	NR	NR[10]	18	18	18	NY	18	18	18	18	NY	NY	18	NR	18	18	18	18	4.5	4.5	4.5
Marksman	SY	SY	SY	NY	SY	NR	NR	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NR	SY	SY	SY	SY	10	10	10
Marvel	18	18	18	NR	18	10	18	18	18	18	10	10	4	18	NR	NR	4	18	10	18	4	18	NR	4	4	4
Matrix	4	12	18	10	10	NR	18	10	18	10	18	8	12	12	10	4	9	18	10	18	NR	12	NR	12	12	4
Maverick	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3–12[15]	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B
Metribuzin	4	18	12	12	12	4	12	18	18	18	12	8	12	12	12	NR	12	18	4	12	4	18	12	4	12	4
Micro-Tech/ Intrro	AH	NI	AH	NY	NY	NR	NR[10]	NI	NI	NI	NR	NY	NY	NY	NY	NY	AH	NI	NR	NY	NY	NI	NY	AH	AH	AH
Milestone	24B	12B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	12	12	12
NorthStar	8	18	18	18	18	0.5[8]	8	18	18	18	8	8	18	18	8	8	8	18	8	8	18	18	8	3	3	3
Optill	4	40	4	18	18	8.5	18	40	40	40	4	4	18	40	4	0–1	18	40	18	9.5	18	40	18	4	4	4
Option	2	2	2	2	2	0.25	2	2	2	2	2	2	2	2	2	0.5	2	2	2	2	2	2	2	2	2	2

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Osprey	10	10	10	3	10	3	3	10	10	10	3	3	10	10	10	3	10	10	12	10	10	10	10	1	10	0.25
Outlook	NY	NY	NY	NY	NY	NR	NR[10]	NY	NY	NY	NR	NY	NY	NY	NY	NR	4	NY	NR	NY	NY	NY	NY	4	4	4
Outrider	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	NR
Overdrive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Paramount	24B	24B	24B	10	24B	10	NR	24B	24B	24B	10	24B	24B	24B	24B	24B	10	24B	10	24B	24B	24B	24B	10	10	NR
Paraquat	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PastureGard	1	NI	1	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	3	NI	NI	NI	NI	NI	NI	3	3	3
Peak (0.25 oz)	22	22	22	10	22	NR	1	22	22	22	10	10	22	22	10	10	NR	22	10	10	22	22	22	NR	NR	NR
Permit	9	15	9	4	9	1[8]	2	9	9	18	6	9	10	9	9	9	2	9	3	SY	8	9	9	2	2	2
Permit Plus	9	15	9	4	9	1[8]	2	9	9	18	6	9	10	9	1.5	9[15]	2	9	3	SY	8	9	9	2	2	2
Poast	NR	NR	NR	NR	NR	AH	AH	NR	NR	NR	NR	NR	NR	NR	NR	NR	AH	NR	NR	NR	NR	NR	NR	AH	AH	AH
PowerFlex HL	9	12	12	9	12	9	9	12	12	12	9	9	12	12	12	5	9	12	9	12	12	12	9	9	12	1
Prefar	4	NR	4	4	NR	4	4	4	NR	NR	4	4	NR	NR	4	4	4	NR	4	4	NR	NR	4	4	4	4
Prefix	18	18	18	1	18	10	18	NR	18	18	10	10	18	18	NR	NR	4.5	18	10	18	18	18	18	4.5	4.5	4.5
Prequel	10	18	18	18	18	NR	10	18	18	18	18	18	18	18	10	10	9	18	10	18	18	18	6	4	4	4
Princep	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY[18]	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Prowl H2O	NY	NY	NY	NR	NY	NR[19]	NY	NR	NY	NY	NR	NY	NY	NY	NY	NR	NY	NY	NY	NR	NY	NY	NY	4	NY	4
Pulsar	9	12	12	9	12	NR	4	12	12	12	12	9	12	12	12	9	0.75	12	4	12	12	12	9	0.75	0.75	0.75
Pursuit[1]	4	18	4	18	18[20]	8.5[8]	18	NR	18	18	NR	4	18[9]	40B	2	NR	18	40B	18	9.5	18[9]	18	18	4	4	4
Python/ Accolade	4	18	26B	18	26B	NR	12	26B	26B	26B	4	4	26B	26B	26B	NR	4	26B	18	9	26B	26B	12	4	4	4
Radius	12	18	18	18	18	NR	12	18	18	18	18	18	18	18	12	6	18	18	12	18	18	18	6	12	12	12
Raptor	3	9	18	9	9	8.5	9	NR	9	9	9	NR	9	9	NR	NR	9	9	8.5	9	9	9	9	4	4	3
Realm Q	10	18	18	10	18	NR	10	18	18	18	10	18	18	18	18	10	9	18	10	18	18	18	10	4	4	4
Reflex	18	18	18	NR	12	10	18	4	12	18	4	4	10[9]	10	NR	NR	4	12	10	18	10[9]	10	NR	4	4	4
Remedy Ultra	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

(continued)

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Resicore	10.5[29]	18	18	18	18	NR[29]	10.5[29]	18	18	18	18	18	18	18	18	10.5[29]	10.5[29]	18	18	18	18	18	18	10.5[29]	10.5[29]	4
Resolve (1 oz)	10	18	10	10	18	NR	10	18	18	18	10	10	18	18	10	10	9	18	10	18	1	18	NR	4	4	4
Resolve Q (1.25 oz)	10	18	10	1	10	NR	10	18	18	18	10	10	18	18	10	10	9	18	10	18	1.5	18	1.5	3	3	3
Resource	1	1	1	1	1	NR	1	1	1	1	1	1	1	1	1	NR	1	1	1	1	1	1	1	1	1	1
Revulin Q[1]	10	18	18	10	18	NR	10	18	18	18	18	18	18	18	18	10	8	18	10[21]	18	18	18	10	4	4	4
Ro-Neet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Roundup	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sandea	9	15	9	4	NR	1	2	NR	NR	18	6	9	10	NR	NR	9	2	NR	3	36	NR	NR	9	2	2	2
Scepter[13]	18	18	18	18	18	9.5[13]	11	18	18	18	11	18	18	18	11	NR	11	18	18	9.5	18	18	18	11	18	3
Select/Select Max	NR	NR	NR	NR	NR	1	1	NR	NR	NR	NR	NR	NR	NR	NR	NR	1	NR	1	1	NR	NR	NR	1	1	1
Sentrallas	4	4	4	4	4	NR	NR	4	4	4	4	4	4	4	4	4	NR	4	4	4	4	4	4	NR	4	NR
Sharpen (1 oz)[1]	4	9	4	1.5	4	NR	NR	9	9	9	4	NR	4	4	4	0–1	NR	9	4	4	4	9	4	NR	NR	NR
Shotgun	SY	SY	SY	NY	SY	NR	NR	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Sierra[1]	24B	24B	24B	24B	24B	11	24B	9	24B	24B	11	24B	24B	24B	24B	6–9	24B	24B	24B	24B	24B	24B	9	9	24B	NR
Sinbar	12	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	NR	24	24	24	24
Solicam	16	24	24	1–16	24	24	24	24	24	24	1–16	24	24	24	24	1.5–16	24	24	24	24	24	24	24	24	24	24
Sonalan	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	9	AH	AH	AH	AH	AH	AH	AH	AH	AH
Solstice	10	18	18	10	18	NR	AH	18	18	18	10	18	18	18	18	10	AH	18	NR	10	18	19	10	4	4	4
Sonic/ Authority First	12	30B	30	18[4]	30	10	12	30B	30B	30B	12	12	30	30	30	NR	12	30B	18	30[9]	30	30B	18	12	12	4
Spartan	12	NR	12	18	12	10	10	NR	12	12	12	12	12	12	12	NR	12	12	18	NR	NR	12	12	4	4	4
Spartan Advance	12	NR[10]	12B	12B	12B	4	18	NR	12B	12B	12B	12B	12B	12B	12B	NR	12B	12B	12	12B	12B	12B	4	4	4	4
Spartan Charge	12	NR[10]	12B	12–18	12B	4	10–18	4	12B	12B	NR	NR	12B	12B	12B	NR	12	12B	12	NR	NR	12B	4	4	4	4
Spin-Aid	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4	NR	NR	NR	NR	NR	NR	NR	NR	NR
Spirit	18	10	18	10	18	1[8]	10	18	18	18	18	10	18	18	10	10	3	18	8	10	10	18	10	3	3	3

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Spur	10.5	NR	10.5B	10.5B	18	NR	10.5	18	18	10.5	10.5B	18	18	18	18	10.5	NR	18	NR	10.5B	10.5B	10.5B	18	NR	NR	NR
Starane Ultra	4	4	4	4	4	NR	NR	4	4	4	4	4	4	4	4	4	NR	4	NR	4	4	4	4	NR	NR	NR
Status	1[5]	4	4	1[5]	4	0.25	1[5]	4	4	4	4	4	4	4	4	1[5]	1[5]	4	4	4	4	4	4	1[5]	1[5]	1[5]
Steadfast/ Steadfast Q	10	18	10	10	10	NR	10	18	18	18	10	10	10	10	10	0.5	8	18	10	10	10	18	10	4	4	4
Stinger	10.5	NR	18	18	18	NR	10.5	18	18	10.5	18	18	18	18	18	10.5	NR	18	10.5	18	18	18	18	NR	NR	NR
Storm	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	NR	3.3	3.3	3.3	3.3	NR	1.5	3.3	3.3	3.3	3.3	3.3	3.3	1.5	1.5	1.5
Stout	10	18	10	10	18	NR	10	18	18	18	18	10	18	18	10	0.5	8	18	10	18	10	18	10	4	4	4
SureStart/ TripleFLEX	NY	26B	NY	26B	26B	NR	12	NY	26B	26B	26B	NY	26B	26B	26B	NY	NY	26B	18	18	26B	26B	18	NY	NY	4
Surpass NXT	9	18	9	NY	18	NR	NR	NY	18	18	NY	NY	18	18	NY	NY	NY	18	NR	18	NY	18	NY	NY	NY	4
Surveil[22]	10	30B	30B	9	30B	9	9	30B	30B	30B	9	9	30B	30B	9	NR	9	30B	18	10[22]	30B	30B	18	30B	30B	3
Synchrony XP[1]	12	18	12	9	18	9	9	9	30	30	15	9	30	18	9	NR	3	30	18	9[9]	9[9]	18	8	3	3	3
Targa	4	4	4	NR	4	4	4	NR	4	4	NR	NR	4	4	NR	NR	4	4	4	4	4	4	4	NR	4	NR
Touchdown	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Travallas	12[30]	34B[30]	34[30]	34B[30]	34B[30]	12	11	34[30]	34B[30]	34B[30]	34B[30]	12	34B[30]	34B[30]	34B[30]	12	34B[30]	34B[30]	34B[30]	34B30	34B[30]	34B[30]	34B[30]	1 day	34B[30]	1 day
Treflan	NR	NR	NR	NR	NR	12	12	NR	5	5	5	NR	NR[9]	5	NR	NR	NR	5	12	5	NR	5	NR	NR	NR	NR
Trivence	10	18	18	18	18	10	18	30	30	30	18	12	30	18	30	NR	18	30	18	18	12	18	30	4	18	4
Ultra Blazer	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	NR	1.5	3.3	3.3	3.3	3.3	3.3	3.3	1.5	1.5	1.5
Valor/Rowel (up to 3 oz)[11]	5[11]	12B	5[11]	2[11]	12B	1	1	12B	12B	12B	NR	12B	12B	12B	4	NR	5[11]	12	4	2	12B	12B	12B	4	4	2
Valor XLT/ Rowel FX[23]	12	18	12[23]	10	18	10[23]	10	18[23]	18[23]	18[23]	18	12	18	18	12	NR	18	18[23]	18	10[9]	12[9]	18	18[23]	4	4	4
Varisto	3	9	18	9	9	8.5[31]	9	NR	9	9	9	NR	9	9	NR	NR	9	9	8.5	9	9	9	9[31]	9[31]	4	3[31]
Verdict	NY	NY	NY	NY	NY	NR	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	4	4	4
Vida	1	1	1	NR	1	NR	1	1	1	1	1	1	1	1	1	NR	1	1	1	1	1	1	NR	1	1	NR
Warrant	9	NI	9	NR	NI	NR	NY	NI	NI	NI	NR	NY	SY	SY	NY	NR	NY	NI	NY	NY	SY	NI	NY	NY	NY	4
Warrant Ultra	18	NI	18	1	18	10	18	NI	NI	NI	10	10	18	18	NY	NR	4	NI	18	18	18	NI	18	4	4	4
Yukon	9	15	9	4	9	1	2	NI	9	18	6	9	10	9	2	9	2	9	3	36	2	9	9	2	2	2

(continued)

	Rotation Crops (months after application)																									
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Zemax	18	18	18	NY	18	NR	NR[10]	18	18	18	NY	18	18	18	18	NY	NY	18	NR	18	18	18	NY	4.5	4.5	4.5
Zeus	12B	NR	12B	18	12B	10	18	NR	12B	12B	NR	12B	12B	12B	12B	NR	12B	12B	18	NR	12B	12B	12B	4	4	4
Zidua[1]	10	18	18	1–4	18	NR	6	18	18	18	4	11	18	18	11	NR	11	18	NR	18	18	18	4	11	11	1

1 Read the label for additional restrictions due to rainfall, soil, pH, geographical region, variety, or application rate.

2 18 months with a soil pH > 6.5. At rates greater than 2.1 oz/A, a rotation interval of 30 months and a successful field bioassay are required.

3 Rotation interval for pea and snap bean is extended to 18 months if Armezon PRO is applied at greater than 20 fl oz/A.

4 Cotton may be planted after 12 months where Authority Elite/BroadAxe was applied at rates less than 36 oz/A, Authority MTZ DF at rates less than 17 oz/A, or Authority First/Sonic at rates less than 5 oz/A and the following conditions are met: medium and fine soils, pH < 7.2, and rainfall or irrigation must exceed 15 inches after herbicide application and prior to planting cotton.

5 Following application of Banvel/Clarity and a minimum of 1 inch of rainfall or overhead irrigation, a waiting interval of 21 days is required per 8 fluid ounces per acre applied prior to planting cotton. 30 days per pint restriction for soybean. 20 days per pint restriction for small grains. If less than 1 inch or rainfall or irrigation is received after application and Status is applied at greater than 5 oz/A, the rotation interval is 4 months.

6 If Basis rate is 0.33 to 0.5 oz/A or Basis Blend rate is 1.25 oz/A, alfalfa, sorghum, pea = 18 months; soybean, snap bean = 10 months; STS soybean = 1 month; spring oat = 9 months; if Basis rate is greater than 0.5 oz/A or Basis Blend rate is 2.5 oz/A, cotton = 10 months and 18 months if greater than and less than 15 inches of rainfall or irrigation occur after application and prior to planting, respectively; STS soybean = 4 months; if Basis rate is 0.33 oz/A or Basis Blend rate is 0.825, soybean = 0.5 month.

7 8 months if 0.38 oz/A Beacon is applied.

8 NR for IMI (IR/IT) or Clearfield (CL) varieties.

9 Transplanted.

10 Use safener with seed.

11 Cotton may be planted no-till or strip-till after 14 or 21 days when applied at 1 oz/A or 1.5 to 2 oz/A, respectively. For winter wheat, at rates up to 2 oz/A, the rotation interval is 7 days for no-till or minimum-till wheat and 30 days for conventional-till wheat. At least 1 inch of rainfall/irrigation must occur between application and cotton, field corn, grain sorghum, tobacco, or wheat planting, or crop injury may occur. For alfalfa, clover, and spring oats the rotation interval is 5 months if the soil is tilled prior to planting or 10 months if no tillage is preformed prior to planting. At lower rates of Valor/Rowel/Chateau, rotation interval for many crops are reduced. Chateau may be applied to potato following hilling at a rate of 1.5 oz/A. Consult labels for more specific information.

12 Command may be applied preemergence to cotton only if Di-Syston or Thimet insecticides are applied in furrow with the seed at planting.

13 Corn hybrids that are classified as IMI-corn or as tolerant (IT) or resistant (IR) may be planted in the spring of the year following regardless of rainfall or time interval from chemical treatment to corn planting.

14 Rotation interval varies by tillage type and use rate. Consult the label for specific rotation intervals.

15 Rotation interval is shorter for STS soybean.

16 10 months if ≤ 0.3 oz/A.

17 If Hornet WDG rate is < 4 oz/A, snap beans, peas, and some varieties of sweet corn = 10.5 months.

18 If no more than 2 lb ai applied the previous year.

19 Regardless of tillage, be sure to plant corn at least 1.5 inches deep and completely cover with soil.

20 Cotton may be planted 9.5 months following Pursuit if all of the following criteria are met: Pursuit is applied to peanuts only; soil texture is sandy loam or loamy sand only; and greater than 16 inches of rainfall/irrigation is received following application of Pursuit through October of the application year.

21 The rotation interval for the sweet corn varieties 'Merit', 'Carnival', and 'Sweet Success' is 15 months.

22 Transplanted tobacco may be planted 10 months after application of 2.1 oz/A of Surveil. Tobacco in seeded nurseries may be planted 18 months after application of 2.1 oz/A of Surveil and following a successful field bioassay. At rates greater than 2.1 oz/A, a rotation interval of 30 months and a successful field bioassay are required.

23 Rotation intervals based on soil pH less than 7.0. In Pennsylvania, rotation interval for clover, lima bean, muskmelon, onion, pepper, spring oat, squash, and white potato is 18, 30, 30, 30, 30, 30, 30, and 30 months, respectively. Consult seed corn agronomist regarding inbred sensitivity to Valor XLT/Rowel FX prior to planting inbred seed corn lines.

24 If applied after June 1, rotating to crops other than corn (all types) may result in crop injury.

25 For Bolt or non-Bolt soybean and minimum- or no-till field corn, if Afforia is used on coarse textured soils, such as sands and loamy sands, or on high-pH soils (>7.9), extend time to planting by 7 additional days. For minimum- or no-till wheat in the states of DE, MD, NJ, or VA, Afforia may be applied at a minimum 7 days before planting. Do not us on Durum wheat and do not irrigate between emergence and spike. Wheat must be planted at least 1 inch deep. Do no graze until wheat has reached 5 inches in height. For conventional-till field corn, grain sorghum, cotton, and wheat, at least 1 inch of rainfall/irrigation must occur between application and planting or crop injury may occur. For alfalfa, cabbage, clover, cucumber, lima bean, muskmelon, onion, pepper, pumpkin, spring oat, squash, sweet corn, tobacco, tomato, watermel on, and white potato, the rotation interval is 4 months if the soil is tilled prior to planting. If no tillage is performed prior to planting these crops, the rotation interval is extended to 8 months.

26 Rotation interval for dry field peas is 4, 6, and 8 months at 1.625 oz/A or less, 3.25 to 4.875 oz/A, and 5.7 oz/A or more, respectively. For grain sorghum, spring oat, winter barley, or winter wheat, at 5.7 oz/A or greater rates, the rotation interval is extended to 18 months. For winter wheat, at 5.7 oz/A or greater rates, the rotation interval is extended to 6 months.

27 Seed corn inbred lines vary in sensitivity to herbicides; therefore, users should seek advice from seed corn agronomist regarding inbred sensitivity to Canopy Blend prior to planting inbred seed corn.

28 For onion, the rotation interval for irrigated and nonirrigated is 8 and 18 months, respectively.

29 For corn, if the original corn crop is lost, do not make a second application. Injury may occur to soybean planted the year following application on soils having a calcareous subsurface layer if products containing atrazine were used at rates greater than 0.75 lb/ai atrazine per acre in tank mixtures and/or sequentially with Resicore. If Resicore is applied after June 1, rotating to crops other than corn or grain sorghum the next spring may result in crop injury.

30 Most rotation intervals are based on a soil pH of 7.9 or lower. For alfalfa, the rotation interval at soil pH 6.8 or lower and 6.9 to 7.9 is 12 and 22 months, respectively. A minimum rotation interval of 34 months and 28 inches of cumulative precipitation during the period are required if the soil pH is not in the specified range. If the minimum cumulative precipitation has not occurred, a field bioassay must be successfully completed before rotation to any minor crops.

31 NR for Clearfield corn (field and seed). For wheat, planting non-Clearfield cultivars in areas receiving less than 10 inches of precipitation from time of application up until wheat planting may result in wheat injury. Injury potential increases if less than normal precipitation occurs in the 2 months just after Varisto application. For barley, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation, pH < 6.2 and < 18 inches of rainfall/irrigation and with moldboard plowing, and pH < 6.2 and < 18 inches rainfall/irrigation and without moldboard plowing is 9, 9, and 18 months, respectively. For potato, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation and pH < 6.2 and < 18 inches of rainfall/irrigation is 9 and 18 months, respectively.

a role if only a small amount of residue is necessary to cause injury and the herbicide persists. Quite often, small-seeded legumes and grasses, like the clovers and ryegrass, and mustard species, like canola, are very sensitive to some herbicides.

Tables 1-6 and 1-7 provide some persistence and carryover information for some commonly used corn and soybean herbicides. Some of this information is our best guess and only pertains to the eastern United States, not heavy Midwest soils or the western United States where soils have high soil pH and rainfall is lower.

Herbicide-resistant Crops

Herbicide-resistant crops are available for use in crop production systems. Corn, soybean, sorghum, alfalfa, and canola varieties are currently the key agronomic crops with herbicide resistance that can be grown in the Northeast. Herbicide resistance in crops results from two different procedures: tolerance selection and genetic engineering techniques. Tolerance selection involves selecting naturally occurring herbicide-tolerant cells from a particular crop cultivar or cell culture and incorporating them into crop varieties and hybrids using traditional breeding techniques. Genetically engineering herbicide-resistant plants involves transferring a gene with a certain trait from one organism to another (e.g., from bacteria to plant) using complex technology (also called a GMO). The transferred genetic trait(s) is then incorporated into crop varieties using breeding techniques. (The same genetic engineering technology is used to create crop protection to insect pests—e.g., Bt corn.) Several crop protection chemical companies and seed companies are involved in developing and marketing these crops. Following is a brief summary of the herbicide-resistant corn and soybean varieties currently available or soon to be released. See the corn and soybean chapters of this guide for detailed information on herbicide use for these crops.

Clearfield (CL) corn is non-GMO that was developed by tolerance selection to be resistant/tolerant to imidazolinone herbicides (e.g., Pursuit, Scepter). Although these hybrids initially were introduced to help manage herbicide carryover, Pursuit and Pursuit-containing products such as Lightning can be applied directly to the CL corn hybrids as part of the weed management program.

Inzen Z herbicide-tolerant sorghum is a non-GMO trait that provides tolerance to certain Group 2 or ALS-inhibitor herbicides. Nicosulfuron (Zest) from DuPont is the product that will be co-marketed with Inzen Z sorghum.

LibertyLink (LL) corn and soybean are genetically engineered (GMOs) to allow over-the-top applications of Liberty (glufosinate) herbicide. This program should provide broad-spectrum control of annual broadleaves and grasses of low to moderate pressure. Sequential applications or tank mixtures may be required for new weed flushes and perennials.

Roundup Ready alfalfa, corn, canola, and soybean were developed using genetic engineering techniques (GMOs). They have an altered target site not sensitive to glyphosate and allow postemergence applications of glyphosate directly to alfalfa, corn, canola, and soybean. Glyphosate-resistant weeds are becoming an increasing issue in Roundup Ready crops.

The STS and BOLT soybean/herbicide systems enhance crop safety from certain sulfonylurea herbicides such as thifensulfuron and chlorimuron. STS is a non-GMO, but Bolt also includes the GMO glyphosate-resistant trait. Although these varieties were developed to be used in combination with STS-labeled herbicides, they also provide greater safety from many of the ALS-type herbicides. The BOLT Herbicide-Tolerant trait provides enhanced tolerance to additional herbicides such as rimsulfuron (Basis Blend).

Herbicide-resistant Weeds

A number of weed species that once were susceptible to and easily managed by certain herbicides have developed resistance. These weeds are no longer controlled by applications of previously effective herbicides. As a result of repeated use of a certain type of herbicide on the same land, many different species of weeds have developed resistance to these chemicals. Globally, resistance has developed in all herbicide modes of action in about 250 weed species and the number of species continues to increase each year. (More information about herbicide-resistant weeds and herbicide modes of action can be found at **weedscience.org.**) It is believed that within any population of weeds, a few plants have sufficient tolerance to survive any herbicide that is used. Since only the survivors can produce seed, it is only a matter of time until the population of resistant weeds (or biotypes) outnumbers the susceptible type. Depending on the herbicide family and weed species, resistance can occur within 5 to 20 years. Reasons or mechanisms for resistance vary depending on the herbicide family. Resistant biotypes may have slight structural or biochemical differences at the cellular level from their susceptible counterparts that make them less sensitive to certain herbicides, and therefore they are not killed. Regardless of the mechanism for resistance, becoming familiar with the herbicide mode of action can help when designing programs that prevent the introduction and spread of herbicide-resistant weeds.

Growers, consultants, and those working with herbicides to manage weeds should know which herbicides are best suited to combat specific resistant weeds. The Weed Science Society of America (WSSA) developed a grouping system to help with this process. Herbicides that are classified as the same WSSA group number kill weeds using the same mode of action. Therefore, choose a combination of different herbicide modes of action that each contribute to the control of the target weeds. In other words, make sure to have at least two unique modes of action that are effective against the same weed during the season whether in tank mixtures or

Table 1-6. Corn herbicide half-lives and their potential to injure fall-established cover crops.

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive.

Trade Name	Common Name	Normal Rate/Acre	Half-life (days)[1]	Fall-established Cover Crops		Other
				OK to plant	Concern for	
2,4-D 4S	2,4-D	1–2 pt	7	All grasses	Wait 30 days before planting sensitive broadleaves	Amine formulations more water soluble and can leach into seed zone
Accent 75DF/ Steadfast75DF	nicosulfuron/ nicosulfuron+ rimsulfuron	0.66 oz/ 0.75 oz	21	Fall cereal grains, ryegrass	Small-seeded legumes, mustards, sorghum[2]	More persistent in high pH soils (> 7)
Armezon/Impact 2.8SC	topramesone	0.75 fl oz	14	Wheat, barley, oats, and rye are allowed after 3 months; ryegrass should also be OK	Although many broadleaves are restricted, Impact does not have much soil activity	We have not seen this herbicide carry over in PA
Atrazine 4L	atrazine	1–2 qt	15–90	Sorghum species	Cereals, ryegrass, legumes, and mustards	More persistent in high pH soils (> 7); rates < 1 lb/acre can allow more flexibility; half-life in PA probably closer to 30
Balance Pro 4L/ Balance Flexx 2L (Prequel 45WG also contains isoxaflutole)	isoxaflutole	3 fl oz 6 fl oz	50–120	Fall cereals grains	Cereals, ryegrass, legumes, and mustards	15 inches of cumulative precipitation required from application to planting rotation crops except soybean, barely, wheat, sorghum, and sunflower
Callisto (includes Acuron, Halex GT, Instigate, Lexar, Lumax, Resicore, Zemax, etc.)	mesotrione	3–6 fl oz	10–50	All grasses	Small-seeded legumes, mustards	Sequential applications (PRE fb POST) increase the potential for injury
Capreno 3.45SC	tembotrione + thiencarbazone	3 fl oz	15	Wheat, triticale, rye	Small-seeded legumes, mustards, sorghum	15 inches of cumulative precipitation required from application to planting rotation crops except wheat
Clarity/Banvel 4S (DiFlexx, Distinct, Status)	dicamba	16–24 fl oz	5–14	All crops	Only at high rates or less than 120 days after application	Anything can be planted after 120 days with 24 fl oz/acre or less
Corvus 2.63SC	isoxaflutole + thiencarbazone	5.6 fl oz	50–120	Wheat, triticale, rye	Small-seeded legumes, mustards, sorghum	15 to 30 inches of cumulative precipitation from application to planting for sensitive crops
Dual II Mag 7.62E/ Cinch	metolachlor	1.67 pt	15–50	Almost anything	Annual ryegrass or other small-seeded grasses	Higher rates and later applications more of a potential problem
Glyphosate 4L	glyphosate	0.75–1.25 lb	47[3]	All	None	Glyphosate does not have soil activity at normal use rates
Gramoxone 2S	paraquat	2 pt	1,000[3]	All	None	Paraquat does not have soil activity at normal use rates
Harmony 50WDG	thifensulfuron	1/8 oz	12	No restrictions for wheat, barley, and oats	None with 45-day waiting interval	Harmony Extra also contains tribenuron
Harness 7E (Degree, Surpass, Warrant)	acetochlor	2 pt	10–20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops are allowed after corn harvest
Laudis 3.5SC (DiFlexx Duo)	tembotrione	3 fl oz	14	Cereal grains after 4 months	Unknown; small-seeded legumes, mustards could be a problem	Other crops may be seeded after a successful field bioassay

Trade Name	Common Name	Normal Rate/Acre	Half-life (days)[1]	Fall-established Cover Crops		Other
				OK to plant	Concern for	
Liberty 2.34L	glufosinate	22–36 fl oz	7[3]	All	Food or feed residues rather than crop injury may be a concern	Glufosinate does not have soil activity at normal use rates
Metribuzin 75DF (Sencor)	metribuzin	0.33 lb	14–60	Cereal grains and ryegrass	Slight risk for small-seeded legumes and mustards	Nonfood/feed winter cover crops allowed
Outlook 6E (Armezon Pro)	dimethenamid	16 fl oz	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops should be OK after corn harvest
Peak 57WG (and Spirit)	prosulfuron	1 oz	9–152	Cereal grains and sorghum are labeled, other grasses	Small-seeded legumes, mustards	More persistent in high pH soils (> 7)
Permit/Sandea 75DF	halosulfuron	2/3 oz	9–27	Cereal grains and sorghum after 2 mo. and other grasses	Small-seeded legumes, mustards	Halosulfuron also an ingredient in Yukon
Prowl H2O 3.8CS	pendimethalin	3 pt	44	Cereal grains	Small-seeded legumes and annual ryegrass	We have not seen this herbicide carry over in PA; nonfood/feed winter cover crops should be OK
Python 80WDG (Hornet and SureStart)	flumetsulam	1 oz	14–120	Cereal grains	Small-seeded legumes, mustards, and annual ryegrass	Cover crops and forage grasses are restricted for 9 months
Resolve 25DF (Resolve Q)	rimsulfuron	2 oz	2–4	Based on the short half-life, most fall cover crops should be OK in PA	None	More persistent in drought conditions
Sharpen 2.85SC (Verdict, Zidua Pro)	saflufenacil	3 fl oz	7–35	All	None	This product has been reported more persistent in western Canada
Simazine 4L (Princep)	simazine	1–2 qt	60	Sorghum species	Cereals, ryegrass, legumes, and mustards	Soil pH > 7
Stinger 3S (Hornet, Resicore, SureStart)	clopyralid	5 oz	40	All grasses	Small-seeded legumes	
Zidua (Anthem)	pyroxasulfone	0.133	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops should be OK after corn harvest

[1] The herbicide half-life is defined as the time it takes for 50 percent of the herbicide active ingredient to dissipate. See the "Managing Herbicides" section for additional information. Herbicide half-life estimates are derived for the *WSSA Herbicide Handbook* and other scientific literature.

[2] Common small-seeded legumes include alfalfa, clovers, and hairy vetch.

[3] This herbicide does not have soil residual activity at normal application rates.

Table 1-7. Soybean herbicide half-lives and their potential to injure fall-established cover crops.

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive.

Trade Name	Common Name	Normal Rate/Acre	Half-life (days)[1]	Fall-established Cover Crops		Other
				OK to plant	Concern for	
2,4-D 4S	2,4-D	1–2 pt	7	All grasses	Wait 30 days before planting sensitive broadleaves	Amine formulations more water soluble and can leach into seed zone
Assure II/ Targa 0.88E	quizalofop	8 oz	60	Most broadleaves	All grasses if less than 120 days or at high rates	Plant anything after 120 days
Authority 75DF (BroadAxe, Sonic, Spartan)	sulfentrazone	4 oz	32–302	Cereals and ryegrass	Small-seeded legumes, mustards, sorghum[2]	Labeled on tobacco, sunflowers, trans-planted tomato
Classic 25DF (Authority XL, Canopy, Envive, Fierce, Fierce XLT, Synchrony, Trivence, Valor XLT, etc.)	chlorimuron	0.5–2 oz	40	Cereals and ryegrass	Small-seeded legumes, mustards, sorghum	More persistent in high-pH soils (> 7) and with higher soil applied rates
Dual II Mag 7.62E/Cinch	metolachlor	1.67 pt	15–50	Almost anything	Annual ryegrass or other small-seeded grasses	Higher rates and later applications more of a potential problem
FirstRate 84WDG	cloransulam	0.3 to 0.6 oz	8–33	Wheat, triticale, rye	Small-seeded legumes, mustards, sorghum	The restriction for transplanted tobacco is 10 months for 0.3 oz/acre; sugarbeet and sunflower have a 30-month restriction
Glyphosate 4L	glyphosate	0.75–1.25 lb	47[3]	All	None	Glyphosate does not have soil activity at normal use rates
Gramoxone 2S	paraquat	2 pt	1,000[3]	All	None	Paraquat does not have soil activity at normal use rates
Harmony 50WDG	thifensulfuron	1/8 oz	12	No restrictions for wheat, barley, and oats	None with 45-day waiting interval	Harmony Extra also contains tribenuron
Liberty 2.34L	glufosinate	22–36 fl oz	7[3]	All	Food or feed residues rather than crop injury may be a concern	Glufosinate does not have soil activity at normal use rates
Metribuzin 75DF (Sencor)	metribuzin	0.33 lb	14–60	Cereal grains and ryegrass	Slight risk for small-seeded le-gumes and mustards	Nonfood/feed winter cover crops allowed
Outlook 6E (Verdict)	dimethenamid	16 fl oz	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops should be OK after corn harvest
Prowl H2O 3.8CS	pendimethalin	3 pt	44	Cereal grains	Small-seeded legumes and annual ryegrass	We have not seen this herbicide carry over in PA; nonfood/ feed winter cover crops should be OK
Pursuit 2S (Authority Assist, Optill)	imazethapyr	4 fl oz	60–90	Wheat, triticale, rye, alfalfa, clover	Oats, sorghum, mustards	Any crop can be planted 40 months after Pursuit appli-cation

Trade Name	Common Name	Normal Rate/Acre	Half-life (days)[1]	Fall-established Cover Crops		Other
				OK to plant	Concern for	
Python 80WDG	flumetsulam	1 oz	14–120	Cereal grains	Small-seeded legumes, mustards, and annual ryegrass	Cover crops and forage grasses are restricted for 9 months
Raptor 1E	imazamox	5 fl oz	20–30	Wheat, triticale, rye, alfalfa, clovers	Slight risk for mustards	Most cash crops allowed 9 months following application
Reflex 2E/ Flexstar 1.88E (Warrant Ultra)	fomesafen	1.5 pt	100	Cereal grains	Small-seeded legumes, mustards, sorghum	Since fomesafen is often applied postemergence, soil activity can surprise users
Scepter 1.5AS	imazaquin	0.66 pt	60–90	Cereal grains	Small-seeded legumes, mustards	Carryover much more of a risk with drought
Select 2E	clethodim	10 oz	3	All broadleaves	None assuming at least 30 days	Plant anything after 30 days
Sharpen 2.85SC (Optill, Verdict, Zidua Pro)	saflufenacil	3 fl oz	7–35	All	None	This product has been reported more persistent in western Canada
Valor 51WDG (Envive, Fierce, Surveil, Trivence, Valor XLT, etc.)	flumioxazin	2.5 oz	12–20	All grasses	Small-seeded legumes and mustards	Based on the half-life, all nonfood/feed winter cover crops should be OK
Warrant	acetochlor	2 pt	10–20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops are allowed after corn harvest
Zidua (Fierce, Anthem, etc.)	pyroxasulfone	0.133	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops should be OK after corn harvest

[1] The herbicide half-life is defined as the time it takes for 50 percent of the herbicide active ingredient to dissipate. See the "Managing Herbicides" section for additional information. Herbicide half-life estimates are derived for the *WSSA Herbicide Handbook* and other scientific literature.

[2] Common small-seeded legumes include alfalfa, clovers, and hairy vetch.

[3] This herbicide does not have soil residual activity at normal application rates.

sequential applications. Try to avoid using the same products and herbicide mode of action every year. This is especially important on weeds that are typically prone to resistance such as pigweed species, common lambsquarters and ragweed, horseweed, and foxtail species. WSSA group numbers can be found on many herbicide product labels (Fig. 1-8) and used as a tool to choose herbicides in different mode of action groups so mixtures or rotations of active ingredients can be planned to better manage weeds and resistant species. Keep in mind that many products contain similar active ingredients even though the products may have different trade or brand names. Using a different product or brand does not guarantee that you are selecting a different herbicide mode of action. Refer to Table 1-1 for herbicide—or WSSA—mode of action group numbers and corresponding herbicides. Other resources, such as university pest guides or recommendations, can provide effectiveness ratings of numerous herbicides on many different weed species to help with this process of developing appropriate weed management programs.

Dependence on a single strategy or herbicide family for managing weeds will increase the likelihood of additional herbicide resistance problems in the future. Management programs to combat herbicide resistance should emphasize an integrated approach. Some management guidelines for an integrated approach include using herbicide tank mixtures containing more than one herbicide mode of action that are active on similar weeds, shorter residual herbicides, crop rotations that allow for application of different herbicide classes, judicious and non-continuous use of herbicide-resistant crops in a rotation, non-chemical control measures, and combinations of weed management techniques such as avoiding spreading resistant weed seed with machinery or in manure and ensiling to help destroy weed-seed-infested forage.

Reducing the risk for developing herbicide-resistant weed populations requires incorporating a number of guidelines in managing your fields, including:

- Spray only when necessary
- Use alternative methods of control whenever possible such as mechanical cultivation or delayed planting (row crops), mowing (forage crops), and using weed-free crop seeds
- Rotate crops and their accompanying herbicides' site of action
- Limit number of applications of herbicide(s) with same site of action in a given growing season

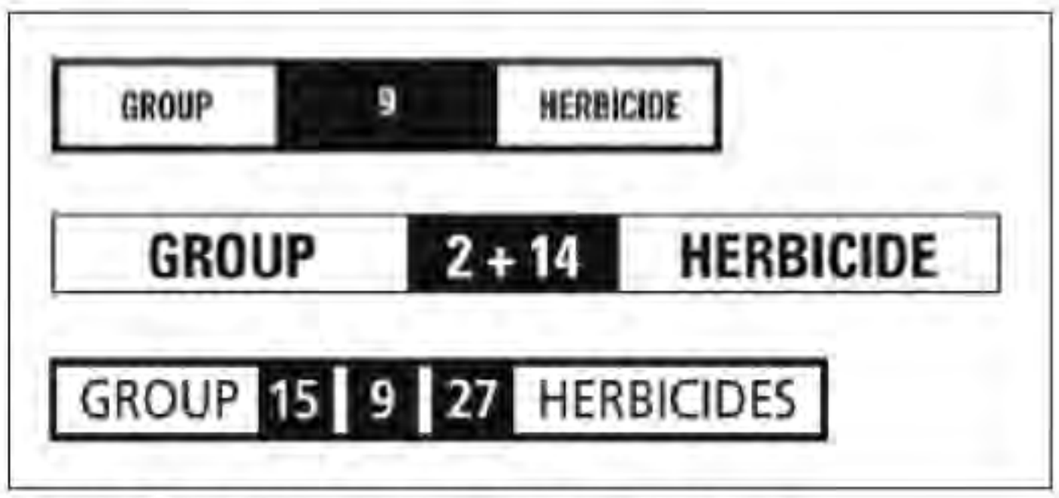

Figure 1-8. Herbicide group numbers on product labels.

- Use mixtures or sequential herbicide treatments having different sites of action that will control the weeds of concern
- Scout fields after herbicide application to detect weed escapes or shifts (Table 1-8)
- Clean equipment before leaving fields infested with or suspected to have resistant weeds

Banded Herbicide Application

Herbicide use can be reduced by 50 to 75 percent by applying the herbicide in a narrow strip or band over the row. Preemergence and postemergence herbicides can be applied as banded sprays to reduce cost and the amount of herbicide used in conventional and certain minimum-tillage systems. Band spraying consists of applying an herbicide in an 8- to 15-inch band over the crop row, leaving the row middles unsprayed. Weeds that emerge between the rows must be controlled by mechanical cultivation, which may be done more economically than treating them with herbicides. Banding is not practical with herbicides that must be preplant incorporated, in no-till planting systems, or when rows are planted at a close spacing.

Drift

Drift is the movement of any pesticide through the air to areas not intended for treatment. During application, droplet or particle drift occurs as spray droplets or dust particles are carried by air movement from the application area to other places. Vapor drift takes place after application as herbicides evaporate (volatilize) and yield fumes (gases) that are carried on wind currents and deposited on soils or plants in untreated areas.

Herbicide drift may injure sensitive crops, ornamentals, gardens, livestock, wildlife, or people, and may contaminate streams, lakes, or buildings. It may contaminate crops and cause illegal or intolerable residues. Excessive drift may mean poor performance in the desired spray area because the application rate is lower than expected.

Drift control should be considered with each pesticide application. Here are some ways to prevent severe drift problems:

- Use sprayer nozzles especially designed for drift reduction
- Use low-volatile or nonvolatile formulations
- Use low spray-delivery pressures (15–30 psi) and nozzles with a larger orifice
- Use drift-inhibiting adjuvants in the spray mixture when spraying under less-than-ideal conditions
- Use nozzles that allow for lowered boom height
- Avoid application of volatile chemicals at high temperatures
- Spray when wind speed is low (less than 10 mph) or when the wind is blowing away from areas that should not be contaminated
- Use higher spray volumes during applications (e.g., 20 to 30 gallons per acre versus 5 to 10 gallons per acre)
- Spray during the early morning or evening hours when there is usually less wind
- Leave border areas unsprayed if they are near sensitive crops

Table 1-8. Weed species prone to resistance and of concern in the Mid-Atlantic region.

	WSSA Site of Action Numbering											
	1	2	3	4	5	7	9	10	14	15	22	27
Broadleaf Species												
Chickweed, Common		■										
Horseweed/Marestail		■			■		■				■	
Lambsquarters, Common		■			■							
Pigweed (Amaranth), Palmer		■			■		■					■
Pigweed, Redroot/Smooth		■			■		■					
Ragweed, Common		■			■		■		■			
Ragweed, Giant		■					■					
Grass Species												
Barnyardgrass	■	■		■	■	■	■					
Foxtail, Giant	■	■			■							
Goosegrass			■		■		■					
Johnsongrass	■	■	■				■					
Ryegrass, Annual/Italian	■	■					■	■		■		
Shattercane		■	■		■		■					

General Herbicide Mixing Procedures

Specific mixing or tank-mixing procedures may vary among product labels. When using a product alone, adhere to the mixing instructions on the product label. When tank-mixing two or more products, adhere to the most restrictive label's instructions. If it is difficult to determine which instructions to follow or when the instructions on the labels contradict each other, use the general instructions outlined below.

1. Make sure the spray equipment is properly cleaned according to the labels of the products that were last applied with the sprayer.
2. Make sure the sprayer is properly calibrated, has good agitation, and is equipped with the appropriate screens (no finer than 50 mesh; 100 mesh is finer than 50 mesh) and spray tips.
3. If tank-mixing two or more products, make sure there are no label restrictions prohibiting those products from being tank-mixed.
4. If tank-mixing two or more herbicides that are not specifically allowed on the labels, or if the labels require it, perform a compatibility test (such as a jar test) to ensure that the products mix properly.
5. If a suspension or liquid fertilizer is being used as the carrier, perform a compatibility test (such as a jar test) to ensure that the products dissolve properly and remain stable.
6. Fill the spray tank one-half to three-quarters full with clean water or suspension or liquid fertilizer (if being used as the carrier) and begin agitation. If possible, maintain agitation until all applications are completed.
7. If ammonium sulfate (AMS) is being added as a water conditioner, add the AMS first. This is particularly important if glyphosate (Roundup, Touchdown, etc.) or paraquat (Gramoxone) products are being used. Make sure the AMS is completely dissolved before continuing.
8. If compatibility agents are required, follow the herbicide label first and then the directions with the compatibility agent. Compatibility agents are generally either mixed or slurried with the products and/or added to the carrier solution prior to adding any products.
9. Add water-soluble packets and thoroughly mix. Make sure the packets are completely dissolved.
10. Add wettable powders (WP) and thoroughly mix.
11. Add dispersible granules (DG) and dry flowables (DF) that are not in water-soluble packets and thoroughly mix.
12. Add liquid flowable (FL) formulations and thoroughly mix.
13. The products in steps 9 through 12 can be slurried in water to ensure that the products are completely dissolved before adding them to the spray tank. Some labels require that the product be slurried, particularly when using a suspension or liquid fertilizer as the carrier. Make sure to use enough water to allow the products to be completely dissolved.
14. Add water-soluble concentrates (SC) and other aqueous solution products and thoroughly mix.
15. Add emulsifiable concentrate (EC) formulations and thoroughly mix.
16. Add spray adjuvants (non-ionic surfactants, crop oil concentrates, methylated seed oil, etc.).
17. Add a nitrogen fertilizer solution such as urea ammonium nitrate (UAN) or ammonium sulfate (AMS) that is not being added as a water conditioner.

18. Add other tank products such as defoamers, drift control agents, dyes, etc., unless labels require their addition earlier in the mixing process.
19. Finish filling the spray tank.

General Jar Test Procedures

A "jar test" is a type of compatibility test used to determine if two or more herbicides will mix properly, or if an herbicide(s) will mix properly with a carrier solution such as a suspension or liquid fertilizer. Incompatibility of tank mixtures is more common with suspensions of liquid fertilizers and pesticides. The idea of the jar test is to create a miniature of the actual spray tank mixture with all of the components in the proper ratios. Many herbicide labels have specific jar test procedures. If possible, follow the procedures outlined on the product label(s). If it is difficult to determine which label instructions to follow or when the instructions on the labels contradict each other, use the general instructions outlined below:

1. Use only water or carrier solution from the intended source and at the source temperature.
2. One jar will usually be adequate if only herbicide compatibility in water is being tested. Two or three jars may be needed if compatibility agents and/or adjuvants will be compared to the tank mixture alone. Use quart-size jars with resealable lids.
3. Add the appropriate amount of water or carrier solution to each quart jar using this formula:

   spray volume (gal/A) x 0.04 = carrier to add in pint/jar

   For example, for a spray volume of 20 gallons per acre (gal/A), add 20 x 0.04 = 0.8 pint (378 ml) of carrier to each jar.

4. If a compatibility agent will be used, add the appropriate amount of the compatibility agent to one labeled jar based on this formula:
   compatibility agent rate (pint/100 gal) x spray volume (gal/A) x 0.005 = compatibility agent to add in teaspoons/jar

   For example, if the label rate for the compatibility agent is 3 pints/100 gal and the spray volume is 20 gal/A, then add 3 x 20 x 0.005 = 0.3 teaspoon (1.5 ml) of compatibility agent to one jar.

5. Add the appropriate amount of pesticides in the proper order (wettable powders, dispersible granules, dry flowables, liquid flowables, soluble concentrates and other aqueous solutions, and emulsifiable concentrates) to all jars according to one of the methods below. After each addition, shake, invert several times, or stir gently to thoroughly mix.
   a. Use the formula **product rate/A x 0.005** and convert to an appropriate measurement using the conversion factors below.
   b. Or, for dry products, add 1 teaspoon per pound of product per acre, and for liquid products, add ½ teaspoon per pint of product per acre.

   Dry product conversion factors:
   1 pound = 16 ounces = 454 grams
   1 ounce = 28.3 grams

   Liquid product conversion factors:
   1 gallon = 4 quarts = 8 pints = 128 fluid ounces
   1 pint = 2 cups = 16 fluid ounces = 473 milliliters
   1 fluid ounce = 29.57 milliliters = 2 tablespoons = 6 teaspoons
   1 teaspoon = 4.93 milliliters = 60 drops

6. If adjuvants are being tested for compatibility, these should be added last to one labeled jar. Use one of these formulas based on how the adjuvant rate is expressed:
   adjuvant rate (pint/100 gal) x spray volume (gal/A) x 0.005 = adjuvant to add in teaspoons/jar
   or
   adjuvant rate (pint/A) x 0.48 = adjuvant to add in teaspoons/jar

7. When all components have been added to the jar(s), invert each jar 10 times to mix and let stand for 15 to 30 minutes. If the spray solution balls up or forms flakes, sludges, gels, oily films or layers, or other precipitates, it is not compatible. If a compatibility agent has not already been tested, repeat the test with a suitable compatibility agent. The tank mixture should not be used if any signs of incompatibility are evident. If the mixture separates but can be remixed readily, the mixture can be sprayed as long as good agitation is used.

8. Compatibility may be improved by using the following methods when testing **and** mixing.
   a. Slurry the dry pesticides in water before adding to the mixture.
   b. Oily films are usually caused by incompatibility of emulsifiable concentrates (EC). Add half of the compatibility agent to the carrier and half to emulsifiable concentrates and/or flowable pesticides before adding them to the mixture.

Sprayer Cleanout

Modified from "Sprayer Clean-out Guidelines: Avoiding Crop Injury Due to Contamination," PAT-30 (November 1997), Iowa State University of Science and Technology, Ames, Iowa.

Crop injury due to contaminated sprayers is a continuing problem for both vegetables and field crops. Herbicide residues can be dissolved with time, and some herbicide formulations are very effective at removing residues. This problem can be avoided by ensuring that sprayers are properly cleaned between tank loads. Sprayer cleaning is particularly important before you begin spraying a different crop. When determining the correct clean-out procedure, it is important to consider the product's mode of action, carrier, and additives. They all have an impact on what cleaning solutions to use and potential damage to sensitive crops.

Rinsate disposal. Clean the sprayer in an area that will not contaminate water supplies, streams, or crops and that is inaccessible to children, pets, and livestock. Pay particular attention to sensitive vegetation that is in the runoff area. The best method for rinsate disposal is in the field in a manner consistent with the product's label. The easiest way to do this is to have rinse water available in the field, on either the sprayer or the support vehicle.

Tank-cleaning agents. A tank-cleaning agent's function is to penetrate, loosen, and dissolve herbicide residues, and then remove them through dilution. In some cases, the agent will provide deactivation or decomposition of the herbicide.

- Commercial tank cleaners are recommended on many product labels and help remove water and oil-soluble herbicides.
- Household ammonia, a commonly recommended cleaning agent, is effective at penetrating and loosening deposits and residues in the spraying system. Although ammonia does not decompose herbicides, it increases the solubility of some herbicides by raising the pH.
- Chlorine bleach can decompose residues of most sulfonylurea and other herbicides into inactive compounds. However, some tank-mix partners may inhibit the decomposition. Care must be used with chlorine bleach. Chlorine bleach can combine with fertilizers containing ammonia to produce dangerous chlorine gas, which is irritating to the eyes, nose, throat, and lungs. Also, rinsate containing chlorine bleach is not labeled for application to cropland.
- Kerosene or fuel oil should be used to remove oil-based herbicide formulations such as 2,4-D esters. Following the oil rinse, the system should be cleaned with detergent or ammonia.

Removing precipitated pesticides. Tank-mixing more than one pesticide can sometimes result in the chemicals forming a "gunky mess" in the bottom of the tank. The result is that the pesticides are not compatible with one another and the pesticides will settle out (form gunk). If your tank does end up with incompatible pesticides gunking up the bottom, use a compatibility agent (usually at a pint per 100 gallons; follow directions).

Surfactants and fertilizer additives. When switching from a growth regulator herbicide (2,4-D, Banvel, or Stinger) to a postemergence application in soybeans, special care should be taken if the application involves surfactants or fertilizer additives. Such materials are particularly adept at removing these herbicides from poly tanks, hoses, and strainers. It is recommended that a small amount of fertilizer or crop oil be flushed through the system before the application.

General cleaning guidelines. To avoid drying and hardening of pesticide residues, and potential corrosion and damage to equipment, clean the sprayer immediately following an application. If you are continuing with the same pesticide the next day, flushing with water is sufficient. However, if you are switching products or crops, a more thorough cleaning is required.

Be sure to clean the entire sprayer system, not just the tank. Operate the pump and flush the cleaning solution through all hoses, strainers, screens, nozzles, and the boom. Small amounts of residue left in these areas can be sufficient to cause serious damage to a sensitive crop.

Most injury occurs when switching between crops. The following procedure is recommended when there are no specific cleaning requirements given on the label.

1. Drain the sprayer tank and lines and rinse tank, boom, and lines with water for a minimum of 5 minutes.

2. Fill the tank with clean water and one of the following cleaning solutions per 100 gallons of water:
   - 1 gallon of household ammonia
     or
   - 8 pounds of trisodium phosphate cleaner detergent
     or
   - commercial tank cleaner (follow instructions)

   Flush the solutions through the entire sprayer system. For growth regulator herbicides (2,4-D, Banvel, Clarity, Distinct, Stinger, etc.), let the solution stand overnight. Add more water to fill tank and agitate solution for at least 15 minutes and flush through the nozzles. Drain the tank.

3. Remove the nozzles, screens, and strainers and clean them separately in a bucket of cleaning agent and water.

4. Rinse the entire system with clean water.

Sprayer Calibration

Proper sprayer calibration is one of the most important steps in any integrated pest management program. There are many reasons why you should calibrate your sprayers at least once a year. One of the most important reasons is to ensure you are not overapplying or underapplying a pesticide. Applying too

much pesticide hurts your bottom line, may harm nontarget plants or insects, and is illegal. Too little can lead to poor pest control. Sprayer calibration is a step many producers skip because they think it is too complicated or time consuming.

A simple method for sprayer calibration has been developed that requires very few calculations. This method is based on spraying 1/128 acre per nozzle and simply collecting the spray released during the time it takes to travel over that area. Since there are 128 fluid ounces in 1 gallon, the number of ounces collected equals the application rate in gallons per acre. This method works well for broadcast applications, banded applications, and directed applications.

To calibrate your sprayer, you will need a measuring tape, a stopwatch, and a graduated liquid measuring cup. Follow these steps to determine the sprayer output:

1. Determine the nozzle spacing, band width, or row spacing based on type of application (e.g., 18-inch band application; see table below).
2. Determine the calibration distance for the appropriate spacing using the information in the table below (e.g., 18-inch band = 226.9-foot calibration distance).
3. Mark off the appropriate calibration distance you determined in step 2. To obtain the most accurate results, conduct this step in the actual field or under similar conditions to where you will be spraying.
4. Drive the calibration distance at a safe operating speed several times to determine the average time to travel the course. Note: It is important that all attachments such as harrows or planters are in operation to ensure proper calibration. Write down the engine RPM, gear, speed and time required to travel the calibration distance. To ensure accuracy, drive the course at least twice and calculate the average time to travel the distance.
5. With the sprayer parked and operating at the same engine speed used to drive the calibration distance (step 4), adjust spray pressure to the desired setting. The recommended spray pressure setting can be found on the pesticide label or based on the nozzles selected.
6. With the sprayer running, collect the spray from all nozzles that contribute to the desired spacing for the number of seconds that were required to travel the calibration distance in step 4. The number of nozzles that contribute to the spray area will depend on your application method:
   a. Broadcast application: All outlets are evenly spaced; however, because pressure differences can occur along the length of the boom, collect spray from all nozzles for the number of seconds required to travel the calibration distance.
   b. Band application: Spray from one or more nozzles contributes to cover a specific area. Collect spray from the total number of nozzles that contribute to the selected band width for the number of seconds required to travel the calibration distance.
   c. Directed application/row application: Spray from one or more nozzles contributes to cover a specific area. Collect spray from the total number of nozzles that contribute to the selected width for the number of seconds required to travel the calibration distance.

The total number of fluid ounces collected is equal to the gallons per acre rate. The rate can be altered by adjusting the pressure, changing nozzles, or changing the applicator speed. If speed is adjusted, begin at step 4 and recalibrate.

Determining Tank Mixture

To determine the amount of chemical to mix into the spray tank, divide the number of gallons in the tank by the broadcast application rate in gallons per acre (step 6) and multiply by the labeled per-acre application rate for the pesticide. For example, a sprayer has a 200-gallon tank and is calibrated to apply 20 gallons per acre. The labeled rate is 1 pint of pesticide per acre.

a. 200-gallon tank ÷ 20 gallons per acre = 10 acres covered per tank.
b. 10 acres × 1 pint per acre = 10 pints of chemical per tank.

Determining the Total Number of Acres Covered by a Banded Application

Use the broadcast pesticide rates to mix into the tank for a banded application. Since a banded application sprays less area than a broadcast application, the total treated acres can be determined by dividing the treated band width by the total treated band width plus the untreated band area (e.g., the above sprayer set to spray a 12-inch band over a 36-inch row spacing).

a. 12-inch band ÷ 36-inch row spacing = 0.33.
b. 0.33 × 10 acres per tank (broadcast) = 3.3 acres sprayed for every 10 acres covered.
c. 10 acres per tank (broadcast) ÷ 0.33 acres sprayed in the band = 30.3 acres sprayed per tank.

Calibration distance based on sprayer width (inches by nozzle):

Row Spacing, Nozzle Spacing (Broadcast), or Band Width (Banded Application) (inches)	Calibration Distance (feet)
48	85.1
40	102.1
36	113.4
32	127.6
30	136.1
28	145.8
24	170.2
20	204.2
18	226.9
12	340.3
8	510.5

To determine a nozzle spacing not listed in the above, divide the band width in feet into 340.3. For example, 7-inch band = 340.3 ÷ (7 inches ÷ 12 inches) = 583.4.

Source: Taken with permission from Rutgers Cooperative Extension Fact Sheet FS1085 by Stephen Komar, Bill Bamka, and Robert Mickel.

Chapter 2. Corn Weed Management

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Integrated Weed Management

An integrated approach to managing weeds in corn includes using cultural weed control, mechanical controls where applicable, and the judicious use of herbicides. Corn fields that are weed free for the first 4 to 6 weeks after planting will often yield the same as fields that are weed free for the entire growing season. This approach relies on starting with a clean seedbed and using residual soil-applied herbicides or mechanical control. Weeds that germinate with the crop but are controlled in a timely fashion (4 to 5 weeks after planting) will also not impact final yields. This POST herbicide approach relies on effective and timely postemergence weed control. Also, it is not necessary to control all weeds in a field to achieve maximum yield. However, certain weeds can still be problematic at harvest even at low levels (e.g., burcucumber). Weed populations of 1 to 2 weeds per 10 square feet are sufficient to cause severe yield loss depending on the species. However, weed populations at 1 plant per 100 square feet will have no impact on final yield. The impact of weed populations between 1 and 10 per 100 square feet is difficult to predict. The decision to treat the field depends on the weed species present, crop vigor, weather conditions, and herbicide cost.

Chemical Weed Control

Herbicides are useful tools in most weed management programs. This chapter will focus on herbicides available for use in corn. They should be used to supplement, not replace, other methods or tools available. The following are definitions of terms you will find in this and similar publications on herbicides:

Early preplant (EPP). The herbicide is applied at least 14 days before planting. EPP applications are generally used in no-till systems to control existing vegetation and provide residual control of early emerging weed species.

Preplant. The herbicide is applied from 0 to14 days before planting. Preplant applications are generally used in no-till systems to control emerged weed species.

Preplant incorporated (PPI). The herbicide is applied to the soil after primary tillage, but before planting, and mechanically mixed with the top 1 to 3 inches of soil with one of a variety of secondary tillage implements.

Preemergence (PRE). The herbicide is applied to the soil after the crop is planted but before emergence. Rainfall or irrigation is needed to move the herbicide into the zone of weed seed germination before weed emergence for maximum effectiveness. If adequate rainfall for herbicide activation does not occur, a shallow cultivation or rotary hoeing should be done to control weeds that have germinated.

Postemergence (POST). The herbicide is applied to the foliage of the crop and weeds after they have emerged.

Post-directed (or directed). Refers to use of special spray equipment to direct the spray at the weeds but avoid it coming in contact with as much of the crop as possible.

Residual activity. Herbicides that can be taken up by a plant's roots and shoots and injure or kill the plant. All soil-applied herbicides, as well as many postemergence herbicides, have residual activity. Length of residual activity ranges from a few weeks to the entire growing season.

Translocated herbicide. These herbicides move throughout the plant and can cause injury to parts of the plants that do not come in direct contact with the herbicide spray.

Contact herbicide. These herbicides do not move throughout the plant. They cause injury only to those parts of the plant that come in contact with the spray. Spray coverage is more critical for contact than translocated herbicides.

Non-selective herbicide. This refers to herbicides that control a broad spectrum of plant species, including most crops and weeds. These herbicides are generally used with no-tillage production and sprayed prior to planting when control of all plants is required.

Herbicide-resistant Varieties

Some corn hybrids have been genetically enhanced to withstand herbicide applications that previously would have injured or killed corn. Genetically enhanced varieties allow herbicides to be used that provide a broader spectrum of control than would otherwise be available. Herbicide programs for genetically enhanced varieties also reduce the risk of crop injury associated with herbicide programs for conventional varieties.

Clearfield (CL) corn is non-GMO and was developed by tolerance selection to be resistant/tolerant to imidazolinone herbicides (e.g., Pursuit, Scepter). Although these hybrids were initially introduced to help manage herbicide carryover, Pursuit and Pursuit-containing products such as Lightning can be applied directly to the CL corn hybrids as part of the weed management program. These hybrids are harder to find in our area than in the past.

LibertyLink corn is GMO to allow over-the-top applications of Liberty (glufosinate) herbicide. This program should provide broad-spectrum control of annual broadleaves and grasses of low to moderate pressure. Sequential applications or tank mixtures may be required for new weed flushes and peren-

nials. This herbicide is becoming more important for the management of glyphosate-resistant weeds such as horseweed and Palmer amaranth.

Roundup Ready corn was developed using genetic engineering techniques. It has an altered target site not sensitive to glyphosate and allows for postemergence applications of glyphosate directly to corn. Glyphosate-resistant weeds are becoming an increasing issue in Roundup Ready crops.

Enlist corn was developed using GMO to tolerate 2,4-D herbicide. This technology may be first available in our area in 2016.

Herbicide-resistant Weeds in Corn

Herbicide-resistant weeds are common in corn in the Mid-Atlantic region. Populations of herbicide-resistant weeds are selected for by repeated use of the same or similar herbicide over a period of time. Resistance is most likely to occur with residual herbicides having one specific mode of action. Weed species with a very high amount of seed production and a variable genetic pool are more likely to develop resistant populations—for example, common lambsquarters and pigweed species. Resistance management requires using herbicides with multiple modes of action and integrating mechanical (tillage and cultivation) and cultural weed control (cover crops, narrow row spacing, proper crop fertility, etc.) with chemical weed control.

Triazine resistance. Weeds resistant to the Group 5 herbicides in the Mid-Atlantic region include common lambsquarters, Palmer amaranth, redroot and smooth pigweed, horseweed, scattered populations of barnyardgrass, giant foxtail, goosegrass, and suspected populations of common ragweed and velvetleaf. Atrazine and simazine are the primary products that are problematic in corn. A number of POST products can provide good control of triazine-resistant (TR) weeds on corn.

For TR pigweed control, include a Group 15 herbicide for residual control (acetochlor, dimethanamid, metolachlor, or pyroxasulfone) at planting. The Group 15 herbicides will suppress initial TR pigweed, but in most years a postemergence application of a non-triazine herbicide will be needed for full-season control.

For TR lambsquarters, some of the Group 15 herbicides will help suppress emergence (acetochlor and pyroxasulfone), but they are not as active on lambsquarters as they are on pigweed. The Group 3 herbicide pendimethalin can provide good control of TR lambsquarters when applied prior to emergence. In addition, residual control can be obtained with products such as mesotrione or isoxaflutole.

ALS resistance. Weeds resistant to the Group 2 herbicides in the Mid-Atlantic region include several pigweed species, common and giant ragweed, common chickweed, horseweed, Italian ryegrass, giant foxtail, Johnsongrass, and shattercane. The principal issue with most ALS-resistant weeds in corn is lack of efficacy with POST ALS inhibitor products. For example, do not rely on nicosulfuron or rimsulfuron for POST control of resistant foxtail, Johnsongrass, or shattercane. ALS-resistant Johnsongrass and shattercane are a particular concern as only glyphosate and glufosinate are available for POST control in corn. Also, ALS-resistant broadleaves will not be controlled with halosulfuron or other Group 2 herbicides.

Glyphosate resistance. Weeds resistant to the Group 9 herbicide glyphosate in the Mid-Atlantic region include Palmer amaranth and waterhemp, common and giant ragweed, and horseweed. In corn, all of these can be managed with alternative herbicides, including the Group 4 growth regulators, the triazines if they are not Group 5 resistant, and several others, including the Group 27 herbicides such as mesotrione and isoxaflutole.

Control of Roundup Ready Corn: Volunteers or Replanting

There are times when corn has to be removed from a field with the intention of replanting a corn crop. Tillage is one effective method, but it is not appropriate in no-tillage situations. Use of glyphosate is highly effective for non–Roundup Ready corn. But, the challenge is in removing Roundup Ready hybrids. There are limited herbicides to consistently kill small corn plants. Gramoxone SL, Liberty, and Select are three products that have shown the most activity. Research conducted in this region with Gramoxone and Select demonstrated that Select was the most effective for corn 2 to 3 inches tall. For taller corn (4 to 6 inches tall), Gramoxone in combination with a photosystem II–inhibiting herbicide (metribuzin, Lorox, or atrazine) was the most effective. Liberty is a third option, but it will not control LibertyLink hybrids.

Select Max. Up to 6 ounces of Select Max with a nonionic surfactant at 0.25 percent v/v plus AMS at 2.5 to 4 pounds per acre. Do not use a COC or MSO. Wait a minimum of 6 days from time of application until planting corn due to risk of crop injury. (Select Max will also control corn hybrids containing Roundup Ready and LibertyLink stacked traits.)

Gramoxone SL. 3 to 4.5 pints per acre in combination with metribuzin (4 to 6 ounces per acre), Lorox (1 pint per acre), or atrazine (1 pound per acre). These photosystem II inhibitors are not added to control the corn but used to slow down the Gramoxone activity, which helps provide more consistent control.

Liberty 280. 22 to 29 ounces of Liberty has not been as consistent for control corn as Gramoxone.

Table 2-1. Corn herbicides and their restrictions.

Trade Name	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide[1]	Water Quality Advisory[2]	Worker Reentry (Hours)[3]
2,4-D amine 4S	2,4-D amine	4	several	—	—	48
2,4-D LVE 4E	2,4-D LVE	4	several	—	—	12
Aatrex, Atrazine 4L/90DF	atrazine	5	Syngenta, others	yes	yes	12
Accent 75DF/SP	nicosulfuron	2	DuPont	—	—	4
Accent Q 54.5WG	nicosulfuron + safener	2	DuPont	—	—	4
Acuron 3.44SC	s-metolachlor + atrazine + mesotrione + bicyclopyrone	15/5/27/27	Syngenta	yes	yes	24
Acuron Flexi 3.26SC	s-metolachlor + mesotrione + bicyclopyrone	15/27/27	Syngenta	yes	yes	24
Aim 1.9EW/2EC	carfentrazone-ethyl	14	FMC	—	—	12
Anthem 2.15SE/Anthem Maxx 4.3SC	pyroxasulfone + fluthiacet	15, 14	FMC	—	yes	12
Anthem ATZ 4.5SE	pyroxasulfone + fluthiacet + atrazine	15/14/5	FMC	yes	yes	12
Armezon 2.8SC	topramezone	27	BASF	—	—	12
Armezon PRO 5.35EC	topramezone + dimethenamid-P	27/15	BASF	—	yes	12
Autumn Super 51WDG	iodosulfuron + thiencarbazone	2/2	Bayer CropScience	—	—	12
Axiom 68DF	flufenacet + metribuzin	15/5	Bayer CropScience	—	yes	12
Balance Flexx 2SC	isoxaflutole + safener	27	Bayer CropScience	yes	yes	12
Banvel 4S	dicamba	4	Arysta LifeScience	—	yes	24
Basagran 4S	bentazon	6	Arysta LifeScience	—	yes	12
Basis Blend 30DF	rimsulfuron + thifensulfuron	2/2	DuPont	—	—	4
Beacon 75DF	primisulfuron	2	Syngenta	—	—	12
Bicep II Magnum 5.5L/ Cinch ATZ	s-metolachlor + atrazine + safener	15/5	Syngenta/DuPont	yes	yes	24
Bicep Lite II Magnum 6L/ Cinch ATZ Lite	s-metolachlor + atrazine + safener	15/5	Syngenta/DuPont	yes	yes	24
Bullet 4ME	alachlor + atrazine	15/5	Monsanto	yes	yes	12
Cadet 0.91EC	fluthiacet	14	FMC	—	yes	12
Callisto 4SC	mesotrione	27	Syngenta	—	—	12
Callisto Xtra 3.7SC	mesotrione + atrazine	27/5	Syngenta	yes	yes	12
Camix 3.67SC	s-metachlor + mesotrione	15/27	Syngenta	—	—	24
Capreno 3.45SC	tembotrione + thiencarbazone + safener	27/2	Bayer CropScience	—	yes	12
Celebrity Plus 70DF	nicosulfuron + dicamba + diflufenzopyr	2/4/19	BASF	—	yes	12
Clarity 4S	dicamba	4	BASF	—	yes	24
Corvus 2.63SC	isoxaflutole + thiencarbazone + safener	27/2	Bayer CropScience	yes	yes	12
Curtail 2.38L	clopyralid + 2,4-D	4/4	Dow AgroSciences	—	—	48
Defol 5L	sodium chlorate	not classified	Drexel	—	—	12
Degree 3.8ME	acetochlor	15	Monsanto	—	yes	12
Degree Xtra 4.04ME	acetochlor + atrazine	15	Monsanto	yes	yes	12
DiFlexx 4SC	dicamba + safener	4	Bayer CropScience	—	yes	24
DiFlexx Duo 1.53SC	dicamba + tembotrione + safener	4/27	Bayer CropScience	—	yes	24
Distinct 70DF	dicamba + diflufenzopyr	4/19	BASF	—	yes	12
Dual Magnum 7.62E	s-metolachlor	15	Syngenta	—	—	24

Trade Name	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide[1]	Water Quality Advisory[2]	Worker Reentry (Hours)[3]
Dual II Magnum 7.64E/ Cinch	s-metolachlor + safener	15	Syngenta/DuPont	—	—	24
Durango DMA/Duramax 4S	glyphosate	9	Dow AgroSciences	—	—	4
Evik 80W	ametryn	5	Syngenta	—	—	12
Expert 4.88L	atrazine + s-metolachlor + glyphosate	5/15/9	Syngenta	yes	yes	12
Fierce 76WDG	pyroxasulfone + flumioxazin	15/14	Valent	—	yes	12
FulTime NXT 4.04EC	acetochlor + atrazine	15/5	Dow AgroSciences	yes	yes	12
Gramoxone SL 2S	paraquat	22	Syngenta	yes	—	12–24
Guardsman Max 5L/ G-Max Lite 5L	dimethenamid-P + atrazine	15/5	BASF	yes	yes	12
Halex GT 4.39EC	s-metolachlor + mesotrione + glyphosate[4]	15/27/9	Syngenta	—	yes	24
Harmony Extra SG 50WDG	thifensulfuron + tribenuron	2/2	DuPont	—	—	12
Harmony SG 50WDG	thifensulfuron	2	DuPont	—	—	4
Harness 7E	acetochlor + safener	15	Monsanto	—	yes	12
Harness Xtra 5.6/6L	acetochlor + atrazine	15/5	Monsanto	yes	yes	12
Hornet 78.5WDG/Stanza	flumetsulam + clopyralid	2/4	Dow AgroSciences/ FMC	—	yes	48
Impact 2.8SC/Armezon	topramezone	27	AMVAC/BASF	—	—	12
Instigate 46 WDG	rimsulfuron + mesotrione	2/27	DuPont	—	—	12
Intrro 4L	alachlor	15	Monsanto	yes	yes	12
Keystone LA NXT 6SE/ Breakfree NXT Lite	acetochlor + atrazine	15/5	Dow AgroSciences/ DuPont	yes	yes	12
Keystone NXT 5.6SE/ Breakfree NXT ATZ	acetochlor + atrazine	15/5	Dow AgroSciences/ DuPont	yes	yes	12
Lariat 4E	alachlor + atrazine	15/5	Monsanto	yes	yes	12
Laudis 3.5SC	tembotrione	27	Bayer CropScience	—	yes	12
Liberty 280 2.34L[5]/ Rely 280	glufosinate	10	Bayer CropScience	—	—	12
Lightning 70DG[6]	imazethapyr + imazapyr	2/2	BASF	—	yes	12
Lorox 50DF/Linex 4L	linuron	5	Nova Source	—	—	24
Lumax EZ 3.67 SC/ Lexar EZ 3.7SC	s-metolachlor + mesotrione + atrazine	15/27/5	Syngenta	yes	yes	24
Maestro 2E/ Moxy (Buctril)	bromoxynil	6	Nufarm/WinField	—	—	24
Marksman 3.2L	dicamba + atrazine	4/5	BASF	yes	yes	48
Metribuzin 75DF/4L	metribuzin	5	various	—	yes	12
NorthStar 47.4WG	primisulfuron + dicamba	2/4	Syngenta	—	—	12
Option 35WDG	foramsulfuron	2	Bayer CropScience	—	—	12
Outlook 6E	dimethenamid-P	15	BASF	—	yes	12
Panoflex 50WDG	thifensulfuron + tribenuron	2/2	DuPont	—	—	12
Peak 57WG	prosulfuron	2	Syngenta	—	yes	12
Permit 75WG	halosulfuron	2	Gowan	—	—	12
Permit Plus 74WDG	halosulfuron + thifensulfuron	2/2	Gowan	—	—	12
Prequel 45WG	isoxaflutole + rimsulfuron	27/2	DuPont	yes	yes	12
Princep, Simazine, 4L/90DF	simazine	5	Syngenta, others	—	yes	12
Prowl 3.3E	pendimethalin	3	BASF	—	—	24
Prowl H2O 3.8CS	pendimethalin	3	BASF	—	—	24

(continued)

Trade Name	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide[1]	Water Quality Advisory[2]	Worker Reentry (Hours)[3]
Pursuit 2S/70DG[6]	imazethapyr	2	BASF	—	—	12
Pursuit Plus 3E[6]	imazethapyr + pendimethalin	2/3	BASF	—	—	12
Python 80WDG/Accolade	flumetsulam	2	Dow AgroSciences/ FMC	—	yes	12
Ready Master ATZ 4L	glyphosate + atrazine	9/5	Monsanto	yes	yes	12
Realm Q 39WDG	rimsulfuron + mesotrione + safener	2/27	DuPont	—	yes	12
Resicore 3.29SE	acetochlor + mesotrione + clopyralid + safener	15/27/4	Dow AgroSciences	—	yes	12
Resolve 25DF	rimsulfuron	2	DuPont	—	—	4
Resolve Q 22.4WDG	rimsulfuron + thifensulfuron + safener	2/2	DuPont	—	—	4
Resource 0.86E	flumiclorac	14	Valent	—	—	12
Revulin Q 51.2WDG	nicosulfuron + mesotrione	2/27	DuPont	—	—	12
Roundup WeatherMAX 4.5S/PowerMAX 4.5S	glyphosate	9	Monsanto	—	—	4
Sharpen 2.85SC	saflufenacil	14	BASF	—	yes	12
Solstice 4SC	fluthiacet + mesotrione	14/27	FMC	—	—	12
Spirit 57WG	primisulfuron + prosulfuron	2/2	Syngenta	—	yes	12
Starane 1.5L	fluroxypyr	4	Dow AgroSciences	—	—	12
Status 56WG	dicamba + diflufenzopyr + isoxadifen	4/19	BASF	—	yes	12
Steadfast 75DF	nicosulfuron + rimsulfuron	2/2	DuPont	—	—	4
Steadfast Q 37.7WG	nicosulfuron + rimsulfuron + safener	2/2	DuPont	—	—	4
Stinger 3S	clopyralid	4	Dow AgroSciences	—	yes	12
Stout 72.5WDG	nicosulfuron + thifensulfuron	2/2	DuPont	—	—	4
SureStart II 4.25SE/ TripleFLEX II	acetochlor + flumetsulam + clopyralid	15/2/4	Dow AgroSciences/ Monsanto	—	yes	12
Surpass NXT 7E/ Breakfree NXT	acetochlor + safener	15	Dow AgroSciences/ DuPont	—	yes	12
TopNotch 3.2ME	acetochlor + safener	15	Dow AgroSciences	—	yes	12
Touchdown HiTech 5S	glyphosate	9	Syngenta	—	—	12
Touchdown Total 4.17S	glyphosate	9	Syngenta	—	—	12
ValorSX 51WDG	flumioxazin	14	Valent	—	—	12
Verdict 5.57EC	saflufenacil + dimethenamid-P	14/15	BASF	no	yes	12
Warrant 3CS	acetochlor	15	Monsanto	—	yes	12
Yukon 67.5WDG	halosulfuron + dicamba	2/4	Gowan	—	—	12
Zemax 3.67SC	s-metolachlor + mesotrione	15/27	Syngenta	—	yes	24
Zidua 85WDG	pyroxasulfone	15	BASF	—	yes	12

[1] Only licensed applicators may purchase and apply restricted-use pesticides. To become licensed, contact your state Department of Agriculture.

[2] These herbicides have properties that may result in groundwater or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for dissolved runoff and/or runoff erosion. See the herbicide label for specific restrictions.

[3] If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

[4] For use on glyphosate-resistant corn hybrids only (Roundup Ready).

[5] For use on glufosinate-resistant corn hybrids only (LibertyLink).

[6] For use only on IMI (IR/IT) or Clearfield (CL) corn hybrids.

Table 2-2. Corn herbicide prepackaged mixes, or co-packs, and equivalents.

Trade Name	Components (ai/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai)	An Equivalent Tank Mixture of
Acuron 3.44SC	2.14 lb s-metolachlor	15	2.5 qt	1.34 lb s-metolachlor	1.4 pt Dual II Magnum 7.64E
	0.24 lb mesotrione	27		0.15 lb mesotrione	4.8 fl oz Callisto 4SC
	0.06 lb bicyclopyrone	27		0.038 lb bicyclopyrone	0.038 lb bicyclopyrone
	1 lb atrazine	5		0.625 lb atrazine	0.625 qt atrazine 4L
Acuron Flexi 3.26SC	2.86 lb s-metolachlor	15	2 qt	1.43 lb s-metolachlor	1.5 pt Dual II Magnum 7.64E
	0.32 lb mesotrione	27		0.16 lb mesotrione	5.12 fl oz Callisto 4SC
	0.08 lb bicyclopyrone	27		0.04 lb bicyclopyrone	0.04 lb bicyclopyrone
Anthem ATZ 4.5SE	4 lb atrazine	5	2 pt	1 lb atrazine	2 pt atrazine 4L
	0.485 lb pyroxasulfone	15		0.12 lb pyroxasulfone	2.25 oz Zidua
	0.014 lb fluthiacet	14		0.004 lb fluthiacet	0.6 fl oz Cadet
Anthem Maxx 4.3SC	4.174 lb pyroxasulfone	15	4 fl oz	0.133 lb pyroxasulfone	2.5 oz Zidua 85DF
	0.126 lb fluthiacet	14		0.004 lb fluthiacet	0.56 oz Cadet 0.91L
Armezon PRO 5.35EC	0.1 lb topramezon	27	24 fl oz	0.017 lb topramezon	0.76 fl oz Armezon
	5.25 lb dimethenamid-P	15		0.84 lb dimethenamid-P	18 fl oz Outlook
Axiom 68DF	0.544 lb flufenacet	15	16 oz	0.544 lb flufenacet	17 oz Define 4SC
	0.136 lb metribuzin	5		0.136 lb metribuzin	2.9 oz Metribuzin 75DF
Basis Blend 30DF	0.20 lb rimsulfuron	2	0.825 oz	0.01 lb rimsulfuron	0.64 oz Resolve 25DF
	0.10 lb thifensulfuron	2		0.005 lb thifensulfuron	0.16 oz Harmony SG 50DF
Bicep II Magnum 5.5L/ Cinch ATZ	2.4 lb s-metolachlor	15	2.1 qt	1.26 lb s-metolachlor	1.33 pt Dual II Magnum 7.64E
	3.1 lb atrazine	5		1.63 lb atrazine	1.63 qt atrazine 4L
Bicep Lite II Magnum 6L/Cinch ATZ Lite	3.33 lb s-metolachlor	15	1.3 qt	1.08 lb s-metolachlor	1.13 pt Dual II Magnum 7.64E
	2.67 lb atrazine	5		0.87 lb atrazine	0.87 qt atrazine 4L
Bullet 4ME	2.5 lb alachlor	15	3 qt	1.875 lb alachlor	1.9 qt Intrro 4L
	1.5 lb atrazine	5		1.125 lb atrazine	1.13 qt atrazine 4L
Callisto GT	0.38 lb mesotrione	27	2 pt	0.095 lb mesotrione	3.04 fl oz Callisto
	3.8 lb glyphosate	9		0.95 lb glyphosate	1.8 pt Touchdown
Callisto Xtra 3.7SC	0.5 lb mesotrione	27	24 fl oz	0.09 lb mesotrione	3 fl oz Callisto
	3.2 lb atrazine	5		0.6 lb atrazine	1.2 pt atrazine 4L
Capreno 3.45SC	2.88 lb tembotrione	27	3 fl oz	0.068 lb tembotrione	2.5 fl oz Laudis 3.5SC
	0.57 lb thiencarbazone	2		0.013 lb ai thiencarbazone	0.21 oz ai thiencarbazone
Celebrity Plus 70DF	0.424 lb dicamba	4	4.7 oz	0.12 lb dicamba	3.4 oz Status 56WDG
	0.17 lb diflufenzopyr	19		0.05 lb diflufenzopyr	0.05 lb diflufenzopyr
	0.106 lb nicosulfuron	2		0.031 lb nicosulfuron	0.67 oz Accent 75DF
Corvus 2.63SC	1.88 lb isoxaflutole	27	5.6 fl oz	0.083 lb isoxaflutole	5.3 fl oz Balance Flexx 2SC
	0.75 lb thiencarbazone	2		0.033 lb thiencarbazone	0.52 oz ai thiencarbazone
Curtail 2.38L	0.38 lb clopyralid	4	2 pt	0.095 lb clopyralid	0.25 pt Stinger 3S
	2 lb 2,4-D	4		0.5 lb 2,4D	1.0 pt 2,4-D 4S
Degree Xtra 4.04ME	2.7 lb acetochlor	15	3 qt	2.03 lb acetochlor	4.3 pt Degree 3.8ME
	1.34 lb atrazine	5		1 lb atrazine	1 qt atrazine 4L
DiFlexx Duo 1.53SC	1.26 lb dicamba	4	32 fl oz	0.32 lb dicamba	10.25 oz DiFlexx 4SC
	0.27 lb tembotrione	27		0.068 lb tembotrione	2.5 fl oz Laudis 3.5SC
Expert 4.88L	1.74 lb s-metolachlor	15	3 qt	1.3 lb s-metolachlor	1.4 pt Dual II Magnum 7.64E
	2.14 lb atrazine	5		1.6 lb atrazine	1.6 qt atrazine 4L
	0.75 lb ae glyphosate	9		0.75 lb glyphosate	1.5 pt glyphosate 4S

(continued)

Trade Name	Components (ai/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai)	An Equivalent Tank Mixture of
Fierce 76WDG	0.335 lb flumioxazin	14	3 oz	0.063 lb flumioxazin	2 oz Valor SX 51WG
	0.425 lb pyroxasulfone	15		0.08 lb pyroxasulfone	1.5 oz Zidua 85WG
FulTime NXT 4.04CS	2.7 lb acetochlor	15	3 qt	2 lb acetochlor	2.5 qt TopNotch 3.2ME
	1.34 lb atrazine	5		1 lb atrazine	1 qt atrazine 4L
Guardsman Max 5L	1.7 lb dimethenamid-P	15	3.5 pt	0.74 lb dimethenamid	15.9 fl oz Outlook 6E
	3.3 lb atrazine	5		1.44 lb atrazine	1.44 qt atrazine 4L
Halex GT 4.39EC	2.09 lb s-metolachlor	15	3.6 pt	0.94 lb s-metolachlor	1 pt Dual Magnum
	0.209 lb mesotrione	27		0.09 lb mesotrione	3 fl oz Callisto
	2.09 lb glyphosate	9		0.94 lb glyphosate (ae)	24 fl oz Touchdown HiTech
Harness Xtra 6.0L	4.3 lb acetochlor	15	2 qt	2.15 lb acetochlor	2.46 pt Harness 7E
	1.7 lb atrazine	5		0.85 lb atrazine	0.85 qt atrazine 4L
Harness Xtra 5.6L	3.1 lb acetochlor	15	2.5 qt	1.94 lb acetochlor	2.21 pt Harness 7E
	2.5 lb atrazine	5		1.56 lb atrazine	1.56 qt atrazine 4L
Hornet 78.5 WDG/ Stanza	0.185 lb flumetsulam	2	5 oz	0.058 lb flumetsulam	1.15 oz Python 80WDG
	0.5 lb clopyralid	4		0.195 lb clopyralid	6.7 fl oz Stinger 3S
Instigate 46WDG	0.0417 lb rimsulfuron	2	6 oz	0.016 lb rimsulfuron	1 oz Resolve 25WG
	0.417 lb mesotrione	27		0.16 lb mesotrione	5 fl oz Callisto 4SC
Keystone LA NXT 6SE or Breakfree NXT Lite	4.3 lb acetochlor	15	2.3 qt	2.47 lb acetochlor	2.7 pt Surpass NXT 7EC
	1.5 lb atrazine	5		1.43 lb atrazine	1.95 pt atrazine 4L
Keystone NXT 5.6SE or Breakfree NXT ATZ	3.1 lb acetochlor	15	2.5 qt	1.94 lb acetochlor	2.22 pt Surpass/Breakfree NXT
	2.5 lb atrazine	5		1.57 lb atrazine	3.15 pt atrazine 4L
Lariat 4L	2.5 lb alachlor	15	4 qt	2.5 lb alachlor	2.5 qt Lasso 4E
	1.5 lb atrazine	5		1.5 lb atrazine	1.5 qt atrazine 4L
Lexar EZ 3.7SC	1.74 lb s-metolachlor	15	3 qt	1.3 lb s-metolachlor	1.36 pt Dual II Magnum 7.64E
	0.224 lb mesotrione	27		0.168 lb mesotrione	5.36 oz Callisto 4SC
	1.74 lb atrazine	5		1.3 lb atrazine	1.3 qt atrazine 4L
Lumax EZ 3.67SC	2.49 lb s-metolachlor	15	2.7 qt	1.67 lb s-metolachlor	1.75 pt Dual II Magnum 7.64E
	0.249 lb mesotrione	27		0.168 lb mesotrione	5.36 oz Callisto 4SC
	0.935 lb atrazine	5		0.625 lb atrazine	0.625 qt atrazine 4L
Marksman 3.2L	1.1 lb dicamba	4	3.5 pt	0.48 lb dicamba	0.96 pt Banvel 4S/Clarity 4S
	2.1 lb atrazine	5		0.92 lb atrazine	1.84 pt atrazine 4L
NorthStar 47.4WDG	0.075 lb primisulfuron	2	5 oz	0.023 lb primisulfuron	0.5 oz Beacon 75WG
	0.399 lb dicamba	4		0.138 lb dicamba	4 oz Banvel 4S/Clarity 4S
Permit Plus 74WDG	0.662 lb halosulfuron	2	0.75 oz	0.031 lb halosulfuron	0.67 oz Permit 75WG
	0.078 lb thifensulfuron	2		0.004 lb thifensulfuron	0.12 oz Harmony SG
Prequel 45WG	0.15 lb rimsulfuron	2	1.66 oz	0.016 lb rimsulfuron	1 oz Resolve 25 WG
	0.30 lb isoxaflutole	27		0.04 lb isoxaflutole	0.66 oz isoxaflutole 75WG
Realm Q 38.75WDG	0.075 lb rimsulfuron	2	4 oz	0.019 lb rimsulfuron	1.2 oz Resolve 25WG
	0.313 lb mesotrione	27		0.078 lb mesotrione	2.5 fl oz Callisto 4SC
Resicore 3.29SE	2.8 lb acetochlor	15	2.5 qt	1.75 lb acetochlor	2 pt Surpass NXT 7E
	0.3 lb mesotrione	27		0.18 lb mesotrione	5.76 fl oz Callisto 4SC
	0.19 lb clopyralid	4		0.119 lb clopyralid	0.3 pt Stinger 3S
Resolve Q 22.4WDG	0.184 lb rimsulfuron	2	1.25 oz	0.014 lb rimsulfuron	0.9 oz Resolve SG
	0.04 lb thifensulfuron	2		0.003 lb thifensulfuron	0.1 oz Harmony SG
Revulin Q 51.2WDG	0.144 lb nicosulfuron	2	4 oz	0.036 lb nicosulfuron	1.1 oz Accent Q WG
	0.368 lb mesotrione	27		0.094 lb mesotrione	3 fl oz Callisto 4SC

Trade Name	Components (ai/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai)	An Equivalent Tank Mixture of
Solstice 4SC	0.216 lb fluthiacet	15	3 fl oz	0.0051 lb fluthiacet	0.7 fl oz Cadet 0.91EC
	3.784 lb mesotrione	27		0.089 lb mesotrione	2.85 fl oz Callisto 4SC
Spirit 57WG	0.142 lb prosulfuron	2	1 oz	0.009 lb prosulfuron	0.25 oz Peak 57WG
	0.428 lb primisulfuron	2		0.027 lb primisulfuron	0.58 oz Beacon 75WG
Steadfast 75DF	0.5 lb nicosulfuron	2	0.75 oz	0.023 lb nicosulfuron	0.5 oz Accent 75DF
	0.25 lb rimsulfuron	2		0.012 lb rimsulfuron	0.19 oz rimsulfuron
Steadfast Q 37.7WG	0.125 lb rimsulfuron	2	1.5 oz	0.012 lb rimsulfuron	0.76 oz Resolve 25WG
	0.252 lb nicosulfuron	2		0.02 lb nicosulfuron	0.7 oz Accent Q 54.5WG
Stout 72.5WDG	0.675 lb nicosulfuron	2	0.75 oz	0.031 lb nicosulfuron	0.67 oz Accent
	0.05 lb thifensulfuron	2		0.002 lb thifensulfuron	0.05 oz Harmony GT 75DF
SureStart II 4.25SE or TripleFLEX II	3.75 lb acetochlor	15	2 pt	0.94 lb acetochlor	1.1 pt Surpass NXT 7E
	0.29 lb clopyralid	4		0.075 lb clopyralid	3.2 fl oz Stinger 3S
	0.12 lb flumetsulam	2		0.03 lb flumetsulam	0.6 oz Python WDG
Verdict 5.57EC	5 lb dimethenamid-P	15	13 fl oz	0.5 lb dimethenamid-P	11 fl oz Outlook 6EC
	0.57 lb saflufenacil	14		0.058 lb saflufenacil	2.6 fl oz Sharpen 2.85L
Yukon 67.5WDG	0.125 lb halosulfuron	2	4 oz	0.03 lb halosulfuron	0.67 oz Permit 75WG
	0.55 lb dicamba	4		0.125 lb dicamba	4 fl oz Clarity 4S
Zemax 3.67SC	3.34 lb s-metolachlor	15	2 qt	1.67 lb s-metolachlor	1.75 pt Dual II Magnum 7.64E
	0.33 lb mesotrione	27		0.165 lb mesotrione	5.36 fl oz Callisto 4SC

Table 2-3. Relative effectiveness of burndown treatments for control of weeds in no-till corn.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating:
10 = 95–100% | 9 = 85–95% | 6 = 55–65% | 8 = 75–85%
7 = 65–75 | N = less than 55% or no control | — = not applicable or no local data available

Herbicide[1]	Site of Action Number	Brome, Downy	Burdock, Common	Chickweed	Dandelion	Dock, Curly	Dogbane, Hemp; Dewberry; Milkweed; etc.	Evening Primrose, Cutleaf	Fleabanes, Annual	Foxtail spp.	Garlic, Wild	Geranium, Carolina	Groundsel, Common[2]	Henbit/Deadnettle	Horseweed/Marestail[3]	Lambsquarters	Mustard spp.	Quackgrass Sod	Ragweed, Common	Smartweed	Thistle, Canada	Violet, Field/Pansy
2,4-D (spring-applied) (1 qt)	4	N	7	6	8	7	N	9	6	N	7	—	6	N	8+	9	9	N	9	7	8	6
2,4-D + dicamba (spring-applied)	4/4	N	8	8	8	7+	6	9	8	N	7	7+	7	6	9	9	9	N	9	9	8+	7
Atrazine	5	7	6	8	N	6	N	7	7+	7	N	9	9	8	8	N	8	8	9	9	6	8
Atrazine + 2,4-D	5/4	7	7+	8	9	7	N	9	7+	7	7	9	9	8	9	9	9	7	9	9	8+	8
Autumn Super + 2,4-D (fall-applied)	2/4	N	9	9[4]	9	7	N	9	8	N	—	—	8	9	9	—	9	N	—	—	6	6
Balance/Corvus/Prequel	27/(2)	N	7	8	6	N	N	—	7	6	—	—	8	7+	7	7	8	N	7	6	6	6
Glyphosate (fall-applied)[5]	9	9	8+	9	9	7	8+	7	8	—	9	8	9	8	8+[6]	—	9	9	—	—	9	7
Glyphosate (spring-applied)[5]	9	9	7	9	6	6	7	6	7+	9+	8	7	9	6	8	9	9	8	9	7	8	6
Glyphosate + 2,4-D or dicamba (fall-applied)	9/4	9	9+	9	9	7	9	9+	9[6]	—	9	8	9	8+[6]	9+[6]	—	9[6]	9	—	—	9+	7
Glyphosate + 2,4-D or dicamba (spring-applied)	9/4	9	7+	9	8	7	7+	9	8	9+	8	7	9	8+	9	9	9	9	9	8+	8+	8
Glyphosate + atrazine	9/5	9	7+	9	7	6	N	6	7+	9	8	7	9	9	9	9	9	9	9	9	8	8
Glyphosate + metribuzin	9/5	9	7	9	6	6	7	6	8	9	8	7	9	8+	8+	9	9	9	9	9	8	8
Gramoxone	22	7	N	8+	N	N	6	7	6	9	6	8	8+	7	7	8	8	6	8	7	6	8
Gramoxone + 2,4-D or dicamba[5]	22/4	7	7	9	7	7	6	9	7	9	7	8	8+	8	8+	9	9	6	9	8+	8	8+
Gramoxone + atrazine	22/5	8	6	9	N	6	6	7	7	9	6	8	8+	9	8+	8	8+	8	9	9	7	8
Gramoxone + metribuzin	22/5	7	6	9	N	N	6	7	6	9	6	8	8+	8	8	8	8+	6	9	9	6	8
Harmony Extra	2/2	N	6	9	6	8	6	—	N	N	8+	—	9	8	7+	9	9	N	6	9	8	N
Hornet/Stanza (spring-applied)	2/4	N	8	N	6	7	N	—	9	N	N	—	8+	N	8+	7	N	N	9	7	8	N
Liberty	10	6	6	8	6	—	N	—	8	8	—	—	7	6	8	8	8	6	8	8	6	N
Lumax	15/5/27	N	8	9	8	8	N	—	8	6	N	8+	9	8	8	9	8	N	8+	9	7	7
Sharpen	14	N	N	6	7	—	N	N	7+	N	—	—	8	6	8	8	8	N	8	8	6	N
Sharpen + glyphosate	14/9	9	7	9	8	6	7	6	8	9+	—	—	9	6	9	9	9	8	9	9	8	6
Valor SX/Fierce	14/(15)	8[7]	N	9	7	N	N	6	N	N	—	—	7	7	6	9	8	N	7	7	N	N

1 See Table 1-4 for additional formulations or trade names containing some of these same active ingredients.
2 Certain populations of common groundsel in the northeastern U.S. are resistant to triazine herbicides. Herbicide programs that contain bromoxynil (Buctril, Maestro, Moxy) or clopyralid (Stinger) provide good control of groundsel in crop.
3 Roundup, Touchdown, and other glyphosate products are not effective on glyphosate-resistant horseweed biotypes.
4 Will not control ALS-resistant common chickweed.
5 Activity is reduced if applied in certain tank-mixes; glyphosate with photosynthesis inhibitors such as triazine herbicides; 2,4-D and Clarity with Gramoxone. May still be tank-mixed for convenience, but burndown is improved if applied separately.
6 Based on control in early spring. Emergence of seedlings in the spring will reduce effectiveness.
7 Valor provides control of germinating dandelion seedling; however, it is weak on dandelion when applied POST.

Table 2-4. Effectiveness of herbicides for control of common cash or cover crops in spring before corn establishment.

Control ratings:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55%

Herbicide	Rate (lb/acre)[1]	Alfalfa[2]	Bluegrass/Timothy[2]	Bromegrass/ Orchardgrass/Fescue[2]	Clover, Crimson	Clover, Red[2]	Clover, White[2]	Mustards/Radish/ Rapeseed	Ryegrass, Annual	Rye, Cereal	Wheat, Winter	Vetch, Hairy
2,4-D ester	0.5	7+	N	N	7	8	6	8	N	N	N	9
	1	8	N	N	8	9	7	9	N	N	N	10
2,4-D ester + dicamba	0.5 + 0.5	9+	N	N	8+	9	9	8	N	N	N	10
Atrazine	1	N	6	6	6	6	6	6	6	6	6	7
	2	6	7	7	7	7	7	7	7	7	7	8
Clopyralid	0.25	8+	N	N	8	9	9	N	N	N	N	9
Dicamba	0.5	9	N	N	8	9	9	7	N	N	N	9
Glyphosate	0.75	6	9	8	8	7	6	7+	8	9	9	7
	1.5	7	9+	8+	8+	7+	7	8+	9	9	9	8
Glyphosate + 2,4-D ester or dicamba	0.75 + 0.5	8+	9	8	9	8	8	9	8	9	9	10
		9	9	8	9	9	9	8	8	9	9	10
Mesotrione + atrazine	0.168 + 1	7	6	6	8	7+	7+	8	6	6	6	7
Paraquat	0.5	N	7	6	8	7	7	8	6	7	8	7
	0.75	N	7+	7	9	8	7	8+	6	8	8+	8
Paraquat+ atrazine or metribuzin	0.5 + 1 or 0.25	7	9	8	10	8+	7	9	7	8+	8+	9
Paraquat + 2,4-D or dicamba	0.75 + 0.5	7+	7	6	9	8+	8	9	6	8	8+	10

[1] 0.75 lb glyphosate = 32 fl oz of a 41% glyphosate; 0.5 lb paraquat = 2 pt Gramoxone SL. Clopyralid is a component of Stinger, Hornet, and SureStart/TripleFLEX.

[2] Application in the fall can improve control with some herbicides.

Table 2-5. Comments on burndown herbicides for no-till corn.

See Table 2-3 for relative effectiveness of these treatments. May need to combine with residual treatment or postemergence program (Tables 2-8 and 2-13) for complete no-till weed control program.

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D LVE 4E	2,4-D ester	4	1–2 qt	1–2

- Apply 7–14 days before planting or 3–5 days after planting for greater crop safety.
- Plant corn at least 1.5 inches deep.
- Add Clarity (dicamba) to increase efficacy on legume sods.
- This product is poor on chickweed, henbit, and red deadnettle, and ineffective on all grasses.

2,4-D LVE 4E +	2,4-D ester +	4	0.5–1 pt	0.25–0.5
Clarity 4S/Banvel 4S	dicamba	4	0.5–1 pt	0.25–0.5

- Apply 7–14 days before planting or 3–5 days after planting for greater crop safety.
- Plant corn at least 1.5 inches deep.
- A combination of 2,4-D + Clarity/Banvel controls most annual broadleaf weeds and alfalfa. Emerged perennial broadleaves are partially controlled. This combination is fair on chickweed, henbit, and red deadnettle, and ineffective on all grasses.

Atrazine 90DF	atrazine	5	1.8–2.2 lb	1.6–2

- Apply 1.6–2 qt atrazine 4L prior to planting.
- Controls small emerged annual broadleaves and some grasses.
- Can be applied in liquid nitrogen as the carrier to improve burndown characteristics.

Atrazine Use Restrictions

Preplant or Preemergence
On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):
- Fields where more than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.
- Fields where less than 30%of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb of active ingredient per acre as a broadcast spray.
- Apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.

Postemergence
- If no atrazine was applied prior to crop emergence, use a maximum rate of 2 lb of active ingredient per acre.
- If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb of active ingredient per acre.

Safety Precautions for Using Atrazine
- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.
- *Restricted-use pesticide and water quality advisory.*

Atrazine 4L +	atrazine +	5	1.8–2.2 lb	1.6–2
2,4-D LVE	2,4-D ester	4	1 pt	0.5

- Adding 2,4-D improves control of broadleaf weeds.
- See the atrazine and 2,4-D comments.
- See atrazine use restrictions above.
- *Restricted-use pesticide and environmental hazard warning.*

Autumn Super 51WDG	iodosulfuron	2	0.3–0.5 oz	0.15–0.26 oz

- Autumn Super may be applied after fall harvest and up to 30 days prior to corn planting.
- Do not apply to frozen ground. Apply to actively growing weeds.
- Autumn Super will provide short-term residual control of small seeded broadleaves but will not provide season-long PRE control of annual grasses and broadleaf weeds.
- Apply Autumn Super at 0.3–0.5 oz/A plus necessary adjuvants.
- For enhanced burndown activity, tank-mix with 2,4-D, glyphosate, paraquat, simazine, or metribuzin.
- Be cautious of crop rotation restrictions.

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Expert 4.88L	s-metolachlor +	15	2.5–3.75 qt	3.05–4.58
	atrazine +	5		
	glyphosate	9		

- Expert is a premix of metolachlor (Dual II Magnum), atrazine, and glyphosate.
- The 3 qt rate contains 1.3 lb s-metolachlor, 1.6 lb atrazine, and 0.75 lb ae glyphosate.
- Expert can be used as a burndown/PRE program in corn or as an early POST application in Roundup Ready hybrids.
- See Expert label for additional information.
- *Restricted-use pesticide and water quality advisory.*

Glyphosate[2]	glyphosate	9	See Table 1-2	

- Fall applications of glyphosate are better than spring applications for control of orchardgrass sods and quackgrass.
- If controlling orchardgrass sod in spring, it is best to spray when sod is 6 to 10 inches tall.
- Use at least 1.13 lb ae glyphosate or higher, especially if tank-mixing with preresidual herbicide and nitrogen carriers.
- Spring applications may be used for control of annual weeds.
- Using low-volume sprays may allow for a reduced rate.
- For control of small annual weeds or volunteer small grains, glyphosate may be used at reduced rates.
- Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers, but it may be less effective on certain annual grasses and perennials.
- Do not use glyphosate with suspension-type liquid fertilizers.

Glyphosate +	glyphosate +	9	See Table 1-2	0.5
2,4-D LVE or	2,4-D ester or	4	1 pt	
Clarity 4S/Banvel 4S	dicamba	4	0.5 pt	0.25

- Adding 2,4-D or Clarity/Banvel improves control of large annual broadleaf weeds, dandelion, and alfalfa.
- See previous glyphosate, 2,4-D, or Clarity/Banvel comments.

Glyphosate +	glyphosate +	9	See Table 1-2	
Atrazine 90DF	atrazine	5	1.1–2.2 lb	1–2

- When tank-mixing glyphosate with residual herbicides, apply in 10–20 gal water/A or 10–60 gal liquid fertilizer nitrogen/A.
- Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers.
- Do not use glyphosate with suspension-type liquid fertilizers.
- Glyphosate activity may be reduced when tank-mixing with residual herbicides that have contact activity on emerged weeds.
- See atrazine use restrictions above.
- *Restricted-use pesticide and water quality advisory.*

Gramoxone SL 2S	paraquat	22	2–4 pt	0.5–1

- Apply in 20–60 gal/A for control of emerged annual weeds.
- Add 16–32 oz non-ionic surfactant/100 gal of spray.
- Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier.
- Use appropriate precautions when handling paraquat to minimize exposure to the herbicide.
- Do not use flood jet tips larger than size 20 or spacing greater than 40 inches.
- *Gramoxone is a restricted-use pesticide.*

Gramoxone SL 2S +	paraquat +	22	2–4 pt	0.5–1
2,4-D LVE or	2,4-D ester or	4	1 pt	0.5
Clarity 4S/Banvel 4S	dicamba	4	0.5 pt	0.25

- See comments under Gramoxone.
- Adding 2,4-D or Clarity/Banvel improves control of large annual broadleaf weeds and alfalfa. Alfalfa control is improved by applying 2,4-D or Clarity/Banvel separately at least 1 day ahead of paraquat.
- *Gramoxone is a restricted-use pesticide.*

Gramoxone SL 2S +	paraquat +	22	2–4 pt	0.5–1
Atrazine 90DF	atrazine	5	1.1–2.2 lb	1–2

- Adding atrazine to paraquat can improve control of fescue and certain other perennial sods.
- See atrazine use restrictions at the beginning of this table.
- *Restricted-use pesticide and water quality advisory.*

Harmony Extra SG 50DF	thifensulfuron +	2	0.45–0.9 oz	0.014–0.028
	tribenuron	2		

Comments
- Adding Harmony Extra to glyphosate or 2,4-D can improve control of certain winter annual broadleaves and perennials.
- Must be applied in fall or early spring at least 14 days ahead of planting.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Hornet 78.5WDG/Stanza	flumetsulam + clopyralid	2 4	3–5 oz	0.13–0.21 oz
• See Table 2-8 for comments about Hornet.				
Metribuzin 75DF/4L	metribuzin	5	2–4 oz DF	0.094–0.19
• Include metribuzin as part of an herbicide program for burndown of existing vegetation prior to crop emergence. • Metribuzin may be tank-mixed with 2,4-D LVE, Gramoxone, or glyphosate. • Use a maximum of 4 oz DF if applying less than 10 days before planting or on soils with less than 2% organic matter. • Do not use on coarse soils with less than 1.5% organic matter or on soils having pH 7.0 or greater. • Plant corn at least 1.5 inches deep to avoid injury. • *Water quality advisory.*				
Sharpen 2.85SC	saflufenacil	14	1–3 fl oz	0.022–0.067
• Sharpen may be applied as a preplant/burndown treatment from 14 days early preplant through preemergence timings. • Apply Sharpen in a typical glyphosate burndown herbicide program to enhance the speed of burndown and increase weed spectrum, including glyphosate-resistant horseweed. • Depending on the rate, Sharpen can provide some short-term residual control of certain annual broadleaf weeds. Include necessary additives MSO or COC plus nitrogen solution or AMS to the spray mixture. • Do not apply to emerged corn or if OP or carbamate insecticides are being used. Sharpen is a Group 14 herbicide, and due to concerns for long-term viability of this herbicide mode of action, extension specialists in the Mid-Atlantic region recommend not using it every year. • This mode of action has greater utility in soybeans than corn, especially for control of glyphosate-resistant horseweed (marestail). As such, we suggest that Sharpen and other saflufenacil-containing products (e.g., Verdict, Optill) be used in soybean first and only in alternate years. • The use of Sharpen in continuous corn should also be limited to every other year (alternating years with HPPD-containing herbicide [Group 27]) and avoided if Sharpen is used in soybean in a corn-soybean rotation.				
Valor SX 51WDG	flumioxazin	14	1–2 oz	0.51–1.02 oz
• Valor may be included in a typical no-till burndown herbicide program to enhance the speed of burndown and increase weed spectrum. • Corn can be planted 7 days after application if there is at least 25% soil residue cover and ¼ inch of rainfall. • On coarse-textured soils: stunting is often observed with Valor; corn must be planted between 14 and 30 days after application; and only use where last year's crop residue has not been incorporated into the soil. • Fierce 76WDG contains the active ingredients in Valor and Zidua and can be used in burndown programs; see Table 2-8 for additional details. • Valor is a Group 14 herbicide, and due to concerns for long-term viability of this herbicide mode of action, extension specialists in the Mid-Atlantic region recommend not using it every year. This mode of action has greater utility in soybeans than corn, especially for control of glyphosate-resistant horseweed (marestail). As such, we suggest that Valor and other flumioxazin-containing products (e.g., Fierce, Valor XLT, Envive) be used in soybean first and only in alternate years. • The use of Valor in continuous corn should also be limited to every other year (alternating years with HPPD-containing herbicide [Group 27]) and avoided if Valor is used in soybean in a corn-soybean rotation.				

[1] See Table 2-1 for additional formulations or trade names containing some of these same active ingredients.

[2] Refer to current product label for active ingredient concentration and application rate (e.g., 1 qt/A glyphosate 4S = 22 fl oz/A Roundup WeatherMAX).

Table 2-6. Water solubility and longevity of soil-applied herbicides.

Solubility (parts per million; ppm) refers to how many microliters of the herbicide will dissolve in 1 liter of water. The less soluble the herbicide, the more moisture (rain or irrigation) is needed to activate the herbicide and move it into the root zone. Solubility is used as a guideline for rainfall or irrigation required within a short time after application. Moisture needed also depends on the soil moisture at time of application.

Relative moisture levels to move herbicide into the soil to achieve optimum level of control:

Relative Moisture to Activate	ppm	Estimated Water to Activate*
Low	>500 ppm (very soluble)	0.33 inch
Medium	250–500 ppm	0.33–0.5 inch
High	100–250 ppm	0.5–0.75 inch
Very high	<100 ppm	>0.75 inch

*More water (additional irrigation) may be necessary if soil is dry at time of application, for soils with higher clay content, or if high plant residues are present.

Relative duration of residual control is for comparison only based on herbicide half-life (length of time it takes for half the herbicide to break down). Herbicide breakdown results from chemical and/or microbial activity. Since the speed of breakdown is affected by a number of factors, including soil pH, soil temperature, and soil moisture, duration can vary for herbicides based on the specific conditions. Residual activity is not the same as herbicide carryover.

Duration of residual control assumes (1) good activation, (2) no excessive rain or irrigation, and (3) that weed species are sensitive to the herbicide(s) applied.

Trade Name	Solubility (ppm)	Relative Moisture Amount Required to Activate	Duration of Residual Weed Control
Atrazine	33	Very high	4–5 weeks
Balance Flexx	7	Very high	2–4 weeks
Callisto	1,500	Low	2–4 weeks
Dual II Magnum/Cinch	488	Medium	4–5 weeks
Harmony SG	pH 5: 223	High	1–2 weeks
	pH 7: 2,240	Low	
Harness/Degree/Breakfree/Surpass	223	High	2–4 weeks
Intrro	242	High	2–4 weeks
Metribuzin	1,200	Low	2–4 weeks
Outlook	1,174	Low	2–4 weeks
Princep	5	Very high	4–5 weeks
Prowl/Other Pendimethalin Formulations	1	Very high	4–5 weeks
Python	5,600	Low	4–6 weeks
Resolve SG	pH 7: 7,300	Low	1–2 weeks
Stinger	1,000	Low	1–3 weeks
Thiencarbazone-methyl	436	Medium	2–4 weeks
Topnotch	223	High	2–4 weeks
Valor SX	2	Very high	4–5 weeks
Zidua	3.49	Very high	4–5 weeks

Premixes	Constituents
Acuron	Dual II Magnum, Callisto, atrazine, bicyclopyrone
Acuron Flexi	Dual II Magnum, Callisto, bicyclopyrone
Anthem ATZ	Zidua, Cadet, atrazine
Anthem Maxx	Zidua, Cadet
Bicep II Magnum/Cinch ATZ	Dual II Magnum (or Cinch), atrazine
Bicep Lite II Magnum	Dual II Magnum, atrazine
Bullet	Intrro, atrazine
Corvus	Balance Flexx, thiencarbazone
Fierce	Valor SX, Zidua
FulTime/Keystone/Breakfree ATZ	Topnotch (or Surpass), atrazine
Harness Xtra/Degree Xtra	Harness (or Degree), atrazine
Hornet WDG	Python, Stinger
Lumax EZ/Lexar EZ	Dual II Magnum, Callisto, atrazine
Resicore	Surpass, Callisto, Stinger
Resolve Q/Basis Blend	Resolve SG, Harmony SG
SureStart II/TripleFLEX II	Harness, Python, Stinger
Zemax	Dual II Magnum, Callisto, atrazine

Table 2-7. Relative effectiveness of soil-applied (preemergence) corn herbicides.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Grasses Trade Name[1]	Site of Action Number	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Atrazine	5	7	N	7	6+	7	N	N	6	6	6	N	7+	6	N
Balance Flexx[2]	27	8	N	7	8[3]	N	6	7+	N	N	8	N	N	7+	N
Dual products, Cinch	15	9	N	9	9	9+	N	6	N	8	8+	N	N	6	8
Harness, Degree[4], Surpass NXT, or TopNotch	15	9	N	8+	9	9+	N	7	N	7+	8+	N	N	6	8
Intrro	15	9	N	8	9	9+	N	6	N	7+	8	N	N	6	8
Outlook	15	9	N	8	9	9	N	6	N	7+	8+	N	N	6	7
Princep	5	8+	N	8	8	8	N	6	8	6	8+	N	7	6	N
Prowl	3	8+	N	8+	8	8	N	7	N	6	8+	7	N	7	8
Zidua	15	8+	N	9	8+	9+	N	6	N	6	8+	N	N	6	8
Mixtures															
Acuron	5/15/27	9	N	9	9	9+	N	6	6	8+	9	N	6	6	8
Acuron Flexi	15/27/27	9	N	9	9	9+	N	6	N	8+	9	N	N	6	8
Anthem ATZ	5/14/15	8+	N	9	8+	9+	N	N	6	6	8+	N	6	6	—
Anthem Maxx	14/15	8+	N	9	8+	9+	N	6	N	6	8+	N	N	6	8

Grasses Trade Name[1]	Site of Action Number	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Atrazine + Princep	5/5	**8+**	N	**8+**	**8+**	8	N	6	8	**8+**	**8+**	N	**8+**	6	N
Axiom	5/15	**9**	N	**9**	**9**	8	N	6	N	6	**8+**	N	N	6	N
Bicep, Bullet, Cinch ATZ, or Guardsman	5/15	**9**	N	**9**	**9**	**9+**	N	6	6	**8+**	**9**	N	6	6	8
Corvus	2/27	8	N	8	**8+**	N	7	7+	N	7	**8+**	N	N	7+	N
Fierce	14/15	**8+**	N	**9**	**9**	**9+**	N	6	N	6	**8+**	N	N	6	—
Harness Xtra, Degree Xtra, FulTime NXT, Keystone NXT, or Breakfree NXT ATZ	5/15	**9**	N	**9**	**9**	**9+**	N	7	6	**8+**	**9**	N	6	6	8
Hornet/Stanza	2/4	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Instigate	2/27	8	N	6	8	N	N	N	N	N	8	N	N	N	N
Lumax/Lexar	5/15/27	**9**	N	**9**	**9**	**9+**	N	6	6	**8+**	**9**	N	6	6	8
Prequel	2/27	8	N	7	8	N	6	7	N	N	8	N	N	7	N
Prowl + atrazine	3/5	8	N	**9**	8	7	N	7	N	7+	**9**	6	6	7	8
Radius + atrazine	5/15/27	**9**	N	**9**	**9**	8	6	7+	N	6	**8+**	N	N	7+	N
Resicore	15/27/4	**9**	N	**8+**	**9**	**9+**	N	7	N	7+	**8+**	N	N	6	8
SureStart II/TripleFLEX II	2/4/15	8	N	8	8	**9+**	N	6	N	6	8	N	N	6	8
Verdict	14/15	8	N	8	8	**9**	N	N	N	7+	8	N	N	N	N
Zemax	15/27	**9**	N	**9**	**9**	**9+**	N	6	N	**8+**	**9**	N	N	6	8

[1] See Tables 1-4 and 2-1 for additional products that contain these active ingredients.
[2] Performance ratings based on full labeled rates.
[3] Herbicide is less effective on yellow foxtail: Balance, 6; Liberty, 7; Lightning, 8; Pursuit, 6; and Option, 7+.
[4] Degree and Degree Xtra may be less consistent on TR lambsquarters control compared to other acetochlor products.

(continued)

Broadleaves Trade Name[1]	Site of Action Number	Amaranth, Palmer/Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters[2]	Morningglory, Annual	Nightshade, Eastern Black	Pigweed[2]	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Corn Tolerance, Medium Soils	Corn Tolerance, Coarse Soils
Atrazine	5	9+	8	6	8+	9	N	8+	9	N	9	8	9	9+	8	E	E
Balance Flexx	27	8	—	7	N	8	9	N	9	8	8	7	7	7+	9	F–G[3]	G
Banvel	4	8	—	N	7+	7+	8+	6	6	9	8	N	N	8+	7	F–G	F
Dual Products, Cinch	15	8+	N	N	N	N	6	N	7+	8	6	N	N	N	N	G	G
Harness, Degree[4], Surpass NTX, or TopNotch	15	8	N	N	N	N	7	N	8+	9	7+	N	N	7	6	G	G
Intrro	15	8+	N	N	N	N	6+	N	7+	8+	6	N	N	6	N	G	G
Lorox	7	7	—	N	7+	7	8+	N	6	8	7	N	N	9	7	F–G	F
Outlook	15	8	N	N	N	N	6	N	7+	8	6	N	N	6	N	G	G
Princep	5	9+	8	6	8	9	N	9	9	N	9+	7	9	9	8	E	E
Prowl	3	8	N	N	N	6	9	N	N	8	N	N	N	8	8	G[3]	F–G
Python	2	9	7	6	8	8	8+	N	7	9	7+	6	8	8+	8	F–G[3]	F
Zidua	15	9	N	N	N	7	8	N	8	9	7+	6	6	7	7	G	G
Mixtures																	
Acuron	5/15/27	9+	—	7	9	9	9	9	9	9	9	8+	9	9	9	G	G
Acuron Flexi	15/27/27	8+	—	N	6	8	9	6	8+	8+	7	7	N	8+	9	G	G
Anthem ATZ	5/14/15	9+	8	6	9	9	8	8+	9	9	8+	8	9	9	8	G	G
Anthem Maxx	14/15	9	N	N	N	7	8	N	8	9	7+	6	6	7	7	G	G
Atrazine + Princep	5/5	9+	8	7	9	9+	N	9	9	N	9	8+	9	9	8+	E	E
Axiom	5/15	7	—	N	N	6	N	N	N	N	N	N	6+	6	N	G	F–G
Basis Blend/Resolve[5]	2/2	N	—	N	6	6	8+	N	N	9	N	N	N	6	6	F–G	F
Bicep, Bullet, Cinch ATZ, or Guardsman	5/15	9+	9	6	8+	9	7	8+	9	8+	8+	8	9	9	8+	G	G
Corvus	2/27	8	—	7	8	8	9	7	9	9	7+	7+	7	8+	9	G	F
Fierce	14/15	9	8	N	6	8	9	7+	9	9	7+	6	8	7	8	G	F
Harness Xtra, Degree Xtra[4], FulTime NXT, Keystone NXT, Breakfree NXT ATZ	5/15	9+	9	6	8+	9	7+	8+	9	9	8+	8	9	9	8+	G	G
Hornet/Stanza	2/4	—	—	N	8+	8	8+	6	8	9	8+	8	7+	8+	9	F–G[3]	F

Broadleaves Trade Name[1]	Site of Action Number	Amaranth, Palmer/Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters[2]	Morningglory, Annual	Nightshade, Eastern Black	Pigweed[2]	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Corn Tolerance, Medium Soils	Corn Tolerance, Coarse Soils
Instigate	2/27	8	—	7	8	7	9	7	9	9	7+	7	7	9	9	G	F
Lexar	5/15/27	9	9	7	9	9	9	9	9	8+	8+	8+	9	9	9	G	G
Lumax	5/15/27	9	9	6	8+	9	9	8+	9	8+	9	8	7+	9	9	G	G
Marksman	4/5	9+	8	6+	8	8+	8+	8+	9	9	8+	8	8	9	8	F–G	F
Prequel	2/27	8	—	7	6	8	9	N	8	9	8	7	7	7	9	F–G	F
Prowl + atrazine	3/5	9+	8	6	8+	9	9	8+	9	9	8+	8	9	9+	9+	G[3]	FG
Radius + atrazine	5/15/27	9	—	7	8+	9	9	8+	9	8	9	8	9	9	9	F–G[3]	G
Resicore	15/27/4	8+	—	N	6	8	9	6	8+	8+	7	7	N	8+	9	G	G
SureStart II/TripleFLEX II	2/4/15	8+	—	N	7	7	8	6	8	8+	8	7+	7	8	8	G	F
Verdict	14/15	9	—	6	8	8	9	8	9	9	8	8	7	9	8	G	G
Zemax	15/27	8+	—	N	6	8	9	6	8+	8+	7	7	N	8+	9	G	G

[1] See Tables 1-4 and 2-1 for additional products that contain these active ingredients.
[2] Triazine-resistant (TR) biotypes of common lambsquarters and redroot/smooth pigweed are widespread in the region and thus triazine (Group 5) herbicides are not effective against these populations.
[3] See remarks in Table 2-8 and the herbicide label for specific management guidelines to maximize crop tolerance.
[4] Degree and Degree Xtra may be less consistent on lambsquarters control compared to other acetochlor products.
[5] Corn stunting is likely with products that contain rimsulfuron if (1) used on coarse-textured soils, (2) applied within 7 days of planting, and (3) growing conditions are less than ideal.

Table 2-8. Comments on preplant or preemergence herbicides for conventional, min-, or no-till corn.

See specific product label to determine correct rate for soil type and weed species found in each field. These treatments may be used in conventional, reduced-till, and no-till systems. Thiocarbamate herbicides (EPTC and butylate) are highly volatile and are lost if left on the soil surface. Other than EPTC, treatments may be applied preplant-incorporated or preemergence, unless stated otherwise. Incorporation reduces the need for timely rainfall after application and may improve control of certain weeds. The higher rates for a given soil may be required for no-till. In no-till situations, burndown herbicides may be required to control weeds or cover crops present at time of application. Tables 2-3, 2-4, and 2-5 list characteristics of burndown herbicides.

EPP = early preplant (application prior to plant; in most cases, 7–14 days before planting)
PPI = applied to conventionally tilled soil then mechanically incorporated
PRE = preemergence (applied before the crop has emerged)
EPOST = early postemergence (during the early stages of crop and weed growth)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Anthem ATZ 4.5SE	pyroxasulfone + atrazine + fluthiacet	15 5 14	EPP, PRE, or EPOST	1.75–4 pt	0.98–2.25
• Anthem ATZ is a premix of pryoxasulfone (Zidua), atrazine, and fluthiacet (Cadet) and provides control of several key annual grasses and broadleaves. • Anthem ATZ can be applied preplant (surface or incorporated; burndown) up to 45 days before planting. • The typical use rate is 2 pt/A on medium-textured soils. Rates can be adjusted for soil type or two-pass application programs. • Anthem ATZ can be tank-mixed with certain other corn herbicides to broaden control spectrum. • Anthem ATZ may be applied early postemergence from crop emergence to V4 corn stage, but tank-mix if weeds are emerged. • Anthem ATZ may be applied in the fall. • Other pyroxasulfone-containing products include Anthem, Fierce, and Zidua. • *Water quality advisory.*					
Anthem Maxx 4.3SE	pyroxasulfone + fluthiacet	15 14	EPP, PRE, or EPOST	3–6 fl oz	0.1–0.2
• Fluthiacet (Cadet) does not provide any residual weed control. • See Zidua (pyroxasulfone) entry for more details.					
Atrazine 4L	atrazine	5	EPP or PRE	1–2 qt	1–2
• Atrazine may be used at 1–2 qt/A. Most commonly used in combination with other herbicides at 1–1.5 qt. • On highly erodible ground with less than 30% surface residue, no more than 1.6 qt may be applied prior to crop emergence.					

Atrazine Use Restrictions

Preplant or Preemergence
- On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):
- Fields where more than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.
- Fields where less than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb of active ingredient per acre as a broadcast spray.
- Apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.

Postemergence
- If no atrazine was applied prior to crop emergence, use a maximum rate of 2 lb of active ingredient per acre.
- If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb of active ingredient per acre.

Safety Precautions for Using Atrazine
- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.
- *Restricted-use pesticide and water quality advisory.*

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Balance Flexx 2SC	isoxaflutole + corn safener	27	EPP, PRE, or EPOST	3–6 fl oz	0.047–0.094

- Balance Flexx contains isoxaflutole plus a corn safener (cyprosulfamide) and can be applied from preplant through early postemergence (up to V2 corn).
- The medium soil texture rate is 5 fl oz/A.
- Tank-mix with pregrass products (Define, Dual, Harness, TopNotch, Outlook, etc.) to improve residual grass control. Balance Flexx can be mixed with atrazine, 2,4-D, Gramoxone, or glyphosate plus COC or MSO to improve burndown activity on emerged weeds in a no-till setting.
- Early postemergence applications of Balance Flexx will likely not control weeds that are larger than one-leaf stage, but the addition of atrazine can improve control.
- Balance Flexx also can be used as a foundation herbicide in a planned pre herbicide followed by post herbicide system.
- Do not apply with adjuvants, tank-mix with other herbicides or OP or carbamate insecticides, or use fluid fertilizer carriers after corn has emerged.
- To improve crop safety, it is best to plant corn at least 1.5 inches deep and make sure seed is completely covered and seed slit is firmed.
- *Restricted-use pesticide and water quality advisory.*

Basis Blend 30WDG	rimsulfuron + thifensulfuron	2 2	PRE	0.825–1.25 oz	0.015–0.023

- Basis Blend is a mixture of rimsulfuron (Resolve) and thifensulfuron (Harmony SG).
- Soil application of Basis Blend is permitted in the Mid-Atlantic region, including Pennsylvania.
- Soil-applied Basis Blend is effective on triazine-resistant lambsquarters and pigweed.
- Corn stunting is commonly observed when Basis Blend is used on coarse-textured soils.
- Tank-mix with other products to broaden the spectrum of control.
- For additional remarks, see Basis Blend remarks in the postemergence herbicide for corn section.

Bicep II Magnum 5.5L/Cinch ATZ Bicep Lite II Magnum 6L/Cinch ATZ Lite	s-metolachlor + atrazine	15/5	EPP, PRE, or EPOST	1.3–2.6 qt 0.9–2.2 qt	1.8–3.6 1.35–3.3
Degree Xtra 4.04ME or FulTime NXT 4.04CS	acetochlor + atrazine	15/5	EPP, PRE, or EPOST	2.9–3.7 qt 2.9–4.4 qt	2.9–3.7 2.9–4.4
Guardsman Max 5L or G-Max Lite 5L	dimethenamid-P + atrazine	15/5	EPP, PRE, or EPOST	2.4–4 pt 2–3.5 pt	1.5–2.5 1.25–2.19
Harness Xtra 6L or Harness Xtra 5.6L Keystone LA NXT 6SE/Breakfree NXT Lite or Keystone NXT 5.6SE/Breakfree NXT ATZ	acetochlor + atrazine	15/5	EPP, PRE, or EPOST	1.8–2.3 qt 1.4–3 qt 1.8–2.7 qt 1.4–3 qt	2.7–3.4 2–4.2 2.7–4.05 1.96–4.2

- These mixtures contain one of the chloroacetamide herbicides plus atrazine.
- Breakfree NXT Lite, Bicep Lite II Magnum, Cinch ATZ Lite, G-Max Lite, Harness Xtra 6L, and Keystone LA NXT mare premixes of reduced-atrazine-rate ratios.
- The application rates based on soil texture for each of these products are listed in Table 2-9.
- These products may be applied to emerged corn in a water carrier; refer to Table 2-10 for maximum corn and weed size restrictions.
- Degree Xtra can be applied early POST in a UAN carrier if the temperature is below 85°F. Some corn leaf burn should be expected. Refer to label for more details. Do not include surfactants, crop oils, or other additives.
- See individual component sections in this table and atrazine use restrictions under that entry for additional information.
- *Restricted-use pesticides and water quality advisory.*

Clarity 4S or Banvel 4S	dicamba	4	PRE or EPOST	16 fl oz 1 pt	0.5

- Clarity or Banvel may be applied after planting on medium- to fine-textured soils.
- Do not apply preemergence to soil containing less than 2% organic matter or to coarse-textured soils.
- Preemergence applications have a greater potential to injure corn under conditions of excessive moisture and cool temperatures.
- Crop tolerance is greatest to dicamba, and weeds are generally most susceptible when corn is from the spike to five-leaf stage of growth.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Corvus 2.63SC	isoxaflutole + thiencarbazone + corn safener	27 2	EPP, PRE, or EPOST	3.33–5.6 fl oz	0.07–0.12

- Corvus is a premix of isoxaflutole, cyprosulfamide (Balance Flexx), and thiencarbazone (ALS-inhibitor herbicide that improves control of annual weeds) and can be applied from preplant through early postemergence (up to V2 corn) to provide residual control of annual broadleaves and grasses, especially when tank-mixed with atrazine.
- The typical use rate is 5.6 fl oz/A.
- Corvus can provide some control of small, emerged annual weeds (<6 inches) in no-till.
- To improve burndown activity on emerged weeds in a no-till setting, mix with atrazine, 2,4-D, Gramoxone, or glyphosate plus COC or MSO.
- Early postemergence applications of Corvus will control small, emerged weeds, but the addition of atrazine can improve control.
- Corvus also can be used as a foundation herbicide in a planned preherbicide followed by postherbicide system.
- Do not apply with adjuvants (COC or MSO), tank-mix with other herbicides or OP or carbamate insecticides, or use fluid fertilizer carriers after corn has emerged.
- To improve crop safety, it is best to plant corn at least 1.5 inches deep and make sure seed is completely covered and seed slit is firmed.
- *Restricted-use pesticide and water quality advisory.*

Dual II Magnum 7.64E/Cinch	s-metolachlor	15	EPP or PRE	1–2 pt	0.96–1.9

- Dual II Magnum/Cinch are similar in activity to Harness, Intrro, Outlook, and Surpass.
- Dual II Magnum/Cinch contains a crop-safening agent.
- These may be applied broadcast on up to 5-inch-tall corn prior to weed emergence.
- The medium soil texture rate is 1.67 pt for Dual II Magnum/Cinch.
- For early preplant applications or fields with heavy surface plant residue, the Dual II Magnum/Cinch rate may need to be increased by up to 20%.
- Incorporation improves control of yellow nutsedge.
- *Water quality advisory.*

Fierce 76WDG	pyroxasulfone + flumioxazin	15 14	EPP or PRE	3 oz	0.143

- Fierce contains pyroxasulfone (Zidua) and flumioxazin (Valor) and can be used only in no-till or minimum-tilled fields where crop residue has not been incorporated into the soil and corn will be planted directly into a stale seedbed, cover crop, or previous crop residue.
- Apply Fierce at 3 oz/A to field corn early preplant.
- Corn must be planted between 7 and 30 days after application.
- When applied as part of a burndown program, Fierce must be tank-mixed with appropriate herbicides and adjuvants to control emerged weeds.
- In addition, Fierce provides residual control of several annual grass and broadleaf weeds, but other herbicides can be tank-mixed to improve control spectrum.
- Do not use on soils with less than 1% organic matter unless an activation rainfall (0.5 inch or more) has occurred between application and planting.
- Fierce also can be used as part of a fall burndown program.
- *Water quality advisory.*

Harness 7E or				1.25–3 pt	1–2.6
Degree 3.8ME	acetochlor	15	EPP or PRE	2.25–5 pt	1.07–2.38
Surpass NXT 7E/Breakfree NXT				1.25–3 pt	1.09–2.6
TopNotch 3.2CS				2–3.75 qt	1.6–3

- Harness, Degree, Surpass NXT, and TopNotch contain acetochlor.
- Acetochlor is similar in activity to Dual, Intrro, and Outlook, but it is more active on certain broadleaf weeds.
- Acetochlor may be applied on up to 11-inch-tall corn depending on the tank-mix partner.
- The medium soil texture rate is about 2 pt/A for Harness, 2.25 pt for Surpass NXT/Breakfree NXT, 2.25 qt for TopNotch, and 4 pt for Degree.
- For early preplant applications or fields with heavy surface plant residue, the rate of acetochlor may need to be increased by up to 20%.
- Incorporation improves control of yellow nutsedge.
- *Restricted-use pesticide and water quality advisory.*

Hornet 78.5WDG/Stanza	flumetsulam + clopyralid	2 4	EPP or PRE	3–5 oz	0.13–0.21

- Hornet/Stanza is a mixture of flumetsulam (Python/Accolade) + clopyralid (Stinger). The addition of clopyralid improves ragweed control and may help with Canada thistle.
- The medium soil texture rate is 5 oz/A. Hornet WDG/Stanza may be used at 3 oz/A in combination with an atrazine/pregrass herbicide premix.
- Apply at soil-applied rates to corn up to spike stage before weed emergence.
- Plant corn at least 1.5 inches deep, do use where soil pH is greater than 7.8, where organic matter is less than 1.5%, or when extended cool, not wet conditions exist.
- Apply all soil insecticides in a T-band or a band to avoid serious crop injury. Do not use if Counter insecticide was applied.
- See Table 1-5 for recrop restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.
- *Water quality advisory.*

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Instigate 46WDG	rimsulfuron + mesotrione	2 27	EPP, PRE, or EPOST	5.25–7 oz	0.15–0.2

- Instigate contains rimsulfuron (Resolve) and mesotrione (Callisto), the same active ingredients in Realm Q.
- Instigate can be applied from preplant to early post (V2).
- The typical soil-applied use rate is 6 oz/A and will provide some initial residual weed control of annual grasses and broadleaves, but it will likely need to be followed by a POST application of glyphosate (RR-corn), glufosinate (LL-corn), or conventional herbicides as needed.
- Tank-mix with atrazine or other products to improve control and spectrum.
- Crop injury may occur following an application of Instigate if there is a prolonged period of cold weather and/or in conjunction with wet soil.
- Regardless of PRE and/or POST applications, do not apply more than a total of 1 oz/A/season active ingredient rimsulfuron.
- Do not tank-mix Instigate with foliar-applied organophosphate insecticides such as Lorsban, malathion, parathion, etc., as severe crop injury may occur. To avoid crop injury or antagonism, apply these products at least 7 days before or 3 days after the application of Instigate. Do not apply Counter within 60 days of a preemergence or preplant application of Instigate because crop injury may result. Do not apply Instigate within 45 days of crop emergence where Counter was applied as a treatment because crop injury may occur.
- Do not apply another solo HPPD inhibitor POST herbicide (e.g., Callisto, Impact/Armezon, Laudis) to a field that has been treated with Instigate in the same season.

Intrro 4E	alachlor	15	EPP or PRE	3–6 lb	2–4

- Intrro is similar in activity to Dual, Harness, Outlook, and Surpass.
- Intrro may be applied on up to 5-inch-tall corn prior to weed emergence.
- The medium soil texture rate is about 2.25 qt/A.
- For early preplant applications or fields with heavy surface plant residue, increase the rate of alachlor by up to 20%.
- Incorporation improves control of yellow nutsedge.
- *Restricted-use pesticide and water quality advisory.*

Lexar EZ 3.7SC or Lumax EZ 3.67SC	s-metolachlor + mesotrione + atrazine	15/27/5	EPP, PRE, or EPOST	3–3.5 qt 2.7–3.25 qt	2.78–3.24 2.48–2.98
Acuron 3.44SC	s-metolachlor + mesotrione + atrazine + bicyclopyrone	15/27/5	EPP, PRE, or EPOST	2.5–3 qt	2.15–2.58
Acuron Flexi 3.26SC	s-metolachlor + mesotrione + bicyclopyrone	15/27	EPP, PRE, or EPOST	2–2.25 qt	1.63-1.83
Zemax 3.67SC	s-metolachlor + mesotrione	15/27	EPP, PRE, or EPOST	2–2.4 qt	1.8–2.2

- Lexar EZ and Lumax EZ are mixtures of s-metolachlor (Dual II Magnum), mesotrione (Callisto), and atrazine.
- Acuron contains the same active ingredients as Lumax/Lexar with the addition of another Group 27 herbicide, bicyclopyrone. In general, it controls a broader weed spectrum and is better on ragweed, cocklebur, and annual morningglory, and effective on many annual broadleaves and some grasses compared to Lumax/Lexar.
- The typical use rates in all tillage systems are 3 qt/A Lexar EZ, 2.7 qt/A Lumax EZ, and 2.5 qt/A Acuron.
- These products may be applied broadcast on up to 12-inch-tall corn, but prior to annual grass emergence.
- Do not apply more than 3.5 qt/A Lexar EZ, 3.25 qt/A Lumax EZ, or 3 qt/A Acuron per growing season.
- Do not apply Lexar, Lumax, or Acuron early POST if the corn was treated with Counter insecticide. Do not tank-mix Lexar, Lumax, or Acuron with organophosphate (OP) or carbamate insecticides and apply as a foliar POST application. Do not make a foliar POST application of any OP or carbamate insecticide within 7 days before or 7 days after a Lexar EZ, Lumax EZ, or Acuron application, or severe corn injury may occur.
- Corn, soybeans, small grains, and sorghum may be planted the spring following Lexar EZ, Lumax EZ, or Acuron application.
- Zemax is similar to Lumax EZ but contains no atrazine. The typical use rate is 2 qt/A.
- *Restricted-use pesticide and water quality advisory.*

Lorox 50DF	linuron	7	PRE	0.7–1 lb	0.3–0.5

- Lorox applied at 0.7 to 1 lb/A will help control TR lambsquarters.
- Do not incorporate.
- Plant corn at least 1.5 inches deep to minimize risk of crop injury.
- May cause crop injury under adverse conditions.

Marksman 3.2L	dicamba + atrazine	4 5	PRE or EPOST	2–3.5 pt	0.8–1.4

- Marksman may be applied after planting on medium- to fine-textured soils.
- Do not apply preemergence on soil containing less than 2% organic matter or to coarse-textured soils.
- Preemergence applications have a greater potential to injure corn under excessive moisture or cool temperature conditions.
- Crop tolerance is greatest and weeds are generally most susceptible to Marksman when corn is from spike to five-leaf stage of growth.
- See remarks under atrazine.
- *Restricted-use pesticide and water quality advisory.*

(continued)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Outlook 6.0E	dimethenamid-P	15	EPP or PRE	10–21 fl oz	0.47–0.98

- Outlook is similar in activity to Dual, Harness, Micro-Tech, and TopNotch.
- Outlook (dimethenamid-P) may be applied preemergence on up to 12-inch-tall corn prior to weed emergence.
- The medium soil texture rate is 16 fl oz/A for Outlook.
- For early preplant applications or fields with heavy surface plant residue, increase the Outlook rate by 1–2 fl oz/A.
- Lower use rates, 6–16 fl oz/A, may be used in situations where partial control or reduced length of residue control is required, such as early postemergence applications or preemergence applications followed by postemergence herbicides.
- Incorporation improves control of yellow nutsedge.
- *Water quality advisory.*

Prequel 45WG	isoxaflutole +	27	EPP or PRE	1.66–2.5 oz	0.047–0.7
	rimsulfuron	2			

- Prequel is a premix of isoxaflutole (Balance Pro) and rimsulfuron (Resolve) that is designed to be used in a two-pass program.
- The typical use rate is 1.66 oz/A and will provide some initial residual weed control of annual grasses and broadleaves but will likely need to be followed by a POST application of glyphosate (RR-corn), glufosinate (LL-corn), or conventional herbicides as needed.
- Tank-mixing with atrazine improves control and spectrum.
- Prequel can provide some control of small, emerged weeds in a no-till burndown setting, but it is recommended to tank-mix with 2,4-D, atrazine, glyphosate, or Gramoxone plus necessary adjuvants to improve control of larger weeds.
- Do not apply to emerged corn, or severe crop injury will occur.
- To improve crop safety, it is best to plant corn at least 1.5 inches deep and make sure seed is completely covered and seed slit is firmed. Be cautious of interactions with OP insecticides (e.g., Counter), which can cause corn injury.
- *Restricted-use pesticide and water quality advisory.*

Princep 90DF	simazine	5	EPP or PRE	1.1–3.3 lb	1–3

- Princep is similar to atrazine but has better grass activity and less broadleaf control.
- Like atrazine, Princep can persist in soil and leave carryover residues.
- Use in combination with other herbicides to lower the necessary rate and broaden the weed spectrum.
- If using Princep in combination with atrazine, follow recrop restrictions.
- *Water quality advisory.*

Princep 90DF	simazine	5	EPP or PRE	1.1–1.7 lb	1–1.5
Atrazine 90DF	atrazine	5			

- Both simazine and atrazine have long soil residuals.
- Plant corn, sorghum, or sudangrass the following year.
- Simazine improves annual grass control; use 2:1 ratio of simazine to atrazine in fields with heavy grass pressure.
- See comments under atrazine.
- When tank-mixing or sequentially applying simazine and/or atrazine or products containing either active ingredient to corn, the total pounds of simazine and/or atrazine applied must not exceed 2.5 lb ai/acre per calendar year.
- *Atrazine is a restricted-use pesticide, and both atrazine and simazine have a water quality advisory.*

Prowl 3.3E or	pendimethalin	3	PRE or EPOST	1.8–4 pt	0.75–1.65
Prowl H2O 3.8CS				2–4 pt	0.95–1.9

- Plant corn at least 1.5 inches deep to avoid Prowl injury.
- Do not incorporate.
- Must be applied after planting up until corn reaches 30 inches tall.
- Preemergence applications can injure corn.
- Delaying application until spike stage helps maximize crop safety.
- Prowl H2O is a water-based capsule suspension formulation that provides similar weed control as the older 3.3E product but causes less staining and odor.

Prowl 3.3E or	pendimethalin	3	PRE or EPOST	1.8–3.6 pt	0.75–1.5
H2O 3.8CS +				2–4 pt	0.95–1.9
Atrazine 90DF	atrazine	5		1.1–2.2 lb	1–2

- Plant corn at least 1.5 inches deep to avoid Prowl injury.
- Do not incorporate.
- Must be applied after planting up until corn reaches 12 inches tall.
- Preemergence applications can injure corn.
- Delaying application until spike stage helps maximize crop safety.
- See remarks under atrazine.
- *Atrazine is a restricted-use pesticide and has a water quality advisory.*

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Python 80WDG/Accolade	flumetsulam	2	EPP or PRE	0.8–1.14 oz	0.04–0.057

- Flumetsulam is available as a single active ingredient in Python WDG/Accolade.
- Apply before crop or weed emergence.
- Plant corn at least 1.5 inches deep.
- Do not use where soil pH is greater than 7.8, where organic matter is less than 1.5%, or when extended cool, wet conditions exist.
- Apply all insecticides in a T-band or a band to avoid serious crop injury.
- Do not use if Counter insecticide was applied. IMI corn hybrids will reduce the potential for crop injury.
- See Table 1-5 for recrop restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.
- *Water quality advisory.*

Resicore 3.29SE	acetochlor + mesotrione + clopyralid + corn safener	27 2 4	EPP, PRE, or POST	2.255–3 qt	1.85–2.47

- Resicore can be used with any field or silage corn hybrids.
- Controls many annual broadleaf and grass weeds but will not provide consistent control if grasses have already emerged.
- Cam be applied PRE thru POST; when applied in a planned PRE followed by POST programs better weed control usually can be expected and more modes of action can be incorporated for better resistance management.
- Typical medium soil rate is 2.5 qt/ A Resicore.
- Resicore does not contain atrazine, so it provides a non-atrazine alternative for triazine-sensitive areas. However, atrazine, glyphosate, 2,4-D, and other herbicides can be tank-mixed with Resicore to broaden the weed control spectrum.
- Contains acetachlor, so be sure to follow acetachlor use restrictions for soil type, organic matter, and depth to water table.
- Adequate soil moisture is required for optimum herbicidal activity. If adequate soil moisture is not received within 7–10 days after a surface-applied treatment, a shallow cultivation is recommended.
- Observe the rotation restrictions on the label.
- If corn has received an at-plant phorate or terbufos insecticide application, POST applications of Resicore may cause severe injury. Refer to label for additional restrictions with insecticides.
- Do not make POST applications of Resicore using liquid fertilizer carriers or tank-mixed with OP insecticides otherwise severe crop injury will occur.
- Resicore can be applied to corn that is no more than 11 inches tall.

Resolve 25DF	rimsulfuron	2	PRE	0.5–2 oz	0.0078–0.03

- Resolve can be applied PRE and may be tank-mixed with full or reduced rates of other soil-applied corn herbicides.
- Crop injury may occur following an application of Resolve if there is a prolonged period of cold weather and/or in conjunction with wet soil.
- Corn stunting is commonly observed when Resolve is used on coarse-textured soils.
- See additional comments about Resolve in Table 2-13.

SureStart II 4.25SE or TripleFLEX II	acetochlor + flumetsulan + clopyralid	15 2 4	EPP, PRE, or EPOST	1.5–3 pt	0.8–1.6

- SureStart II or TripleFLEX II is intended to be used with Roundup Ready or LibertyLink field or silage corn hybrids.
- When applied PRE, it is designed to provide early season control of common annual grasses and broadleaf weeds to allow better timing of the in-crop application of glyphosate or glufosinate.
- The typical medium soil rate is 1.75 pt/A SureStart II/TripleFLEX II. For longer residual control, use up to 3 pt/A.
- SureStart II/TripleFLEX II does not contain atrazine, so it provides a non-atrazine alternative for triazine-sensitive areas. However, atrazine, glyphosate, 2,4-D, and other herbicides can be tank-mixed with SureStart II/TripleFLEX II to broaden the weed control spectrum.
- Contains acetachlor, so be sure to follow acetachlor use restrictions for soil type, organic matter, and depth to water table.
- Adequate soil moisture is required for optimum herbicidal activity. If adequate soil moisture is not received within 7–10 days after a surface-applied treatment, a shallow cultivation is recommended.
- Observe the rotation restrictions on the label.
- Injury to corn has been observed when cool, wet soil conditions follow application.
- Apply soil insecticides in furrow, a T-band, or a band. To avoid serious crop injury if using OP insecticides, apply in a T-band or a band. Do not use if Counter or Thimet insecticide was applied. Refer to label for additional restrictions with soil insecticides.
- Corn must be planted at least 1.5 inches deep.
- Do not use as a soil treatment in fields with less than 1.5% organic matter unless the risk of crop injury is acceptable.

Verdict 5.57EC	saflufenacil + dimethemamid-P	14 15	EPP or PRE	10–16 fl oz	0.44–0.7

- Verdict can be used in a burndown program or in a planned PRE followed by POST herbicide system. In a burndown program it is best to include glyphosate and atrazine in addition to the necessary adjuvants (COC or MSO plus AMS or nitrogen solution) to improve control of emerged weeds including horseweed.
- The medium soil texture rate is 13 fl oz/A and will provide some initial residual weed control, but it will likely need to be followed by a POST application of glyphosate (RR-corn), glufosinate (LL-corn), or conventional herbicides as needed.
- The use of Verdict can follow a burndown application of Sharpen (1 fl oz/A).
- Do not apply Verdict to emerged corn or if OP or carbamate insecticides are being used.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Zidua 85WDG	pyroxasulfone	15	EPP or PRE	1.5–4 oz	0.08–0.21

- Zidua contains the single active ingredient pyroxasulfone.
- Zidua has annual grass activity similar to Dual, Harness, Outlook, Surpass, etc., but also provides good control of several annual broadleaves.
- Zidua can be applied preplant (surface or incorporated) up to 45 days before planting or preemergence.
- The typical use rate is 2.5 oz/A on medium-textured soils. Rates can be adjusted for soil type or two-pass application programs.
- Corn must be planted at least 1 inch deep.
- Zidua does not control existing weeds and must be activated by at least 0.5 inch of rainfall prior to weed germination; otherwise, effectiveness may be reduced.
- Zidua can be tank-mixed with atrazine or other corn herbicides to broaden weed control spectrum.
- Zidua may be applied in a carrier of water (5 gal/A or more) or liquid nitrogen fertilizer solution (20 gal/A or more). Also, it may be impregnated and applied on certain dry bulk fertilizers.
- Zidua may be applied early postemergence, but tank-mix if weeds are emerged.
- Zidua may be applied in the fall.
- Other pyroxasulfone-containing products include Anthem, Anthem ATZ, and Fierce.
- *Water quality advisory.*

[1] See Tables 1-4 and 2-1 for additional formulations or trade names containing some of these same active ingredients.

Table 2-9. Corn herbicide preplant or preemergence rates per acre based on soil texture and organic matter.

This table shows application rates for products applied alone. Rates may vary if tank-mixed with other products, weed infestations are heavy, or if used in conservation tillage situations. See specific product label for additional information on application rates and use.

Trade Name	Site of Action Number	Unit	<1.5–3% Organic Matter			>3% Organic Matter			Inc. for No-till	Max Rate Unit on HEL, Less than 30% Residue
			Coarse	Medium[1]	Fine	Coarse	Medium	Fine		
Acuron 3.44SC	5/15/27/27	qt	2.5	2.5	2.5	3.0	3.0	3.0	no	N/A
Acuron Flexi 3.26SC	15/27/27	qt	2.0	2.0	2.0	2.25	2.25	2.25	no	—
Anthem ATZ 4.5SE	5/14/15	pt	1.75	2.0	2.25	2.0	2.25	2.5	no	3.2
Anthem Maxx 4.3SC	14/15	fl oz	3.0	4.0	5.0	4.0	5.0	6.0	no	—
Atrazine 4L[2]	5	qt	1.25	1.5	1.5	1.25	1.5	2.04	no	1.6
Atrazine 90DF[2]	5	lb	1.4	1.67	1.67	1.4	1.67	2.24	no	1.8
Axiom 68DF	5/15	oz	13.0	16.0	20.0	15.0	18.0	22.0	1–2 oz	—
Balance Flexx 2SC	27	fl oz	3.0	6.0	6.0	4.0	6.0	6.0	no	—
Basis 75DF	2/2	oz	0.33	0.33	0.33	0.33	0.33	0.33	no	—
Basis Blend 30DF	2/2	oz	0.825	0.825	0.825	0.825	0.825	0.825	no	—
Bicep II Magnum 5.5L/ Cinch ATZ	5/15	qt	1.8	2.1	2.1	2.1	2.4	2.6	up to 25%	2.1
Bicep Lite II Magnum 6L/ Cinch ATZ Lite	5/15	qt	1.5	1.5	1.5	1.3	1.9	1.9	up to 20%	N/A
Bullet 4L	5/15	qt	2.5	3.0	3.75	3.0	3.75	4.0	20%	N/A
Corvus 2.63SC	2/27	fl oz	3.3[3]	5.6	5.6	5.6	5.6	5.6	no	—
Degree 3.8ME	15	pt	3.0	4.0	4.25	3.75	4.0	5.0	up to 25%	—
Degree Xtra 4.04 ME	5/15	qt	2.0	3.0	3.2	2.0	3.2	3.7	up to 25%	N/A
Dual II Magnum 7.64E/ Cinch	15	pt	1.33	1.67	1.67	1.33	2.0	2.0	up to 20%	—
Fierce 76WDG	14/15	oz	3.0	3.0	3.0	3.0	3.0	3.0	no	—
FulTime 4.04CS	5/15	qt	2.5	2.9	3.1	2.5	3.0	4.0	no	4.0
G-Max Lite 5L	5/15	pt	2.5	3.0	3.0	3.0	3.5	3.5	no	N/A
Guardsman Max 5L	5/15	pt	3.0	4.0	4.0	4.0	4.5	4.5	10–20%	3.9
Harness 7E	15	pt	1.5	2.0	2.0	1.75	2.0	2.25	up to 25%	—
Harness Xtra 6.0L	5/15	qt	1.8	2.0	2.3	2.0	2.3	2.3	up to 25%	N/A
Harness Xtra 5.6L	5/15	qt	1.8	2.0	2.3	1.8	2.3	2.6	up to 25%	2.5
Hornet 78.5WDG/ Stanza[4]	2/4	oz	4.0	5.0	5.0	5.0	5.0	6.0	no	—
Instigate 46WDG	2/27	oz	5.25	6.0	7.0	6.0	7.0	7.0	no	—
Intrro 4ME	15	qt	2.0	2.25	2.5	2.5	2.5	2.75	20%	—
Keystone LA NXT 6SE/ Breakfree NXT Lite	5/15	qt	1.8	2.0	2.1	1.8	2.1	2.4	no	N/A
Keystone NXT 5.6 SE/ Breakfree NXT	5/15	qt	1.4	2.0	2.5	2.0	2.5	2.5	up to 20%	2.5
Lexar EZ 3.7SC	5/15/27	qt	3.0	3.0	3.0	3.5	3.5	3.5	no	N/A
Lumax EZ 3.67SC	5/15/27	qt	2.7	2.7	2.7	3.25	3.25	3.25	no	N/A
Outlook 6.0E	15	fl oz	14.0	16.0	18.0	16.0	16.0	18.0	add 1–2 oz	—
Prequel 45WG[5]	2/27	oz	1.66	1.66	1.66	1.66	1.66	1.66	no	—
Princep 4L	5	qt	1.0	2.5	2.7	1.0	2.7	3.0		
Princep 90DF	5	lb	1.1	2.6	3.0	1.1	3.0	3.3	no	—
Prowl 3.3E	3	pt	2.0	3.6	4.0	3.6	4.0	4.2	no	—

(continued)

Trade Name	Site of Action Number	Unit	<1.5–3% Organic Matter			>3% Organic Matter			Inc. for No-till	Max Rate Unit on HEL, Less than 30% Residue
			Coarse	Medium[1]	Fine	Coarse	Medium	Fine		
Prowl H2O 3.8CS	3	pt	2.5	3.0	3.0	3.0	4.0	4.0	no	—
Python 80WDG/ Accolade	2	oz	0.8	0.89	1.0	0.89	1.0	1.1	no	—
Resicore 3.29SE	4/15/27	qt	2.25	2.5	2.75	2.5	2.75	3.0	up to 0.25 qt/A	—
Sharpen 2.85SC	14	fl oz	2.0	2.5	3.0	2.0	2.5	3.0	no	—
SureStart II 4.25SE/ TripleFLEX II	2/4/15	pt	1.5	1.75	2.0	1.75	1.75	2.0	no	—
Surpass NXT 7E	15	pt	1.5	2.0	2.25	2.0	2.5	2.5	up to 25%	—
TopNotch 3.2ME	15	qt	2.0	2.25	2.5	2.0	2.5	3.0	no	—
Verdict 5.57EC	14/15	fl oz	10.0	13.0	16.0	11.0	13.0	16.0	no	—
Zemax 3.67SC	15/27	qt	2.0	2.0	2.0	2.4	2.4	2.4	no	—
Zidua 85WDG	15	oz	2.0	2.5	2.5	2.5	2.5	3.0	no	—

[1] Average soil type in most Mid-Atlantic areas.
[2] On highly erodible ground with less than 30% residue, apply no more than 1.6 qt/A or 1.8 lb/A of 90 DF (i.e., 1.6 lb ai).
[3] Reduce Corvus rate to 3.33 fl oz/A if soils are coarse and have < 2% O.M.
[4] On soils with less than 3% O.M., tank-mix Hornet WDG/Stanza at 3 oz/A with a recommended label rate of an atrazine/grass herbicide premix.
[5] Prequel may be used up to 2.55 oz/A if necessary.

Table 2-10. Maximum corn and weed sizes for delayed preemergence/early postemergence herbicide applications.

See specific herbicide label(s) for additional information on application. This type of application generally is used when weather conditions preclude the use of a standard preemergence program. For most products, do not apply in liquid fertilizer if corn has emerged. Poor control from residual herbicides may result if annual grasses such as foxtail and panicum have emerged at the time of application; tank-mix with product that controls emerged grasses. Delayed preemergence/early postemergence programs can work well with herbicide-resistant corn hybrids now available (e.g., Roundup Ready, LibertyLink, Clearfield [CL], or IMI). When tank-mixing with other pesticides, follow the most restrictive product label.

Trade Name	Maximum Corn Size	Maximum Weed Size
Acuron	12 inches	3-inch broadleaves; inconsistent on emerged grasses
Acuron Flexi	30 inches	3-inch broadleaves
Anthem, Anthem ATZ	4 collars (V4)	2-inch broadleaves, before grass emergence
Atrazine	12 inches	1.5 inches
Axiom	before emergence	before emergence
Balance Flexx	2-leaf (V2)	1 true leaf stage
Bicep II Magnum, Cinch ATZ + Prowl	4-leaf or 2 collars	1- to 2-leaf
Clarity or Marksman + Outlook	8 inches	1-inch grass
Corvus	2-leaf (V2)	<2 inches (in general)
Dual or Intrro + atrazine, Bullet	5 inches	2-leaf
Dual II Magnum (Dual + atrazine), Bicep II Magnum, Bicep Lite II Magnum, Cinch ATZ Lite	5 inches	2-leaf
Dual II Magnum + Clarity	5 inches	3-inch pigweed
Dual + Marksman	3 inches	2-leaf
Fierce	before emergence	2-inch broadleaves; by tank-mix partner for grasses
Guardsman Max/G-Max Lite	12 inches	1.5 inches broadleaves; before grass emergence
Halex GT	30 inches	4 inches
Harness, Harness Xtra[1], Degree, or Degree Xtra	11 inches or by tank-mix partner	before broadleaf emergence, 2-leaf grasses or by tank-mix partner
Instigate	2-leaf (V2)	3 inches
Lexar EZ	12 inches	3-inch broadleaves; before grass emergence
Lumax EZ	12 inches	3-inch broadleaves; inconsistent on emerged grasses
Marksman + Prowl	2-leaf	1-inch grass
Outlook	12 inches	before emergence or by tank-mix partner
Prequel	before emergence	before emergence
Princep	before emergence	before emergence
Prowl H2O	30 inches	before weed emergence
Python WDG/Accolade	2 inches	before weed emergence
Resicore	11 inches	3-inch broadleaves
Resolve	12 inches	2-inch grasses; 3-inch broadleaves (in general)
SureStart II/TripleFLEX II	11 inches	limited activity on 1-inch broadleaves; before grass emergence
Surpass NXT, FulTime NXT, TopNotch, or Keystone NXT, Breakfree NXT ATZ[2]	11 inches or by tank-mix partner	before emergence or by tank-mix partner
Verdict	before emergence	before emergence
Zemax	30 inches (8-leaf)	3-inch broadleaves; before grass emergence
Zidua	early postemergence	before emergence or by tank-mix partner

[1] May be tank-mixed with Accent, Atrazine (Harness), Banvel or Clarity, Marksman, Permit, Pursuit (IMI or CL corn), or Roundup (Roundup Ready corn).
[2] May be tank-mixed with a number of different products, including Accent, Banvel or Clarity, Prowl, Pursuit (IMI or CL corn), etc. See an herbicide label for specific information.

Table 2-11. Relative effectiveness of postemergence corn herbicides.

Weed control rating:
10 = 95–100% 7 = 65–75%
9 = 85–95% 6 = 55–65%
8 = 75–85% N = less than 55% or no control

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Grasses Trade Name (rate/A)[1]	Site of Action Number	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Accent Q (0.9 oz)	2	8+	N	7	9	N	8+	9	7	6	9	9	8+	9	9+
Atrazine (1 qt)	5	8	N	6	7+	9	N	N	6	7	6	N	7	6	7
Basagran (1.5 pt)	6	N	N	N	N	N	N	N	N	8	N	N	N	N	N
Beacon (0.75 oz)	2	6	N	6	7	N	8	9	6	7	8	N	8+	9	N
Callisto (3 fl oz)	27	N	N	8[2]	N	N	N	N	N	8	N	N	N	N	N
Glyphosate[3,4] (0.75 lb ae)	9	9+	9	9+	9+	10	9	9+	9	7	9+	9	9	9	10
Impact/Armezon (0.75 fl oz)	27	7	N	8	8+	7	N	N	6	7	8	8	N	7	N
Laudis (3 fl oz)/DiFlexx Duo (32 fl oz)	27/4	8	N	8	8+	7	N	6	6	7	N	8	N	7+	8
Liberty[5] (28 fl oz)	10	8	N	8	9[6]	N	6	8	7	6	7+	8	6	8	7
Option (1.5 oz)	2	9	N	7	9[6]	N	8+	9	7	7+	8+	N	8+	9	N
Permit/Sandea (1 oz)	2	N	N	N	N	N	N	N	N	9+	N	N	N	N	N
Mixtures															
Basis Blend (0.83 oz)/Resolve Q (1.25 oz)	2/2	8	N	6	8+	N	7	8+	6	6	8+	7	7+	8+	8
Capreno (3 fl oz)	2/27	8	N	8	8+	7	7	8	6	7	8	9	6	8	6
Celebrity Plus (4.7 oz)	2/4	8+	N	7	9	N	8+	9	6+	6	9	9	9	9	9
Halex GT (3.6 pt)	9/15/27	9+	N	9+	9+	10	9	9+	9	8	9+	9	9	9	10
Liberty[5] + atrazine	5/10	8	N	8	9[6]	N	N	8	7	6+	8	8	6	8	7

Grasses Trade Name (rate/A)[1]	Site of Action Number	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Realm Q (4 oz)	2/27	8	N	8	8+	N	7	8+	6	8	8+	7	7+	8+	8
Revulin Q (4 oz)	2/27	8+	N	8	9	N	8+	9	7	8	9	9	8+	9	9
Spirit (1 oz)	2/2	N	N	N	N	N	7+	8+	N	6	N	N	7	8+	N
Steadfast Q (1.5 oz)	2/2	8+	N	7	9	N	8	9	6+	6	9	9	9	9	9+
Stout (0.75 oz)	2/2	8+	N	7	9	N	8+	9	7	6	9	9	8+	9	9+
Yukon (4 oz)/ Permit Plus (0.75 oz)	2	N	N	N	N	N	N	N	N	9+	N	N	N	N	N

[1] See Tables 1-4 and 2-1 for additional products that contain these active ingredients.
[2] Large crabgrass only.
[3] For use on Roundup Ready corn varieties only.
[4] Glyphosate-containing products include Roundup, Touchdown, Durango, and many others; see Table 1-2.
[5] For use on glufosinate-resistant corn varieties only.
[6] Herbicide is less effective on yellow foxtail: Balance, 6; Liberty, 7; Lightning, 8; Pursuit, 6; and Option, 7+.

Control of Roundup Ready Corn: Volunteers or Replanting

There are times when corn has to be removed from a field with the intention of replanting a corn crop. Tillage is one effective method, but it is not appropriate in no-tillage situations. Use of glyphosate is highly effective for non–Roundup Ready corn. But, the challenge is in removing Roundup Ready hybrids. There are limited herbicides to consistently kill small corn plants. Gramoxone SL, Liberty, and Select are three products that have shown the most activity. Research conducted in this region with Gramoxone and Select demonstrated that Select was the most effective for corn 2 to 3 inches tall. For taller corn (4 to 6 inches tall), Gramoxone in combination with a photosystem II–inhibiting herbicide (metribuzin, Lorox, or atrazine) was the most effective. Liberty is a third option, but it will not control LibertyLink hybrids.

Select Max: up to 6 oz of Select Max with a non-ionic surfactant at 0.25% v/v plus AMS at 2.5 to 4 lb/A. Do not use a COC or MSO. Wait a minimum of 6 days from time of application until planting corn due to risk of crop injury. (Select Max will also control corn hybrids containing Roundup Ready and LibertyLink stacked traits.)

Gramoxone SL: 3 to 4.5 pt/A in combination with metribuzin (4 to 6 oz/A), Lorox (1 pt/A), or atrazine (1 lb/A). These photosystem II inhibitors are not added to control the corn but used to slow down the Gramoxone activity, which helps provide more consistent control.

Liberty 280: 22 to 29 oz Liberty has not been as consistent for control of corn as Gramoxone.

(continued)

Broadleaves Trade Name (rate/A)[1]	Site of Action Number	Amaranth, Palmer/Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters[2]	Marestail/Horseweed[3]	Morningglory, Annual	Nightshade, Eastern Black	Pigweed[2]	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Corn Tolerance
2,4-D (1 pt)	4	9	—	6	9	8	9	7+	9	7	9	9	9	9	7	8	F[4]
Accent Q (0.9 oz)	2	9	—	7	7	7	6	N	7	N	9	6	N	N	8	7	F–G
Aim (0.8 oz)/Cadet (0.9 oz)	14	N	—	N	N	N	9	N	8+	9	9	N	N	7	N	9+	G
Atrazine (1 qt)	5	9+	—	8	9	9	N	N	9	9	N	9	8	8+	10	8	VG
Basagran (1.5 pt)	6	N	7	N	9	9	8	6	N	N	6+	8	7	8	9	8+	G
Beacon (0.75 oz)	2	9	—	8	8+	9	7	N	6	7	9	9	9	7	8	8	F–G
Callisto (3 fl oz)	27	8+	8	7+	8+	9	9	6	7+	9	8+	8	8	6	9	9	G
Clarity/Banvel (8 fl oz)	4	9	—	7	9	9	9	8+	9	8	9	9	9	8	10	8	F–G[4]
DiFlexx (8 fl oz)/DiFlexx Duo (32 fl oz)	4	9	—	7	9	9	9	8+	9	8	9	9	9	8	10	8	G
Glyphosate[5,6] (0.75 lb ae)	9	N	8	8+	9	9	8+	6	7	8	9	8+	8	7	8+	8	E
Harmony SG (0.125 oz)	2	9	N	7	7+	7	9	N	N	N	9	6	N	N	9	8+	G
Impact/Armezon (0.75 fl oz)	27	8+	—	7+	8+	9	9	6	7+	9	8+	8	8	6	9	9	VG
Laudis (3 fl oz)	27	8+	—	7	8+	9	9	6	7	9	8+	8	8	N	9	9	VG
Liberty[7] (22 fl oz)	10	9	—	8	9	9	8+	9	8	8	8	9	8+	8	8+	8	E
Maestro/Moxy (Buctril) (1 pt)	6	N	—	8	9	9	9	6	8	9	7	7+	8	N	9	8+	F–G[4]
Option (1.5 oz)	2	8+	—	7	7+	7+	8	N	6	9	8+	8	6	N	N	8	F–G
Permit/Sandea (1 oz)	2	9	—	6	9	N	N	6	6	6	9	9	8	7	8	9	G
Resource (6 fl oz)	14	7	—	7	6	7	7	N	N	8	7+	8	6	7	6	9+	G
Stinger (0.5 pt)	4	N	—	N	9	8	6	7	N	7	6	9+	9	7	7	6	VG
Mixtures																	
Accent + Clarity	2/4	9	—	7+	8+	8	8+	8+	9	8	9	8	8	7	8+	7+	F–G
Basis Blend (0.83 oz)	2/2	9	—	N	7	7	8+	N	6	N	9	7	N	N	9	9	F–G
Capreno (3 fl oz)	2/27	9	—	7	8+	9	9	6	7	9	9	8	8	6	9	9	G
Curtail	4/4	9	—	6	9	8	9	7+	9	7	9	9	9+	9	7	8	F
Celebrity Plus (4.7 oz)	2/4	9	—	7+	9	9	9	8+	9	9	9	9	9	8	10	9	F–G
Halex GT (3.6 pt)	9/15/27	8+	—	8+	9	9	9+	6	7+	9+	9	8+	8	7	9	9	G
Hornet/Stanza (3 oz)	2/4	7	—	N	8+	8	7	7	7	6	8	8+	8	7	8	8+	G

Broadleaves Trade Name (rate/A)[1]	Site of Action Number	Amaranth, Palmer/Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters[2]	Marestail/Horseweed[3]	Morningglory, Annual	Nightshade, Eastern Black	Pigweed[2]	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Corn Tolerance
Liberty[7] + atrazine	5/10	8	—	8	9	9	8+	9	9	9	8	9	8+	8+	9	8	E
Marksman (3 pt)	4/5	9	—	8	9	10	9	9	9	9	9	9+	9	9	10	9	F–G
NorthStar (5 oz)	2/4	9	—	8+	9	9	9	8+	9	8	9	9+	9	8	9	8+	F–G
Permit Plus (0.75 oz)	2/2	9	—	7	9	7	9	6	6	6	9	9	8	7	9	9	G
Realm Q (4 oz)	2/27	9	8	7+	8+	9	9	6	7+	9	9	8	8	6	9	9	G
Resolve Q (1.25 oz)	2/2	9	—	N	7	7	8+	N	6	N	9	7	N	N	9	9	G
Revulin Q (4 oz)	2/27	9	—	7+	8+	9	9	N	7+	9	9	8	8	6	9	9	G
Spirit (1 oz)	2/2	8	—	8+	8	9	7+	N	7	7+	8+	9	8	7	9	8	F–G
Status (5–8 oz)	4/19	9	—	7	9	9	9	9	9	9	9	9	9	8	10	9	G
Steadfast Q (1.5 oz)	2/2	9	—	7	7	7	6	N	7	N	9	6	N	N	8	8+	F–G
Stout (0.5 oz)	2/2	9	—	7	7	7	9	N	7	N	9	6	N	N	8+	8	F–G
Yukon (4–8 oz)	2/4	9	—	6	9	9	9	8+	9	8	9	9	8	8	9+	9	F–G

1 See Tables 1-4 and 2-1 for additional products that contain these active ingredients.

2 Triazine-resistant (TR) biotypes of common lambsquarters and redroot/smooth pigweed are widespread in the region and thus triazine (Group 5) herbicides are not effective against these populations.

3 Most marestail populations in the region are resistant to glyphosate (Group 9); some populations are also resistant to ALS (Group 2) herbicides. For best management of marestail, control in the fall or with an effective burndown program before planting. There are several herbicides that provide effective residual activity. However, in-crop control of marestail can be challenging since there are only a few herbicides that are effective postemergence. Make sure to apply herbicide before marestail reaches 6 inches tall. See Chapter 7: Problem Weeds for more details.

4 See remarks in Table 2-8 and the herbicide label for specific management guidelines to maximize crop tolerance.

5 For use on Roundup Ready corn varieties only.

6 Glyphosate-containing products include Roundup, Touchdown, Durango, and many others; see Table 1-2.

7 For use on glufosinate-resistant corn varieties only.

Table 2-12. Herbicide effectiveness on perennial broadleaf weeds.

Performance ratings are based on seasonal control from early season application in corn.

Weed control rating:
10 = 95–100%
8 = 75–85%
6 = 55–65%
9 = 85–95%
7 = 65–75%
N = less than 55% or no control
— = not applicable or no local data available

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Trade Name	Site of Action Number	Artichoke, Jerusalem	Bindweed, Hedge	Dandelion	Dewberry spp.	Dock spp.	Dogbane, Hemp	Horsenettle	Ivy, Poison	Milkweed	Mugwort	Pokeweed	Thistle, Canada	Corn Tolerance
Postemergence														
2,4-D	4	7	8	8	6	7+	7	6	7	6	6	7	7+	F
Accent	2	6	7	N	8	N	6	6	—	6	N	7	6	F–G
Atrazine[1]	5	N	7+	6	6	7	6	6	6	N	N	6	6	VG
Basagran + atrazine	5/6	6+	7+	7	N	7+	6	7	7	N	N	6	8	G
Beacon	2	8	7	6	N	—	6	7	—	7	6	7	7	F–G
Callisto	27	—	—	7+	N	—	7	7+	—	7	—	7	8	G
Clarity/Banvel/DiFlexx	4	8	**8+**	7+	6	8	7	7	7+	6	7+	6	8	F–G
Glyphosate[2]	9	8	7+	7	8	8	8	7	8	8	7	8	**8+**	E
Marksman	4/5	8	**8+**	8	6	8	7	8	7+	6	7+	7	**8+**	F–G
Starane	4	N	8	N	N	N	**8+**	N	N	N	N	N	N	VG
Stinger	4	**9**	N	7	N	**8+**	N	6	7	N	8	N	**9**	VG
Mixtures														
Accent + Clarity/Celebrity	2/4	8	8	8	8	7	7	7+	7	7	7+	8	8	F–G
Beacon + Clarity or 2,4-D/ NorthStar	2/4	8	8	8	6	7	7	8	—	7	7+	8	**8+**	F–G
Celebrity Plus	2/4	8	8	8	8	7	7	7+	7	7	7+	8	8	F–G
Curtail	4/4	**9**	8	8	6	**8+**	7	6	7	6	8	7	**9**	F
Spirit + Clarity or 2,4-D	2/4	8	8	8	6	7	7	7+	—	7	7+	8	**8+**	F–G
Status	4/19	8	**8+**	**8+**	6	8	7	7	7+	7	7+	8	**8+**	G
Yukon	2/4	7	8	8	6	7	7	7+	—	8	7+	8	**8+**	F–G

[1] Ratings based on 1.6–2 lb/A rate.
[2] For use on Roundup Ready corn varieties only. Glyphosate-containing products include Roundup, Touchdown, Durango, and many others; see Table 1-2.

Table 2-13. Comments on postemergence herbicides for corn.

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D amine 4S	2,4-D amine	4	0.5–1 pt	0.2–0.5

- Use from time corn emerges until approximately 36 inches.
- Risk of 2,4-D injury increases as corn increases in size.
- Use 0.5 pt rate with drop nozzles after corn exceeds 8 inches in height.
- Corn is most susceptible to injury when growing rapidly.
- Adjust sprayer to minimize drift in order to prevent injury to non-target plants.

Accent 75DF	nicosulfuron	2	0.67 oz	0.031

- Apply when shattercane is 4–12 inches, rhizome Johnsongrass 8–18 inches, foxtail 2–4 inches, and quackgrass 4–10 inches tall.
- Apply to corn broadcast or directed up to 24 inches tall or directed up to 36 inches tall.
- Include appropriate adjuvant in spray tank (see Table 2-16).
- Accent may be tank-mixed with certain herbicides.
- Do not tank-mix with Basagran or 2,4-D.
- Do not use Counter 15G. Do not use Counter 20CR in furrow or over the row at cultivation; may be banded, but may cause injury, especially on soils with less than 4% organic matter. Less restrictive for IR hybrids (not IT). The use of Dyfonate, Lorsban, Thimet may result in temporary injury. There are no precautions for non-OP insecticides.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Accent Q 54.4WG	nicosulfuron + safener	2	0.9 oz	0.031

- Do not confuse Accent Q with Accent 75DF. Accent Q contains nicosulfuron plus isoxadifen (corn safener) and has similar utility as Accent 75DF; however, it is a different formulation and rates must be adjusted.
- The typical use rate of Accent Q is 0.9 oz/A and it controls many annual grasses and some broadleaves. Accent Q is weak on crabgrass.
- Apply to corn broadcast or directed up to 20 inches tall (V6) or directed up to 36 inches tall (V10).
- Include appropriate adjuvant in spray tank (see Table 2-16).
- Accent Q may be tank-mixed with certain herbicides. Do not tank-mix with Basagran, 2,4-D, or certain OP insecticides such as Lorsban, malathion, etc. Do not use Counter 15G. Do not use Counter 20CR in furrow or over the row at cultivation; may be banded, but may cause injury, especially on soils with less than 4% organic matter. The use of Dyfonate, Lorsban, Thimet may result in temporary injury. There are no precautions for non-OP insecticides.
- Revulin Q is a premix that contains nicosulfuron + mesotrione.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Aim 2EC	carfentrazone	14	0.5–1 fl oz	0.008–0.016

- Apply to corn up to 8-leaf collar stage and when weeds generally are 1–4 inches tall.
- Include a non-ionic surfactant (2 pt/100 gal).
- Tank-mix with other herbicides to increase weed control spectrum.

Atrazine 4L	atrazine	5	1–2 qt	1–2

- Apply before weeds are 1.5 inches tall and before corn reaches 12 inches in height.
- Add 1 qt crop oil concentrate/A to spray solution. Do not include oil if corn is under stress from prolonged cold, wet weather or other factors.

Atrazine Use Restrictions

Preplant or Preemergence

On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):

- Fields where more than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.
- Fields where less than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb of active ingredient per acre as a broadcast spray.
- Apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.

Postemergence

- If no atrazine was applied prior to crop emergence, use a maximum rate of 2 lb of active ingredient per acre.
- If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb of active ingredient per acre.

Safety Precautions for Using Atrazine

- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.
- *Restricted-use pesticide and water quality advisory.*

(continued)

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Basagran 4S	bentazon	6	1.5–2 pt	0.75–1

- Apply when weeds are small and actively growing.
- Split treatments may be required for yellow nutsedge and Canada thistle.
- Include the appropriate adjuvant in the spray tank (see Table 2-16).
- Basagran poses less threat to off-target plants from drift than 2,4-D or Clarity/Banvel.
- Basagran is weak on pigweed.

Basis Blend 30WDG	rimsulfuron +	2	0.825 oz	0.015
	thifensulfuron	2		

- Basis Blend is a mixture of rimsulfuron (Resolve) and thifensulfuron (Harmony) (SG); however, its formulation is different from Basis 75DF; thus, the application rate has changed.
- Apply 0.825 oz/A Basis Blend to corn from spike stage through 2 collars (about 6 inches tall). Do not apply to corn having 3 fully emerged collars or corn over 6 inches tall.
- Basis Blend controls some small annual grasses and broadleaves.
- Basis Blend must include an adjuvant including an ammonium nitrogen fertilizer.
- Crop injury may occur following an application of Basis Blend if there is a prolonged period of cold weather and/or in conjunction with wet soil.
- Do not tank-mix with Basagran.
- Regardless of PRE and/or POST applications, do not apply more than a total of 1 oz/A/season active ingredient rimsulfuron.
- Do not tank-mix Basis Blend with foliar-applied organophosphate insecticides such as Lorsban, malathion, parathion, etc., as severe crop injury may occur. To avoid crop injury or antagonism, apply these products at least 7 days before or 3 days after the application of Basis Blend. Do not apply Counter within 60 days of a preemergence or preplant application of Basis Blend since crop injury may result. Do not apply Basis Blend within 45 days of crop emergence where Counter was applied as a treatment since crop injury may occur. There are no precautions for Force and Fortress.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Beacon 75DF	primisulfuron	2	0.38–0.76 oz	0.018–0.036

- Apply when shattercane is 4–12 inches, rhizome Johnsongrass is 8–16 inches, quackgrass is 4–8 inches, fall panicum is less than 2 inches, and broadleaved weeds are less than 4–9 inches tall depending on species.
- Apply to corn between 4 and 20 inches in height. A second application may be made before tassel emergence (0.57 + 0.19 or 0.38 + 0.38 oz).
- Include the appropriate adjuvant in the spray tank (see Table 2-16).
- Beacon may be applied at a reduced rate (0.38 oz) alone or in combination with Atrazine, Accent, Banvel, Clarity, Buctril, or 2,4-D for control of certain broadleaves or grasses. (NorthStar is a prepackaged product containing Beacon + dicamba.)
- May be applied with drop nozzles if corn is too tall.
- Do not use Counter 15G. Do not use Counter 20CR in furrow or over the row at cultivation; may be banded, but may cause injury. Do not make foliar or soil applications of an OP insecticide within 10 days before or 7 days after Beacon application. Less restrictive for IR or IMR hybrids (not IT). Dyfonate, Lorsban, Thimet, other OP's may result in temporary injury. There are no precautions for non-OP insecticides.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Buctril 2E	bromoxynil	6	1–1.5 pt	0.25–0.375

- Apply to small actively growing weeds.
- Buctril poses less threat to off-target plants from drift than 2,4-D or Clarity/Banvel.
- Buctril is weak on pigweed.

Cadet 0.91EC	fluthiacet	14	0.4–0.9 fl oz	0.0028–0.006

- Application timing to corn ranges from 2 visible collars (V2) until the corn is 48 inches tall (or prior to tasseling).
- Apply 0.4 to 0.6 fl oz/A with glyphosate (RR corn) or glufosinate (LL corn) or 0.5 to 0.9 fl oz when applied alone.
- Include the necessary spray additives (NIS or COC plus AMS or nitrogen solution).
- Applications should be made when susceptible broadleaf weeds are small.
- Cadet is very effective on velvetleaf (up to 36 inches tall), but other broadleaf weeds must be small to achieve control/suppression.
- Cadet does not provide residual weed control.
- Cadet can cause burning/speckling on the corn leaves.
- Cadet is similar to Aim herbicide.
- Solstice is a premix of Cadet and mesotrione (Callisto).

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Callisto 4SC	mesotrione	27	3 fl oz	0.094

- Callisto can be applied postemergence at 3 fl oz/A to corn up to 30 inches tall (8-leaf stage).
- Always include crop oil concentrate and UAN or AMS in the spray mixture. Do not use methylated seed oil (MSO).
- To broaden broadleaf weed control include atrazine (0.25–0.5 lb) in the mixture. (Callisto Xtra is a premix of Callisto + atrazine.)
- Do not apply more than a total of 7.7 oz/A of Callisto/A/season (i.e., 0.24 lb ai/A mesotrione).
- Do not apply Callisto postemergence in a tank mixture with emulsifiable concentrate grass herbicides.
- Do not apply Callisto postemergence:
  (1) if the crop was previously treated with Counter or Lorsban insecticide
  (2) with any OP or carbamate insecticide
  (3) 7 days before or after an OP or carbamate insecticide was applied
- Small grains may be planted 4 months after application. Corn, soybeans, and sorghum can be planted the year after application, 10-month restriction for alfalfa, and 18-month restriction for clover. See Table 1-5 for additional rotational crops.
- Other postemergence premixes that contain mesotrione include:
  - Callisto GT (mesotrione + glyphosate)
  - Callisto Xtra (mesotrione + atrazine)
  - Halex GT (mesotrione + s-metolachlor + glyphosate)
  - Realm Q (mesotrione + rimuslfuron)
  - Revulin Q (mesotrione + nicosulfuron)
  - Solstice (mesotrione + fluthiacet)

Capreno 3.45SC	tembotrione + thiencarbazone + corn safener	27 2	3 fl oz	0.08

- Capreno is a premix of tembotrione (Laudis), thiencarbazone (ALS-inhibitor herbicide that improves control of annual weeds), and cyprosulfamide (corn safener) and can be applied postemergence up to V7 corn stage to provide control of annual broadleaves and grasses, especially when tank-mixed with atrazine.
- The use rate is 3 fl oz/A in addition to COC and UAN or AMS in the spray mixture. (Do not use NIS or MSO.)
- For best results, apply Capreno when broadleaf weeds are less than 4 to 6 inches tall and grasses are less than 3 inches tall and not tillering.
- Capreno can be tank-mixed with atrazine (≥0.5 lb), glyphosate, or glufosinate to broaden control spectrum.
- Do not use Capreno in the same season as OP insecticides such as Lorsban, Counter, Dyfonate, or Thimet.

Clarity 4S or Banvel 4S	dicamba	4	8–16 fl oz 0.5–1 pt	0.25–0.5

- May apply Clarity or Banvel up to 1 pint before corn is 8 inches tall (5-leaf stage). Use 0.5 pint on corn between 8 and 36 inches.
- Take precautions to prevent drift of dicamba off the target site.
- Early postemergence applications are preferable for lambsquarters control.

Curtail 2.38L	clopyralid + 2,4-D	4 4	2 pt	0.6

- Curtail contains clopyralid (Stinger) and 2,4-D.
- Apply to corn less than 8 inches tall (V4).
- For increased control of Canada thistle, tank-mix Curtail with Stinger (2–6 fl oz).

DiFlexx 4SC	dicamba + safener	4	8–32 fl oz	0.25–1

- This safened dicamba product contains cyprosulfamide, which is the same safener used in Balance Flexx and Corvus.
- Can be applied to field corn from spike stage to V6 (36 inches tall).
- The lower use rates (8–16 fl oz) are recommended for annual broadleaf weeds that are small and actively growing, while the mid and higher rates are recommended for larger annual weeds and established biennial and perennial species.
- The addition of UAN or AMS plus NIS or COC/MSO is recommended to improve control.
- See label for additional use details and restrictions.

DiFlexx Duo 1.53SC	dicamba + safener + tembotrione	4 27	24–40 fl oz	0.287–0.478

- DiFlexx Duo contains the active ingredients in DiFlexx (dicamba) and Laudis (tembotrione) and has activity on both broadleaf and grassy weeds.
- DiFlexx Duo can be applied from corn emergence to 36 inches tall or before V7 stage, whichever comes first.
- For best results, apply before annual broadleaf weeds reach 6 inches tall and grasses reach 3 inches tall.
- The addition of UAN or AMS plus MSO or COC is recommended to improve control.
- See label for additional use details and restrictions.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Halex GT 4.39EC	s-metolachlor + mesotrione + glyphosate	15 27 9	3.6–4 pt	1.98–2.2

- Halex GT contains s-metolachlor (Dual Magnum) plus mesotrione (Callisto) plus glyphosate (Touchdown HiTech) and can only be applied to glyphosate-resistant (RR) corn hybrids from emergence to 30 inches tall (8-leaf stage).
- For best results, apply to weeds before they are 4 inches tall.
- Include NIS and AMS in the spray mixture.
- Atrazine can be tank-mixed with Halex GT.
- Do not apply another HPPD-inhibitor herbicide (Callisto, Capreno, Impact/Armezon, Laudis) postemergence in the same season.
- Do not apply more than 4 pt/A Halex GT per season (0.0105 lb mesotrione, 1.05 lb s-metolachlor, and 1.05 lb glyphosate) or make more than one application per year.
- Halex GT is not recommended for use as a preplant or PRE application.
- Halex GT can be used in a planned PRE followed by POST herbicide program.
- Use caution if applying OP or carbamate insecticides 7 days before or after Halex GT application.
- See label for additional use restrictions.

Harmony SG 50WDG	thifensulfuron	2	0.125 oz (1/8 oz)	0.063 oz

- Harmony SG can be applied to 2- to 6-leaf corn (1–4 collars, up to 12 inches tall) at a rate of 1/8 oz/A.
- Harmony SG can be used in a tank-mix to control velvetleaf, pigweed, smartweed, wild mustard, and lambsquarters (including triazine-resistant species).
- Include the necessary adjuvants in the spray solution.
- Do not apply Harmony SG to normal or IT corn previously treated with Counter 15G or 20CR, Thimet, Dyfonate, Lorsban, or other OP insecticides, otherwise crop injury will result. No insecticide herbicide restriction with IR corn hybrids. There are no precautions for Fortress or Force insecticides.
- Harmony SG is an ALS (Group 2) inhibitor herbicide. To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Hornet 78.5WDG/Stanza	flumetsulam + clopyralid	2 4	2–5 oz	0.086–0.214

- Hornet/Stanza is a mixture of flumetsulam (Python) plus clopyralid (Stinger).
- Apply to corn up to 20 inches tall (V6 corn stage) when broadleaf weeds are 1 to 8 inches in height depending on use rate.
- Include the necessary adjuvants in the mixture (see Table 2-16).
- Do not use Hornet/Stanza if Counter insecticide was applied. Other organophosphate insecticides such as Aztec, Dyfonate, Lorsban, or Thimet or may cause temporary crop injury. Do not tank-mix with foliar postemergence organophosphate insecticides.
- Refer to product label for use restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.
- *Water quality advisory.*

Impact 2.8SC or Armezon	topramezone	27	0.5–1 fl oz	0.011–0.022

- Impact/Armezon is similar to Callisto but has more annual grass activity.
- Impact/Armezon can be applied postemergence at 0.5 to 0.75 fl oz/A to corn up to 45 days prior to corn harvest (use drop nozzles when necessary).
- Always include methylated seed oil (MSO) or crop oil concentrate (COC) and UAN or AMS in the spray mixture.
- To broaden broadleaf weed control include atrazine (0.25–1 lb/A) in the mixture.
- Impact/Armezon can be applied up to 1 fl oz/A for larger or harder-to-control weeds such as fall panicum, yellow foxtail, or seedling Johnsongrass.
- Impact/Armezon can be used in sequence after herbicides such as Balance, Lumax, Lexar, etc., but be cautious of rate restrictions. Impact/Armezon may be used after or in combination with all soil or foliar-applied insecticides registered for use in corn.
- Impact/Armezon will control/suppress crabgrass, foxtails, and other grass species but is weak on fall panicum.
- Corn can be planted any time after Impact/Armezon application; 3-month restriction for small grains; 9-month restriction for alfalfa, potato, soybean, and sorghum; and 18 months for other crops. See Table 1-5 for other rotational crops.
- Armezon PRO is a premix containing topramazone plus dimethenamid-P (Outlook) and can be applied over the top of corn for additional residual weed control.

Laudis 3.5SC	tembotrione	27	3 fl oz	0.082

- For best results apply Laudis at 3 fl oz/A when weeds are small (i.e., 1 to 3 inches tall).
- Methylated seed oil (MSO) or crop oil concentrate (COC) adjuvants are recommended by manufacturer. In addition, nitrogen fertilizer is required (UAN or AMS).
- Tank-mix with 0.25 to 1 lb ai/A of atrazine for improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Laudis and atrazine to corn greater than 12 inches tall.
- Laudis can be tank-mixed with other herbicides to improve weed control spectrum.
- Laudis will control/suppress crabgrass, foxtails, and other grass species, but it will not control fall panicum.
- Do not make more than 2 applications of Laudis in a growing season.
- Be cautious of crop rotation restrictions; see Table 1-5.
- See label for additional use details.

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Liberty 280 2.34L	glufosinate	10	22–29 fl oz	0.40–0.53

- Liberty controls most annual grasses and broadleaves.
- Apply over the top to glufosinate-resistant (e.g., LibertyLink) corn only.
- Do not use POST if Liberty was used prior to planting in a burndown application.
- Two postemergence applications of Liberty can be applied at least 10 to 14 days apart.
- Broadcast applications may be made from corn emergence until corn is in the V-5 stage of growth, whichever comes first.
- For best results, apply 22 to 29 fl oz of Liberty when weeds are 2 to 6 inches tall.
- Do not apply more than 44 fl oz/A/growing season.
- Liberty herbicide should generally follow a soil residual herbicide program and/or be tank-mixed with an appropriate postemergence product to broaden the spectrum of control.
- Applications should be made between dawn and 2 hours before sunset to avoid the possibility of reduced lambsquarters or velvetleaf control.
- Weed control can be reduced if application is made when heavy dew, fog, or mist are present or when weeds are under environmental stress.
- Liberty provides no soil residual activity.
- See Table 2-16 for adjuvant information. Include ammonium sulfate (AMS) at 3 lb/A (17 lb/100 gal), but a lower rate is recommended if temperatures exceed 85 degrees (8.5 lb/100 gal) to reduce risk of leaf burn. Do not add any surfactants or crop oils.

Marksman 3.2L	dicamba + atrazine	4 5	2–3.5 pt	0.8–1.4

- Consider previous atrazine applications and do not exceed 2.5 lb (qt)/A/year. Marksman contains 1.1 plus 2.1 lb dicamba and atrazine, respectively, per gallon.
- Apply Marksman up to the 5-leaf stage of corn.
- Use 3.5 pt/A on medium-textured soils or 2 pt/A on coarse-textured soils.
- Corn tolerance is greatest to Marksman at the spike stage of growth.
- Be cautious of drift from Marksman.
- See additional restrictions under the atrazine entry.
- *Restricted-use pesticide and water quality advisory.*

Metribuzin 75DF	metribuzin	5	2 oz	0.094

- Metribuzin may be applied postemergence at the 2 oz rate in tank-mix combination with atrazine, Banvel, Clarity, Basagran, Buctril, Marksman, and 2,4-D for improved control of certain broadleaf weeds (e.g., velvetleaf).
- Observe precautions and limitations of tank-mix partners.
- *Water quality advisory.*

NorthStar 47.4WDG	primisulfuron + dicamba	2 4	5 oz	0.148

- NorthStar is a premix of primisulfuron (Beacon) plus the sodium salt of dicamba.
- NorthStar can be broadcast at 5 oz/A to corn 4 to 20 inches tall. Apply on a directed spray if corn is 20 to 36 inches tall.
- Include necessary adjuvants in the spray solution (see Table 2-16).
- Do not apply if Counter was used. Do not make a foliar POST or soil application of any OP insecticide within 10 days before or 7 days after NorthStar application.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Option 35WDG	foramsulfuron	2	1.5–1.75 oz	0.033–0.038

- Broadcast application of Option can be made from corn emergence to 16 inches tall (V5 growth stage); use drop nozzles when corn is 16–36 inches tall.
- The typical use rate is 1.5 oz/A.
- Include methylated seed oil (MSO) plus nitrogen fertilizer (UAN or AMS) in the spray mixture. (The use of non-ionic surfactant or crop oil concentrate will result in unacceptable weed control.)
- Do not use Option in the same season as Counter 15G or 20CR, Dyfonate, or Thimet. There are no precautions with other insecticides, including Regent, Aztec, Force, and Lorsban.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Peak 57WG	prosulfuron	2	0.25–1 oz	0.009—0.036

- Peak is an ALS (Group 2) herbicide and can be applied in field corn to control broadleaf weeds.
- Peak at 0.25 oz/A can be tank-mixed with Spirit to improve and extend the residual control of burcucumber.
- Include necessary adjuvants in the spray mixture.
- Be cautious of interactions with certain OP insecticides.
- Refer to label for additional information on use and restrictions.

Permit 75WG or Sandea	halosulfuron	2	0.67–1.33 oz	0.032–0.063

- Apply to corn from spike through layby (last cultivation).
- The 0.67 oz rate is the standard rate for annual weed control.
- Permit/Sandea is excellent on yellow nutsedge but weak on common lambsquarters.
- Tank-mix with products such as Clarity/Banvel or 2,4-D to increase the weed control spectrum. Yukon is a prepackaged product containing Permit + dicamba.
- Permit/Sandea has no insecticide use restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Permit Plus 74WDG	halosulfuron + thifensulfuron	2 2	0.75 oz	0.035

- The addition of thifensulfuron (Harmony SG) to halosulfuron (Permit) allows for a broader spectrum of control, especially on lambsquarters postemergence.
- Apply 0.75 oz/A plus necessary adjuvants to corn with 2–6 leaves (but with no more than 5 collars).
- Tank-mix to broaden control spectrum.
- Permit Plus contains two ALS-type (Group 2) herbicides. To prevent herbicide resistance, avoid repeated annual applications of ALS herbicides.

Realm Q 38.8WDG	rimsulfuron + mesotrione + corn safener	2 27	4 oz	0.097

- Realm Q contains the active ingredients in Resolve and Callisto and the postemergence corn safener isoxadifen.
- For best results, apply Realm Q at 4 oz/A in a two-pass program and when weeds are small and prior to corn reaching 12 inches tall.
- Realm Q requires use of nitrogen fertilizer (AMS or UAN) in addition to COC or NIS.
- Make only one application per season.
- The addition of atrazine will improve postemergence weed control and is strongly recommended.
- Realm Q can be used alone, in combination with glyphosate on Roundup Ready corn or glufosinate on LibertyLink corn, or included in other POST herbicide programs to improve weed control spectrum.
- Realm Q will provide some residual as well as foliar control.
- Regardless of PRE and/or POST applications, do not apply more than a total of 1 oz/A/season active ingredient rimsulfuron and 3.85 oz/A/season active ingredient mesotrione.
- Do not tank-mix with an organophosphate insecticide. Do not apply to corn previously treated with Counter or Lorsban.

Resolve 25DF	rimsulfuron	2	0.5–2 oz	0.0078–0.03

- Resolve contains the single active ingredient rimsulfuron.
- Resolve can be applied PRE or POST in corn at 0.5–2 oz/A. Use the higher rate when applying as a tank-mix partner in a PRE program. The typical use rate for POST applications is 1 oz/A, plus the necessary adjuvants.
- Resolve alone will control small seedling weeds, grasses less than 2 inches and broadleaves less than 3 inches. Resolve will control crabgrass less than 0.5 inch tall.
- Resolve can be tank-mixed with glyphosate to provide residual control of broadleaf and grass weed species emerging after the application. Resolve may be tank-mixed with full or reduced rates of other corn herbicides as well.
- Do not apply Resolve to corn under stress due to crop injury.
- Refer to the Resolve label for all restrictions concerning increased injury when tank-mixed with organophosphate insecticides (Counter, Lorsban, or Thimet).
- Do not tank-mix with Basagran due to crop injury concern.
- Apply Resolve up to 12-inch-tall corn or before the appearance of 6 or more collars, whichever is more restrictive.
- Resolve must be applied with a non-ionic surfactant (NIS) and nitrogen fertilizer. Crop oil concentrate (COC) may be used in place of non-ionic surfactant. When applying Resolve in a tank mixture with a glyphosate product that contains a "built-in" adjuvant system, the Resolve label does not recommend the use of extra adjuvants.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Resolve Q	rimsulfuron + thifensulfuron	2 2	1.25 oz	0.0175

- Do not confuse Resolve with Resolve Q. Resolve Q contains rimsulfuron (Resolve) plus thifensulfuron (Harmony SG) and a postemergence corn safener.
- Apply 1.25 oz/A postemergence to corn up to 20 inches tall.
- Applications made after weed emergence will provide contact control of labeled weeds and limited residual control of later emergence.
- For control of emerged weeds, include a nonionic surfactant and an ammonium nitrogen fertilizer. If applied in combination with a glyphosate or glufosinate herbicide that contains a built-in adjuvant system, no additional surfactant needs to be added.
- Resolve Q may be tank-mixed with glyphosate or glufosinate herbicides if applications are made to corn hybrids containing appropriate herbicide tolerance genes, and can be tank-mixed with full or reduced rates of other products registered for use in corn.
- Resolve Q may be tank- mixed with full or reduced rates of preemergence grass and broadleaf herbicides to provide added residual activity. Do not tank-mix Resolve Q with Basagran.
- Resolve Q may negatively interact with certain OP insecticides, see label for specific details.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Resource 0.86EC	flumiclorac	14	4–6 fl oz	0.027–0.04

- Apply to corn from 2-leaf to 10-leaf stage.
- Good on velvetleaf up to 30 inches tall.
- Tank-mix with other products such as Clarity/Banvel or atrazine to increase the weed control spectrum.

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Roundup WeatherMAX 4.5S	glyphosate	9	22 fl oz	0.75 lb ae
or Touchdown Total 4S			24 fl oz	0.75 lb ae
or Durango DMA			24 fl oz	0.75 lb ae
or other glyphosate products				

- Apply over the top to Roundup Ready corn hybrids only.
- Apply from corn emergence through the V8 stage (or 30 inches) in a 10–20 GPA spray solution.
- Do not apply more than 32 oz/A (or 1.13 lb ae/A) Roundup WeatherMAX in a single in-crop application or more than 64 oz/A/growing season (or 2.25 lb ai). (Note: Adjust application rate if using glyphosate 3S or Touchdown; for example: 22 fl oz WeatherMAX = 1 qt glyphosate/Touchdown. Refer to current product label for other use restrictions.)
- For corn grain and silage corn, 2 in-crop applications of Roundup can be made; allow 10 days between applications.
- For best results, apply a PRE residual herbicide (e.g., Harness, Harness Xtra, Bicep, FulTime, Guardsman) followed by glyphosate when weeds are 4–6 inches tall (for best results tank-mix with other POST herbicides to improve weed control spectrum and prevent glyphosate-resistant weed species.)
- Early postemergence programs that include glyphosate plus a residual herbicide also are an option, but they may not be as consistent as the preemergence followed by the postemergence program.
- Be cautious of corn height restrictions for residual herbicides.
- Roundup WeatherMAX does not require additional adjuvants in the spray tank under most conditions.
- Do not harvest silage for 50 days or grain for 7 days after last application.
- Refer to Table 1-2 for various glyphosate products and see specific product label for additional application information and restrictions.

Spirit 57WG	prosulfuron +	2	1 oz	0.036
	primisulfuron	2		

- Spirit is a 3:1 mixture of primisulfuron (Beacon) and prosulfuron (Peak).
- Soybeans may be planted 10 months after a Spirit application.
- Apply to corn between 4 and 24 inches in height (directed after 20 inches) when broadleaf weeds are small and actively growing.
- May be tank-mixed with certain herbicides to increase weed control spectrum.
- Include the appropriate adjuvant with all Spirit applications (see Table 2-16). Do not use Counter 15G. Do not use Counter 20CR in furrow or over the row at cultivation; may be banded, but may cause injury. Do not make foliar or soil applications of an OP insecticide within 10 days before or 7 days after Exceed application. Less restrictive for IR or IMR hybrids (not IT). Dyfonate, Lorsban, Thimet, and other OPs may result in temporary injury. There are no precautions for non-OP insecticides.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Status 56WDG	dicamba +	4	2.5–10 oz	0.09–0.34
	diflufenzopyr +	19		
	safener			

- Status contains dicamba (Clarity) plus another plant growth regulator (diflufenzopyr) and the postemergence corn safener isoxadifen.
- Apply Status at 5 oz/A to 4- to 36-inch-tall corn (V2–V10).
- Status can be tank-mixed with glyphosate at 2.5 oz/A. Use higher rates for more difficult to control weeds. Do not exceed a total of 12.5 oz/A per season.
- Include a non-ionic surfactant at 1 qt plus 5 qt of UAN (28–34% nitrogen) per 100 gallons of water (COC or MSO may be used instead of NIS).
- Status is effective on many broadleaf weeds.
- Do not tank-mix with products that contain 2,4-D, dicamba, or clopyralid.
- Refer to product label for additional precautions.
- *Water quality advisory.*

Steadfast 75DF	nicosulfuron +	2	0.75 oz	0.56 oz
	rimsulfuron	2		

- Steadfast contains a 2:1 ratio of nicosulfuron to rimsulfuron.
- Apply Steadfast at 0.75 oz/A to corn up to 20 inches tall (7 collars) and while weeds are young and actively growing.
- Always include the necessary adjuvants in the spring mixture.
- Steadfast can be tank-mixed to improve control and increase weed spectrum.
- Refer to product label for additional use restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.
- See Table 1-5 for recrop restrictions.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
Steadfast Q 37.7WG	nicosulfuron + rimsulfuron + corn safener	2 2	1.5 oz	0.56 oz

- Do not confuse Steadfast Q with Steadfast 75DF. Steadfast Q also contains a 2:1 ratio of nicosulfuron to rimsulfuron in addition to the postemergence corn safener isoxadifen and is a different formulation.
- Apply Steadfast Q at 1.5 oz/A to corn up to 20 inches tall (6 collars) and while weeds are young and actively growing.
- Steadfast Q is weak on crabgrass, especially if >1 inch tall. Always include the necessary adjuvants in the spring mixture.
- Steadfast Q can be tank-mixed to improve control and increase weed spectrum.
- Do not tank-mix with Basagran, 2,4-D, or certain OP insecticides such as Lorsban, malathion, etc. Do not use Counter 15G. Do not use Counter 20CR in furrow or over the row at cultivation; may be banded, but may cause injury, especially on soils with less than 4% organic matter. The use of Dyfonate, Lorsban, or Thimet may result in temporary injury. There are no precautions for non-OP insecticides.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

Stinger 3S	clopyralid	4	0.25–0.66 pt	0.093–0.25

- Apply to corn up to 24 inches tall. Use 0.25–0.5 pt/A for ragweed, cocklebur, and Jerusalem artichoke, and 0.33–0.66 pt/A for Canada thistle.
- Delay planting soybeans for 18 months following Stinger application.
- *Water quality advisory.*

Stout 72.5WDG	nicosulfuron + thifensulfuron	2 2	0.5–0.75 oz	0.023–0.034

- Stout contains nicosulfuron (Accent) and thifensulfuron (Harmony SG).
- The typical use rate for Stout is 0.75 oz/A and must include a crop oil concentrate (COC) or a non-ionic surfactant (NIS) in the spray mixture as well as a nitrogen fertilizer (UAN or AMS).
- Stout can be applied up to 16 inch tall corn or to corn with less than 6 collars, whichever is more restrictive.
- Stout will not control crabgrass species.
- Do not tank-mix Stout with Basagran due to crop safety concerns. Do not tank-mix with 2,4-D due to reduced grass control.
- Refer to Stout label for restrictions regarding OP insecticides such as Counter, Lorsban, Malathion, and Thimet. Do not tank-mix with other ALS-inhibitor herbicides unless stated on herbicide label.
- Refer to product label for additional use restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

SureStart II 4.25SE or TripleFLEX II	acetochlor + flumetsulam + clopyralid	15 2 4	1.5–3.0 pt	0.8–1.6

- SureStart II/TripleFLEX II can be applied up to the early POST stage (11-inch-tall corn) and is intended to be used with Roundup Ready or LibertyLink field or silage corn hybrids.
- When applied PRE, it is designed to provide early season control of common annual grasses and broadleaf weeds to allow better timing of the in-crop application of glyphosate or glufosinate.
- The use rate on medium-textured soils ranges from 1.5 to 1.75 pt/A, but for longer residual control, use up to 3 pt/A.
- SureStart II/TripleFLEX II does not contain atrazine, so it provides a non-atrazine alternative for triazine-sensitive areas. However, atrazine and other herbicides can be tank-mixed with SureStart II/TripleFLEX II to broaden the weed control spectrum.
- SureStart II/TripleFLEX II can be tank-mixed with glyphosate (in Roundup Ready corn) or glufosinate (LibertyLink corn) to provide residual weed control.
- Applications should be made to weeds 2 inches or less in height.
- Make sure to plant corn 1.5 inches deep and be cautious of interactions with certain OP insecticides that may cause crop injury.
- See label for additional details.

Warrant 3CS	acetochlor	15	1.5–3 qt	1.13–2.25

- Warrant can be tank-mixed with glyphosate and POST applied to emerged corn to provide residual control of annual weeds.
- Warrant does not control emerged weeds.
- The typical use rate is 1.5 qt/A.
- *Water quality advisory.*

Yukon 67.5WDG	halosulfuron + dicamba	2 4	4–8 oz	0.17–0.34

- Yukon is a premix of halosulfuron (Permit) plus the sodium salt of dicamba.
- Yukon can be applied at 4–8 oz/A to corn from spike to 36 inches tall; use drop nozzles when necessary. (The 4 oz/A Yukon rate equals 0.67 oz/A Permit plus 4 fl oz/A Clarity.)
- Include necessary adjuvants in the spray solution (see Table 2-16).
- Yukon has no insecticide use restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

[1] See Tables 1-4 and 2-1 for additional formulations or trade names containing some of these same active ingredients.

Table 2-14. Weed sizes for postemergence corn herbicides.

This table lists postemergence corn herbicides, their rates, and heights of weed species that are controlled or suppressed. This table is for "quick reference" only; refer to the herbicide label for additional information on application and timing.

Grasses	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Trade Name (rate/A)	Height Range (inches) at Application													
Accent (0.66 oz)	2–4	—	—	2–4	—	8–18	4–12	8–12*	—	2–4	≤3	4–10	4–12	≤2
Accent Q (0.9 oz)	<4	—	—	<4	—	<18	<12	<8*	—	<4	≤3	<10*	<12	≤2
Basis Blend (0.825 oz)	1–2	—	—	1–2	—	—	—	—	—	1–2	—	—	—	—
Beacon (0.76 oz)	—	—	—	1–2	—	8–16*	4–12	—	1–4*	≤2	—	4–8	4–12	—
Callisto (3 fl oz)	—	—	≤2	—	—	—	—	—	—	—	—	—	—	—
Capreno (3 fl oz)	<5	—	<3	<3	—	—	<5	—	—	<5	≤3	—	<12	≤5
Celebrity Plus (4.7 oz)	2–4	—	—	2–4	—	8–18	4–12	8–12*	—	2–4	1–3	4–10	4–12	1–2
Glyphosate (0.75 ae)	4–6	L*	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6
Halex GT (3.6 pt)	<4	—	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Impact/Armezon (0.75 fl oz)	≤4	—	≤3	3–4[1]	≤3	—	4*	—	—	≤3*	≤3*	—	—	≤3*
Laudis (3 fl oz)/DiFlexx Duo (32 fl oz)	1–5	—	1–3	1–3	1–3	—	1–5	—	—	—	1–3	—	1–6	1–4
Liberty (22 fl oz)[2]	≤3	—	≤3	≤62	≤2	—	≤3	—	*	≤3	≤4	—	≤6	≤3
Liberty (29 fl oz)[2]	≤5	—	≤5	≤12	≤3	—	≤5	*	*	≤5	≤6	*	≤8	≤5
NorthStar (5 oz)	—	—	—	1–3*	—	8–16*	4–12*	—	1–4*	1–3	—	4–8*	4–12	—
Option (1.5 oz)	≤4	—	≤2*	≤3	≤4	≤16	≤16	≤10	—	≤3	≤2	≤10	≤12	≤2*
Permit (1 oz)	—	—	—	—	—	—	—	—	4–12	—	—	—	—	≤2*
Realm Q (4 oz)	1–2	—	≤0.5	1–2	—	—	1–2*	—	1–2*	1–2	—	1–2*	1–4	≤2*
Require Q (4 oz)	1–2	—	0.5	1–2		—	*	—	*	1–2		*	1–4	
Resolve (1 oz)	1–2	—	≤0.5	1–2	—	—	1–2*	—	1–2*	1–2	—	1–2*	1–4	1–2*
Resolve Q (1.25 oz)	1–2	—	0.5	1–2	—	—	*	—	*	1–2	—	*	1–4	1–2*
Revulin Q (4 oz)	1–4	—	≤2	≤4	—	<18	<12	<6*	—	<4	<3	<10*	<12	≤2
Roundup WeatherMAX (22 fl oz)[3]	4–6	L*	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6	4–6
Steadfast (0.75 oz)	≤4	—	≤1*	≤4	<2	≤8*	≤8	≤8*	2*	≤4	≤4	≤8*	≤6	≤2
Steadfast Q (1.5 oz)	<4	—	<1*	<4	≤2	<12	<12	<4*	—	<4	≤4	<8*	<6	≤2
Stout (0.75 oz)	≤4	—	—	≤4	—	≤18	≤12	≤8*	—	≤3	≤3	≤10*	≤12	≤2
Yukon (6–8 oz)	—	—	—	—	—	—	—	—	1–12	—	—	—	—	—

*Suppression only; additional control measures may be necessary.

[1] Yellow foxtail suppression only.

[2] For use on LibertyLink/GR corn hybrids only.

[3] For use on Roundup Ready corn hybrids only.

(continued)

Broadleaves	Amaranth, Palmer /Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Marestail/Horseweed	Morningglory, Annual	Nightshade, Eastern Black	Pigweed	Ragweed, Common	Ragweed, Giant	Smartweed	Velvetleaf
Trade Name (rate/A)	Maximum Height (inches) at Application													
2,4–D[1]	4	—	—	6	3	4	4	6	2	4	6	6	—	2
Accent (0.67 oz)	—	—	3	—	3	—	—	2	—	4	—	—	4	—
Accent Q (0.9 oz)	—	—	3	—	3	—	—	2	—	4	—	—	4	—
Aim (0.5 oz)	—	—	—	—	—	4	—	2–3 lvs	4	4	—	—	—	36
Atrazine (2 qt)[1]	4	—	4	4	4	—	4*	4	4	—	4	4	4	2
Basagran (2 pt)	—	4	—	10	10	2*	—	—	—	—	3	6	10	5
Basis Blend (0.825 oz)	3	—	—	—	—	3	—	—	—	3	—	—	3	3
Beacon (0.38 oz)	3	—	—	4	4	—	3*	—	4	3	6	6	2	—
Beacon (0.76 oz)	4	—	4	4	4	<1.5*	3*	<1.5*	4	4	9	9	4	4
Beacon + 2,4–D or Clarity	4	—	3	4	4	3	6	—	4	5	6	6	4	4
Cadet (0.9 fl oz)	2*	4*	3	—	2	3*	—	3	2	4	—	—	2	36
Callisto, Solstice (3 fl oz)	3*	—	—	5	5	5	3*	5*	5	5	5*	5	5	5
Capreno (3 fl oz)	<6	—	<6*	<6	<6	<6	—	<6*	<6	<6	<6	<6	<6	<6
Celebrity Plus (4.7 oz)	3	—	3	3	3	3	3	3	3	3	3	3	3	3
Clarity/Banvel1	4	—	4	4	4	4	4	4	4	4	4	4	6	2
DiFlexx (8 fl oz)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
DiFlexx Duo (32 fl oz)	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Glyphosate (0.75 ae)	6	3	6	6	6	6	6*	6	6	6	6	6	6	6
Halex GT (3.6 pt)	<4*	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Harmony SG (0.125 oz)	4	—	—	—	—	4	—	—	—	12	—	—	6	6
Hornet/Stanza (3 oz)	—	3	—	6	6	<2*	6	<2*	<2*	<2*	6	6	6	6
Impact/Armezon (0.75 fl oz)	6*	—	—	8	6	6	—	6*	6	6	6	8	3	8
Laudis (3 fl oz)	<6	—	<6*	<6	<6	<6	—	<6*	<6	<6	<6	<6	<6	<6
Liberty (22 fl oz)[2]	—	3	6	6	6	4	4*	6	6	3*	6	6	6	3*
Liberty (29 fl oz)[2]	4*	5	10	14	10	6	6	8	8	4*	10	12	14	4*
Maestro, Moxy (Buctril) (1.5–2 pt)	—	—	4	10	6	8	4*	4	6	2	6	6	6	5
Marksman[1]	6	—	4	6	6	4	6	6	6	4	6	6	8	6
NorthStar (5 oz)	4	—	4	6	6	4	4	3*	6	5	9	9	4	4

Broadleaves	Amaranth, Palmer /Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Marestail/Horseweed	Morningglory, Annual	Nightshade, Eastern Black	Pigweed	Ragweed, Common	Ragweed, Giant	Smartweed	Velvetleaf
Option (1.5 oz)	—	—	3	2	3	2	—	3*	4	3	2	3*	—	3
Permit/Sandea (0.67 oz)	—	—	3*	9	—	2*	—	—	—	3	9	3	2	9
Permit/Sandea (1–1.33 oz)	—	—	12*	14	—	2*	—	3*	—	6	12	6	2	12
Permit Plus (0.75 oz)	4	—	3*	9	4*	4	—	3*	—	12	9	3	6	9
Realm Q (4 oz)	5	—	5	5	5	5	5*	5*	5	5	5	5	5	5
Resolve (1 oz)	—	—	—	3*	—	3*	—	3*	—	3	3*	—	3*	3*
Resolve Q (1.25 oz)	—	—	—	1–3*	—	1–3*	—	1–3*	—	1–3	1–3*	—	1–3*	1–3
Resource (6 oz)[3]	3 lvs	—	—	—	—	3 lvs	—	—	—	3 lvs	3 lvs	—	—	6 lvs
Revulin Q (4 oz)	<5	—	<2	<5	<5	<5	—	<5	<5	<5	<5	<5	<5	<5
Roundup WeatherMAX (22 fl oz)[4]	6	3	6	6	6	6	6*	6	6	6	6	6	6	6
Spirit (1 oz)	4	—	6	8	6	3	3*	4*	5	4	9	9	6	6
Status1 (5 oz)	4	—	4	4	4	4	4	4	4	4	4	4	4	4
Steadfast (0.75 oz)	—	—	—	—	4	4*	—	4	—	4	—	—	4*	4*
Steadfast Q (1.5 oz)	—	—	4	4*	4	4*	—	4	—	4	—	—	4*	4*
Stout (0.75 oz)	—	—	3	—	3	4	—	2–3	—	4	—	—	4	4
Yukon (4–8 oz)	3	—	12*	14	4	6	4	6	6	12	12	6	3	12

*Suppression only, additional control measures may be necessary.

[1] No sizes given on label, sizes listed above are best estimates.

[2] For use on glufosinate-resistant corn hybrids only.

[3] Resource label refers to weed size by number of leaves (lvs).

[4] For use on Roundup Ready corn hybrids only.

Table 2-15. Postemergence herbicide application restrictions for corn.

Trade Name	Over-the-Top Application	Use of Drop Nozzles	Comments
2,4-D	<8 inches tall	0.5 pt: 8–36 inches tall	Some 2,4-D formulations allow application up to tasseling
Accent/Accent Q	20 inches tall (free-standing) or <6 collars (V6 stage)	20–36 inches tall or V6 to V10 stage	—
Aim	Up to 8-leaf collar stage (V8)	Up to 14-leaf collar stage	Use drop nozzles or directed sprayers that target weeds but spray away from the corn whorl
Armezon PRO	Up to 30 inches tall (or 8-corn leaf stage)	When necessary	Do not make application within 45 days of corn harvest or after V8 corn growth stage
Atrazine	12 inches tall	—	—
Banvel or Clarity	1 pt: 8 inches tall or 5 leaves 0.5 pt: 8–36 inches tall or 15 days before tassel emergence	—	Do not apply Banvel or Clarity near soybeans if corn is >24 inches tall, or if soybeans are >10 inches tall or have begun to bloom
Basagran	No restrictions	—	—
Basis Blend	Spike to 4 leaves (2 collars) or 0.5–6 inches tall	—	Do not apply to corn >6 inches tall or having 3 collars
Beacon	4–20 inches tall (free standing)	For splits, 20 inches tall to before tassel emergence	—
Cadet	Up to 48 inches tall	When necessary	Apply before tasseling
Callisto, Callisto GT, Solstice	Up to 30 inches tall (or 8-corn leaf stage)	—	—
Callisto Xtra	12 inches tall	—	—
Capreno	Up to V6 (6 collars)	to V7 (7 collars)	—
Celebrity Plus	4–24 inches tall (free standing) or <6 collars (V6 stage)	When necessary	—
Curtail	<8 inches tall	—	—
DiFlexx/DiFlexx Duo	Spike to V6 or 36 inches tall	V7–V10	Apply 15 days prior to tasseling
Glyphosate products	Up to 30 inches tall (V8 stage)	30–48 inches tall	Apply to Roundup Ready hybrids only
Halex GT	Emergence to 30 inches tall (8-leaf stage)	—	—
Harmony SG	2–6 leaves up to 12 inches tall (1 to 4 collars)	—	Do not apply to corn >12 inches tall or having 4 collars
Hornet/Stanza	Emergence up to 20 inches tall (V6)	20–36 inches tall (V6)	—
Impact/Armezon	Up to 45 days prior to corn harvest	When necessary	—
Laudis	Emergence up to V8 stage	—	—
Liberty 280	Emergence to V5 (5 developed collars)	>20–36 inches tall	Apply to LibertyLink or GR corn hybrids only
Maestro, Moxy (Buctril)	1 pt: emergence to tassel 1.5 pt: 4 leaves to tassel	—	Postemergence application before 3-leaf stage may result in corn leaf burn
Marksman	Emergence to 5-leaf stage or up to 8 inches tall	—	—
Metribuzin	Emergence to pretassel	When necessary	See tank-mix partner
NorthStar	4–20 inches or 6 collars	>20–30 inches tall	—
Option	Emergence to 16 inches (V5 stage)	>16–36 inches tall	—
Peak	4–30 inches tall (6 collars)	When necessary	—

Trade Name	Over-the-Top Application	Use of Drop Nozzles	Comments
Permit	Spike to 48 inches tall	When necessary	If tank-mixed: with 2,4-D, apply to corn up to 8 inches tall; with Banvel or Clarity, apply to corn up to 36 inches tall
Permit Plus	2- to 6-leaf corn (1–5 collars)	—	Do not apply to corn with more than 6 leaves (5 collars)
Realm Q	Up to 20 inches tall but with no more than 6 collars	—	—
Resicore	Up to 11 inches tall	—	—
Resolve	Up to 12 inches tall (<6 collars)	—	—
Resolve Q	Up to 20 inches tall (<6 collars)	—	—
Resource	2-leaf to 10-leaf stage (collars must be visible)	When necessary, to direct below corn leaves	—
Revulin Q	Up to 20 inches tall (<6 collars)	—	—
Roundup products	Up to 30 inches tall (V8 stage)	—	Apply to Roundup Ready hybrids only
Spirit	4 inches to 20 inches tall or 6 collars	>20–24 inches tall	—
Status	4–36 inches tall (V2–V10)	—	Do not apply within 15 days before tassel emergence
Steadfast/Steadfast Q	Up to 20 inches tall (6 collars)	—	Best if applied when corn is <12 inches tall
Stout	Up to 16 inches tall (<6 collars)	—	—
SureStart II/TripleFLEX II	Up to 11 inches tall	—	—
Touchdown	Emergence through V8 stage	—	Apply to Roundup Ready hybrids only
Warrant	Emergence to 30 inches tall	When necessary	Does not control emerged weeds; tank-mix with glyphosate in Roundup Ready corn
Yukon	Spike to 36 inches tall	When necessary	—

Table 2-16. Spray additives and rainfastness for burndown and postemergence corn herbicides.

Trade Name	Adjuvant(s)[1]	Rate	Rainfastness (hours)
2,4-D amine/	none, except in certain tank-mixes	—	6–8
2,4-D LVE			1–2
Accent/Accent Q	crop oil concentrate or	1 gal/100 gal	4
	non-ionic surfactant	1–2 qt/100 gal	
	plus nitrogen solution or ammonium sulfate	2–4 qt/A	
+ atrazine	crop oil concentrate	1 gal/100 gal	
	plus nitrogen solution or ammonium sulfate	2–4 qt/A	
+ Banvel, Clarity, Maestro, Marksman	non-ionic surfactant	1 qt/100 gal	
	plus nitrogen solution or	2–4 qt/A	
	ammonium sulfate	2–4 lb/A	
Aim/Cadet	non-ionic surfactant or	2 pt/100 gal	1
	crop oil concentrate	1 gal/100 gal	
	plus ammonium sulfate or	2–4 lb/A	
	nitrogen solution (optional)	2–4 gal/100 gal	
Atrazine	crop oil concentrate	1 gal/100 gal	1–2
Banvel	non-ionic surfactant or	1 qt/100 gal	4
	nitrogen solution	2–4 qt/A	
Basagran[2]	crop oil concentrate	2 pt/A	8
	plus nitrogen solution or	1 gal/A	
	ammonium sulfate	2.5 lb/A	
Basis Blend	crop oil concentrate or	1–2 gal/100 gal	4
	non-ionic surfactant	1–2 qt/100 gal	
	plus nitrogen solution or ammonium sulfate	2–4 qt/A	
+ atrazine, Hornet, Marksman	crop oil concentrate plus nitrogen solution	1–2 gal/100 gal	
+ Clarity or Banvel	non-ionic surfactant or	1–2 qt/100 gal	
	crop oil concentrate plus	1–2 gal/100 gal	
	nitrogen solution	2–4 qt/A	
Beacon/NorthStar	non-ionic surfactant or	1 qt/100 gal	4
	crop or vegetable oil concentrate	1–4 pt/A	
	plus nitrogen solution or	2–4 qt/A	
	ammonium sulfate (optional)		
+ 2,4-D, Banvel, Clarity, Maestro, or Marksman	non-ionic surfactant	1 qt/100 gal	
Callisto, Callisto Xtra, Solstice	crop oil concentrate	1 gal/100 gal	1
	plus nitrogen solution or	2.5 gal/100 gal	
	ammonium sulfate	8.5 lb/100 gal	
Callisto GT	non-ionic surfactant plus	1–2 qt/100 gal	1
	ammonium sulfate (optional)	8.5–17 lb/100 gal	
Capreno	crop oil concentrate	1 gal/100 gal	1
	plus nitrogen solution or	1.5 qt/A	
	ammonium sulfate	1.5 lb/A or 8.5 lb/100 gal	

Trade Name	Adjuvant(s)[1]	Rate	Rainfastness (hours)
Celebrity Plus	non-ionic surfactant plus nitrogen solution or ammonium sulfate	1–2 qt/100 gal 1–2 qt/A 1–2 lb/A	4
Clarity[3]	non-ionic surfactant or crop oil concentrate plus nitrogen solution	1 qt/100 gal 1 gal/100 gal 2–4 qt/A	4
DiFlexx	non-ionic surfactant or crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate	1 qt/100 gal 1–2 pt/A 1–2 pt/A 2–4 qt/A 8.5–17 lb/100 gal	4
DiFlexx Duo	methylated seed oil or crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 gal/100 gal 1.5 qt/A 8.5–17 lb/100 gal	4
Durango/Duramax DMA	no NIS/COC required ammonium sulfate (optional)	8.5–17 lb/100 gal	1
Glyphosate (if not fully loaded with formulation adjuvants)	non-ionic surfactant plus ammonium sulfate (optional)	2 qt/100 gal 8.5–17 lb/100 gal	6
Gramoxone SL	non-ionic surfactant or crop oil concentrate	1 pt/100 gal 1 gal/100 gal	0.5
Halex GT	non-ionic surfactant plus ammonium sulfate	1–2 qt/100 gal 8.5–17 lb/100 gal	1–6
Harmony SG	non-ionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate	1 qt/100 gal 1 gal/100 gal 2–4 qt/A 2–4 lb/A	1
Hornet/Stanza	non-ionic surfactant or methylated seed soil plus nitrogen solution (optional)	1 qt/100 gal 1 qt/100 gal 2.5 gal/100 gal	2
Impact/Armezon	methylated seed oil or crop oil concentrate plus nitrogen solution or ammonium sulfate	1–1.5 gal/100 gal 1–1.5 gal/100 gal 1.25–2.5 gal/100 gal 8.5 lb/100 gal	1
Laudis	methylated seed oil (MSO) or crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 gal/100 gal 1–5 qt/A 1.5 lb/A	1
Liberty 280	ammonium sulfate	3 lb/A	4
Maestro, Moxy (Buctril)[4]	non-ionic surfactant or crop oil concentrate or nitrogen solution	1 qt/100 gal 1 gal/100 gal 1–4 gal/100 gal	1

(continued)

Trade Name	Adjuvant(s)[1]	Rate	Rainfastness (hours)
Marksman[5]	non-ionic surfactant or	1 qt/100 gal	4
	crop oil concentrate or	1 gal/100 gal	
	nitrogen solution or	2–4 qt/A	
	ammonium sulfate	2–2.5 lb/A	
Option	methylated or	1.5 pt/A	2
	ethylated seed oil	1.5–2 qt/A	
	plus nitrogen solution or ammonium sulfate	1.5–3 lb/A	
Peak (+ Spirit)	crop oil concentrate	1 gal/100 gal	4
Permit/Permit Plus	non-ionic surfactant or	1–2 qt/100 gal	4
	crop oil concentrate	1 gal/100 gal	
	plus nitrogen solution (optional)		
+ 2,4-D, Banvel, Clarity, Maestro, or Marksman	non-ionic surfactant		
+ atrazine	crop oil concentrate	1 gal/100 gal	
Realm Q	crop oil or modified seed oil	1 gal/100 gal	4
	concentrate or non-ionic surfactant	1 qt/100 gal	
	plus nitrogen solution or	2 qt/A	
	ammonium sulfate	2 lb/A	
Resolve/Resolve Q	crop oil or modified seed oil	1 gal/100 gal	4
	concentrate or non-ionic surfactant	1 qt/100 gal	
	plus nitrogen solution or	2 qt/A	
	ammonium sulfate	2 lb/A	
Resource	crop oil concentrate	1 pt/A	1
	plus nitrogen solution (optional)		
Revulin Q	crop oil concentrate	1 gal/100 gal	4
	plus nitrogen solution or	2 qt/A	
	ammonium sulfate	2 lb/A	
Roundup/Glyphosate	non-ionic surfactant	2 qt/100 gal	6
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Roundup PowerMAX/Roundup WeatherMAX	no NIS/COC required	—	<1
	ammonium sulfate (optional)	8.5–17 lb/100 gal	
Spirit	crop or vegetable oil concentrate or	1–4 pt/A	4
	non-ionic surfactant	1–2 qt/100 gal	
	plus nitrogen solution or	2–4 qt/A	
	ammonium sulfate	2–4 lb/A	
Status	non-ionic surfactant or	1 qt/100 gal	4
	crop oil concentrate or	1–2 pt/A	
	methylated seed oil	1–2 pt/A	
	plus nitrogen solution or	5 qt/100 gal	
	ammonium sulfate	5–17 lb/100 gal	
Steadfast/Steadfast Q	crop oil concentrate or	1 gal/100 gal	4
	non-ionic surfactant	1–2 qt/100 gal	
	plus nitrogen solution or	2 qt/A	
	ammonium sulfate	2 lb/A	

Trade Name	Adjuvant(s)[1]	Rate	Rainfastness (hours)
Stinger	none	—	6–8
Stout	crop oil or modified seed oil	1 gal/100 gal	4
	concentrate or non-ionic surfactant	1 qt/100 gal	
	plus nitrogen solution or	2 qt/A	
	ammonium sulfate	2 lb/A	
Touchdown Total	no NIS/COC required	—	1–6
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Touchdown HiTech	non-ionic surfactant	1 qt/100 gal	1–6
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Yukon	non-ionic surfactant or	1–2 qt/100 gal	4
	crop oil concentrate	1 gal/100 gal	
	plus nitrogen solution or	2–4 qt/A	
	ammonium sulfate (optional)	2–4 lb/A	

[1] In general, non-ionic surfactants should contain at least 80% surface active agent; crop or vegetable oil concentrates should be nonphytotoxic, containing at least 15% approved emulsifier; nitrogen solution is an ammonium-based fertilizer such as 28%, 30%, or 32% N; and ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0). 10-34-0 also may be used with some products.

[2] Use crop oil concentrate if lambsquarters, common ragweed, Canada thistle, yellow nutsedge, or field bindweed are present. Include nitrogen solution if velvetleaf is the primary target.

[3] Do not use COC after corn exceeds 5 inches tall. Adjuvant addition depends on tank-mix partner.

[4] When Maestro, Moxy, or Buctril is applied alone, spray additives generally are not needed and may cause excessive leaf burn.

[5] Do not use COC if corn has emerged.

Table 2-17. Comments on harvest aid herbicides for corn.

The following treatments are applied prior to harvest to control established weeds in order to aid in the harvesting process. See specific product label to determine correct rate, timing, weed species controlled, and other restrictions with this type of application.

Trade Name[1]	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D LV4	2,4-D ester	4	1–2 pt	0.5–1

- Apply 1–2 pt/A after the hard dough or dent stage to suppress large weeds that may interfere with harvest and to decrease production of weed seeds.
- Use higher rate on larger weeds and those under stress.
- Do not forage or feed corn fodder for 7 days after application.

Aim 2EC	carfentrazone	14	2 fl oz	0.031

- May be applied 3 days before harvest.
- Use as a harvest aid to desiccate certain broadleaf weeds.
- Apply in 10 gal/A water.
- Include necessary adjuvants and make sure spray coverage is sufficient, otherwise poor control will result.
- See label for additional details.

Defol 5L	sodium chlorate	not classified	4.8 qt	6

- Defol products are labeled for preharvest applications to desiccate problem weeds in early maturing corn.
- Apply at least 14 days before anticipated harvest date.
- Apply in 10 to 20 gal/A water.
- Desiccation of morningglory and other vine weeds may be erratic.
- Do not graze treated fields or feed fodder, forage, or residual grain within 14 days of application.
- Refer to product label for additional details.

Glyphosate	glyphosate	9	see Table 1-2	up to 0.75 lb ae

- Glyphosate products are labeled for preharvest applications in corn.
- They can be applied from a week or more prior to harvest.
- Apply when grain has 35% or less moisture and after maximum kernel fill is complete and corn is physiologically mature.
- Do not apply to corn for seed.
- Refer to product label for application restrictions.

Gramoxone SL 2S	paraquat	22	1.2–2 pt	0.3–0.5

- Apply after corn is mature and black layer has formed.
- Make application at least 7 days before harvest.
- Use lower rates in most cases as a harvest aid, otherwise the 2 pt/A rate can be used to desiccate mature broadleaves and grasses over 18 inches tall.
- Include a non-ionic surfactant (1 qt/100 gal) in the spray solution.

[1] See Table 2-1 for additional formulations or trade names containing some of these same active ingredients.

Table 2-18. Grazing and forage restrictions for corn herbicides.

These products restrict grazing and/or foraging (silage) following their use in corn.

Trade Name	Graze	Silage/Grain
	(days after treatment)	
2,4-D	7	7
Accent	30	30
Acuron	45	60
Acuron Flexi	45	60
Anthem ATZ	60	70
Anthem Maxx	30	70
Anthem ATZ	60	70
Atrazine	60	60
Basagran	12	12
Basis Blend	30	30
Beacon/NorthStar	30	45/60
Cadet	30	90
Callisto Xtra	60	60
Capreno	45	45
Celebrity Plus	72	32/72
Clarity/Banvel or Marksman	after milk stage	after milk stage
Corvus	45	45
Curtail	40	40
DiFlexx/DiFlexx Duo	45	45
Glyphosate[1]	50	50/7
Glyphosate (spot treatment)	14	14
Gramoxone (POST directed)	do not graze	do not feed
Halex GT	45	45
Harmony SG	30	30
Hornet	85	45
Impact/Armezon	45	45
Instigate	45	45
Laudis	45	45
Lexar	45	60
Liberty[2]	70	70
Maestro, Moxy (Buctril)	30	30
Metribuzin	60	60
Option	45	70
Outlook	40	40
Permit/Sandea/Permit Plus/Yukon	30	30
Prequel	30	30
Prowl H2O	21	21
Python	45	45
Realm Q	45	45/70
Resicore	45	45
Resolve/Resolve Q	30	30
Resource	28	28

(continued)

Trade Name	Graze	Silage/Grain
	(days after treatment)	
Revulin Q	45	45
Roundup[1]/Touchdown	50	50/7
Roundup (spot treatment)	14	14
Sharpen	80	80
Status	72	32/72
Steadfast	30	30
Stinger	40	40
Stout	30	30
SureStart II/TripleFLEX II	45	45/85
Verdict	80	80
Warrant	40	40
Zidua	—	—

[1] For use only with Roundup Ready corn hybrids.
[2] For use only with LibertyLink corn hybrids.

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Integrated Weed Management

An integrated approach to managing weeds in sorghum includes using cultural weed control, mechanical controls where applicable, and the judicious use of herbicides. Sorghum fields that are weed free for the first 4 to 6 weeks after planting will often yield the same as fields that are weed free for the entire growing season. This approach relies on starting with a clean seedbed and using residual soil-applied herbicides or mechanical control. Weeds that germinate with the crop but are controlled in a timely fashion (4 to 5 weeks after planting) will also not impact final yields. This POST herbicide approach relies on effective and timely postemergence weed control. Also, it is not necessary to control all weeds in a field to achieve maximum yield.

Plant sorghum in a timely fashion to ensure the crop emerges uniformly and achieves rapid early growth. Seeding sorghum in narrow (15-inch) rows will improve overall weed control since the crop canopy will close the rows sooner and help to outcompete smaller weeds.

Chemical Weed Control

Herbicides are useful tools in most weed management programs. This chapter will focus on herbicides available for use in sorghum. They should be used to supplement, not replace, other methods or tools available. The following are definitions of terms you will find in this and similar publications on herbicides:

Early preplant (EPP). The herbicide is applied at least 14 days before planting. EPP applications are generally used in no-till systems to control existing vegetation and provide residual control of early emerging weed species.

Preplant. The herbicide is applied from 0 to14 days before planting. Preplant applications are generally used in no-till systems to control emerged weed species.

Preplant incorporated (PPI). The herbicide is applied to the soil after primary tillage, but before planting, and mechanically mixed with the top 1 to 3 inches of soil with one of a variety of secondary tillage implements.

Preemergence (PRE). The herbicide is applied to the soil after the crop is planted but before emergence. Rainfall or irrigation is needed to move the herbicide into the zone of weed seed germination before weed emergence for maximum effectiveness. If adequate rainfall for herbicide activation does not occur, a shallow cultivation or rotary hoeing should be done to control weeds that have germinated.

Postemergence (POST). The herbicide is applied to the foliage of the crop and weeds after they have emerged.

Post-directed (or directed). Refers to use of special spray equipment to direct the spray at the weeds but avoid it coming in contact with as much of the crop as possible.

Residual activity. Herbicides that can be taken up by a plant's roots and shoots and injure or kill the plant. All soil-applied herbicides, as well as many postemergence herbicides, have residual activity. Length of residual activity ranges from a few weeks to the entire growing season.

Translocated herbicide. These herbicides move throughout the plant and can cause injury to parts of the plants that do not come in direct contact with the herbicide spray.

Contact herbicide. These herbicides do not move throughout the plant. They cause injury only to those parts of the plant that come in contact with the spray. Spray coverage is more critical for contact than translocated herbicides.

Non-selective herbicide. This refers to herbicides that control a broad spectrum of plant species, including most crops and weeds. These herbicides are generally used with no-tillage production and sprayed prior to planting when control of all plants is required.

Herbicide-resistant hybrids. Currently, there are no commercial herbicide-resistant hybrids for sorghum.

Herbicide-resistant Weeds in Sorghum

Herbicide-resistant weeds are common in sorghum in the Mid-Atlantic region. Populations of herbicide-resistant weeds are selected for by repeated use of the same or similar herbicide over a period of time. Resistance is most likely to occur with residual herbicides having one specific mode of action. Weed species with a very high amount of seed production and a variable genetic pool are more likely to develop resistant populations—for example, common lambsquarters and pigweed species. Resistance management requires using herbicides with multiple modes of action and integrating mechanical (tillage and cultivation) and cultural weed control (cover crops, narrow row spacing, proper crop fertility, etc.) with chemical weed control.

Triazine resistance. Weeds resistant to the Group 5 herbicides in the Mid-Atlantic region include common lambsquarters, redroot and smooth pigweed, and scattered populations of barnyardgrass, giant foxtail, goosegrass, and suspected populations of common ragweed and velvetleaf. Atrazine is the primary product that is problematic in sorghum. Careful selection of soil-applied and/or POST herbicides can provide good control of triazine-resistant (TR) weeds in sorghum.

For TR pigweed control, include a Group 15 herbicide for residual control (acetochlor, dimethanamid, or metolachlor) at planting. The Group 15 herbicides will suppress initial TR pigweed, but in most years a postemergence application of a non-triazine herbicide will be needed for full-season control.

For TR lambsquarters, some of the Group 15 herbicides will help suppress emergence (acetochlor), but they are not as active on lambsquarters as they are on pigweed. In addition, residual control can be obtained with products such as mesotrione.

ALS resistance. Weeds resistant to the Group 2 herbicides in the Mid-Atlantic region include several pigweed species, common and giant ragweed, common chickweed, horseweed, Italian ryegrass, giant foxtail, Johnsongrass, and shattercane. The principal issue with most ALS-resistant weeds in sorghum is lack of efficacy with POST ALS-inhibitor products. ALS-resistant broadleaves will not be controlled with halosulfuron or prosulfuron, other Group 2 herbicides. Group 2 herbicides can be used in a wide range of crops and application timings. Be sure to consider all herbicide applications when developing an herbicide-resistance management strategy.

Glyphosate resistance. Weeds resistant to the Group 9 herbicide glyphosate in the Mid-Atlantic region include Palmer amaranth and waterhemp, common and giant ragweed, and horseweed. In sorghum, this could pose a problem in no-till if these biotypes are present at the time of burndown applications. If they are, be sure to include an alternate herbicide group to ensure these species are controlled prior to planting.

No-till Weed Management

Successful production of no-till sorghum requires control of existing vegetation (cover crops and weeds) at planting and summer annual weeds that emerge after planting. Existing vegetation is traditionally controlled by the non-selective herbicides, which are often tank-mixed with residual herbicides. However, in many fields the presence of winter annual weeds, such as horseweed, requires an application while these plants are small and more susceptible to non-selective herbicides; this may require an application 3 to 5 weeks prior to planting. Some residual herbicides, such as Lumax or Bicep, can enhance burndown weed control. However, when the products are applied 14 to 28 days before sorghum planting, they provide residual weed control for only a week or two after planting soybean. In fields with weeds that are difficult to control, an application of a non-selective herbicide and 2,4-D should be used early to control winter annuals weeds, and a second application of the residual herbicides maybe need at the time of sorghum planting. This second application will improve overall weed control.

Management of Johnsongrass and Shattercane

Johnsongrass, shattercane, and sorghum are closely related, and there are no satisfactory broadcast treatments currently available for controlling either species in grain sorghum. The only alternative available for rhizome Johnsongrass control is spot spraying glyphosate. Grain sorghum should not be planted in fields infested with Johnsongrass or shattercane.

Table 3-1. Sorghum herbicides and their restrictions.

Trade Name	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide[1]	Water Quality Advisory[2]	Worker Reentry (hours)[3]
2,4-D amine 4S	2,4-D amine	4	several	—	—	48
2,4-D LVE 4E	2,4-D LVE	4	several	—	—	12
Aatrex, Atrazine 4L/90DF	atrazine	5	Syngenta, others	yes	yes	12
Aim 2EC	carfentrazone-ethyl	14	FMC	—	—	12
Banvel 4S	dicamba	4	Arysta LifeScience	—	yes	24
Basagran 4S	bentazon	6	Arysta LifeScience	—	yes	12
Bicep II Magnum 5.5L/ Cinch ATZ	s-metolachlor + atrazine + safener	15/5	Syngenta/DuPont	yes	yes	24
Bullet 4ME	alachlor + atrazine	15/5	Monsanto	yes	yes	12
Callisto 4SC	mesotrione	27	Syngenta	—	—	12
Clarity 4S	dicamba	4	BASF	—	yes	24
Degree Xtra 4.04ME	acetochlor + atrazine	15/5	Monsanto	yes	yes	12
Dual II Magnum 7.64EC/ Cinch	s-metolachlor + safener	15	Syngenta/DuPont	—	—	24
Durango DMA/ Duramax 4S	glyphosate	9	Dow AgroSciences	—	—	4
Facet L 1.5L	quinclorac	4	BASF	—	—	12
FulTime NXT 4.04CS	acetochlor + atrazine	15/5	Dow AgroSciences	yes	yes	12
Gramoxone SL 2S	paraquat	22	Syngenta	yes	—	12–24
Huskie 2.06EC	pyrasulfotole + bromoxynil	27/6	Bayer CropScience	—	yes	24
Intrro 4EC	alachlor	15	Monsanto	yes	yes	12
Lexar EZ 3.7SC	s-metolachlor + mesotrione + atrazine + safener	15/27/5	Syngenta	yes	yes	24
Lorox 50DF/Linex 4L	linuron	5	Nova Source	—	—	24
Lumax EZ 3.67SC	s-metolachlor + mesotrione + atrazine + safener	15/27/5	Syngenta	yes	yes	24
Maestro 2EC (Buctril)	bromoxynil	6	Nufarm	—	—	12
Marksman 3.2L	dicamba + atrazine	4/5	BASF	yes	yes	48
Outlook 6EC	dimethenamid	15	BASF	—	yes	12
Peak 57WG	prosulfuron	2	Syngenta	—	yes	12
Permit 75WG	halosulfuron	2	Gowan	—	—	12
Roundup WeatherMAX 4.5S/PowerMAX 4.5S	glyphosate	9	Monsanto	—	—	4
Sandea 75WG	halosulfuron	2	Gowan	—	—	12
Sharpen 2.85SC	saflufenacil	14	BASF	—	yes	12
Starane Ultra 2.8L	fluroxypyr	4	Dow AgroSciences	—	—	24
Touchdown Total 4.17S	glyphosate	9	Syngenta	—	—	12
Verdict 5.57EC	saflufenacil + dimethenamid	14/15	BASF	—	yes	12
Warrant 3CS	acetochlor	15	Monsanto	—	yes	12
Yukon 67.5WDG	halosulfuron + dicamba	2/4	Gowan	—	—	24
Zemax 3.67EC	s-metolachlor + mesotrione + safener	15/27	Syngenta	—	—	24

[1] Only licensed applicators may purchase and apply restricted-use pesticides. To become licensed, contact your state Department of Agriculture.

[2] These herbicides have properties that may result in groundwater or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for dissolved runoff and/or runoff erosion. See the herbicide label for specific restrictions.

[3] If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

Table 3-2. Sorghum herbicide prepackaged mixes, or co-packs, and equivalents.

Trade Name	Components (ai/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai)	An Equivalent Tank Mixture of
Bicep II Magnum 5.5L/ Cinch ATZ	2.4 lb s-metolachlor	15	2.1 qt	1.26 lb s-metolachlor	1.33 pt Dual II Magnum 7.64EC
	3.1 lb atrazine	5		1.63 lb atrazine	1.63 qt atrazine 4L
Bullet 4ME	2.5 lb alachlor	15	2.75 qt	1.72 lb alachlor	1.7 qt Intrro 4EC
	1.5 lb atrazine	5		1.04 lb atrazine	1 qt atrazine 4L
Degree Xtra 4.04ME	2.7 lb acetochlor	15	2.5 qt	1.67 lb acetochlor	31.8 qt Degree 3.8ME
	1.34 lb atrazine	5		0.83 lb atrazine	0.8 qt atrazine 4L
FulTime NXT 4.04CS	2.7 lb acetochlor	15	2.5 qt	1.67 lb acetochlor	2.1 qt TopNotch 3.2ME
	1.34 lb atrazine	5		0.83 lb atrazine	0.8 qt atrazine 4L
Huskie 2.06EC	0.31 lb pyrasulfotole	27	13 fl oz	0.031 lb pyrasulfotole	0.031 lb pyrasulfotole
	1.75 bromoxynil	6		0.178 bromoxynil	11.4 fl oz Maestro 2EC (Buctril)
Lexar EZ 3.7SC	1.74 lb s-metolachlor	15	3 qt	1.3 lb s-metolachlor	1.36 pt Dual II Magnum 7.64EC
	0.224 lb mesotrione	27		0.168 lb mesotrione	5.36 oz Callisto 4SC
	1.74 lb atrazine	5		1.3 lb atrazine	1.3 qt atrazine 4L
Lumax EZ 3.67SC	2.49 lb s-metolachlor	15	2.7 qt	1.67 lb s-metolachlor	1.75 pt Dual II Magnum 7.64EC
	0.249 lb mesotrione	27		0.168 lb mesotrione	5.36 oz Callisto 4SC
	0.935 lb atrazine	5		0.625 lb atrazine	0.625 qt atrazine 4L
Marksman 3.2L	1.1 lb dicamba	4	3.5 pt	0.48 lb dicamba	0.96 pt Banvel 4S/Clarity 4S
	2.1 lb atrazine	5		0.92 lb atrazine	1.84 pt atrazine 4L
Verdict 5.57EC	5 lb dimethenamid	15	10 fl oz	0.38 lb dimethenamid	8.5 fl oz Outlook 6EC
	0.57 lb saflufenacil	14		0.045 lb saflufenacil	2 fl oz Sharpen 2.85L
Yukon 67.2WDG	0.125 lb halosulfuron	2	4 oz	0.03 lb halosulfuron	0.67 Permit/Sandea 75 WG
	0.55 lb dicamba	4		0.125 dicamba	4 fl oz Clarity 4S

Table 3-3. Relative effectiveness of burndown herbicides for no-till sorghum.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Delaying applications, thus treating larger weeds, will result in reduced control. Treatments are rated only for control of vegetation existing at the time of application. Add preemergence herbicides as required for the specific situation.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control
— = no local data available

Trade Name[1]	Site of Action Number	Alfalfa	Brome, Downy	Burdock, Common	Chickweed	Dandelion	Dock, Curly	Dogbane, Hemp; Dewberry; Milkweed; etc.	Fleabanes, Annual	Foxtail spp.	Garlic, Wild	Geranium, Carolina	Groundsel, Common[2]	Henbit/Deadnettle	Horseweed/Marestail[3]	Lambsquarters	Mustard spp.	Quackgrass	Ragweed, Common	Smartweed	Thistle, Canada	Violet, Field/Pansy
Atrazine	5	6	7	6	8	N	6	N	7+	7	N	8+	9	8	8	9	8	8	9	9	6	8
Glyphosate[4]	9	7	9	7	9	6	6	7	7+	9+	7	8	9	6	8	9	9	8	9	7	8	6
Glyphosate + atrazine	5/9	7+	9	7+	9	7	6	N	7+	9	6	8+	9	9	9	9	9	9	9	9	8	8
Glyphosate + Clarity	9/4	8+	9	7+	9	8	7	7+	8	9+	6	8	9	8+	9	9	9	9	9	9	8+	8
Gramoxone	22	N	7	N	8+	N	N	6	6	9	6	8	8+	7	7	8	9	6	8	9	6	8
Gramoxone + atrazine	22/5	7	8	6	9	N	6	6	7	9	6	9	8+	9	8+	9	8	8	9	7	7	8
Lumax/Lexar	5/15/27	6	N	8	9	8	8	N	8	6	N	8+	9	8	8	9	9	N	8+	7	7	7
Sharpen	14	N	N	N	6	7	—	N	7+	N	—	—	8	6	8	8	9	N	8	9	6	N
Sharpen + glyphosate	14/9	7	9	7	9	8	6	7	8	9+	—	8	9	6	9	9	8	8	9	9	8	6

[1] See generic herbicide table for additional formulations or trade names containing some of these same active ingredients; see Table 1-2 (glyphosates table) and Table 1-4 (generics table).
[2] Certain populations of common groundsel in the northeastern U.S. are resistant to triazine herbicides. Herbicide programs that contain Maestro (Buctril) provide good control of groundsel in crop.
[3] Roundup, Touchdown, and other glyphosate products are not effective on glyphosate-resistant horseweed biotypes.
[4] Activity is reduced if applied in certain tank-mixes; Roundup or Touchdown with photosynthesis inhibitors such as triazine herbicides; Clarity with Gramoxone. May still be tank-mixed for convenience, but burndown is improved if applied separately.

Table 3-4. Comments on burndown herbicides for no-till sorghum.

May need to be combined with residual treatment or postemergence program for complete no-till weed control program.

Trade Name[1]	Common Name	Site of Action Number	Sorghum Type	Product/A	lb ai/A
Atrazine 90DF or Atrazine 4L	atrazine	5	grain, forage	1.8–2.2 lb 1.6–2 qt	1.6–2
• Labeled for grain and forage sorghum. • Sorghum is not as tolerant as corn to atrazine; labels do not recommend use on coarse-textured soils and have precautions for use on medium- and fine-textured soils with less than 1% organic matter. • Controls small emerged annual broadleaves and some grasses. • Can be applied in liquid nitrogen as the carrier to improve burndown characteristics. • Tank-mixing with paraquat improves burndown control; however, this can antagonize glyphosate activity on some species. • Premixes containing atrazine include Bicep II Magnum, Bullet, Degree Xtra, Lumax, Lexar, and others; atrazine rates differ among these products, refer to their labels for amount of atrazine. • Observe atrazine use restrictions; see atrazine entry in the soil-applied comments table. • *Restricted-use pesticide and water quality advisory.*					
Banvel 4S/Clarity 4S	dicamba	4	grain, forage	8 oz	0.25
• Labeled for grain and forage sorghum. • Tank-mix with glyphosate or paraquat to broaden spectrum of control. • Wait at least 15 days between application and planting to reduce risk of injury. • Include a non-ionic surfactant (NIS) to improve control. • Clarity is a less volatile formulation than Banvel.					
Gramoxone SL 2S	paraquat	22	grain	2–4 pt	0.5–1
• Apply in 20–60 gal/A for control of emerged annual weeds. • Addition of atrazine will often improve paraquat performance. • Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier. • Use appropriate precautions when handling paraquat to minimize exposure to the herbicide. • Do not use flood jet tips larger than size 20 or spacing greater than 40 inches. • *Gramoxone is a restricted-use pesticide.*					
Glyphosate[2]	glyphosate	9	grain, forage	varies with formulation	0.75–1.5 ae
• Use at least 1.13 lb ae glyphosate or higher, especially if tank-mixing with residual herbicide. • Spring applications may be used for control of annual weeds. • Using low-volume sprays may allow for a reduced rate. • Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers, but they may be less effective on certain annual grasses and perennials. • Do not use glyphosate with suspension-type liquid fertilizers.					
Lexar EZ 3.67SC	mesotrione + s-metolachlor + atrazine	27 15 5	grain	3 qt	0.168 1.3 1.3
Lumax EZ 3.7SC	mesotrione + s-metolachlor + atrazine	27 15 5	grain	2.7 qt	0.168 1.68 0.63
• Labeled for grain sorghum only. • Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15). • Apply prior to sorghum emergence; application to emerged sorghum will result in severe injury. • Applying either product less than 7 days before sorghum planting will increase the risk of crop injury, especially if irrigation or rainfall is received following the application. • Injury symptoms include temporary bleaching of newly emerging sorghum leaves or in extreme conditions, stunting or partial stand loss. • Lexar or Lumax will improve performance of paraquat, but can antagonize glyphosate on some weed species. • *Restricted-use pesticides and water quality advisory.*					
Sharpen 2.85SC	saflufenacil	14	grain	1–2 fl oz	0.022–0.044
• Labeled for grain sorghum only. • Sharpen may be applied as a preplant/burndown treatment from 14 days early preplant through preemergence timings. Do not apply to emerged sorghum. • Apply Sharpen in a typical glyphosate burndown herbicide program to increase weed control spectrum, including glyphosate-resistant horseweed. • Include necessary additives methylated seed oil (MSO) plus nitrogen solution or ammonium sulfate (AMS) to the spray mixture. • Verdict is a prepackaged mixture containing Sharpen. • Sharpen will provide very short residual activity at the rates labeled for sorghum.					

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.

[2] Consult specific product label for active ingredient concentration and application rate; various formulations of this herbicide are available (e.g., 1 qt/A glyphosate = 22 fl oz/A WeatherMAX); see Table 1-2 (glyphosates table).

Table 3-5. Water solubility and longevity of soil-applied herbicides.

Solubility (parts per million; ppm) refers to how many microliters of the herbicide will dissolve in 1 liter of water. The less soluble the herbicide, the more moisture (rain or irrigation) is needed to activate the herbicide and move it into the root zone. Solubility is used as a guideline for rainfall or irrigation required within a short time after application. Moisture needed also depends on the soil moisture at time of application.

Relative moisture levels to move herbicide into the soil to achieve optimum level of control:

Relative Moisture to Activate	ppm	Estimated Water to Activate*
Low	>500 ppm (very soluble)	0.33 inch
Medium	250–500 ppm	0.33–0.5 inch
High	100–250 ppm	0.5–0.75 inch
Very high	<100 ppm	>0.75 inch

*More water (additional irrigation) may be necessary if soil is dry at time of application, for soils with higher clay content, or if high plant residues are present.

Relative duration of residual control is for comparison only based on herbicide half-life (length of time it takes for half the herbicide to break down). Herbicide breakdown results from chemical and/or microbial activity. Since the speed of breakdown is affected by a number of factors, including soil pH, soil temperature, and soil moisture, duration can vary for herbicides based on the specific conditions. Residual activity is not the same as herbicide carryover.

Duration of residual control assumes (1) good activation, (2) no excessive rain or irrigation, and (3) that weed species are sensitive to the herbicide(s) applied.

Trade Name	Solubility (ppm)	Relative Moisture Amount Required to Activate	Duration of Residual Weed Control
Atrazine	33	Very high	4–5 weeks
Callisto	1,500	Low	2–4 weeks
Degree/TopNotch/Warrant	223	High	2–4 weeks
Dual II Magnum/Cinch	488	Medium	4–5 weeks
Intrro	242	High	2–4 weeks
Linex/Lorox	75	Very high	4–5 weeks
Outlook	1,174	Low	2–4 weeks

Premixes	Constituents
Bicep II Magnum/Cinch ATZ	Dual II Magnum (or Cinch), atrazine
Bicep Lite II Magnum	Dual II Magnum, atrazine
Bullet	Intrro, atrazine
FulTime NXT	Topnotch, atrazine
Degree Xtra	Degree, atrazine
Lumax EZ/Lexar EZ	Dual II Magnum, Callisto, atrazine
Verdict	Outlook, Sharpen
Zemax	Dual II Magnum, Callisto

Table 3-6. Relative effectiveness of soil-applied herbicides.

Ratings are based on labeled application rates for the soil type and timely rainfall or irrigation to incorporate the herbicides. Ratings are also based on control 3 to 4 weeks after application. Length of effective control (residual control) beyond 4 weeks after application often declines. Results may differ with variations in soil type, temperature, rainfall, soil moisture, soil organic matter, and soil pH. For ratings on herbicide combinations not listed, see the component parts.

Weed control rating:

10 = 95–100%	9 = 85–95%	8 = 75–85%	7 = 65–75%
6 = 55–65%	N = less than 55% or no control	— = no local data available	

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Grasses Trade Name[1]	Site of Action Number	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Atrazine	5	7	N	7	6+	7	N	N	6	6	6	N	7+	6	N
Bicep, Bullet, Cinch ATZ	5/15	9	N	9	9	9+	N	6	6	8+	9	N	6	6	8
Degree Xtra, FulTime NXT	5/15	9	N	8+	9	9+	N	7	6	8+	9	N	6	6	8
Dual products, Cinch	15	9	N	9	9	9+	N	6	N	8	8+	N	N	6	8
Intrro	15	9	N	8	9	9+	N	6	N	7+	8	N	N	6	8
Linex/Lorox	7	6	N	6	6	6	N	N	N	N	6	N	N	N	N
Lumax/Lexar	5/15/27	9	N	9	9	9+	N	6	6	8+	9	N	6	6	8
Outlook	15	9	N	8	9	9	N	6	N	7+	8+	N	N	6	8
Verdict	14/15	8	N	8	8	9	N	N	N	6	8	N	N	N	N
Warrant	15	9	N	8+	9	9+	N	7	N	7+	8+	N	N	6	8

[1] Performance ratings based on full labeled rates. See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.

Broadleaves Trade Name[1]	Site of Action Number	Amaranth, Palmer/ Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters[2]	Morningglory, Annual	Nightshade, Eastern Black	Pigweed	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Sorghum Tolerance, Medium Soils	Sorghum Tolerance, Coarse Soils
Atrazine	5	9+	8	6	8+	9	9+	8+	9	N	9	8	9	9+	8	E	G
Bicep/Bullet/Cinch ATZ	5/15	9+	9	6	8+	9	9	8+	9	8+	8+	8	9	9	8+	G	G
Degree Xtra[3]/FulTime NXT	5/15	9+	9	6	8+	9	9	8+	9	9	8+	8	9	9	8+	G	FG
Dual Products, Cinch	15	8+	N	N	N	N	6	N	7+	8	6	N	N	N	N	G	G
Intrro	15	8+	N	N	N	N	6+	N	7+	8+	6	N	N	6	N	G	G
Lexar	5/15/27	9	9	7	9	9	9	9	9	8+	8+	8+	9	9	9	G	F
Linex/Lorox	7	9	6	6	7	7	8+	6	6	9	7+	6	7+	8	7	G	G
Lumax	5/15/27	9	9	6	8+	9	9	8+	9	8+	9	8	7+	9	9	G	F
Outlook	15	8	N	N	N	N	6	N	7+	8	6	N	N	6	N	G	G
Verdict	14/15	9	—	6	8	8	9	8	9	9	8	8	7	9	8	G	G
Warrant	15	8	N	N	N	N	7	N	8+	9	7+	N	N	7	6	G	FG

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.
[2] Triazine-resistant (TR) biotypes of common lambsquarters and redroot/smooth pigweed are widespread in the region, and thus triazine (Group 5) herbicides are not effective against these populations.
[3] Degree Xtra may be less consistent on TR lambsquarters control compared to other acetochlor products.

Table 3-7. Comments on preplant or preemergence herbicides for conventional, min-, or no-till sorghum.

See specific herbicide label to determine correct rate for soil type and weed species found in each field. These treatments may be used in conventional, reduced-till, and no-till systems; treatments may be applied preplant-incorporated or preemergence, unless stated otherwise. Incorporation reduces the need for timely rainfall after application and may improve control of certain weeds. Higher rates for a given soil may be required for no-till. In no-till situations, burndown herbicides may be required to control weeds or cover crops present at time of application.

EPP = early preplant (application prior to planting; in most cases, 7 to 14 days before planting)
PPI = applied to conventionally tilled soil, then mechanically incorporated
PRE = preemergence (applied before the crop has emerged)
EPOST = early postemergence (during the early stages of crop and weed growth)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Atrazine 4L or Atrazine 90DF	atrazine	5	EPP, PPI, PRE	1–2 qt 1.1–2.2 lb	1–2

- Sorghum is not as tolerant to atrazine as corn.
- Labeled for grain and forage sorghum.
- Atrazine may be used at 1–2 qt/A. Usually used in combination with other herbicides at 1–1.5 qt.
- Can be applied to emerged corn up to 12 inches tall.
- On highly erodible ground with less than 30% surface residue, no more than 1.6 qt may be applied prior to crop emergence.
- Heavy rain immediately following application tends to cause excessive concentrations in seed furrow, result in higher risk of injury.
- Do not apply to coarse-textured soils (i.e., sand, loamy sand, and sandy loam), or injury may occur.
- Do not apply to medium- or fine-textured soils having less than 1% organic matter, or injury may occur.
- *Restricted-use pesticide and water quality advisory.*

Atrazine Use Restrictions

Preplant or Preemergence
On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):
- Fields where more than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.
- Fields where less than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb of active ingredient per acre as a broadcast spray.
- Apply a maximum of 2 lb of active ingredient per acre as a broadcast spray.

Safety Precautions for Using Atrazine
- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.

Bicep II Magnum 5.5L/ Cinch ATZ	s-metolachlor + atrazine	15 5	EPP, PPI, PRE	1.6–2.1 qt	0.96–1.26 1.22–1.6

- Labeled for grain or forage sorghum.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Not labeled for use on coarse-textured soils with less than 1% organic matter.
- Bicep Lite II Magnum and Cinch ATZ Lite are premixes of reduced-atrazine-rate ratios.
- See individual component sections in this table and atrazine use restrictions for additional information.
- *Restricted-use pesticides and water quality advisory.*

Bullet 4ME	alachlor + atrazine	15 5	EPP, PPI, PRE	2.5–4 qt	1.56–2.5 0.94–1.5

- Labeled for grain sorghum only.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- See individual component sections in this table and atrazine use restrictions for additional information.
- *Restricted-use pesticides and water quality advisory.*

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Callisto 4SC	mesotrione	27	EPP or PRE	6–6.4 fl oz	0.188–0.2

- Labeled for grain sorghum only.
- Do not apply to sorghum grown on sand, loamy sand, or sandy loam soils due to risk of sorghum injury.
- Do not apply to emerged sorghum, or injury will occur.
- Applying Callisto less than 7 days before planting will increase risk of crop injury, especially if irrigation or rainfall is received following application. Applying more than 7 days prior to planting will reduce risk of injury.
- Do not apply more than 21 days prior to planting.
- If applied prior to planting, minimize disturbance of the herbicide-treated soil during planting process.

Degree Xtra 4.04ME/	acetochlor +	15	EPP, PPI, PRE	2–3.7 qt	1.3–2.4
FulTime NXT 4.04CS	atrazine	5			0.67–1.23

- Labeled for grain sorghum only.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Do not apply preplant incorporated on course- or medium-textured soils.
- These products can be applied to emerged sorghum up to 11 inches in height.
- See individual component sections in this table and atrazine use restrictions and acetochlor restrictions.
- *Restricted-use pesticides and water quality advisory.*

Dual II Magnum 7.64EC/Cinch	s-metolachlor	15	EPP, PPI, PRE	1–1.67 pt	0.96–1.6

- Labeled for forage and grain sorghum.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Dual II Magnum/Cinch are similar in activity to Harness, Intrro, Outlook, and Warrant.
- Dual II Magnum/Cinch contains a crop-safening agent.
- Incorporation improves control of yellow nutsedge.
- Dual can be applied to emerged sorghum, but it will not control emerged weeds. Do not apply after emergence if Dual or an s-metolachlor-containing product was used prior to crop emergence.
- *Water quality advisory.*

Intrro 4EC	alachlor	15	EPP, PPI, PRE	1.5–2.25 qt	1.5–2.25

- Labeled for grain sorghum only.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Intrro is similar in activity to Dual, Harness, Outlook, and Surpass.
- For early preplant applications or fields with heavy surface plant residue, increase the rate of alachlor.
- *Restricted-use pesticide and water quality advisory.*

	s-metolachlor +	15			1.3
Lexar EZ 3.7SC	mesotrione +	27	EPP, PRE	3 qt	0.168
	atrazine	5			1.3
	s-metolachlor +	15			1.68
Lumax EZ 3.67SC	mesotrione +	27	EPP, PRE	2.7 qt	0.168
	atrazine	5			0.63
Zemax 3.67SC	s-metolachlor +	15	EPP, PRE	2 qt	1.67
	mesotrione	27			0.168

- Labeled for grain sorghum only.
- Applying less than 7 days before sorghum planting will increase the risk of crop injury, especially if irrigation or rainfall is received shortly after application.
- The label does not recommend application to sorghum grown on sandy soils (sand, sandy loam, or loamy sands).
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Do not apply to emerged sorghum, or severe injury will occur. See individual component sections in this table and atrazine use restrictions.
- *Restricted-use pesticides and water quality advisory.*

Linex 4L or	linuron	7	PRE	0.625–2 pt	0.25–1
Lorox 50DF				0.5–2 lb	

- Label does not specify sorghum type.
- Apply as tank mixture with other labeled herbicides.
- Apply after planting but before crop emergence.
- Plant seed at least 1 inch deep, or crop injury may occur.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Outlook 6.0EC	dimethenamid	15	EPP, PPI or PRE	12–21 fl oz	0.56–0.98

- Labeled for grain sorghum only.
- Outlook is similar in activity to Dual, Degree, and Intrro.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Outlook (dimethenamid) may be applied to sorghum up to 12 inches tall; Outlook will not control weeds that have emerged.
- Outlook is not recommended for coarse-textured soils due to limited residual control.
- For early preplant applications or fields with heavy surface plant residue, increase Outlook rate; see label.
- Verdict contains dimethenamid but will need additional Outlook added to provide consistent residual control; see Verdict label.
- Incorporation improves control of yellow nutsedge.
- *Water quality advisory.*

Verdict 5.57EC	saflufenacil +	14	EPP, PPI, or PRE	10 fl oz	0.38
	dimethenamid	15			0.045

- Labeled for grain sorghum only.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Verdict can be used in a burndown program or as a preemergence treatment. If used in a burndown program, it is best to include glyphosate and atrazine in addition to the necessary adjuvants (methylated seed oil [MSO] plus ammonium sulfate [AMS] or nitrogen solution) to improve control of emerged weeds including horseweed.
- Amount of dimethenamid in Verdict is low, additional Outlook can be included to improve residual control; refer to label for additional Outlook rates.
- Do not apply Verdict to emerged sorghum, or severe injury will occur.
- The use of Verdict can follow a burndown application of Sharpen (1 fl oz/A).
- *Water quality advisory.*

Warrant 3CS	acetochlor	15	EPP, PPI, or PRE	1.5–3 qt	1.125–2.25

- Labeled for forage and grain sorghum
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Acetochlor is similar in activity to Dual, Intrro, and Outlook, but it is more active on certain broadleaf weeds.
- Warrant may be applied on up to 11-inch-tall sorghum, but Warrant alone will not control emerged weeds.
- For early preplant applications or fields with heavy surface plant residue, the rate of acetochlor may need to be increased; refer to label.
- *Water quality advisory.*

Acetochlor Use Restrictions

- Do not apply within 50 feet of any well where depth to groundwater is 30 feet or less, sands with less than 3% organic matter, loamy sands with less than 2% organic matter, or sandy loams with less than 1% organic matter.
- Do not mix or load within 50 feet of any wells, streams, rivers, lakes, or reservoirs.
- Do not apply under conditions that favor runoff or wind erosion of soil containing this product to non-target areas.

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.

Table 3-8. Sorghum herbicide preplant or preemergence rates per acre based on soil texture and organic matter.

This table shows application rates for products applied alone. Rates may vary if tank-mixed with other products, if weed infestations are heavy, or if used in conservation tillage situations. See specific product label for additional information on application rates and use.

Trade Name	Site of Action Number	Unit	< 3% Organic Matter			>3% Organic Matter			Inc. for No-till
			Coarse	Medium	Fine	Coarse	Medium	Fine	
Atrazine 4L	5	qt	not recommended	1.6	1.6	not recommended	1.6	1.6	yes
Atrazine 90DF	5	lb	not recommended	1.8	1.8	not recommended	1.8	1.8	yes
Bicep II Magnum 5.5L/ Cinch ATZ	5/15	qt	do not use	2.1	2.1	do not use	2.1	2.1	yes
Bullet 4L	5/15	qt	2.5	2.75	3.0	2.75	3.0	3.5	yes
Callisto 4SC	27		do not use	6.0	6.0	do not use	6.0	6.0	no
Degree Xtra 4.04ME	5/15	qt	2.0	2.5	2.75	2.3	3.0	3.7	no
Dual II Magnum 7.64EC/Cinch	15	pt	1.33	1.67	1.67	1.3	1.67	1.67	yes
FulTime 4.04CS	5/15	qt	2.0	2.5	2.9	2.5	3.0	3.2	no
Intrro 4EC	15	qt	1.5	1.75	2.0	1.5	1.75	2.0	yes
Lexar EZ 3.7SC	5/15/27	qt	do not use	3.0	3.0	do not use	3.0	3.0	no
Linex 4L	7	pt	1.0	1.25	1.5	1.25	1.5	1.75	no
Lorox 50DF	7	lb	1.0	1.25	1.5	1.25	1.5	1.75	no
Lumax EZ 3.67SC	5/15/27	qt	do not use	2.7	2.7	do not use	2.7	2.7	no
Outlook 6.0EC	15	fl oz	14.0	18.0	18.0	16.0	18.0	20.0	yes
Verdict 5.57EC	14/15	fl oz	10.0	10.0	10.0	10.0	10.0	10.0	yes
Warrant 3CS	15	qt	1.5	1.75	3.0	2.0	2.5	2.75	no
Zemax 3.67SC	15/27	qt	do not use	2.0	2.0	do not use	2.0	2.0	no

Table 3-9. Relative effectiveness of postemergence herbicides.

Ratings are based on labeled application rates and weeds at 4 inch height. Results may differ with variations in weed size, temperature, rainfall soil moisture, and good spray coverage. Ratings are based only on postemergence activity and do not reflect possible residual activity. For ratings on herbicide combinations not listed, see the component parts.

Weed control rating:

10 = 95–100%	9 = 85–95%	8 = 75–85%
7 = 65–75%	6 = 55–65%	N = less than 55% or no control
— = no local data available		

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Grasses Trade Name (rate/A)[1]	Site of Action Number	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Atrazine (1 qt)	5	7+	N	6	7+	6	N	N	6	7	6	N	7	6	7
Basagran (1 qt)	6	N	N	N	N	N	N	N	N	8	N	N	N	N	N
Facet (>26 fl oz)	4	8	N	7	7	—	N	N	N	N	6	—	N	N	8
Huskie (12.8 fl oz)	6/27	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Linex/Lorox (POST directed)	7	7	—	8	8	8+	—	8	—	6	8	8	—	—	8
Permit (0.67 oz)	2	N	N	N	N	N	N	N	N	9+	N	N	N	N	N
Yukon (4 oz)	2	N	N	N	N	N	N	N	N	9+	N	N	N	N	N

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.

Broadleaves Trade Name (rate/A)[1]	Site of Action Number	Amaranth, Palmer/ Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Morningglory, Annual	Nightshade, Eastern Black	Pigweed	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Sorghum Tolerance
2,4-D (1 pt)	4	9	—	6	9	8	9	9	7	9	9	9	9	7	8	F
Aim (0.5 oz)	14	7	—	N	N	N	6	6	8	7	N	N	6	N	9	FG
Atrazine (1 qt)	5	9+	—	8	9	9	9+	9	9	N	9	8	8+	9+	8	FG
Basagran (1 qt)	6	N	7	N	9	9	8	N	N	6+	8	7	8	9	8+	FG
Buctril (1.5 pt)	6	N	—	8	9	9	9	8	9	7	7+	8	N	9	8+	F
Clarity/Banvel (8 fl oz)	4	9	—	7	9	9	9	9	8	9	9	9	8	9+	8	F
Facet (>26 fl oz)	4	N	—	—	—	—	6[2]	7	—	N	6[2]	6[2]	—	N	6[2]	G
Huskie (12.8 fl oz)	6/27	8	—	—	8+	7+	9	8	8+	8	8	7	—	8+	8	G
Linex/Lorox (POST directed)	7	9		—	8+	8+	8+	8	—	9	9	—	8	7	8+	FG
Marksman (1 qt)	4/5	9	—	8	9	9+	9	9	9	9	9+	9	9	9+	9	FG
Peak (0.75 oz)	2	9	—	—	N	8	8	7	—	9	9	6	6	7	8+	G
Permit/Sandea (0.67 oz)	2	9	—	6	9	N	N	6	6	9	9	8	7	8	9	G
Starane Ultra (6.4 fl oz)	4	7+	—	—	8+	—	—	8+	6	7+	8+	8+	—	—	8+	G
Yukon (4 oz)	2/4	9	—	6	9	9	9	9	8	9	9	8	8	9+	9	FG

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.
[2] Facet is labeled for suppression of this species on weeds less than 2 inches tall.

Table 3-10. Comments on postemergence herbicides for sorghum.

The following treatments are applied after sorghum emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name[1]	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
2,4-D amine 4S	2,4-D amine	4	grain only	6 to 15 inches; over 8 inches, drops recommended	1 pt	0.5

- Sorghum is not as tolerant to 2,4-D as corn.
- Apply between 6- and 15-inch-tall sorghum; if sorghum is over 8 inches tall, consider drop nozzles to keep spray off the foliage; do not treat during the boot, flowering, or dough stages.
- Do not apply during periods of rapid growth (high soil moisture, warm temperatures, recent nitrogen application) due to increased risk of crop injury.
- Make only one application per season to emerged sorghum.
- 2,4-D is volatile; be cautious of off-target movement.
- Surfactants can increase risk of injury; be cautious of surfactant use when tank-mixing with other herbicides.
- 2,4-D does not provide any residual weed control.

Aim 2EC	carfentrazone	14	grain only	4 inches to boot stage	0.5 fl oz	0.008

- At rate labeled for Aim 2EC, control is limited to weeds less than 3 inches tall, or morningglory with no more than 3 leaves, and velvetleaf up to 4 inches.
- Application timing is 4 inches tall to just prior to boot stage, but application should be based on small weeds.
- Tank-mix with other herbicides to increase weed control spectrum.
- Aim does not provide residual weed control.
- Use a non-ionic surfactant (NIS); do not use crop oil concentrate (COC) on emerged sorghum with either formulation.

Atrazine 4L or Atrazine 90DF	atrazine	5	grain, forage	before 12 inches 0.83–2.2 lb	0.75–2 qt	0.75–2

- Apply before sorghum exceeds 12 inches; apply before weeds are 1.5 inches tall.
- Sorghum is not as tolerant as corn to atrazine.
- If no atrazine was applied prior to sorghum emergence, maximum application rate is 2 qt/A. If POST application is following an earlier atrazine application, total atrazine amount cannot exceed 2.5 lb active ingredient.
- Length of residual control depends on rate applied.
- Add 1 qt crop oil concentrate (COC)/A to spray solution.

Atrazine Use Restrictions

Safety Precautions for Using Atrazine

- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.
- *Restricted-use pesticide and water quality advisory.*

Basagran 4S	bentazon	6	grain, forage	before heading	1.5–2 pt	0.75–1

- Apply to sorghum before heading or blooming; however, Basagran needs to be applied when weeds are small and actively growing.
- Basagran is weak on pigweed species, including Palmer amaranth.
- Tank-mix with atrazine to broaden spectrum of control.
- Label recommends use of crop oil concentrate.
- Split treatments may be required for yellow nutsedge and Canada thistle.
- Basagran does not provide residual weed control.
- *Water quality advisory.*

Clarity 4S (dicamba) or Banvel 4S	dicamba	4	grain, forage	spike to 15 inches; over 8 inches, drops recommended	4–8 fl oz	0.125–0.25

- May apply Clarity or Banvel at rates up to 8 fl oz from spike stage but before it is 15 inches tall; for best performance, apply when sorghum is in the 3- to 5-leaf stage; use drop nozzles if sorghum is taller than 8 inches to avoid spray getting into the whorl.
- Applications during periods of rapid growth may increase the risk of injury.
- Clarity formulation reduces the risk of off-target movement, but potential risks still exist.
- Under most situations, dicamba does not provide acceptable levels of residual weed control.
- Banvel provides minimal residual weed control.
- *Water quality advisory.*

(continued)

Trade Name[1]	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Facet 1.5L	quinclorac	4	grain only	before 12 inches tall	22–32 fl oz	0.25–0.375

- Sorghum stage is from emergence up to 12 inches tall.
- For best activity apply with atrazine at 0.5 to 1 lb ai to weeds less than 2 inches tall.
- Add 1 qt crop oil concentrate or methylated seed soil for better weed control. Ammonium sulfate (AMS) or urea ammonium nitrate (UAN) can also be added for improved efficacy. Non-ionic surfactant (NIS) plus a nitrogen source (AMS) may be used when Facet is tank-mixed with products that restrict use of crop oil concentrates.
- Facet can provide residual control of susceptible weed species.

Huskie 2.06EC	pyrasulfotole + bromoxynil	27 6	grain, forage	3 leaves to 30 inches tall (prior to flag leaf emergence)	12.8–16 fl oz	0.21–0.26

- Application timing for sorghum stage is 3-leaf up to 30 inches and/or prior to flag leaf emergence.
- Huskie label does not require a surfactant. Non-ionic surfactant (NIS) and ammonium sulfate (AMS) can be included under challenging growing conditions, or if tank-mix partner requires an additive.
- Huskie can be tank-mixed with atrazine at 0.25 to 1 lb ai to improve and broaden spectrum of control; see atrazine entry in this table for precautions.
- Addition of atrazine with Huskie is recommended for most situations.
- Two applications of Huskie can be applied POST, but there must be an interval of 11 days between Huskie applications.
- Crop injury can occur if Huskie is applied to fields treated with mesotrione (Lumax or Lexar).
- *Water quality advisory.*

Maestro (Buctril) 2E	bromoxynil	6	grain, forage	4 leaves to preboot stage	1–1.5 pt	0.25–0.375

- Apply to sorghum between 4-leaf stage and up to preboot stage; however, Maestro needs to be applied when weeds are small and actively growing.
- When applied alone, Maestro does not need any additional surfactant; when tank-mixing, it can be applied in combination with surfactants or crop oil concentrate.
- Maestro is weak on pigweed species, including Palmer amaranth.
- Maestro does not provide residual weed control.

Marksman 3.2L	dicamba + atrazine	4 5	grain, forage	before 12 inches tall	0.75–1 qt 0.39–0.53	0.20–0.27

- Apply Marksman before sorghum reaches 12 inches in height; label recommends application to sorghum in 2- to 3-leaf stage.
- Applications during period of rapid growth increases risk of injury.
- If no atrazine was applied prior to sorghum emergence, total atrazine amount cannot exceed 2 lb ai/A. If POST application is following an earlier atrazine application, total atrazine amount cannot exceed 2.5 lb ai/A.
- Do not add crop oil when applying to emerged sorghum.
- Be cautious of drift from Marksman (dicamba component).
- Marksman provides very short period of residual control.
- See additional restrictions under the atrazine entry.
- *Restricted-use pesticide and water quality advisory.*

Peak 57WG	prosulfuron	2	grain only	5 to 20 inches tall; over 20 inches, drops are recommended	0.5–1 oz	0.018–0.036

- Application timing is between 5 and 30 inches tall, and prior to head emergence; use drop nozzles after sorghum is 20 inches tall. Application should focus on weed size rather than crop stage.
- Tank-mix with other labeled POST herbicides to broaden spectrum of control.
- Peak applications should include a non-ionic surfactant (NIS). Crop oil concentrate can be included if tank-mix partner recommends COC.
- Refer to label for additional information on use and restrictions.
- Peak will provide residual control of susceptible species.
- Peak is an ALS (Group 2) herbicide and there is widespread resistance to Group 2 herbicides in the region. To prevent herbicide resistance, avoid repeated annual applications of ALS (Group 2) herbicides.
- *Water quality advisory.*

Permit 75WG or Sandea 75WG	halosulfuron	2	grain only	2 leaves to before head emergence	0.67–1 oz	0.031–0.047

- Apply from 2-leaf stage but before grain head emergence.
- The 0.67 oz rate is the standard rate for annual weed control.
- Permit/Sandea is excellent on yellow nutsedge but weak on common lambsquarters.
- Tank-mix with other labeled POST herbicides to broaden spectrum of control. Yukon is a prepackaged product containing Permit + dicamba.
- Permit/Sandea should be applied with non-ionic surfactant (NIS); use of crop oil concentrate (COC) increases risk of crop injury.
- Permit/Sandea will provide residual control of susceptible species.
- Permit/Sandea is an ALS (Group 2) herbicide and there is widespread resistance to Group 2 herbicides in the region. To prevent herbicide resistance, avoid repeated annual applications of ALS (Group 2) herbicides.

Trade Name[1]	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Starane Ultra 2.8L	fluroxypyr	4	grain, forage	3- to 7-leaf stage; use drops for 8-leaf to boot stage	0.4 pt (6.4 fl oz)	0.14

- Timing for broadcast application 3-leaf of sorghum through 7-leaf stage, and drop nozzles from 8-leaf to boot stage.
- Can be tank-mixed with other labeled herbicides to broaden spectrum of control.
- Surfactants not needed; Starane Ultra is applied alone, but surfactants may be used when required by tank-mix partner.
- Two applications of Starane Ultra can be made.
- Starane Ultra will not provide residual weed control.

Yukon 67.5WDG	halosulfuron + dicamba	2 4	grain only	2 to 15 inches tall; use drops after 8-leaf stage	4–6 oz	0.03 + 0.125

- Yukon is a premix of halosulfuron (Permit) plus the sodium salt of dicamba.
- Yukon can be applied from 2-leaf through 15-inch-tall sorghum; use drop nozzles after sorghum is 8 inches tall.
- Include non-ionic surfactant (NIS); crop oil concentrate (COC) can be used, but it increases the risk of injury.
- See entry for each component of Yukon for more information.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.
- Yukon will provide residual control of susceptible species.

POST Directed

Linex 4L or Lorox 50DF	linuron	6	label does not specify	1–2 pt 1–2 lb	0.5–1

- POST-directed application only. Do not apply over the top of emerged sorghum.
- Use only when there is sufficient differential between height of sorghum and weeds so that weeds are thoroughly covered and upper leaves of sorghum and whorl are not exposed to spray or drift.
- Include a non-ionic surfactant (NIS).
- Weeds should be treated prior to 2-inch-tall grass weeds and 6-inch broadleaf weeds.
- Linex/Lorox will provide residual control of susceptible species.

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.

Table 3-11. Weed sizes for postemergence sorghum herbicides.

This table lists postemergence sorghum herbicides, their rates, and height ranges of weed species that are controlled or suppressed. This table is for "quick reference" only; refer to the herbicide label for additional information on application and timing.

Grasses	Barnyardgrass	Bermudagrass	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Trade Name (rate/A)	Height Range (inches) at Application													
Atrazine (2 pt)	L-s[1]	—[2]	L-s	L-s	—	—	—	—	—	—	—	—	—	—
Basagran (2 pt)	—	—	—	—	—	—	—	—	8	—	—	—	—	—
Facet (>26 fl oz)	2	—	2	2	—	—	—	—	—	—	—	—	—	2
Linex/Lorox (directed)	2	—	2	2	2	—	—	—	—	2	2	—	—	2
Permit (0.67 oz)	—	—	—	—	—	—	—	—	6	—	—	—	—	—
Yukon (4 oz)	—	—	—	—	—	—	—	—	6	—	—	—	—	—

[1] L-s species are on the atrazine label as suppression.
[2] — = weed size is not on the herbicide label.

Broadleaves	Amaranth, Palmer/ Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Morningglory, Annual	Nightshade, Eastern Black	Pigweed spp.	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf
Trade Name (rate/A)	Maximum Height at Application (inches)													
2,4–D[1]	4	—	—	6	3	4	6	2	4	6	6	—	—	2
Aim (0.5 oz)	2	—	—	—	—	3	3 lvs	4	4	—	—	—	—	4
Atrazine (2 pt)[1]	4	—	4	4	4	6	4	4	—	4	4	4	4	2
Basagran (2 pt)	—	4	—	10	10	2*	—	—	—	3	6	4	10	5
Clarity/Banvel1	4	—	4	4	4	4	4	4	4	4	4	4	6	2
Facet (>26 fl oz)	—	—	—	—	—	—	2	—	—	2-s	2-s	—	—	2-s
Huskie (12.8 fl oz)	4	—	4	4	—	4	4	4	4	4	4	—	—	4
Linex/Lorox (directed)	6	—	—	6	—	6	6	—	6	6	—	6	6	—
Maestro/Buctril (1.5–2 pt)	—	—	4	10	6	8	4	6	2	6	6	—	6	5
Marksman (1 qt)[1]	6	—	4	6	6	6	6	6	4	6	6	4	8	6
Peak (0.75 oz)	4	—	4-s*	10	6	4	4-s*	—	5	10	3	3-s*	4	6
Permit/Sandea (0.67 oz)	—	—	3*	9	—	2*	—	—	3	9	3	3	2	9
Starane Ultra[2]	—	—	—	8	8	—	8	8-s*	—	8	8	—	—	8
Yukon (4–8 oz)	4–6	–	2–5	9–14	2–4	2–4	2–6	2–4	3–6	9–12	3–6	2–4	2–4	9–12

*Suppression only; additional control measures may be necessary.
[1] No sizes given on label; sizes listed above are best estimates.
[2] Starane Ultra label states that susceptible broadleaf species will be controlled if treated before they reach a height of 8 inches.

Table 3-12. Herbicide effectiveness on perennial broadleaf weeds.

Performance ratings are based on seasonal control from a postemergence application in sorghum.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control
— = no local data available

Trade Name (rate/A)	Site of Action Number	Artichoke, Jerusalem	Bindweed, Hedge	Dandelion	Dewberry spp.	Dock spp.	Dogbane, Hemp	Horsenettle	Ivy, Poison	Milkweed	Mugwort	Pokeweed	Thistle, Canada
2,4-D (1 pt)	4	7	8	8	6	7+	6	6	7	6	6	7	7+
Atrazine (1.5 lb ai)	5	N	7+	6	6	7	6	6	6	N	N	6	6
Basagran + atrazine (1 qt + 1 qt)	5/6	6+	7+	7	N	7+	6	7	7	N	N	6	8
Clarity/Banvel (8 fl oz)	4	8	**8+**	7+	6	8	7	7	7+	6	7+	6	8
Huskie + atrazine (12.8 fl oz + 0.75 lb ai)	27/6/5	L-s[1]	—	L-s	—	L-s	—	—	—	—	—	—	L-s
Marksman (1 qt)	4/5	8	**8+**	8	6	8	7	8	7+	6	7+	7	**8+**
Peak + Clarity (0.75 oz + 8 fl oz)	2/4	—	—	—	—	—	L-s	—	—	—	—	—	L-s
Starane Ultra (0.4 pt)	4	N	8	N	N	N	**8+**	N	N	N	N	N	N
Yukon (6 oz)	2/4	7	8	8	6	7	7	7+	—	8	7+	8	**8+**

[1] Herbicide label lists this species for partial control.

Table 3-13. Grain harvest and forage restrictions for sorghum herbicides.

Trade Name	Forage	Grain
	(days after treatment)	
2,4-D amine 4S	30	30
2,4-D LVE 4E	30	30
Aatrex, Atrazine 4L/90DF	60 PRE/45 POST	60 PRE/45 POST
Aim 2EC	not specified	not specified
Banvel 4S	do not graze or feed prior to mature grain stage	30
Basagran 4S	12	not specified
Bicep II Magnum 5.5EC/Cinch ATZ	60	not specified
Bullet 4ME	70	not specified
Callisto 4SC	not labeled for forage	not specified
Clarity 4S	do not graze or feed prior to mature grain stage	30
Degree Xtra 4.04ME	not labeled for forage	60
Dual II Magnum 7.64EC/Cinch	75	75
Facet L 1.5L	not specified	not specified
FulTime NXT 4.04CS	60	not specified
Huskie 2.06EC	7	60
Intrro 4EC	70	not specified
Lexar EZ 3.7SC	not specified	not specified
Lorox 50DF/Linex 4L	90	75
Lumax EZ 3.67SC	45	not specified
Maestro 2EC	45	not specified
Marksman 3.2L	21	60 PRE/45 POST
Outlook 6EC	60	80
Peak 57WG	30 graze/40 silage	60
Permit 75WG	30	30
Sandea 75WG	30	30
Sharpen 2.85SC	70	not specified
Starane Ultra 2.8L	40	70
Verdict 5.57EC	70	not specified
Warrant 3CS	60	not specified
Yukon 67.5WDG	30	30

Table 3-14. Comments on harvest aid herbicides for sorghum.

Treatments are based on broadcast application, not wiper-bar or rope-wick applications.

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
Aim 2EC	carfentrazone	14	1 fl oz	0.016
• Use as a harvest aid to desiccate a limited number of broadleaf weed species. • Application shall be made when the crop is mature and the grain has begun to dry down. • Use with a crop oil concentrate at 1% v/v (1 gal/100 gal). • Can be tank-mixed with glyphosate to improve the spectrum of control. • Apply in 10 gal/A water. • Include necessary adjuvants and make sure spray coverage is sufficient, otherwise poor control will result. • Allow at least 3 days between application and harvest.				
Defol 5	sodium chlorate		4.8 qt	6
• Labeled to dry weeds and facilitate harvest. • Apply to sorghum 7 to 10 days before anticipated harvest, when sorghum is mature and ready to harvest. • Use lower rates when grain moisture is low and weather is clear and dry; use higher rates when conditions for desiccation is poor. • Apply in at least 5 to 10 gallons of water by air, and 10 to 20 gallons of water with ground application.				
Glyphosate	glyphosate	9	varies with formulation	0.75–1.5
• Apply glyphosate to sorghum at 30% grain moisture. • Apply glyphosate in 10–20 gallons of water/A to control weeds that may interfere with harvest or to control perennials such as quackgrass or Canada thistle. • Allow a minimum of 7 days between application and harvest. • Do not use on sorghum grown for seed. • Will not control glyphosate-resistant weeds. • See Table 1-2 for more information on various glyphosate formulations.				

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Integrated Weed Management

Soybean fields that are weed free for the first 3 to 4 weeks after planting will often yield the same as fields that are weed free for the entire growing season. This approach relies on a residual soil-applied herbicide program. Weeds that germinate with the crop but are controlled in a timely fashion (3 to 4 weeks after planting) will not impact final yields. This approach relies on effective and timely postemergence weed control. Also, it is not necessary to control all weeds in a field to achieve maximum yield. Weed populations of 20 to 30 weeds per 100 square feet are sufficient to cause yield loss. However, weed populations of 10 plants per 100 square feet will have no impact on final yield. The impact of weed populations between 10 and 20 per 100 square feet is difficult to predict. The decision to treat the field depends on the weed species present, crop vigor, weather conditions, and herbicide cost.

Planting soybeans in narrow rows (15 inches less) will improve overall weed control since the crop canopy will close the rows sooner and help to outcompete smaller weeds.

Chemical Weed Control

Herbicides are useful tools in most weed management programs. They should be used to supplement, not replace, other methods or tools available. The following are definitions of terms you will find in this and similar publications on herbicides:

Early preplant (EPP). The herbicide is applied at least 14 days before planting. EPP applications are generally used in no-till systems to control existing vegetation and provide residual control of early emerging weed species.

Preplant. The herbicide is applied from 0 to 14 days before planting. Preplant applications are generally used in no-till systems to control existing vegetation and should include residual herbicides.

Preplant incorporated (PPI). The herbicide is applied to the soil after primary tillage but before planting, and mechanically mixed with the top 1 to 3 inches of soil with one of a variety of secondary tillage implements.

Preemergence (PRE). The herbicide is applied to the soil after the crop is planted but before emergence. Rainfall or irrigation is needed to move the herbicide into the zone of weed seed germination before weed emergence for maximum effectiveness. If adequate rainfall for herbicide activation does not occur, a shallow cultivation or rotary hoeing should be done to control weeds that have germinated.

Postemergence (POST). The herbicide is applied to the foliage of the crop and weeds after they have emerged.

Residual activity/soil-applied herbicide. These herbicides can be taken up by a plant's roots and shoots and injure or kill the plant. All soil-applied herbicides, as well as many postemergence herbicides, have residual activity. Length of residual activity ranges from a few weeks to the entire growing season.

Translocated herbicide. These herbicides move throughout the plant and can cause injury to the parts of the plants that do not come in direct contact with the herbicide spray.

Contact herbicide. These herbicides do not move throughout the plant. They cause injury to only those parts of the plant that come in contact with the spray. Spray coverage is more critical for contact than translocated herbicides.

Non-selective herbicide. This refers to herbicides that control a broad spectrum of plant species, including most crops and weeds. These herbicides are generally used with no-tillage production and sprayed prior to planting when control of all plants is required.

Herbicide-resistant Varieties

Some soybean varieties have been genetically enhanced to withstand herbicide applications that previously would have injured or killed soybeans. Some of these enhanced varieties were developed by genetic engineering, while others were developed through traditional breeding methods. Genetically enhanced varieties allow herbicides to be used that provide a broader spectrum of control than would otherwise be available while reducing the risk of crop injury. Herbicide-resistant soybean varieties include LibertyLink,, Roundup Ready, and STS and Bolt.

LibertyLink soybeans are GMO soybeans developed for over-the-top application of Liberty. This is a broad-spectrum weed control program, but it does not provide any residual weed control. Tank mixtures are necessary when fields are infested with late emerging weed species such as Palmer amaranth.

Roundup Ready soybeans were developed to allow over-the-top application of glyphosate, providing broad-spectrum control of annual broadleaf, grasses, and perennials weeds. Exclusive use of glyphosate has led to the selection of glyphosate-resistant weed biotypes.

STS and Bolt soybeans are non-GMO soybeans developed to be resistant to sulfonylurea herbicides (Group 2). STS were developed for their tolerance to Harmony (thifensulfuron) and Classic (chlorimuron). Bolt soybeans were developed for tolerance to Resolve (rimsulfuron). These varieties have the Roundup Ready trait as well. Weed biotypes resistant to Group 2 herbicides are widespread in the region.

Herbicide-resistant Weeds in Soybeans

Herbicide-resistant weeds are common in the Mid-Atlantic region. Populations of herbicide-resistant weeds are selected for by repeated use of the same or similar herbicide over a period of time. Resistance is most likely to occur with residual herbicides having one specific mode of action. Weed species with a very high amount of seed production and a variable genetic pool are more likely to develop resistant populations—for example, common lambsquarters and pigweed species. Resistance management requires using herbicides with multiple modes of action and integrating mechanical (tillage and cultivation) and cultural weed control (cover crops, narrow row spacing, proper crop fertility, etc.) with chemical weed control.

ALS resistance. Weeds resistant to the Group 2 herbicides in the Mid-Atlantic region include several pigweed species, common and giant ragweed, common chickweed, horseweed, Italian ryegrass, giant foxtail, Johnsongrass, and shattercane.

Glyphosate resistance. Weeds resistant to the Group 9 herbicide glyphosate in the Mid-Atlantic region include Palmer amaranth and waterhemp, common and giant ragweed, and horseweed. In soybeans, all of these can be managed with alternative herbicides, including those in Group 14 (PPO herbicides), Group 5 (triazine), or Group 10 (requires LibertyLink soybeans).

PPO resistance. Weed resistant to Group 14 herbicides include common ragweed. This is not widespread in the region, but there are a few fields with biotypes resistant to Groups 14, 2, and 9. The only option in these fields is applying metribuzin at planting and using LibertyLink soybeans and applying Liberty in a timely fashion.

Triazine resistance. Weeds resistant to the Group 5 herbicides in the Mid-Atlantic region include common lambsquarters, Palmer amaranth, redroot and smooth pigweed, horseweed, scattered populations of barnyardgrass, giant foxtail, goosegrass, and suspected populations of common ragweed and velvetleaf. Metribuzin is the primary triazine herbicide in may premixes. For triazine-resistant (TR) pigweed control, include a Group 14 (flumioxazin or sulfentrazone) or Group 15 herbicide (acetochlor, dimethenamid, metolachlor, or pyroxasulfone) at planting.

For TR lambsquarters, some of the Group 15 herbicides will help suppress emergence (acetochlor and pyroxasulfone), but they are not as active on lambsquarters as they are on pigweed. The Group 14 herbicides provide better control.

No-till Weed Management

Successful production of no-till soybeans requires control of existing vegetation at planting (cover crops and weeds) and summer annual weeds that emerge after planting. Existing vegetation is traditionally controlled by the non-selective herbicides, which are often tank-mixed with residual herbicides. However, in many fields the presence of winter annual weeds, such as horseweed, requires an application while these plants are small and more susceptible to non-selective herbicides; this may require an application 3 to 5 weeks prior to planting. Some residual herbicides, such as Canopy or Envive, can enhance burndown weed control. However, when the products are applied 14 to 28 days before soybean planting, they provide residual weed control for only a week or two after planting soybeans. In fields with weeds that are difficult to control, an application of a non-selective herbicide and 2,4-D should be used early to control winter annuals weeds, and a second application of the residual herbicides should be made at the time of soybean planting. This second application will improve overall weed control.

Weed Management for Soybeans Planted after Wheat or Barley

Weed control for soybeans grown after a small grain crop has additional considerations. As with full-season no-till, the fields should be treated to kill all weeds present at the time of planting. This includes winter annual weeds as well as summer annual weeds. The situation may involve controlling weeds that have been cut off and damaged during the small grain harvest operation, leaving little leaf surface to be treated. Plants maybe present that are resistant to both glyphosate and Group 2 herbicides (e.g., Palmer amaranth and horseweed). Summer annual species maybe present that require an application of glyphosate or a Group 1 herbicide (Select, etc.). Growers need an herbicide choice that does not further delay soybean planting, thus eliminating 2,4-D applications or Sharpen on coarse-textured soils. Local research shows that a combination of glyphosate plus Liberty before planting provides good control of many troublesome species without impacting grass control.

Postemergence weed control needs to be timely. Since late emerging weeds are often not as competitive as weeds emerging in the early summer, plants emerging 4 weeks after planting soybean often do not impact yields. Since double-cropped soybeans are treated in the late summer, be sure to observe crop rotations with herbicides. A 9-month crop rotation may be too short of an interval to treat soybeans postemergence and allow for an early spring-planted crop.

Management of Glyphosate-resistant Horseweed

Many of the horseweed populations in the region are glyphosate resistant, but in addition to glyphosate resistance, some populations in the region are also resistant to the ALS inhibitors (Classic, FirstRate, etc.). The most economical treatments for control include 2,4-D ester at 2 pints per acre applied to small plants (less than 3-inch rosettes) to ensure effective control. Herbicides containing Kixor will also provide excellent horseweed control if applied to small plants. A primary goal for horseweed management in soybean should be effective control of emerged plants prior to planting since there are very few options to control it once soybeans have emerged.

Management of Palmer Amaranth

Palmer amaranth control is difficult because (1) it emerges throughout the summer, so residual herbicides are important; (2) it grows rapidly, so once the plants emerge there are only a few weeks before it becomes too tall to control; and (3) many of the populations are resistant to glyphosate as well as Group 2 herbicides.

There are many herbicides that can provide effective control of Palmer amaranth when used in a timely manner, which includes using a residual herbicide applied within 7 to 10 days of planting and at the full labeled rates. Applying residual herbicides 2 weeks or more ahead of planting means there is a limited period of control once soybeans are planted. Postemergence applications should be made to small susceptible Palmer amaranth plants—according to various trials, about 4 weeks after the soil-applied herbicides were applied. The most consistent options have been fomesafen (Reflex or Flexstar GT) or Liberty (with LibertyLink soybeans). The postemergence herbicide applications should include a product that provides residual control of Palmer amaranth, such as fomesafen (Reflex), Dual, Outlook, Warrant, or Zidua. In double-cropped soybeans, rotation intervals may limit the use of Reflex, so Ultra Blazer can be used. Ultra Blazer will not provide residual control.

Table 4-1. Soybean herbicides and their restrictions.

Restricted-use pesticides can be purchased and used only by licensed applicators. To become licensed, contact your state's Department of Agriculture.

Herbicides with water quality advisory have properties that may result in groundwater or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for dissolved runoff and/or runoff erosion. See the herbicide label for specific restrictions.

Worker reentry is the minimum time between application and reentry into a treated area. If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

Trade Name[1]	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide	Water Quality Advisory	Worker Reentry (hours)
2,4-D amine 4S	2,4-D amine	4	several	—	—	48
2,4-D LVE 4E	2,4-D LVE	4	several	—	—	12
Afforia 50.8WG	flumioxazin + thifensulfuron + tribenuron	14/2/2	DuPont	—	—	12
Aim 2EC	carfentrazone ethyl	14	FMC	—	—	12
Anthem 2.15SE	pyroxasulfone + fluthiacet	15/14	FMC	—	yes	12
Anthem Maxx 4.3SC	pyroxasulfone + fluthiacet	15/14	FMC	—	yes	12
Assure II 0.88E/Targa	quizalofop	1	DuPont/Gowan	—	—	12
Authority Assist 4L	sulfentrazone + imazethapyr	14/2	FMC	—	yes	12
Authority Elite 7E/BroadAxe	sulfentrazone + s-metolachlor	14/15	FMC/Syngenta	—	yes	24
Authority First 70DF/Sonic 70DF	sulfentrazone + cloransulam	14/2	FMC	—	yes	12
Authority MTZ 45DF	sulfentrazone + metribuzin	14/5	FMC	yes	yes	12
Authority XL 70WG/Authority Maxx 66WG	sulfentrazone + chlorimuron	14/2	FMC	—	yes	12
Basagran 4S	bentazon	6	Arysta LifeScience	—	yes	12
Boundary 6.5EC	s-metolachlor + metribuzin	15/5	Syngenta	—	yes	12
BroadAxe 7E/Authority Elite	sulfentrazone + s-metolachlor	14/15	Syngenta/FMC	—	yes	24
Butyrac 200 2E	2,4-DB	4	Bayer CropScience	—	yes	48
Cadet 0.91EC	fluthiacet	14	FMC	—	yes	12
Canopy 75DF	chlorimuron + metribuzin	2/5	DuPont	—	yes	12
Canopy Blend 58.3DG	chlorimuron + metribuzin	2/5	DuPont	—	yes	12
Canopy EX 29.5WDG	chlorimuron + tribenuron	2/2	DuPont	—	—	12
Clarity 4S	dicamba	4	BASF	—	yes	24
Classic 25DF	chlorimuron	2	DuPont	—	—	12
Cobra 2E/Phoenix 2E	lactofen	14	Valent	—	—	12
Command 3ME	clomazone	13	FMC	—	—	12
Dual Magnum 7.62EC/Cinch	s-metolachlor	15	Syngenta	—	yes	24
Durango DMA2/Duramax 4S[2]	glyphosate	9	Dow AgroSciences	—	—	4
Enlite 48WDG	chlorimuron + flumioxazin + thifensulfuron	2/14/2	DuPont	—	—	12

(continued)

Trade Name[1]	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide	Water Quality Advisory	Worker Reentry (hours)
Envive 41.3WDG	chlorimuron + flumioxazin + thifensulfuron	2/14/2	DuPont	—	—	12
Extreme 2.17L[2]	imazethapyr + glyphosate	2/9	BASF	—	yes	48
Fierce 76WDG	pyroxasulfone + flumioxazin	15/14	Valent	—	yes	12
Fierce XLT 62.41WDG	pyroxasulfone + flumioxazin + chlorimuron	15/14/2	Valent	—	yes	12
FirstRate 84WDG	cloransulam-methyl	2	Dow AgroSciences	—	yes	12
Flexstar GT 3.5 2.82L[2]	fomesafen + glyphosate	14/9	Syngenta	—	yes	24
Fusilade DX 2E	fluazifop	1	Syngenta	—	—	12
Fusion 2.56E	fluazifop + fenoxaprop	1/1	Syngenta	—	—	24
Gangster (co-pack)/Surveil (co-pack)	flumioxazin + cloransulam	14/2	Valent	—	yes	12
Gramoxone SL 2S	paraquat	22	Syngenta	yes	—	12
Harmony SG 50WDG	thifensulfuron	2	DuPont	—	—	4
Interline 2.34SL[3]	glufosinate	10	United Phosphorus, Inc.	—	—	12
Intrro 4EC	alachlor	15	Monsanto	yes	yes	12
LeadOff	rimsulfuron + thifensulfuron	2/2	DuPont	—	—	4
Liberty 280 2.34SL[3]	glufosinate	10	Bayer CropScience	—	—	12
Lorox 50DF/Linex 4L	linuron	7	Nova Source	—	—	24
Marvel 3L	fluthiacet + fomesafen	14/14	FMC	—	yes	24
Metribuzin 75DF/4L	metribuzin	5	various	—	yes	12
OpTill 68WG	saflufenacil + imazethapyr	14/2	BASF	—	yes	12
OpTill PRO (co-pack)	saflufenacil + imazethapyr + dimethenamid-p	14/2/15	BASF	—	yes	12
Outlook 6EC	dimethenamid-P	15	BASF	—	yes	12
Panoflex 50WDG	thifensulfuron + tribenuron	2/2	DuPont	—	—	12
Permit Plus 74WDG[4]	halosulfuron + thifensulfuron	2/2	Gowan	—	—	12
Poast 1.5E	sethoxydim	1	BASF	—	—	12
Poast Plus 1E	sethoxydim	1	BASF	—	—	12
Prefix 5.3EC	s-metolachlor + fomesafen	15/14	Syngenta	—	yes	24
Prowl 3.3E/H2O 3.8CS	pendimethalin	3	BASF	—	—	12
Pursuit 2S	imazethapyr	2	BASF	—	yes	12
Python 80WDG/Accolade	flumetsulam	2	Dow AgroSciences/ FMC	—	yes	12
Raptor 1S	imazamox	2	BASF	—	—	4
Reflex 2E/Flexstar 1.88E	fomesafen	14	Syngenta	—	yes	24
Resource 0.86EC	flumiclorac	14	Valent	—	—	12
Roundup WeatherMAX/ PowerMAX 4.5S[2]	glyphosate	9	Monsanto	—	—	4
Rowel 51WDG/Valor	flumioxazin	14	Monsanto/Valent	—	—	12

Trade Name[1]	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide	Water Quality Advisory	Worker Reentry (hours)
Rowel FX 40.3WDG/Valor XLT	chlorimuron + flumioxazin	2/14	Monsanto/Valent	—	—	12
Scepter 70DG	imazaquin	2	AMVAC	—	—	12
Select 2E/Max 0.97E	clethodim	1	Valent	—	—	12
Sequence[2]	s-metolachlor + glyphosate	15/9	Syngenta	—	yes	24
Sharpen 2.85SC	saflufenacil	14	BASF	—	yes	12
Sonic 70WG	sulfentrazone + cloransulam	14/2	Dow AgroSciences	—	yes	12
Spartan 4F	sulfentrazone	14	FMC	—	yes	12
Storm 4S	acifluorfen + bentazon	14/6	United Phosphorus, Inc.	—	yes	48
Surveil 48WG (co-pack)/ Gangster	flumioxazin + cloransulam	14/2	Dow AgroSciences	—	yes	12
Synchrony XP 28.4WDG[4]	chlorimuron + thifensulfuron	2/2	DuPont	—	—	12
Touchdown HiTech 5S[2]	glyphosate	9	Syngenta	—	—	12
Touchdown Total 4.17S[2]	glyphosate	9	Syngenta	—	—	12
Treflan, Tri-4, Trific, Trilin 4E	trifluralin	3	Dow AgroSciences	—	—	12
Trivence 61.3WDG	chlorimuron + flumioxazin + metribuzin	2/14/5	DuPont	—	yes	12
Ultra Blazer 2S	acifluorfen	14	United Phosphorus, Inc.	—	yes	48
Valor SX 51WDG	flumioxazin	14	Valent	—	—	12
Valor XLT 40.3WDG	chlorimuron + flumioxazin	2/14	Valent	—	—	12
Verdict 5.57EC	saflufenacil + dimethenamid-P	14/15	BASF	—	yes	12
Warrant 3CS	acetochlor	15	Monsanto	—	yes	12
Warrant Ultra 3.45CS	acetochlor + fomesafen	14/15	Monsanto	—	yes	24
Zidua 85WDG	pyroxasulfone	15	BASF	—	yes	12
Zidua PRO 4.09SC	imazethapyr + pyroxasulfone + saflufenacil	2/15/14	BASF	—	yes	12

[1] Generic alternatives to some of these products are available. See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.
[2] May be applied over the top on Roundup Ready soybean varieties only.
[3] For use on LibertyLink soybean varieties only.
[4] For use on STS soybean varieties only.

Table 4-2. Soybean herbicide prepackaged mixes, or co-packs, and equivalents.

Trade Name	Components (ai or ae/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai or ae lb/A)	An Equivalent Tank Mixture of
Afforia 50.8WG	0.408 lb flumioxazin	14	2.5 oz	0.064 flumioxazin	2 oz Valor SX 51WDG
	0.05 lb thifensulfuron	2		0.008 thifensulfuron	0.17 oz Harmony 75DF
	0.05 lb tribenuron	2		0.008 tribenuron	0.25 oz Express 50DF
Anthem 2.15SE	2.087 lb pyroxasulfone	15	6 fl oz	0.098 pyroxasulfone	1.86 oz Zidua 85WDG
	0.063 lb fluthiacet	14		0.003 fluthiacet	0.42 fl oz Cadet 0.91E
Anthem Maxx 4.3SC	4.174 lb pyroxasulfone	15	3 fl oz	0.098 pyroxasulfone	1.86 oz Zidua 85WDG
	0.126 lb fluthiacet	14		0.003 fluthiacet	0.42 fl oz Cadet 0.91E
Authority Elite 7SE or BroadAxe	0.7 lb sulfentrazone	14	28 fl oz	0.153 sulfentrazone	4.9 fl oz Spartan 4L
	6.3 lb s-metolachlor	15		1.38 s-metolachlor	1.45 pt Dual Magnum 7.62EC
Authority First 70DF	0.621 lb sulfentrazone	14	6.45 oz	0.25 sulfentrazone	5.28 oz Authority 75DF
	0.079 lb cloransulam	2		0.032 cloransulam	0.6 oz FirstRate 84WDG
Authority MTZ 45DF	0.18 lb sulfentrazone	14	16 oz	0.18 sulfentrazone	3.8 oz Authority 75DF
	0.27 lb metribuzin	5		0.27 metribuzin	5.8 oz metribuzin 75DF
Authority XL 70WG	0.62 lb sulfentrazone	14	7 oz	0.27 sulfentazone	5.76 oz Authority 75DF
	0.08 lb chlorimuron	2		0.035 chlorimuron	2.24 oz Classic 25DF
Boundary 6.5L	5.25 lb s-metolachlor	15	2 pt	1.24 s-metolachlor	1.3 pt Dual Magnum 7.62EC
	1.25 lb metribuzin	5		0.314 metribuzin	6.7 oz metribuzin 75DF
Canopy 75DF	0.107 lb chlorimuron	2	5 oz	0.033 chlorimuron	2.14 oz Classic 25DF
	0.643 lb metribuzin	5		0.2 metribuzin	4.27 oz metribuzin 75DF
Canopy Blend 58.3DG	0.083 lb chlorimuron	2	6.5	0.033 chlorimuron	2.14 oz Classic 25DF
	0.5 lb metribuzin	5		0.2 metribuzin	4.27 oz metribuzin 75DF
Canopy EX 29.5WDG	0.227 lb chlorimuron	2	2.2 oz	0.031 chlorimuron	2 oz Classic 25DF
	0.068 lb tribenuron	2		0.009 tribenuron	0.2 oz Express 75DF
Envive 41.3WDG	0.292 lb flumioxazin	14	5.3 oz	0.094 flumioxazin	3 oz Valor SX 51WDG
	0.029 lb thifensulfuron	2		0.009 oz thifensulfuron	0.2 oz Harmony 75DF
	0.092 lb chlorimuron	2		0.031 chlorimuron	1.9 oz Classic 25DF
Extreme 2.17L	0.17 lb imazethapyr	2	3 pt	0.063 imazethapyr	4 fl oz Pursuit 2L
	1.48 lb ae glyphosate	9		0.56 lb ae glyphosate	1.5 pt Roundup 4S
Fierce 76WDG	0.335 lb flumioxazin	14	3 oz	0.063 flumioxazin	2 oz Valor SX 51WDG
	0.425 lb pyroxasulfone	15		0.08 pyroxasulfone	1.5 oz Zidua 85WDG
Fierce XLT 62.41WDG	0.3117 lb pyroxasulfone	15	4 oz	0.078 pyroxasulfone	1.47 oz Zidua 85WDG
	0.2457 lb flumioxazin	14		0.061 flumioxazin	1.93 oz Valor SX 51WDG
	0.0667 lb chlorimuron	2		0.017 chlorimuron	1.07 oz Classic 25DF
Flexstar GT3.5L	0.56 lb fomesafen	14	4.5 pt	0.315 fomesafen	1.3 pt Reflex 2E
	2.26 lb ae glyphosate	9		1.28 lb ae glyphosate	1.3 qt Touchdown Total 4.17S
Fusion 2.67E	2 lb fluazifop	1	8 fl oz	0.125 fluazifop	8 fl oz Fusilade DX 2E
	0.67 lb fenoxaprop	1		0.042 fenoxaprop	0.042 lb fenoxaprop
Gangster CoPack	flumioxazin	14	3 oz	0.080 flumioxazin	2.5 oz Valor SX 51WDG
	cloransulam	2		0.026 cloransulam	0.5 oz FirstRate 84WDG
Marvel 3L	0.117 lb fluthiacet	14	7.25 fl oz	0.007 fluthiacet	0.9 fl oz Cadet 0.91E
	2.883 lb fomesafen	14		0.163 fomesafen	10.4 fl oz Reflex 2E
OpTill 68WG	0.502 lb imazethapyr	2	2 oz	0.063 imazethapyr	4 fl oz Pursuit 2L
	0.178 lb saflufenacil	14		0.022 saflufenacil	1 fl oz Sharpen 2.85SC

Trade Name	Components (ai or ae/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai or ae lb/A)	An Equivalent Tank Mixture of
OpTill PRO CoPack	dry: 0.502 lb imazethapyr	2	dry: 2 oz wt	0.063 imazethapyr	4 fl oz Pursuit 2L
	+ 0.178 lb saflufenacil	14		0.022 saflufenacil	1 fl oz Sharpen 2.85SC
	liquid: 6 lb dimethenamid	15	liquid: 10 fl oz	0.469 dimethenamid	10 fl oz Outlook 6EC
Permit Plus	0.662 lb halosulfuron	2	1.25 oz	0.052 halosulfuron	1.1 oz Permit 75WDG
	0.078 lb thifensulfuron	2		0.006 thifensulfuron	0.128 oz Harmony 75DF
Prefix 5.3EC	4.34 lb s-metolachlor	15	2 pt	1.05 s-metolachlor	1.1 pt Dual Magnum 7.62EC
	0.95 lb fomesafen	14		0.24 fomesafen	0.95 pt Reflex 2E
Sonic 70DF	0.621 lb sulfentrazone	14	6.45 oz	0.25 sulfentrazone	5.28 oz Authority 75DF
	0.079 lb cloransulam	2		0.032 cloransulam	0.6 oz FirstRate 84WDG
Storm 4S	2.67 lb bentazon	6	1.5 pt	0.50 bentazon	1 pt Basagran 4S
	1.33 lb acifluorfen	14		0.25 acifluorfen	1 pt Blazer 2S
Surveil 48WDG	0.36 lb flumioxazin	14	3.5 oz	0.080 flumioxazin	2.5 oz Valor SX 51WDG
	0.12 lb cloransulam	2		0.026 cloransulam	0.5 oz FirstRate 84WDG
Synchrony XP 28.4WDG	0.215 lb chlorimuron	2	0.375 oz	0.005 chlorimuron	0.32 oz Classic 25DF
	0.069 lb thifensulfuron	2		0.0014 thifensulfuron	0.03 oz Harmony 75DF
Trivence 61.3WDG	0.039 lb chlorimuron	2	6 oz	0.014 chlorimuron	0.9 oz Classic 25DF
	0.128 lb flumioxazin	14		0.048 flumioxazin	1.5 oz Valor 51WDG
	0.446 lb metribuzin	5		0.169 metribuzin	3.6 oz metribuzin 75DF
Valor XLT 40.3WDG or Rowel FX	0.3 lb flumioxazin	14	3.5 oz	0.065 flumioxazin	2.1 oz Valor SX 51WDG
	0.103 lb chlorimuron	2		0.022 chlorimuron	1.44 oz Classic 25DF
Verdict 5.57EC	5 lb dimethenamid	15	5 fl oz	0.19 dimethenamid	4 fl oz Outlook 6EC
	0.57 lb saflufenacil	14		0.022 saflufenacil	1 fl oz Sharpen 2.85SC
Warrant Ultra 3.45CS	2.82 lb acetochlor	15	3 pt	1.06 acetochlor	2.8 pt Warrant 3CS
	0.631 lb fomesafen	14		0.24 fomesafen	15 fl oz Reflex 2E

Table 4-3. Relative effectiveness of burndown herbicides for control of weeds in no-till full-season soybeans.

Relative effectiveness of herbicides on individual weeds that are commonly present prior to planting soybeans are listed in this table. Ratings are based on labeled application rates and weed size or growth stage, which often means an application is made weeks prior to planting. Delaying applications will result in reduced control. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control
— = not applicable or no local data available

Herbicide[1]	Site of Action Number	Brome, Downy	Burdock, Common	Chickweed	Dandelion	Dock, Curly	Dogbane, Hemp; Dewberry; Milkweed; etc.	Evening Primrose, Cutleaf	Fleabanes, Annual	Foxtail spp.	Garlic, Wild	Geranium, Carolina	Groundsel, Common[2]	Henbit/Deadnettle	Horseweed/Marestail[2]	Lambsquarters	Mustard spp.	Quackgrass	Ragweed, Common	Smartweed	Thistle, Canada	Violet, Field/Pansy
2,4-D (spring-applied) (1 qt)	4	N	7	6	8	7	N	9	6	N	7	—	6	N	8+	9	9	N	9	7	8	6
Glyphosate (fall-applied)[3]	9	9	8+	9	9	7	8+	7	8	—	9	8	9	8	8+[4]	—	9	9	—	—	9	7
Glyphosate (spring-applied)[3]	9	9	7	9	6	6	7	6	7+	9+	8	7	9	6	8	9	8	8	9	7	8	6
Glyphosate + 2,4-D (fall-applied)	9/4	9	9+	9	9	7	9	9+	9[4]	—	9	8	9	8+[4]	9+[4]	—	9[4]	9	—	—	9+	7
Glyphosate + 2,4-D (spring-applied)	9/4	9	7+	9	8	7	7+	9	8	9+	8	7	9	8+	9	9	9	9	9	8+	8+	7+
Glyphosate + metribuzin	9/5	9	7	9	6	6	7	6	8	9	8	7	9	8+	8+	9	9	9	9	9	8	8
Gramoxone	22	7	N	8+	N	N	6	7	6	9	6	8	8+	7	7	8	8	6	8	7	6	8
Gramoxone + 2,4-D[3]	22/4	7	7	9	7	7	6	9	7	9	7	8	8+	8	8+	9	9	6	9	8+	8	8+
Gramoxone + metribuzin	22/5	7	6	9	N	N	6	8	6	9	6	9	8+	8	8	8	8+	6	9	9+	6	8
Harmony Extra	2/2	N	6	9	6	8	6	—	N	N	8+	—	9	8	7+	9	9	N	6	9+	8	N
Liberty	10	6	6	8	6	—	N	—	8	8	—	—	7	6	8	8	8	6	8	8	6	N
Sharpen	14	N	N	6	7	—	N	N	7+	N	—	—	8	6	8	8	8	N	8	8	6	N
Sharpen + glyphosate	14/9	9	7	9	8	—	7	6	8	9+	—	—	9	6	9	9	9	8	9	9	8	6
Valor	14	—	N	9	7[5]	N	N	6	N	N	—	—	7	N	6	9	8	N	7	7	N	8+

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.
[2] Roundup, Touchdown, and other glyphosate products are not effective on glyphosate-resistant horseweed biotypes.
[3] Activity is reduced if applied in certain tank-mixes, Roundup or Touchdown with photosynthesis inhibitors such as triazine herbicides, or 2,4-D with Gramoxone. May still be tank-mixed for convenience, but burndown is improved if applied separately.
[4] Based on control in early spring. Emergence of seedlings in the spring will reduce full-season control.
[5] Valor provides control of germinating dandelion seedling; however, it is weak on dandelion when applied POST.

Table 4-4. Relative effectiveness of herbicides for control of common cash or cover crops in the spring before planting soybeans.

Cover crop control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control

Herbicide	Rate (lb ai/acre)[1]	Alfalfa[2]	Bluegrass/Timothy[2]	Bromegrass/ Orchardgrass/Fescue[2]	Clover, Crimson	Clover, Red[2]	Clover, White	Mustards/Radish/ Rapeseed	Rye, Cereal	Ryegrass, Annual	Wheat, Winter	Vetch, Hairy
2,4-D ester	0.5	7+	N	N	7	8	6	7+	N	N	N	**9**
	1	8	N	N	8	**9**	7	**8+**	N	N	N	**10**
Glyphosate	0.75	6	**9**	8	8	7	6	6	**9**	8	**9**	7
	1.5	7	**9+**	**8+**	**8+**	7+	7	7+	**9**	**9**	**9**	8
Glyphosate + 2,4-D ester	0.75 + 0.5	**8+**	**9**	8	**9**	8	8	8	**9**	8	**9**	**10**
Paraquat	0.5	N	7	6	8	7	7	7	7	6	8	7
	0.75	N	7+	7	**9**	8	7	8	8	6	**8+**	8
Paraquat + 2,4-D	0.75 + 0.5	7+	7	6	**9**	**8+**	8	8	8	6	**8+**	**10**
Paraquat + metribuzin	0.5 + 0.25	7	**9**	8	**10**	**8+**	7	**8+**	**8+**	7	**8+**	**9**

[1] 0.75 lb glyphosate = 32 fl oz of a 41% glyphosate; 0.5 lb paraquat = 2 pt Gramoxone SL; see Table 1-2 (glyphosate table) for more information on glyphosate formulations.
[2] Application in the fall can improve control with some herbicides.

Table 4-5. Comments on burndown herbicides for no-till soybeans.

In no-till situations, burndown herbicides may be required to control weeds or cover crops present at time of application. See appropriate tables for relative effectiveness of burndown herbicides.

Fall applications are one strategy to manage difficult-to-control winter annuals. Winter annuals are more susceptible in the fall because they are (1) smaller; (2) have not been stressed by cold wintery weather; and (3) air and soil temperatures are higher so plants are "actively" growing. However, many species may have a prolonged germination period and seedlings could emerge after application. There has been interest in including a residual herbicide with the non-selective to reduce the likelihood of weed emergence. Products labeled for this use are:

- Authority First
- Authority XL
- Autumn Super
- Canopy EX
- Envive
- Fierce XLT
- Gangster
- Valor XLT

Refer to product label for rates and precautions for fall applications. Note: Many of these products have rotation restrictions that require soybeans only be planted in the spring after fall applications.

University of Delaware and University of Maryland research has not found a residual herbicide that will consistently provide residual control over the winter and early spring, as most fields will still require an additional burndown application before planting. Furthermore, this approach leaves the soil surface bare over the winter and early spring months and therefore exposed to wind and water erosion.

Residual Herbicides That Can Enhance Preplant Burndown Control

Products containing cloransulam (FirstRate), chlorimuron (Classic), and thifensulfuron (Harmony) have some activity on emerged broadleaf weeds and can improve preplant burndown control. However, these products will not control ALS-resistant biotypes. When using an herbicide with one of these active ingredients as part of a burndown program, use full labeled rates, follow label recommendations for adjuvants, and apply to small, actively growing weeds. If relying on these herbicides to provide residual weed control, applications should be made within 7 to 10 days of planting. Applications earlier than this may require a postemergence (POST) herbicide application shortly after planting. Prepackage mixtures containing these specific active ingredients include the following:

Cloransulam (FirstRate)	Chlorimuron (Classic)	Thifensulfuron (Harmony)	Flumioxazin (Valor)
Authority First	Authority XL	Afforia	Afforia
Gangster	Canopy DF/Blend	Canopy EX	Envive
Sonic	Canopy EX	Envive	Fierce
Survell	Envive	Synchrony	Fierce XLT
	Fierce XLT		Gangster
	Synchrony XP		Survell
	Trivence		Trivence

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D 4L formulations (many trade names)	2,4-D	4	0.5–2 pt	0.25–1 ae lb

- For spring applications, the 1 qt rate of 2,4-D has been more effective and more consistent than lower rates. Applications made 30 days preplant have been more effective on horseweed than applications made 14 days preplant.
- Apply 2,4-D ester (LVE) at 1 qt at least 30 days before planting, 1 pt or less at least 7 days ahead of planting, or up to 2 pt at least 30 days before planting; some LVE formulations allow a 15-day interval between application and planting soybean (e.g., Salvo, Shredder E-99, Weedone 650).
- 2,4-D amine at 1 qt should be applied 30 days before planting and at 1 pt or less at least 15 days ahead of planting.
- Add 2,4-D to paraquat or glyphosate for added burndown of hard-to-control broadleaf weeds.
- Use 2,4-D for added control or suppression of mustard spp., plantains, horseweed, and 2,4-D susceptible annual broadleaf weeds.
- Do not apply 2,4-D prior to planting soybeans if you are not prepared to accept the results of soybean injury, including possible loss of stand and yield.
- Do not apply when weather conditions favor drift.

Canopy 75DF/ Canopy Blend 58.3DG	chlorimuron +	2	4–8 oz	0.026–0.053
	metribuzin	5	5–9 oz	0.16–0.32

- Metribuzin will enhance the activity of paraquat or glufosinate when used as a tank mixture for burndown weed control.
- See comments in preemergence section.

Canopy EX 29.5DG	chlorimuron +	2	1.1–3.3 oz	0.016–0.047
	tribenuron			0.0047–0.013

- Apply with glyphosate or Gramoxone to no-till fields any time after harvest in the fall at 2.2 to 3.3 oz/A up to 14 days before soybean planting, or 1.1 to 2.2 oz/A up to 7 days before soybean planting; consult label for details.
- For best results apply to annual weeds less than 3 inches in height or diameter and perennial weeds less than 6 inches in height or diameter.
- The addition of 1 pint/A of 2,4-D ester is recommended, and required for some species.
- Applications must include either a crop oil concentrate or a non-ionic surfactant. Crop oil concentrate is the required adjuvant unless tank-mixing with a product that precludes its use.
- On soils with pH 7.0 or less, Canopy EX can be applied at rates of 1.5–3.3 oz/A and will provide residual control or suppression of several winter and summer annual weeds through normal planting dates, but it will not provide season-long control.

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
Glyphosate[1]	glyphosate	9	varies by formulation and acid equivalent	0.36–3 lb ae

- Fall applications of glyphosate are better than spring applications for control of orchardgrass sods and quackgrass. Spring applications may be used to control annual weeds. For control of most annual weeds, apply 0.75–1.13 lb ae/acre.
- Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers. Do not use glyphosate with suspension-type liquid fertilizers.
- Use rates vary by product, formulation, and weed size. Higher rates are usually recommended for annual weeds taller than 6 inches.
- To aid in the control of marestail/horseweed, mustard species, common lambsquarters, common ragweed, and other emerged, susceptible broadleaf weeds, 2,4-D or dicamba may be added.
- Glyphosate is available in some prepackaged mixtures, but glyphosate rate may not be adequate for burndown control.

Gramoxone SL	paraquat	22	2–4 pt	0.48–1

- Use appropriate precautions when handling paraquat to minimize exposure to the herbicide.
- Apply in 20 to 60 gallons of water per acre; increase gallonage as density of stubble, crop residue, or weeds increases.
- Rate is dependent on weed size (see label). Paraquat may not control weeds taller than 6 inches.
- 2,4-D at 0.5–0.75 pint per acre may be added to this program for additional control of marestail (horseweed), common lambsquarters, common ragweed, and other emerged, susceptible broadleaf weeds.
- Phosphate-containing liquid fertilizers diminish paraquat activity.
- The addition of metribuzin will improve overall control with paraquat (this includes Glory, TriCor, Boundary, Canopy, Trivence, and Authority MTZ).
- *Restricted-use pesticide.*

Liberty 280 2.34SL	glufosinate	10	29–36 oz	0.53–0.66

- Liberty 280 may be applied as a burndown treatment prior to the planting or emergence of any conventional or transgenic soybean variety.
- Apply a minimum of 29 fl oz/A to young, actively growing weeds; burndown and in-crop applications may not exceed 65 fl oz/A per season.
- Warm temperatures, high humidity, and bright sunlight improve the performance of Liberty 280. Weed control may be reduced when applications are made to weeds under stress from drought or cool temperatures.
- Liberty 280 performs better as a POST herbicide or burndown for double-cropped soybeans compared to burndown applications in April.
- Liberty 280 must be applied with ammonium sulfate at the rate of 3 lb/A.
- Uniform, thorough spray coverage is necessary to achieve consistent weed control; do not use nozzles that produce large droplets; use at least 15 gal/A (20 gal/A if dense vegetation is present).

Sharpen 2.85SC	saflufenacil	14	1–2 oz	0.022–0.044

- Sharpen may be applied as a burndown treatment from 44 days early preplant through preemergence timings as directed on the label.
- Apply Sharpen in a typical glyphosate or glufosinate burndown herbicide program to increase weed spectrum, including glyphosate-resistant horseweed; 1.5 oz provides more consistent horseweed control than lower rates.
- The label requires use of methylated seed oil (MSO) plus a nitrogen source.
- On coarse-textured soils with less than 2% organic matter: a minimum of 30 days between application of 1 to 1.5 oz of Sharpen and soybean planting is required; minimum of 44 days between application of 2 oz of Sharpen and soybean planting.
- All other soils: no waiting period if 1 oz of Sharpen is applied; minimum of 14 days between applications of 1.5 oz of Sharpen and planting on all other soil types; and 30 days if 2 oz of Sharpen is used.
- Do not apply during soybean cracking stage or after emergence, as severe crop damage will occur. Control of emerged grasses will require adding an additional herbicide.
- Do not apply Sharpen with other Group 14 herbicides such as sulfentrazone or flumioxazin as a tank-mix or sequential application within 30 days, or crop injury may result on coarse-textured soils with less than 2% organic matter, and a minimum of 14 days is required on all other soil types (see label).
- Local research indicates limited residual control with Sharpen at rates and use pattern for soybeans.
- Sharpen is a Group 14 herbicide and due to concerns for long-term viability of this herbicide mode of action, extension specialists in the Mid-Atlantic region recommend not using it every year. This mode of action has greater utility in soybeans than corn, especially for control of glyphosate-resistant horseweed (marestail). As such, we suggest that Sharpen and other saflufenacil-containing products (e.g., Verdict, OpTill) be used in soybean and only in alternate years. The use of Sharpen in continuous corn should also be limited to every other year (alternating years with HPPD-containing herbicide [Group 27]).
- OpTill, OpTill PRO, or Verdict contain Sharpen and improve residual control of selected broadleaf and grass weeds in a planned two-pass control program for Roundup Ready or LibertyLink soybeans.

Valor SX 51WDG	flumioxazin	14	1–2.5 oz	0.032–0.08 lb

- Valor may be included in a typical burndown herbicide program to enhance the speed of burndown and increase weed spectrum.
- Valor has fair to good postemergence activity on field pansy.
- Premixes containing Valor: Valor XLT contains chlorimuron (Classic) and can also be used as a PRE/burndown treatment; Fierce XLT is similar to Valor XLT but also contains pyroxasulfone (Zidua); Envive contains chlorimuron (Classic) and thifensulfuron (Harmony); Gangster or Surveil contains cloransulam (FirstRate).

[1] See Table 1-2 (glyphosate formulations) for information on various formulations of this herbicide.

Table 4-6. Water solubility and longevity of soil-applied herbicides.

Solubility (parts per million; ppm) refers to how many microliters of the herbicide will dissolve in 1 liter of water. The less soluble the herbicide, the more moisture (rain or irrigation) is needed to activate the herbicide and move it into the root zone. Solubility is used as a guideline for rainfall or irrigation required within a short time after application. Moisture needed also depends on the soil moisture at time of application.

Relative moisture levels to move herbicide into the soil to achieve optimum level of control:

Relative Moisture to Activate	ppm	Estimated Water to Activate*
Low	>500 ppm (very soluble)	0.33 inch
Medium	250–500 ppm	0.33–0.5 inch
High	100–250 ppm	0.5–0.75 inch
Very high	<100 ppm	>0.75 inch

*More water (additional irrigation) may be necessary if soil is dry at time of application, soils with higher clay content, or high plant residues are present.

Relative duration of residual control is for comparison only Based on herbicide half-life (length of time it takes for half the herbicide to break down). Herbicide breakdown results from chemical and/or microbial activity. Since the speed of breakdown is affected by a number of factors including soil pH, soil temperature, and soil moisture, duration can vary for herbicides based on the specific conditions. Residual activity is not the same as herbicide carryover.

Duration of residual control assumes (1) good activation, (2) no excessive rain or irrigation, and (3) that weed species are sensitive to the herbicide(s) applied.

Trade Name	Solubility (ppm)	Relative Moisture Amount Required to Activate	Duration of Residual Control (weeks)
Classic	pH 5: 11	Very high	4–5 weeks
	pH 6.5: 450	Medium	
	pH 7: 1,200	Low	
Command	1,100	Low	2–4 weeks
Dual Magnum	530	Medium	4–5 weeks
Express	pH 5: 48	Very high	1–2 weeks
	>pH 7: >2,040	Low	
FirstRate	pH 5: 3	Very high	2–4 weeks
	pH 7: 184	High	
Harmony SG	pH 5: 223	High	1–2 weeks
	>pH 7: >2,240	Low	
Intrro	242	High	2–4 weeks
Lorox/Linex	75	Very high	4–5 weeks
Metribuzin	1,200	Low	4–5 weeks
Outlook	1,174	Low	2–4 weeks
Prowl/other pendimethalin formulations	1	Very high	4–5 weeks
Pursuit	1,400	Low	4–6 weeks
Python	5,600	Low	4–6 weeks
Reflex/Flexstar	600,000	Low	2–4 weeks
Sharpen	pH 5: 30	Very high	1–3 weeks
	pH 7: 2,100	Low	
Spartan	780	Low	4–6 weeks
Treflan/other formulations	1	Very high	4–5 weeks
Valor SX	2	Very high	4–5 weeks
Zidua	3.49	Very high	4–5 weeks

Premix	Constituents
Anthem/Anthem Maxx	Cadet, pyroxasulfone
Authority First/Sonic	Spartan, FirstRate
Authority MTZ	Spartan, metribuzin
Authority XL	Spartan, Classic
Boundary	Dual, metribuzin
Canopy DF/Blend	Classic, metribuzin
Canopy EX	Classic, Express
Envive	Classic, Valor SX, Harmony SG
Fierce	Valor SX, Zidua
Gangster/Surveil	Valor SX, FirstRate
OpTill	Sharpen, Pursuit
OpTill PRO	Sharpen, Pursuit, Outlook
Permit Plus	Harmony SG, Sandea
Prefix	Dual, Reflex
Sequence	Dual, glyphosate
Synchrony XP	Classic, Harmony SG
Valor XLT	Valor SX, Classic
Verdict	Sharpen, Outlook

Table 4-7. Relative effectiveness of soil-applied herbicides.

Ratings are based on labeled application rates for the soil type and timely rainfall or irrigation to incorporate the herbicides. Ratings are also based on weed control 3 to 4 weeks after application. Length of effective control (residual control) beyond 4 weeks after application often declines. Results may differ with variations in soil type, temperature, rainfall, soil moisture, soil organic matter, and soil pH. For ratings on herbicide combinations not listed, see the component parts.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Grasses Trade Name	Site of Action Number	Barnyardgrass	Bermudagrass	Corn, Volunteer	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Command[1]	13	8+	6	7	8+	9	9+	N	8	N	N	9	8	7	7	9+
Dual products/Cinch	15	9	N	N	9	9	9+	N	6	N	8	8+	6	N	6	8
Intrro	15	9	N	N	9	9	9+	N	6	N	7+	8	6	N	6	8
Lorox/Linex	7	6	N	N	6	N	7	N	6	6	6	N	N	N	6	N
Metribuzin	5	6	N	N	6	N	6	N	6	N	6	N	N	N	6	N
Outlook	15	9	N	N	8+	9	9	N	6	N	7+	8+	6	N	6	7
Prowl	3	8+	N	N	8+	8+	9	N	7	N	6	9	8	N	7	9
Pursuit	2	8	N	6	7	8	N	N	6	N	7	7	N	N	6	N
Treflan[1]	3	9	N	6	9	9	9	7	8	N	N	9	8+	7	8	9
Warrant	15	8+	N	N	8	8+	8+	N	6	N	6	8	N	N	N	7
Zidua	15	9	N	N	9	9	9+	N	6	N	6	8+	7	N	6	8+
Mixtures																
Anthem/Anthem Maxx	14/15	9	N	N	9	9	9+	N	6	N	6	8+	7	N	6	8+
Authority Elite/BroadAxe	14/15	9	N	N	9	9	9+	N	6	N	8	8+	6	N	6	8
Boundary	5/15	8+	N	N	8+	8+	9	N	N	N	7	8	N	N	N	7
Canopy DF/Canopy Blend	2/5	6	N	7	6	N	—	N	N	N	8	N	N	N	8	6
Fierce/Fierce XLT	14/15/(2)	9	N	N	9	9	9+	N	6	N	6	8+	7	N	6	8
OpTill	2/14	8	N	6	7	8	—	N	6	N	6	7	6	N	8	N
OpTill PRO	2/14/15	8+	N	N	8+	8+	8+	N	N	N	6	8+	6	N	N	6+
Prefix	15/15	9	N	N	9	9	9+	N	6	N	8	8+	6	N	6	8
Warrant Ultra	15/15	8+	N	N	8	8+	8+	N	6	N	6	8	N	N	N	7

[1] Command 4E, Treflan, and trifluralin require incorporation; Command 3ME may be applied preemergence and not incorporated.

Broadleaves Trade Name*	Site of Action Number	Amaranth, Palmer/Waterhemp[1]	Anoda, Spurred	Burcucumber	Cocklebur	Horseweed/Marestail[1]	Jimsonweed	Lambsquarters[2]	Morningglory, Annual	Nightshade, Eastern Black	Pigweed[2]	Ragweed, Common[3]	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Soybean Tolerance, Medium Soils	Soybean Tolerance, Coarse Soils
Command[4]	13	6	9+	N	7+	N	9	9+	N	6	6	8	N	8+	8+	9+	E	E
Dual products/Cinch	15	8+	N	N	N	N	N	6	N	7+	8	6	N	N	N	N	E	E
FirstRate	2	9	9	N	8+	9[1]	8	9	8	N	9[2]	9[3]	8	7	8	8+	E	E
Intrro	15	8+	N	N	N	N	N	6+	N	7+	8+	6	N	N	6	N	E	E
Lorox/Linex	7	8	N	N	7+	—	7	8+	N	7	8	6	N	7+	9	7	G	FG
Metribuzin	5	9	7	6	8	8+	8	9	N	N	8+	7	N	8+	9	8	G	FG
Outlook	15	8	N	N	N	N	N	6	N	7+	8	6	N	N	6	N	VG	VG
Prowl	3	8	N	N	N	N	6	9	N	N	8	N	N	N	8	8+	VG	G
Pursuit	2	9	N	6	8	—	8	8	7	8	9[2]	7+[3]	6	8	9	8	VG	VG
Spartan	14	9	N	N	N	8+	6	8+	9	8	9	7	6	6	7	8	VG	VG
Treflan[4]	3	9	N	N	N	N	N	9	N	N	9	N	N	N	6	7+	E	E
Valor	14	9	8	N	6	8+	8	9	7+	9	9	7+	6	8	7	7	VG	G
Warrant	14	8	N	N	N	N	N	6	N	7	8	6	N	N	N	N	VG	G
Zidua	15	9	N	N	N	N	7	8	N	8	9	7	6	6	7	6	VG	VG
Mixtures																		
Anthem/Anthem Maxx	14/15	9	N	N	N	N	7	8	N	8	9	7	6	6	7	6	VG	VG
Authority Elite/BroadAxe	14/15	9	N	N	6	8+	6	9	8	8	9	7	6	6	7	7+	VG	VG
Authority First/Sonic	2/14	9	9	N	8	8+	8	8+	8	8	9	8+	7	7+	7+	8	VG	VG
Authority MTZ	5/15	9	7	6	8	8+	8+	9	8	8	9	8	N	8+	9	8	G	FG
Authority XL	2/14	9	8	7	8+	8+	8	8+	9	8	9	8	6	8	8+	8	G	FG
Boundary	5/15	8+	7	N	7+	N	7+	8+	N	6	8+	7	N	8+	8+	7	G	G
Canopy DF/Canopy Blend	2/5	9	8	7	9	8+	9	9	7+	6	9+	7+	8	9	9	9	FG	F
Envive	2/2/14	9	8	7	8+	8+	9	9	7+	9	9	8	7	8+	8+	8+	G	FG
Fierce	14/15	9	8	N	6	8+	8	9	7+	9	9	7	6	8	7	7	G	G
Fierce XLT	2/14/15	9	8	7	8+	8+	9	9	8	9	9	8	8	8+	8+	8+	G	FG
Gangster (co-pack)/Surveil	2/14	9	8	N	8+	8+	8	9	8	9	9	9	8	8	8	8+	G	VG
OpTill	2/14	9	N	6	8	6	8	9	7	8	9	7+	6	8	9	8	G	G–F
OpTill PRO	2/14/15	9	N	6	8	6	8	9	7	8	9	7+	6	8	9	8	G	G–F
Prefix	14/15	8	N	N	N	N	8	8	6	7+	8	7+	6	7	7	6	E	VG
Trivence	2/5/14	9	8	7	9	8+	9	9	8	9	9	8	7	9	9	9	G	G
Valor XLT	2/14	9	8	7	8+	8+	9	9	7+	9	9	8	7	8+	8+	8+	E	E
Warrant Ultra	14/15	8	N	N	N	N	8	8	6	7+	8	7+	6	7	7	6	VG	G

*See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.

[1] Biotypes resistant to Group 2 herbicides are common in the region; do not rely on Group 2 herbicides to provide effective control.

[2] Triazine-resistant (Group 5) lambsquarters and pigweed are common in the region; metribuzin will not control these biotypes.

[3] Common ragweed biotypes resistant to Group 2 herbicides have been confirmed in Delaware.

[4] Command 4E, Treflan, and trifluralin require incorporation; Command 3ME may be applied preemergence and not incorporated.

Table 4-8. Comments on preplant or preemergence herbicides for conventional, minimum-till, or no-till soybeans.

See specific product label to determine correct rate for soil type, tillage practices, and weed species found in each field.

Mechanical incorporation reduces the need for timely rainfall after application and may improve control of certain weeds. Mechanical incorporation will improve weed control when no rainfall or irrigation occurs within 7 to 10 days after planting.

In no-till situations, burndown herbicides may be required to control weeds or cover crops present at time of application.

EPP = early preplant (application at least 7 days prior to planting)
PPI = applied to conventionally tilled soil and then mechanically incorporated
PRE = preemergence (applied before the crop has emerged)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Anthem 2.15SC/ Anthem Maxx 4.3SC	pyroxasulfone +	15	EPP, PPI, or PRE	5–11 oz	0.081–0.179
	fluthiacet	14		2–5.5 oz	0.04–0.088
• Fluthiacet (Cadet) does not provide any residual weed control. • See Zidua entry for details.					
Authority products	sulfentrazone	14	EPP, PPI, or PRE	varies	0.132–0.309
• Spartan contains the single active ingredient sulfentrazone, but products that include sulfentrazone are branded as "Authority"; several premixed products contain sulfentrazone (Authority/Spartan). • Each of these products contains different active ingredients and/or ratios. See various tables in this guide and product labels for additional details about these products. • Rates are based on region, soil type, and soil organic matter. Applications made after soil cracking occurs or crop emergence will result in severe crop injury; soybean stunting may occur if excessive rainfall occurs after application but before soybeans emerge. • Sulfentrazone provides good to excellent control of yellow nutsedge. • Observe labeled crop rotation restrictions for all products containing sulfentrazone (refer to Table 1-5, crop rotation table). • Sulfentrazone becomes more available when soil pH exceeds 7.0, increasing the risk of soybean injury. • Refer to label regarding applications with/or in sequence with Sharpen and other Group 14 herbicides. • Products that contain sulfentrazone include Authority Assist (Authority + Pursuit), Authority Elite/BroadAxe (Authority + Dual), Authority First/Sonic (Authority + FirstRate), Authority MTZ (Authority + metribuzin), Authority XL/Maxx (Authority + Classic), and Spartan Charge (Authority + Aim). • *Water quality advisory.*					
Authority Elite 7E or BroadAxe	sulfentrazone +	14	EPP, PPI, or PRE	19–38.7 fl oz	0.104–0.153
	s-metolachlor	15			0.94–1.87
• Authority Elite and BroadAxe are the same products. • See Dual and Authority entry for comments. • *Water quality advisory.*					
Authority First 70DF/ Sonic	sulfentrazone +	14	EPP, PPI, or PRE	6.45–8 oz	0.25–0.31
	cloransulam	2			0.032–0.04
• Authority First and Sonic are identical products. • See entries for FirstRate and Authority for more comments.					
Authority MTZ 45WDG	sulfentrazone +	14	EPP, PPI, or PRE	12–18 oz	0.135–0.202
	metribuzin	5			0.202–0.304
• See Authority and metribuzin entry for comments. • *Water quality advisory.*					
Authority XL 70WG	sulfentrazone +	14	EPP, PPI, or PRE	3–9 oz	0.116–0.347
	chlorimuron	2			0.015–0.045
• Authority XL is a premix of Authority (sulfentrazone) + Classic (chlorimuron) and can be used as a burndown and/or preemergence application. • For burndown, Authority XL may be tank-mixed with glyphosate, Gramoxone, or 2,4-D plus COC or MSO to increase activity. • See Authority entry for additional comments.					
Boundary 6.5EC	s-metolachlor +	15	EPP, PPI, or PRE	1.2–3 pt	0.74–1.9
	metribuzin	5			0.188–0.469
• See metribuzin and Dual entry for comments. • The amount of Dual in this premix is low compared to amount recommended when applied by itself. • *Water quality advisory.*					

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Canopy 75DF/ Canopy Blend 58.3WDG	chlorimuron +	2	EPP, PPI, or PRE	4–7 oz	0.027–0.047
	metribuzin	5		5.1–9 oz	0.16–0.28

- Apply prior to soybean emergence. Do not use on sand or any soil with less than 0.5% organic matter.
- Do not apply more than 2.25 oz/A if soil pH is 7.0 or higher.
- Observe crop rotation restrictions. Do not use on soils with a pH greater than 6.8, or carryover injury may result the following year.
- Observe labeled crop rotation restrictions for all products containing chlorimuron (Classic) (see Table 1-5, crop rotation table).
- Adding chlorimuron to metribuzin improves control of ragweed, cocklebur, velvetleaf, jimsonweed, and annual morningglory.
- *Water quality advisory.*

Command 3ME	clomazone	13	EPP or PRE	1.33–2.67 pt	0.5–1

- Command 3ME must be used as a preemergence soil-applied treatment without incorporation.
- Do not apply within 1,200 feet of towns; residential areas; commercial fruit, nut, or vegetable production; or commercial greenhouses or nurseries.
- Do not apply during temperature inversions or when wind speed is greater than 10 mph. Apply in a minimum spray volume of 10 gal/A. Use coarse sprays to reduce drift.
- Observe labeled crop rotation restrictions (see Table 1-5, crop rotation table).

Dual Magnum 7.62EC or Cinch	s-metolachlor	15	EPP, PPI, or PRE	1–2 pt	0.95–1.9

- Dual and Cinch are similar in activity to Outlook, Intrro, Zidua, and Warrant. Dual II Magnum contains a crop-safening agent for corn.
- For early preplant applications or fields with heavy surface plant residue, Dual rate may need to be increased by up to 20%.
- Incorporation improves control of yellow nutsedge.
- Dual can be applied after soybean emergence, but Dual will not control emerged weeds.
- *Water quality advisory.*

Envive 41.3DG	flumioxazin +	14	EPP or PRE	2.5–5.3 oz /A	0.044–0.094
	chlorimuron +	2			0.015–0.031
	thifensulfuron	2			0.004–0.009

- Do not mechanically incorporate into the soil after application.
- Can be tank-mixed with products such as Command or pendimethalin for improved grass control.
- Envive label allows tank-mixes with chloroacetamides if soybean is planted no-till into wheat or corn stubble.
- Do not apply if soybeans have begun to emerge.
- Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- Envive can to provide some burndown and residual weed control when applied 2 weeks before planting up to 3 days after planting (before soybean emergence), but it often needs to be tank-mixed with glyphosate and/or 2,4-D to achieve complete burndown.
- Refer to label regarding applications with/or in sequence with Sharpen and other Group 14 herbicides.
- See Valor entry for more information.

Fierce 76WDG	pyroxasulfone +	15	EPP or PRE	3–3.75 oz	0.08–0.13
	flumioxazin	14			0.063–0.105
Fierce XLT 62.41WDG	pyroxasulfone +	15	EPP or PRE	3.75–5.25 oz	0.073–0.102
	flumioxazin+	14			0.057–0.08
	chlorimuron	2			0.016–0.022

- See Zidua and Valor entry for comments.
- Fierce XLT improves morningglory control compared to Fierce due to addition of chlorimuron.
- Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- *Water quality advisory.*

FirstRate 84WDG	cloransulam	2	EPP, PPI, or PRE	0.6–0.75 oz	0.031–0.039

- Cloransulam provides good control of several annual broadleaves, including lambsquarters, pigweed, ragweed, velvetleaf, and cocklebur.
- FirstRate water-dispersible packets are not soluble in liquid fertilizer solutions; premixing in water is required.
- Gangster and Surveil are co-packs that contain flumioxazin (Valor) and cloransulam (FirstRate).
- Gangster/Surveil can be applied as a fall (after October 15) or spring preplant treatment or preemergence.
- *Water quality advisory.*

(continued)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Gangster/Surveil co-pack/ Surveil 48WDG	flumioxazin +	14	EPP or PRE	2.5–3 oz	0.08–0.096
	cloransulam	2		0.5–0.6 oz/ 3.5–4.2 oz	0.026–0.031

- Gangster and Surveil are co-packs that contain flumioxazin (Valor) and cloransulam (FirstRate). Surveil 48WDG is a single product containing both active ingredients.
- Do not mechanically incorporate.
- Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- See FirstRate and Valor entries for more comments.
- *Water quality advisory.*

Intrro 4EC	alachlor	15	EPP, PPI, or PRE	2–4 qt	2–4

- Intrro is similar in activity to Dual, Outlook, Zidua, and Warrant.
- For early preplant applications or fields with heavy surface plant residue, increase the rate of alachlor by 20%.
- Incorporation improves control of yellow nutsedge, but alachlor is not recommended for incorporation on coarse soils in the Southeast.
- *Restricted-use pesticide and water quality advisory.*

Lorox 50DF/	linuron	7	EPP or PRE	0.75–2 lb	0.38–1
Linex 4L				1 to 2 pt	

- Do not mechanically incorporate.
- Do not use on sands or loamy sands, or on soils with less than 0.5% organic matter.
- Do not apply after soybean emergence.
- Provide good agitation in tank before and during application.
- Follow labeled directions regarding soybean planting depth.
- Do not plant any crop not on label within 4 months of application.

Metribuzin 75DF	metribuzin	5	EPP, PPI, or PRE	0.3–0.5 lb	0.2–0.4

- Do not use on sands or loamy sands or on soils with less than 0.5% organic matter, or crop injury may result. If used on coarse-textured soils with less than 2% organic matter or if heavy rainfall follows soon after application, severe stand losses can occur.
- Soybean varieties have different levels of tolerance to metribuzin; refer to product label for list of susceptible varieties.
- Do not apply after soybean emergence.
- Metribuzin is a triazine herbicide and does not control triazineresistant weeds.
- Potential for crop injury may increase if atrazine was used the previous year due to the additive effect of residual atrazine and metribuzin.
- Plant at least 1.5 inches deep.
- *Water quality advisory.*

OpTill 68WG	saflufenacil +	14	EPP or PRE	2 oz	0.022
	imazethapyr	2			0.063
OpTill PRO (co-pack)	saflufenacil +	14	EPP or PRE	2 oz dry + 10 fl oz	0.022
	imazethapyr +	2			0.063
	dimethenamid	15			0.469

- On coarse-textured soils with less than 2% organic matter, a minimum of 30 days between application of OpTill or OpTill PRO and soybean planting is required.
- OpTill or OpTill PRO may be applied as a preplant burndown application from early spring through preemergence; do not apply if soil cracking has begun or soybeans have emerged.
- In a burndown program it is best to include glyphosate or glufosinate in addition to the necessary adjuvants (COC or MSO plus AMS or nitrogen solution) to improve control of emerged weeds, including horseweed.
- Do not apply OpTill (PRO) with any other Group 14 herbicide (flumioxazin, sulfentrazone, fomesafen) as a tank mixture or sequential application within 30 days, or crop injury may result.
- Postemergence herbicides containing a Group 14 herbicide (Reflex or Flexstar GT) can be applied 14 days after soybean emergence.
- An additional 0.5 oz of Sharpen can be tankmixed with OpTill, but an additional 14 days is required between application and planting (additional Sharpen is not allowed with OpTill PRO).
- Outlook at 10 fl oz is lower than recommended rates for medium- and fine-textured soils.

Outlook 6.0EC	dimethenamid-P	15	EPP, PPI, or PRE	10–21 fl oz	0.47–0.98

- Outlook is similar in activity to Dual, Intrro, Zidua, and Warrant.
- For early preplant applications or fields with heavy surface plant residue, increase Outlook rate by 1–2 fl oz/A.
- Incorporation improves control of yellow nutsedge.
- Do not exceed a rate of 12 oz/A of Outlook on coarse soils with less than 1.5% organic matter. PPI applications are not recommended on these soils. Outlook will have very short residual when used on coarse-textured soils.
- Outlook can be applied after soybean emergence (up to 5th trifoliate), but Outlook will not control emerged weeds.
- OpTill PRO is a co-pack of OpTill and Outlook.
- *Water quality advisory.*

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Prefix 5.3EC	s-metolachlor +	15	EPP, PPI, or PRE	2–3 pt	0.73–1.1
	fomesafen	14			0.16–0.24

- Prefix contains s-metolachlor (Dual Magnum) and fomesafen (Reflex) for annual grass, nutsedge, and broadleaf control. The ratio of fomesafen in this product is relatively low, below what is typically recommended for soil applications.
- In most situations, Prefix provides foundational weed control but will likely need to be followed by additional weed control measures.
- Be cautious of restrictions associated with fomesafen use in consecutive years and use rates that vary across the region. Refer to label for additional use restrictions.
- Prefix followed by sequential applications of Reflex are prohibited; use of fomesafen as a postemergence treatment is preferable to use as a soil application.
- Refer to label regarding applications with/or in sequence with Sharpen and other Group 14 herbicides.

Prowl 3.3E/	pendimethalin	3	EPP, PPI, or PRE	1.2–3.6 pt	0.5–1.5
Prowl H20 3.8CS				2–3 pt	0.95–1.4

- Prowl 3.3E: do not exceed 2.4 pt/A rate when using surface application.
- Under certain environmental conditions, preemergence applications may cause callus tissue development at soil line, resulting in brittle soybean stems and increased incidence of lodging.
- Prowl (all formulations) should be applied preplant incorporated (PPI) north of I-80 due to stem callus and possible lodging concerns.
- Do not apply to emerged soybeans.
- Generic EC formulations are available; consult individual labels for rates and restrictions.

Pursuit 2S	imazethapyr	2	EPP, PPI, or PRE	4 fl oz	0.063

- Adequate soil moisture is necessary for optimum activity.
- Do not plant corn until 8.5 months after application. Consult label for other rotation restrictions. Do not apply products containing chlorimuron during the same season, or injury to rotation crops may result.
- *Water quality advisory.*

Python 80WDG	flumetsulam	2	EPP or PRE	0.8–1.33 oz	0.04–0.066

- Python may be tankmixed with other herbicides to broaden the spectrum of control. Check individual herbicide labels for potential tank-mix partners.
- Do not apply where soil pH is greater than 7.8.
- Do not apply to emerged soybeans.
- *Water quality advisory.*

Treflan 4E	trifluralin	3	PPI	1–2 pt	0.5–1

- Incorporate thoroughly to a depth of 2–3 inches within 24 hours of application. Label recommends two-pass incorporation.
- Plant soybeans after early season adverse weather has passed.
- Do not plant deeper than 2 inches.

	chlorimuron +	2			0.014–0.023
Trivence 61.3WDG	flumioxazin +	14	EPP or PRE	6–10 oz	0.048–008
	metribuzin	5			0.169–0.282

- Do not mechanically incorporate Trivence into the soil after application.
- Do not apply Trivence if soybeans have begun to emerge.
- Trivence has some burndown activity, but it should be tankmixed with glyphosate or paraquat in most cases.
- Trivence can be tank-mixed with products such as Command or pendimethalin for improved grass control. Do not tank-mix Trivence with alachlor (Intrro), s-metolachlor (Dual, Boundary), or dimethenamid (Outlook) if application is made within 14 days of planting.
- Splashing soil from irrigation or heavy rainfall may cause injury to newly emerged soybeans. Do not irrigate when soybeans are cracking.
- Products containing flumioxazin have specific tankcleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- Refer to label regarding applications with/or in sequence with Sharpen and other Group 14 herbicides.
- See Valor SX entry for additional information and mode of action statement.

Valor SX 51WDG	flumioxazin	14	EPP or PRE	2–2.5 oz	0.063–0.08 oz

- Valor may be tank-mixed with certain herbicides to broaden weed control spectrum.
- Do not use more than 3 oz/A of Valor per season.
- Rate is dependent on weed species targeted, soil type, and soil organic matter; refer to label.
- Do not mechanically incorporate Valor into the soil after application.
- Do not apply products containing Valor if soybeans have begun to emerge. Splashing soil from irrigation or heavy rainfall may cause injury to newly emerged soybeans.
- Valor SX tank-mixed with alachlor (Intrro), s-metolachlor (Dual, Boundary), or dimethenamid (Outlook) must be applied a minimum of 14 days prior to planting. Or, Valor SX may be applied 14 days prior to planting, followed by one of these products applied at planting.
- Valor at 1–2.5 oz/A can enhance the speed of burndown and increase weed spectrum of typical burndown herbicide programs.
- Refer to label regarding applications with, or in sequence with, Sharpen and other Group 14 herbicides.
- Gangster and Surveil are co-packs that contain flumioxazin (Valor) and cloransulam (FirstRate). Other premix products that contain flumioxazin include Afforia, Envive, Fierce, Fierce XLT, Trivence, and Valor XLT.
- Products containing flumioxazin have specific tankcleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Valor XLT 40WDG	flumioxazin +	14	EPP or PRE	3–5 oz/A	0.056–0.094
	chlorimuron	2			0.019–0.032

- Do not mechanically incorporate into the soil after application.
- Can be tank-mixed with products such as Command or pendimethalin for improved grass control.
- Do not tank-mix Valor XLT with alachlor (Intrro), s-metolachlor (Dual, Boundary) or dimethenamid (Outlook) if application is made with 14 days of planting.
- Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- Refer to label regarding applications with, or in sequence with, Sharpen and other Group 14 herbicides.
- See Valor entry for more information.

Warrant 3CS	acetochlor	15	EPP or PRE	1.25–2 qt	0.94–1.5

- Warrant can be soil applied for residual control of certain annual grasses and broadleaves.
- Warrant can be applied after soybean emergence (up to R2 stage) but will not control emerged weed seedlings.
- Do not mechanically incorporate Warrant prior to planting (PPI).
- Warrant Ultra is a prepackaged mixture of Warrant and Reflex; however, the ratio of fomesafen in this product is relatively low, below what is typically recommended for soil applications.
- Water quality advisory.

Zidua 85WDG	pyroxasulfone	15	EPP, PPI, or PRE	1.5–3.5 oz	0.08–0.186

- Zidua has annual grass activity similar to Dual, Harness, Outlook, Warrant, etc., but also provides control of several annual broadleaves.
- Zidua can be applied as an early preplant application up through planting and then as an early POST application from first to third trifoliate stage. Do not apply Zidua to soybeans from emergence (at cracking) through unifoliate stage due to injury. Zidua will not control emerged weed seedlings.
- Must be activated by at least 0.5 inch of rainfall prior to weed germination or effectiveness may be reduced.
- Zidua can be tank-mixed with other herbicides to increase the spectrum of control.
- Refer to the labels for rotation restrictions (most vegetables have an 18-month rotation restriction); see Table 1-5 (crop rotation table).
- Fierce is a prepackaged mixture of Zidua and Valor; Fierce XLT is Zidua, Valor, and Classic.

[1] See Table 1-4 (generics table) for additional herbicides that contain these active ingredients.

Table 4-9. Soybean herbicide preplant or preemergence rates based on soil texture and organic matter.

The herbicide rates presented are for conventionally tilled soils for the given soil texture and organic matter levels. This table shows application rates for products applied alone. Rates may vary if tank-mixed with other products and/or if weed infestations are heavy or if used in conservation tillage situations. See specific product label for additional information on application rates and uses.

Trade Name	Site of Action Number	Unit	<3% Organic Matter			≥3% Organic Matter			Inc. for No-till
			Coarse	Medium	Fine	Coarse	Medium	Fine	
Anthem 2.15SE	14/15	fl oz	6.0	8.0	9.0	6.5	9.0	10.5	no
Anthem Maxx 4.3SC	14/15	fl oz	3.0	4.0	4.5	3.25	4.5	5.25	no
Authority Elite 7E/BroadAxe	14/15	fl oz	25.0	28.0	28.0	25.0	28.0	34.0	no
Authority First 70WDG/Sonic	2/14	oz	6.45	6.45	6.45	8.0	8.0	8.0	no
Authority MTZ 45WG	5/14	oz	12.0	16.0	18.0	14.0	18.0	20.0	no
Authority XL 70WG	2/14	oz	5.3	7.0	8.0	5.3	7.5	8.5	no
Boundary 6.5EC	5/15	pt	1.25	2.0	2.5	1.5	2.5	2.75	yes
Canopy 75DF	2/5	oz	4.0	5.0	6.0	4.0	5.0	7.0	no
Canopy Blend 58.3WDG	2/5	oz	5.1	6.4	7.75	5.1	6.4	9.0	no
Command 3ME	13	pt	1.25	2.0	2.67	1.25	2.67	2.67	no
Dual Magnum 7.64EC	15	pt	1.25	1.33	1.33	1.25	1.33	1.67	yes
Envive 41.3WDG	2/2/14	oz	3.5	3.5	4.0	3.5	4.0	5.0	no
Fierce 76WDG	14/15	oz	3.0	3.0	3.0	3.0	3.0	3.0	no
Fierce XLT 62.41WDG	2/14/15	oz	4.0	4.0	4.75	4.0	4.5	50	no
FirstRate 84WDG	2	oz	0.6	0.6	0.6	0.75	0.75	0.75	no
Gangster/Surveil (co-pack)	2/14	oz	3.0	3.6	3.6	3.0	3.6	3.6	no
Intrro 4E	15	qt	2.0	2.25	2.5	2.0	2.5	2.75	no
Linex 4L	7	pt	1.25	1.3	1.75	1.5	1.75	2.0	no
Lorox 50DF	7	lb	1.25	1.3	1.75	1.5	1.75	2.0	no
Metribuzin 75DF	5	lb	4.0	8.0	10.0	4.0	11.0	12.0	no
OpTill 68WG	2/14	oz	2.0	2.0	2.0	2.0	2.0	2.0	no
OpTill PRO	2/14/15	oz + fl oz	2.0 + 10.0	2.0 + 10.0	2.0 + 10.0	2.0 + 10.0	2.0 + 10.0	2.0 + 10.0	no
Outlook 6.0E	15	fl oz	14.0	16.0	18.0	14.0	16.0	18.0	no
Prefix 5.3E	14/15	pt	2.0	2.25	2.5	2.25	2.5	2.5	yes
Prowl 3.3E	3	pt	1.8	2.4	2.4	1.8	2.4	3.0	yes
Prowl H2O 3.8CS	3	pt	1.5	2.0	2.0	1.5	2.0	2.5	yes
Pursuit 2S	2	fl oz	4.0	4.0	4.0	4.0	4.0	4.0	no
Spartan 4F	14	fl oz	6.0	8.0	10.0	8.0	10.0	12.0	no
Surveil 48WG	2/14	oz	3.5	4.2	4.2	3.5	4.2	4.2	no
Treflan 4E	3	pt	1.0	1.5	2.0	1.5	2.0	2.0	no
Trivence 61.3WDG	2/5/14	oz	7.0	8.0	8.0	7.0	8.0	8.0	
Valor 51WDG	14	oz	2.5	2.5	2.5	2.5	2.5	2.5	no
Valor XLT 40.3WDG	2/14	oz	3.0	3.5	4.0	3.0	4.0	4.5	no
Warrant 3CS	15	qt	1.5	1.5	1.5	1.5	1.5	1.5	no
Warrant Ultra	14/15	fl oz	48.0	50.0	50.0–60.0[1]	48.0	60.0–70.0[1]	60.0–70.0[1]	no
Zidua 81WDG	15	oz	2.0	2.5	3.0	2.0	2.5	3.0	no

[1] Maximum rate depends on the location; refer to label for rates based on area use map.

Table 4-10. Herbicides commonly used after soybean emergence (POST).

Comparable residual activity is given for comparison purposes only. The data are based on herbicide half-life, which is the length of time it takes for half the herbicide to break down. Herbicide degradation (breakdown) is the result of chemical and/or microbial activity, which can be dependent on soil pH, soil temperature, and soil moisture levels. Since degradation is dependent on a number of factors, length of time can vary for herbicides based on the specific environmental conditions. Residual activity is *not* the same as herbicide carryover.

Postemergence (POST) Activity

- **Translocated herbicide:** These herbicides move throughout the plant and can cause injury to parts of the plants that do not come in direct contact with the herbicide spray.
- **Contact herbicide:** These herbicides do not move throughout the plant. They cause injury only to those parts of the plant that come in contact with the spray. Spray coverage is more critical for contact than translocated herbicides.

Group 1 herbicides only control grass weed species (no activity on yellow nutsedge).
Group 15 herbicides do not control weeds that are emerged at time of application.

Trade Name	Site of Action Number	POST Activity	Residual Activity[1]
Assure II/Targa	1	translocated	short
Basagran	6	contact	none
Cadet	14	contact	none
Classic	2	translocated	yes
Cobra	14	contact	short
Dual	15	none	yes
FirstRate	2	translocated	yes
Fusilade DX	1	translocated	short
Glyphosate	9	translocated	none
Halosulfuron	2	translocated	yes
Harmony	2	translocated	none
Liberty	10	contact	none
Poast	1	translocated	short
Pursuit	2	translocated	yes
Raptor	2	translocated	yes
Reflex/Flexstar	14	contact	yes
Resource	14	contact	none
Select Max	1	translocated	short
Ultra Blazer	14	contact	none
Warrant	15	none	yes
Zidua	15	none	yes

[1] None; short = 1 to 2 weeks of residual control; yes = more than 2 weeks of residual control.

Premixes	Constituent Products	Site of Action Number
Extreme	glyphosate, Pursuit	9/2
Flexstar GT	glyphosate, Reflex	9/14
Permit Plus	halosulfuron (Permit/Sandea), Harmony	2/2
Prefix	Dual, Reflex	15/14
Storm	Basagran, Ultra Blazer	6/14
Synchrony	Harmony, Classic	2/2
Warrant Ultra	Warrant, Reflex	15/14

Table 4-11. Relative effectiveness of postemergence herbicides.

Ratings are based on labeled application rates and weeds at 4 inch height. Results may differ with variations in weed size, temperature, rainfall soil moisture, and good spray coverage. Ratings are based only on postemergence (POST) activity and do not reflect possible residual activity. For ratings on herbicide combinations not listed, see the component parts. Ratings assume good growing conditions and proper usage of adjuvants.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Grasses Trade Name (rate/A)	Site of Action Number	Barnyardgrass	Bermudagrass	Corn, Volunteer	Crabgrass	Foxtail spp.	Goosegrass	Johnsongrass (Rhizome)	Johnsongrass (Seedling)	Muhly, Wirestem	Nutsedge, Yellow	Panicum, Fall	Panicum, Texas	Quackgrass	Shattercane	Signalgrass, Broadleaf
Assure II (8 fl oz)	1	9	9	9+	8+	9+[1]	9	9	9	6	N	9	8+	9	9+	9
Basagran (1 qt)	6	N	N	N	N	N	N	N	N	N	7+	N	N	N	N	N
Classic (0.67 oz)	2	N	N	6	N	N	N	N	N	N	8	N	N	N	6	N
Fusilade DX (12 fl oz)	1	9	9	9+	8+	8+	9	9	9	8+	N	9	8+	9	9+	9
Glyphosate (0.75 lb ae)[2]	9	9+	9	9+[3]	9+	9+	9+	9	9+	9	7	9	9+	9	9	9+
Liberty (32 fl oz)[4]	10	8	6	7[5]	8+	8+[1]	6	6	9	7	6	8+	8	6	9	8+
Poast (1–1.5 pt)[6]	1	9+	8+	8	9	9+	9	8	8+	7	N	9	9+	8	8+	9+
Pursuit (4 fl oz)	2	8	N	6	7	8+[1]	N	7	9	N	7	8	6	6	9	8
Raptor (5 fl oz)	2	8	N	8	7	8+[1]	N	7	8+	N	6	8	6	N	8+	8
Select (8 fl oz)	1	9	9	9	9	9+	9	9	9	8+	N	9	9+	8+	9	9+
Mixtures																
Extreme (3 pt)[2]	2/9	9+	8+	9[3]	9+	9+	8+	9	9+	9	6	8+	9	8+	9	9
Flexstar GT (4.5 pt)[2]	9/14	9+	9	9+[3]	9+	9+	9+	9	9+	9	7	9	9+	9	9	9+
Fusion (8 fl oz)	1/1	9	9	8	8+	9[1]	9	8	8	6	N	9	8+	8	8	9
Permit Plus (0.75 oz)[7]	2/2	N	N	N	N	N	N	N	N	N	9+	N	N	N	N	N
Storm (1.5 pt)	6/14	N	N	N	N	N	N	N	N	N	7+	N	N	N	N	N
Synchrony (0.75 oz)[7]	2/2	N	N	6	N	N	N	N	6	N	8	N	N	N	6	N

[1] Herbicide is less effective on yellow foxtail compared to giant foxtail. Ratings for yellow foxtail: Assure II/Targa = 7; Fusion = 8; Liberty = 6; Pursuit = 6; Raptor = 6.
[2] For use on Roundup Ready soybean varieties only.
[3] Glyphosate will not control Roundup Ready corn
[4] For use on glufosinate-resistant soybean varieties only.
[5] Liberty will control LibertyLink corn or many hybrids with Bt traits.
[6] Ratings for Poast on annual grasses is 1 pt and 1.5 pt for perennial grasses.
[7] For use on STS or non-STS soybean varieties; a lower rate must be used on non-STS varieties.

(continued)

Broadleaves Trade Name (rate/A)	Site of Action Number	Amaranth, Palmer/Waterhemp[1,2]	Anoda, Spurred	Burcucumber	Cocklebur	Horseweed/Marestail[1,2]	Jimsonweed	Lambsquarters	Morningglory, Annual	Nightshade, Eastern Black	Pigweed1	Ragweed, Common[2,3]	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf	Soybean Tolerance
Basagran (1 qt)	6	6	8+	N	9	N	9	8	N	N	6	8	7	8	9	8+	FG
Cadet (0.9 oz)	14	7	7	N	N	N	N	7	7	7	7	N	N	7	N	9+	F
Classic (0.67 oz)	2	9[1]	N	8	9+	7[1]	9	7	7	N	9[1]	8[3]	7+	N	8+	8	F
Cobra (12.5 fl oz)	14	9	7	8	8	N	9	7	8	8+	9	9	8+	6	7	8+	F
FirstRate (0.3 oz)	2	N	9	6	9	8[1]	8	N	8+	N	N	9[3]	9	N	8	9	VG
Glyphosate (0.75 lb ae)[4]	9	9+[2]	9	8+	9	6[2]	9	8+	8	8	9+	9[2]	8	8	8+	8	E
Harmony SG (0.125 oz)[5]	2	9[5]	N	7	7+	N	7	9	N	N	9[1]	6[3]	N	N	9	8+	—[6]
Liberty (32 fl oz)[7]	10	8+	7+	8	9	8+	9	9	8	8	8+	9	8+	8	8+	8	VG
Pursuit (4 fl oz)	2	9[1]	7	6	9	N	8	7	7+	8+	9[1]	8[3]	6	6	8+	9	FG
Raptor (5 fl oz)	2	9[1]	7	6	9	N	8	8+	7	8+	9[1]	8[3]	8	6	8	9	G
Reflex/Flexstar (1.25 pt)	14	9	6	7	8	N	9	6	8	8+	9	9	8	N	8	7+	FG
Resource (6 fl oz)	14	7+	6	6	6	N	7	7	N	8	7+	7+	6	6	6	9+	FG
Ultra Blazer (1.5 pt)	14	9	6	7	8	N	9	7	8	8	9	9	8	N	8+	7+	F
Mixtures																	
Extreme (3 pt)[4]	2/9	9[1,2]	8+	8	9	6[2]	9	8+	7+	8	9	8+[2,3]	8	7	8+	9	VG
Flexstar GT (4.5 pt)[4]	9/14	9[2]	9	8+	9	6[2]	9	8+	8	8	9	9[2]	9	8	8+	8+	F
Permit Plus (0.75 oz)[5]	2/2	9[1]	—	7	9	N	7	9	6	6	9[1]	9[3]	8	7	9	9	—[6]
Storm (1.5 pt)	6/14	8+	8	6	8	N	9	7	7+	7	8+	8+	7	7	8+	8	FG
Synchrony (0.75 oz)[5]	2/2	9+[1]	N	8+	9+	8[1]	9	9	7	N	9+[1]	8[3]	7+	N	9	9	—[6]

[1] Group 2 resistance has been confirmed for this species and it is common in the region; Group 2 herbicides will not control these biotypes.
[2] Glyphosate resistance has been confirmed for this species and it appears to be widespread in the region.
[3] Common ragweed biotypes resistant to Group 2 herbicides have been confirmed in Delaware.
[4] For use on Roundup Ready soybean varieties only.
[5] For use on STS or non-STS soybean varieties; a lower rate must be used on non-STS varieties.
[6] Excellent crop tolerance for STS varieties, but fair or worse ratings if used on non-STS varieties.
[7] For use on glufosinate-resistant soybean varieties only.

Table 4-12. Effectiveness of postemergence herbicides on perennial broadleaf weeds in soybean (based on seasonal control).

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control
— = no local data available

Trade Name	Site of Action Number	Artichoke, Jerusalem	Bindweed, Hedge	Dandelion	Dewberry	Dock spp.	Dogbane, Hemp	Groundcherry	Horsenettle	Ivy, Poison	Milkweed, Common	Pokeweed	Thistle, Canada
Basagran	6	6+	7	N	N	7	N	N	6	N	N	N	7
Blazer, Cobra, Reflex	14	6	7	N	N	6	6	6	7	N	6	7	6
Classic	2	7+	8	7	7	7	7	—	7	6	6	7+	7
Glyphosate (broadcast)[1]	9	8	8	7	8	8	**8+**	7+	8	8	8	**9**	**9**
Glyphosate (wiper application)[2]	9	7+	N	N	N	N	7+	6	N	6	7+	**8+**	7
Pursuit/Raptor	2	7	7+	7	6	7	7	—	8	6	6	6	6
Synchrony	2/2	7+	7	7	7	6	7	—	N	6	7+	7+	7+

[1] Broadcast applications of certain glyphosate products for use on Roundup Ready soybean varieties only. Refer to product label use restrictions. Information on various glyphosate formulations can be found in Table 1-2 (glyphosate table).

[2] Mix one-third glyphosate product with two-thirds water. Two passes in opposite directions is most effective.

Table 4-13. Weed sizes for postemergence soybean herbicides.

This table lists postemergence soybean herbicides, their rates, and height ranges of weed species that are controlled or suppressed. This table is only a "quick reference"; refer to the herbicide label for additional information on application and timing. Postemergence grass herbicide rates may vary if tank-mixed with broadleaf herbicides due to antagonism. Split applications should be made if target growth stages for broadleaves and grasses do not correspond or if grasses to be managed are difficult-to-control species such as perennials. For split-applications, it is best to apply postemergence grass herbicides 24 hours before or about 7 days after broadleaf herbicide application.

Herbicides	Assure II/Targa[1]			Fusillade DX[1,2]			Fusion[1,2]			Liberty		Poast[1]				Pursuit 2L		Raptor		Glyphosate[3]		Select/Clethodim[4,5]		
		rate/A			rate/A[6]			rate/A[6]				gr. size[6]		rate/A[6]									rate/A[6]	
Grasses Annuals	grass size (in.)	alone	w/ BH	grass size (in.)	alone	w/ BH	grass size (in.)	alone	w/ BH	grass size (in.)	rate/A (fl oz)	alone	w/ BH	alone	w/ BH	grass size (in.)	rate/A (oz)	grass size (in.)	rate/A (fl oz)	grass size (in.)	rate/A (lb ae/A)	grass size (in.)	alone	w/BH
		—(fl oz)—			(fl oz)			—(fl oz)—				—(in)—		—(fl oz)—									—(fl oz)—	
Barnyard-grass	2–6	8	S[7]	2–3	12	12	2–4	8	10	3	22	<4	—	18	—	1–3	1.44	2–5	5	4–8	0.75	1–4	4	—
										5	29	<8	4	24	24							2–8	6	8–10
												<12[8]	—	36	—	1–3	1.44	2–4*	5	4–8	0.75	1–4	4–5	—
Crabgrass	2–6	8	S[7]	1–2	12	12	1–4	8	10	3	22	<6	4	24	24							2–6	6	8–10
										5	29	<8[8]	—	36	—									
Foxtail, Giant	2–4	5	5	2–6	12	12	2–8	7	10	6	22	<4	18	—	—	1–6	1.44	2–6	5	4–8	0.75	1–4	4	—
	2–8	7	7				≤16[8]	8–14	—	12	29	<8	6	24	24							2–12	6	8–10
												<16	36	—	—									
Foxtail, Green	2–4	7	8	2–4	12	12	2–4	8	10	6	22	<4	18	—	—	1–3	1.44	2–6	5	4–8	0.75	2–8	6	8–10
										12	29	<8	6	24	24									
												<16[8]	36	—	—									
Foxtail, Yellow	2–4	7	S[7]	2–4	12	12	2–4	8	10	3	22	<8	6	24	24	1–3	1.44	2–6	5	4–8	0.75	2–8	6	8–10
										4	29	<16[8]	—	36	—									
Goosegrass	2–6	7	8	2–4	8		2–4	8	8–12	2	22	6		16	—	—	—	2–4	5			2–6	6	
										3	29													
Panicum, Fall	2–6	7	8	2–6	12	12	26	8	10	3	22	<4	18	—	—	—*	—*	2–6	5	4–8	0.75	1–4	4–5	—
										5	29	<8	4	24	24					2–8	0.19	8–10	2–8	8–10
												<12[8]	36											
Panicum, Texas	2–4	8		2–8	12		2–8	8	8–12	4	22	8		16	—	—	—	—	—			2–6	6	
										6	29													
Shattercane	6–12	5	5	6–12	6	12	6–12	6	8	6	22	<18	—	24	—	1–8	1.44	2–8	5	4–8	0.75	4–10	4	—
										3	29											6–18	6	8–10
Signalgrass, Broadleaf	2–6	10		2–4	12		2–4	8–10	10–12	3	22	8		16	—	1–8	4	2–5	5			2–6	6	
										5	29													

Herbicides	Assure II/Targa[1]			Fusillade DX[1,2]			Fusion[1,2]			Liberty		Poast[1]				Pursuit 2L		Raptor		Glyphosate[3]		Select/Clethodim[4,5]		
		rate/A			rate/A[6]			rate/A[6]				gr. size[6]		rate/A[6]									rate/A[6]	
Grasses Annuals	grass size (in.)	alone	w/ BH	grass size (in.)	alone	w/ BH	grass size (in.)	alone	w/ BH	grass size (in.)	rate/A (fl oz)	alone	w/ BH	alone	w/ BH	grass size (in.)	rate/A (oz)	grass size (in.)	rate/A (fl oz)	grass size (in.)	rate/A (lb ae/A)	grass size (in.)	alone	w/BH
		—(fl oz)—			(fl oz)			—(fl oz)—				—(in)—		—(fl oz)—									—(fl oz)—	
Volunteer Corn	6–18	5	5	12–24	6	12	12–24	6	8	10	22	<12	18	—	—	—	—	2–8[9]	5	4–8	0.75	4–12	4	—
										12	29	<20	12	24	24							12–24	6	8–10
Bermu-dagrass																								
1st applic.	<6	10		4–8	12		4–8	12			22	6 sto-lon		24		—	—	—	—			3	8	
2nd applic.	<6	7		4–8	8		4–8	8			22	4 sto-lon		16		—	—	—	—			3	8	
John-songrass (rhizome)																								
1st applic.	10–24	10	10	8–18	12	12	8–18	12		—*	—*	20–25		24		6–12*	1.44	6–12*	5	<18	0.75–1.5	12–24	8	16
2nd applic.	6–10	7	—	6–12	8	—	6–12	8				6–12		24						<24		6–18	6	—
Quackgrass																								
1st applic.	6–10	10	S[7]	6–10	12	12	6–10	12		—*	—*	6–8		36	—	—	—	4–8*	5	6–8	0.75–1.5	4–8	8	16
2nd applic.	4–8	7		<10	8	—	10	8				6–8		36				4–8*	8	—				
Wirestem Muhly																								
1st applic.	4–8*	8	S[7]	4–12	12	12	4–12	8		—*	—*	<6		36	—	—	—	—	—	<8	0.75–1.5	4–8+	8	16
2nd applic.	4–8*	7	—	4–12	12	—	4–12	8				<6		36								4–8	8	—

* Suppression only; provides <75% control.

1 May be tank-mixed with certain broadleaf herbicides only; refer to herbicide labels.

2 Special reduced rates may be possible if applied early and under certain conditions; refer to label.

3 For use on Roundup Ready soybean varieties only. Split applications may be necessary if new weed flushes occur.

4 Select/Clethodim can be applied at a special high rate of 8 oz/A for annual grasses and 16 oz/A for perennials. These high rates should be used only for heavy grass pressure or when grasses are at maximum height.

5 Select/Clethodim application rates vary when tank-mixed with certain broadleaf herbicides. Average rate ranges are shown above. Refer to label for additional information.

6 Refers to rate per acre of herbicide if applied alone or if tank-mixed with broadleaf herbicides ("w/BH"). For Poast, target grass sizes are smaller if tank-mixed with broadleaf herbicides.

7 Split applications may be necessary. May not provide adequate control of this species if tank-mixed with a broadleaf herbicide.

8 Rescue application only; better control will result if applied alone. Do not tank-mix Fusion with broadleaf herbicides for rescue treatments.

9 Except IMI corn hybrids.

(continued)

BROADLEAVES	Amaranth, Palmer/ Waterhemp	Anoda, Spurred	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Morningglory, Annual	Nightshade, Eastern Black	Pigweed	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Velvetleaf
Trade Name (rate/A)	Height Range (inches) at Application													
Basagran (2 pt)	–	4	–	≤10	≤10	≤2*	–	–	–	≤3	≤6	3	≤10	≤6
Cadet (0.9 fl oz)	≤4	–	≤3	–	≤2	≤3*	≤3	≤2	≤4	–	–	–	≤2	≤36
Classic (0.5 oz)	1–2	–	–	2–6	2–4	–	1–2	–	1–2	–	–	–	1–2	–
Classic (0.66 oz)	1–3	–	2–3*	2–8	2–5	–	1–3	–	1–3	2–3	2–4*	–	1–3	2–4
Classic (0.75 oz)	1–4	–	2–6*	2–12	2–6	–	1–4	–	1–4	2–4	2–6	–	1–4	2–6
Cobra[1] (12.5 oz)	6 lvs	2*	4 lvs	6 lvs	4 lvs	–	<4 lvs	6 lvs	6 lvs	6 lvs	4 lvs	3	4 lvs*	4 lvs
FirstRate (0.3 oz)	–	–	–	<10	<4	–	<6	–	–	<10	<10	–	<6	<6
Flexstar GT 3.5 (3.5 pt)	≤4	4	–	≤4	≤4	≤4	≤3	≤4	≤4	≤4	≤4	2	≤4	≤4
Glyphosate[2] (0.75 lb ae)	4–8	2	4–8	4–8	4–8	3–6	3–6	4–8	4–8	4–8	4–8	2	3–6	4–8
Harmony SG (0.125 oz)	2–8	–	–	2–6*	2–4*	2–4	–	–	2–8	–	–	–	2–6	2–6
Liberty (22 oz)	3	3	6	6	6	4	6	6	3	6	6	4	6	3
Liberty (29 oz)	4	5	10	14	10	6	8	8	4	10	12	5	14	4
Permit Plus (0.75 oz)	≤6	–	≤3	≤9	≤4	≤4	≤3	–	≤6	≤9	≤3	–	≤6	≤9
Pursuit 2L (1.44 oz)	1–8	1-2	–	1–8	1–3	1–2*	1–2*	1–3	1–8	1–3*	1–3*	–	1–3	1–3
Raptor (5 fl oz)	2–8	–	–	2–8	2–6	2–5	2–4	2–5	2–8	2–5*	2–5	4*	2–5	2–8
Reflex[1] (1.25 pt)	2–6 lvs	2 lvs	–	2 lvs	6 lvs	2 lvs	2 lvs	4 lvs	2–6 lvs	4 lvs	4 lvs	–*	4 lvs	2 lvs
Resource[1] (6 oz)	≤3 lvs[3]	–	–	–	–	2–3 lvs*	–	–	≤3 lvs[3]	≤4 lvs	–	3	–	≤8 lvs
Storm (1.5 pt)	2–3	2	–	≤6	≤6	≤2*	≤2	≤2	2–3	≤3	≤6	2	≤6	≤2*
Synchrony[4]	2–8	3*	2–3*	2–8	2–5	2–4	1–3*	–	2–8	2–4	2–4*	–	2–8	2–8
Ultra Blazer (1.5 pt)	≤4	–	–	≤2	≤6	≤2	≤2	≤2	≤4	≤3	–	–	≤6	–

Note: See Table 1-4 (generics table) for additional herbicides that contain these active ingredients and Table 1-2 (glyphosate table) for information on glyphosate formulations.

* Suppression only; additional control measures may be necessary.

[1] Labels refer to weed size by number of leaves (lvs).

[2] For use on Roundup Ready soybean varieties only.

[3] Smooth pigweed control only.

[4] For use on STS soybeans or non-STS varieties; use lower rate on non-STS soybeans.

Table 4-14. Comments on postemergence herbicides for soybeans.

The following herbicides can be added with postemergence herbicides to improve residual weed control. They will not provide control of emerged weeds, so they should be applied to weed-free soil surface or with products that will provide postemergence control of weeds present at time of application. Consult labels when tank-mixing with any herbicide. Some pesticides or adjuvants used in combination with the following herbicides could increase the chance of soybean injury.

Trade Name	Common Name	Site of Action Number	Application (Timing on Soybean Growth Stage)	Product/A	lb ai/A
Anthem Maxx 4.3SC	pyroxasulfone + fluthiacet	15 14	postemergence	2–5.7 fl oz	0.033–0.186 0.002–0.006
• Application timing is not specified on label. • Do not exceed a seasonal total of 3.4 fl oz on coarse soils or 5.7 fl oz on all other soils. • Contains fluthiacet (Cadet); see Cadet for more information. • Make applications at least 60 days before harvest.					
Dual Magnum 7.62EC	s-metolachlor	15	postemergence	1–1.33 pt	0.95–1.27
• Application timing is not specified on label. • Do not exceed a seasonal total of 2.6 pt/A. • Make applications at least 90 days before harvest. • A prepackaged mixture with glyphosate is available as Sequence; application timing is cracking through third leaf stage. • A prepackaged mixture with fomesafen (Reflex) is available as Prefix; label mentions early postemergence application timing. Ratio of fomesafen (Reflex) is too low for consistent postemergence control of emerged weeds.					
Outlook 6EC	dimethenamid	15	cracking stage to 5th trifoliate	12–21 fl oz	0.56–0.98
• Rates vary with soil type; refer to label. • Limited residual control when applied to coarse-textured soils. • Do not exceed a seasonal total of 24 fl oz.					
Warrant 3CS	acetochlor	15	emergence to R2	1.25–2 qt	0.94–1.5
• Rates vary with soil type and organic matter; refer to label. • Do not exceed 4 quarts per acre per year. • Label recommends application at V2 to V3 stage. • A prepackaged mixture with fomesafen (Reflex) is available as Warrant Ultra; ratio of fomesafen (Reflex) is too low for consistent postemergence control of emerged weeds.					
Zidua 85WDG	pyroxasulfone	15	1st to 3rd trifoliate	1–3.5 oz wt	0.053–0.186
• Rates vary with soil type; refer to label. • Do not apply to emerged soybeans before the first trifoliate stage. • On coarse-textured soils, do not exceed 2.1 oz per acre per season, or 3.5 oz on medium- to fine-textured soils.					

The following herbicides are commonly applied postemergence to control emerged weeds. Most of these herbicides require an adjuvant to improve control; refer to proper tables to assist with adjuvant selection.

Trade Name	Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Assure II 0.88E/Targa	quizalofop	1	postemergence	5–10 fl oz	0.03–0.06
• Do not use crop oils manufactured from vegetable oils. • When tank-mixing with a broadleaf herbicide, always read both labels to make sure the right surfactant and concentration are used. • Apply when grasses are within the recommended growth stage specified on the label. • Perennial grasses may require a second application for complete control. • Apply to actively growing grasses in 10 to 40 gallons of water per acre using flat fan or hollow cone nozzles. • To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2–3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application. • Assure II/Targa must be applied at least 80 days before harvest.					

(continued)

Trade Name	Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Basagran 4S	bentazon	6	postemergence	1.5–2 pt	0.75–1

- Application should be made while weeds are small and actively growing and before weeds reach maximum size listed on product label. Basagran will not control pigweed species.
- Add crop oil concentrate or nitrogen solution to spray mixture as directed.
- Apply in a minimum of 20 gal of water/A and at minimum pressure of 40 psi.
- Tank-mixing with Reflex or Ultra Blazer improves pigweed control.
- Apply at least 30 days prior to harvest as forage.
- *Water quality advisory.*

Butyrac 200 2L	2,4-DB	4	postemergence	0.7–0.9 pt	0.175–0.22

- 2,4-DB is not recommended for use by itself due to limited control and potential for crop injury. Rather, 2 oz of 2,4-DB can improve morningglory, cocklebur, and jimsonweed control when tank-mixed with other postemergence herbicides.
- Potential for crop injury is increased under hot, dry growing conditions.
- If more than 2 oz/A rate is used, apply as directed spray into rows when soybeans are 8 to 12 inches high and cocklebur, morningglory, jimsonweed, and pigweed have not exceeded a height of 3 inches.
- Top of weed seedling must be sprayed. Use precision directed spray application equipment. Apply with sprayer nozzles mounted on skids or gauge wheels. Do not spray more than one-third of the base of soybean as severe injury may occur.
- Apply at least 60 days prior to harvest (forage or grain).

Cadet 0.91EC	fluthiacet	14	emergence to full flowering	0.4–0.9 fl oz	0.0028–0.006

- Apply 0.4 to 0.6 fl oz/A with glyphosate (RR soybean) or glufosinate (LL soybean), or 0.6 to 0.9 fl oz when applied alone.
- Include the necessary spray additives (NIS or COC plus AMS or nitrogen solution). Applications should be made when susceptible broadleaf weeds, are small. Cadet is very effective on velvetleaf, but other broadleaf weeds must be small (less than 3 inches) to achieve control/suppression. Tank-mixing with other herbicides will usually be necessary to provide broad-spectrum weed control.
- Cadet does not provide residual weed control.
- Cadet can cause bronzing or browning of the soybean leaves.
- Marvel is prepackaged mixture with Reflex and Cadet, but rate of Reflex is below what is typically recommended and needed for effective weed control.
- Apply at least 60 days prior to grain harvest.

Classic 25DF	chlorimuron	2	after 1st trifoliate	0.5–0.75 oz wt	0.008–0.012

- Application should be made while weeds are small and actively growing.
- Always read the label to determine the proper adjuvants.
- Observe labeled crop rotation restrictions for all products containing Classic (see Table 1-5).
- If the soil pH is greater than 7.0, at Classic rates of 0.5 oz/A or greater, do not plant corn for at least 9 months after application.
- Use of STS varieties will reduce the risk of injury. Synchrony XP can be applied to non-STS soybean varieties at 0.375 oz/A use rate or to STS varieties at rates up to 1.125 oz/A.
- Classic is a Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
- Apply at least 60 days prior to harvesting for grain.

Cobra 2E	lactofen	14	postemergence	6–12.5 fl oz	0.09–0.19

- Soybeans should have 1 to 2 trifoliate leaves.
- Applications should be made while weeds are small and actively growing.
- Use surfactant or crop oil concentrate as directed.
- Cobra often causes foliar injury to soybeans.
- Use 6–8 fl oz/A for control of 4- to 6-leaf common ragweed or pigweed.
- Apply at least 45 days prior to harvesting for grain.

Extreme	glyphosate +	9	postemergence	1.5 qt	0.56 (ae)
	imazethapyr	2			0.06

- Prepackaged mixture of glyphosate plus Pursuit. Amount of glyphosate in Extreme is lower compared to amount when applied; additional glyphosate maybe needed for some species.
- Pursuit is a Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
- Apply at least 85 days prior to harvesting for grain.
- Refer to comments in sections for individual herbicides for more information.

FirstRate 84WDG	cloransulam	2	1st trifoliate to 50% flowering	0.3–0.6 oz	0.016–0.031

- Tank-mix to broaden weed spectrum.
- FirstRate may be applied up to 0.6 oz for heavy weed infestations or added residual control.
- FirstRate water-dispersible packets are not soluble in liquid fertilizer solutions; premixing in water is required. UAN will improve velvetleaf control.
- Two applications of 0.3 oz/A are allowed. Do not exceed 1.05 oz/A per season.
- FirstRate is a Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
- Apply at least 65 days prior to harvesting for grain and 14 days prior to harvesting for forage.
- *Water quality advisory.*

Trade Name	Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Flexstar GT 3.5	glyphosate + fomesafen	9 14	postemergence	3–4.5 pt	1–1.47 (ae) 0.24–0.35
• Prepackaged mixture of glyphosate plus Reflex; refer to comments in those sections for more information.					
Fusilade DX 2E	fluazifop	1	postemergence	6–12 fl oz	0.09–0.18
Fusion 2.56EC	fluazifop + fenoxaprop	1 1	postemergence	6–12 fl oz	0.094–0.188 0.031–0.062
• See label for rate and size of weed to be controlled. • Most annual grasses should be treated when 2–4 inches in height. Perennial grasses may require second application to achieve complete control. • To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2–3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application. • Apply before soybeans begin to bloom.					
Glyphosate	glyphosate	9	postemergence	varies by formulation and acid equivalent[1]	0.75–1.5 (ae)
• Apply over the top to glyphosate-tolerant (Roundup Ready) soybean varieties only. • There are many formulations available; be sure to read the label for rates, adjuvants, etc. • Treat in-crop from soybean emergence through full flowering of soybeans. • If additional weed emergence is anticipated, consider including an herbicide that provides residual control. • Perennial weeds may require higher rates and repeat applications. Best control may be obtained when perennial weeds are treated in the bud to bloom growth stage. • Include ammonium sulfate in the tank to improve control of weeds and be sure to read the label to determine if additional adjuvants are required or recommended. • Observe maximum rates per application and per crop. • If glyphosate-resistant weeds are present or Palmer amaranth is in the vicinity, include a second, highly effective herbicide to control these species. • Avoid drift to adjacent crops or other desirable vegetation.					
Harmony SG 50DF	thifensulfuron	2	at least 1st trifoliate	0.125 oz wt (1/8 oz)	0.004
• Harmony SG is a very concentrated formulation. Be sure to use proper application rate, otherwise soybean injury may occur. • Various formulations of Harmony 50SG and generic 75DF thifensulfuron are available; be sure proper rate is applied. • Apply when weeds are actively growing and before they reach maximum size listed on product label. • Any crop may be planted within 45 days following Harmony SG application. • For adequate velvetleaf control, add 1 gallon of liquid nitrogen solution per acre. • Use of STS varieties will reduce the risk of injury. • Harmony Extra plus Classic is available as a prepackaged mixture called Synchrony XP. • Harmony plus Sandea/Permit is available as a prepackaged mixture called Permit Plus. • Synchrony XP can be applied to non-STS soybean varieties at the 0.375 oz/A use rate or to STS varieties at rates up to 1.125 oz/A. • Harmony SG, generic thifensulfuron products, Permit Plus, and Synchrony XP labels state that the first trifoliate leaf of the soybean is fully expanded before the application is made. • Permit Plus is excellent for yellow nutsedge control. • Apply Harmony 7 days before harvesting forage green; 30 days before harvesting dried forage; and 60 days before harvesting for grain. • Harmony is a Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.					
Liberty 280 2.34L	glufosinate	10	emergence to bloom stage	22–36 fl oz	0.4–0.66
• Apply over the top to glufosinate-resistant soybean varieties (e.g., LibertyLink) only. • For best results, plant in narrow rows and apply up to 36 fl oz Liberty about 4 weeks after residual herbicides were applied, when weeds are 2–4 inches tall, and before soybean canopy begins to interfere with spray coverage. • If using sequential applications of Liberty, apply 10–14 days apart and do not apply more than 65 fl oz per acre per season and before soybean bloom stage. • A residual soil-applied product or a sequential POST application may be necessary depending on weed species and severity. • Liberty provides no soil residual activity. • Tank-mixing Liberty with other herbicides including residual products (e.g., Outlook, Warrant) is allowed. Local university research has not observed increased injury with most herbicide combinations; some stunting and leaf burn was observed when Liberty was tank-mixed with Prefix. • Liberty 280 must be applied with ammonium sulfate at the rate of 3 lb/A. • Use of surfactants or crop oils may increase risk of crop response. • Uniform, thorough spray coverage is necessary to achieve consistent weed control; do not use nozzles that produce large droplets; use at least 15 gal/A (20 gal/A if dense vegetation is present). • Applications should be made between dawn and 2 hours before sunset to avoid the possibility of reduced weed control. • Liberty 280 has been observed to antagonize grass control with postemergence grass herbicides. • Apply 45 days before harvesting for grain or forage.					

(continued)

Trade Name	Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Permit Plus 74WDG	halosulfuron + thifensulfuron	2 2	1st trifoliate to R2 stage	0.75 oz wt	0.031 0.004

- Permit Plus is labeled only for soybeans designated as "sulfonylurea-tolerant soybeans" (STS).
- Permit Plus can be applied from V1 stage up until 88 days before harvest.
- Can be tank-mixed with glyphosate.
- See Harmony entry for more information.
- Permit Plus contains two Group 2 herbicides, and there is widespread resistance in the region to this family of herbicides.

Poast 1.5E	sethoxydim	1	postemergence	0.75–1.5 pt	0.14–0.28

- Application should be made when grasses are actively growing and within the recommended stage of growth on the Poast label. Perennial grasses may require a second application to achieve complete control.
- Nitrogen fertilizer additives may improve control of some species.
- To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2–3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application.
- Poast must be applied at least 75 days before harvest.

Pursuit 2S	imazethapyr	2	before bloom	4 fl oz	0.063

- A prepackaged mixture with glyphosate is available as Extreme. The amount of glyphosate is lower than the rate commonly used when glyphosate is applied alone.
- Only one application of Pursuit can be made per soybean growing season.
- Extreme can only be applied to soybean varieties designated Roundup Ready.
- Observe rotation restrictions for products containing imazethapyr (see Table 1-5).
- Pursuit is a Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
- Apply at least 85 days prior to grain harvest.
- *Water quality advisory.*

Raptor 1S	imazamox	2	before bloom	4–5 fl oz	0.031–0.039

- Occasionally, internode shortening and/or temporary yellowing of soybeans may occur, especially if under environmental stress.
- When adequate soil moisture is present, Raptor will provide residual activity of susceptible germinating weeds.
- Apply when weeds are actively growing and before they reach the maximum size listed on product label. Add a non-ionic surfactant and fertilizer solution as directed.
- Less persistent than Pursuit, but follow labeled crop rotation restrictions (see Table 1-5).
- Raptor is a Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
- Apply at least 85 days prior to grain harvest.

Reflex 2E or Flexstar 1.88E	fomesafen	14	postemergence	1–1.5 pt 0.235–0.35	0.25–0.375

- Do not apply Reflex or Flexstar more than once every 2 years.
- Follow labeled rotation restrictions (see Table 1-4).
- Flexstar can cause more soybean injury than Reflex.
- Tank-mixing Reflex with glyphosate formulated as a potassium salt can cause compatibility issues; glyphosate formulations as isopropyl or diammonium salts do not have this issue.
- Flexstar GT contains glyphosate plus fomesafen and should be applied only to glyphosate-tolerant soybeans.
- Marvel is prepackaged mixture with Reflex and Cadet, but rate of Reflex is below what is typically recommended and needed for effective weed control.
- Prefix is a premix of Reflex and Dual and must be applied at least 90 days before grain harvest. Warrant Ultra is a premix of Reflex with Warrant and must be applied at least 45 days before grain harvest. Both have low ratio of Reflex that is below what is typically recommended for effective control.
- Apply Reflex prior to soybean bloom.
- Do not apply within 14 days of an application of saflufenacil (Kixor or Sharpen).
- *Water quality advisory.*

Resource 0.86EC	flumiclorac	14	postemergence	4–12 fl oz	0.027–0.08

- Apply to actively growing weeds at growth stages recommended on the label.
- Tank-mixing broadens the weed control spectrum; use higher rates for larger velvetleaf. Resource has activity against several other weeds when they are in the 2- to 3-leaf stage, including cocklebur, lambsquarters, common ragweed, jimsonweed, pigweed species, and prickly sida, but control declines on larger weeds.
- Apply in a minimum of 10 gal of water/A and a minimum pressure of 30 psi.
- In most cases, use a crop oil concentrate or other additive according to product label.
- Apply at least 60 days prior to grain harvest.

Trade Name	Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Select 2E or Select Max 0.97EC	clethodim	1	postemergence	6–16 fl oz 6–32 fl oz	0.094–0.25 0.05–0.25
• Clethodim is also available as Select Max, which contains a specialized adjuvant system, thus non-ionic surfactant plus ammonium sulfate (AMS) is the standard adjuvant recommendation. Also, Select Max does not require additional adjuvants (other than AMS) when tank-mixed with a "loaded" glyphosate product and provides greater flexibility in additive selection when tank-mixed with other products. • Select 2E should always include crop oil concentrate at 1 qt/A. Add ammonium sulfate at 2.5 lb/A to improve quackgrass control. • To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2–3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application. • Apply at least 60 days prior to grain harvest.					
Storm	bentazon + aciflourfen	6 14	postemergence	1–1.5 pt	0.33–0.5 0.167–0.25
• Prepackaged mixture of Basagran plus Ultra Blazer; refer to comments in those sections for more information. • Apply at least 50 days prior to grain harvest.					
Synchrony XP 28.4XP	chlorimuron + thifensulfuron	2 2	fully expanded 1st trifoliate	0.375–1.125 oz	0.005–0.015 0.0016–0.0045
• Synchrony XP may be applied postemergence to STS soybeans at a use rate of 0.375–1.125 oz/A and to non-STS soybeans at 0.375 oz/A. • Synchrony XP may be tank-mixed to improve weed control spectrum. • Carefully observe crop rotation intervals, and note that extended crop rotation intervals apply when Synchrony XP is applied following preemergence applications of other sulfonylurea or imidazolinone herbicides (see Table 1-5). • Synchrony contains two Group 2 herbicides, and there is widespread resistance in the region to this family of herbicides. • Apply at least 60 days before harvest.					
Ultra Blazer 2S	acifluorfen	14	at least 1st trifoliate	0.5–1.5 pt	0.125–0.38
• Apply in a minimum of 20 gal of water/A and at a minimum pressure of 40 psi. • Do not apply when weeds or crop are under stress; applications made under these conditions generally will be less satisfactory than those made under optimum conditions. • Tank-mixing with Basagran improves velvetleaf and common lambsquarters control. • Apply at least 50 days prior to grain harvest. • *Water quality advisory.*					

[1] Various glyphosate formulations exist; see Table 1-2 (glyphosate formulations) for more information.

Table 4-15. Spray additives and rainfastness for burndown or postemergence soybean herbicides.

Spray additives, or adjuvants, are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactants (NIS), crop oil concentrate (COC), methylated or ethylated seed oil (MSO or ESO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate (AMS) should be spray-grade dry ammonium sulfate (21-0-0).

Trade Name	Adjuvant(s)	Rate	Rainfastness (hours)
Aim/Cadet/Marvel	non-ionic surfactant or crop oil concentrate plus ammonium sulfate or nitrogen solution (optional)	2 pt/100 gal 1 gal/100 gal 2–4 lb/A 2–4 gal/100 gal	1
Assure II/Targa	non-ionic surfactant or crop oil concentrate	1 qt/100 gal 4 qt/100 gal	1
Basagran	crop or vegetable oil concentrate or nitrogen solution or ammonium sulfate (for velvetleaf)	5 qt/100 gal (2 pt/A maximum) 2–4 qt/A 2.5 lb/A	8
Blazer/Ultra Blazer	non-ionic surfactant or crop oil concentrate or ammonium sulfate or nitrogen solution (for velvetleaf)	1–2 pt/100 gal 1–2 pt/100 gal 2.5 lb/A 2–4 qt/A	6
Classic	non-ionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate (for velvetleaf)	1 qt/100 gal 1 gal/100 gal 2–4 pt/A 2–4 lb/A	1
Cobra[1]	non-ionic surfactant or crop oil concentrate plus/or nitrogen solution or ammonium sulfate	1 qt/100 gal 1–2 pt/100 gal 4 qt/A 2.5 lb/A	0.5
Durango DMA/Duramax	no NIS/COC recommended ammonium sulfate (optional)	 8.5–17 lb/A	1
Envive (burndown)	crop oil/modified seed oil or non-ionic surfactant	1 gal/100 gal 1 qt/100 gal	1
Extreme	non-ionic surfactant plus ammonium sulfate	1 pt/100 gal 2.5 lb/A	1
FirstRate	non-ionic surfactant plus nitrogen solution or ammonium sulfate or crop oil concentrate plus nitrogen solution (optional)	1–2 pt/100 gal 2.5 gal/100 gal 2 lb/A 1.2 gal/100 gal 2.5 gal/100 gal	2
Flexstar	non-ionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate	1–2 qt/100 gal 2–4 qt/100 gal 1 gal/100 gal (minimum) 4 lb/100 gal (minimum)	1
Flexstar GT	ammonium sulfate	8.5–17 lb/100 gal	1
Fusilade	non-ionic surfactant or crop oil concentrate plus nitrogen solution or 10-34-0 (optional)	1–2 qt/100 gal 2–4 qt/100 gal 1 gal/A 2 pt/A	1
Fusion	non-ionic surfactant or crop oil concentrate plus nitrogen solution (optional)	1–2 qt/100 gal 2–4 qt/100 gal 4 gal/100 gal	1
Glyphosate	non-ionic surfactant plus ammonium sulfate (optional)	2 qt/100 gal 8.5–17 lb/100 gal	1–6
Gramoxone SL	non-ionic surfactant or crop oil concentrate	1 pt/100 gal 1 gal/100 gal	0.5
Harmony SG[2]	non-ionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate (for velvetleaf)	1–2 pt/100 gal 2 qt/100 gal 4 gal/100 gal 2–4 lb/A	1

Trade Name	Adjuvant(s)	Rate	Rainfastness (hours)
Liberty 280	ammonium sulfate	3 lb/A	4
Permit Plus	non-ionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate (for velvetleaf)	1–2 pt/100 gal 2 qt/100 gal 4 gal/100 gal 2–4 lb/A	4
Poast	crop or vegetable oil concentrate or Dash HC plus nitrogen solution or ammonium sulfate (certain species)	2 pt/A 1 pt/A 2–4 qt/A 2.5 lb/A	1
Pursuit	non-ionic surfactant or crop oil concentrate or vegetable oil concentrate plus nitrogen solution or ammonium sulfate	1 qt/100 gal 2 pt/A 1.5–2 pt/A 1–2 qt/A 2.5 lb/A	1
Raptor	crop oil concentrate or vegetable seed oil or non-ionic surfactant plus nitrogen solution or ammonium sulfate	2 pt/A 1.5–2 pt/A 1 qt/100 gal 1–2 qt/A 2.5 lb/A	1
Reflex	non-ionic surfactant or crop oil concentrate plus nitrogen solution (optional)	1–2 qt/100 gal 2–4 qt/100 gal 4 qt/A	1
Resource	crop oil concentrate plus nitrogen solution (optional)	2–4 qt/100 gal 2–4 qt/A	1
Roundup WeatherMAX/ PowerMAX	no NIS/COC required ammonium sulfate (optional)	8.5–17 lb/100 gal	<1
Select	crop oil concentrate plus nitrogen solution (optional)	2–4 qt/100 gal 1–2 qt/A	1
Sharpen (burndown)	methylated seed oil (MSO) plus ammonium sulfate or nitrogen solution	1 gal/100 gal 8.5–17 lb/100 gal 1.25–2.5 gal/100 gal	1
Storm	non-ionic surfactant or crop oil concentrate or nitrogen solution or ammonium sulfate (for velvetleaf or pigweed)	1–2 pt/100 gal 1–2 pt/A 2 qt/A 2 lb/A	8
Synchrony XP	crop oil concentrate plus nitrogen solution or 10-34-0 or ammonium sulfate (for velvetleaf)	1 gal/100 gal 2–4 qt/A 1–2 qt 2–4 lb/A	1
Touchdown HiTech	non-ionic surfactant plus ammonium sulfate (optional)	1 qt/100 gal 8.5–17 lb/100 gal	1–6
Touchdown Total	no NIS/COC required plus ammonium sulfate (optional)	— 8.5–17 lb/100 gal	1–6
Valor XLT (burndown)	crop oil concentrate or non-ionic surfactant plus ammonium sulfate (optional)	1–2 pt/A 1 qt/100 gal 8.5–17 lb/100 gal	1

[1] Adjuvants for use with Cobra depend on relative humidity and weed species.
[2] Use crop oil concentrate (COC) under drought-stressed conditions.

Table 4-16. Grain harvesting interval and forage restrictions for soybean herbicides.

Trade Name	Forage	Grain
	(ok to feed)	(days to harvest)
2,4-D	no	—*
2,4-DB	60 days	60
Afforia	no	—
Aim/Cadet	no	60
Anthem	no	—
Anthem Maxx	no	60
Assure II/Targa	no	80
Authority Elite	30	—
Authority First	no	65
Authority MTZ	no	—
Authority XL	no	—
Basagran	30 days	none
Boundary	40 days	—
BroadAxe	30	—
Canopy DF/Blend	no	—
Classic	no	60
Cobra	no	45
Command	no	—
Dual	no	—
Envive	no	—
Extreme	no	85
Fierce/Fierce XLT	no	—
FirstRate	14 days	65
Flexstar GT	no	45
Fusilade	no	before bloom
Fusion	no	before bloom
Gangster	no	—
Glyphosate	no	14
Gramoxone (preharvest)	no	application restriction[1]
Harmony SG	7 days (green), 30 days (dried)	60
Intrro	40 days[2]	
Liberty	45 days	45
Lorox	yes	—
Marvel	no	60
Metribuzin	40 days	—
OpTill	no	85
OpTill PRO	no	85
Outlook	no	—
Permit Plus	30	88
Poast	yes[3]	75
Prefix	no	90
Prowl	yes	—
Pursuit	no	85
Python	no	—
Raptor	no	85
Reflex/Flexstar	no	before bloom
Resource	no	60

Trade Name	Forage	Grain
	(ok to feed)	(days to harvest)
Roundup (in-crop)[4]	14	14
Select	no	60
Sharpen	65	—
Sonic	no	65
Storm	no	50
Surveil	no	—
Synchrony XP	no	60
Touchdown	no	14
Treflan	yes	—
Trivence	no	—
Ultra Blazer	no	50
Valor/Valor XLT	no	—
Warrant	no	no
Warrant Ultra	no	45
Zidua	yes	—

* — = not addressed on the label.

[1] When at least 65% of the seed pods have reached a mature brown or when seed moisture is 30% or less.

[2] Do not feed if applied after crop emergence.

[3] Do not feed green forage.

[4] Allow 7 days between preharvest application and grain harvest.

Table 4-17. Comments on harvest aids for soybeans.

Treatments are based on broadcast application, not wiper-bar or rope-wick applications.

Trade Name	Common Name	Site of Action Number	Timing	Product/A	lb ai/A
Alm 2EC	carfentrazone	14	at least 3 days before harvest	1.5 fl oz	0.024
• Use as a harvest aid to desiccate a limited number of broadleaf weed species. • Application shall be made when the crop is mature and the grain has begun to dry down. • Apply in 10 gal/A water. • Include necessary adjuvants and make sure spray coverage is sufficient, otherwise poor control will result.					
Clarity 4S	dicamba	4	at least 7 days before harvest	8–64 fl oz	0.25–2
• Apply Clarity to actively growing weeds after soybean pods have reached mature brown color and at least 75% leaf drop has occurred. • Do not feed soybean fodder or hay following a preharvest application of Clarity. • Water quality advisory.					
Defol 5	sodium chlorate		7 to 10 days before harvest	4.8 qt	6
• Labeled to dry weeds in early maturing soybeans and to facilitate harvest. • Apply to soybeans 7 to 10 days before anticipated harvest, when beans are mature and ready to harvest. • Do not graze treated field or feed treated fodder. • Apply in at least 5 gallons of water by air, and 20 gallons of water with ground application.					
Glyphosate	glyphosate	9	at least 7 days before harvest	varies with formulation	Up to 0.75
• Refer to individual herbicide label to be sure the formulation used is labeled for this type of application. • Apply glyphosate to soybeans after pods have set and lost all green color (80–90% drop of leaves has occurred). • Apply glyphosate in 10–20 gallons of water/A to control weeds that may interfere with harvest or to control perennials such as quackgrass or Canada thistle. • Do not graze or harvest the treated crop for livestock feed within 25 days of application. • Do not use on soybeans grown for seed. • Will not control glyphosate-resistant weeds or dry down Roundup Ready varieties. • See Table 1-2 (glyphosate table) for more information on glyphosate formulations.					
Gramoxone SL 2S	paraquat	22	at least 15 days before harvest	8–16 fl oz	0.125–0.25
• Gramoxone may be used for drying certain weeds and quickening berry drop of eastern black nightshade just before soybean harvest. • Soybean plants must be mature (65% or more of the seed pods have reached mature brown color or seed moisture is 30% or less). • Do not graze or harvest for forage or hay.					

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Integrated Weed Management

A well-planned weed management program for small grains involves using multiple strategies. These strategies include preventive techniques such as monitoring, cultural controls, mechanical or physical controls, biological controls, and chemical control tactics. Preventive techniques start with planting weed-free crop seed or choosing an alternative field or planting date. Regularly monitoring for pests is an important predictive tool. Rotating crops to disrupt weed life cycles and planting adapted varieties are good examples of cultural controls. Mechanical or physical controls may include tillage and mowing. Biological controls may include using insect or disease organisms or even grazing animals in pasture production systems. Finally, chemical controls are an important component of many integrated pest management (IPM) systems, but their use should be based on sound management decisions. See the introductory chapter of this guide for more information on an IPM system.

A good small grain stand is highly competitive and usually does not require herbicides to control weeds. Planting an adapted variety at recommended populations into a weed-free field should serve as the foundation for weed control in small grains. Winter annuals such as chickweed and henbit are becoming more common in small grain fields.

This guide provides chemical control suggestions based on university research and manufacturer recommendations. Management information for common small grain weed problems is outlined in the following pages. This publication strives for accuracy; however, omissions, inaccuracies, or dated information can occur because of the dynamics of pests and pest management. Seek out additional information from the manufacturer or other reliable sources when making important management decisions. Remember, this guide is not a substitute for the manufacturer's product label.

Fall-planted Small Grains

This chapter pertains to fall-planted small grains for the Mid-Atlantic region. Herbicide application timing, expected control levels, and comments are based on fall planting. See below for spring oats.

Fields should be scouted in late fall or early spring to determine if populations warrant treatment. Early application while weeds are still small is the key to successful control of weeds in small grains. Apply herbicides only at recommended stages of crop growth in order to avoid crop injury. See Figure 5-1 and Tables 5-3 through 5-5.

Wheat and barley are sensitive to triazine residues; therefore, use a short residual herbicide program in crops preceding small grains. Read the corn weed control section for information on the effect of pH on triazine residues and weed control programs that reduce triazine residues.

Specific Weed Issues

Downy brome control is listed on Finesse, Maverick, Olympus Flex, and PowerFlex labels. (Refer to label to determine if chess or cheat species will be controlled). Maverick, PowerFlex, and Olympus Flex provide control of downy brome when applied in the fall and suppression when applied in the spring. Soybeans can be planted 3 months after PowerFlex application. However, be cautious of crop rotation intervals when using these Maverick or Olympus Flex herbicides. Aside from STS soybean and IR corn, most other rotational crops cannot be planted for at least 12 to 18 months or more after application depending on the herbicide used.

Group 2 (ALS)–resistant common chickweed populations have been identified in the Mid-Atlantic region since Group 2 herbicides such as Harmony Extra are routinely used in small grains. If Group 2–resistant chickweed is suspected, contact your local county educator to report the incident. Starane Ultra (Dow AgroSciences) at 0.3 to 0.4 pint per acre up to flag leaf growth stage on wheat, barley, and oats has resulted in good chickweed control in university trials. However, it will not control other key species such as wild garlic, mustards, and henbit. (It will, however, injure/kill underseeded legumes.) Starane Ultra can be tank-mixed with Harmony Extra to broaden the spectrum of control. Valor SX also provides very effective residual control of common chickweed and can be used in an early preplant burndown program before seeding wheat. Apply up to 2 ounces per acre of Valor SX (plus other burndown herbicides) at least 7 days before planting wheat. Glory and TriCor (metribuzin) have a 24(c) use label and at 2 to 4 ounces per acre have provided excellent control of Group 2–resistant chickweed in university trials when applied in either fall or spring.

Annual Ryegrass

Most of the annual ryegrass in the region is resistant to Group 1 (ACCase) herbicides, which includes Axial and Hoelon. Annual ryegrass control is listed on Finesse, Maverick, and PowerFlex herbicide labels. However, research at Mid-Atlantic universities has shown inconsistent results on ryegrass control. After a Maverick application the following rotational crops may be planted within a year: wheat, anytime; STS soybean and IR corn, 3 months; soybean, 5 months. Only STS soybeans can be planted after 6 months following a Finesse application.

Spring Oats

Oats are sensitive to triazine residues; therefore, use a short residual herbicide program when small grains follow in the crop rotation. Read the corn weed control section for information on the effect of pH on triazine residues and weed control programs that reduce triazine residues.

In addition to comments for other small grains, the following comments regarding herbicide use in small grains pertain:

2,4-D: Use only 0.5 pint per acre for oats. Certain varieties, especially 'Pennuda', are more sensitive to 2,4-D than other small grains.

Callisto: For use on to oats only (Callisto should not be applied to other small grains). If PRE, apply 6 fluid ounces per acre of Callisto prior to oat emergence. If POST, apply 3 fluid ounces per acre of Callisto after oat emergence but before weeds reach 5 inches tall. Callisto controls many broadleaf weeds. Callisto may cause temporary injury of the oat crop. Callisto has a 10-month rotation restriction to soybeans and an 18-month rotation restriction to most vegetables.

Clarity/Banvel: On spring-seeded oats, apply before 5-leaf stage.

Harmony Extra: On spring-seeded oats, apply at 3-leaf to before jointing (growth stages 2–5). Apply at 0.45 to 0.6 ounce per acre. Do not use on 'Ogle', 'Porter', or 'Premier' oat varieties.

Harmony SG: On spring-seeded oats, apply at three-leaf to before jointing (growth stages 2–5). Apply at 0.45 to 0.6 ounce per acre. Do not use on 'Ogle', 'Porter', or 'Premier' oat varieties.

MCPA amine or ester: Safer than 2,4-D (amine formulation only) on oats underseeded with legumes, but use the lower rate (0.25–0.5 pint) and apply in 5–10 gallons of water per acre; legumes should be 2–3 inches tall and cereal should be 8 inches tall to provide canopy to protect legume.

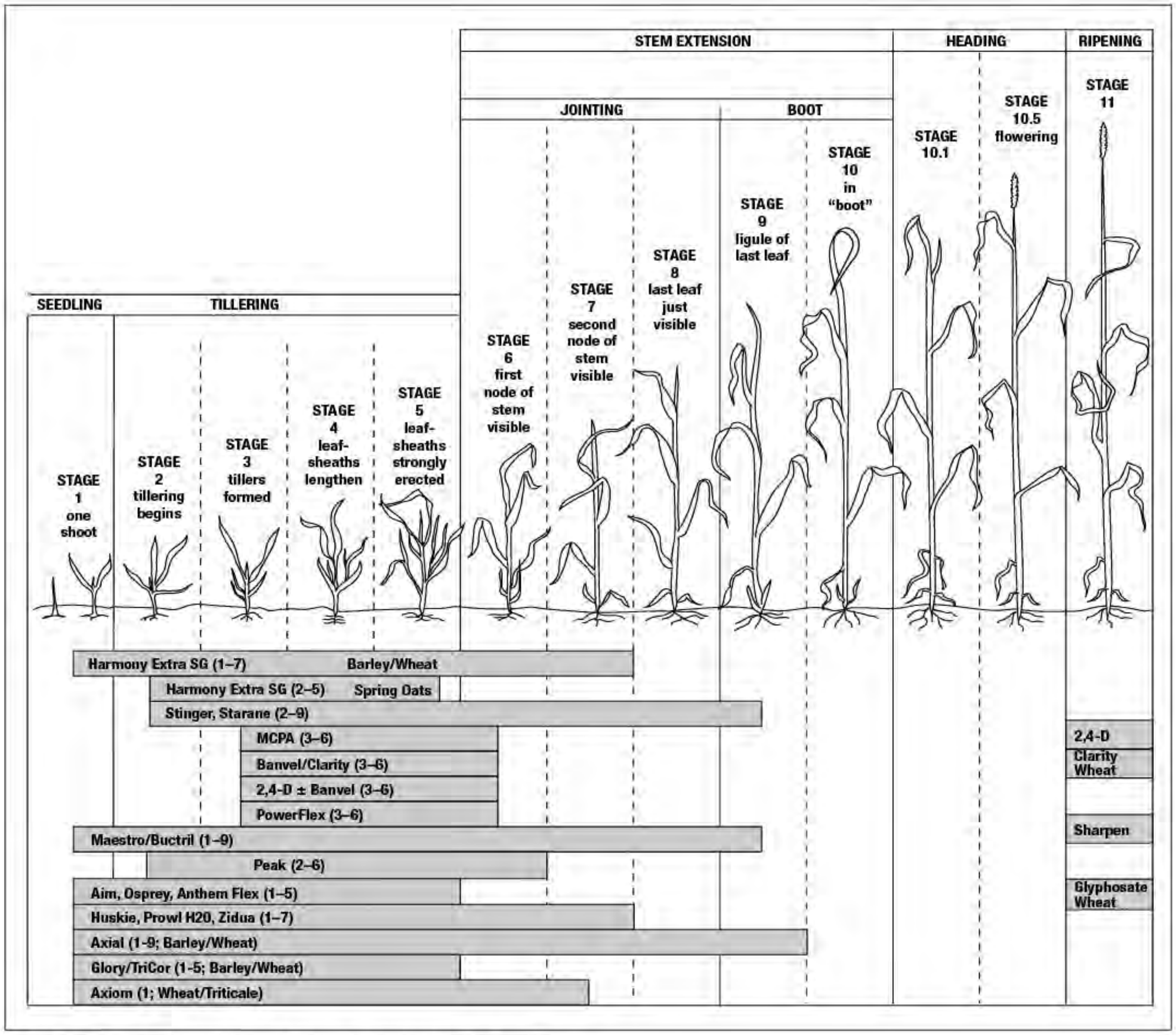

Figure 5-1. Growth stages in cereals when herbicides may be applied.

Table 5-1. Small grain herbicides and their restrictions.

Trade Name[1]	Common Name	Site of Action Number	Manufacturer	Restricted-use Pesticide[2]	Water Quality Advisory[3]	Worker Reentry[4] (hours)
2,4-D (4 lb/gal)	2,4-D	4	Several	—	—	12–48
Aim 2EC	carfentrazone	14	FMC	—	—	12
Anthem Flex 4SE	pyroxasulfone + carfentrazone	15/14	FMC	—	yes	12
Axial Star 1.15L	pinoxaden + fluroxypyr	1/4	Syngenta	—	—	48
Axial XL 0.42L	pinoxaden	1	Syngenta	—	—	48
Axiom 68DF	flufenacet + metribuzin	15/5	Bayer CropScience	—	—	12
Callisto 4SC[5]	mesotrione	27	Syngenta	—	—	12
Clarity 4S/Banvel 4S	dicamba	4	BASF	—	—	24
Curtail 2.4L	clopyralid + 2,4-D	4	Dow AgroSciences	—	yes	48
Finesse Cereal and Fallow 75DF	chlorsulfuron + metsulfuron methyl	2	DuPont	—	—	4
Glory 75WDG[6]/TriCor 75DF	metribuzin	5	ADAMA/ United Phosphorus, Inc.	—	yes	12
Gramoxone SL 2S	paraquat	22	Syngenta	yes	—	12
Harmony Extra 50DF	thifensulfuron + tribenuron	2	DuPont	—	—	12
Harmony SG 50DF	thifensulfuron	2	DuPont	—	—	4
Huskie 2.06L	pyrasulfotole + bromoxynil	27/6	Bayer CropScience	—	yes	12
Huskie Complete 2.4L	pyrasulfotole + bromoxynil + thiencarbazone	27/6/2	Bayer CropScience	—	yes	24
Maestro (Buctril 2E)	bromoxynil	6	Nufarm	—	—	12
Maverick 75DF	sulfosulfuron	2	Monsanto	—	yes	12
MCPA (4 lb/gal)	MCPA	4	Several	—	—	12–48
Osprey 4.5WDG	mesosulfuron	2	Bayer CropScience	—	—	4
Peak 57WDG	prosulfuron	2	Syngenta	—	—	12
PowerFlex HL 13WDG	pyroxsulam	2	Dow AgroSciences	—	—	12
Prowl H2O 3.8CS	pendimethalin	3	BASF	—	—	24
Pulsar 1.67L	fluroxypyr + dicamba	4/4	Syngenta	—	—	24
Roundup PowerMAX 4.5S/ Roundup WeatherMAX 4.5S/ other glyphosates	glyphosate	9	Monsanto/ others	—	—	4–12
Sentrallas	thifensulfuron + fluroxypyr	2/4	DuPont	—	24	1
Sharpen 2.85SC	saflufenacil	14	BASF	—	yes	12
Starane Ultra 2.8L	fluroxypyr	4	Dow AgroSciences	—	—	12
Stinger 3S	clopyralid	4	Dow AgroSciences	—	yes	12
Travallas	metsulfuron + thifensulfuron + fluroxypyr	2/2/4	DuPont	—	—	24
Valor 51WDG	flumioxazin	14	Valent	—	—	12
Zidua 85WDG	pyroxasulfone	15	BASF	—	yes	12

[1] Generic alternatives to some of these products are available. See Table 1-4 in the introductory chapter of this guide.
[2] Only licensed applicators may purchase and apply restricted-use pesticides.
[3] These herbicides have an "Environmental Hazard Warning" on their labels and have been detected in water supplies from normal agricultural use. Special precautions apply for their use on coarse-textured soils or where water tables are shallow. See the product label for specific restrictions.
[4] If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.
[5] Callisto is only registered for use in spring oats.
[6] Glory is approved for use under 24(c) labels in Delaware, New Jersey, Pennsylvania, and West Virginia. TriCor is approved for use under 24(c) label in Virginia.

Table 5-2. Herbicides labeled for use in small grains by small grain species.

Trade Name	Fall-seeded				Spring Oats
	Wheat	Barley	Rye	Triticale	
2,4-D[1]	x	x	x		x
Alm	x	x	x		x
Anthem Flex	x				
Axial Star	x	x			
Axial XL	x	x			
Axiom	x			x	
Callisto					x
Clarity/Banvel	x	x	x	x	x
Curtail	x	x			
Finesse Cereal and Fallow	x	x		x	
Glory/TriCor	x	x			
Gramoxone	x	x	x	x	x
Harmony Extra	x	x		x	x
Harmony SG	x	x		x	x
Huskie	x	x	x	x	
Huskie Complete	x				
Maestro (Buctril)	x	x	x	x	x
Maverick	x				
MCPA	x	x	x		x
Osprey	x			x	
Peak	x	x	x	x	x
PowerFlex HL	x			x	
Prowl H2O	x			x	
Pulsar	x	x			
Roundup	x	x	x	x	x
Sentrallas	x	x			
Sharpen	x	x	x	x	x
Starane Ultra	x	x		x	x
Stinger	x	x			x
Travallas	x	x			
Valor	x	x			
Zidua	x				

[1] 2,4-D is manufactured by various companies; labels may vary among manufacturers.

Table 5-3. Relative effectiveness of burndown treatments for no-till small grains.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size (young weeds) or growth stage. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control
L = labeled but no university data
— = not applicable or no information available

	Trade Name					
	Clarity/ Banvel	Gramoxone	Harmony Extra (Fall-applied)	Roundup/ Glyphosate (Fall-applied)	Roundup/ Glyphosate (Spring-applied)	Sharpen
Site of Action Number	4	22	2	9	9	14
Chickweed, Common	7	**8+**	**9**	**9**	**9**	L
Clover, Red	**9**	8	6	**8+**	7	—
Dandelion	7	N	6	**8+**	6	—
Dogbane, Hemp; Dewberry; Milkweed; etc.	6	6	N	**8+**	6	N
Foxtail spp.	N	**9**	N	**9**	**9**	N
Lambsquarters, Common	**9**	8	**9**	**9**	**9**	L
Marestail	8	7	7	**9**	**9**	**9+**
Mustard spp.	**9**	8	**9**	**9**	**9**	L
Ragweed, Common	**9**	8	6	**9**	**9**	L
Rye Cover, Volunteer Small Grains	N	**9**	N	**10**	**10**	N
Smartweed	**9**	7	**9**	7	7	L
Sod, Alfalfa	8	N	N	**8+**	7	—
Sod, Bromegrass or Quackgrass	N	6	N	**9**	7	N
Sod, Orchardgrass or Fescue	N	N	N	**9**	7	N
Thistle, Canada	8	6	7	**9**	7	—
Timothy or Bluegrass	N	7	N	**10**	**10**	N
Vetch, Hairy	**9**	7	7	8	6	—

Table 5-4. Comments on burndown herbicides for no-till small grains.

See specific product label to determine correct rate for soil type and weed species found in each field. These treatments may be used in conventional, reduced-till, and no-till systems. Tables 5-1 and 5-3 list characteristics and efficacy of burndown herbicides.

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Clarity 4S/Banvel 4S	dicamba	4	preplant or preemergence to postemergence	4 fl oz	0.125
• The 4 fl oz rate controls small annual broadleaf weeds and there is no waiting period prior to planting at this rate. • Clarity/Banvel may be used at greater than 4 fl oz prior to planting wheat; however, for each pt/A of Banvel applied, delay crop planting for 20 days.					
Gramoxone SL 2S	paraquat	22	preplant or preemergence	2–4 pt	0.5–1
• Apply in 20–60 gal/A for control of emerged annual weeds. • Add 8–32 oz non-ionic surfactant/100 gal of spray. • Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier. • Use appropriate precautions when handling paraquat to minimize exposure to the herbicide. • Do not use flood jet tips larger than size 20 or spacing greater than 40 inches. • *Restricted-use pesticide.*					
Harmony Extra SG 50DF	thifensulfuron + tribenuron	2 2	preplant or preemergence to postemergence	0.45–0.9 oz	0.014–0.028
• For use on wheat, barley, and oats only. • Apply burndown treatment before or shortly after planting but before small grain emergence.					
Roundup 3S/ glyphosate[2]	glyphosate	9	preplant or preemergence	1–3 qt	1–3 lb ae/A
• Apply before, during, or after planting but before crop emergence. • Use the low rate for annual weeds up to 6 inches tall and higher rates for weeds taller than 6 inches.					
Sharpen 2.85SC	saflufenacil	14	preplant or preemergence	1–4 fl oz	0.022–0.044
• Apply preplant surface, preplant incorporated, or preemergence for broadleaf weed control. • For optimum burndown activity, include methylated seed oil (MSO) plus ammonium sulfate (AMS) at 8.5 to 17 lb/100 gallons. • Apply 1 to 2 oz/A for burndown activity. If residual weed control is desired, apply 2 to 4 oz/A. Burndown activity does not increase at rates greater than 2 oz/A.					

[1] The legitimate use of 2,4-D for burndown in wheat is uncertain. None of the 2,4-D ester or amine labels specify application just prior to wheat seeding or emergence. Some research suggests a minimum delay of 7–10 days after application at rates up to 1 pt/A 2,4-D ester. However, use of 2,4-D burndown in wheat is ambiguous at best and, if injury occurs, liability rests with the consultant or applicator.

[2] Various formulations of this product are available. See Table 1-2 in the introductory chapter of this guide. Refer to current product label for active ingredient concentration, application rate, and other restrictions.

Table 5-5. Relative effectiveness of fall-planted small grain herbicides for winter annuals.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Results may differ with variations in weed size, temperature, rainfall, and soil moisture. Crop tolerance rating of VG or E is rarely significant.

Weed control rating:

10 = 95–100%	6 = 55–65%
9 = 85–95%	N = less than 55% or no control
8 = 75–85%	L = labeled but no university data
7 = 65–75%	— = not applicable or no information available

Crop tolerance:

E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Trade Name	Site of Action Number	Bluegrass, Annual[1]	Bluegrass, Roughstalk	Brome spp.[2]	Buckwheat, Wild	Catchweed, Bedstraw	Chickweed, Common[2]	Corn, Chamomile	Groundsel, Common	Henbit/Purple Deadnettle	Horseweed/Marestail	Knawel	Lettuce, Prickly	Mustard spp.	Pansy, Field	Pennycress, Field	Ryegrass, Annual[2]	Shepherdspurse	Speedwell spp.[3]	Vetch, Hairy/Annual	Crop Tolerance
Preplant																					
Sharpen	14	N	N	N	N	N	L	N	8	—	L	N	L	L	N	L	N	L	—	—	E
Valor	14	6	—	6	6	—	8	—	L	8	9	N	L	7	N	8	9	8	—	—	FG
Delayed Preemergence																					
Axiom	5/15	8+	N	7	—	—	8+	8+	—	9	8	9	—	8+	N	8	8+	6	—	—	VG
Prowl	3	6	—	—	—	—	7+	—	—	8+	N	N	—	7+	N	—	8	7+	N	N	VG
Zidua/Anthem Flex	15	9	—	8	—	—	7	—	—	8	8	6	—	—	N	—	8+	—	—	N	VG
Delayed Preemergence to Early Postemergence																					
Axial	1	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	9[4]	N	N	N	G
Osprey	2	9	8+	8	N	N	7	7	N	7	N	8	N	8	6	N	9	N	N	8+	G
Postemergence																					
2,4-D[5]	4	N	N	N	6	7	6	—	6	6	8+	N	9	9	N	9	N	9	6	8	F
Aim	14	N	N	N	6	8	N	—	N	6	N	6	6	6	—	8	N	6	6	6	VG
Clarity/Banvel	4	N	N	N	8+	N	7	—	7	7	8	7	8	7	N	7	N	8	6	9	F
Glory/TriCor	5	8+	6	6+	—	—	9	—	—	9	N	8+	—	7	N	L	N	N	8	6	FG[6]
Harmony Extra	2/2	N	N	N	8	N	8[3]	—	9	9	7	8+	8	9	7	9	N	9	N	7	VG
Harmony SG	2	N	N	N	8	N	7	—	9	7	N	—	7	9	—	9	N	9	N	6	VG
Maestro (Buctril)	6	N	N	N	9	N	6	—	9	8	7	N	6	9	—	8	N	8	N	6	VG
MCPA	4	N	N	N	8	N	6	—	6	6	8+	—	9	9	N	9	N	8+	6	7	FG
Peak	2	N	N	N	8	N	7	—	N	6+	8	—	8+	9	—	9	N	8	N	9	G
PowerFlex	2	N	8+	8	6	7	8	9+	N	8	6	9	6	9	7	9	9	8	8	9	FG
Starane Ultra	4	N	N	N	—	L	7+	—	—	8	L	6	—	L	N	L	N	—	N	—	G
Stinger	4	N	N	N	9	N	N	—	9	N	9+	—	9	N	N	N	N	N	N	9	FG

[1] Annual bluegrass control is listed on Osprey and Olympus Flex labels. Fall applications are best.
[2] See the introduction of this chapter for more detailed information on these weeds.
[3] There are several speedwell (Veronica) species, including corn, common, ivy leaf, and others. Depending on the species, their life cycle is either annual or perennial. Many of the commonly used small grain herbicides provide little or no control of speedwell. Finesse has a few annual and perennial speedwells listed on its label and usually provides 80–90 percent control of them. PowerFlex has provided control of certain speedwell species in some university trials. Be cautious of crop rotation intervals if using Finesse. If speedwell is small, Aim provides some control/suppression.
[4] Will not control Group 1 (ACCase) resistant annual ryegrass biotypes.
[5] 2,4-D ester provides better control of hairy vetch than 2,4-D amine.
[6] Crop tolerance with Glory/TriCor is dependent on weather at time of application and variety. Crop tolerance is improved if applications are made in the spring rather than in the fall.

Table 5-6. Relative effectiveness of fall-planted small grain herbicides for postemergent perennial weed control.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Results may differ with variations in weed size, temperature, rainfall, and soil moisture. Crop tolerance rating of VG or E is rarely significant.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control
L = labeled but no university data
— = not applicable or no information available

Crop tolerance:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
F = fair; some crop injury is commonly observed

Trade Name	Site of Action Number	Bedstraw, Smooth	Cockle, White	Dandelion	Dock spp.	Garlic or Onion, Wild	Thistle, Canada	Crop Tolerance
2,4-D	4	6	7+	7+	6+	7	7	FG
Aim	14	6	N	N	N	N	N	VG
Clarity/Banvel	4	N	8	6	7	6	7	F
Glory/TriCor	5	—	—	L	N	N	N	FG[1]
Harmony Extra	2/2	N	—	6	8	9	7	VG
Harmony SG	2	N	—	6	7	9	N	VG
Maestro (Buctril)	6	N	6	6	6	N	6	G
MCPA	4	6	N	8	6+	6	7	FG
Peak	2	N	—	6	8	9	6+	VG
PowerFlex	2	N	N	N	N	N	N	FG
Starane Ultra	4	L	—	7	—	—	N	VG
Stinger	4	N	7+	7+	7	N	8	FG

[1] Crop tolerance with Glory/TriCor is dependent on weather at time of application and variety. Crop tolerance is improved if applications are made in the spring rather than in the fall.

Table 5-7. Comments on herbicides for small grains.

See specific product label to determine correct rate for soil type and weed species found in each field. Tables 5-4, 5-5, and 5-6 list characteristics and efficacy of herbicides. A good small grain stand is very competitive and normally does not require an herbicide treatment. It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
2,4-D amine 4S	2,4-D	4	full tiller to prejointing (growth stages 3–6)	0.5–2 pt	0.25–1

- For use on wheat, barley, rye, and oats.
- Use lower rates for small annual weeds.
- Use lower rate (0.25–0.5 pt/A) if underseeded with legume (alfalfa, red or white clover are labeled; vetch and sweet clover will be severely injured).
- Spraying small grains too young or after jointing can result in reduced yields or uneven ripening.
- In general, apply when small grain is 4 to 8 inches tall.
- May be tank-mixed with Harmony Extra SG, Banvel, or Maestro (Buctril).
- No rotation restriction to soybean; 3-month rotation restriction to vegetables; see Table 1-5.

2,4-D LVE 4E	2,4-D	4	full tiller to prejointing (growth stages 3–6)	0.5–2 pt	0.25–1

- For use on wheat, barley, rye, and oats.
- Use lower rates for annual weeds.
- For wild garlic or onion control, apply 1.5–2 pt.
- Avoid use if temperatures are expected to exceed 75°F.
- No rotation restriction to soybean; 3-month rotation restriction to vegetables; see Table 1-5.

Aim 2EC	carfentrazone	14	up to the jointing stage (growth stages 1–5)	0.5–2 fl oz	0.13–0.26 oz

- For use on wheat, barley, and oats to control certain broadleaves.
- Apply before weeds are 4 inches tall.
- May be tank-mixed with 2,4-D, MCPA, or other common small grain herbicides to improve control and increase weed spectrum. Some research has shown that Aim provides suppression of Star-of-Bethlehem and speedwell.
- No rotation restrictions to soybean or vegetables; see Table 1-5.

Axial XL 0.42L	pinoxaden	1	2-leaf to preboot (growth stages 2–8)	16.4 fl oz	0.053

- For use on wheat or barley only.
- Controls certain grassy weeds such as annual ryegrass, foxtails, barnyardgrass, and wild oat. (Apply Axial XL before weeds have more than 5 leaves on the main stem.)
- Axial XL does not control downy brome or ACCase-resistant grasses.
- Tank-mix with other labeled herbicides to enhance weed control spectrum.
- No rotation restriction to soybean; 30 days for leafy and root crops, all other vegetables after 90 days; see Table 1-5.

Axiom 68 DF	flufenacet + metribuzin	5 15	spiking to 2 leaf (growth stage 1)	4–10 oz	2.7–6.8 oz

- For use on wheat and triticale.
- Apply when crop is between full germination and 2-leaf stage and when weeds have not germinated (preemergence) and 1-leaf stage. Apply prior to weed emergence to 1-leaf-stage weeds.
- Use rate depends on soil texture; see product label.
- Some crop varieties are more sensitive; see product label.
- No rotation restriction to soybean; 12-month rotation restriction to vegetables; see Table 1-5.
- *Water quality advisory.*

Clarity 4S/Banvel 4S	dicamba	4	full tiller to jointing (growth stages 3–6)	2–4 fl oz	0.06–0.12

- For use on fall-seeded barley and wheat only.
- May be tank-mixed with Maestro (Buctril) or 2,4-D to broaden spectrum of control.
- Do not use if legumes are underseeded.
- No rotation restrictions.

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Glory 75WDG/ TriCor 75DF	metribuzin	5	2-leaf to 4-tiller (growth stages 1–4)	2–4 oz	0.047–0.19

- For use on wheat and barley only.
- Glory has a section 24(c) special local need registration in Delaware, Maryland, New Jersey, Pennsylvania, and West Virginia, and TriCor has a section 24(c) label in Virginia for control of Group 2 (ALS) resistant common chickweed.
- The typical use rate is 2–4 oz/A (3 oz/A is recommended) either in the fall or spring when the crop is in the 2-leaf to 4-tiller growth stage.
- Rate depends on soil texture; see product label.
- Glory can be tank-mixed with other small grain herbicides to broaden control spectrum.
- Certain wheat and barley varieties are sensitive to metribuzin. Refer to the Glory label for additional details on varieties and other use restrictions.
- In general, fall-applied herbicide generally provided more consistent common chickweed control, but spring metribuzin treatments were adequate as well.
- For best results, apply metribuzin when chickweed is small (4–6 inches in diameter).
- No rotation restriction to soybean; 4 to 18 months for vegetables; see Table 1-5.

Harmony Extra SG 50DF	thifensulfuron + tribenuron	2 2	2-leaf to before visible flag leaf (growth stages 1–7)	0.45–0.9 oz	0.014–0.028

- For use on wheat and barley only.
- Controls wild garlic and broadleaf weeds. Not recommended for cornflower.
- Rates depend on type of weeds and severity.
- For garlic control use higher rates of Harmony Extra SG plus 2,4-D when garlic is less than 12 inches tall.
- Always premix Harmony Extra SG in water before adding to the spray tank.
- Tank-mixing with Banvel or Maestro (Buctril) may result in reduced control of certain broadleaf weeds.
- Do not tank-mix with Malathion.
- Any crop may be planted 45 days after application; see Table 1-5.

Harmony SG 50DF	thifensulfuron	2	2-leaf to before visible flag leaf (growth stages 1–7)	0.45–0.9 oz	0.014–0.028

- Harmony SG can be used on fall-seeded wheat, barley, triticale, and oats.
- Harmony SG controls wild garlic and broadleaf weeds. Not recommended for cornflower.
- The common rate is 0.75 oz/A, but higher or lower rates may be used.
- Tank-mix with other herbicides to increase weed control spectrum.
- Harmony SG also may be used as a preplant burndown application before small grain emergence.
- Any crop may be planted 45 days after application; see Table 1-5

Huskie 2.06L	pyrasulfotole + bromoxynil	6 27	first-leaf to flag-leaf emergence (growth stages 1–7)	11–15 oz	0.18–0.24

- For use on wheat, barley, and triticale only.
- Huskie controls many annual broadleaf weeds.
- In some university trials, Huskie provided control of marestail at the rosette stage when applied in the spring.
- 4-month rotation restriction to soybean; more than 9 months for vegetables; see Table 1-5.

Maestro (Buctril 2E)	bromoxynil	6	emergence to boot stage (growth stages 1–9)	1–2 pt	0.25–0.5

- For use on wheat, barley, rye, and oats.
- May be applied to a small-grain/alfalfa underseeding.
- Apply before weeds have more than four leaves or are 2 inches tall, or rosettes exceed 1 inch in diameter.
- Use flat fan nozzles and a minimum of 10 gal/A for best results.
- Weak on chickweed and henbit.
- May be tank-mixed with Harmony Extra SG, MCPA, 2,4-D, or Banvel/Clarity.
- 30-day rotation restriction for all crops; see Table 1-5.

MCPA amine or Ester 4L	MCPA	4	full tiller to prejoint stage (growth stages 3–6)	0.5–1 pt	0.25–0.5

- For use on wheat, barley, rye, and oats.
- Safer on small grains underseeded with legumes than 2,4-D (amine formulation only), but use the lower rate (0.25–0.5 pt) and apply in 5–10 gal water/A; legumes should be 2–3 inches tall and cereal should be 8 inches tall to provide canopy to protect legume.
- For best results, apply while weeds are small, typically when cereal is 4–8 inches tall.
- No rotation restrictions are indicated.

(continued)

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Osprey 4.5 WDG	mesosulfuron	2	emergence to jointing stage (growth stages 1–5)	4.75 oz	0.013

- For use on winter wheat only.
- In our region, Osprey will be primarily targeted for control of annual ryegrass, including ACCase-resistant biotypes and downy brome.
- Applications should be made when weeds are young and actively growing at the 1-leaf to 2-tiller stage.
- To broaden weed control spectrum, Osprey may be tank-mixed with other herbicides, including Harmony Extra SG, Harmony SG, MCPA, Maestro (Buctril), and Stinger.
- Do not topdress with nitrogen fertilizer within 14 days following an Osprey application.
- Certain insecticides and fungicides may be tank-mixed.
- Soybean can be planted after 90 days of application, corn after 12 months, vegetables after 10 months, and alfalfa after 10 months; see Table 1-5.

Peak 57WDG	prosulfuron	2	3-leaf to before visible second node (growth stages 2–6)	0.25–0.5 oz (1 pack/6–12 A)	0.14–0.29 oz

- For use on wheat, barley, oats, rye, and triticale.
- Peak controls wild garlic and broadleaf weeds.
- For best results apply when weeds are small and use the 0.5 oz/A rate if used alone.
- May be tank-mixed with Banvel/Clarity, 2,4-D, MCPA, or Maestro (Buctril) to broaden weed spectrum; however, certain application timing restrictions may apply.
- Do not apply organophosphate (op) insecticide 15 days before or 10 days after Peak application.
- Be cautious of crop rotation restrictions (10 months for soybean and 22 months for alfalfa; see label for other cropping restrictions); see Table 1-5.

PowerFlex HL 13WDG	pyroxsulam	2	3-leaf to jointing (growth stage 6)	2 oz	0.016

- For use on wheat and triticale only.
- The PowerFlex label claims control or suppression of certain grass and broadleaf weeds, including annual ryegrass and downy brome.
- Soybean can be planted 3 months after application. Vegetables can be planted after 9 to 12 months; see Table 1-5.

Prowl H2O 3.8SC	pendimethalin	3	first-leaf to before the flag leaf is visible (growth stages 1–7)	1.5–3 pt	0.7–1.4

- For use on wheat or triticale only.
- Must be applied before weed emergence. Any emerged weeds will not be controlled, so use a tank mixture to control them.
- For best results, apply Prowl H2O once the wheat rows are visible and before weeds have emerged.
- Prowl controls many annual grass and broadleaf weeds.
- Wheat or triticale must be planted 0.5–1 inch deep to avoid crop injury.
- No rotation restriction to soybean or vegetables; see Table 1-5.

Sharpen 2.85SC	saflufenacil	14	preplant or preemergence	1–4 fl oz	0.022–0.088

- For use on wheat, barley, oats, rye, and triticale.
- Apply Sharpen for burndown and/or limited residual control of certain annual broadleaf weeds; see Table 5-3.
- Sharpen does not control grass weeds.
- Do not apply Sharpen if crop has emerged.
- No rotation restriction to soybean; 1 to 5 months for vegetables, depending on species; see Table 1-5.

Starane Ultra 2.8L	fluroxypyr	4	2-leaf to early boot (growth stages 2–9)	0.3–0.4 pt	0.09–0.13

- For use on wheat, barley, triticale, and oats.
- The Starane label claims to control bedstraw, chickweed, hemp dogbane, prickly lettuce, ragweed, and velvetleaf and to suppress bindweed, wild buckwheat, mustard species, and others.
- Starane provides good control of Group 2 (ALS) resistant common chickweed.
- 120-day rotation restriction to crops not listed, including soybean. 24(c) labels in Delaware and Virginia permit 90-day rotation to soybeans.

Stinger 3S	clopyralid	4	3-leaf to early boot (growth stages 2–9)	0.25–0.33 pt	0.1–0.125

- For use on wheat, barley, and oats only.
- For best results, apply while weeds are actively growing.
- For Canada thistle, apply when thistle is 1–2 feet tall.
- May be tank-mixed with any other small grain herbicide to increase weed spectrum. (Curtail is a premix of clopyralid and 2,4-D. See product label for details.)
- Do not use plant residues or manure from animals that consumed forage from treated areas for compost or mulch where susceptible plants may be grown the following season.
- 10.5-month rotation restriction to soybean for soils with greater than 2% organic matter; 18-month restriction for soils with less than 2% organic matter. See label, as vegetable rotation varies greatly by species; see Table 1-5.
- *Water quality advisory.*

Trade Name[1]	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Valor SX 51WDG	flumioxazin	14	early preplant	1–2 oz	0.032–0.064

- For use on wheat only.
- Must be applied 7 days prior to planting in no-till or minimum-till wheat; 30-day preplant restriction from conventionally tilled wheat.
- When using as a burndown, apply 2 oz/A.
- Wheat must be planted a minimum of 1 inch deep.
- Valor improves control of horseweed and other broadleaf weeds when tank-mixed with other herbicides that broaden control spectrum.
- No rotation restriction to soybean; more than 4 months for vegetables; see Table 1-5.

Zidua 85WDG	pyroxasulfone	15	delayed pre- to early postemergence	0.7–2 oz	0.037–0.106

- For use on wheat only.
- Zidua can be applied as a delayed preemergence (80% germination with 0.5-inch-long shoot to spiking) to control annual grasses and small-seeded broadleaf weeds.
- Consult label as soil texture influences rate; may be tank-mixed with Sharpen or glyphosate when applied preemergence.
- If applied as an early postemergence (spike to 4 tillers) Zidua may be tank-mixed with Clarity, Prowl H2O, metribuzin, or Axial XL; consult label, as soil texture influences rate.
- Zidua alone will not control emerged weeds.
- Crop injury may result under prolonged wet soil conditions.
- Anthem Flex is a premix of pyroxasulfone and carfentrazone (Aim) and can be applied delayed PRE to early POST for control of certain annual broadleaves and grasses.
- No rotation restriction to soybean; 18 months for vegetables; see Table 1-5.
- *Water quality advisory.*

[1] Various formulations are available; see Table 1-2 in the first chapter of this guide for various glyphosate products and rates. Refer to current product label for active ingredient concentration, application rate, and other restrictions. Adjust application rate if using Roundup WeatherMAX 4.5S.

Table 5-8. Spray additives and rainfastness for burndown or postemergence herbicides in small grains.

Trade Name	Adjuvant(s)[1]	Rate	Apply in Nitrogen Carrier (50:50)	Rainfastness (hours)
2,4-D amine 4S/2,4-D LVE 4E	non-ionic surfactant or crop oil concentrate	2 pt/100 gal 4 qt/100 gal	yes	1
Aim	non-ionic surfactant or crop oil concentrate plus ammonium sulfate or nitrogen solution (optional)	2 pt/100 gal 1 gal/100 gal 2–4 lb/A 2–4 gal/100 gal	yes	6 to 8
Axial	none required		yes	0.5
Axiom	do not add crop oil concentrate, vegetable, or petroleum oils		no	N/A
Callisto	non-ionic surfactant or crop oil concentrate plus ammonium sulfate	2 pt/100 gal 1 gal/100 gal 8.5 lb/100 gal	yes	N/A
Clarity/Banvel	non-ionic surfactant or crop oil concentrate plus nitrogen solution	1 qt/100 gal 1 gal/100 gal 2–4 qt/A	yes	4
Glory/TriCor	not recommended		not recommended	N/A
Harmony Extra	non-ionic surfactant nitrogen solution (optional)	see table below 2 qt/A	yes	several hours
Harmony SG	non-ionic surfactant nitrogen solution (optional)	see table below 2 qt/A	yes	several hours
Huskie	ammonium sulfate or urea ammonium nitrate	0.5–1 lb/A 1–2 qt/A	yes	1
Maestro (Buctril)	non-ionic surfactant or crop oil concentrate or nitrogen solution	2 pt/100 gal 1 gal/100 gal 2–4 gal/100 gal	yes	N/A
MCPA	no information		yes	N/A
Osprey	methylated seed oil (MSO) or non-ionic surfactant plus nitrogen solution	2 gal/100 gal 2 pt/100 gal 1–2 qt/A	yes, but no more than 15% of solution	4
Peak	non-ionic surfactant or crop oil concentrate nitrogen solution (optional)	1–2 qt/100 gal 1–4 qt/A 2–4 qt/A	yes, but do not use crop oil with N-carrier	4
PowerFlex	non-ionic surfactant plus nitrogen solutions (optional) or crop oil concentrate (nitrogen solution is not recommended with COC)	1–2 qt/100 gal 1–2 qt/A 1 gal/100 gal	yes	4
Sharpen	methylated seed oil nitrogen solution	1 gal/100 gal 1.25–2.5 gal/100 gal	N/A	1
Starane Ultra	none recommended		N/A	1
Stinger	none recommended		yes	6
Valor	methylated seed oil nitrogen solution	1 qt/A 1–2 qt/A	N/A	1
Zidua	none recommended		N/A	N/A

[1] In general, non-ionic surfactants should contain at least 80% surface active agent; crop or vegetable oil concentrates should be nonphytotoxic, containing at least 15% approved emulsifier; nitrogen solution is ammonium-based fertilizer such as 28%, 30%, or 32% N; and ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0). You also may use 10-34-0 with some products.

Adjuvant recommendations for Harmony SG and Harmony Extra SG:

Carrier	Situation	Rate of NIS/100 gallons
Water	normal	1 qt
Nitrogen diluted with water (>50% nitrogen)	normal	0.5 to 1 pt
Liquid nitrogen fertilizer	garlic over 8 inches	0.5 pt
Liquid nitrogen fertilizer	garlic less than 8 inches	None
Liquid nitrogen fertilizer	with 8 fl oz of 2,4-D	None
Water	with 8 fl oz of 2,4-D	1 pt

Table 5-9. Comments on herbicides for harvest aid in small grains.

Paraquat/Gramoxone is not labeled as a harvest aid in small grains.

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D LVE 4E	2,4-D	4	1–2 pt	0.5–1
• For use on wheat, barley, rye, and oats. (Only certain 2,4-D products have all of these small grains listed.) • 2,4-D is generally not recommended as a harvest aid due to its volatility and potential damage to the crop during application. • Avoid use if temperatures are expected to exceed 75°F. • 14-day preharvest interval.				
Aim 2EC	carfentrazone	14	2 fl oz	0.26 oz
• Use as a harvest aid to desiccate a limited number of broadleaf weed species. • Application shall be made when the crop is mature and the grain has begun to dry down. • Apply in 10 gal/A water. • Include necessary adjuvants and make sure spray coverage is sufficient, otherwise poor control will result. • Allow at least 3 days between application and harvest.				
Clarity 4S/Banvel 4S	dicamba	4	up to 8 fl oz	up to 0.12
• For use on fall-seeded barley and wheat. • Apply 7 days before harvest • Do not apply to grain grown for seed.				
Roundup PowerMAX 4.5S/ Glyphosate[1]	glyphosate	9	1–2 pt	0.5–1
• For use on wheat or feed barley only, or as spot treatment (<30% moisture). • Spot treatments are permitted in all cereal crops. Apply before heading in small grains and do not treat more than 10% of field. • Apply at least 7 days before harvest. • Wheat stubble may be grazed immediately after harvest. • Do not apply to wheat grown for seed. • Be cautious of drift.				
Sharpen 2.85SC	saflufenacil	14	1–2 fl oz	0.022–0.044
• For use on wheat, barley, and triticale. • Include the necessary additives in the spray mixture. • Ground applications require 10 gallons spray volume per acre; aerial requires 5. • No rotation restriction to soybean; 1 to 5 months for vegetables.				

[1] Various formulations of this product are available; see Table 1-2 in the introductory chapter of this guide for various glyphosate products and rates. Refer to current product label for active ingredient concentration, application rate, and other restrictions. Adjust application rate if using Roundup WeatherMAX 4.5S (e.g., 1 qt Roundup 4S = 22 fl oz WeatherMAX 4.5S).

Table 5-10. Grazing and feeding restrictions for small grain herbicides and livestock use.

Trade Name	Days after Treatment before:				
	Grazing		Feeding Straw	Withdrawals for Meat	Silage
	Beef	Dairy			
2,4-D[1]	0	14	0	14	—[2]
2,4-D[1] (late)	no	no	no	—	—
Aim	7	7	7	—	7
Axial XL	30	30	60	—	30
Axiom	30	30	—	—	—
Callisto[3]	30	30	30	—	30
Clarity/Banvel	0	7	37	30	37
Glory/TriCor	14	14	no	—	21
Harmony Extra	7	7	yes	—	7/30
Harmony SG	7	7	yes	—	7/30
Huskie	25	25	60	—	25
Maestro (Buctril)	30	30	30	30	30
MCPA[1]	0	7	0	7	—
Osprey	30	30	60	—	30
Peak	30	30	30	—	40
PowerFlex	7	7	28	—	28
Prowl	11	11	60	—	11
Sharpen	30	30	30	—	30
Starane Ultra	7	7	40	—	14
Stinger	0	7	no	7	—
Valor	5 inches in height	5 inches in height	—	—	—
Zidua	7	7	—	—	—

[1] 2,4-D and MCPA labels may vary depending on brand name. Consult label for restrictions.
[2] — = no information available.
[3] Callisto is labeled for use in spring oats only.

Chapter 6.
Forage, CRP, and Farmstead Weed Management

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Integrated Weed Management

Managing weeds in forages requires a different approach from managing weeds in row crops. Proper management to establish and maintain a dense stand of forage will render it competitive to most common weeds. Managing soil pH, nutrients, grazing or cutting, and insects, as well as using disease-resistant varieties and selective herbicides when necessary, will help the forage stand be competitive. A well-planned pest management program for forage crops involves using multiple strategies. These should include prevention, monitoring, cultural control, mechanical or physical control, biological control, and chemical control tactics. Preventive techniques may start with planting weed-free crop seed or choosing an alternative field or planting date. Regularly monitoring for pests is an important predictive tool. Rotating crops to disrupt pest life cycles and planting adapted varieties are good examples of cultural controls. Mechanical or physical controls may include tillage and mowing to disrupt certain pests. Mixed grazing by including small ruminants into the livestock community will help manage brushy weeds in a pasture. Other biological controls such as utilizing insect or disease organisms are implemented to lesser extents in pasture production systems. Finally, chemical controls are an important component of many IPM systems, but their use should be based on sound management decisions. See Chapter 1 of this guide for more information about designing an integrated pest management program.

This guide provides chemical control recommendations based on university research and manufacturer recommendations. Table 6-1 contains general information about herbicides available for use in legume or grass forage and pasture. Burndown herbicides available for use in legume forage seedings are listed in Tables 6-2 and 6-3. Herbicides available for use in legumes are listed in Table 6-4. The effectiveness of various herbicides at or during establishment is included in Table 6-5. Herbicides available for use during the establishment year are included in Table 6-6.

This publication strives for accuracy; however, omissions, inaccuracies, or outdated information can occur because of the dynamics of pests and pest management. Seek out additional information from the manufacturer or other reliable sources when making important management decisions. Remember, this guide is not a substitute for the manufacturer's product label.

Legumes

If weeds become a problem, they can compete for or interfere with light, nutrients, water, and space, directly influencing yield and forage stand. For instance, winter annuals and perennials such as common or mouseear chickweed, henbit, and purple deadnettle have been reported to reduce alfalfa stands by more than 30 percent. They emerge in the fall and winter, and develop a thick, lush mat early in the spring that can compete with the first forage cutting. Once they complete their life cycle in early summer, summer annuals, such as foxtails, lambsquarters, and pigweeds, or perennial weeds such as dandelion or dock can fill in the bare spots and continue to reduce forage yield and quality.

Unlike most grain or fiber crops from which weeds are separated at harvest, weeds often are harvested along with the forage crop, potentially reducing hay quality. Reductions in quality often are in the form of low protein content and feed digestibility. Forage value of weeds may vary from species to species. For example, dandelion is comparable to alfalfa in protein and total digestible nutrients (TDN). Dandelion control 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.

Quality of monocot weeds (grasses) can also be similar to that of the forage. In general, weedy grasses have about 75 percent of the quality of alfalfa. Controlling quackgrass in alfalfa can increase forage protein levels 4 to 7 percent. Weeds with woody stems or flower stalks, such as yellow rocket, white cockle, rough fleabane, curly dock, and broadleaf dock, have lower protein levels (about 50 percent 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 during the seedling year, the forage crop seldom requires additional herbicide treatments for at least the first two years of the stand.

Weed management in legume 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 broadleaf and grass weeds such as dandelion, curly dock, Canada thistle, horsenettle, and quackgrass are much easier to manage prior to planting a forage crop. While combating such weeds in the establishment year, prudent use of a genetically modified, glyphosate-tolerant (Roundup Ready) alfalfa seed could be of value. Biennial weeds, including musk thistle 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:

- Weeds that emerge with the crop are generally more destructive.
- Maintain the forage relatively weed free for the first 60 days.
- Weeds that emerge beyond 60 days will not influence that year's forage yield.
- Later emerging weeds may still influence forage quality.
- Winter annual weed competition in early spring is most damaging to forage.
- Broadleaf or dicotyledonous 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. Weed control is also very important while the forage is young and prone to competition from invading species. In no-till seedings, adequately controlling the existing vegetation, especially perennials, is very important. Burndown herbicides available for use in legume forage seedings are listed in Tables 6-2 and 6-3. Herbicides available for use in legumes are listed in Table 6-4. The effectiveness of various herbicides at or during establishment is included in Table 6-5. Herbicides available for use during the establishment year are included in Table 6-6.

Control in an Established Stand

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 contribute much less to yield in the second and succeeding harvests. Before using an 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 an herbicide in established forage stands:

- Thin or irregular stands do not thicken once weeds are removed. Be sure there are sufficient desirable species to fill in the gaps. A minimum of 5 alfalfa plants per square foot should be present.
- Weeds tolerant of the herbicide may invade the space left by susceptible species, ultimately creating a new or more severe weed problem.
- Treat only well-established, vigorous stands with herbicides.
- If the forage stand is at least 2 years old and 25 percent to 30 percent of the plants are weeds, removing them with an herbicide application is of questionable value.
- If 50 percent or more of the plants are weeds, it is time to rotate to a different crop or renovate the existing crop.

If weeds become a problem in established forages, several herbicide options are available (Table 6-6). Chemical control in established forage legumes is often limited to late fall or early spring applications. Many herbicides require the addition of adjuvants for effective control (Table 6-7). Also, many products have harvesting, feeding, or grazing restrictions on their use (Table 6-8).

Grass Forages and Pastures

Without proper management, broadleaf weeds can directly compete with forage grasses or pasture to reduce their nutritional value and longevity. Weeds can replace desirable grass species, filling in gaps or voids and reducing yield and overall quality of the hay or pasture. In addition, certain plants such as poison hemlock, white snakeroot, or black locust have toxic properties that can cause livestock injury or loss under certain circumstances (see Poisonous Weeds below).

Biennial and perennial weeds are considered especially troublesome by grass hay and pasture producers. Both biennials and perennials produce seed each year, potentially starting new infestations. In addition, perennial weeds such as hemp dogbane, Canada thistle, and multiflora rose reproduce from underground roots or rhizomes. Perennial rooting structures can survive for several years in the soil and are often unaffected by occasional mowing or livestock grazing.

Good cultural practices such as maintaining optimum soil fertility, using a competitive cutting schedule for forages, rotationally grazing pastures, and periodic clipping and/or coring pastures can help keep the crop competitive with weeds. The most critical time for weed control is during the establishment year. If a no-till seeding is desired, be sure the preplant vegetation is adequately controlled. See Tables 6-2 and 6-3 for information on burndown herbicides in controlling preplant vegetation.

In general, use preplant tillage or herbicides, companion seedings, mowing, and/or a postemergence herbicide to ensure that weeds are not a problem in the seeding year. To reduce weed shading, mow at a height above the grass seedlings when weeds are 8 to 10 inches tall. For warm-season grasses, do not mow after early August.

Certain application methods used in forage crops, including spot spraying and wiper applications, are not commonplace in row crops. With spot spraying, the herbicide is applied to weed-infested areas of the field, typically less than one-tenth of the total area. Spot applications are accomplished using a hand-held sprayer or a spray gun. Refer to the spot treatment section of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gallon per 1,000 square feet) to provide thorough coverage. Most backpack sprayers hold only 1 to 3 gallons of spray solution. Specialized equipment capable of measuring a small volume or weight (e.g., syringes, gram scales) is recommended to

accurately dispense the desired quantity of herbicide product into small volumes of spray solutions (see Table 6-18). Apply all herbicides at least 7 days before crop harvest, or harvest around weed patches, leaving them standing to be treated later. Apply all herbicides at least 7 days before a killing frost. Spot treatment may kill desirable vegetation that is contacted by the herbicide. Select an herbicide based on its effectiveness on the target weed, safety to existing desirable vegetation, and grazing, overseeding, or rotational crop intervals.

Wiper applicators (weed wipers) are devices that physically wipe a concentrated solution of herbicide directly onto weeds by taking advantage of sufficient height difference between the weeds and crop canopy. The height difference in pasture can be increased by grazing the forage prior to wiper application and allowing some days for trampled weeds to recover. Sufficient contact from the wiper applicator while preventing contact with the crop controls weeds selectively as a result. Since only the top several inches of the weeds are contacted with herbicide solution, a translocated herbicide such as Clarity or glyphosate is usually required for effective control. Repeat applications may be required to manage certain perennial weeds. A healthy actively growing crop that can develop a canopy over suppressed weeds is important to the success of wiper applications. There are several types of wiper applicators on the market. Wiper applicators must be designed and operated so that the rope, roller, sponge, or panel remains moist enough to transfer a sufficient amount of herbicide to the weed while not allowing drips to contact the crop. The two most common types are wick and roller applicators. Wick applicators use short braided ropes or appropriate fabric to "wick" the herbicide solution from inside a pipe to the plants that are wiped. With roller applicators, herbicide is manually sprayed intermittently onto a carpet-covered roller that is rotated with a motor or a ground-driven shaft. The main advantage of the roller applicator is that more herbicide solution can be maintained on the roller because the centripetal force from the rotation inhibits dripping. Compared to wick applicators, roller applicators provide consistent weed control. Bidirectional application is recommended to provide thorough control. Herbicides labeled for wiper application will usually provide specific application instructions on the label. In addition, research trials have indicated that a 5 percent solution applied in a wiper applicator is somewhat comparable to a broadcast application rate of 1 quart per acre.

Controlling woody perennial species (brush) or vines can be very difficult with standard broadcast herbicide applications. Achieving acceptable weed control can require multiple years of intensive and persistent management. Product labels often have specific recommendations concerning herbicide rate, spray volume, seasonal application, retreatment, and growth stage. Recommendations are often species specific, and tank-mixes with other herbicides or alternative application methods may be required. Application methods may include basal bark, cut stump, dormant stem, oil-water emulsions, or high-volume foliar applications. Carefully read and follow all herbicide label recommendations.

Several herbicides are labeled for broadleaf weed control in grass forages and pastures. Tables 6-9 and 6-10 list herbicides that can be used in grass pasture or hay and labeled application timings. See Tables 6-11 through 6-14 for specific information about grass forage and pasture herbicide effectiveness, use, adjuvant requirements, rainfastness, and grazing and haying restrictions. Table 6-15 lists herbicides labeled for use in conservation reserve program (CRP) acres. Table 6-16 lists herbicides labeled for summer annual grass crops, and Table 6-17 shows the optimum time of year to treat selected weeds. Table 6-19 lists herbicides labeled for farmstead use.

Poisonous Weeds

Poisonous weeds are known to affect forage and hay quality. Health effects ranging from none to sickness or occasional death can occur when grazing animals contact or consume potentially toxic plants. To protect animals, it is important to be aware of how toxic plant poisoning occurs commonly. Toxicity is usually derived from certain compounds synthesized by the plant to deter pests, to tolerate extreme soil or other environmental conditions, etc. The toxic potential (the ability to cause detrimental effects) of a given weed on a given day is dependent on many factors, including the species, age, reproductive status, or health of animal consuming it; the plant part, growth stage, condition, and amount of the plant consumed; and the season or environmental conditions when consumed. Discrepancies on poisonous attributes of weeds noted by different sources may be attributed to these variables. Since most of the poisonous substances emit a repulsive odor or are inherently distasteful, the animals typically stay away from plants or plant parts that are poisonous. This is especially true if other more desirable forage species are available. Occasional cases of poisoning, however, do occur when the stand of desirable species is significantly lower than the harmful plants, when extreme weather conditions such as drought occur, with excessive soil fertility, when livestock are contained for extended periods where poisonous plants are prevalent, or when accidental ingestion is followed by lactation and subsequent poisoning of the offspring.

With some weeds, the toxic compound remains in harvested hay or silage (poison hemlock), while in others it is reduced (hairy vetch) or eliminated (buttercup). Some tree leaves are more toxic after wilting (red maple, wild cherry). Some toxic compounds occur naturally in plants, while others are released by fungi (fungal endophytes) growing in association with a living host forage plant (tall fescue toxicosis, ryegrass staggers, red clover slobbers); by fungi in molded hay or clippings (aflatoxin, botulism, sweet clover poisoning); or by undesirable bacteria in silage (listeriosis). Applications

of some herbicides may increase the palatability of certain poisonous plants. Blister beetle poisoning in horses results from consuming a toxin in dead beetles that are bailed into alfalfa hay. Certain weeds such as wild garlic or wild onion, while not toxic, may impart a disagreeable flavor to the milk of lactating animals.

About 200 to 300 plant species have been listed as poisonous to animals. While a complete list of poisonous plants is beyond the scope of this publication, below is a sampling of plant families and species with toxic potential:

- Beech family: oak species
- Boxwood family (highly toxic): boxwood, pachysandra
- Buckwheat family: buckwheat, dock species, rhubarb
- Buttercup family: buttercup species, baneberry, larkspur species
- Heath family (highly toxic): azalea, rhododendron, mountain laurel
- Legume family: black locust, crown or hairy vetch, golden chain tree, lupine species, pea species, alsike clover, sweet clover, red and white clover
- Lily family: autumn crocus, lily-of-the-valley, Star-of-Bethlehem, hyacinth species, skunk cabbage, onion and garlic (both wild and cultivated), tulip, asparagus
- Maple family: red maple
- Nightshade family: nightshade species, jimsonweed, ground cherry, horsenettle, tomato, potato
- Rose family: wild black cherry, chokecherry
- Yew family (highly toxic): English or American yew
- Other species: black walnut (shavings used as bedding), bleeding heart, bouncing bet, bracken fern, burning bush, cocklebur, dogbane species, foxglove, ground-ivy, hemp dogbane, horse chestnut species, horsetail, Johnsongrass, milkweed species, oleander, pigweed (amaranthus species), poison hemlock, pokeweed, privet, ryegrass species, shattercane, St. Johnswort, tall fescue, water hemlock species, white snakeroot, etc.

Toxic weed consumption most often occurs when animals are undernourished, they are introduced to new grazing areas, toxic plants are fed directly to them, or they escape enclosures and feed on toxic plants. It can also occur when the forage provided is not suitable for the species or grazed at the wrong growth stage (prussic acid poisoning), while experiencing environmental stress (nitrate poisoning), or during rapid growth with imbalanced fertility (grass tetany). In addition, otherwise suitable feed, hay, or forage can have toxic effects when animals are transitioned to the new source too quickly.

Provide grazing animals with adequate pasture to meet their nutrient and energy requirements or supplement their diets with a balanced ration to reduce the chance that they will consume toxic plants. Make gradual transitions to new food sources. Be aware of environmental, seasonal, and fertility conditions that may cause forages to accumulate toxic compounds and test if necessary. Scout for toxic plants (inside and outside the fence), implement good forage and weed management practices, spray for weed control when needed, wait after herbicide treatment until plants are no longer palatable, and remove dangerous plants from your property. Minimize the potential for accidental introductions of toxic plants via downed tree limbs, yard cuttings (especially ornamentals), or others feeding your animals. Provide animals with safe bedding materials.

If you suspect plant poisoning has occurred, call a veterinarian immediately. Remove all animals from the area. Identify the suspected plants. Remove accidentally introduced plant material or eradicate toxic plant species by hand-weeding, herbicide applications, pasture renovation, or other recommended practices. Monitor the grazing area over time to ensure the toxic species has been eradicated.

Discussion of toxic ingredients within plants, their specific effects on grazing animals, or toxic dosages (amount required to cause toxicity symptoms) is beyond the scope of this publication. More information can be found in the following sources:

Burrows, G. E., and R. J. Tyrl, *Handbook of Toxic Plants of North America* (Oxford: Blackwell Publishing, 2006)

- Colorado State University Veterinary Internal Medicine: **southcampus.colostate.edu/poisonous_plants/index.cfm**
- Cornell University Animal Science: **www.ansci.cornell.edu/plants/index.html**
- Knight, A. P., and R. G. Walter, *A Guide to Plant Poisoning of Animals in North America* (Wyoming: Teton NewMedia, 2001)
- Nova Scotia Museum, The Poisonous Patch: **museum.gov.ns.ca/poison/?section=species&id=111**
- University of Pennsylvania Veterinary Medicine: **research.vet.upenn.edu/Home/tabid/5849/Default.aspx**

Table 6-1. Forage and pasture herbicides and their restrictions.

Trade Name[1]	Common Name	Site of Action Number	Manufacturer	Crop	Restricted-use Pesticide[2]	Water Quality Advisory[3]	Worker Reentry[4] (hours)
2,4-D amine or ester (3.8 lb ae/gal)	2,4-D	4	several	grass	—	yes	48 or 12
Alm 2EC	carfentrazone	14	FMC	grass and legume	—	—	12
Balan 60DF	benefin	3	Loveland	legume	—	—	12
Butyrac 200 2E	2,4-DB	4	several	legume	—	yes	48
Chaparral 71.6WG	aminopyralid + metsulfuron	4/2	Dow AgroSciences	grass	—	yes	48
Chateau 51WDG	flumioxazin	14	Valent	alfalfa	—	—	12
Cimarron Max (co-pack)	metsulfuron + 2,4-D + dicamba	2/4/4	DuPont	grass	—	—	48
Cimarron Plus 63WDG	metsulfuron + chlorsulfuron	2/2	DuPont	grass	—	—	4
Clarity/Banvel 4S	dicamba	4	BASF/Arysta LifeScience	grass	—	yes	24
Crossbow 3L	2,4-D + triclopyr	4/4	Dow AgroSciences	grass	—	yes	until dry
Curtail 2.38L	clopyralid + 2,4-D	4/4	Dow AgroSciences	grass	—	yes	4
Eptam 7E/20G	EPTC	8	Gowan	legume	—	—	12
Escort XP 60DF	metsulfuron	2	Bayer CropScience	grass	—	—	4
Facet 1.5L	quinclorac	4	BASF	grass	—	yes	12
Gramoxone SL 2S	paraquat	22	Syngenta	legume	yes	—	12
GrazonNext HL 3.74E	aminopyralid + 2,4-D	4/4	Dow AgroSciences	grass	—	yes	48
Grazon P+D 2.54SL	picloram +2,4-D	4/4	Dow AgroSciences	grass	yes	yes	48
Huskie 2.06EC[5]	pyrasulfotole + bromoxonyl	27/6	Bayer	grass	—	yes	24
Kerb 50W	pronamide	3	Dow AgroSciences	legume	yes	—	24
Maestro 2E (Buctril)	bromoxynil	6	Nufarm	legume	—	—	24
MCPA amine or ester (3.7 lb ae/gal)	MCPA	4	several	grass and legume	—	yes	48 or 12
Metribuzin 75DF/4L	metribuzin	5	several	legume	—	yes	12
Metsulfuron 60WG	metsulfuron	2	several	grass	—	—	4
Milestone 2L	aminopyralid	4	Dow AgroSciences	grass	—	yes	48
Outrider 75WDG[6]	sulfosulfuron	2	Monsanto	grass	—	—	12
Overdrive 70WDG	dicamba + diflufenzopyr	4/19	BASF	grass	—	yes	12
PastureGard HL 4SL	triclopyr + fluroxypyr	4/4	Dow AgroSciences	grass	—	yes	12
Poast 1.5E	sethoxydim	1	BASF	legume	—	—	12
Prowl H2O 3.8CS	pendimethalin	3	BASF	alfalfa and grass	—	—	24
Pursuit 2AS	imazethapyr	2	BASF	alfalfa and grass mix	—	yes	4
Raptor 1AS	imazamox	2	BASF	legume	—	—	4
Remedy Ultra 4L	triclopyr	4	Dow AgroSciences	grass	—	yes	until dry
Roundup 3S/Roundup WeatherMAX 4.5S/ glyphosate[7]	glyphosate	9	Monsanto/others	grass and legume	—	—	4–12
Sandea 75DF	halosulfuron	2	Gowan	grass	—	yes	12

Trade Name[1]	Common Name	Site of Action Number	Manufacturer	Crop	Restricted-use Pesticide[2]	Water Quality Advisory[3]	Worker Reentry[4] (hours)
Satellite HydroCap 3.8CS	pendimethalin	3	United Phosphorus, Inc.	alfalfa	—	—	24
Select Max 1E/ Select 2E	clethodim	1	Valent	legume	—	—	24
Sharpen 2.85SC	saflufenacil	14	BASF	grass and alfalfa	—	yes	12
Sinbar 80W	terbacil	5	NovaSource	legume	—	yes	12
Spike 20P/80DF	tebuthiuron	7	Dow AgroSciences	grass	—	yes	—
Starane Ultra 2.8L	fluroxypyr	4	Dow Agro/Loveland	grass	—	—	12
Stinger 3S	clopyralid	4	Dow AgroSciences	grass	—	yes	12
Surmount 1.34E	picloram + fluroxypyr	4/4	Dow AgroSciences	grass	yes	yes	12
Touchdown Total 4S[7]	glyphosate	9	Syngenta	legume	—	—	12
Velpar AlfaMax 77.7WG	hexazinone + diuron	5/7	DuPont	alfalfa	—	yes	24
Velpar 2L/90DF	hexazinone	5	DuPont	legume	—	yes	24
Weedmaster 3.87L	dicamba + 2,4-D	4/4	Nufarm	grass	—	yes	48
Yukon 67.5WG	halosulfuron + dicamba	2/4	Gowan	grass	—	—	24

1 Generic alternatives to some of these products are available.
2 Only licensed applicators may purchase and apply restricted-use pesticides. To become licensed, contact your state's Department of Agriculture.
3 These herbicides have properties that may result in groundwater or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for dissolved runoff and/or runoff erosion. See the herbicide label for specific restrictions.
4 If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.
5 Huskie is recently registered on grass forage; there is little local experience for this use.
6 Outrider is for use in warm-season forage grasses.
7 Various formulations available. Refer to product label application rates and other restrictions.

Table 6-2. Relative effectiveness of burndown treatments for no-till forages.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control

Species		Roundup/Glyphosate	
	Gramoxone	(Fall-applied)	(Spring-applied)
Chickweed	**8+**	**9**	**9**
Clover, Red	8	**8+**	7
Dandelion	N	**8+**	6
Dogbane, Hemp; Dewberry; Milkweed; etc.	6	**8+**	6
Foxtail spp.	**9**	**9**	**9**
Horseweed (Marestail)	7	**9**	**9**
Lambsquarters	8	**9**	**9**
Mustard spp.	8	**9**	**9**
Ragweed, Common	8	**9**	**9**
Rye Cover, Volunteer Small Grains	**9**	**10**	**10**
Smartweed, Annual	7	7	7
Sod, Alfalfa	N	**8+**	7
Sod, Bromegrass or Quackgrass	6	**9**	**9**
Sod, Orchardgrass or Fescue	N	**9**	7
Thistle, Canada	6	**9**	8
Timothy, Bluegrass	7	**10**	**10**
Vetch, Hairy	7	8	6

Table 6-3. Comments on burndown herbicides for no-till forages.

See specific product label to determine correct rate for the weed species found in individual fields.

Trade Name[1]	Common Name	Crop(s)	Product/A	lb ai/A
Gramoxone SL 2S	paraquat	alfalfa	2–4 pt	0.5–1

- Gramoxone SL controls emerged weeds only (no residual activity).
- Apply in a minimum of 10 gal/A (ground, 20–60 gal/A preferred) or 5 gal/A (air) of water.
- Apply before, during, or after planting but before crop emerges.
- Phosphate-containing liquid fertilizer solutions diminish Gramoxone activity if used as a carrier.
- Gramoxone SL is effective on small annual weeds.
- Improved activity on perennial grass sods can be achieved when 2 applications are made. Graze or mow sod to a height of 3 inches or less and apply 2 pt/A followed in 10 to 14 days by 1.5 pt/A.
- Use appropriate precautions when handling Gramoxone to minimize exposure to the herbicide.
- Do not use flood jet tips larger than size 20 or spacing greater than 40 inches.
- See Tables 6-7 and 6-8
- *Restricted-use pesticide.*

Roundup[2] 3S or Roundup WeatherMAX 4.5S	glyphosate	alfalfa, clover, and alfalfa or clover- grass mixtures	1.5–4 qt or 1–3 qt	1–3

- Glyphosate controls emerged weeds only (no residual activity).
- Make ground applications in 10 to 40 gal/A of water. Increase the spray volume within this range as the weed density increases.
- Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers. Do not use Roundup/glyphosate with suspension-type liquid fertilizers.
- Preplant applications can be made before, during, or after planting but before the crop emerges.
- Glyphosate is effective on annual, biennial, and, especially, perennial weeds as well as small grain cover crops.
- Repeated applications may be needed for effective perennial weed control.
- Fall applications of glyphosate are better than spring applications for control of orchardgrass sods and quackgrass.
- Spring applications may be used for control of annual weeds.
- Existing perennial grass stands can be renovated by applying 0.7 to 3.3 qt/A (consult the label for rates for specific species). The existing crop can be grazed or harvested for feed after applications totaling 2 qt/A or less. For applications greater than 2 qt/A, remove livestock before application and wait 8 weeks before grazing or harvest.
- See Tables 6-7 and 6-8.

[1] See Table 6-1 for additional formulations or trade names containing these same active ingredients.

[2] Various formulations of this product are available; see Table 1-2. Refer to current product label for active ingredient concentration, application rate, and other restrictions.

Table 6-4. Application timings for herbicides used in legume forage.

Establishment: Herbicide is applied preplant in no-till establishment to control existing weeds, preplant in existing stands of alfalfa or clover to kill the existing crop and plant a new one (renovation), or preplant incorporated (PPI) or preemergence (PRE) in conventional tillage for residual weed control.

Seedling stand POST: Herbicide is applied postemergence (POST) to seedling alfalfa or clover that has reached a specific growth stage and is actively growing.

Established stand POST: Herbicide is applied POST to alfalfa or clover that has been established for a minimum length of time and is actively growing.

Fall/spring dormant: Herbicide is applied POST to dormant alfalfa or clover legume; may be for seedling legume at a specific growth stage, for legume established for a minimum length of time, or for either. Herbicide rate may be different for seedling or established stands.

Post cutting: Herbicide is applied to alfalfa or clover between forage or hay cuttings, but within a certain time period after cutting or before the legume achieves a specified level of regrowth.

Spot-spray application: Herbicide is applied only to weed-infested areas of the field, usually with hand-held equipment.

Trade Name	Crop(s)[1]	Establishment	Seedling Stand POST	Established Stand POST	Fall/ Spring Dormant (Seedling)	Fall/Spring Dormant (Established)	Post Cutting	Spot-spray or Wiper Applicator
2,4-DB	alfalfa/ clovers		NR[2]	NR				
Balan	alfalfa/ clovers	PPI						
Chateau	alfalfa					<6 inches regrowth	< 6 inches regrowth	
Eptam	alfalfa/ clovers	PPI						
Glyphosate	alfalfa/ clovers	preplant renovation						spot spray and wiper
Gramoxone SL	alfalfa/ clovers	preplant			< 1 year	> 1 year	within 5 days of cut[3]	spot spray
Kerb	alfalfa/ clovers				1-trif[4]	> 1 season[5]		
Maestro (Buctril)	alfalfa		4-trif[6]					
MCPA	alfalfa/ clovers		2-trif[7]			> 1 season[3]		
Metribuzin	alfalfa					> 1 year		
Poast	alfalfa/ clovers		NR	NR				spot spray
Prowl H2O/ Satellite Hydro-Cap	alfalfa		2-trif to 6 inches		2-trif	after 1 cut	< 6 inches regrowth	
Pursuit	alfalfa/ clovers		2-trif	fall	2-trif	> 1 season	< 3 inches regrowth	
Raptor	alfalfa		2-trif		2-trif	> 1 season	< 3 inches regrowth	
Roundup PowerMAX/ WeatherMAX	Roundup Ready alfalfa	preplant renovation	emergence to first cut[8]	after first cut; 1 appl./cut[8]				spot spray and wiper
Select Max	alfalfa		NR	NR				spot spray
Sinbar	alfalfa					> 1 year	< 2 inches regrowth	
Velpar	alfalfa					> 1 year[4]	< 2 inches regrowth	

[1] See herbicide comments table or herbicide label to determine for which clovers herbicide application is labeled.
[2] NR = no alfalfa size restriction on label; application based on weed stage.
[3] Application labeled for alfalfa only, not clover.
[4] Spring application.
[5] Fall application before soil freeze-up.
[6] Trifoliate leaf stage (#-trif) that must be reached before herbicide application.
[7] Application labeled for clover only, not alfalfa.
[8] For use on Roundup Ready alfalfa only; up to 5 days before cutting.

Table 6-5. Relative effectiveness of herbicides on weeds and crop tolerance in legume forages.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Results may differ with variations in weed size, temperature, rainfall, soil moisture, soil type, and soil pH. Crop tolerance rating of VG or less is rarely significant.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
N = less than 55% or no control

Crop tolerance rating:
E = excellent; almost never any crop injury observed
VG = very good; on rare occasion is crop injury observed
G = good; crop injury is seldom observed or is transient
FG = fair to good; occasionally is crop injury observed
F = fair; transient crop injury can be expected

Trade Name	Aim	Balan	Butyrac/2,4-DB	Chateau	Eptam	Gramoxone	Kerb	Maestro (Buctril)	Metribuzin	Poast	Prowl H20/Satellite HydroCap	Pursuit	Raptor	Roundup/Glyphosate	Select	Sinbar	Velpar
Site of Action Number	14	3	4	14	8	22	3	6	5	15	3	2	2	9	15	5	5
Crop Tolerance[1]	G	VG	G	F	FG	FG	VG	F	F	E	FG	G	G	G	E	FG	FG
Winter Annuals																	
Bluegrass, Annual	N	8+	N	7+	8+	8+	8+	N	8	6	6+	6	6	9	7+	7+	8
Brome, Downy	N	9	N	N	9	9	9	N	9	9	6	6	N	9	9	9	9
Chickweed, Common	8+	8	6	8+	7	9	8	6	9	N	7	8+	8+	9+	N	9	9
Henbit/Deadnettle	7+	6	6	8+	9	9	8	8	9	N	8	7	7	8	N	9	9
Horseweed/Marestail	N	N	8	8+	N	6	N	6	6	N	N	N	N	9	N	7	7
Mustard, Wild	8	N	10	7	6	9	6	8	9	N	6	9	9	9	N	9	9
Pennycress, Field	9	N	9	6	6	9	6	9	9	N	6	9	9	9	N	9	9
Pepperweed spp.	8	N	10	7	6	9	6	8	9	N	6	9	9	9	N	9	9
Radish, Wild	8	N	7	7	N	7	N	6	7	N	6	8+	8+	9	N	7	7
Rocket, Yellow	8+	N	8	6	N	8	N	7	9	N	6	8+	9	9	N	9	9
Ryegrass, Annual	N	8+	N	N	9	8	8+	N	7	9	8	6	6	8	9	N	7
Shepherdspurse	9	N	9	6	7	9	6	9	9	N	6+	8+	9	9	N	9	9
Summer Annuals																	
Amaranth, Spiny	8	9	8+	9	9	9	6	8	9	N	9	9	9+	9	N	8+	9
Barnyardgrass	N	9	N	6	9	8	8	N	6	9	8+	8	8	9+	9	6	7
Crabgrass	N	9	N	6	9	6	8	N	6	9	9	8	8	9	9	7	7
Foxtail spp. (Annual)	N	9	N	6	9	9	8	N	6	9	9	8+	8+	9+	9+	7	7
Goosegrass	N	9	N	6	9	9	8	N	6	9	9	8	6	9+	9+	7	7
Lambsquarters	9	9	8+	9	9	8	6	10	9	N	9	7	8+	9	N	9	9
Nightshade, Eastern Black	8	6	8+	8+	9	9	N	9	6	N	N	7+	7+	9	N	8+	7
Panicum, Fall	N	9	N	6	9	9	6	N	6+	9	9	8	8+	9+	9	6+	6+

(continued)

Trade Name	Aim	Balan	Butyrac/2,4-DB	Chateau	Eptam	Gramoxone	Kerb	Maestro (Buctril)	Metribuzin	Poast	Prowl H20/Satellite HydroCap	Pursuit	Raptor	Roundup/Glyphosate	Select	Sinbar	Velpar
Pigweed spp.[2]	**9**	**9**	**8+**	**9**	**9**	**9**	6	8	**9**	N	**9**	**9+**	**9+**	**9**	N	**8+**	**9**
Ragweed, Common	7	N	**9**	7	N	**9**	N	**9**	8	N	N	7	8	**9**	N	8	**8+**
Smartweed, Penn.	8	N	6	7	N	**9**	N	**9**	**8+**	N	8	**8+**	8	**9**	N	**8+**	**8+**
Velvetleaf	**9**	N	**9**	7	N	**9**	N	8	8	N	**8+**	**9**	**9**	**9**	N	8	**8+**
Perennials																	
Aster spp.	N	N	6	N	N	6	N	N	6	N	N	7	7	**8+**	N	6	6
Bedstraw, Smooth	6	N	N	N	N	6	N	N	N	N	N	7	7	8	N	N	N
Bermudagrass	N	N	N	N	7	6	N	N	N	8	N	N	N	8	8	6	N
Cockle, White	6	N	7	N	N	6	N	N	7	N	N	6	6	**9**	N	7	7
Dandelion	6	N	7+	7+	N	N	N	N	7	N	N	7	6	8	N	6	8
Dock spp.	6	N	6	N	N	N	N	N	6	N	N	7	7+	8	N	6	7
Dogbane, Hemp	N	N	N	N	N	6	N	N	N	N	N	N	N	**8+**	N	6	6
Fescue, Tall	N	N	N	N	N	6	8	N	N	6	N	N	N	**9**	7	7	7
Horsenettle	N	N	N	N	N	6	N	N	6	N	N	N	N	7	N	6	6
Johnsongrass	N	6	N	N	7	6	N	N	N	8	N	8	8	**9**	**9**	N	N
Milkweed, Common	N	N	N	N	N	N	N	N	N	N	N	N	N	7	N	6	6
Nutsedge, Yellow	N	N	N	N	8	N	N	N	N	N	6	7	6	7	N	N	N
Orchardgrass	N	N	N	N	6	6	7	N	N	6	N	N	N	8	7+	6	7
Plantain spp.	6	N	7	N	N	N	N	N	7	N	N	6	6	8	N	7	7
Quackgrass	N	N	N	N	8	6	8	N	N	7	N	6	N	**9**	8	6	6
Thistle, Canada	N	N	N	N	N	N	N	N	N	N	N	6	6	**9**	N	N	N

[1] Crop tolerance ratings are for forage crops listed under each herbicide in Table 6-6.
[2] Not triazine-resistant biotypes.

Table 6-6. Comments on herbicides for legume forages.

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name[1]	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Preplant					
Balan 60DF	benefin	alfalfa, birdsfoot trefoil, red clover, ladino clover, alsike clover	preplant incorporated	2 lb	1.2
• Balan provides approximately 1 month of soil residual control of many annual grass weeds and some annual broadleaf weeds. • Apply in 5 to 40 gal/A of water or liquid fertilizer to clean, dry soil within 3 weeks of planting. • Soil incorporation must occur within 8 hours after application. Operate equipment to uniformly incorporate into the top 2 to 3 inches of soil. Refer to the product label for specific instructions on soil incorporation equipment and methods. • Do not use with companion seedings of small grains or forage grasses. • Forage grasses, small grains, sorghum, and corn can be planted 10 months after application. • See Table 6-8.					
Eptam 7E	EPTC	alfalfa, birdsfoot trefoil, clovers, lespedeza; not white Dutch clover	preplant incorporated	3.5–4.5 pt	3–4
• Eptam provides approximately 1 month of soil residual control of many annual grass weeds, some annual broadleaf weeds, and yellow nutsedge. • Apply in 10 to 50 gal/A of water or liquid fertilizer to clean, dry soil just before planting and incorporate immediately. Operate equipment to uniformly incorporate into the top 2 to 3 inches of soil. Refer to the product label for specific instructions on soil incorporation equipment and methods. • Do not use if atrazine was applied within 12 months of planting. • Do not use on white Dutch clover. • Do not use on soils with greater than 10% organic matter. • Forage grasses, small grains, sorghum, and corn can be planted after normal harvest of the legume forage. • See Table 6-8.					
Postemergence					
Aim 2EC	carfentrazone	alfalfa, clover, and alfalfa or clover-grass mixtures	seedling: POST established: POST	1–2 fl oz	0.016–0.032
• Aim controls emerged weeds only (no residual activity). • Apply in spring or summer immediately after cutting but before 6 inches of new growth. • Apply when weeds are actively growing and no more than 3 inches in height or rosettes are less than 2 inches across. • Aim may be applied when crop is in dormancy such as alfalfa fall application through breaking dormancy but before 6 inches of new growth. • There are no rotational crop or overseeding restrictions for labeled crops; see label. • See Tables 6-7 and 6-8. • *Water quality advisory.*					
Butyrac 200 2E (2,4-DB)	2,4-DB	alfalfa, birdsfoot trefoil, CRP	seedling: POST established: POST	1–3 qt	0.5–1.5
• Butyrac 200 controls a relatively narrow spectrum of emerged broadleaf weeds and is particularly effective on morningglory species. • Apply in spring or summer when seedling legumes have 2 to 4 trifoliate leaves. • Apply by ground in a minimum of 10 gal/A or by air in 5 to 40 gal/A of water. • Apply when weeds are actively growing and no more than 3 inches in height, or rosettes are less than 2 inches across. • Do not apply if temperatures above 90°F or below 40°F are expected during or shortly after application. • 2,4-DB labels vary concerning overseeding or rotational crop restrictions or do not mention them. Unless specified on the label, most crops can be safely planted 3 months after application under normal environmental conditions. • See Tables 6-7 and 6-8. • *Water quality advisory.*					

(continued)

Trade Name[1]	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Chateau 51WDG	flumioxazin	Alfalfa	established: dormant between cuttings	2–4 oz	0.064–0.128

- Chateau provides 1 to 2 months of residual control of many annual broadleaf weeds and suppression of some annual grasses as they germinate.
- It will not control weeds that have already emerged at the time of application.
- Apply by ground in 10 to 30 gal/A or by air in 5 to 10 gal/A of water.
- Dormant applications can be made in the fall after the last cutting, during winter dormancy, or anytime in the spring prior to 6 inches of alfalfa regrowth.
- Postcutting applications should also be made prior to 6 inches of regrowth. Application to alfalfa with more than 6 inches of regrowth may result in unacceptable crop injury.
- Wait a minimum of 60 days between applications.
- Do not apply with any adjuvant or tank-mix with any products formulated as an emulsifiable concentrate (EC) unless the application follows the last cutting of the season.
- Application with paraquat can be used to burndown winter annuals prior to the winter dormant period.
- Do not apply to mixed alfalfa-grass stands.
- When applied at the 3 to 4 oz/A rate, forage grasses can be planted 6 months after application if soil is tilled or 12 months after application if planted no-tillage; at the 2 oz/A rate it is 4 months (tilled) and 8 months (no-till); see label for more details.
- See Tables 6-7 and 6-8.

Extreme 2.17L	imazethapyr + glyphosate	Roundup Ready alfalfa	seedling: POST established: dormant established: POST		0.6–1.2

- Extreme controls or suppresses many annual and some perennial broadleaf and grass weeds.
- Extreme also provides 1 to 2 months of residual control of many emerging weeds.
- Apply over the top to Roundup Ready alfalfa varieties only.
- Apply Extreme to seedling RR alfalfa at the second trifoliate stage or larger.
- Apply Extreme to established RR alfalfa in the fall, spring, or between cuttings before alfalfa regrowth reaches 3 inches.
- Apply when the majority of weeds are 1 to 3 inches (height or rosette diameter).
- A typical application rate of Extreme is 3 pt/A.
- Allow a minimum of 7 days between treatments.
- Due to breeding constraints, some alfalfa plants may not contain the glyphosate-resistant gene; thus, some seedlings may not survive the application.
- Do not apply more than 3 pt/A Extreme during the last year of the stand, or crop rotation options will be very limited.
- Forage grasses are not listed on the Extreme label in rotational crops section; small grains can be planted 4 months after application; see label.
- If replanting is necessary, do not plant alfalfa for 4 months following an Extreme application.
- See Tables 6-7 and 6-8.

Gramoxone SL 2S	paraquat	alfalfa, clover, or trefoil	seedling: dormant	1–2 pt	0.25–0.5
			established: dormant	2–3 pt	0.5–0.75
			between cuttings	1 pt	0.25
			spot treatment	0.2–0.7 fl oz/gal	0.15–0.5% solution

- Gramoxone SL controls emerged weeds only (no residual activity).
- Dormant applications provide control of many winter annual weeds, control of some seedling biennial and perennial weeds, and suppression of other biennial and perennial weeds.
- Apply only one dormant application per year by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- To avoid injury, use only on seedling alfalfa or clover stands that are completely dormant, established clover stands with less than 2 inches of remaining fall regrowth that are completely dormant, or established alfalfa stands with less than 6 inches of remaining fall regrowth or 2 inches of new spring regrowth.
- On seedling alfalfa stands (first year), 2 between-cutting applications may be made. First-year alfalfa stands and yields may be reduced if alfalfa is allowed to regrow more than 2 inches after cutting and before application.
- On established alfalfa stands, 3 between-cutting applications may be made. Do not make between-cutting applications more than 5 days after cutting.
- Between-cutting applications are not allowed on other legumes or alfalfa-grass mixtures.
- There are no rotational crop restrictions when applying Gramoxone in legume forages.
- Spot spraying with Gramoxone SL is recommended when only small areas are to be sprayed with labeled applications.
- Refer to weed rate tables of the herbicide label for the recommended herbicide concentration and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- Always add a nonionic surfactant at 0.5 fl oz/gal (15 ml/gal).
- See Tables 6-7, 6-8, and 6-18.
- *Restricted-use pesticide.*

Trade Name[1]	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Kerb 50W	pronamide	alfalfa, birdsfoot trefoil, crown vetch, clovers	seedling: dormant established: dormant	1–3 lb	0.5–1.5

- Kerb provides 1 to 2 months of soil residual control or suppression of several annual grass and some broadleaf weeds, and also has postemergence activity on several small annual grass weeds.
- Apply by ground in 20 to 50 gal/A of water. Make applications in fall or winter when temperatures fall below 55°F but before soil freeze-up.
- Kerb may be applied to fall-seeded legumes after they reach the trifoliate leaf stage.
- Do not apply to spring-seeded legumes until the following fall or early winter.
- Do not use on alfalfa-grass mixtures.
- Rainfall or overhead irrigation is required after application to activate the herbicide.
- Do not use on soils with greater than 4% organic matter.
- Forage grasses, as well as most other crops, can be planted 12 months after application; see label.
- See Tables 6-7 and 6-8.
- *Restricted-use pesticide.*

Maestro 2EC (Buctril)	bromoxynil	alfalfa and alfalfa/ small grain companion seedings, CRP	seedling: POST	1–1.5 pt	0.25–0.375

- Maestro controls emerged weeds only (no residual activity).
- Apply in spring or fall to seedling alfalfa with at least 4 trifoliate leaves.
- May be applied to a small grain companion seeding up to the boot stage.
- Apply by ground in 10 to 20 gal/A or by air in a minimum of 5 gal/A of water or liquid fertilizer. Applications in liquid fertilizer may increase leaf burn to alfalfa.
- Weeds should not exceed the 4-leaf stage, 2 inches in height, or 1 inch in diameter (whichever comes first).
- Maestro application where temperatures are expected to exceed 70°F at or 3 days following application can result in unacceptable crop injury.
- Any crop can be planted 30 days after application.
- Do not use an adjuvant unless a tank-mix partner requires it. See Table 6-7.
- See Table 6-8.

MCPA amine 4S	MCPA	alfalfa, clovers, or trefoil with small grain companion seeding, CRP	seedling: POST	0.25–0.5 pt	0.125–0.25

- MCPA controls or aids in control of some emerged annual, biennial, or perennial weeds.
- Treat after the grain is tillered and legumes are 2 to 3 inches tall.
- Do not use more than 5 to 10 gal/A of water; higher volumes may result in injury to legumes.
- Do not spray when grain is in the boot to dough stage.
- Do not use on sweet clover or vetch.
- Follow all label recommendations to reduce the potential for spray drift.
- MCPA labels vary concerning overseeding or rotational crop restrictions or do not mention them. Unless specified on the label, most crops can be safely planted 3 months after application under normal environmental conditions.
- See Tables 6-7 and 6-8.
- *Water quality advisory.*

Metribuzin 75DF	metribuzin	alfalfa and alfalfa-grass mixtures	established: dormant	0.5–1.3 lb	0.38–1

- Metribuzin provides both postemergence and 1 to 2 months of soil residual control of several annual broadleaf weeds and a few grasses (bromus species and annual bluegrass, green foxtail, and barnyardgrass).
- Apply by ground in 10 to 40 gal/A or by air in a minimum of 2 to 10 gal/A of water or liquid fertilizer.
- Apply in fall after alfalfa goes dormant or in the spring before new growth starts. Alfalfa may be severely injured if new growth is present at spring application.
- May be applied after dormancy is broken, but before 3 inches of new growth, if impregnated on dry fertilizer.
- Apply the appropriate rate from the label when weeds are less than 2 inches tall or 2 inches in diameter.
- May be used on alfalfa-grass mixtures. Orchardgrass in mixed stands will generally tolerate metribuzin at rates of up to 0.67 lb/A. Rates of 0.67 to 1 lb/A can be used in mixed stands of alfalfa and grass to reduce grass stands and prevent crowding out of alfalfa.
- Do not use metribuzin on sand soils or serious crop injury can occur. Crop injury can also occur on loamy sand soils.
- Forage grasses and corn can be planted 4 months, small grains 8 months, and sorghum 12 months after application.
- See Tables 6-7 and 6-8.
- *Water quality advisory.*

(continued)

Trade Name[1]	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Poast 1.5E	sethoxydim	alfalfa, clovers, and birdsfoot trefoil	seedling: POST	1–2.5 pt	0.19–0.47
			established: POST	1–2.5 pt	0.19–0.47
			spot treatment	1.3–1.9 fl oz/gal	1–1.5% v/v solution

- Poast controls many annual and perennial grass weeds (emerged weeds only).
- Apply to actively growing grasses by ground in 5 to 20 gal/A or by air in a minimum of 5 gal/A of water.
- Refer to the herbicide label for the recommended herbicide concentration based on grass species and size (generally less than 8 inches tall) and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Repeated applications may be needed for complete control of perennial species.
- Any crop can be planted 30 days after application.
- Spot applications are allowed, but do not make spot treatments in addition to broadcast treatments.
- Apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- Always add a crop oil concentrate at 1.3 fl oz/gal (38 ml/gal).
- See Tables 6-7, 6-8, and 6-18.

Prowl H2O/ Satellite HydroCap 3.8AS	pendimethalin	alfalfa	seedling: POST	0.5–1 qt	0.5–0.95
			seedling: dormant	0.5–1 qt	0.5–0.95
			established: dormant	1.1–4.2 qt	1–4
			between cuttings	1.1–4.2 qt	1–4

- Prowl H2O provides 1 to 2 months of residual control of most annual grasses and some annual broadleaf weeds as they germinate. It will not control any weeds that have already emerged at the time of application.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- Adequate rainfall or overhead irrigation is required after application to activate Prowl H2O.
- Apply to seedling alfalfa after the legume has 2 fully expanded trifoliate leaves but before it reaches 6 inches in height.
- Established alfalfa is defined by the label as alfalfa planted in the fall or spring that has gone through a first cutting/mowing.
- Apply to established alfalfa before weed emergence. Applications can be made in the fall after the last cutting, during winter dormancy, in the spring, or between cuttings. Applications should be made prior to the alfalfa reaching 6 inches in regrowth.
- Some stunting and yellowing of the alfalfa may occur with post applications.
- Rotational restrictions are based on Prowl rate used, rainfall received, and time of year applied; see label.
- See Tables 6-7 and 6-8.

Pursuit 2S	imazethapyr	alfalfa and alfalfa-grass mixtures, clover, CRP	seedling: POST seedling: dormant established: POST established: dormant between cuttings	3–6 fl oz	0.047–0.094

- Pursuit controls or suppresses many annual and some perennial broadleaf weeds, as well as several grasses when they are small.
- Pursuit also provides 1 to 2 months of residual control of many emerging weeds.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- Seedling applications are for pure seeded alfalfa or clover only. Apply when legume has 2 fully expanded trifoliate leaves or larger.
- Dormant applications can be made in the fall after the last cutting or anytime in the spring prior to 3 inches of alfalfa or clover regrowth.
- Between cutting applications should also be made prior to 3 inches of regrowth.
- Apply when weeds are 1 to 3 inches in height or rosette width.
- Do not apply Pursuit to alfalfa-grass mixtures during the establishment year.
- Do not apply more than 4 oz/A to alfalfa or clover in the last year of the stand (crop rotation considerations).
- Forage grasses are not listed on the Pursuit label in rotational crops section; small grains can be planted 4 months after application; see label.
- See Tables 6-7 and 6-8.
- *Water quality advisory.*

Trade Name[1]	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Raptor 1AS	imazamox	alfalfa	seedling: POST seedling: dormant established: dormant between cuttings	4–6 fl oz	0.031–0.047

- Raptor controls or suppresses many annual and some perennial broadleaf weeds, as well as several grasses when they are small.
- Raptor also provides approximately 1 month of residual control of many emerging weeds.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- Do not apply Raptor in liquid fertilizer as a carrier.
- Apply when seedling alfalfa has 2 fully expanded trifoliate leaves or larger.
- Seedling alfalfa may experience a temporary reduction in growth.
- Apply when weeds are 1 to 3 inches in height or rosette width.
- Apply to established alfalfa in the fall, winter, or spring to dormant or semi-dormant alfalfa or between cuttings.
- Any application should be made before significant alfalfa growth or regrowth (3 inches).
- Forage grasses can be planted 18 months, small grains 3 to 18 months (see label), and sorghum 9 months after application.
- See Tables 6-7 and 6-8.

Roundup 3S[2] or Roundup WeatherMAX 4.5S[2]	glyphosate	alfalfa, clover, and alfalfa or clover-grass mixtures	spot treatment wiper applicator	2% solution 33–77% solution	

- Make applications with hand-held equipment or wiper applicator.
- Apply only to weed-infested areas of the field, and do not treat more than one-tenth of the total area at any one time.
- Refer to weed rate tables of the herbicide label for the recommended herbicide concentration and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- Apply to actively growing susceptible weeds.
- Avoid contact with desirable species as severe injury or death can occur.
- Further application may be made at 30-day intervals if necessary.
- Consult the herbicide label for specific wiper applicator recommendations.
- For best results, do not graze or harvest forage for 7 days after application, and make applications at least 7 days before a killing frost.
- There are no rotational crop restrictions when applying glyphosate in legume forages.
- See Tables 6-7, 6-8, and 6-18.

Roundup 3S or Roundup WeatherMAX 4.5S[2]	glyphosate	alfalfa or alfalfa-grass mixtures	preharvest	32–63 fl oz 22–44 fl oz	0.77–1.5

- For use on declining alfalfa stands prior to crop rotation.
- Apply before last cutting in fall or spring to control certain perennials such as quackgrass.
- Can be grazed or harvested in 36 hours. However, harvest should be delayed for 7 to 10 days after application to allow herbicide to have full effect.
- Deep tillage after harvest improves control.
- Fall applications are more effective on perennial grasses.
- Refer to herbicide label for additional application information and use restrictions.
- There are no rotational crop restrictions when applying glyphosate in legume forages.
- See Tables 6-7 and 6-8.

(continued)

Trade Name[1]	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Roundup PowerMAX or WeatherMAX 5.5L	glyphosate	Roundup Ready alfalfa only	seedling: POST established: POST	22–44 fl oz	0.77–1.9

- Roundup provides broad-spectrum control of existing grass and broadleaf weeds but has no effect on weeds emerging after application.
- Some species of weeds may require retreatment for complete control, as will species with multiple germination flushes.
- Apply by ground in 3 to 40 gal/A or by air in 3 to 15 gal/A of water.
- Two applications may be made to seedling stands prior to the first cutting. The first application is from emergence up to the 4-trifoliate leaf stage and is necessary to remove the small percentage of glyphosate-susceptible alfalfa plants that are present in the new seeding.
- The second application is from the 5-trifoliate leaf stage to 5 days before the first cutting.
- After the first cutting, a single application per cutting may be made up to 5 days before cutting.
- In established stands, a single application per cutting may be made up to 5 days before cutting.
- The highest level of control is achieved when annual weeds are less than 4 inches tall.
- For perennial weed problems, glyphosate should be applied during early fall.
- Sequential applications of glyphosate should be at least 7 days apart.
- The combined total for all in-crop applications cannot exceed 4.1 qt/A per year. The combined total for all applications (in-crop and establishment) cannot exceed 5.3 qt/A per year.
- There are no rotational crop restrictions when applying glyphosate in legume forages.
- See Tables 6-7 and 6-8.
- The Roundup Ready system in alfalfa is easy to use and very effective on most weeds common to alfalfa plantings. However, herbicide-resistant weeds are selected for by repeated use of the same or similar herbicide over a period of time. Weed species with a very high amount of seed production and a variable genetic pool are more likely to develop resistant populations—for example, horseweed, common lambsquarters, ragweed species, and pigweed species. Therefore, it is recommended that the Roundup Ready system be used during the establishment year when the most benefit can be recognized, and then rotate between Roundup and other herbicides with different modes of action through subsequent seasons.

Select 2EC or Select Max 1EC	clethodim	alfalfa, birdsfoot trefoil	seedling: POST	6–16 fl oz or 12–32 fl oz	0.09–0.25 or 0.09–0.25
			established: POST	6–16 fl oz or12–32 fl oz	0.09–0.25 or 0.09–0.25
			spot treatment	0.33–0.65 fl oz/gal	0.25–0.5% v/v solution

- Select Max controls many annual and perennial grass weeds (emerged weeds only).
- Apply to actively growing grasses by ground in 10 to 40 gal/A or by air in a minimum of 10 gal/A of water.
- Apply to grasses at the size recommended on herbicide label (generally less than 6 inches tall).
- Repeated applications are required for complete control of perennial grasses. Allow a minimum interval of 14 days between repeat applications.
- For annual bluegrass control, apply 6 to 16 fl oz Select or 12 to 32 fl oz Select Max before the 4-leaf stage of bluegrass.
- Any crop can be planted 30 days after application.
- Select 2EC and Select Max 1EC require different adjuvants. See Table 6-7.
- Spot treatments are allowed but do not exceed a total of 32 fl oz/A per season for Select or 64 fl oz/A per season for Select Max for spot treatments and broadcast treatments combined.
- Refer to weed rate tables of the herbicide label for the recommended herbicide concentration and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- Always add a crop oil concentrate at 1.3 fl oz/gal (38 ml/gal).
- See Tables 6-8 and 6-18.

Sinbar 80WG	terbacil	alfalfa	established: dormant between cuttings	0.75–1.5 lb	0.6–1.2

- Sinbar provides postemergence control (small weeds) and 1 to 2 months of soil residual control of many annual weeds and some biennial and perennial weeds.
- Use only on alfalfa established for 1 year or more.
- Apply by ground in water with sufficient spray volume for uniform coverage.
- Dormant applications can be made in the fall through winter to dormant alfalfa or in the spring prior to 2 inches of alfalfa regrowth. Spring between-cutting applications should also be made prior to 2 inches of regrowth.
- Two applications per year are allowed, but they must be separated by 60 days, and the total amount of Sinbar cannot exceed 1.5 lb/A per year.
- Apply before weeds germinate or before they exceed 2 inches in height or width.
- Do not use on alfalfa-grass mixtures.
- Do not use on sand, loamy sand, or gravel soils, or on soils with less than 1% organic matter or serious crop injury can occur.
- No other crops can be planted for 2 years following an application of Sinbar.
- Do not use any spray adjuvants. See Table 6-7.
- See Table 6-8.
- *Water quality advisory.*

Trade Name[1]	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Velpar 2L or 75DF	hexazinone	alfalfa	established: dormant between cuttings	2–6 pt 0.67–2 lb	0.5–1.5

- Velpar provides postemergence control (small weeds) and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as suppression of some woody species.
- Use only on alfalfa established for 1 year or more.
- Apply by ground in a minimum of 20 gal/A or by air in a minimum of 5 gal/A of water.
- Make a single application after alfalfa becomes dormant and before new growth begins in the spring. Where weeds have emerged, include a surfactant. Weeds should be less than 2 inches tall or 2 inches in diameter.
- If no dormant application is made, a between-cuttings treatment may be made; apply before 2 inches of alfalfa regrowth. Severe injury may result with between-cutting applications if significant alfalfa foliage is present at application or air temperature exceeds 90°F.
- Do not use an adjuvant with between-cutting applications.
- Do not use on gravelly or rocky soils, exposed subsoils, or hardpan, sand, or poorly drained soils, or serious crop injury can occur.
- Unacceptable weed control may occur on soils with greater than 5% organic matter.
- When applied at 3 pt/A or less, corn can be planted 12 months after application.
- Other crops may be planted 24 months after application.
- See Tables 6-7 and 6-8.
- *Water quality advisory.*

[1] See Table 6-1 for additional formulations or trade names containing these same active ingredients.

[2] Various formulations of this product are available. Refer to current product label for active ingredient concentration, application rate, and other restrictions. Adjust application rate if using Roundup.

Table 6-7. Adjuvants and rainfastness for postemergence herbicides in legume forage.

Adjuvants are products you include in the spray tank to improve the performance of your herbicides. These include non-ionic surfactant (NIS), crop oil concentrate (COC), methylated seed oil (MSO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient, and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0). Crop injury can occur with the use of adjuvants. Adding additional adjuvants than what is labeled can increase the chance or severity of crop injury. Following are recommended adjuvants for broadcast postemergence applications; refer to herbicide labels for adjuvant recommendations with other application types. Rainfastness is number of hours needed between time of application and rainfall or irrigation to ensure sufficient absorption in the plant.

Trade Name	Adjuvant(s)	Rate	Rainfastness (hours)
Alm 2EC	non-ionic surfactant or crop oil concentrate	1 qt/100 gal 0.5–1 gal/100 gal	not specified
Butyrac 200 2L/2,4-DB 2L	none		not specified
Glyphosate preplant or spot treatment	varies by product, check label ammonium sulfate (optional)	see label 8.5–17 lb/100gal	1–6
Gramoxone 2SL	non-ionic surfactant or crop oil concentrate	1 qt/100 gal 1 gal/100 gal	0.5
Kerb 50W	none		not specified
Maestro 2EC (Buctril)	not recommended (see label for instructions when tank-mixing)	1	
MCPA 3.7L	none		not specified
Metribuzin 75DF	none		not specified
Poast 1.5EC	crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate (optional)	2 pt/A 1.5 pt/A 2–4 qt/A 2.5 lb/A	1
Pursuit 2AS	non-ionic surfactant or crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate (required)	1 qt/100 gal 1 gal/100 gal 1.25 gal/100 gal 1.25–2.5 gal/100 gal 12–15 lb/100 gal	1
Raptor 1AS	non-ionic surfactant or crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate (required)	1 qt/100 gal 1–2 gal/100 gal 1–2 gal/100 gal 2.5 gal/100 gal 12–15 lb/100 gal	1
Roundup PowerMAX or Weather-MAX 5.5L in RR alfalfa	ammonium sulfate (optional)	8.5–17 lb/100 gal	not specified
Select 2EC	crop oil concentrate plus nitrogen solution or ammonium sulfate (optional)	1 gal/100 gal 1–2 qt/A 2.5–4 lb/A	1
Select Max 1EC	non-ionic surfactant or crop oil concentrate or methylated seed oil	1 qt/100 gal 1 gal/100 gal 1 gal/100 gal	1
Sinbar 80WP	do not use		not specified
Velpar 2L	non-ionic surfactant on dormant alfalfa none on non-dormant alfalfa	1 qt/100 gal	not specified

Table 6-8. Grazing, harvest, haying, and slaughter restrictions for legume forage herbicides.

Trade Name	Type	Length	Comments
Aim (carfentrazone)	Grazing (forage) and haying (harvest)	21 days	May be used in established, mixed grass-clover stands as well as established pure forage legume stands
Butyrac (2,4-DB)	Grazing or feeding	60 days	Seedling alfalfa
		30 days	Established alfalfa
Chateau (flumioxazin)	Grazing or harvest	25 days	Established alfalfa; less than 6 inches of regrowth
Gramoxone (paraquat)	Grazing or harvest	60 days	Fall or spring dormant application alfalfa or clover
	Grazing or harvest	30 days	Between-cutting application alfalfa only
Kerb (pronamide)	Grazing or harvest	120 days	Fall or dormant application alfalfa or clover
Maestro (bromoxynil)	Grazing or harvest	30 days	After spring application
		60 days	After fall or winter application
MCPA	Forage or grazing	7 days	Do not forage or graze meat animals within 7 days of slaughter or dairy animals within 7 days of treatment; alfalfa or clover
Metribuzin	Grazing or harvest	28 days	Dormant application
Poast (sethoxydim)	Forage (grazing)	7/20 days	On the label, forage refers to green, undried alfalfa; Poast has 20-day restriction for clover hay only
	Hay (harvest)	14/20 days	Hay is dried alfalfa; Poast has 20-day restriction for clover hay only
Prowl H2O (pendimethalin)	Forage or hay harvest	28 days	Apply before 6 inches of alfalfa regrowth; has a 28-day restriction for 2.1 qt/A or less, 50-day restriction for more than 2.1 qt/A
Pursuit (imazethapyr)	Feeding, grazing, or harvest	30 days	Alfalfa or clover; be cautious of rotational crop restrictions
Raptor (imazamox)	Feeding, grazing, or harvest	NA	Not specified on the label
Roundup/glyphosate	Grazing or harvest (preplant)	0 days	Alfalfa or clover may be grazed or cut for hay immediately following preplant application
	RR alfalfa only	5 days	In RR alfalfa varieties, apply glyphosate up to 5 days before cutting
	Grazing or harvest (spot treatment)	3–14 days	Spot treatment on alfalfa or clover depends on glyphosate product used
Select (clethodim)	Feeding, grazing, or harvest	15 days	Increases when tank-mix with 2,4-DB (60 days)
Velpar (hexazinone)	Grazing or feeding	30 days	Plant only corn for 12 months following application of Velpar

Table 6-9. Application timings for herbicides used in grass pasture or hay.

Use only in: If left blank, these products are available in Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia.
Establishment: Herbicide is applied preplant in no-till establishment to control existing weeds. There are currently no herbicides registered for preplant incorporated (PPI) or preemergence (PRE) applications in grass forage for residual weed control.
Seedling stand POST: Herbicide is applied postemergence (POST) to seedling grass that has reached a specific growth stage and is actively growing, or at a maximum allowable rate.
Established stand POST: Herbicide is applied POST to grass that has been established for a minimum length of time and is actively growing.
Spot-spray application: Herbicide is applied only to weed-infested areas of the field, usually with hand-held equipment. If the herbicide is labeled for seedling or established stands postemergence, then herbicide use rates, application timing, and minimum establishment periods should be observed unless otherwise stated on the label. Grazing, harvest, slaughter, and transfer restrictions still apply for all spot-spray applications.
Grazed fencerows: Herbicide is applied along a grazed fencerow to control emerged weeds and/or prevent seedling emergence. Use postemergence broadcast rates and timings unless grazed fencerows are specifically mentioned on the label. If the herbicide is labeled for spot applications, and the total area of the fencerows being treated is less than 10% of the total area inside the fencerows, spot application recommendations can be used. Grazing, harvest, slaughter, and transfer restrictions still apply for all applications to grazed fencerows.

Trade Name	Use Only in	Establishment	Seedling Stand POST	Established Stand POST	Spot-spray or Wiper Applicator	Grazed Fencerows
2,4-D amine[1]				L[2]	—[3]	yes
2,4-D ester[1]				L	—[3]	yes
Aim			L	L		yes
Arsenal						yes
Banvel			1 pt max[4]	L	spot	yes
Chaparral (aminopyralid + metsulfuron)	PA, VA, WV			after tillering[5]	spot	yes
Clarity			1 pt max[4]	L	spot and wiper	yes
Clarity/Banvel + 2,4-D tank-mix				L		yes
Crossbow (triclopyr + 2,4-D)				after tillering[5]	spot	yes
Facet L				L	spot	yes
Glyphosate		preplant renovation			spot and wiper	yes
Gramoxone SL		preplant				no
GrazonNext HL (aminopyralid + 2,4-D)	PA, VA, WV			after tillering[5]	spot	yes
Grazon P+D (picloram + 2,4-D)	VA, WV			after tillering[5]		yes
MCPA			½ pint max[6]	L		yes
Metsulfuron				6–24 months[7]	spot	yes
Milestone				after tillering[5]	spot	yes
Overdrive (dicamba + diflufenzopyr)				L	spot	yes
PastureGard HL (triclopyr + fluroxypyr)				after tillering[5]	spot	yes
Prowl H2O				6 or more tillers		yes
Remedy Ultra				after tillering[5]		yes
Sandea				L	spot	yes
Sharpen				L		yes
Spike 20P (pelleted)[8]				L	spot	yes
Stinger				L	spot	yes
Surmount (picloram + fluroxypyr)	VA, WV			after tillering[5]	spot	yes
Weedmaster (dicamba + 2,4-D)			2 pt max[4]	L	spot	yes

1 2,4-D is manufactured by various companies; labels may vary among manufacturers.
2 L = allowed on herbicide label with no specific grass size or establishment period restrictions.
3 Most 2,4-D labels do not include spot-spray applications, while some do.
4 Labels state that "newly seeded areas" may be severely injured if rates greater than 1 pt/A (Banvel or Clarity) or 2 pt/A (Weedmaster) is applied, but no minimum size or growth stage is given. In practice, these products should not be applied until seedling grasses have attained the 3 to 4-leaf stage, have reached a minimum height of 6 inches, and are healthy and actively growing.
5 Grasses should be tillering and have developed a good secondary root system.
6 This is labeled for mixed clover/grass stands after 2-trifoliate clover.
7 Six months after establishment for bluegrass, bromegrass, and orchardgrass; 12 months for Timothy; 24 months for fescue.
8 Spike is labeled for broadcast applications, but because it can persist for several years in the soil, it is generally only recommended for hand treatment of single plants, multistem clumps, or small stands of woody vegetation in land (including fencerows) dedicated to long-term grass pasture.

Table 6-10. Grass pasture or hay herbicide prepackaged mixes, or co-packs, and equivalents.

Trade Name	Components (ai/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai)	An Equivalent Tank Mixture of
Chaparral 71.6WG	0.6213 lb aminopyralid	4	2.5 oz	0.098 lb aminopyralid	6.25 fl oz Milestone 2L
	0.0945 lb metsulfuron	2		0.015 lb metsulfuron	0.4 oz Metsulfuron 60DF
Cimarron Max (co-pack 60DF and 2.87L)	dry: 0.6 lb metsulfuron	2	dry: 0.4 oz	0.015 lb metsulfuron	0.4 oz Metsulfuron 60DF
	liquid: 1.87 lb 2,4-D	4	liquid: 1.6 pt	0.57 lb 2,4-D	1.2 pt 2,4-D amine 3.8L
	+ 1 lb dicamba	4		0.2 lb dicamba	6.4 fl oz Banvel 4S
Cimarron Plus 63WDG	0.48 lb metsulfuron	2	0.5 oz	0.015 lb metsulfuron	0.4 oz Metsulfuron 60DF
	0.15 lb chlorsulfuron	2		0.0047 chlorsulfuron	0.1 oz Telar 75DF
Crossbow 3L	2 lb 2,4-D	4	4 qt	2 lb 2,4-D	2 qt 2,4-D ester
	1 lb triclopyr	4		1 lb triclopyr	2 pt Remedy Ultra 4L
Curtail 2.38L	0.38 lb clopyralid	4	3 qt	0.285 lb clopyralid	12 fl oz Stinger 3L
	2 lb 2,4-D	4		1.5 lb 2,4-D	1.5 qt 2,4-D amine 3.8L
GrazonNext HL 3.74E	0.41 lb aminopyralid	4	2.1 pt	0.108 lb aminopyralid	6.9 fl oz Milestone 2L
	3.33 lb 2,4-D	4		0.9 lb 2,4-D	1 qt 2,4-D amine 3.8L
Grazon P+D 2.54SL	0.54 lb picloram	4	4 pt	0.27 lb picloram	1 qt Tordon 2L
	2 lb 2,4-D	4		1 lb 2,4-D	1 qt 2,4-D amine 3.8L
Huskie 2.06 EC	0.31 lb pyrasulfotole	27	15 fl oz	0.036 lb pyrasulfotole	0.31 lb pyrasulfotole
	1.75 lb bromoxynil	6		0.2 lb bromoxynil	13 fl oz Maestro 2EC
Overdrive 70WDG	0.2 lb diflufenzopyr	19	8 oz	0.1 lb diflufenzopyr	0.1 lb diflufenzopyr
	0.5 lb dicamba	4		0.25 lb dicamba	8 fl oz Clarity 4L
PastureGard HL 4SL	3 lb triclopyr	4	2 pt	0.75 lb triclopyr	1.5 pt Remedy Ultra 4L
	1 lb fluroxypyr	4		0.25 lb fluroxypyr	11 fl oz Vista XRT 2.8L
Surmount 1.34E	0.67 lb picloram	4	4 pt	0.34 lb picloram	1.4 pt Tordon 2L
	0.67 lb fluroxypyr	4		0.34 lb fluroxypyr	1 pt Vista XRT 2.8L
Weedmaster 3.87L	1 lb dicamba	4	4 pt	0.5 lb dicamba	1 pt Banvel 4S
	2.87 lb 2,4-D	4		1.44 lb 2,4-D	3 pt 2,4-D amine 3.8L
Yukon 67.5WDG	0.125 lb halosulfuron	2	6 oz	0.047 lb halosulfuron	1 oz Permit 75WG
	0.55 lb dicamba	4		0.206 lb dicamba	6.6 fl oz Clarity 4S

Table 6-11. Relative effectiveness of grass pasture, hay, and CRP grassland herbicides.

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Results may differ with variations in weed size, temperature, rainfall, soil moisture, soil type, and soil pH. Spike 20P also is available for control of problem woody perennials as well as some herbaceous perennials. See a Spike label for additional information. Some products show for which states they are registered under the rate. These should be used only in the listed states.

Weed control rating:
10 = 95–100%
9 = 85–95%
8 = 75–85%
7 = 65–75%
6 = 55–65%
L = weed is listed as control on herbicide label, but local data is limited
N = less than 55% or no control
— = unknown; consult the label for use rates and precautions

Trade Name (rate/acre)	2,4-D[1] (2–3 pt)	2,4-D + Clarity/ Banvel[1] (1 qt + 1 pt)	Aim (1–2 oz)	Chaparral (2–3 oz) (PA,VA,WV)	Clarity/Banvel[1] (1 pt)	Crossbow (2–4 qt)	GrazonNext HL (1.5–2.6 pt) (PA,VA,WV)	Grazon P+D (3–4 pt) (VA,WV)	Metsulfuron 60DF (0.1–0.3 oz)	Milestone (5–7 oz) (PA,VA,WV)	Overdrive (4–6 oz)	PastureGard HL (1–1.5 pt)	Remedy Ultra (2–4 pt)	Roundup/glyphosate (1–2 qt) (spot treatment)	Stinger (0.66–1.33 pt)	Surmount (1.5–3 pt) (VA, WV)
Winter Annuals																
Chamomile, Mayweed	7	10	6	L	8+	8	7+	—	10	—	8+	—	—	9	9	—
Chickweed, Common	7	8	8+	10	7	9	9	8	10	7	8	8	7+	10	6	9
Cockle, Corn	8	10	9	L	10	8+	—	—	L	—	10	—	—	10	N	—
Cockle, Cow	8	10	9	9+	10	8+	—	—	9	—	10	—	—	10	N	—
Fleabane spp.	9	10	7	9	8	9+	8	9	9	L	8	—	—	8+	9	—
Henbit/Deadnettle	6	8+	N	9	7+	9+	8	9+	9	8+	7+	8+	7+	9+	—	9
Horseweed/Marestail	9	9	N	9	9	10	9	10	9	9+	9	6	6	9+	9+	9
Mustard, Garlic	N	8	7	8	7	8	—	—	8	—	7	—	—	8	N	—
Mustard spp.	9	10	8+	8	8	10	7+	7	8+	N	8	8	8	10	N	—
Pennycress, Field	9	10	8+	10	8	9+	8	10	9	—	8+	L	—	10	N	9+
Pepperweed spp.	9	10	8+	8	8	9+	8	7	10	N	8+	8	8	10	N	—
Rocket, Yellow	9	10	9	8+	9	10	8	—	9	—	9	—	—	9	6	—
Shepherdspurse	8+	10	9	10	8	9	8	—	10	—	8	—	—	10	N	—
Summer Annuals																
Amaranth, Spiny	9	10	9	8+	9	9	8	7+	8	8	9	N	N	9	6	9
Cocklebur, Common	9	10	8	10	10	10	9	10	8+	L	10	8+	8+	9	9	9
Groundsel, Common	7	7	8	9	6	8	7	—	9+	—	7	—	—	9	9	L
Jimsonweed	8	10	9	8+	10	9	9	7	9	8+	10	—	—	9	8	7+
Lambsquarters, Common	10	10	9	9+	10	10	9	9+	9	9+	10	9	9	9	6	10
Lettuce, Wild/Prickly	9+	10	9	10	8+	9	9	10	9	9+	8+	9	—	9	9	9
Nightshade, Eastern Black	7+	8+	9	8+	8+	8+	7	6	8	9	8+	6	—	9	8	L
Pigweed spp.	9	10	9	9	9	9	8	7	10	9	9	9	8	9	6	9+
Ragweed, Common	9	10	7	9	9	10	9	9+	N	9	9	9	8+	10	9+	9
Ragweed, Giant	8+	10	N	9	9	10	9	9+	N	9	9	9	8+	10	9+	9
Smartweed ssp.	7	9	N	9	8	9	9	9	7	8+	8	N	—	9	8+	9+
Velvetleaf	8+	10	9	—	10	9	8	8+	8	—	10	9	—	9	6	9

Trade Name (rate/acre)	2,4-D[1] (2–3 pt)	2,4-D + Clarity/ Banvel[1] (1 qt + 1 pt)	Aim (1–2 oz)	Chaparral (2–3 oz) (PA,VA,WV)	Clarity/Banvel[1] (1 pt)	Crossbow (2–4 qt)	GrazonNext HL (1.5–2.6 pt) (PA,VA,WV)	Grazon P+D (3–4 pt) (VA,WV)	Metsulfuron 60DF (0.1–0.3 oz)	Milestone (5–7 oz) (PA,VA,WV)	Overdrive (4–6 oz)	PastureGard HL (1–1.5 pt)	Remedy Ultra (2–4 pt)	Roundup/glyphosate (1–2 qt) (spot treatment)	Stinger (0.66–1.33 pt)	Sumount (1.5–3 pt) (VA, WV)
Biennials																
Burdock, Common	9	10	N	8+	8	9	8	9+	7	9	8	9	9	9	9	8
Carrot, Wild	9	10	N	10	8	9+	8	9+	9	N	8+	7	7	9	6	8+
Evening Primrose, Common	9	10	7+	9	8	9+	9	—	—	9	8+	—	—	10	—	—
Evening Primrose, Cutleaf	9	10	N	8+	7	8	9	9	7+	9	7	8	8	6	—	—
Hemlock, Poison	7+	9	7+	—	8	9	8	8+	N	N	8	N	N	9	N	8
Mullein, Common	N	6	N	9+	N	N	—	7+	8	—	N	N	N	—	N	7+
Parsnip, Wild	9	10	N	9	9	10	8+	8+	7	7	9	—	—	9	N	—
Teasel	7+	10	8	9	9	8+	8+	8+	6	9	9	—	—	9	9	—
Thistle, Bull	9+	10	N	9+	9	9+	9	9	6	9	9	6	7	9	9+	9
Thistle, Musk	8+	10	N	9+	9	9+	9	9	8	9+	9	6	7	9	9+	8+
Thistle, Plumeless	8+	10	N	9+	9	9+	9	9	8	9+	9	6	7	9	9+	8+
Herbaceous Perennials																
Aster spp.	9	10	N	9	8+	9	7	8	7	—	8+	—	—	9	9+	—
Bedstraw spp.	7	7	6	9	N	8	9	7	N	9	N	L	—	9	7	L
Bindweed, Field	8	8+	6	—	8+	8	7	6	N	—	8+	7	7	8	N	8
Bindweed, Hedge	9	10	N	—	9	9	8	8+	N	—	9	7+	8	8	N	8+
Brackenfern	7	7	N	7	N	7+	7	—	7	—	N	—	—	6	—	—
Buttercup spp.	8+	9	7	8+	8	10	9	10	9	8+	8	8	8	9	8	8+
Catsear, Common	7	9	N	9	7+	—	9	—	—	9	7+	—	—	8+	—	—
Chickweed, Mouseear	6	8	6	10	7+	8+	7	9	10	8	7+	8	8+	9	6	9
Chicory	9	10	7	9	8	9	9	9+	7+	9	8	9	8+	9	9	8+
Clover spp.	7	8+	N	10	8+	8+	9+	10	8+	9+	8+	8+	9	10	9	10
Cockle, White	7	9	6	—	8+	9	N	—	8	—	8+	L	—	9+	9	L
Daisy spp.	9	10	N	9	8+	9+	9	8	6	9	8+	—	—	8+	8+	—
Dandelion	9+	10	6	8+	7	9+	9	9	7+	9	9	8	7+	7	7	9
Dock spp.	8	10	7	9	8	9	9	9	8+	9	8+	8	8	9	7+	9
Dogbane, Hemp	6	7	N	N	7	8	6	7	N	N	7	7	7	8	6	8+
Dogfennel	7	7+	N	N	7	7	7	7+	6	N	7	9	8	8	6	9
Garlic or Onion, Wild	8	8+	N	—	7	8	6	N	9+	N	7	N	N	9	N	N
Goldenrod spp.	8	8+	N	8	7	8	8	9	8	6	7	7	7+	9	6	9
Groundcherry spp.	7	7+	7	9	7	8+	7	—	—	9	8	—	—	8	N	—
Hawkweed spp.	8	9	6	L	7+	9	8	6	7	L	7+	—	—	9	8	—
Horsenettle	6	7+	N	9	7	8	8+	9	7	9	7	6	6	8	N	8+
Ironweed, Tall	8	9	N	8+	8+	9	9	9+	N	8	8+	7	6	9	6	8+
Knapweed, Spotted	7	8	N	8+	7	7	9	9	6	8+	7	6	6	9	9	8+
Knotweed, Japanese	7	7+	6	7+	7+	7	7	N	—	7+	7+	N	—	8	8	L
Milkweed, Common	6	7	N	N	6	7	6	7	N	N	6	6	6+	7+	N	8+
Mugwort	6	7	6	8	7	8	8	7	7	8	7	—	—	7	8+	—

(continued)

Trade Name (rate/acre)	2,4-D[1] (2–3 pt)	2,4-D + Clarity/ Banvel[1] (1 qt + 1 pt)	Aim (1–2 oz)	Chaparral (2–3 oz) (PA,VA,WV)	Clarity/Banvel[1] (1 pt)	Crossbow (2–4 qt)	GrazonNext HL (1.5–2.6 pt) (PA,VA,WV)	Grazon P+D (3–4 pt) (VA,WV)	Metsulfuron 60DF (0.1–0.3 oz)	Milestone (5–7 oz) (PA,VA,WV)	Overdrive (4–6 oz)	PastureGard HL (1–1.5 pt)	Remedy Ultra (2–4 pt)	Roundup/glyphosate (1–2 qt) (spot treatment)	Stinger (0.66–1.33 pt)	Sumount (1.5–3 pt) (VA, WV)
Nettle, Stinging	8	**9**	6	8	8	**9**	**9**	**9**	6	**9**	8	**9**	**9**	**9**	7	**9**
Nightshade, Bitter	7	**8+**	6	—	7	—	7	7	—	—	7	—	—	**9**	8	—
Plantain spp.	**9**	**10**	7	**9**	8	**9**	7+	**9**	**9**	N	**8+**	**9**	8	**9**	N	**8+**
Pokeweed, Common	7	7	N	6	7	**9**	8	7+	N	7+	8	N	N	8	N	**8+**
Snakeroot, White	8	**9**	7	—	**9**	**9**	8	8	N	—	**9**	—	—	8	N	—
Sorrel, Red	6	**10**	**8+**	8	**8+**	—	—	**9**	**8+**	—	**8+**	6	—	**9**	8	—
Sowthistle, Perennial	7	**9**	N	**8+**	8	8	**9**	**9+**	7	**9**	8	8	8	**9**	8	—
Star-of-Bethlehem	N	N	**8+**	—	N	—	—	—	—	—	N	—	—	8	—	—
Thistle, Canada	7	7+	N	**9+**	7	8	**9**	**9**	7	**9**	7+	N	6	8	**9**	7
Toadflax, Yellow	7	8	**8+**	—	7+	—	7	—	—	—	7+	—	—	8	N	—
Waterhemlock, Spotted	7+	**9**	N	—	8	**9**	7	—	N	—	8	—	—	**9**	N	—
Wingstem	**8+**	**8+**	N	**9**	6	7+	**9**	**9**	N	**9**	6	6	7+	—	6	**8+**
Woodsorrel, Yellow	7	7+	7	L	7	8	**8+**	—	**9**	—	7	—	—	**9**	8	—
Yarrow, Common	7	**9**	N	L	**9**	**8+**	7	—	8	L	**9**	L	L	**9**	7	L
Woody Perennials[1]																
Blackberry spp.	6	6+	N	L	6	8	N	7+	7	N	6	L	7+	8	7	8
Creeper, Trumpet	6	7+	N	—	6	8	—	7	N	—	7	—	L	7+	N	7
Creeper, Virginia	7	**9**	N	—	8	**8+**	7	—	—	—	8	L	L	8	N	—
Dewberry spp.	6	7	N	L	6	7+	N	—	**8+**	—	6	—	—	7	7	7
Grape, Wild	8	**9**	N	—	8	**9**	8	—	—	—	8	L	—	8	N	L
Honeysuckle spp.	7	7+	N	L	N	**8+**	7	8	**10**	—	N	L	—	8	N	L
Kudzu	N	6	N	8	6	—	8	**9**	N	8	6	—	7	—	—	—
Locust, Black	7	**8+**	N	L	8	8	L	—	7	L	8	L	L	8	N	**9+**
Olive, Autumn	7	8	N	—	7+	8	7	—	—	—	7+	—	—	8	N	—
Poison-ivy, Oak	7	**8+**	N	—	7+	**8+**	7	**8+**	6	—	7+	L	L	8	N	7
Rose, Multiflora	6	7+	N	—	6	**8+**	—	**8+**	**8+**	—	6	6	**8+**	8	N	7
Sumac spp.	6	7+	N	—	7	**8+**	L	7	N	—	7+	L	L	8	7	8

[1] Higher rates may be more effective on some species.

Table 6-12. Comments on herbicides for grass forages or pasture and CRP grassland areas.

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
2,4-D LVE 3.8L or 2,4-D amine 3.8L	2,4-D	established: POST	1.5–3 qt 1–2 qt	1.4–2.8 0.95–1.9	yes

- 2,4-D is marketed by various companies with various trade names. Refer to the label provided with the product for specific recommendations and restrictions.
- Provides postemergence control and very limited (less than 1 month) of soil residual control of several annual, biennial, and perennial broadleaf weeds.
- Make application when grasses are well established, usually 4–5 inches tall with a good root system and tiller development.
- Do not treat in the boot to milk stage.
- Apply to actively growing broadleaf weeds.
- Make applications by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- Higher rates or repeat treatments may be required for less susceptible species, perennial weeds, and woody plants.
- Treat biennials in the rosette stage of growth and perennials such as Canada thistle in the bud stage.
- Treat susceptible woody perennials in the spring after leaves are fully expanded.
- Do not mow for at least 7 days after application.
- Follow label recommendations to reduce the potential for spray drift or volatility to sensitive plants.
- Ester formulations are slightly more effective (more leaf-absorbed) than amine formulations, but also slightly more volatile.
- Amine formulations have slightly more soil activity.
- 2,4-D will severely injure alfalfa, clover, and other legumes.
- 2,4-D labels vary concerning overseeding or rotational crop restrictions. Unless specified on the label, most crops can be safely planted 3 months after application under normal environmental conditions.
- See Tables 6-13 and Table 6-14.
- *Water quality advisory.*

Aim 2EC	carfentrazone	seedling: POST established: POST	1–2 fl oz	0.016–0.032	yes

- For new seedings apply to grasses that have at least 3 or 4 leaves. Significant crop response will likely occur.
- Aim has a relatively narrow spectrum of weed control and is primarily used for control of winter or summer annual broadleaf weeds up to 4 inches tall (emerged weeds only).
- Aim has activity on Star-of-Bethlehem, dayflower species, and speedwell species. Star-of-Bethlehem may require additional application at least 10 days after the first.
- Apply in a minimum of 10 gal/A of water or liquid fertilizer. Applying Aim in liquid fertilizer may increase the level of crop response.
- Applications made within 8 hours of rainfall or irrigation or when heavy dew is present may cause significant crop response.
- Three applications per season are allowed, but do not make applications less than 7 days apart.
- Aim has only recently been labeled on forage grasses, so local experience is minimal. Experience in small grains would suggest that some level of crop response (speckling or chlorosis) will occur from Aim applications to most forage species.
- There are no rotational crop or overseeding restrictions for labeled crops; see label.
- See Tables 6-13 and 6-14.

Arsenal 2AS	imazapyr	grazed fencerows	1–3 pt 0.4–1.2 fl oz/gal	0.25–0.75 0.3–0.9% v/v solution	no

- Arsenal is labeled for spot treatment in grass pasture. However, due to its length of residual activity on cool-season grass species, bare spots in the pasture could persist for several months. Therefore, it is only recommended for use along permanent or long-term fencerows.
- This use falls under the spot treatment part of the label, so grazed fencerows can be treated so long as the total area to be treated is no more than 10% of the total pasture and fencerow areas combined.
- Arsenal provides postemergence and 3 to 6 months of soil residual control of many annual, biennial, and perennial grass and broadleaf weeds as well as several vine and brush species.
- Make applications with hand-held equipment.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Rotational crops can be planted 12 months after application and completion of a successful field bioassay.
- See Tables 6-13, 6-14, and 6-18.

(continued)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Chaparral 71.6WG (PA. VA, WV only)	aminopyralid + metsulfuron	established: POST	2–3.3 oz	0.078–0.128 + 0.012–0.019	yes
		seed head suppression	2–2.5 oz	0.078–0.098 + 0.012–0.015	
		spot treatment	0.025–0.033 oz/gal	0.02–0.026% w/v solution	

- Chaparral provides postemergence control and 2 to 3 months of soil residual control of on many annual, biennial, and perennial weed species and suppression of blackberry and multiflora rose in permanent grass pasture.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- High-volume foliar applications for brush control (volume not specified) are allowed; consult herbicide label for details.
- In general, Chaparral may be applied in the spring or early summer, depending on the target weed species, as a broadcast application over grass that was planted at least 4 months prior to the application and growing under favorable conditions for establishment. Grasses should have well-established root systems and be tillering.
- Smooth bromegrass may be more sensitive to applications of Chaparral than other perennial grasses, and temporary growth suppression may occur.
- Special precautions are provided on the label for applications to tall fescue to minimize injury and stunting. Make application later in spring after new growth is 5–6 inches tall or in the fall. Do not use more than 2 oz/A of Chaparral and tank-mix with 2,4-D. Use only a non-ionic surfactant (0.5–1 pt/100 gal) when mixing with water; do not use any adjuvant when mixing with liquid fertilizer. Adhere strictly to these precautions, or severe injury may occur. Even when these precautions are followed, some stunting, yellowing, or seed head suppression of fescue may occur.
- Do not use Chaparral on timothy, Italian (annual) ryegrass, or perennial ryegrass, or severe injury will occur.
- Avoid mowing, haying, or soil disturbance in treated areas for at least 14 days after application.
- Do not use Chaparral if loss of desirable legume species cannot be tolerated.
- Do not allow spray drift to come in contact with any broadleaf crop or other desirable broadleaf plant.
- With fall applications, do not plant grasses the following spring; do not overseed ryegrass for 4 months after application.
- Do not rotate to any crop within 1 year following treatment, or to any broadleaf crop until an adequately sensitive field bioassay shows that the aminopyralid level in soil will not adversely affect that broadleaf crop. Cereals and corn can be planted 1 year after treatment; most broadleaf crops require at least a 2-year wait until planting.
- The Chaparral label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain aminopyralid residues. These include important restrictions concerning the movement and sale of hay products treated with aminopyralid. Be certain you understand and are able to follow these label restrictions before using this product.
- For tall fescue seed head suppression and broadleaf weed control: Chaparral may be used to reduce the number of seed heads of tall fescue when applied prior to flower emergence. For best results apply 2–2.5 oz/A after initial greenup when grass height is approximately 6 inches. Later applications may still be effective; however, the seed head suppression will be less effective and the number of seed heads could be noticeably higher. Many weed species can be controlled with this application timing in addition to the suppression of seed head development.
- Make spot applications with hand-held equipment.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Spot treatments may be applied at equivalent broadcast rates of up to 6.6 oz/A (0.066 oz/gal), but no more than 50% of the acreage may be treated, and the total amount of Chaparral applied from all applications must not exceed 3.3 oz per acre per year.
- A non-ionic surfactant should be added to enhance foliage wetting.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Repeat treatments may be made, but the total amount of Chaparral applied from all applications must not exceed 3.3 oz per acre per year.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Clarity 4S or Banvel 4S	dicamba	seedling: POST	0.5–1 pt	0.25–0.5	yes
		established: POST	0.5–2 pt	0.25–1	
		spot treatment	0.2–1.6 fl oz/gal	0.16–1.25% v/v solution	

- Dicamba provides postemergence control and less than 1 month of soil residual control of a relatively broad spectrum of annual, biennial, and perennial broadleaf weeds.
- Application to seedling grasses should not exceed 1 pt/A, and grasses should be actively growing, unstressed, and have attained the 3- to 4-leaf stage and 6 inches tall.
- For higher rates delay application until grasses are well established, usually 4–5 inches tall with a good root system and tiller development.
- Apply to actively growing broadleaf weeds by ground in a minimum of 10 gal/A of water or liquid fertilizer, or by air in 2 to 40 gal/A of water.
- Use the lower rates for susceptible annuals when they are small and actively growing.
- Treat biennials in the rosette stage of growth.
- High-volume foliar applications for brush control (up to 600 gal/A) are allowed; consult herbicide label for details.
- Do not make applications when the temperature is expected to exceed 85 degrees that day as drift is more likely to occur.
- Follow label recommendations to reduce the potential for spray drift or volatility to sensitive plants.
- Do not mow for at least 7 days after application.
- Dicamba will severely injure alfalfa, clover, and other legumes.
- Forage grasses or small grains can be overseeded after 30 days per pint of dicamba applied.
- Legumes and other broadleaf crops may be planted 4 months after application.
- Make spot applications with hand-held equipment.
- Do not treat more than one-tenth of the total area at any one time.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Clarity is also labeled for wiper applications. Consult the herbicide label for specific recommendations.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Crossbow 3E	triclopyr + 2,4-D	established: POST	1–6 qt	0.25–1.5 + 0.5–3	yes
		spot treatment	1.5–2 fl oz/gal	1.2–1.6% v/v solution	

- The label states, "This product may not be applied to forage that is to be cut and sold for commercial purposes."
- Crossbow provides postemergence control and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as many woody plants.
- Apply only to grasses with well-established root systems that are tillering.
- Apply to actively growing weeds or brush by ground or air (helicopter only) in 10 to 30 gal/A of water or liquid fertilizer.
- For best results, treat biennial or winter annual weeds in the rosette stage.
- Some hard-to-control perennial weeds and woody species may require retreatment. Use higher rates for less susceptible species.
- High-volume foliar applications for brush control (100–200 gal/A) are allowed; consult herbicide label for details.
- Follow all label recommendations to reduce the potential for spray drift or volatility to sensitive plants.
- Crossbow will severely injure alfalfa, clover, and other legumes.
- Forage grasses may be overseeded 21 days after application. Other crops can be planted the next growing season.
- Make spot applications with hand-held equipment.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Do not spray to the point of runoff.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

(continued)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Facet L 1.5SL	quinclorac	established: POST	12–64 fl oz	0.14–0.75	no
		spot treatment	0.55–1.6 fl oz/gal	0.4–1.25% v/v solution	

- Facet L (formerly Paramount 75WDG) provides postemergence control and 1 to 2 months of soil residual control or suppression of several annual grass weeds, a few annual broadleaf weeds, and field or hedge bindweed.
- Facet L is the only herbicide labeled for postemergence control of grass weeds in grass forage crops. Labeled grass weeds are barnyardgrass, large crabgrass, giant, green, and yellow foxtails, junglerice, and broadleaf signalgrass.
- Rates greater than 32 fl oz/A and less than 22 fl oz/A are for leafy spurge control and bindweed maintenance, respectively. For grass and broadleaf control apply 22–32 fl oz/A.
- Use only on labeled established grasses (timothy and reed canarygrass not included) that have developed a good root system and are tillering.
- Local experience indicates that Facet may cause more injury to orchardgrass than to the other labeled cool-season grasses.
- Apply to actively growing plants by ground in a minimum of 5 gal/A of water. Aerial applications are not allowed in the Northeast region.
- For best results apply to labeled grass and broadleaf weeds up to 2 inches tall and prior to grass tiller development.
- Do not apply Facet when air temperature is more than 90°F.
- Follow label recommendations to reduce the potential for spray drift to sensitive plants.
- Facet will severely injure alfalfa, clover, and other legumes.
- Forage grasses can be overseeded 10 months after application.
- Legume crops can be planted 24 months after application and completion of a successful field bioassay.
- For spot applications, do not exceed the maximum per-area rates for broadcast application.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Do not spray to the point of runoff.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

GrazonNext HL 3.74E (PA, VA, WV only)	aminopyralid + 2,4-D	established: POST	1.2–2.1 pt	0.062–0.108 + 0.5–0.9	yes
		spot treatment	0.5–0.9 fl oz/gal	0.4–0.7% v/v solution	

- GrazonNext provides postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species in permanent grass pasture.
- In general, it is best to wait about 45–60 days after grass planting before applying GrazonNext.
- Smooth bromegrass may be more sensitive to applications of GrazonNext than other perennial grasses, and temporary growth suppression may occur.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- High-volume foliar applications for brush control (volume not specified) are allowed; consult herbicide label for details.
- Avoid mowing, haying, or soil disturbance in treated areas for at least 7 days after application.
- Do not use GrazonNext if loss of desirable legume species cannot be tolerated.
- Do not allow spray drift to come in contact with any broadleaf crop or other desirable broadleaf plant.
- Grass can be overseeded in the fall after a spring or early summer application.
- Do not rotate to any crop within 1 year following treatment or to any broadleaf crop until an adequately sensitive field bioassay shows that the aminopyralid level in soil will not adversely affect that broadleaf crop. Cereals and corn can be planted 1 year after treatment; most broadleaf crops require at least a 2-year wait until planting.
- The GrazonNext label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain aminopyralid residues. These include important restrictions concerning the movement and sale of hay products treated with aminopyralid. Be certain you understand and are able to follow these label restrictions before using this product.
- Make spot applications with hand-held equipment.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Spot treatments may be applied at equivalent broadcast rates of up to 4.2 pt/A (1.7 fl oz/gal), but no more than 50% of the acreage may be treated, and the total amount of GrazonNext applied from all applications must not exceed 2.1 pints per acre per year.
- A non-ionic surfactant should be added to enhance foliage wetting.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Repeat treatments may be made, but the total amount of GrazonNext applied from all applications must not exceed 2.1 pints per acre per year.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Grazon P+D 2.54SL (VA and WV only)	picloram + 2,4-D	established: POST	2–8 pt	0.14–0.54 + 0.5–2	yes

- Grazon P+D provides postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species in permanent grass pasture.
- The distribution of Grazon P+D may be further restricted within Virginia and West Virginia due to the picloram content of the product and sensitivity of certain broadleaf crops.
- Apply to grasses that are well established as indicated by tillering, development of secondary root system, and vigorous growth.
- Smooth bromegrass may be more sensitive to applications of Grazon P+D than other perennial grasses, and temporary growth suppression may occur.
- Apply by ground in 10–40 gal/A or by air in a minimum of 2 gal/A of water, an oil-water emulsion, or liquid fertilizer.
- High-volume foliar applications for brush control (100 gal/A) are allowed; consult herbicide label for details.
- Avoid mowing, haying, or soil disturbance in treated areas for at least 7 days after application.
- Do not use Grazon P+D if loss of desirable legume species cannot be tolerated.
- Do not allow spray drift to come in contact with any broadleaf crop or other desirable broadleaf plant.
- Cool season grasses can be seeded a minimum of 21 days after application (60 days for smooth bromegrass).
- Do not rotate to food or feed crops on treated land if they are not registered for use with picloram until an adequately sensitive field bioassay or chemical test shows that no detectable picloram is present in soil.
- The Grazon P+D label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain picloram residues. Be certain you understand and are able to follow these label restrictions before using this product.
- See Tables 6-13 and 6-14.
- *Water quality advisory.*
- *Restricted-use pesticide.*

Metsulfuron 60DF	metsulfuron	established: POST	0.1–0.4 oz	0.004–0.015	yes
		seed head suppression	0.3–0.4 oz	0.011–0.015	
		spot treatment	0.01 oz/gal	0.008% w/v solution	

- Metsulfuron provides both postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species, and suppression of blackberry and multiflora rose in permanent grass pasture.
- Apply by ground in a minimum of 10 gal/A or by air in 2 to 5 gal/A of water or liquid fertilizer.
- Postemergence applications are rainfast in 4 hours, after which rainfall or overhead irrigation is required to activate the herbicide in the soil.
- Applications up to 0.4 oz/A may be made to grasses that have been established for a minimum amount of time as follows: bermudagrass (2 months); bluegrass, bromegrass, and orchardgrass (6 months); timothy (12 months); and fescue (24 months).
- Special precautions are provided on the label for applications to fescue or timothy. Apply to fescue in late spring or fall or to timothy in late summer or fall. Either species should be at least 6 inches tall and actively growing. Use the lowest recommended rate of metsulfuron (up to 0.4 oz/A) for the target weeds and tank-mix with 2,4-D for added safety. Use only a non-ionic surfactant at 0.5 pt/100 gal when mixing with water; do not use any adjuvant when mixing with liquid fertilizer. Adhere strictly to these precautions, or severe injury may occur. Even when these precautions are followed, some stunting or yellowing of timothy or fescue may occur.
- Do not use metsulfuron on Italian (annual) or perennial ryegrass, or severe injury will occur.
- Apply to weeds in the spring or early summer before annual broadleaves are 4 inches tall.
- Metsulfuron will severely injure alfalfa, clover, and other legumes.
- Overseeding intervals for grasses are specific to region, soil pH, metsulfuron rate, and grass species. In our region with soils of pH 7.5 or less, the interval range is from 6 to 34 months (see label).
- Metsulfuron is persistent in soil; rotation to most broadleaf crops is 34 months or completion of a successful field bioassay.
- Cimarron Max is a co-pack that contains the active ingredients of metsulfuron and 2,4-D plus dicamba.
- Cimarron Plus is a premix with the active ingredients metsulfuron and chlorsulfuron (Glean or Telar).
- For tall fescue seed head suppression and broadleaf weed control: Metsulfuron may be used to reduce the number of seed heads of tall fescue when applied prior to flower emergence. For best results apply 0.3–0.4 oz/A after initial greenup when grass height is approximately 6 inches. Later applications may still be effective; however, the seed head suppression will be less effective and the number of seed heads could be noticeably higher.
- Spot treatment with metsulfuron is effective for suppression or control of multiflora rose, blackberry, and Canada thistle.
- Make applications with hand-held equipment.
- Apply 1 oz/100 gal (0.28 gr/gal) on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- A non-ionic surfactant at 2–4 pt/100 gal should be added to enhance foliage wetting.
- Do not spray to the point of runoff, but dense stands of brush may need to be treated form both sides to achieve adequate coverage.
- Make applications after plants are fully leafed in the spring up through late summer.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- See Tables 6-13, 6-14, and 6-18.

(continued)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Milestone 2E (PA, VA, WV only)	aminopyralid	established: POST	3–7 fl oz	0.047–0.109	yes
		spot treatment	0.13–0.36 fl oz/gal	0.1–0.3% v/v solution	

- Milestone provides postemergence control and 2 to 3 months of soil residual control of on many annual, biennial, and perennial weed species in permanent grass pasture.
- In general, it is best to wait about 45–60 days after grass planting before applying Milestone.
- Smooth bromegrass may be more sensitive to applications of Milestone than other perennial grasses, and temporary growth suppression may occur.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- High-volume foliar applications for brush control (volume not specified) are allowed; consult herbicide label for details.
- Avoid mowing, haying, or soil disturbance in treated areas for at least 7 days after application.
- Do not use Milestone if loss of desirable legume species cannot be tolerated.
- Do not allow spray drift to come in contact with any broadleaf crop or other desirable broadleaf plant.
- Grass can be overseeded the fall after a spring treatment.
- Do not rotate to any crop within 1 year following treatment or to any broadleaf crop until an adequately sensitive field bioassay shows that the aminopyralid level in soil will not adversely affect that broadleaf crop. Cereals and corn can be planted 1 year after treatment; most broadleaf crops require at least a 2-year wait until planting.
- The Milestone label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain aminopyralid residues. Follow the label restrictions carefully.
- Make spot applications with hand-held equipment.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Spot treatments may be applied at equivalent broadcast rates of up to 14 fl oz/A (0.32 fl oz/gal), but no more than 50% of the acreage may be treated, and the total amount of Milestone applied from all applications must not exceed 7 fl oz per acre per year.
- A non-ionic surfactant should be added to enhance foliage wetting.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Repeat treatments may be made, but the total amount of Milestone applied from all applications must not exceed 7 fl oz per acre per year.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Overdrive 70WDG	dicamba + diflufenzopyr	established: POST	4–8 oz	0.125–0.25 + 0.05–0.1	no
		spot treatment	0.1–0.2 oz/gal	0.08–0.16% w/v solution	

- Overdrive provides postemergence control and less than 1 month of soil residual control of several annual, biennial, and perennial broadleaf weeds.
- Use only on established grasses that have developed a good root system and are tillering.
- Some leaf burn may occur on certain forage grasses (orchardgrass, timothy), especially with spring applications.
- Apply to actively growing plants by ground in a minimum of 10 gal/A of water. Do not apply by air.
- Use the higher rate when treating large annual and biennial weeds or when treating perennial weeds.
- Multiple applications are allowed as long as all treatments do not exceed 8 oz/A during a growing season.
- Do not mow for at least 7 days after application.
- Follow label recommendations to reduce the potential for spray drift to sensitive plants.
- Overdrive will severely injure alfalfa, clover, and other legumes.
- Grass or broadleaf crops can be planted 30 days after application.
- Make spot applications with hand-held equipment.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
PastureGard HL 4L	triclopyr + fluroxypyr	established: POST	0.75–4 pt	0.28–1.5 + 0.094–0.5	not recommended
		spot treatment	0.2–1.5 fl oz/gal	0.16–1.2% v/v solution	

- PastureGard provides postemergence control and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as many woody plants.
- Apply to actively growing weeds or brush by ground in a minimum of 5 gal/A or by air in a minimum of 3 gal/A (broadleaf weeds) or 4 gal/A (woody plants) of water.
- For brush control, high-volume foliar applications (50–100 gal/A), basal methods, and cut stump methods are allowed; consult herbicide label for details.
- Biennial or winter annual weeds are most susceptible while in the rosette stage.
- For best results treat blackberry either before first flower or after fruit drop.
- Some hard-to-control woody species may require retreatment.
- Apply only to grasses with well-established root systems that are tillering.
- Follow all label recommendations to reduce the potential for spray drift or volatility to sensitive plants.
- PastureGard will severely injure alfalfa, clover, and other legumes.
- Forage grasses or small grains can be overseeded 21 days after application.
- Other crops can be planted 4 months after application.
- For spot treatments apply at rates equivalent to broadcast application rates.
- Refer to weed rate tables of the herbicide label and apply the recommended per gallon concentration above on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Prowl H2O 3.8AS	pendimethalin	established POST (fall, winter, spring); between cuttings	1.1–4.2 qt	1–4	yes

- Prowl H2O has a supplemental label (expires April 30, 2019) for use in cool-season forage grasses (forage, green chop, silage, hay, or pasture).
- Provides 1 to 2 months of residual control of most annual grass weeds and a few broadleaf weeds as they germinate (refer to label for weeds controlled). It will not control any weeds that have already emerged at the time of application.
- An early April application may be required to control annual grasses such as foxtails, Japanese stiltgrass, jointhead arthraxon, crabgrass, and others. Applications may be made in fall after last cutting/grazing, in winter, spring, or between cuttings (but before weed emergence).
- Apply to solid (established) stands of perennial forage grasses with a minimum of 6 tillers.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water or liquid fertilizer.
- Adequate rainfall or overhead irrigation is required to activate Prowl H2O.
- Multiple applications are allowed, however maximum use rate of Prowl H2O is 4.2 qt/A/year with 30 days between sequential applications.
- Adverse environmental conditions or weak stands of grass may cause temporarily injury.
- Do not apply to mixed stands with forage legumes other than alfalfa.
- Rotational restrictions are based on Prowl rate used, precipitation, and application timing; see label.
- See Table 6-14.

Remedy Ultra 4L	triclopyr	established: POST	0.5–4 pt	0.25–2	yes

- Remedy Ultra provides postemergence control and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as many woody plants.
- Apply to actively growing weeds or brush by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A (broadleaf weeds) or 4 gal/A (woody plants) of water or liquid fertilizer.
- Do not use liquid fertilizer as the carrier when treating woody plants (brush).
- For brush control, high-volume foliar applications (100–200 gal/A), basal methods, and cut stump methods are allowed; consult herbicide label for details.
- Biennial or winter annual weeds are most susceptible while in the rosette stage.
- For best results treat blackberry during or after bloom.
- Some hard-to-control woody species may require retreatment.
- Apply only to grasses with well-established root systems that are tillering.
- Follow all label recommendations to reduce the potential for spray drift or volatility to sensitive plants.
- Remedy Ultra will severely injure alfalfa, clover, and other legumes.
- Forage grasses can be overseeded 21 days after application.
- Other crops can be planted the next season after application.
- See Tables 6-13 and 6-14.
- *Water quality advisory.*

(continued)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Roundup 3S or Roundup Weather-MAX4.5S	glyphosate	spot treatment	2.5 fl oz/gal	2% v/v solution	no

- Glyphosate controls emerged weeds only (no residual activity).
- Make applications with hand-held equipment or wiper applicators. Avoid contact with desirable vegetation.
- At rates up to 2 qt/A, any portion up to the entire field may be treated. For rates above 2 qt/A, apply only to weed-infested areas of the field, and do not treat more than one-tenth of the total area at any one time.
- Subsequent applications to the same areas can be made at 30-day intervals.
- Refer to weed rate tables of the herbicide label for the recommended herbicide concentration.
- For spot treatment, apply on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- Consult the herbicide label for specific wiper applicator recommendations.
- For best results, do not graze or harvest for 7 days after any application, and make applications at least 7 days before a killing frost.
- There are no overseeding restrictions for spot treatment with glyphosate.
- See Tables 6-13, 6-14, and 6-18.

Sandea 75WDG	halosulfuron	established: POST	0.67–1.3 oz	0.031–0.063	no
		spot treatment	0.019 oz/gal	0.016% w/v solution	

- Sandea provides excellent postemergence control of yellow nutsedge and has both preemergence (3 to 4 weeks soil residual) and/or postemergence activity on several annual broadleaf weeds.
- Apply by ground in a minimum of 10 gal/A water or by air in 3 to 15 gal/A water.
- For best results, spray actively growing nutsedge plants at the 3- to 5-leaf stage and susceptible broadleaf plants that are 1 to 3 inches tall.
- Heavy nutsedge infestations may require additional applications.
- Wait at least 48 hours after application before irrigation.
- Yukon is a premix of Sandea and dicamba.
- Sandea and Yukon will injure alfalfa, clover, and other legumes.
- Forage grasses, small grains, sorghum, and corn can be overseeded 2 months after application.
- Legume forages can be planted 9 months after application; see label for other broadleaf crops.
- Apply Sandea as a postemergence spot treatment only to those areas of emerged nutsedge.
- Do not exceed a rate of 0.75 oz/A (0.019 oz/gal).
- Apply on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- A second postemergence spot application at 0.75 oz/A is allowed where nutsedge has emerged or regrown. Follow the same procedures as first application.
- The potential for injury to desirable broadleaf and grass plants is increased with a second application.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Sharpen 2.85SC	saflufenacil	established: dormant established: POST	1–2 fl oz	0.022–0.044	yes

- Sharpen has a relatively narrow spectrum of weed control and is primarily used for control of winter or summer annual broadleaf weeds up to 6 inches tall. It primarily controls emerged weeds but has some very short (1–2 weeks at the labeled rates) residual activity.
- Apply by ground in a minimum of 5 gal/A water or 20 gal/A liquid fertilizer, or by air in a minimum of 3 gal/A water.
- Make dormant applications in the fall, during the winter, or in early spring before greenup.
- Make in-season applications before weeds reach the maximum size (usually 3–6 inches) listed on the weed table of the label.
- Sharpen may cause transitory injury to forage grasses.
- There are no replant restrictions for forage grasses, small grains, or sorghum at the 2 fl oz/A rate.
- For other crops, rotation restrictions are up to 5 months at the 2 fl oz/A rate; see label.
- See Tables 6-13 and 6-14.
- *Water quality advisory.*

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Spike 20P	tebuthiuron	established: POST	10–20 lb	2–4	n/a
		individual plant	0.4–0.7 oz/100 sq ft	2–4	

- Spike 20P is a pelleted formulation for control of woody plants (trees, shrubs, etc.) and vines.
- Apply by hand evenly over the area occupied by individual plants, multistem clumps, or small stands of woody vegetation.
- For multiflora rose control, apply Spike in early spring after ground thaw and before multiflora rose growth.
- Requires rainfall to move herbicide to root zone.
- Make only one application per year.
- Desirable grasses or legumes in the treated area may be injured or killed. Dormant season application is recommended to minimize herbicidal activity on forage grasses.
- For best results, do not disturb treated plants by wood cutting or removal for 2 years after application.
- Poor or erratic results are likely to occur in soils containing more than 5% organic matter or more than 30% clay, and in areas where woody plants are rooted directly in a shallow water table.
- Spike can persist in the soil for several years, and should therefore only be used on land dedicated to long-term grass forage production unless severe herbicide injury to legumes, row crops, shrubs, or trees can be tolerated in treated areas for several years. A field bioassay is required before planting sensitive crops.
- Do not apply Spike 20P in the vicinity of desirable plants. Exposure of even a small part of a plant root system to Spike may cause severe plant injury or death. Treatment setback distance from desirable plants should be one to two times the height or width of adjacent non-target vegetation, whichever is greater.
- Do not apply more than 10 lb/A on "vulnerable sites" as described on the herbicide label under "Use Restrictions for Groundwater Protection." Do not apply in areas where the water table is predominately shallow (5 feet or less), to interior ditch banks, or to ditches used to transport irrigation water or potable water. Do not apply within areas identified by state or local authorities as protected groundwater recharge zones.
- See Tables 6-14 and 6-18.
- *Water quality advisory.*

Stinger 3S	clopyralid	established: POST	0.66–1.3 pt	0.25–0.50	no
		spot treatment	0.13–0.5 fl oz/gal	0.1–0.4% v/v solution	

- Stinger provides postemergence control and 1 to 3 months of soil residual control of some annual, biennial, and perennial broadleaf weeds, but it is primarily used for Canada thistle control.
- Apply to actively growing weeds by ground in a minimum of 10 gal/A of water. Do not apply by aircraft.
- For Canada thistle, apply in rosette stage or after thistle is at least 4 inches tall, but before the bud stage.
- Multiple treatments are allowed as long as all treatments do not exceed 1.33 pt/A during a growing season.
- Apply only to actively growing well-established grasses that are tillering and have developed secondary roots.
- Follow all label recommendations to reduce the potential for spray drift to sensitive plants.
- The Stinger label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain herbicide residues. Follow the label recommendations carefully.
- Do not treat desirable crops such as alfalfa or clover.
- There are no overseeding restrictions for forage grasses, small grains, or field corn.
- Most broadleaf crops can be planted 10.5 to 18 months after application; see label.
- Spot treatment with Stinger is primarily for Canada thistle control.
- Refer to weed rate table of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- Repeat treatments may be made, but the total amount of Stinger applied must not exceed 1.3 pints per acre per year.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

(continued)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
Surmount 1.33L (VA and WV only)	picloram + fluroxypyr	established: POST	3–6 pt	0.25–0.5 + 0.25–0.5	yes
		spot treatment	0.6–1.1 fl oz/gal	0.5–0.85% v/v solution	

- Surmount provides postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species in permanent grass pasture. It may provide improved control of hemp dogbane, milkweed, dewberry, or sumac species over Grazon P+D.
- The distribution of Surmount may be further restricted within Virginia and West Virginia due to the picloram content of the product and sensitivity of certain broadleaf crops.
- Apply to grasses that are well established as indicated by tillering, development of secondary root system, and vigorous growth.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water, an oil-water emulsion, or liquid fertilizer.
- High-volume foliar applications for brush control (100 gal/A) are allowed; consult herbicide label for details.
- Avoid mowing, haying, or soil disturbance in treated areas for at least 7 days after application.
- Do not use Surmount if loss of desirable legume species cannot be tolerated.
- Do not allow spray drift to come in contact with any broadleaf crop or other desirable broadleaf plant.
- Cool-season grasses can be seeded a minimum of 21 days after application.
- Do not rotate to any crop within 1 year following treatment other than range or pasture grasses, grasses for hay or silage, barley, oats, rye, or grain sorghum. Thereafter, other crops may be planted after an adequately sensitive field bioassay shows that the risk of crop injury is within acceptable limits.
- The Surmount label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain picloram residues. Be certain you understand and are able to follow these label restrictions before using this product.
- Spot treatment with hand-held sprayers should be applied at a rate equivalent to a broadcast application.
- Refer to weed rate table of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*
- *Restricted-use pesticide.*

Weedmaster 3.87L	dicamba + 2,4-D	seedling: POST	0.5–2 pt	0.06-0.25 + 0.18–0.72	yes
		established: POST	1–4 pt	0.125–0.5 + 0.36–1.4	
		spot treatment	0.4–1.6 fl oz/gal	0.3–1.25% v/v solution	

- Weedmaster provides excellent postemergence control and less than 1 month of soil residual control of many annual, biennial, and perennial broadleaf weeds.
- For broadcast applications, apply by ground in 5 to 40 gal/A of water or liquid fertilizer or by air in 3 to 10 gal/A of water.
- For brush control, foliar and basal applications in oil and water emulsions and cut surface applications are allowed; consult herbicide label for details.
- Applications to newly seeded areas should not exceed 2 pt/A and should only be applied to actively growing unstressed grasses that have attained the 3- to 4-leaf stage and have reached a minimum height of 6 inches.
- Multiple applications are allowed on established grasses as long as all treatments do not exceed 8 pt/A during a growing season.
- Do not make applications when the temperature is expected to exceed 85°F that day, as drift is more likely to occur.
- Follow label recommendations to reduce the potential for spray drift or volatility to sensitive plants.
- Do not mow for at least 7 days after application.
- Weedmaster will severely injure alfalfa, clover, and other legumes.
- Forage grasses and small grains can be overseeded after 10 days per pint of Weedmaster applied.
- Legumes and other broadleaf crops may be planted 4 months after application.
- Make spot applications with hand-held equipment.
- Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft^2) to provide thorough coverage.
- Add a surfactant at 0.5% v/v for improved control.
- Weedmaster is effective on many woody species as a spot spray at the higher rates.
- Do not spray to the point of runoff.
- For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost.
- Do not make spot treatments in addition to broadcast treatments.
- See Tables 6-13, 6-14, and 6-18.
- *Water quality advisory.*

Table 6-13. Adjuvants and rainfastness for postemergence herbicides in grass pasture or hay.

Adjuvants are products you include in the spray tank to improve the performance of your herbicides. These include non-ionic surfactant (NIS), crop oil concentrate (COC), methylated seed oil (MSO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient, and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0). Crop injury can occur with the use of adjuvants. Adding additional adjuvants than what is labeled can increase the chance or severity of crop injury. Following are recommended adjuvants for broadcast postemergence applications; refer to herbicide labels for adjuvant recommendations with other application types. Rainfastness is number of hours needed between time of application and rainfall or irrigation to ensure sufficient absorption in the plant.

Trade Name	Adjuvant(s)	Rate	Apply in Liquid Fertilizer as a Carrier	Rainfastness (hours)
2,4-D amine 3.8L	none recommended[1] or non-ionic surfactant[2] or crop oil concentrate[2]	1 qt/100 gal 1–2 qt/A	yes	1
2,4-D ester 3.8L	none recommended[1] or non-ionic surfactant[2] or crop oil concentrate[2]	1 qt/100 gal 1–2 qt/A	yes	1
Aim 2EC	non-ionic surfactant or crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate (optional)	1 qt/100 gal 1 gal/100 gal 1 gal/100 gal 2–4 gal/100 gal 2–4 lb/A	yes	not specified
Arsenal 2AS	non-ionic surfactant or methylated seed oil	1 qt/100 gal 1.5–2 pt/A	N/A	1
Chaparral 71.6WG[3]	crop oil concentrate or methylated seed oil or non-ionic surfactant plus nitrogen solution or ammonium sulfate (optional)	1 gal/100 gal 0.5–1 gal/100 gal 1 qt/100 gal 2 qt/A 2 lb/A	yes	not specified
Clarity/Banvel 4L	non-ionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate (optional)	1–2 pt/100 gal 1 qt/A 2–4 qt/A 2.5 lb/A	yes	4
Crossbow 3L	none recommended		yes	not specified
Facet 1.5L	crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate (optional)	2 pt/A 1–2 pt/A 2–4 qt/A 8.5 lb/100 gal	no	6
Glyphosate preplant or spot treatment	varies by product; check label ammonium sulfate (optional)	see label 8.5–17 lb/100gal	no	1-6
Gramoxone 2SL	non-ionic surfactant or crop oil concentrate	1 qt/100 gal 1 gal/100 gal	no	0.5
GrazonNext HL 3.74E	non-ionic surfactant	1–2 qt/100 gal	yes	not specified
Grazon P+D 2.54SL	non-ionic surfactant[1]	1 qt/100 gal	yes	not specified
MCPA 3.7L	none recommended		yes	not specified
Metsulfuron 60DF	non-ionic surfactant or non-ionic surfactant (on fescue) non-ionic surfactant (on timothy)	1–2 qt/100 gal 0.5–1 pt/100 gal 0.5 pt/100 gal	yes	4
Milestone 2L	non-ionic surfactant	1–2 qt/100 gal	yes	not specified
Overdrive 70WG	non-ionic surfactant or methylated seed oil	1 qt/100 gal 1.5 to 2 pt/A	no	4

(continued)

Trade Name	Adjuvant(s)	Rate	Apply in Liquid Fertilizer as a Carrier	Rainfastness (hours)
PastureGard HL 4L	non-ionic surfactant[4] or nitrogen solution[4]	1–2 qt/100 gal 1–2 qt/100 gal	not recommended	not specified
Prowl H2O 3.8AS	none recommended		yes	not applicable
Remedy Ultra 4L	non-ionic surfactant[1]	1 qt/100 gal	yes	not specified
Sandea 75DF	non-ionic surfactant	1–2 qt/100 gal	no	4
Sharpen 2.85SC	methylated seed oil plus ammonium sulfate (dormant only)	1 gal/100 gal 8.5–17 lb/100 gal	yes	1
Stinger 3S	not recommended[5]		no	6
Surmount 1.33L	non-ionic surfactant[2] or nitrogen solution[2]	1–2 qt/100 gal 1–2 qt/100 gal	yes	not specified
Weedmaster 3.87L	non-ionic surfactant plus nitrogen solution (optional)	2–4 pt/100 gal 2–4 qt/A	yes	4

[1] An adjuvant is allowed, but not required, in water dilutions to provide improved wetting of the foliage.
[2] An adjuvant is recommended for control of woody plants only.
[3] See fescue precautions on herbicide label for specific adjuvant recommendations.
[4] An adjuvant is allowed for improved weed or woody plant control, especially when plants are drought stressed.
[5] The label states that the addition of adjuvants is not usually necessary and that adding a surfactant to the spray mixture may increase effectiveness on weeds but may reduce selectivity to the crop, particularly under situations of plant stress.

Table 6-14. Grazing, harvest, haying, and slaughter restrictions for grass forage and pasture herbicides.

Trade Name	Type of Animal	Interval between Application and Grazing	Interval between Application and Green Harvest[1]	Interval between Application and Haying	Comments
2,4-D amine or	Lactating dairy	7 days	—[2]	30 days	Remove meat animals from treated area 3 days before slaughter; 2,4-D labels vary; see specific label of product used
2,4-D LVE	Other livestock	0	—	30 days	
Alm (carfentrazone)	All	0	0	0	Slaughter restrictions are not mentioned on label
Chaparral (aminopyralid + metsulfuron)	All	0	—	0	No slaughter restrictions
Cimarron Plus (metsulfuron + chlorsulfuron)	All	0	0	0	Be cautious of crop rotation restrictions; see label for details
Clarity/Banvel (dicamba)	Lactating dairy	7 days if < 1 pt	—	37 days if < 1 pt	Remove meat animals from treated areas 30 days prior to slaughter
		21 days if 1–2 pt		51 days if 1–2 pt	
		40 days if 2–4 pt		70 days if 2–4 pt	
	Other livestock	0	—	0	
Crossbow (2,4-D + triclopyr)	Lactating dairy	Do not graze until next season	—	14 days	Remove meat animals from treated areas or dried hay 3 days prior to slaughter
	Other livestock	0	—	14 days	
Facet L (quinclorac)	All	0	—	7 days	No slaughter restrictions on the label
GrazonNext HL (aminopyralid + 2,4-D)	All	0	—	7	Do not transfer grazing animals for 3 days from treated areas to areas with Milestone-sensitive species; do not spread manure to areas where sensitive species are or will be grown
Grazon P+D (picloram + 2,4-D)	Lactating dairy	7 days	—	30 days	Remove meat animals from treated area 3 days before slaughter
	Other livestock	0	—	30 days	
Metsulfuron	All	0	0	0	Do not seed to other crops for 1 or more years; see label for restrictions
Milestone (aminopyralid)	All	0	0	0	Do not transfer grazing animals for 3 days from treated areas to areas with Milestone-sensitive species; do not spread manure to areas where sensitive species are or will be grown
Overdrive (dicamba + diflufenzopyr)	All	0	0	0	Do not apply more than 8 oz/A per season
PastureGard HL (triclopyr + fluroxypyr)	Lactating dairy	Next season	Next season	14 days	Remove meat animals from treated areas at least 3 days before slaughter
	Other livestock	0	0		

(continued)

Trade Name	Type of Animal	Interval between Application and Grazing	Interval between Application and Green Harvest[1]	Interval between Application and Haying	Comments
Prowl H2O (pendimethalin)	All	0	0	0	Mixed-stand alfalfa/ cool-season forage grasses may be grazed or harvested for forage or hay 14 or more days after applying Prowl H2O
Remedy Ultra (triclopyr)	All	0	0	14 days	Remove meat animals from treated areas at least 3 days before slaughter
Roundup/glyphosate	All	Spot: 7 days	Spot: 7 days	Spot: 7 days	Use as spot treatment; do not treat more than one-tenth of any acre; leaves no soil residue
		Renovate: 56 days	Renovate: 56 days	Renovate: 56 days	
Sandea (halosulfuron)	All	0	37	37	0-day preslaughter interval
Sharpen (saflufenacil)	All	0	0	0	No slaughter restrictions on the label
Spike (tebuthiuron)	All	if < 20 lb/A	–	1 year	Leaves soil residue up to 2 years
Stinger (clopyralid)	All	0	0	0	Do not use hay or straw from treated areas for compost or mulch on susceptible broadleaved crops
Surmount (picloram + fluroxypyr)	Lactating dairy	14	14	14	Remove meat animals from treated areas at least 3 days before slaughter
	Other livestock	0	0	0	
Weedmaster (dicamba + 2,4-D)	Lactating dairy	7	37	37	Remove meat animals from treated areas 30 days prior to slaughter
	Other livestock	0	37	37	

[1] Green harvest includes harvest for silage, green-chop, or haylage.
[2] — = interval not specified on the label.

Table 6-15. Herbicides labeled for use in CRP acres.

This table contains herbicides that are available for use on Conservation Reserve Program (CRP) acres seeded to grasses or legumes. Many products labeled for use on grass forage have the same label requirements for CRP grasses. These uses are listed in the first column of the table, and the grass forage section of this guide also applies to use on CRP acres. Some products labeled for use on grass or legume forage can be used on CRP acres but have specific label recommendations or supplemental labels for CRP acres (columns 2 and 4). Other products are not labeled for use on forages grown in Delaware, but their use is allowed on CRP acres (columns 3 and 5). When choosing products for CRP acres, it is very important to consult the herbicide labels to determine non-target plant, environmental, and human risks, grass or legume species tolerance, weed species susceptibility, use rates, rotational crop or overseeding restrictions, and adjuvant requirements.

Trade Name	CRP Grass Same as Forage (use guide)	Specific CRP Grass Section (see label)	Labeled for CRP Grass, Not Forage (see label)	Specific CRP Legume Section (see label)	Labeled for CRP Legume, Not Forage (see label)
2,4-D amine/ester	POST				
2,4-DB/Butyrac 200			POST	POST	
Alm	POST				
Buctril			POST	POST	
Chaparral[1]	POST				
Cimarron Max		POST			
Cimarron Plus		POST			
Clarity/Banvel		POST			
Crossbow	POST				
Facet	POST				
Glyphosate		preplant, renovation, or dormant POST		preplant or renovation	
Gramoxone SL		preplant		preplant	
GrazonNext HL[1]	POST				
Grazon P+D[2]	POST				
Huskie	POST				
Journey			preplant[3]		preplant
Kerb			POST		
MCPA		POST		POST	
Metsulfuron	POST[4]				
Milestone[1]	POST				
PastureGard		POST			
Plateau			PRE[3] or POST[3]		PRE or POST
Poast				POST	
Prowl EC/pendimethalin					PPI or PRE
Pursuit			POST	POST	
Remedy Ultra	POST				
Sandea	POST				
Starane Ultra			POST		
Stinger		POST			
Telar XP			POST		
Weedmaster		POST			

[1] For Pennsylvania, Virginia, and West Virginia only.
[2] For Virginia and West Virginia only.
[3] Primarily for use on warm-season grasses.
[4] Not on all metsulfuron labels.

Table 6-16. Herbicides labeled for summer annual grass crops.

Weed management in summer annual grasses begins with a clean seedbed, tillage close to planting in conventional tillage, or preplant herbicides like glyphosate in no-tillage. Use fields with fewer perennial and annual grass weeds. Successful establishment begins with properly amended soils (pH and fertility) and appropriate seeding rate, depth, and equipment. When moisture is adequate, annual forage grasses emerge and grow quickly and compete well with weeds. There is often no need for additional weed control. Chemical weed control may be warranted when establishment is slow, weed populations are high, potentially toxic weeds are present, or high-quality (weed-free) hay or forage is desired. Herbicide options are limited. Some plant growth regulator (PGR) herbicides are labeled for use in annual grass forages. However, PGR herbicides are not recommended in many areas during the hot summer months due to potential injury to sensitive plants with physical or vapor drift. Non-PGR herbicide options are listed below. Pay particular attention to rotational crop restrictions; consult labels for crops not listed. Atrazine is typically not recommended due to its long rotation to other forage crops and should only be used if corn or sorghum will be planted in the spring. Check labels for weeds controlled. The listed postemergence herbicides typically control only small annual broadleaf weeds, so check labels for maximum weed size or growth stage.

Herbicide	Labeled Annual Grasses	Timing/ Weed Type	Use Rate per Acre	Crop Stage	Season Maximum Rate	Grazing/ Harvest Interval	Rotation to Grasses (months)	Rotation to Small Grains (months)	Rotation to Alfalfa/Clover (months)
Aim[1]	teff, crabgrass	POST/broadleaf	0.5 to 2 fl oz	any	5.9 fl oz (3 appl.)	0	0	0	12/12
Aim[1]	millets	POST/broadleaf	0.5 to 2 fl oz	up to jointing	2 fl oz	7 days	0	0	12/12
Aim[1]	forage sorghum	POST/broadleaf	0.5 to 1 fl oz	up to 6-leaf	1 fl oz	after 6 leaf	0	0	12/12
Atrazine[1] 4L	forage sorghum, sorghum-sudan hybrid	PPI, PRE, POST/ broadleaf	3.2 to 4 pt (see label)	up to 12 inches	5 pt	PPI/Pre: 60 days POST: 45 days	second year	next year to second year[2]	second year
Basagran[1]	forage sorghum	POST/broadleaf	1 to 2 pt	before heading	2 pt	12 days	0	0	0
Callisto[1]	pearl millet	PRE/broadleaf	up to 6 fl oz	n/a	6 fl oz (1 appl.)	n/a	18	4	10/18
Dual II Magnum[3,4]	forage sorghum	PRE/grass	1 to 1.67 pt[5]	n/a	1 appl.	n/a	next spring	4.5	4/9
Huskie[1]	forage sorghum	POST/broadleaf	12.8 to 16 fl oz	3-leaf but prior to flag leaf or 30 inches	32 fl oz	7/7	1 (9 for timothy)	1 week	4/bioassay
Maestro 2EC (Buctril) (for 4EC formulation cut rates in half)[3]	forage sorghum, sudangrass, sor-sudan hybrid	POST/broadleaf	1 to 1.5 pt	3-leaf but prior to preboot/4-leaf but prior to preboot	2 pt	45 days	1	1	1
Sandea[1]	pearl millet	POST/broadleaf and nutsedge	0.5 to 0.67 oz	2 lf but prior to head	0.67 oz	0/0 forage 37 hay	2	2	9
Sandea[1]	sorghum	POST/broadleaf and nutsedge	0.67 to 1 oz	2 lf but prior to head	1 oz	30/30	2	2	9

[1] Check label for adjuvant recommendations.
[2] Next year if applied before June 10; second year if applied after June 10.
[3] No adjuvant recommended.
[4] Requires the use of Concep-treated seed.
[5] Coarse soils, 1 to 1.33 pt; medium soils, 1.33 to 1.5 pt; fine soils, 1.33 to 1.67 pt.

Table 6-17. Optimum time of year for foliar application of systemic herbicides to selected weeds.

Winter annual weeds should be treated in late fall to spring. Summer annual weeds should be treated in early to late summer soon after emergence. Biennial weeds should be treated in the fall while in the seedling or rosette stages or in the early spring prior to bolting. Herbaceous and woody perennial weeds can vary significantly by species for when best to apply herbicides. These timings are based on adequate soil moisture and climate of the eastern shore area. Across the Mid-Atlantic region (north to south or east to west) these timings could vary by 1 to 3 weeks either way. Consult this table for general guidelines but herbicide labels for specific application information.

Weeds	March	April	May	June	July	August	September	October	November
Winter Annual Weeds (Chickweed, Henbit, etc.)	■	■						■	■
Summer Annual Weeds (Pigweed, Ragweed, etc.)			■	■					
Biennial Weeds (Wild Carrot, Bull Thistle, etc.)	■							■	■
Herbaceous Perennials									
Buttercup spp.	■							■	
Dandelion	■	■						■	■
Dock spp.	■	■							
Dogfennel			■	■	■	■			
Garlic, Wild	■	■							■
Horsenettle, Carolina					■	■			
Milkweed, Common						■	■		
Star-of-Bethlehem	■								
Thistle, Canada			■	■				■	■
Woody Perennials									
Barberry, Japanese			■	■	■	■	■	■	
Brambles (*Rubus* spp.)				■	■	■	■	■	
Olive, Autumn		■	■	■	■	■	■	■	
Rose, Multiflora		■	■	■	■	■	■	■	

Table 6-18. Accurate herbicide volume and weight measurements for small-volume applications.

Common conversion factors:

Liquid Products	Quart (qt)	Pint (pt)	Cup	Fluid Ounces (fl oz)	Tablespoon (Tbsp)	Teaspoon (tsp)	Milliliter (ml)
1 gallon	4	8	16	128	256	768	3785
1 quart	—	2	4	32	64	192	946
1 pint	—	—	2	16	32	96	473
1 cup	—	—	—	8	16	48	237
1 fl oz	—	—	—	—	2	6	29.57
1 Tbsp	—	—	—	—	—	3	14.8
1 tsp	—	—	—	—	—	—	4.9

Dry products:
1 pound (lb) = 16 oz-wt = 453.6 grams (gr)
1 oz-wt = 28.35 grams (gr)

Spot-spray, wiper bar, or other small-area applications often require preparation of a small volume of spray solution. Backpack sprayers usually have a 1- to 3-gallon capacity. Spray concentrations for liquid herbicide formulations can be as low as 0.05 fl oz (1.5 ml) per gallon, and concentrations for dry herbicide formulations as low as 0.01 oz-wt (0.28 gr) per gallon. Inaccurate measurement of these very small concentrations can cause large deviations above or below the intended application rate, resulting in possible crop damage, carryover, or poor weed control. For example, when measuring a pint of liquid herbicide, a deviation of 0.5 ml, which is equivalent to 6 drops from a dropper, would result in a negligible increase or decrease of 0.1% from the intended rate. However, the same 6 drop deviation when measuring 1.5 ml of a liquid herbicide would result in an unacceptable rate increase or decrease of 33%.

Most liquid measuring devices intended for use with agricultural products are good for measuring large volumes (pints, quarts, gallons), but they are usually not accurate below a volume of 10 fl oz (296 ml). Two types of measuring devices are available for low volumes that are accurate and easy to use. Graduated cylinders are tall, narrow cylinders with milliliter graduations along the outside of the tube. They are available in non-breakable polypropylene material that can be washed and reused. They are available in sizes ranging from 10 ml (0.34 fl oz) with 0.2-ml increments to 4,000 ml (1.06 gal) with 50-ml increments. Pouring liquid herbicides into small graduated cylinders from large containers can be difficult. Disposable syringes are probably the cleanest and most accurate way to measure small volumes of liquid herbicide. Although they are termed disposable, they can be easily dismantled, washed, and reused several times. Buy syringes without the needles if possible, or remove and dispose of needles before use to avoid possible injury or exposure to the herbicide through a skin puncture. A syringe is essential for measuring volumes of less than 0.17 fl oz (5 ml) and can be purchased in sizes ranging from 3 ml with 0.1-ml increments up to 60 ml with 1-ml increments. A good arrangement of measuring devices to have for medium- to small-volume measurements includes a 250-ml graduated cylinder with 2-ml graduations, and 3-ml, 10-ml, and 60-ml syringes.

For dry products, postal scales measuring to 0.1 oz-wt are adequate for weights above 1 oz-wt (28.4 gr). A gram scale accurate to 1/100 of a gram (0.01 gr) should be used for measuring weights of less than 1 oz-wt. Converting products measured by mass (oz-wt or grams) into volume (teaspoons, tablespoons, or milliliters) is not practical because of the variability in the density (weight per given volume) of individual products. If sufficiently accurate weighing devices are not available, dry products requiring low concentrations should not be used for small-volume applications.

Table 6-19. Herbicides labeled for farmstead use.

This table lists several herbicides available for use in farmstead areas. Farmstead areas may include areas around buildings (storage buildings, poultry houses, greenhouses, etc.), non-grazed fencerows, non-irrigation ditch banks, unpaved lanes, or other non-cropped agricultural areas where selective weed control or bare ground is desired. Some herbicide labels allow grazing or haying of treated areas within or around these sites, while others do not. Many of these herbicides are toxic to desirable plants when spray particles contact either aboveground plant parts, bare roots, and/or the soil where plant roots have penetrated. Most of these products should not be used on impervious surfaces such as paved or highly compacted areas. Runoff from treated impervious surfaces or transport of treated soils by erosion can severely injure or kill susceptible non-target plants. Do not apply these products directly to water, and exercise caution when using these products near irrigation or domestic water supplies. Many of these products are not recommended for use on highly permeable soils and/or soils with groundwater near the soil surface. Read herbicide labels carefully to determine allowed uses, environmental risks, human risks, desirable plant species tolerance, weed species susceptibility, application types, use rates, adjuvant requirements, and specific grazing or haying restrictions.

Trade Name	Components (ai or ae/gal or lb)	Soil Residual[1]	Grass Control	Broadleaf Control	Woody Plant and Vine Control	Grazing Restriction (days)	Haying Restriction (days)
2,4-D (various formulations)	(varies) 2,4-D	limited	no	yes	few	0–7	7
Arsenal 2AS	2 lb imazapyr	yes	yes	yes	yes	0	7
Banvel/Clarity 4L	4 lb dicamba	limited	no	yes	several	0–40	0–70
Cimarron Max CoPack	Part A (dry): 0.6 lb metsulfuron Part B (liquid): 1 lb dicamba 2.87 lb 2, 4-D	yes	no	yes	several	0–7	37
Cimarron Plus 63WG	0.48 lb metsulfuron 0.15 lb chlorsulfuron	yes	no	yes	several	0	0
Crossbow 3L	2 lb 2,4-D 1 lb triclopyr	limited	no	yes	several	0–NS[2]	14
Escort/Metsulfuron 60WG[3]	0.6 lb metsulfuron	yes	no	yes	few	0	0
EsplAnade 200SC	1.67 lb indaziflam	yes	yes	yes	no	do not	do not
Glyphosate (various formulations)	(varies) glyphosate	no	yes	yes	several	0–56	0–56
Karmex 80DF/Direx 4L	0.8 lb diuron	yes	yes	yes	no	not specified	not specified
PastureGard HL 4L	3 lb triclopyr 1 lb fluroxypyr	limited	no	yes	several	0–NS	14
Payload 51WG	0.51 lb flumioxazin	yes	yes	yes	no	do not	do not
Pramitol 25E	2 lb prometon	yes	yes	yes	no	not specified	not specified
Prowl/Pendulum 3.3EC	3.3 lb pendimethalin	yes	yes	yes	no	do not	do not
Prowl H2O/Satellite Hydro-Cap 3.8AS	3.87 lb pendimethalin	yes	yes	yes	no	see label	see label
Sahara 70DG	0.078 lb imazapyr 0.62 lb diuron	yes	yes	yes	many	not specified	not specified
Solicam 78.6DF	0.79 lb norflurazon	yes	yes	yes	no	do not	do not
Spike 20P	0.2 lb tebuthiuron	yes	no	yes	many	0	365
Starane Ultra/Vista 2.8L	2.8 lb fluroxypyr	limited	no	yes	no	7	14
Stinger 3L	3 lb clopyralid	limited	no	yes	no	0	0
Velpar 2L or 75DF	2 lb hexazinone	yes	yes	yes	several	0–7	60–365
Weedmaster 3.87L	2.87 lb 2,4-D 1 lb dicamba	limited	no	yes	several	0–7	37

[1] Herbicides listed as having limited soil residual activity may, for a short time, provide residual control or suppression of some species and can injure or kill susceptible desirable plants through soil activity.

[2] NS = next season after application.

[3] Not on all metsulfuron labels.

Chapter 7.
Problem Weeds

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Amaranth (Palmer) and Waterhemp

Palmer Amaranth

Scientific name: *Amaranthus palmeri*
Other names: Palmer pigweed or careless weed

Waterhemp

Scientific name: *Amaranthus tuberculatus* or *A. rudis*
Other names: tall waterhemp, common waterhemp

Palmer amaranth and waterhemp are both summer annual weeds from the Amaranthaceae family (pigweed). These two species can look very similar and have similar biological characteristics. They have leaves that are longer and narrower than those of redroot or smooth pigweed (Palmer amaranth leaves are often diamond shaped and waterhemp are lance shaped). Palmer amaranth petioles are long (often as long as the leaf blade), which causes the leaves to droop, while waterhemp's petioles are shorter than the leaf blade. The stems, petioles, and leaves of both species are hairless, while redroot and smooth pigweed have short hairs on the leaf and stem. Both are dioecious, meaning they have separate male and female plants. Both have long seed heads, unlike redroot or smooth pigweed, which have shorter and more compact seed heads. Hybridizations between Palmer amaranth and other pigweeds have been reported, complicating positive identification.

Palmer amaranth and waterhemp have a prolonged germination pattern that allows them to emerge throughout the summer and into the early fall. However, germination is suppressed by a dense crop canopy.

Herbicide Resistance

Both species are prone to developing resistance. Since they are dioecious, they are well adapted for resistance genes carried in the pollen to spread long distances (>3,000 feet). Palmer amaranth populations in the Mid-Atlantic region have been confirmed to have resistance to ALS-inhibiting herbicides (Group 2) and glyphosate (Group 9). In other regions of the United States, Palmer amaranth has developed resistance to dinitroanilines (Group 3), triazines (Group 5), HPPD inhibitors (Group 27), and PPO inhibitors (Group 14).

Waterhemp populations in the Mid-Atlantic region have been confirmed to have resistance to ALS-inhibiting herbicides (Group 2) and glyphosate (Group 9). In other regions of the United States, waterhemp has developed resistance to triazines (Group 5), HPPD inhibitors (Group 27), PPO inhibitors (Group 14), and plant growth regulators (Group 4).

Management

Already well known as the most troublesome weed in cropping systems in the Midwest and southern states, Palmer amaranth has become established in the Delmarva region and waterhemp has been identified in Pennsylvania, New Jersey, and Delaware. These species can be controlled when treated with an effective herbicide applied to plants at a susceptible stage (usually 3 inches or less). However, because these species have a higher growth rate than most species, they quickly become too tall for effective control, and there are no herbicide controls that will serve as a "rescue treatment." These species deserve to be met with a "zero-tolerance" attitude concerning their control. These species have a high drought tolerance and can withstand periods of water stress better than many other weeds.

Due to the prolonged germination period of these two species, the use of residual herbicides is important. Furthermore, residual herbicides need to be applied as close to planting as possible to ensure that they provide effective control for 3 to 4 weeks after planting. Postemergence herbicides need to be applied to plants no taller than 3 inches, and postemergence treatments often need to include an herbicide that will provide effective residual control. Both species are suppressed by a dense crop canopy, which also reduces late season seed germination.

Controlling plants before they produce viable seed is important for long-term management. The seeds of both species decline rapidly after 2 to 3 years in the soil, so stopping the influx of new seeds will reduce seedling density.

Corn

The herbicide options for control of Palmer amaranth and waterhemp in corn are better than for soybean production; however, most fields will require both a preemergence and a postemergence treatment. Be aware that control programs relying on atrazine (Group 5) or HPPD (Group 27) herbicides could be problematic since populations with resistance to atrazine and HPPD herbicides have been reported.

Corn should be planted into a weed-free field that relies on conventional tillage or an effective burndown program. Preemergence herbicides should be applied within 7 to 10 days of planting to maximize residual control during the early stages of corn growth. A range of preemergence herbicides that contain both a Group 15 herbicide and atrazine can provide effective control, including Anthem ATZ, Bicep II Magnum, Cinch ATZ, Degree Xtra, Harness Xtra, FulTime NXT, and Keystone NXT. Balance Flexx, Lexar, and Lumax are herbicide premixes with HPPD inhibitors (Group 27) that have been applied for successful preemergence control of these species. However, do not rely on Group 27 herbicides for both preemergence *and* postemergence control.

Effective postemergence treatments include 2,4-D/dicamba, atrazine, and HPPD inhibitors (Armezon, Callisto, Impact, or Laudis). If additional residual control is needed, products such as Outlook, Dual, or Harness can be applied early postemergence.

Due to heavy reliance on Group 14 herbicides in soybean, avoid using Kixor or Valor products in corn, except in situations of continuous corn.

Sorghum

Palmer amaranth and waterhemp control in sorghum will often require a preemergence and a postemergence application. Start "clean," with all existing weeds dead at the time of planting. Be aware that sorghum is not as tolerant to atrazine as corn, and that there are use restrictions with Lumax or Lexar (refer to labels). Use a preemergence application of Bicep II Magnum, Cinch ATZ, Degree Xtra, FulTime NXT, Warrant plus atrazine, Lexar, or Lumax. Follow up with a timely postemergence application of 2,4-D, Clarity, Huskie, Marksman, or Yukon.

Soybean

Start with a clean field using tillage or an effective burndown treatment. No-till fields with horseweed or other hard-to-control winter annuals may need to be treated early (3 to 5 weeks prior to planting). Residual herbicides applied this early will have limited effectiveness for controlling Palmer amaranth or waterhemp beyond soybean planting. Fields infested with hard-to-control winter annuals *and* waterhemp or Palmer amaranth should be treated early (for winter annual weeds) and with an application of a residual herbicide at planting (for Palmer amaranth or waterhemp control).

Do not expect effective control of emerged waterhemp and Palmer amaranth plants with glyphosate or a Group 2 herbicide (chlorimuron, imazethapyr, thifensulfuron, etc.) due to widespread resistance. 2,4-D or paraquat plus metribuzin have been used as effective burndown treatments for control of these two species. Liberty can also be effective if applied under conditions of full sunlight, with good spray coverage, and to plants less than 4 inches tall. Residual herbicides are important for Palmer amaranth and waterhemp control since the seeds continue to germinate during the growing season. Residual herbicides need to be applied as close to the planting date as possible to ensure maximum weed control. Herbicides and herbicide mixes containing flumioxazin (Envive, Fierce, Gangster, Valor XLT) and sulfentrazone (Authority Assist/XL/First/Maxx/MTZ and Sonic) provide the highest level of control. However, even using these herbicides will only provide short-term control. Postemergence control of Palmer amaranth or waterhemp in soybean is achieved by using fomesafen-containing herbicides (Flexstar, Flexstar GT, Prefix, Reflex), lactofen (Cobra, Phoenix), or glufosinate (Liberty) in cases of LibertyLink soybean. Fomsafen-containing herbicides will provide residual control; otherwise, consider combining postemergence herbicides with residual herbicides to help control later emerging seedlings. S-metolachlor (Dual II Magnum, Sequence), acetochlor (Warrant), and dimethenamid-P (Outlook) can be used here. All postemergence treatments must be made before Palmer amaranth or waterhemp plants are taller than 3 inches.

Double-cropped soybeans need an effective burndown treatment if Palmer amaranth or waterhemp seedlings are present at the time of small grain harvest. Burndown programs based on paraquat or Liberty (glufosinate) have been effective, but they may require additional herbicides if grasses or other species are present.

Heavy reliance on Group 14 herbicides require long-term planning to limit their use to crops where they are needed. Fields with continuous soybean should not use Group 14 herbicides every year.

Perennial Forages

Applications of 2,4-D and/or dicamba or triclopyr-containing herbicides will control emerged Palmer amaranth or waterhemp in grass hay or pasture. Alfalfa could be treated with Chateau after cutting, or rely on 2,4-DB (Butyrac).

Burcucumber

Scientific name: *Sicyos angulatus*
Other names: wild pickle, pickle, wild cucumber

Burcucumber (*Sicyos angulatus*) is a summer annual broadleaf weed that is a serious problem in agronomic crops in some regions of the Northeast. Because of its prolonged seedling emergence and aggressive growth habit, burcucumber is not easily controlled using conventional weed management strategies. Like most weeds, burcucumber cannot be eradicated; however, an integrated control approach can reduce the size of burcucumber infestations and slow or stop the weed's further spread.

Burcucumber can be identified by its pentagon-shaped leaves, long vines, and spiny seed clusters. The individual seeds are flattened, have a hard seed coat about the size of a watermelon seed, and are enclosed in a prickly, fleshy shell, or pericarp. The hard seed coat contributes to the burcumber's prolonged seed dormancy, which means that fields currently infested with burcucumber will have a lasting seed reservoir in the soil and the potential for a burcucumber problem for many years.

Herbicide Resistance

None reported.

Management

The first step is to prevent burcucumber seed spread by thoroughly cleaning tillage and harvesting equipment before leaving infested fields. Encourage aggressive crop growth through good cultural practices such as maintaining adequate

soil fertility, choosing appropriate high-yielding crop varieties, and regularly scouting for and managing pests. Include in the rotation crops that provide early competition such as alfalfa or small grains. Include no-till in fields that are infested with burcucumber. Research suggests that no-till allows burcucumber seed to remain near the soil surface, thus allowing germination to occur over a shorter time period and reducing the number of germination flushes. This also improves herbicide effectiveness and performance. Harvest burcucumber-infested fields for silage to prevent viable seed production.

Corn

Herbicides are essential in a burcucumber management program, but use them in combination with other control methods. Several corn herbicides provide good control of burcucumber and they are most effective on young seedlings rather than larger plants. Include herbicides that have residual activity to control new burcucumber flushes. POST (foliar-applied) herbicides provide the best burcucumber control. In corn, if possible, include at least 1.5 pounds of atrazine in the herbicide program for residual control. Other effective herbicides include prosulfuron (Peak or Spirit), primisulfuron (Beacon), mesotrione (Callisto), and glyphosate. In addition, other Group 6 herbicides such as bromoxynil are effective for controlling emerged plants.

Sorghum

Management of burcucumber in sorghum should be similar to corn and relies on POST herbicides. Some of the same herbicides, except glyphosate, can be used in sorghum.

Soybean

Burcucumber may be easier to manage in soybean than in corn simply because you can better monitor control and apply herbicides later in soybean than in corn. The most effective herbicides for control in soybean are glyphosate plus a residual product like chlorimuron. More than one foliar application may be necessary.

Small Grains

Burcucumber is only an issue in spring-seeded small grains and generally not winter grains, so it could be problematic in oats or other spring-seeded cereals. Seed spring grains as early as possible to get a head-start on the burcucumber. Some suppression can be obtained from the Group 2 or ALS herbicides or Group 6 or 14 contact-type herbicides.

Perennial Forages

Perennial forages are an excellent crop for managing burcucumber. In particular, established alfalfa that can be mowed four or more times per season will suppress burcucumber seedlings and it is rarely a problem in these crops. Establish alfalfa in late summer to avoid burcucumber problems at establishment. Burcucumber is rarely a problem in perennial grass hay or pasture.

Fallow or Spot Treatment

Spot spray with glyphosate or paraquat, or use a Group 4 growth regulator herbicides.

Dock (Broadleaf and Curly)

Broadleaf Dock

Scientific name: *Rumex obtusifolius*
Other names: bitter dock

Curly Dock

Scientific name: *Rumex crispus*
Other names: sour dock, yellow dock, narrowleaf dock, or curled dock

Broadleaf dock and curly dock are introduced taprooted perennials that are found throughout North America and common in the Mid-Atlantic region. Both species initially form basal rosettes of lanceolate leaves; the plant later bolts and produces an erect flower stalk that is typically 3 feet in height but can be up to 5 feet. Curly dock can produce more than 60,000 seeds per plant, some of which readily germinate, while others remain viable for over 10 years. Approximately 50 percent of seeds remain viable after 3 years. Seeds readily disperse via wind or float on water. To distinguish between species, leaf width and margins are most readily used; curly dock has narrower leaves with wavy margins, while broadleaf dock has wider leaves with smooth or finely undulate margins. However, control measures are similar between these species.

Herbicide Resistance

None reported.

Management

Broadleaf dock and curly dock are generally weeds of no-till and perennial systems. Tillage is an effective option for control. Continual mowing will reduce seed production and can deplete the energy reserves in the taproot, but it is not an effective management strategy on its own. Heavy grazing should be avoided, as these plants are rarely grazed (but can be poisonous to livestock); docks thrive in open canopies, thus heavy grazing can lead to increased infestations. Conversely, docks are not competitive in aggressive, vigorous competition. Seedlings are best controlled in early spring, but once the perennial structures are established, fall applications may be more effective. Contact herbicides readily control top growth, but regrowth from taproots will occur.

Corn

In corn, it is best to control dock species prior to planting through burndown herbicides or tillage. Glyphosate (Round-

up, others) plus higher rates of 2,4-D or dicamba (Banvel, Clarity, others) is most effective, but regrowth from taproots can occur. Observe all rotation restrictions. Atrazine will help control dock species and is similarly effective when applied PRE or POST. Clopyralid-containing products (Stinger, Curtail) are most effective POST, but growers should be aware of long rotation restrictions for many crops. Other effective POST options include 2,4-D, dicamba, and glyphosate (in glyphosate-resistant hybrids only).

Sorghum

Management of broadleaf dock and curly dock in sorghum is similar to corn except that clopyralid and glyphosate cannot be used after sorghum emerges.

Soybean

Dock control in soybean is more challenging due to fewer herbicide options. Similar to corn, management should focus on control prior to planting through tillage or burndown herbicides. Harmony Extra (thifensulfuron plus tribenuron) and chlorimuron-ethyl-containing products (Authority XL, Classic, Canopy, Envive, Valor XLT, others) applied with glyphosate are effective. Glyphosate plus 2,4-D is another good option, but it is not as effective as others mentioned. Observe all rotation restrictions. The best POST option is glyphosate (to glyphosate resistant varieties only), but imazethapyr (Pursuit), imazamox (Raptor), and bentazon (Basagran) are options for suppression.

Small Grains

Broadleaf dock and curly dock are not as problematic in small grains. Burndown options include glyphosate plus dicamba and Harmony Extra. POST herbicide options include Harmony Extra and clopyralid-containing products (Stinger). Again, producers should be aware of long rotation restrictions with clopyralid.

Perennial Forages

A vigorous, competitive forage is the best tool for managing dock infestations. Proper grazing or haying management and optimizing soil fertility and pH will help prevent infestation or spread. In established alfalfa and other legume forages, herbicide options are limited; imazethapyr (Pursuit) and imazamox (Raptor) will suppress dock species. Control prior to establishment is critical. In grass forages, several very effective herbicide options exists as well; 2,4-D plus dicamba is perhaps the most economical option and results in excellent control. Crossbow (2,4-D plus triclopyr) and aminopyralid-containing products (GrazonNext HL; Milestone; Pennsylvania, Virginia, and West Virginia only) are also very effective. Apply in March through early April.

Fallow or Spot Treatment

Spot treat with 2,4-D plus dicamba. Glyphosate spot treatment is also a good option.

Henbit

Scientific name: *Lamium amplexicaule*
Other names: n/a
Similar species: purple or red deadnettle, *Lamium purpureum*
Henbit is a winter annual species from the Lamiaceae family (mint). New plants emerge from seeds primarily in the fall, with some early spring germination. Stems are square, green to purple, and nearly hairless. Henbit is a short plant, seldom more than 5 inches tall, but can develop a low-growing (prostrate) growth with plants of over 5 inches in diameter. Lower leaves are round to heart-shaped and have petioles (petoliate); upper leaves do not have petioles (sessile), with leaves encircling the stem at the base. Henbit is one of the first species to flower in the spring, developing showy pink to purple flowers. Henbit is effectively controlled with most spring burndown applications for corn or soybean, but these applications are often made after viable seeds are produced. It competes primarily with winter forage and grain crops.

Herbicide Resistance

Resistance to Group 2 (ALS herbicides chlorsulfuron and propoxycarbazone) was reported in Kansas in 2014. No known resistance has been reported in the Mid-Atlantic region.

Management

Plants are easier to control in the fall. Plants can be controlled with full rates of thifensulfuron plus tribenuron, 2,4-D plus dicamba, or aminopyralid. For burndown, fall applications of glyphosate or paraquat, or spring applications of glyphosate plus atrazine, paraquat plus atrazine, or glyphosate plus metribuzin are effective. When considering long-term management of henbit, apply burndown treatments in the fall or early spring shortly after henbit begins flowering to stop the production of viable seed.

Plants emerging with fall-seeded forage grasses are difficult to control. Treatments with the low labeled rates of dicamba plus 2,4-D on seedling grasses are somewhat effective when applied early in the fall. However, these early applications sometimes result in significant crop injury and have little to no residual activity to control later emerging winter annual weeds.

Corn and Sorghum

Typically only present in no-till fields. Glyphosate plus triazine or paraquat plus triazine applied preplant burndown are effective.

Soybean

Typically only present in no-till fields. Plants are often senescing (ending their life cycle) during the period soybean burndown applications are made. Effective preplant burndown with glyphosate or glyphosate plus metribuzin.

Small Grains

Thifensulfuron plus tribenuron applied during the fall or spring or metribuzin applied during the spring are effective (in states with 24[c] registrations). Thifensulfuron and tribenuron are both Group 2 (ALS inhibitor) herbicides, to which henbit has developed resistance in Kansas. This approach should be rotated with other herbicides with different modes of action such as dicamba, Group 4 (synthetic auxins) or bromoxynil, or Group 6 (PSII inhibitor), which are slightly less effective but adequate.

Perennial Forages

For alfalfa establishment (conventional tillage), preplant-incorporated application of Eptam. For fall no-tillage establishment, glyphosate. For seedling alfalfa, applications of bromoxynil, Roundup (Roundup Ready alfalfa only), or paraquat (dormant application).

For newly seeded grasses, 2,4-D plus dicamba applied early postemergence are marginally effective, but injury can be significant. For established grasses, 2,4-D plus dicamba (higher rates than newly seeded), triclopyr plus 2,4-D, triclopyr plus fluroxypyr, or products containing metsulfuron or aminopyralid (where available) applied during the fall or early spring are effective.

Fallow or Spot Treatment

Fall application of glyphosate or paraquat.

Horsenettle

Scientific name: *Solanum carolinense*
Other names: wild potato, sand brier

Horsenettle is a perennial species from the Solanaceae family (nightshade). New plants emerge readily from seeds as well as creeping rootstocks. Stems and leaves have short stiff spines. In addition to weed competition, horsenettle affects crop production since its berries are harvested with soybeans and processing vegetables and are difficult to separate, and plants can be poisonous to animals at high concentrations.

Herbicide Resistance

None reported.

Management

Plants emerging from seeds are controlled with most triazine herbicides (simazine, atrazine, and metribuzin) applied at planting. Plants emerging from overwintering rootstocks are difficult to control. Postemergence applications of glyphosate, Liberty, atrazine, dicamba, or aminopyralid are effective to varying degrees. Burndown treatments of glyphosate or paraquat in the spring will control the emerged portion of the plant, but additional shoots are likely to emerge. The best time to treat it is in the late summer or with glyphosate or dicamba. This species is sensitive to frost, so applications should be made about 2 weeks before a killing frost. Plants damaged by harvest should be allowed time to recover before treatment. Due to the extensive horsenettle root system, 2 to 3 years of consistent management is needed to significantly reduce horsenettle shoots.

Corn

Soil application of atrazine or simazine at planting are effective for plants emerging from seed. Postemergence applications of glyphosate (in RR corn), glufosinate (Liberty; in LL corn), dicamba, or dicamba plus a Group 2 herbicide (halosulfuron, nicosulfuron, primisulfuron) in early June will provide fair to good control for that cropping season but have minimal impact on long-term management of this species. Fields should be treated after harvest and when horsenettle plants are actively growing. Plants damaged by harvest should be allowed time to recover before treating; thus, keeping the combine header as high as possible will result in quicker horsenettle plant recovery. Wait 7 to 10 days after herbicide application before the field is tilled or mowed.

Sorghum

Soil application of atrazine at planting is effective for seedling control, and a postemergence application of dicamba or dicamba plus halosulfuron is effective for suppression of emerged plants. Fields should be treated after harvest and while the horsenettle plants are actively growing. Plants damaged by harvest should be allowed time to recover before treating; thus, keeping the combine header as high has possible will result in quicker horsenettle plant recovery. Wait 7 to 10 days after herbicide application before the field is tilled or mowed.

Soybean

Soil application of metribuzin at planting is effective for plants emerging from seed. Postemergence applications of glyphosate (RR corn) or glufosinate (Liberty; in LibertyLink soybean) are effective to control emerged plants. Classic, Pursuit, and Synchrony can provide some suppression. Since soybeans are harvested late in the fall and all of the horsenettle leaves are removed during harvest, postharvest applications are not practical. Glyphosate applications as part of a harvest aid approach may be beneficial.

Small Grains

Horsenettle typically does not interfere with small grain.

Perennial Forages

Grass hay crops should be treated after the last cutting of the year, after allowing horsenettle to recover, but before the forages interfere with spray coverage. Dicamba, aminopyralid, and picloram, in labeled crops and states, provide the most consistent control. Roundup Ready alfalfa can be treated with glyphosate. Spot treatments of glyphosate is the best option for conventional alfalfa, or dicamba in a mixed stand to allow the forage grasses to survive.

Horseweed

Scientific name: *Conyza canadensis*
Other names: marestail, Canada fleabane, stickweed

Horseweed is a winter or summer annual and a member of the Asteraceae family. In the winter annual cycle, horseweed germinates in the fall and overwinters as a basal rosette. The following spring, the rosette bolts, reaching 1.5 to 6 feet in height. While most populations of horseweed in the region emerge in the fall, significant spring emergence can occur under certain conditions. Leaves are alternate, simple, linear to oblanceolate in shape, and lack petioles. Leaf margins are either entire or toothed. Flowers consist of numerous small heads arranged in a panicle with many white ray flowers and 20 to 40 yellow disk flowers. Seed are small and have a pappus of tan to white bristles (resemble dandelion seed). Seeds are easily dispersed by the wind, allowing it to quickly spread to nearby fields and within fields.

Herbicide Resistance

In the United States, biotypes of horseweed resistant to Group 9 (glyphosate), Group 2 (acetolactate synthase [ALS] inhibiting), Group 22 (photosystem [PS] I inhibiting), and Group 5 (photosystem II inhibiting) herbicides exist. Regionally, glyphosate- and ALS-resistant horseweed are widespread. Resistance to paraquat (PS I inhibitor) has been reported in Delaware.

Management

Horseweed is more prevalent in no-till fields compared to fields prepared conventionally. Tillage can be useful in the long-term management of horseweed. Chemical control of horseweed is more consistent when the weed is in the seedling or rosette stage compared to bolting plants. Traditionally, glyphosate and ALS-inhibiting herbicides effectively controlled horseweed; however, biotypes resistant to these herbicides are widespread. Chemical control of glyphosate- and ALS-resistant horseweed requires a postemergence herbicide to control emerged horseweed and, depending on application timing, a residual herbicide for horseweed yet to emerge. Due to the prolonged germination period, horseweed seedlings can emerge 5 to 6 weeks after residual herbicide application; thus, fall applications of residual herbicides often have limited effectiveness for spring emergence.

Herbicides used for emerged plants include 2,4-D (1 pint in the fall or 1 quart in the spring), dicamba, glufosinate, saflufenacil, or paraquat plus a triazine herbicide. Herbicides providing residual control include flumioxazin, triazine herbicides (atrazine, simazine, and metribuzin), or an ALS-inhibiting herbicide (if horseweed is not ALS resistant).

Horseweed seedlings do not tolerate shade. Thus, a well-established cover crop or dense crop canopy can be very effective to manage horseweed-infested fields.

Corn

In no-till corn, paraquat plus a triazine herbicide, glyphosate plus atrazine plus 2,4-D or dicamba, and glufosinate plus atrazine applied burndown for control of emerged seedlings and residual control of glyphosate- and ALS-resistant horseweed. Consult labels for waiting interval prior to planting corn. Atrazine alone will provide good residual control of horseweed. Dicamba and 2,4-D are the most effective postemergence herbicides. For small emerged horseweed, foliar-applied HPPD inhibitors or glufosinate plus atrazine are effective.

Sorghum

Glyphosate plus saflufenacil or paraquat plus a triazine applied burndown. Atrazine alone or in combination with paraquat applied preemergence for residual control and control of small emerged horseweed. Atrazine can be used postemergence for control of small horseweed. However, similar to corn, 2,4-D and dicamba are the most effective postemergence options.

Soybean

Horseweed management is challenging in soybeans because of the later planting date and horseweed plants need to be controlled before they begin to bolt (grow upright); this may require an application weeks prior to planting. Glyphosate plus 2,4-D (1 quart per acre) or glyphosate plus saflufenacil will effectively control glyphosate- and ALS-resistant horseweed when they are small. If horseweed is susceptible to the ALS-inhibiting herbicides, chlorimuron-containing herbicides (e.g., Canopy, Valor XLT, Envive, Surveil) are effective. If applications are made early preplant, herbicides containing flumioxazin, metribuzin, or sulfentrazone can be included to provide residual control, or a second application of a non-selective herbicide may be needed at planting. Glufosinate or paraquat also control small horseweed and can be used as a part of the burndown application. If horseweed is present at planting, paraquat plus a residual product containing flumioxazin, sulfentrazone, or metribuzin or saflufenacil is suggested in regions with later emerging horseweed. Foliar- applied PPO-inhibiting herbicides

(acifluorfen, fomesafen, flumiclorac, and lactofen) do not control emerged horseweed. For LibertyLink varieties, glufosinate applied postemergence controls small horseweed. Chlorimuron and cloransulam are postemergence options where horseweed is susceptible to the ALS-inhibiting herbicides and small. (Note: Many prepackaged herbicides are available for soybean; consult the premix equivalent table in the soybean section for active ingredients and rates. Use of residual herbicides as part of an early plant application may not provide acceptable control of summer annual weeds that may emerge shortly after planting. See comments in the soybean section on precautions with the use of saflufenacil.)

Small Grains

2,4-D, dicamba, or Huskie will provide effective postemergence control of horseweed in small grains. Thifensfulfuron plus tribenuron (Harmony Extra) is also very effective on small horseweed that is Group 2 susceptible.

Perennial Forages

For grass hay crops, most of the auxin herbicides effectively control horseweed. For alfalfa, small horseweed can be controlled with 2,4-DB. Also, for Roundup Ready alfalfa and where glyphosate-susceptible horseweed exists, horseweed control by glyphosate is excellent.

Fallow or Spot Treatment

In fields with a history of horseweed, fall-applied herbicides can be helpful in managing the weed. However, a fall herbicide application will not substitute for a spring burndown application. Target applications for emerged horseweed plants in the late fall after one to two killing frosts. 2,4-D or dicamba should serve as the base for these applications. Glyphosate is often suggested in combination with 2,4-D and dicamba to control other winter annual weeds.

Johnsongrass and Shattercane

Scientific names: *Sorghum halepense* (Johnsongrass); *Sorghum bicolor* (shattercane)
Other names: wild cane (shattercane)
Both species are extremely competitive grasses that commonly reach heights of 7 to 9 feet and form thick, dense patches in fields and roadsides. Johnsongrass is a perennial species that reproduces by seed and its scaly, jointed rhizomes. Shattercane is an annual weed that does not have rhizomes. Leaves of shattercane can be as wide as 3 inches, while Johnsongrass leaves are seldom more than 1 inch wide. The seed head of shattercane is a loose or open panicle that tends to droop and shatters easily, spreading seeds and causing future weed problems. Shattercane seed is larger and more rounded than Johnsongrass seed. The seed remains attached to the base of the young seedling and can be seen by carefully removing young seedlings from the soil.

Herbicide Resistance

In the United States, biotypes of Johnsongrass are resistant to glyphosate (Group 9), ALS-inhibiting herbicides (Group 2), ACCase-inhibiting herbicides (Group 1), and dinitroanilines (Group 3). Regionally, biotypes resistant to Groups 1 and 2 have been reported. Biotypes of shattercane resistant to Group 2 exist in the United States and within the region.

Management

Preventing the introduction of either species is important to their management. The perennial habit of Johnsongrass allows it to become established in many settings and to spread. Tillage can break and spread Johnsongrass rhizomes and allow infestations to expand, thus plants along fencerows or field edges can continuously infest fields. Shattercane, on the other hand, is an annual species, thus timely cultivation and mowing are effective strategies for control.

Johnsongrass management requires more than removal of top growth and eliminating seed production; the rhizomes must be depleted. Depleting rhizomes requires consistent control over a few years, and then growers must ensure that new plants do not emerge from seeds in the soil. A fall glyphosate application can help control Johnsongrass rhizomes. Johnsongrass emerging from seeds will develop rhizomes within 3 to 4 weeks, after which it needs to be treated as a perennial plant.

Both species have large seeds that allow them to emerge from over 1 inch deep in the soil. Herbicide concentrations from soil depths of more than 1 to 1.5 inches are often below the levels needed to control seedlings. Therefore, control of these species with soil-applied herbicides is difficult.

Corn

Pendimethalin (Prowl) will suppress seedling Johnsongrass and shattercane, but it will need a postemergence herbicide application. Postemergence control of both species is very good to excellent with nicosulfuron (Accent), primsulfuron (Beacon), or glyphosate.

Sorghum

Johnsongrass, shattercane, and sorghum are closely related, and there are no satisfactory broadcast treatments currently available for controlling either species in grain sorghum. The only alternative available for rhizome Johnsongrass control is spot spraying glyphosate. Grain sorghum should not be planted in fields infested with Johnsongrass or shattercane.

Soybean

Both species are suppressed with pendimethalin (Prowl) or trifluralin (Treflan) if incorporated prior to planting, but they will not provide full-season control and will need to be treated with a postemergence herbicide application. Group 1

herbicides (clethodim [Select], fluazifop [Fusilade], quizalofop [Assure II], sethoxydim [Poast]) and glyphosate will provide excellent control of shattercane and Johnsongrass emerging from weeds, and good control of rhizome Johnsongrass. Sequential applications may be needed for control of rhizome Johnsongrass.

Small Grains

These species are sensitive to frost and emerge in late spring; therefore, they are not problem weeds in small grains.

Perennial Forages

For grass hay crops, there are no postemergence herbicides to control either species. Pendimethalin (Prowl H2O) applied prior to seedling emergence will suppress shattercane and seedling Johnsongrass, but not rhizome Johnsongrass. In alfalfa, Group 1 herbicides and glyphosate will provide excellent control of shattercane and Johnsongrass emerging from weeds, and good control of rhizome Johnsongrass. Sequential applications may be needed for control of rhizome Johnsongrass.

Fallow or Spot Treatment

Glyphosate applied in the fall will provide an opportunity to control Johnsongrass rhizomes.

Lambsquarters (Common)

Scientific name: *Chenopodium album* L.
Other names: goosefoot, fat-hen

Originally from Europe and Asia, common lambsquarters is a summer annual known worldwide as of one of the most important weeds in agriculture. Common lambsquarters is a member of the goosefoot family, which also includes the crops spinach and beets as well as several weedy *Chenopodium* species, including oakleaf goosefoot (*C. glaucum* L.), late flowering goosefoot (*C. strictum*), and narrow-leaved goosefoot (*C. pratericola*). A related genus, *Atriplex*, contains at least three species found in the north central and northeastern United States that can be confused with common lambsquarters, including spreading orach (*Atriplex patula* L.).

Common lambsquarters generally begins emergence in early spring but can emerge throughout the summer, with peak emergence in mid- to late spring. As seedlings, common lambsquarters has two long, linear-shaped cotyledons, with the first ovate-shaped true leaves appearing opposite in arrangement. True leaves eventually become alternate and may be purplish on the underside with both surfaces covered with white granules or a mealy substance. This granular substance is responsible for part of its scientific name—album is Latin for white. More mature plants have broadly triangle-shaped leaves that are alternate with irregular, shallow-toothed margins. The stems can be green or reddish, are grooved, and can be smooth or hairless. Mature plants generally reach a height of 2 to 6 feet. At flowering, very small, green or gray-green flowers are tightly clustered at the tips of stems and branches, which turn into seeds with a thin, papery covering. An average-sized common lambsquarters plant can produce more than 70,000 seeds in a single season. Many of the seeds remain on the plant until early winter and these small, smooth seeds have no other apparent adaptation for dispersal other than their high density and ability to be spread from site to site by various means, including equipment transfer. The seeds can also survive well in the digestive tracts of cows, sheep, and horses, so manure is considered a possible source for introducing seed.

Seed dormancy in common lambsquarters contributes to its success as a weed. Under certain conditions, seeds can remain viable in the soil for a number of years and a portion of these seeds will only germinate when conditions are right. Some research suggests that only 10 to 30 percent of the current season's seed will germinate under favorable conditions the following season.

Herbicide Resistance

Herbicide resistance in common lambsquarters was identified as early as the 1970s with the discovery of triazine (Group 5) resistance. Triazine resistance in common lambsquarters is almost universal in regions of the Mid-Atlantic, especially on dairy farms where corn is often grown for multiple years in the same field allowing annual application of triazine herbicides. More recently, common lambsquarters populations resistant to ALS inhibitors (Group 2) were identified in Michigan, Ohio, and Ontario. For many years, producers in several states have reported problems controlling common lambsquarters with postemergence glyphosate applications (Group 9). Common lambsquarters has become more prevalent in glyphosate-resistant soybean fields in the Midwest and Northeast, and anecdotal observations in several states suggest that common lambsquarters populations are not being controlled effectively with glyphosate in glyphosate-resistant soybean. Historically, common lambsquarters has been problematic for several POST-applied herbicides, and environmental conditions before, during, and after foliar application can influence performance. In addition, weed size at application also affects the response of common lambsquarters to glyphosate and other herbicides.

Management

Historically, common lambsquarters has been a successful weed across tillage systems, being equally problematic in plowed and no-till fields. Cultural practices that help control common lambsquarters include anything that makes the crop more competitive and reduces the success of the weed. Such practices include selecting crops with quick emergence, altering planting dates relative to weed emergence, planting to narrow rows and using higher seeding rates for greater crop competition, placing fertilizer with the crop (not the weed),

and implementing crop rotations that discourage summer annual weed success. In particular, late seeding can give some control because common lambsquarters tends to germinate early in the season and those seedlings are killed through soil preparation or with a burndown herbicide. Rotations that include a winter grain or perennial forage can help break summer annual weed life cycles. In addition, because seeds of common lambsquarters persist in the soil, removing escapes before seed set is useful for long-term management. Consider using tillage, mowing, or an effective herbicide application after cereal grain harvest to prevent seed production.

Corn

A number of PRE and POST herbicides can control common lambsquarters in corn effectively. In general, the chloroacetamides (Group 15) generally need to be tank-mixed with another effective PRE herbicide or followed with a POST herbicide application for complete control The principal PRE corn herbicides include flumetsulam (Python), isoxaflutole (Balance), mesotrione-chloroacetamide mixes (Acuron, Lumax/Lexar), pendimethalin (Prowl), and rimsulfuron (Resolve). Since triazine resistance is so prevalent, it is unlikely that atrazine or simazine will contribute much to control. Many POST corn herbicides are effective for common lambsquarters control in corn, but the plants should be less than 6 inches tall at the time of application for best results. Herbicides include 2,4-D, bromoxynil (Buctril), dicamba (Banvel/Clarity), glyphosate, glufosinate (Liberty), thifensulfuron (Harmony), and the Group 27 herbicides mesotrione (Callisto), tembotrione (Laudis), and topramezone (Armezon/Impact).

Sorghum

Management of common lambsquarters in sorghum is similar to that for corn, although with fewer herbicide options. Safened seed (Concept treated) allows for the use of Group 15 herbicides, including certain acetochlor formulations and mesotrione-chloroacetamide (Lumax, Lexar) premixes. POST herbicide options are fewer, with the Group 4 herbicides, bromoxynil, and several others being available.

Soybean

In soybean, using PRE herbicides or combining a PRE herbicide followed by a POST herbicide provides the most consistent control. Avoid total POST herbicide programs for common lambsquarters control in soybean. PRE herbicides include chlorimuron-containing products (Canopy, Valor XLT, etc.), clomazone (Command), cloransulam (FirstRate), flumioxazin (Valor), imazethapyr (Pursuit), pendimethalin (Prowl), and sulfentrazone (Authority). Apply soybean herbicides with POST activity to small common lambsquarters plants less than about 4 weeks old. POST herbicides include glyphosate, the Group 2 herbicides thifensulfuron (Harmony) and imazamox (Raptor). Thifensulfuron and imazamox must be applied to small lambsquarters 4 inches tall or less. When plants are less than 6 inches tall, apply glyphosate at a rate of 0.75 to 1.5 pounds acid equivalent per acre.

Small Grains

Common lambsquarters is less of a problem in winter small grains but can be a threat in spring-seeded cereals. In oats, thifensulfuron (Harmony) and the Group 4 herbicides are most effective, with 2,4-D or MCPA being most commonly used.

Perennial Forages

Perennial forages are an excellent crop for managing common lambsquarters. In particular, established alfalfa that can be mowed four or more times per season will suppress lambsquarters seedlings, and it is rarely a problem in this crop. Establish a new seeding in late summer to avoid lambsquarters problems at establishment. In new seedings, the use of the Group 4 growth regular 2,4-DB or Group 6 bromoxynil (Buctril) can be effective on seedling lambquarters plants. Common lambsquarters is rarely a problem in perennial grass hay or pasture.

Fallow or Spot Treatment

Spot spray with glyphosate, paraquat, glufosinate, or use a Group 4 growth regulator herbicide.

Milkweed (Common) and Hemp Dogbane

Common Milkweed

Scientific name: *Asclepias syriaca*
Other names: butterfly flower, silk flower

Hemp Dogbane

Scientific name: *Apocynum cannabinum*
Other names: Indian hemp, wild cotton

Common milkweed and hemp dogbane are persistent perennial broadleaf weeds in row crops, pastures, or hay fields. They can reproduce by seed, crown buds, rootstocks, or rhizomes capable of overwintering, thus making it difficult to control them once they are established. Seeds, contained by dehiscent pods, are attached to tufts of silky fibers, which aids in wind dispersal. The waxy cuticle found on the leaf surface affects the uptake of systemic herbicides. Both common milkweed and hemp dogbane are native to North America and considered to have certain beneficial attributes, such as habitat for monarch butterflies (milkweed) and a source of fiber (hemp dogbane).

Herbicide Resistance

None reported.

Management

The seedlings of common milkweed and hemp dogbane germinate initially from seeds, but once the plants are established, they can emerge from adventitious buds on creeping roots or rhizomes. Seedlings may be selectively controlled by certain PRE herbicides, but infestations in crops typically arise from regrowth of established vegetative propagules beneath the soil, which have been reported to form within a month after seedling emergence. Mechanical control by repeated removal of top growth is possible where cultural practices allow; however, tillage is not a viable option due to fragmentation and resultant multiplication of vegetative propagules. Therefore, effective control is limited to applying selective or non-selective systemic herbicides. In general, late bud stage or early bloom stage is a good window to apply such herbicides as long as the label of the respective herbicide allows such an application timing in the particular crop. When possible, glyphosate may be spot applied between crops to manage these weeds. Adding a surfactant and liquid nitrogen or AMS can improve weed control.

Corn

The use of glyphosate in Roundup Ready corn is perhaps the most effective approach for control of milkweed and hemp dogbane in this crop. Glufosinate (Liberty) can suppress these weeds in LibertyLink crops. Selective broadleaf herbicides such as fluroxypyr (Starane) and dicamba (Banvel, Clarity) are somewhat effective in conventional corn. Tank mixtures such as diflufenzopyr plus dicamba (Distinct), primisulfuron (Beacon) plus 2,4-D or dicamba, and nicosulfuron (Accent) plus dicamba can also provide fair control of these weeds.

Sorghum

Herbicides such as dicamba and 2,4-D may provide fair selective control of milkweed and hemp dogbane. Herbicides such as fluroxypyr (Starane Ultra) and halosulfuron plus dicamba (Yukon) may also provide selective control of these weeds in sorghum.

Soybean

Chemical control is limited to the use of glyphosate in Roundup Ready hybrids since there are no selective herbicides to control this weed. Using a weed wiper to apply glyphosate by taking advantage of the height difference between the crop canopy and the weed is also an effective strategy to control this weed in conventional soybean.

Small Grains

Selective herbicides such as fluroxypyr (Starane), dicamba (Banvel/Clarity), and 2,4-D may control these weeds if applied at the proper stage. Otherwise, application of glyphosate or dicamba as a harvest aid or during the same fallow season may provide better control of milkweed and hemp dogbane.

Perennial Forages

In alfalfa, the use of glyphosate in a Roundup Ready variety is perhaps the most effective approach to control milkweed and hemp dogbane. Selective herbicides labeled for alfalfa do not provide satisfactory control of established plants.

In pasture and hay fields, the herbicides picloram plus fluroxypyr (Surmount) and fluroxypyr plus triclopyr (Pasture-Gard) can provide selective control of these weeds; however, sequential applications may be necessary for successful control. Sequential applications of 2,4-D plus dicamba may also provide fair control of these weeds. A weed wiper may also be used to control these weeds in forage crops. In forages, hemp dogbane is considered toxic to animals in both the fresh and dry forms.

Mustard and Radish (Wild)

Scientific names: *Sinapis arvensis* (wild mustard) and *Raphanus raphanisturm* (wild radish)
Other names (wild radish): jointed charlock, jointed radish, jointed wild radish

Both members of the Brassicaceae (mustard) family, wild mustard and wild radish are ubiquitous in the United States and the Mid-Atlantic region. Both are well-known winter annuals; however, wild mustard and wild radish are also capable of spring emergence. Typically, both species emerge during the fall and overwinter in the rosette stage. The following spring, stem regions between the leaves will begin to lengthen and a flower stalk will form at the top (a process known as bolting). Both species have a stout taproot, can reach 3 feet in height, and are capable of producing 800 to 1,200 seeds per plant. It can be difficult to distinguish between wild mustard and wild radish. Leaves of wild radish are much more deeply lobed (often reaching nearly back to the midvein) than those of wild mustard. Flowers of wild mustard are bright yellow. Comparatively, flowers of wild radish are a paler yellow and can become white with age. Wild mustard has straight, jointless seed pods, whereas seed pods of wild radish are jointed (constricted between seeds at maturity) and appear ribbed.

Herbicide Resistance

Regionally, herbicide-resistant biotypes of wild mustard and wild radish do not exist. In North Dakota, wild mustard has developed resistance to ALS-inhibiting (Group 2) herbicides. Herbicide-resistant wild radish has not been observed in the United States. Globally, biotypes of wild mustard and wild radish resistant to Group 2, synthetic auxins (Group 4), and triazine (Group 5) herbicides and Group 2, Group 4, Group 5, glyphosate (Group 9), and carotenoid biosynthesis-inhibiting (Group 12) herbicides exist, respectively.

Management

Wild mustard and wild radish are more prevalent in no-till systems. Although tillage can control wild mustard and wild radish effectively, it can also stimulate seed germination. Wild mustard and wild radish can be difficult to control with herbicides. This is often attributed to plant size at the time of herbicide application. Many herbicides that control small (< 6 inches) wild mustard and wild radish are ineffective once these species begin to bolt. In a no-till system, timing burndown applications prior to bolting of wild mustard and wild radish is the key to successful control of both species. For preplant burndown applications in the Mid-Atlantic region, targeting wild mustard and wild radish in March or early April with 2,4-D is normally in order. Likewise, for winter small grains, wild mustard and wild radish treated in the fall are easier to control than plants treated during the spring.

Corn

Wild mustard and wild radish should be targeted prior to planting corn. Preplant burndown, 2,4-D is the most effective herbicide against small and more mature wild mustard and wild radish. Glyphosate or paraquat plus 2,4-D is a popular choice for both species. Dicamba is less effective than 2,4-D. For small wild mustard or wild radish preplant, thifensulfuron plus tribenuron [Harmony Extra] plus glyphosate or paraquat, saflufenacil [Sharpen] plus glyphosate, atrazine plus paraquat, and flumioxazin [Valor SX] plus glyphosate are effective. Consult labels for information regarding rotation restrictions. Postemergence in corn, 2,4-D and dicamba are most effective.

Sorghum

Wild mustard and wild radish should be targeted prior to planting sorghum. Similar to corn, 2,4-D and dicamba are the most effective preplant and postemergence options. Dicamba is not as effective as 2,4-D. Preplant burndown, glyphosate plus saflufenacil [Sharpen] and paraquat plus atrazine are effective against small wild mustard and wild radish. Consult labels for information regarding rotation restrictions.

Soybean

Wild mustard and wild radish should be targeted prior to planting soybean. Preplant burndown, 2,4-D is most effective followed by dicamba. Glyphosate or paraquat should be applied in combination with 2,4-D or dicamba to improve control. For small wild mustard or wild radish preplant burndown, tribenuron-containing products plus glyphosate or paraquat, rimsulfuron plus thifensulfuron (LeadOff) plus glyphosate or paraquat, saflufenacil (Sharpen) plus glyphosate, metribuzin plus paraquat, and flumioxazin (Valor SX) plus glyphosate are effective. Consult herbicide labels for information regarding rotation restrictions. Large wild mustard and wild radish are difficult to control postemergence in soybean. For very small (< 3 inches) wild mustard or wild radish postemergence, many of the Group 2 and PPO-inhibiting (Group 14) herbicides, bentazon (Basagran), and glufosinate (Liberty) (for LibertyLink cultivars only) provide suppression.

Small Grains

Wild mustard and wild radish should be targeted while still small during the fall. 2,4-D and MCPA control both species effectively. Dicamba is not as effective as 2,4-D or MCPA. For small wild mustard and wild radish, thifensulfuron plus tribenuron (Harmony Extra) and pyroxsulam (PowerFlex HL) offer good control and are the best alternatives to Group 4 herbicides (2,4-D, dicamba, and MCPA).

Perennial Forages

For grass hay crops, most Group 4 herbicides and metsulfuron control both species effectively. For legume forages, 2,4-DB is effective against small wild mustard and wild radish.

Fallow or Spot Treatment

2,4-D and dicamba (less effective than 2,4-D) plus glyphosate or paraquat will provide good control of wild mustard and wild radish that have yet to bolt.

Pokeweed (Common)

Scientific name: *Phytolacca americana*
Other names: pokeberry, inkberry, poke

Common pokeweed is a herbaceous simple (not creeping) perennial weed that has become a problem in agronomic crops in the Mid-Atlantic region, especially in no-till. It is native to North America and can be found in most of the 50 states as well as Canada, Mexico, and Europe. Common pokeweed will grow in wooded areas and along ponds, ditches, roads and fencerows; but more recently it has invaded Northeast farm fields and continues to spread. Traditionally, plowing was used to keep common pokeweed at bay. However, the widespread adoption of no-till along with a decline in the use of soil residual herbicides, especially in soybean, has likely allowed pokeweed populations to explode in some areas. Birds are believed to be the main mechanism of seed dispersal and seedling plants are often observed under trees or power lines where birds roost. An often cited piece of information is that the seeds can remain viable for at least 40 years. The leaves, roots, and stems of pokeweed are poisonous to humans and livestock, although young pokeweed is edible if cooked. The toxin, called phytolaccatoxin, causes damage to the digestive, nervous, and respiratory systems and can result in death.

Herbicide Resistance

None reported.

Management

Common pokeweed is difficult to manage due to the large, persistent taproot and abundant seed production. Pokeweed is less of a problem in tilled systems. In addition, increasing the diversity of the crop rotation to include crops such as winter small grains and perennial forages will provide cultural and mechanical control options not available in corn and soybean.

Corn

Perennial pokeweed plants are difficult to control in corn, mostly due to limitations in herbicide application timing. POST or foliar herbicides are essential, as soil-applied herbicides are not effective on perennial plants. However, soil-applied residual herbicides can be important for seedling pokeweed control. Unfortunately, POST herbicides in corn are generally applied before pokeweed is most susceptible to control. Potentially effective herbicides in corn include the Group 4 growth regulator herbicides and Group 9 glyphosate. Some Group 2 or ALS inhibitors can potentially increase performance, but they must be tank-mixed with a Group 2 or 9 herbicide. In addition, the Group 27 herbicide mesotrione has fair pokeweed activity when applied POST and can help provide control, particularly when tank-mixed with atrazine. Glyphosate is good for control of pokeweed depending on application timing. With the concern for glyphosate-resistant weeds and overreliance on glyphosate in much of the corn and soybean growing areas of the Northeast, our suggestion is to preserve glyphosate for soybean where other effective alternatives for pokeweed control do not currently exist, and use alternative effective modes of action in corn.

Sorghum

Management of pokeweed in sorghum should be similar to corn and relies on POST systemic herbicides. Some of the same herbicides, except glyphosate, can be used in sorghum.

Soybean

The only effective soybean herbicide for control of common pokeweed is POST-applied glyphosate. Penn State tested a number of active ingredients primarily in the Group 2 or ALS inhibitor class along with some others, including glyphosate. Nothing other than glyphosate provided better than 60 percent control. Glyphosate application timing had the largest effect on pokeweed control, while nozzle selection, spray volume, and application rate were less important (full rates are still necessary). Application too early in the season is not effective. In Pennsylvania, glyphosate application after mid-June provided at least 90 percent control of pokeweed. This is possibly due to increased glyphosate translocation when pokeweed was flowering and starting produce fruit.

Small Grains

Pokeweed is only an issue in spring-seeded small grains and generally not winter grains, so it could be problematic in oats or other spring-seeded cereals. Some suppression can be obtained from the Group 4 or growth regulator herbicides, but these will generally need to be applied too early, before pokeweed is susceptible. Spring small grains are a good crop to manage pokeweed.

Perennial Forages

Perennial forages are an excellent crop for managing common pokeweed. In particular, established alfalfa that can be mowed four or more times per season will suppress pokeweed, and it is rarely a problem in these crops. Establish alfalfa in late summer to avoid pokeweed problems at establishment. In addition, a number of effective herbicides can be used to control pokeweed in perennial grass hay or pasture.

Fallow or Spot Treatment

Spot spray with glyphosate or use a Group 4 growth regulator herbicide for effective control. For best results, apply herbicides from bud to bloom and before fruit set.

Ragweed (Common)

Scientific name: *Ambrosia artemisiifolia*
Other names: hay-fever weed, bitterweed, annual ragweed
Common ragweed is a native summer annual weed that is found throughout North America and quite common in parts of the Mid-Atlantic region. It generally is one of the first emerging species in spring with club-shaped cotyledons and opposite leaves that are compound with multiple lobes. Plants generally grow 3 to 6 feet in height and flower in late summer. Common ragweed produces male and female flowers in separate heads on the same plant. The males produce and release pollen in late summer, and it is reported that plants can produce in excess of 1 billon pollen grains per plant. Common ragweed pollen is very well known for being a key allergen during the fall of the year.

Common ragweed is generally considered a weed of tilled systems; it is less common in no-till because of its larger seed size. If is also often considered more problematic in soybean than in other crops, mostly because of the lack of effective herbicides.

Herbicide Resistance

Herbicide resistance to glyphosate and the Group 2 herbicides (ALS inhibitors) is common in some populations but more prevalent in the states of Ohio and Indiana. Group 5 or triazine herbicide resistance or tolerance has been suspected for many years in parts of the Northeast, but conformational tests have been inconclusive. Finally, PPO or Group 14 resistance has been documented in Delaware.

Management

Common ragweed's early spring emergence characteristic can make it more difficult in some crops or easier to manage in others by altering cash crop planting date. It is a particular problem for early planted spring crops such as oats, while delaying planting will allow some control measures prior to crop establishment. No-till management will also reduce the potential success of this weed.

Corn

In corn, atrazine and simazine have traditionally been effective soil-applied herbicides, but as mentioned, herbicide tolerance has reduced their success and required higher application rates in order to achieve effective control. Other soil-applied corn herbicides that have good activity on common ragweed include isoxaflutole (Balance) and clopyralid (Hornet and SureStart). A number of soil-applied corn herbicides have fair activity on common ragweed. A number of POST products are also effective on common ragweed and include the Group 4 or growth regulator herbicides as well as atrazine and the Group 2 herbicide halosulfuron (Permit or Yukon). In general, most Group 2 corn herbicides are not very effective. Glyphosate is an effective POST herbicide for control of common ragweed, assuming they are not resistant, and Liberty or glufosinate can also be effective.

Sorghum

Management of common ragweed in sorghum is similar to corn relying on atrazine and the POST herbicides. Some of the same herbicides, except glyphosate, can be used in sorghum.

Soybean

Ragweed control in soybean is more challenging, particularly for full-season soybean. The most effective soil-applied herbicide is the Group 2 herbicide cloransulam, which is an active ingredient in FirstRate, Authority First/Sonic, Gangster, and others. Chlorimuron-containing herbicides will provide suppression but generally require additional control measures. ALS-resistant biotypes will survive these Group 2 herbicides. POST herbicides are the most effective approach to controlling common ragweed in soybean. Again, cloransulam and glyphosate are effective, assuming it is not ALS or glyphosate resistant. Alternative POST herbicides include the Group 14 products such as lactofen (Cobra), fomesafen (Reflex), or acifluorfen (Ultra Blazer). Liberty or glufosinate can also be used in LibertyLink soybean.

Small Grains

Common ragweed is less of a problem in winter small grains but can be a severe threat in spring-seeded cereals. In oats, the Group 4 herbicides are most effective, with 2,4-D or MCPA being most commonly used.

Perennial Forages

Perennial forages are excellent crops for managing common ragweed. In particular, established alfalfa that can be mowed four or more times per season will suppress ragweed seedlings, and it is rarely a problem in these crops. Establish alfalfa in late summer to avoid ragweed problems at establishment. In new seedings, the use of the Group 4 growth regular 2,4-DB can be effective on young ragweed plants. Ragweed is rarely a problem in perennial grass hay or pasture.

Fallow or Spot Treatment

Spot spray with glyphosate or paraquat, or use a Group 4 growth regulator herbicide.

Ragweed (Giant)

Scientific name: *Ambrosia trifida*
Other names: great ragweed, tall ragweed, horseweed, others
Giant ragweed is the bigger cousin to common ragweed and tends to be less widespread in the Mid-Atlantic. It is also a North American native summer annual that is a particular weed problem in the states of Ohio, Indiana, and parts of Illinois. Giant ragweed can attain heights up to 10 feet tall and flowers in late summer. Like common, giant ragweed also produces male and female flowers in separate heads on the same plant, and giant ragweed pollen can also be a potent allergen during the fall of the year. There are at least two distinct giant ragweed biotypes based on emergence timing and preference for soil disturbance. In much of the Northeast, giant ragweed emerges in late March to late April and is a common plant growing along the margins of fields or in hedge rows, but it is seldom a weed of field crops. In parts of the eastern Corn Belt, the biotype has prolonged seedling emergence and is often found in tilled fields. Like common ragweed, this aggressive biotype is also considered a weed of tilled systems and is less common in no-till because of its large seed size. This Ohio-Indiana biotype is a very competitive weed in field crops and often the key driver for the need for weed management.

Herbicide Resistance

Thirteen states have reported infestations of herbicide-resistant biotypes. Resistance has developed to ALS-inhibiting herbicides (Group 2) and glyphosate (Group 9). As with common ragweed, these resistant biotypes are more prevalent in Ohio and Indiana as well as Ontario, Canada. Currently, no herbicide-resistant biotypes have been reported in the Mid-Atlantic region.

Management

Like common ragweed, giant ragweed's early spring emergence characteristic can make it more difficult in some crops or easier to manage in others by altering cash crop planting date. Again, it is a particular problem for early planted spring

crops such as oats, while delaying planting will allow some control measures prior to crop establishment. The biotype that has prolonged germination is not easily managed with altered planting date. No-till management will also reduce the potential success of this weed.

Corn

In corn, atrazine and simazine have traditionally been effective soil-applied herbicides, but relatively high rates (more than 1.5 pounds per acre) are required to achieve effective control. Other soil-applied corn herbicides that have activity on giant ragweed include isoxaflutole (Balance), clopyralid (Hornet and SureStart), and mesotrione (Lumax/Lexar). A number of POST products are also effective on common ragweed and include the Group 4 or growth regulator herbicides, atrazine, and several Group 2 herbicides. Glyphosate is an effective POST herbicide for control of giant ragweed, assuming it is not resistant, and Liberty or glufosinate can also be effective.

Sorghum

Management of common ragweed in sorghum is similar to corn and relies on atrazine and the POST herbicides. Some of the same herbicides, except glyphosate, can be used in sorghum.

Soybean

Giant ragweed control in soybean is more challenging, particularly for full-season soybean. The most effective soil-applied herbicide is the Group 2 herbicide cloransulam, which is an active ingredient in FirstRate, Authority First/Sonic, Gangster, and others. Chlorimuron-containing herbicides will provide suppression but generally require additional control measures. None of these soil-applied herbicides provide season-long control, and ALS-resistant biotypes will survive these Group 2 herbicides. POST herbicides are the more effective approach to controlling giant ragweed in soybean. Again, cloransulam and glyphosate are effective, assuming the ragweed is not ALS or glyphosate resistant. Chlorimuron (Classic) can also provide some suppression. Alternative POST herbicides include the Group 14 products such as lactofen (Cobra), fomesafen (Reflex), or acifluorfen (Ultra Blazer). Liberty or glufosinate can also be used in LibertyLink soybean.

Small Grains

Giant ragweed is less of a problem in winter small grains but can be a severe threat in spring-seeded cereals. In oats, the Group 4 herbicides are most effective, with 2,4-D or MCPA being most commonly used.

Perennial Forages

Perennial forages are an excellent crop for managing giant ragweed. In particular, established alfalfa that can be mowed four or more times per season will suppress ragweed seedlings, and it is rarely a problem in these crops. Establish alfalfa in late summer to avoid ragweed problems at establishment. In new seedings, the use of the Group 4 growth regulator 2,4-DB can be effective on young ragweed plants. Ragweed is rarely a problem in perennial grass hay or pasture.

Fallow or Spot Treatment

Spot spray with glyphosate or paraquat, or use a Group 4 growth regulator herbicide.

Ryegrass (Annual)

Scientific name: *Lolium multiflorum*
Other names: Italian ryegrass, common ryegrass
Annual ryegrass, also known as Italian ryegrass, is a tufted winter annual or biennial bunchgrass growing 12 to 36 inches tall. Leaf blades are shiny light green, 2.5 to 8 inches in length, and rolled in the bud. The presence of conspicuous auricles (small clawlike appendages) and a lack of hairs around the leaf collar region help to distinguish this species from other grasses. Erect stems of this species will often exhibit a purple coloration at the base.

This weed is primarily a problem in fall-seeded crops such as winter wheat as well as grass seed crops, but it can also present problems to summer crop establishment if not properly managed.

Herbicide Resistance

In the southern and Mid-Atlantic regions of the United States, annual ryegrass has been confirmed to be resistant to ACCase-inhibiting herbicides (Group 1), ALS-inhibiting herbicides (Group 2), or have multiple resistance to both modes of action. In addition, populations with glyphosate resistance have been reported in the southern United States.

Management

Prevention is a key step in ryegrass management. This can be accomplished by ensuring that equipment, feed, and crop seed are free of ryegrass contaminants; managing ryegrass populations on field edges and in ditch banks; and preventing ryegrass plants from producing seeds. This requires burndown applications before ryegrass stems begin to elongate, which maybe earlier than most burndown applications are made.

Corn

Controlling annual ryegrass in the spring prior to planting corn or soybean is challenging due to vigorous growth resulting in larger plants the presence of herbicide-resistant biotypes, and potential antagonism when glyphosate is tank-mixed with other herbicides. Tillage or preplant burndown using glyphosate-based products will control emerged rye-

grass prior to spring planting. Glyphosate plus rimsulfuron products (e.g., Basis) may improve control of populations susceptible to Group 2 herbicides. Applications of Bicep II Magnum, Lexar, or Lumax plus glyphosate may antagonize glyphosate control of ryegrass. Postmergence applications of glyphosate or nicosulfuron can further suppress susceptible populations.

Note: Growers should be cautious of using annual ryegrass blends as a cover crop due to the possibility of herbicide-resistant seed in the mix.

Sorghum

Tillage and/or glyphosate will provide an effective preplant burndown control. The addition of atrazine to the tank may antagonize the effectiveness of glyphosate. There are no highly effective herbicides to control annual ryegrass after sorghum emergence.

Soybean

Tillage and/or residual herbicides such as Boundary, Dual, Treflan, and Zidua may be applied from mid-October to mid-November and can provide residual control of ryegrass. Glyphosate or Gramoxone with surfactant can be used to control emerged ryegrass in the fall. For susceptible populations, Group 1 products such as Select with crop oil and ammonium sulfate will provide control when applied as a preplant burndown, provided ryegrass is less than 6 inches tall. Glyphosate is the preferred treatment for spring burndown of susceptible populations.

Note: Growers should be cautious of using annual ryegrass blends as a cover crop due to the possibility of herbicide-resistant seed in the mix.

Small Grains

Chemical control of annual ryegrass in small grains has often relied on Group 2 herbicides, such as Osprey and PowerFlex, or Group 1 herbicides, such as Axial and Hoelon, applied when the majority of ryegrass plants have emerged. However, larger ryegrass plants are more difficult to control, and with resistance to these two herbicide groups reported in the Mid-Atlantic, more emphasis has been placed on fall applications of soil-applied herbicides such as Dual, Tricor, Valor, and Zidua. Early postemergence applications of Axiom, Anthem, or Zidua will provide good residual ryegrass control but will not control emerged ryegrass plants. Applications of Valor may also be made 7 days prior to planting wheat. POST applications of Group 2 herbicides, such as Osprey or PowerFlex, or the Group 1 herbicide Axial XL will control susceptible ryegrass populations.

Perennial Forages

Glyphosate-based products may be applied as spot treatments or as a broadcast application over dormant forage grasses. Wait 60 days after glyphosate application before the pasture is mowed or grazed. Gramoxone may also be applied as spot treatments or as a broadcast application over dormant forage grasses. Ryegrass that has tillered or entered a period of rapid growth is not sensitive to Gramoxone. Applications should be made when temperatures reach above 50°F using a high rate with a non-ionic surfactant at 0.125 to 0.25 percent v/v. Wait 40 days after Gramoxone application before the pasture is mowed or grazed.

Thistle (Canada)

Scientific name: *Cirsium arvense*
Other names: creeping thistle

Canada thistle is an upright perennial that is 24 to 59 inches tall. Plants are often found in patches due to an extensive rhizome system that extends up to 3.5 feet into the soil. Shoots begin to emerge in early May and plants start bolting 3 to 4 weeks later. Cotyledons are dull green, thick, and club shaped. Young leaves are covered with short hairs and leaf margins are wavy with spines. Stems are grooved, branching at the top, and become pubescent at maturity. Flowering occurs from mid-June to early July. A single plant produces an average of 1,500 wind-dispersed seeds. Although the majority of seeds germinate the following year, buried seed may remain viable for up to 20 years. Plants will also regenerate from root fragments as small as 1 inch. The lack of spines on flowers and stems helps distinguish this species from bull and musk thistles.

Herbicide Resistance

No herbicide resistance has been reported for Canada thistle in the United States; however, resistance to 2,4-D and MCPA has been reported in Europe.

Management

Canada thistle is a major problem in pastures and rangeland, but it is also a problem in row crops. The key to its control is to exhaust the root system's energy reserves. Successive mowing every 3 weeks can help deplete root reserves, and mowing should occur before seed set. Sheep, cattle, and goats will graze on young, tender plants, but they tend to avoid dense patches of older plants. Canada thistle shoots require high light levels to survive. Cover crops such as alfalfa and hairy vetch can provide a competitive edge over emerging plants. Planting crops in narrow rows can also exclude the amount of light reaching the soil surface. Canada thistle completes its life cycle in crops such a corn and soybean, and rotating with winter wheat can aid in control. Glyphosate may be applied as a burndown treatment to control emerged weeds in row crops. There are no preemergence herbicide programs that will provide adequate season-long control. Complete control of established populations of Canada thistle often require multiple applications within a single season for several seasons.

Corn

Stinger, Hornet/Stanza, Callisto, and glyphosate-containing products will provide effective postemergence control. Multiple or split applications may be required to control underground root systems.

Sorghum

Suppression of Canada thistle may be achieved with Basagran, Basagran plus atrazine, dicamba, Marksman, Peak plus dicamba, and Yukon. Spot treatments of 2,4-D, dicamba, glyphosate, or Stinger are an option for small, localized patches of Canada thistle. Always follow label instructions when using dicamba around sensitive crop species.

Soybean

Glyphosate-containing products are effective postemergence options, but multiple applications may be necessary for complete control. Basagran can help to remove aboveground vegetation, but a second application 7 to 10 days later may be necessary to kill the remainder of the top growth. Always use a crop oil with Basagran on soybean.

Small Grains

Earlier plantings can help establish a dense crop canopy to suppress growth. Spring applications of Harmony Extra plus surfactant can be effective in the spring when plants are 4 to 8 inches tall with 4 to 6 inches of new growth. Control can be improved with the addition of 2,4-D ester. 2,4-D application in small grains should be made between the tillering and jointing stages. Glyphosate may also be used as a preharvest treatment once small grains have reached the hard dough stage. A 7-day preharvest interval should be observed when using glyphosate.

Perennial Forages

The standard approach of 2,4-D and dicamba has been shown to be ineffective against established stands. Milestone will provide control of thistles and legumes while not harming established grasses. These products should not be used where desirable trees are present. Spot treatments of glyphosate-containing products will also provide control. Since Canada thistle is not tolerant of shade, proper maintenance of forage species will provide suppression.

Fallow or Spot Treatment

Spot treatments may be made using 2,4-D, Crossbow, glyphosate, metsulfuron, or Stinger. 2,4-D, Crossbow, and Stinger can volatize and drift, causing harm to sensitive crops. Always consult label instructions for proper application procedures.

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