
Controlling Weeds

in Nursery and Landscape Plantings



PENNSTATE



College of Agricultural Sciences
Agricultural Research and Cooperative Extension



Weeds are a year-round problem. This common groundsel plant was found blooming in January in central Pennsylvania.

To the user of this publication:

This information is current and the recommended herbicides are approved for their labeled uses **as of April 1, 2003**. Because pesticide use registrations may change at any time, be sure to read the label very carefully to determine the exact registration status of each product you use. Product registrations may change because of additions or deletions to the label, the product may be reclassified for restricted use, or the U.S. Environmental Protection Agency may cancel or suspend products suspected of being health or environmental hazards. As a pesticide user, you have an obligation to use these chemicals safely and responsibly.

Herbicide cross-reference. Some herbicides are available under more than one trade name. To make the use of this publication as simple as possible, all of the herbicides labeled for use in ornamentals are cross-listed by their most commonly available trade names. The list of chemical names can be used to make comparisons with products marketed to homeowners, which may have many different formulations and trade names for the same product.

Cover: The ultimate in vegetation management in a shade tree nursery. Weeds are totally controlled in the rows with herbicides, and a low-maintenance grass cover crop is grown between the rows to support equipment and prevent erosion.

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COMMON NAME	TRADE NAME	PAGE
Atrazine	Aatrex	14
Bensulide	Betasan, Lescosan, Bensumec 4	14
Bentazon	Basagran T/O	21
Clethodim	Envoy	22
Clopyralid	Lontrel	23
Dazomet	Basamid	25
Dichlobenil	Casoron, Norosac, Dyclomec, Barrier	14
Diquat	Reward	23
Dithiopyr	Dimension	15
Fenoxaprop-p-ethyl	Acclaim Extra	21
Fluazifop-p-butyl	Fusilade, Fusilade II Ornamec	22
Glufosinate	Finale	22
Glyphosate	Roundup Pro/Ultra, Glyphos, Rodeo Touchdown, many others	23
Halosulfuron	Manage	23
Imazaquin	Image	16
Isoxaben	Gallery	15
Isoxaben + trifluralin	Snapshot	19
Metham	Vapam, Sectagon	26
Methyl bromide + chloropicrin	Brom-O-Gas, Terr-O-Gas	25
Metolachlor	Pennant Magnum	17
Napropamide	Devrinol, Hurdle	15
Norflurazon	Predict	17
Oryzalin	Surflan	19
Oryzalin + benefin	XL	20
Oxadiazon	Ronstar	18
Oxadiazon + prodiamine	RegalStar G	18
Oxyfluorfen	Goal 2XL	15
Oxyfluorfen + oryzalin	Rout	18
Oxyfluorfen + oxadiazon	Regal 0-0	18
Oxyfluorfen + pendimethalin	OH2	16
Pelargonic acid	Scythe	24
Pendimethalin	Pendulum, Corral	17
Prodiamine	Barricade, Endurance, RegalKade G	14
Pronamide	Kerb	16
Sethoxydim	Vantage	24
Simazine	Princep, Simtrol, Simazine	17
Triclopyr	Garlon	22
Trifluralin	Treflan	19

TRADE NAME	COMMON NAME	PAGE
Aatrex	Atrazine	14
Acclaim Extra	Fenoxaprop-p-ethyl	21
Barricade	Prodiamine	14
Barrier	Dichlobenil	14
Basagran T/O	Bentazon	21
Basamid	Dazomet	25
Bensumec 4	Bensulide	14
Betasan	Bensulide	14
Brom-O-Gas	Methyl bromide + chloropicrin	25
Casoron	Dichlobenil	14
Corral	Pendimethalin	17
Devrinol	Napropamide	15
Dimension	Dithiopyr	15
Dyclomec	Dichlobenil	14
Endurance	Prodiamine	14
Envoy	Clethodim	22
Finale	Glufosinate	22
Fusilade II	Fluazifop-p-butyl	22
Gallery	Isoxaben	15
Garlon	Triclopyr	22
Glyphos	Glyphosate	23
Goal	Oxyfluorfen	15
Hurdle	Napropamide	15
Image	Imazaquin	16
Kerb	Pronamide	16
Lescosan	Bensulide	14
Lontrel	Clopyralid	23
Manage	Halosulfuron	23
Norosac	Dichlobenil	14
OH2	Oxyfluorfen + pendimethalin	16
Ornamec	Fluazifop-p-butyl	22
Pendulum	Pendimethalin	17
Pennant Magnum	Metolachlor	17
Predict	Norflurazon	17
Princep	Simazine	17
RegalKade G	Prodiamine	14
Regal 0-0	Oxyfluorfen + oxadiazon	18
RegalStar G	Oxadiazon + prodiamine	18
Reward	Diquat	23
Rodeo	Glyphosate	23
Ronstar	Oxadiazon	18
Roundup Pro/Ultra	Glyphosate	23
Rout	Oxyfluorfen + oryzalin	18
Scythe	Pelargonic acid	24

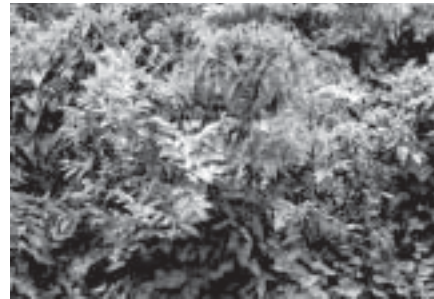
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TRADE NAME	COMMON NAME	PAGE
Sectagon	Metham	26
Simazine	Simazine	17
Simtrol	Simazine	17
Snapshot	Isoxaben + trifluralin	19
Surflan	Oryzalin	19
Terr-O-Gas	Methyl bromide + chloropicrin	25
Touchdown	Glyphosate	23
Treflan	Trifluralin	19
Vapam	Metham	26
Vantage	Sethoxydim	24
XL	Oryzalin + benefin	20

Introduction

Weed control is the leading cultural problem facing growers of nursery and landscape plantings. There are weeds for all places in all seasons, including winter annuals, summer annuals, biennials, perennials, grasses, sedges, and broadleaves. If one type is eliminated, another will take its place.

Weeds must be controlled because they can cause direct or indirect reductions in crop growth or quality and because they are aesthetically objectionable. They directly compete with crops for water, nutrients, and light. Some weeds affect the growth of woody plants by producing chemicals that stunt their growth. Weeds indirectly affect crops or landscapes by harboring rodents that may eat the bark of trees and shrubs, causing severe damage or death. Many nursery practices, such as pruning, are complicated by the presence of weeds. Also, weeds slow air movement, which may result in a higher incidence of foliar diseases or frost damage. Aesthetically, weeds create a poor image for a nursery and are generally unacceptable in a landscape.



The primary reason for controlling weeds in landscape plantings is aesthetics. Weeds growing in a landscape planting detract from the beauty of the site. The landscape in front of this building is overrun with weeds (left). The closeup (right) shows how badly the weeds have infested the planting.



No single preemergence herbicide controls all weeds. In this photograph, Princep plus Pennant Magnum provided total weed control, while Pennant Magnum alone did not control many of the broadleaved weeds.

Weed control program

Too many people look at weed control as a defensive measure that involves killing weeds when they appear. However, it is much easier and cheaper to prevent weed growth than to kill existing weeds. Preventive measures also are safer and longer lasting.

Anyone growing or maintaining ornamental plants should have a weed control program. This means planning how to control weeds in a crop *before* it is planted. The program has three parts:

1. Eliminate weeds in and around the growing area and kill seeds or vegetative parts prior to planting. It is especially important to kill all perennial weeds or their parts because they are not controlled by mulches or preemergence herbicides, and cultivation only serves to propagate them. Some postemergence herbicides that can be used to control perennial weeds prior to planting must be used with extreme caution after planting.
2. Prevent weed growth in and around the growing area. Mulches and/or preemergence herbicides work very well for controlling weeds from seed.
3. Eliminate weeds as they appear. Since few preventive methods provide total control, hand weeding, cultivation, or careful spot treating with a postemergence herbicide usually is necessary.

When developing a weed control program, consider the following guidelines:

1. In most situations, one application of a preemergence herbicide at the recommended rate will *not* provide season-long control. Repeat applications will be needed. Growers who get season-long control from an application probably are applying herbicide at too high a rate and may be stunting the growth of their crop.
2. No one preemergence herbicide controls all weeds. Some control broadleaved weeds better than grasses, while others control grasses better than broadleaved weeds (see Table 3, page 13). Some postemergence herbicides control most weeds, but their use is restricted in established plantings.
3. If one type of weed is controlled and another type in the same area is not, the uncontrolled one will eventually cover the area. For example, if an herbicide controls broadleaved weeds but not grasses, grasses will fill the entire field. To get preemergence control of a broad spectrum of weeds, combinations of herbicides should be used. When more than one application is made in a season, herbicides should be alternated from one application to the next.
4. Growers who spend the time and money to make an area weed-free should take measures to prevent weed regrowth by mulching or applying a preemergence herbicide to the area.

Weed control methods

Weeds can be controlled by using physical methods (i.e., cultivation, mowing, mulching, hand-pulling, selecting a weed-free growing medium, and planting cover crops) or chemicals (fumigants and herbicides). Because of the tremendous variation in times and frequency of seed germination, reproductive and survival structures, growth habits, and growth rates of weeds, all of these methods will be needed at one time or another.

PHYSICAL METHODS

Cultivating

Cultivation is a common method of controlling weeds in nursery and landscape plantings. Tractor-mounted cultivators and rototillers or hand-held hoes and walk-behind rototillers may be used. Though cultivation is an effective way of controlling weeds, several problems are associated with it. Cultivating is time consuming because to maintain a satisfactory level of control, it must be repeated throughout the season. Weeds must be cultivated before they grow too large, and immediately after a cultivation, additional weed seeds may germinate. Moreover, cultivation may break apart underground structures of perennial weeds, such as roots (mugwort), rhizomes (quackgrass), or clusters of nutlets (nutsedge), causing weeds to propagate.

Cultivation also can result in the loss of soil structure. Repeated passes over the field with a tractor-mounted cultivator can cause soil compaction. Repeated tillage with a light rototiller or just one pass with a heavy rototiller can destroy the structure of the upper part of the soil. Cultivation should be done with light equipment and frequently enough to prevent the development of weeds larger than 12 inches.

When cultivating, equipment operators must avoid damaging the roots and trunks of ornamental plants, especially when using a tractor-mounted cultivator or rototiller. The rotary cultivator has been developed for cultivating between rows of trees. It is mounted on the three-point hitch of a tractor and connected to the power takeoff system (PTO). It extends from the side of the tractor and has a retractor bar that leads the way. Each time the bar hits a tree, it gently guides the rotary hoe around the tree. Specialized cultivators and weed “brushes” are available for use in seed and liner beds and in other situations involving narrow row spaces.

Despite the drawbacks of cultivation, it is a useful way to control weeds in herbicide-sensitive crops or clean up a field prior to applying a preemergence herbicide. Cultivation is commonly used in landscape plantings because the large variety of plants growing in a small area limits the use of herbicides.

Mowing

Mowing is commonly used to control weeds in fields of nursery stock or landscapes. However, this method is time consuming, provides only short-term control of weeds, and must be repeated throughout the growing season. Damage to crop plants may occur when equipment operators run into them.

Mulching

Mulches may be applied to limit weed growth around high-value crops in a nursery or in landscape plantings. Mulching can effectively control weeds from seeds that germinate at or near the soil surface. Organic mulches, such as wood chips, shredded bark, or other plant residues, can be applied to weed-free soil soon after planting. To be most effective, they should be applied at least 2 inches, but not more than 4 inches, deep. A thicker layer of mulch may be harmful to landscape ornamentals and may provide habitat in which weed seeds may germinate and survive entirely within the mulch layer. It is important to avoid covering the stems and leaves of plants. Perennial weeds growing from underground structures are capable of growing through organic mulches. They must be controlled with postemergence, translocated herbicides or must be pulled repeatedly. Using a preemergence herbicide in combination with organic mulches results in much improved weed control. The section on preemergence herbicides provides information on which herbicides should be placed under mulches and which should be placed on top.

Inorganic mulches include plastics, gravel, and on a very limited scale, ground rubber tires. The primary inorganic mulches used are black polyethylene film and many types of geotextile weed barriers that allow air and water exchange through holes punched or woven into the fabric. Only black films should be used. Clear or white films allow weeds to grow under them. Black film increases soil temperature and, like the other mulches, maintains high moisture levels at the surface of the soil.

Solid black plastic has been used for years to prevent weed growth in fields and landscapes. The promoters of the weed barriers claim that solid black plastic is harmful to plants because it does not allow for air and water exchange. In theory this is true, but no one has been able to document any harmful effects. After several years of trying the newer weed barriers, many landscapers are returning to the use of solid black plastic. It seems some weeds can grow through weed barriers, while others take root in the organic mulches that are normally placed on top of them. The roots then penetrate the holes in the weed barrier and become extremely difficult to remove. The recommendation now is to use solid black plastic under a mulch on relatively flat surfaces. On slopes, where mulches would slide off solid black plastic, use a weed barrier that has some texture to hold the mulch in place.

Gravel and ground tires should always be used on top of plastic so that they will not blend with the soil during freeze/thaw cycles.

Hand pulling

Hand pulling of weeds is a method that everyone involved in weed control would like to see become obsolete, but it probably never will. Total weed control is difficult to achieve but is necessary in certain high-value areas such as container-grown nursery stock, seedbeds, or highly visible landscape sites. Hand pulling is used to eliminate weeds that escape preventive measures.

Selecting a weed-free growing medium

By selecting a growing medium that is naturally and consistently weed-free, growers can avoid many weed problems in container-grown plants. Vermiculite and perlite are weed-free because of the way in which they are produced. Most peat contains very few, if any, weed seeds. Organic matter that has been properly composted will be weed-free because the high temperatures reached during composting kill weeds and their seeds. Composted or aged bark, sawdust, leaves, or sewage sludge may be used.

Steam pasteurization is an effective way of controlling weeds and most soil-borne insects and pathogens. Media should be heated to between 160° and 180° F and held for 30 minutes. Steamed media should be covered or used within about a week because it can be reinfested while stored. Portable steam generators are available for steaming outdoor beds.

Controlling weed growth around growing areas and preventing weeds from going to seed limit the potential for reinfestation of cleared areas. These tasks require time and attention to matters that seem to have little short-term impact but, in the long run, are very worthwhile.

Planting cover crops

It is possible to achieve almost total weed control in fields through cultivation and the proper selection and use of herbicides. However, clean cultivation and the broadcast application of herbicides can create many aesthetic, environmental, and soil and crop management problems. Soil erosion, pesticide and fertilizer runoff, and impassable fields after rainfall are all problems associated with total weed control. These problems can be overcome with a minimum output of labor and money by properly using a controlled vegetative cover.

Cover crops should not be grown within fields with less than 5 feet between rows, because any established cover crop will be too competitive with the nursery stock. In this situation, ornamentals should be grown in blocks surrounded by strips or roads of cover crop. The distance between strips will be determined by the slope of the site. The more slope there is, the closer together the strips of cover must be.

Cover crops can be grown in plantings with more than 5 feet between rows. A vegetation-free strip 2 to 5 feet wide should be maintained in the row of ornamentals, with the cover crop established in the remaining space between rows. In shade trees, the strip of cover may be 8 feet wide, while in smaller trees or shrubs, the cover may be only 2 feet wide. While 2 feet of cover is not enough to operate equipment on, it is enough to stop erosion. The cover must be kept away from crop plants with herbicides for the same reasons weeds must be controlled.

Allowing volunteer vegetation to grow between tree rows is simple and inexpensive in the short run but has several disadvantages. Volunteer vegetation is composed of annual and perennial weeds that require frequent mowing during the growing season. Many annual weeds die with the first frost and fail to prevent soil erosion in late fall and spring. Perennial weeds that spread by roots, rhizomes, or vine-like stems may invade the tree rows.

Planting a permanent cover crop between tree rows can reduce mowing and minimize weed problems. Cover crops control erosion, limit runoff of pesticides and fertilizer into streams and groundwater, and reduce the amount of herbicide that needs to be applied to a field. If the recommendation for a chemical is 4 quarts per acre and 36-inch strips are sprayed in rows located 72 inches apart, only one-half of the total ground area will be covered, so only 2 quarts of the chemical will be required per acre of nursery stock. The sod is easy to mow because the herbicide does the trimming around the trees. Sod provides a firm, uniform working surface year-round for equipment and laborers. Equipment as well as most nursery practices can be used under wet conditions if there is sod in the field. The sod also helps protect and build soil by limiting compaction and adding organic matter to the soil.

For years tree fruit growers and some nurserymen have planted perennial grass cover crops between tree rows. Orchardgrass, Kentucky 31 tall fescue, and pasture-type perennial ryegrass are most commonly used and provide many benefits. However, orchardgrass, Kentucky 31 tall fescue, and pasture-type perennial ryegrass all have a rapid growth rate and require frequent mowing during the growing season.

A low maintenance cover should grow slowly or low for minimum maintenance, have a low fertility requirement, tolerate a variety of soil conditions, not limit crop growth, and be aesthetically attractive. The fine fescues have these characteristics. Unlike tall fescue, which has a relatively broad, flat leaf, the fine fescues have leaves that are tightly folded and narrow. Though similar in many ways, there are several distinctions between fine fescue species.

- *Creeping red fescue* is distinct from other fine fescues in that it spreads by small, short rhizomes. Improved varieties develop a stronger rhizome system and can spread faster. They have a medium establishment rate and will provide a cover faster than hard or sheep fescue. Because they typically produce very few seedheads, they do not require mowing for seedhead control.
- *Chewings fescue* is very similar to creeping red fescue except that it lacks rhizomes. However, it does produce more seedheads and needs to be mowed once a year to maintain a neat appearance.
- *Hard fescue* has a bunch-type growth habit, excellent drought and heat tolerance, and will survive higher soil moisture and salt levels than red fescue. Its seedlings are smaller and less competitive than those of red or chewings fescue. It produces few seedheads and does not require mowing for seedhead removal.
- *Sheep fescue* is a bunch-type grass that germinates and establishes at about the same rate as hard fescue, but grows more slowly and remains lower.

The best fine fescues to use as cover crops are hard fescue and red fescue. Red fescue establishes faster than hard fescue and forms a denser sod because it produces short rhizomes. Hard fescue grows lower than red fescue.

Many fine fescue cultivars are now available with endophytes. Endophytes are beneficial fungi that live within the grass plant and deter insect feeding. Choose an endophyte enhanced variety if available.

The fine fescues can be weedy during establishment because they have small seedlings and slow (hard and sheep) to medium (red and chewings) lateral spread. Establishment is especially poor during hot summer months. The best time to establish fine fescues is in late summer to early fall or in early spring. Apply 20 to 40 pounds of seed per acre to soil that has been loosened by rototilling or cultivation. Adjusting soil pH and fertility levels according to soil test results will speed establishment of the cover crop.

Because fine fescues do not hold up to heavy traffic as well as tall fescue, tall fescue should be used for grass roadways in and around a nursery.

CHEMICAL METHODS

Chemicals used to control weeds are classified in several ways:

- *Preemergence or postemergence.* Preemergence herbicides control weeds at the seed germination stage, or as they are emerging from the soil. Postemergence herbicides control existing weeds.
- *Contact or translocated.* Contact herbicides kill or injure only that part of the plant with which they come in contact. Annual weeds may be killed, but regrowth of perennial weeds from below-ground parts usually occurs following application of a contact herbicide. Translocated herbicides are absorbed by the leaves or roots of plants and move within the plant. They are needed to kill underground parts of perennial weeds.
- *Selective or nonselective.* Selective herbicides kill some plants but do little or no damage to others; nonselective herbicides kill or injure almost all plants.
- *Fumigants.* Fumigants may kill all living things in the soil including weeds, weed seeds, insects, and disease organisms.



Postemergence, translocated herbicides are needed to kill perennial weeds like this Canada thistle that can resprout from roots or rhizomes after being cut or pulled.

Causes of herbicide injury

If selected and applied properly, the herbicides listed in this publication can be safely used in and around a wide variety of ornamental plants. However, herbicide injury may occur if one of the following mistakes is made:

1. An herbicide is applied to a plant that is sensitive to it.
Gallery is safe for use over the top of many ornamentals but for some unknown reason severely injures winged euonymus (*Euonymus alatus*), which is very sensitive.
2. An herbicide is applied at too high a rate. This can be due to the selection of an excessive rate, a mistake in application caused by poor calibration of application equipment, or uneven distribution of the herbicide during application. Princep (simazine) provides safe, excellent, low-cost weed control when applied at the proper rate, but it will injure or kill many ornamentals if applied at high rates.
3. An improper application is made. Some oil-based herbicides are safe to use over the top of plants prior to budbreak, but may injure the foliage if applied during active growth. Pennant can be applied over white pine in early spring, but if applied as the new growth is expanding, it will cause considerable injury to the new growth.
4. A nonselective postemergence herbicide is applied over the trunk of young trees with thin bark. Finale, Reward, and RoundupPro can be freely used around the base of trees with mature bark but must be used with caution around the base of trees with young, thin bark. Finale and Reward can cause sunken cankers where applied, while Roundup Pro may cause slight to severe bark splitting.

Steps to take before applying an herbicide

1. Identify the predominant weeds to be controlled and read the label to be sure the herbicide selected will be effective against them. Remember that no one preemergence herbicide will control all weeds. The continued use of one herbicide may result in the eradication of the original problem weeds, while other weeds that are resistant to the herbicide begin to thrive. Be aware of a changing weed problem. Appendix 2 provides a listing of all the weeds (classified as annuals, biennials, or perennials) named on the labels of the preemergence herbicides.
 - *Annuals* complete their life cycle in one year. They grow from seed, flower, produce seed, and then die. Summer annuals germinate in the spring or summer, while winter annuals germinate in the fall. Some weeds, such as chickweed, common groundsel, and bittercress, may germinate and grow at almost any time of year. These weeds may grow all year in container overwintering structures. Annuals are easily controlled by preemergence herbicides if the proper

material is applied at the right time. To control summer annuals, preemergence herbicides must be applied in very early spring or in the summer after the soil has been cleared by cultivation or a postemergence herbicide application. To control winter annuals, preemergence herbicides must be applied in late August or September. Either contact or translocated postemergence herbicides can be used to kill annual weeds because they cannot resprout from their roots after their tops have been killed.

- *Biennials*, such as wild carrot, require two growing seasons to complete their life cycle. In the first season after the seeds germinate, the plants develop an extensive root system and a dense cluster of leaves called rosettes. The next year they flower, produce seed, and die. Biennials can be controlled by preemergence herbicides at the seed germination stage, but postemergence translocated herbicides are required after biennials are established.
 - *Perennials* will grow and produce seed year after year. Herbaceous perennials, such as quackgrass, mugwort, and Canada thistle, die back to the ground each year. Woody perennials may drop their leaves, but they do not die back to the ground. The longer perennial weeds are allowed to grow uncontrolled, the larger their root systems become, the more they spread, and the harder it is to control them. Cultivating through patches of perennial weeds propagates and spreads them, as each root piece may grow into a new plant. As with biennials, perennial weeds can be controlled from seed by preemergence herbicides, but postemergence translocated herbicides are required after perennials are established.
2. Carefully read the label to make sure the herbicide is not toxic to any of the desirable plants around which it will be used.
 3. Determine the proper application rate according to:
 - recommended range on the label
 - soil texture (e.g., Princep/simazine is more effective in light sandy soils than in heavy clay soils)
 - length of time since the last application (e.g., no more than 1.5 pounds active ingredient per acre (ai/A) of Factor should be applied in one year)
 - herbicide combinations (Reduce the rate if two herbicides are used in combination. Most herbicide labels list a range of recommended rates rather than a specific rate. If using combinations, choose the lower end of the range listed.)
 4. Calibrate the sprayer or spreader. (See page 8.)
 5. Determine as accurately as possible the area of the field to be sprayed.
 6. Determine how much herbicide will be needed to cover the area at the rate selected in Step 3. Have at least two people make the necessary calculations independently of each other. Do not apply the herbicide if there is any doubt about the accuracy of the calculation.

Herbicide formulations

The formulas for calculating the amount of herbicide needed for an area depend on the formulation of the herbicide. The amount of active ingredient in dry formulations of herbicides is presented as a percentage of active ingredient (ai). The amount of active ingredient in liquid formulations is presented as pounds of active ingredient per gallon (lb ai/gal).

DRY FORMULATIONS	EXAMPLES	
Granular (G)	Ronstar 2G	2% ai
Wettable powders (W or WP)	Devrinol 50WP	50% ai
Dry flowable (DF)	Princep 90DF	90% ai
Water dispersible granules (WDG)	Pendulum 60WDG	60% ai
LIQUID FORMULATIONS	EXAMPLES	
Water soluble	Roundup Pro	4 lb ai/gal
Liquid (L)	Princep 4L	4 lb ai/gal
Aqueous solution (AS)	Surflan 4AS	4 lb ai/gal
Emulsifiable concentrate (E or EC)	Goal 2XL	2 lb ai /gal

All of the dry formulations of herbicides are stable and maintain their activity for many years if protected from moisture. Granular products are more expensive per pound of active ingredient than are sprayable formulations, so they are generally used only in high-value areas, such as landscapes and container nurseries. Wettable powders have one problem. They are dusty. During weighing and mixing, they often form a dust cloud around the equipment. The dust is messy and may be a health hazard. To minimize this problem, chemical companies developed the dry flowable and water dispersible granular formulations. They are pelletized versions of the wettable powders and produce much less dust during handling. There is essentially no difference between DF and WDG formulations.

Water soluble formulations of herbicides mix thoroughly with water and stay in solution even without agitation. Products that are labeled as liquids or aqueous solutions will readily mix with water, but they form suspensions in the spray solution and can settle out if not agitated regularly. Emulsifiable concentrates are oil-based products that maintain the herbicide in suspension. When mixed with water, the oil and herbicide are suspended in the water and can separate without agitation. Unless clearly stated otherwise on their label, all liquid formulations should be protected from freezing. Roundup is an example of a product that can freeze and thaw repeatedly with no loss of activity. Liquids also have a shorter shelf life than dry products. Except for the water soluble products, they can separate into phases in the containers that may or may not remix. Liquid or aqueous solutions may separate into a liquid and solid phase, with the solid phase accumulating on the bottom of the container. If stored too long, it may be impossible to properly mix them again even with vigorous agitation. Emulsifiable concentrates are less likely to separate, but may do so if stored too long. Buy only as much herbicide as you should need in one year. All of the products can be stored for at least that long.

Because many herbicides have more than one formulation, recommendations are often given in terms of pounds of active ingredient per acre (lb ai/A). For example, simazine is available in two formulations: 4L and 90DF. A simple recommendation to a grower might be, "Apply Princep at 2 lb ai/A to your field." The grower then has the option of which formulation to use. When a formulation is chosen, the grower must then calculate the amount of the product purchased to use.

Example:

Princep 90DF (90% ai): $2 \text{ lb} \div .90 = 2.2 \text{ lb}$

Princep 4L (4 lb ai/gal): $2 \text{ lb} \div 4 \text{ lb/gal} = 0.5 \text{ gal}$, or 2 qt

In this example, the grower can get 2 lb active ingredient of simazine from 2.2 lb Princep 90DF or 2 qt Princep 4L. To find the formulations of herbicides available for nursery use, see the sections titled "Preemergence Herbicides" (page 13) and "Postemergence Herbicides" (page 20).

a. Formulation for granular materials and wettable powders:

$$\text{lb ai/A} \times \frac{\text{sq ft to be treated}}{43,560 \text{ sq ft/acre}} \times \frac{100}{\% \text{ ai}} = \text{lb required to treat area}$$

b. Formulation for liquids:

$$\text{lb ai/A} \times \frac{\text{sq ft to be treated}}{43,560 \text{ sq ft/acre}} \times \frac{1}{\text{lb ai/gal}} = \text{gal required to treat area}$$

Sample calculations:

a. How much Ronstar 2G is required to treat a field measuring 800 ft by 210 ft at 3 lb ai/A?

$$800 \text{ ft} \times 210 \text{ ft} = 168,000 \text{ sq ft}$$

2G – Granular containing 2% ai

$$3 \text{ lb ai/A} \times \frac{168,000 \text{ sq ft}}{43,560 \text{ sq ft}} \times \frac{100}{2} = 578 \text{ lb Ronstar 2G}$$

b. How much Princep 90DF or Princep 4L is required to treat an 800 ft by 210 ft field at 2 lb ai/A?

$$800 \text{ ft} \times 210 \text{ ft} = 168,000 \text{ sq ft}$$

90DF – Dry flowable containing 90% ai

$$2 \text{ lb ai/A} \times \frac{168,000 \text{ sq ft}}{43,560 \text{ sq ft}} \times \frac{100}{90} = 8.5 \text{ lb Princep 90DF}$$

4L – Liquid containing 4 lb ai/gal

$$2 \times \frac{168,000 \text{ sq ft}}{43,560 \text{ sq ft}} \times \frac{1}{4} = 1.9 \text{ gal Princep 4L}$$

Table 1 shows the amount of formulated herbicide required to supply the equivalent of 1 lb ai/A on 1 acre or 1000 sq ft.

TABLE 1. FORMULATED HERBICIDE EQUIVALENTS.

Herbicide formulation	Amount to apply 1 lb ai/acre	Amount to apply 1 lb ai/acre on 1000 sq ft	
		(lb)	(oz) ^a
Dry	(lb)	(oz)	(g) ^a
2% G	50.0	18.4	522.0
4% G	25.0	9.2	261.0
5% G	20.0	7.4	210.0
10% G	10.0	3.7	105.0
15% G	7.5	2.8	80.0
20% G	5.0	1.8	51.0
50% WP	2.0	0.7	20.0
65% WP	1.5	0.6	17.0
75% WP	1.3	0.5	14.2
80% WP	1.2	0.5	14.2
90% DF or WDG	1.1	0.4	11.4
Liquid		(Tbls)	(ml)^b
1.6 lb/gal	2.5 qt	3.7	55.0
2 lb/gal	2.0 qt	2.9	43.0
4 lb/gal	1.0 qt	1.5	22.0
7 lb/gal	1.1 pt	0.8	12.0
8 lb/gal	1.0 pt	0.7	10.0

^a1 pound = 454 grams. 1 ounce = 28.4 grams.

^b1 fluid ounce = 2 tablespoons = 29.6 milliliters.

Examples:

1. To apply Princep 4L at the rate of 3 lb ai/A plus Barricade 65WG at 2 lb ai/A to 1 acre of land, note that 1 qt Princep 4L is required to supply 1 lb active ingredient. To get 3 lb active ingredient, you need 3 (1 x 3) qt Princep 4L. To get 1 lb active ingredient requires 1.5 lb Barricade 65WG. To get 2 lb active ingredient requires 3.0 (1.5 x 2) lb Barricade 65WG.

2. To apply Ronstar 2G at the rate of 3 lb ai/A plus Surflan 4AS at 2 lb ai/A to a bed that contains 5000 sq ft, note that 18.4 oz (522 g) Ronstar 2G are required to treat 1000 sq ft at a rate of 1 lb ai/A. Multiply this by 3 to get 3 lb ai/A and again by 5 to cover 5000 sq ft: $18.4 \text{ oz} \times 3 = 55.2 \times 5 = 276 \text{ oz} \div 16 \text{ oz/lb} = 17.3 \text{ lb}$ or $522 \text{ g} \times 3 = 1566 \times 5 = 7830 \text{ g} \div 454 \text{ g/lb} = 17.3 \text{ lb}$.

The table also shows that 1.5 Tbls (22 ml) Surflan 4AS are required to treat 1000 sq ft at a rate of 1 lb ai/A. Multiply this by 2 to get 2 lb ai/A and again by 5 to cover 5000 sq ft: $1.5 \text{ Tbls.} \times 2 = 3 \times 5 = 15 \text{ Tbls} \div 2 \text{ Tbls/oz} = 7.5 \text{ oz}$ or $22 \text{ ml} \times 2 = 44 \times 5 = 220 \text{ ml} \div 29.6 \text{ ml/oz} = 7.5 \text{ oz}$. This shows that 17.3 lb Ronstar 2 G is needed to cover 5000 sq ft at a rate of 3 lb ai/A and 7.5 oz Surflan 4AS is needed to supply a rate of 2 lb ai/A to the same area.

When measuring herbicides, the following conversions (approximate) may be of use:

LIQUID MEASURES

1 gallon	= 4 quarts	= 128 fluid ounces	= 3800 milliliters
1 quart	= 2 pints	= 32 fluid ounces	= 950 milliliters
1 pint	= 2 cups	= 16 fluid ounces	= 475 milliliters
1 cup	= 16 tablespoons	= 8 fluid ounces	= 235 milliliters
1 fluid ounce	= 2 tablespoons	= 6 teaspoons	= 30 milliliters

DRY MEASURES

1 pound	= 16 ounces	= 454 grams
1 ounce		= 28 grams

Calibration of equipment

To be used safely and effectively, herbicides must be applied uniformly and at the precise amount across the area to be treated. To uniformly apply the proper amount, herbicide application equipment must be calibrated. If too little product is applied, weed control will be poor. If too much is applied, crop plants may be injured.

GRANULAR SPREADERS

Granular spreaders must be calibrated using the actual material under field operating conditions. For manually operated spreaders, the person who will make the application should be the one who calibrates the equipment. The operator should establish a test strip of 440 square feet (approximately 1/100 of an acre). The material is weighed prior to application and again afterwards. What is left after application is subtracted from what the operator started with to get the amount applied. The amount applied is multiplied by 100 to get the amount per acre. The operator should adjust the equipment and repeat the test until the correct setting is obtained for the required amount per acre. Different herbicides may have granules of different sizes. Also, if two orders of the same herbicide are purchased in a given year, there may be a change in the size of the granules. Calibration should be repeated for each different granular herbicide and also for different purchases of the same herbicide.

SPRAYERS

In calibrating a sprayer, the speed and pressure at which the sprayer is operated, the nozzle being used, and the height at which the nozzle is held (which controls the width of the band sprayed) must be kept constant.

The parts of the spray system include the pump, pressure regulator, pressure gauge, screens (strainers), and nozzles. Many herbicides are made up of particles suspended in the spray solution. They cause a lot of abrasion and wear on piston pumps. The best pumps to use with these products are diaphragm or centrifugal pumps because they will last much longer than other pumps. Pressure regulators are needed to maintain a constant

pressure during application. Herbicides should be applied at 15 to 40 psi. The pressure gauge makes it possible to reset the pressure regulator from one operation to another.

A 50-mesh in-line strainer should be used to prevent nozzle clogging, especially when wettable powders are being applied. Strainers with check valves are available that require 5 psi pressure to open them. This prevents the dripping of the spray solution that is in the system between the shutoff valve and the tip. The check valve in the strainer closes immediately when the shutoff valve is closed.

Sprayer nozzles

The nozzle tip is a critical component of a sprayer. Although relatively inexpensive, this part of the system must not be neglected. The nozzle affects the flow rate, breaks up the mixture into droplets, and disperses the droplets in a specific pattern. The proper nozzle must be selected for the desired job. *No single nozzle can meet all spraying needs.*

When buying nozzles, the grower must choose from a variety of angles and spray rates. Nozzles with angles ranging from 65° to 130° are available for applying herbicides. Wide-angle nozzles can be operated close to the ground to minimize drift. Narrow-angle nozzles should be used where high clearance over some plants may be needed.

The flow rate of nozzles is measured under standardized conditions, such as a tractor speed of 4 miles per hour and a pressure of 30 psi. The rate of spray applied per acre by a particular nozzle can be increased by driving slower or by increasing the pressure. The rate of spray applied per acre can be decreased by driving faster or by decreasing the pressure. An example of a nozzle used for applying herbicides is an 8004, which provides a spray angle of 80° and has an output of 0.4 gallons per minute at 40 psi.

Different types of nozzles are commonly used to apply herbicides in nursery or Christmas tree plantings.

- *Flat-fan nozzles* disperse droplets in a fan shape. The edges of the flat fan pattern have lower spray volumes than the center of the pattern, so they should be used only in combination on spray booms. To get uniform distribution of the herbicide across the width of the boom, the patterns of adjacent nozzles should overlap by 40 to 50%. With a 20-inch nozzle spacing, the proper overlap would be 8 to 10 inches. To get uniform spray patterns from flat fan nozzles, a pressure of at least 30 psi is required.
- *Low-pressure flat fan nozzles* are for those who want to use lower pressures, as is often the case with backpack sprayers. They are designed to be operated at 10 to 25 psi. The lower operating pressures and larger orifices on these nozzles reduce clogging and provide larger spray droplets that reduce drift. A low-pressure flat fan nozzle is designated with the letters LP after the number (8004 LP). Flat fan and low-pressure flat fan nozzles are recommended for use only on boom sprayers. The nozzles on a boom should all be the same type and size to ensure even distribution. They should never be used for making band applications because, when used alone, the spray distribution pattern is very uneven.

- *Even-spray nozzles* are used to make band applications. They are similar to flat fan nozzles but apply the herbicide uniformly across the entire pattern. Even-spray nozzles are available with 80° or 95° spray angles. Typical working pressures range from 20 to 40 psi. The width of the band can be adjusted by raising or lowering the nozzle. This nozzle should not be used on a boom for broadcast spraying. Even-spray nozzles are identified by the letter E after the number (8004 E).
- *Flooding fan nozzles* produce a wide, flat spray pattern. The wide spray angle (110° to 130°) allows wider nozzle spacing and lower boom heights. The larger orifice produces large droplets and makes the flooding fan nozzle resistant to drift and clogging. Optimum broadcast coverage is achieved by overlapping spray patterns 100% to obtain double coverage. Pressures of 10 to 30 psi are commonly used.
- *Off-center nozzles* produce a pattern that is approximately half that of a flat fan nozzle. They are used for directing a spray at the base of a row of plants without getting the spray on a cover crop between the rows. Off-center nozzles are identified by the letters OC before the number designating rate of output (OC 04).

Nozzles are available in a variety of materials. Brass and aluminum are the least expensive, but the metal is soft and wears quickly when abrasive materials like wettable powders are used. Stainless steel and hardened stainless steel cost three to five times more than brass but wear 19 to 77 times longer. The cost, uniformity, and durability of nylon nozzles vary with the quality of the nylon used to make them. They can be as uniform and durable as stainless steel at one-half the cost, or they may be quite variable in rate of spray output. The operator should consult with the supplier before buying nylon nozzles. An excellent combination of products is a nozzle with a nylon body and a stainless steel orifice. It provides the durability of stainless steel with the low cost of nylon.

To prevent plugging and excessive wear of nozzles, screens should always be used to remove large particles from the spray mixture. Check the manufacturer's recommendation for the nozzle to be used. A general recommendation is to use a 50-mesh screen. Screens with ball check valves are recommended for use when applying postemergence herbicides because they prevent dripping from the nozzle after the control valve has been closed.

A sprayer remains accurately calibrated only as long as the openings of the nozzles remain unchanged. As nozzles wear, the openings become larger and the rate and uniformity of herbicide applied become more variable. To minimize these problems, the operator should buy high-quality nozzles, inspect them regularly, and replace them as needed. To clean a clogged nozzle, use compressed air or a soft-bristled brush, such as a toothbrush. *Never* use wire or a nail because the nozzle orifice can be easily damaged.

Tractor-mounted sprayers

Many configurations and systems can be used with tractor-mounted sprayers. Centrifugal or diaphragm pumps are recommended. They can have their own engines for power or can be run off the PTO of the tractor. The tanks range greatly in size and may be mounted in the back or front of the tractor. Spray booms or individual nozzles may be mounted in the back, front, under the belly, or on the foot plates of the tractor. Flat booms or drop nozzles may be used. The system that is best for a particular situation will depend on the herbicide being used and the growth habit and size of the plants being grown.

Hand-carried sprayers

The most common hand-carried sprayers are the 2- or 3-gallon compression type and the continuous pump backpack sprayers. Either can be used to spray a small or irregular area like a landscape bed without worrying about calibration. Simply add the amount of herbicide needed to treat the area to enough water to spray uniformly over the area at least twice. Marker dyes also can be added to the spray solution to indicate the uniformity of application. The dyes break down in sunlight and disappear within 3 or 4 days.

For treating larger areas, sprayers must be calibrated. Backpack sprayers should be used because the pump can be operated continuously to maintain a uniform pressure. Sprayers with diaphragm pumps are far superior to sprayers with piston pumps because piston pumps wear out faster and tend to leak. Because these sprayers are mounted on the backs of the applicators, any leaks result in considerable direct exposure to the spray solution.

Some backpack sprayers have pressure regulators built into them. They can be used with no further adaptation. Sprayers without pressure regulators need some adaptation to make them more suitable for herbicide application. A pressure gauge is essential for uniform application. It should be mounted on the tank side of the shutoff valve so the tank pressure can be continuously monitored. If the gauge is mounted on the nozzle side of the shutoff, it will show the tank pressure only when the valve is open. For optimum control, a pressure regulator also should be inserted into the system somewhere between the pressure gauge and the nozzle.

Shutoff valves of some hand sprayers are often too slow to prevent dripping from the nozzle after the valve is closed. This can cause serious problems when nonselective herbicides such as Roundup Pro are being used. Such valves should be replaced with a quick, positive pressure shutoff valve or strainers with check valves.

A two- or four-nozzle boom can be adapted to apply herbicides to large plantings or turf.

Calibrating a sprayer

After a tractor-mounted or backpack sprayer has been customized to meet particular needs, it should be calibrated according to the following instructions:

1. On an area that best represents the average topography for the area to be sprayed, measure and mark off the calibration distance that coincides with the band width, if band applying,

or with the nozzle spacing (width covered by a single nozzle) if broadcast applying (see Table 2).

Calibration distance _____ feet

2. Fill the sprayer with water only and record the number of seconds required to travel the calibration distance at a comfortable, steady speed. With a tractor-mounted sprayer, note and record the engine rpm and the gear selection so that the same speed is used during calibration and application. For backpack sprayers, it is important that the person making the application is the person that calibrates the sprayer, because the calibration is based on that person's pace.

Gear _____ rpm _____ time in seconds _____

3. While maintaining the selected application pressure, collect the spray output from one nozzle for the same number of seconds needed to travel the calibration distance.

Collected water in fluid ounces _____. *The number of fluid ounces collected equals the gallons per acre (GPA) output of the spraying system.*

Example 1: With a 32-inch band, if it took 28 seconds to travel 127 feet, collect the nozzle discharge for 28 seconds. 16 ounces collected equals a system output of 16 GPA.

Example 2: With 20-inch nozzle spacing, if it took 35 seconds to travel 204 feet, collect the discharge of one nozzle for 35 seconds. 20 ounces collected equals a system output of 20 GPA.

4. If using a boom, repeat step 3 twice more, collecting water from a different nozzle each time. The *average* number of ounces collected for each of the three nozzles is equal to the gallons of water applied per acre for that boom, speed, and pressure. If the difference in output of any of the nozzles tested varies more than 10% from the others, check all of the nozzles on the boom and replace as needed.

5. To determine the amount of chemical to add to the spray tank, divide the capacity of the tank by the number of gallons of water applied per acre to determine the area that can be covered with a tankful of spray.

Example 1: 3 gal tank ÷ 16 GPA = 0.188 acres covered per tank.

Example 2: 200 gal tank ÷ 20 GPA = 10 acres covered per tank.

6. Multiply the application rate of the product per acre times the area covered per tank. Add that amount of chemical to the sprayer tank.

Example 1: 2 qt per acre = 64 fl oz per acre x .188 acre per tank = 12 fl oz per tank.

Example 2: 5 lb per acre = 80 oz per acre x .188 acre per tank = 15 oz per tank.

Example 3: 2 qt per acre x 10 acres per tank = 20 qt, or 5 gal per tank.

TABLE 2. CALIBRATION DISTANCE BASED ON NOZZLE SPACING OR BAND WIDTH.

Band width or nozzle spacing	Calibration distance
10 inches	408 feet ^a
12 inches	340 feet
16 inches	255 feet
18 inches	227 feet
20 inches	204 feet
24 inches	170 feet
28 inches	146 feet
32 inches	127 feet
36 inches	113 feet
40 inches	102 feet

^a For calibration of a small walk-behind or hand-carried boom having a 10-inch nozzle spacing, use a distance of 204 feet and multiply walking time by 2.

Mixing herbicides

Concentrated herbicides should never be poured directly into an empty tank. Add one-half the necessary water to the tank, then the herbicide concentrate, and finally the remainder of the water. Mix the spray solution by operating the sprayer with the control valve in the closed position for a few minutes.

Never allow a sprayer with mixed chemicals to stand without agitation. Heavy wettable powders may clog nozzles and settle into the corners of the spray tank, becoming very difficult to remove.

When applying combinations of herbicides, add them to the tank in this order: wettable powders, flowables, water solubles, adjuvants, and emulsifiable concentrates. Constant agitation is especially important when combinations of pesticides are in a tank.

When using backpack sprayers, thoroughly mix the chemicals in a bucket with a pour spout; then pour the mixture into the sprayer. It is difficult to get proper mixing if the chemicals are added directly to the sprayer.

Herbicide compatibility

Two pesticides or a pesticide-fertilizer mixture sometimes separates when combined in a sprayer. Including a type of surfactant called a *compatibility agent*, or *adjuvant*, may help get them mixed. Compatibility agents available on the market include Compex, Co-mix, and Unite.

When the compatibility of the materials to be mixed in the tank is uncertain, the following jar test can be used to determine how well they mix:

1. Put 1 pint of water or chosen fluid fertilizer in each of two quart jars.
2. Using rates proportional to those that will be used in the field, combine the chemicals to be mixed in one of the two quart jars.
3. To the other quart jar first add a compatibility agent (1/2 teaspoonful) to water or fluid fertilizer; then add the herbicide mixture.
4. Close both jars and mix contents by inverting jars 10 times.

5. Inspect jars immediately.

6. Allow jars to stand undisturbed for 30 minutes and inspect them again.

If both mixtures remain uniform for 30 minutes, the combination may be used. If the mixture with the compatibility agent stays mixed but the one without the compatibility agent does not, be sure to use the compatibility agent in the spray tank.

Should either mixture separate after 30 minutes but remix readily with 10 jar inversions, the mixture can be used if good agitation is maintained in the tank. If nondispersible oil, sludge, or clumps of solids form, the mixture should not be used.

If tank-mixed chemicals are compatible, time and labor can be saved by applying herbicides in combination with fertilizers. When such mixtures separate, clogged tanks and lines and uneven, deficient, or excessive rates of application result. This can cause crop injury, poor weed control, and residue problems in addition to the expense and disposal required for mixtures that cannot be used.

Procedures after herbicide applications

KEEPING APPLICATION RECORDS

Every time a pesticide of any type is applied, a complete record of the application should be made. Pesticide records will be the basis for any changes that may be needed in the pest control program. If the material did not work, the records could indicate why. A change in the time or rate of application, application technique, or the chemical used may be required. If the crop was injured, well-kept records will help determine what changes must be made to prevent additional problems in the future. The records should include:

1. Application date
2. Chemical
3. Formulation
4. Application rate
5. Area covered
6. Amount of product applied
7. If sprayed, volume of water applied
8. Weather (temperature, clear or cloudy, time to next precipitation of at least 0.5 inch)
9. Growth stage of weeds
10. Growth stage of the crop
11. Comments on any problems at the time of application (e.g., clogged nozzle, broken spray line)

CULTIVATING

Soil treated with most preemergence herbicides can be cultivated to a depth of 1.5 inches without reducing weed control. Cultivating deeper than 2 inches reduces the effectiveness of all herbicides. Soil treated with Ronstar or any herbicide containing oxyfluorfen (Goal, OH2, Rout, Regal O-O, RegalStar G) should not be cultivated following treatment. They form a chemical barrier on the soil surface that burns off weed seedlings as they emerge, and they need light to be active. Anything that breaks that soil barrier or covers the herbicide layer will reduce their effectiveness.

CLEANING SPRAYERS

Immediately after being used, sprayers should be cleaned in the following manner:

1. Flush the system with clean water, including spraying water through all of the lines and nozzles.
2. For more thorough cleaning, rinse the sprayer with a detergent solution.
3. Rinse again with clean water.

It is difficult to remove oil-based compounds such as 2,4-D or Garlon 4E from sprayers. Sprayers used for applying these compounds should be cleaned as follows:

1. Flush the entire system with a detergent solution.
2. Fill the tank and prime the spray system with a 10% ammonia solution (1 gallon of household ammonia in 10 gallons of water) and let it stand for 12 to 24 hours.
3. Disassemble the nozzles and soak the caps, screens, etc. in the ammonia solution.
4. Rinse thoroughly with water and circulate it through the sprayer.
5. Test spray a few plants known to be susceptible, such as tomatoes or peppers, at least 4 days before using the sprayer on crop plants.

If the herbicide label includes cleaning instructions, follow them.

STORING SPRAYERS AND HERBICIDES

After cleaning, drain the spray lines, pump, and tank. To prevent the pump from rusting and freezing, fill it with oil or some other suitable lubricant. Sprayers should be stored in a dry location. Nozzles, caps, screens, etc. should be removed from the sprayer, cleaned, and stored in clean cloth bags.

Store herbicides in a locked dry area out of the reach of children and pets. Keep herbicides in their original containers and make sure the label is not damaged or removed. Do not allow herbicides in liquid form to freeze.

Controlling plant damage from herbicide residues

To determine whether active amounts of an herbicide remain in a soil, a simple test called a bioassay can be conducted. It involves planting the seeds of herbicide-sensitive plants in some containers filled with soil from the test site and in other containers with soil from a site where no herbicides were applied. The following steps are recommended:

1. Fill containers with soil from depths of 0 to 2 inches, 2 to 4 inches, and 4 to 6 inches from several areas within the field to be tested for herbicide residue.
2. Fill other containers with soil from a site where no herbicides were applied.
3. Plant seeds of an herbicide-sensitive broadleaved plant (lettuce or bean) and a sensitive grass (oats or annual ryegrass) in each of the containers.
4. Carefully germinate and grow the plants for 2 to 3 weeks. Be careful not to over- or underwater the plants. Subirrigation is best because it does not disturb the soil surface.
5. The seedlings grown in the soil from the untreated site should grow vigorously. If the seedlings grown in the soil from the test site die or are stunted and twisted, an herbicide residue is in the soil.

If planting in soil where injury from herbicide residues is a possibility, dip the moist roots of the transplants into dry activated carbon or into a slurry of 1 pound activated carbon per gallon of water before setting.

If sensitive plants are to be transplanted into soil containing harmful levels of herbicides, or if an overdose of herbicides is applied, activated carbon may be spread on the field to neutralize the herbicide. From 100 to 200 pounds of activated carbon per acre should detoxify normal herbicide residues. For an overdose, apply the carbon at a rate of 150 pounds times the number of pounds of suspected active ingredient per acre of the applied herbicide. For example, if simazine (Princep) was broadcast at a rate of 6 pounds ai/A, then 6 times 150 or 900 pounds of activated carbon should be applied per acre. Apply the carbon in a band under the plants, rather than broadcast, so that only one-quarter to one-third of the 900 pounds is needed.

If dry powdered charcoal is used, spread it evenly over the affected areas. Some charcoal is treated so it can be added to water to form a slurry and be applied as a spray. Incorporate the charcoal 4 to 6 inches deep, with a rototiller or similar implement. This process ensures that the charcoal is intermixed with the herbicide in the soil. After the charcoal is incorporated, water the area thoroughly every day for 3 to 4 days before planting. If possible, wait a few more days because, under some conditions, deactivation is slowed.

Preemergence herbicides

A listing of the preemergence herbicides labeled for use in ornamental plantings, along with some useful information about them, is presented in the following pages. All of the information listed below should be carefully read because it relates to the use of these herbicides.

1. Preemergence herbicides generally do not control established perennial weeds, even if applied prior to their emergence, or annual weeds that have germinated and begun to grow. Several very important exceptions to this rule exist and will be described.
2. Tillage prior to application allows better penetration and distribution of the herbicide in the soil. Application to moist soils is preferable to dry soils. Following application, all of the preemergence herbicides must be activated by 0.5 to 1 inch of rainfall or irrigation or must be mechanically incorporated to become fully effective. Not only must they be applied prior to emergence of weed seedlings, but they also must be applied early enough so that the herbicide can be activated and incorporated by irrigation or rainfall prior to weed seed germination.
3. It is preferable that herbicides not be applied to new transplants until the soil is settled by irrigation or rainfall and there are no cracks in the soil leading to roots of ornamentals. However, since many weed seeds germinate early in the season, it is also important to make an herbicide application as soon as possible after planting.
4. Unless specifically stated otherwise, none of these materials are recommended for use in greenhouses or other enclosed structures, seedbeds, unrooted cuttings, or prior to planting. Do not apply them within 2 weeks of placing the plants in enclosed structures.
5. Apply granular products to dry foliage. Granules that stick to wet foliage may cause injury. Do not apply granular herbicides to herbaceous plants with whorls of leaves that channel granules to a growing point at their base or the plant may be severely injured.
6. Most preemergence herbicides are more effective and last longer when placed under an organic mulch. The exceptions are Goal and Ronstar, which should be placed on top of mulches because they need sunlight to be active. Rout, OH2, and Regal O-O contain Goal and should be placed on top of mulches. Casoron, Treflan, and Devrinol are much more effective when placed under a mulch than on top. Casoron and Treflan are volatile. Devrinol is sensitive to sunlight.
7. Most of the preemergence herbicides can be safely applied over the top of many ornamentals, even during active growth. There are some exceptions, however, that are mentioned in this publication and on herbicide labels.
8. Applying the same herbicide time after time can result in a buildup of weeds that are resistant to the herbicide. Use combinations of herbicides and periodically switch the herbicides used.

9. No one preemergence herbicide controls all weeds. Some work best on broadleaved weeds and some work best on grasses. A very few provide good control of nutsedge. All of the preemergence herbicides labeled for use in ornamentals are listed in Table 3 and are categorized by the weeds they control best and the sites in which they can be used.

TABLE 3. PREEMERGENCE HERBICIDES LABELED FOR USE IN ORNAMENTALS CATEGORIZED BY WEEDS THEY CONTROL BEST AND SITES IN WHICH THEY CAN BE USED.

Best for broadleaves	Field	Container	Landscape	Ground covers and vines	Herbaceous plants
Aatrex	X				
Gallery	X	X	X	X	X
Goal	X	X			
Princep	X				
Ronstar	X	X	X	X	X
Best for grasses					
Barricade	X	X	X	X	X
Devrinol	X	X	X	X	X
Dimension	X	X	X	X	X
Pendulum	X	X	X	X	X
Pennant Magnum	X	X	X	X	X
Predict	X				
Surflan	X	X	X	X	X
Treflan	X	X	X	X	X
XL (Surflan + Balan)	X	X	X	X	X
Best for nutsedge					
Pennant Magnum	X	X	X	X	X
Combinations					
OH2 (Goal + Pendulum)	X	X	X	X	
Regal O-O (Goal + Ronstar)	X	X	X		
Rout (Goal + Surflan)	X	X	X	X	X
Snapshot (Gallery + Treflan)	X	X	X	X	X
RegalStar G (Ronstar + Barricade)	X	X	X	X	X
Control some perennial weeds					
Casoron	X		X		
Image			X		
Kerb	X				
Pennant Magnum	X	X	X	X	X

Aatrex, many others (atrazine) **Producer: Syngenta**

Application rate: 2–4 lb ai/A.

Formulation	per acre	per 1000 sq ft
4L	2–4 qt	1.5–3 oz
90DF	2.2–4.4 lb	0.8–1.6 oz

Solubility: 33 ppm (low to medium).

Stability on soil: High. Low leaching potential.

Mode of action: Absorbed mostly by roots, but may be absorbed by soft, new growth of both weeds and trees. It translocates to leaves and growing points, where it inhibits photosynthesis.

Crop uses: Newly planted and established field-grown Christmas trees.

Weed control strengths: Controls most broadleaved weeds and some annual grasses. Provides some control of established fine fescues, including hard fescue. Provides some postemergence control of annual weed seedlings.

Weed control weaknesses: Does not provide control of annual grasses for long periods.

Notes: May be applied over the top of trees before budbreak. After budbreak, apply as a directed spray. *Aatrex is a restricted use product.*

Barricade, Endurance, RegalKade G (prodiamine) **Producer: Syngenta**

Application rate: 0.65–1.5 lb ai/A.

Formulation	per acre	per 1000 sq ft
0.5G	150–300 lb	3.4–6.8 lb
65WG	1.0–2.3	0.4–0.8 oz
4FL	21 oz	0.5 oz

Solubility: 0.013 ppm (very low).

Stability on soil: Medium (photodecomposition and volatilization). Strongly adsorbed by soil, not readily leached.

Mode of action: Prevents seed germination. Absorbed through roots and inhibits root and shoot growth.

Crop uses: Barricade—ornamental trees, shrubs, flowers, turf in landscapes. Endurance—ornamental trees, shrubs, and flowers in landscapes; seedling nurseries; noncrop areas.

Weed control strengths: Controls most annual grasses and some broadleaved weeds.

Weed control weaknesses: Does not control many annual broadleaved weeds.

Notes: Apply under mulch. Should be incorporated with cultivation, rainfall, or irrigation within 14 days of application. May be applied over the top of many ornamentals. Do not apply more than 1.5 lb ai/A per year.

Betasan, Lescosan, Prefar (bensulide) **Producer: Gowan Company**

Application rate: 10–20 lb ai/A.

Formulation	per acre	per 1000 sq ft
4E	15–25 pt	5.5–9.2 oz
7G	107–180 lb	2.4–4.1 lb
12.5G	80–100 lb	1.8–2.3 lb

Solubility: 25 ppm (low/medium).

Stability on soil: High, but inactivated by soils containing high amounts of organic matter; temperature stable; slight photodecomposition.

Mode of action: Inhibits root growth.

Crop uses: Established turfgrass, ornamentals, bulbs, other flowers, and ground covers.

Weed control strengths: Controls annual grasses and some broadleaved weeds.

Weed control weaknesses: Does not control many annual broadleaved weeds.

Notes: Apply under mulch and activate with one-half inch of irrigation immediately after application. Use on mineral soils only.

Casoron, Norosac, Dyclomec, Barrier (dichlobenil) **Producer: Uniroyal, PBI/Gordon**

Application rate: 4–6 lb ai/A.

Formulation	per acre	per 1000 sq ft
4G	100–200 lb	2.3–4.6 lb

Solubility: 25 ppm (low/medium).

Stability on soil: Low; evaporates rapidly from moist soils at high temperatures. To ensure herbicide activity, apply in cool weather (below 45°F) just before a rainfall, or follow application with irrigation, cultivation, or mulching. Leaching potential is low on fine-textured soils (clay) and moderate on coarse-textured soils (sandy).

Mode of action: Acts primarily on growing points and root tips, inhibiting growth of meristems. Upward translocation of root-absorbed dichlobenil is rapid. Leaves can easily absorb its vapors.

Crop uses: Established landscape and field-grown woody ornamentals, nut and fruit trees, and noncropland.

Weed control strengths: Preemergence control of annual and perennial broadleaved and grassy weeds. One of the few preemergence herbicides that will control established winter annual and perennial weeds. The best material for controlling perennial mugwort (chrysanthemum weed). Other established perennial weeds controlled or suppressed include field horsetail (*Equisetum*), tall fescue, orchardgrass, wild carrot, yellow nutsedge, quackgrass, and bindweed.

Weed control weaknesses: Does not provide good preemergence weed control far into the growing season.

Notes: Apply under mulch. Do not make surface application to areas cultivated during the fall or summer before application; do

not use for 4 weeks after transplanting, 6 months after cuttings root or after planting rooted cuttings. Do not use on light, sandy soils. Do not allow granules to accumulate and contact trunk at or below the soil line. Do not use on hollies, firs, hemlocks, and spruce or on pines that have been established for less than 2 years. Dichlobenil can move downhill—use with caution on slopes.

Devrinol, Hurdle (napropamide) Producer: Sygenta

Application rate: 4–6 lb ai/A.

Formulations	per acre	per 1000 sq ft
2G	200–300 lb	4.6–6.9 lb
5G	80–120 lb	1.8–2.8 lb
50WP	8–12 lb	3.0–4.4 oz

Solubility: 73 ppm (medium).

Stability on soil: Medium to low. Little is lost to volatilization, but photodecomposition can occur from high-intensity sunlight. Low leaching potential.

Mode of action: Unknown. Inhibits development and growth of germinating weeds.

Crop uses: Landscape, field, liner, and container-grown ornamentals, including ground covers, flowers, and warm-season turf.

Weed control strengths: Controls most annual grasses and some broadleaved weeds, including chickweed.

Weed control weaknesses: Does not control a broad spectrum of annual broadleaved weeds.

Notes: Apply under mulch. Apply to newly planted container stock after soil is settled from first watering. Best applied in fall or early spring. Summer applications should be covered with a mulch or incorporated with irrigation shortly after application. The sooner water is applied (rainfall or irrigation) after application, the better the control.

Dimension (dithiopyr) Producer: Dow AgroSciences LLC

Application rate: 0.5 lb ai/A

Formulation	per acre	per 1000 sq ft
1 EC	2 qt	1.5 fl oz
2 SC	1 qt	0.73 fl oz
40 WP	1.25 lb	0.46 oz

Solubility: 1.38 ppm (very low)

Stability on soil: High. Low leaching potential

Mode of action: Inhibits shoot and root growth through inhibition of cell division and cell elongation.

Crop uses: Landscape, field, and container-grown ornamentals, including ground covers, ornamental grasses, herbaceous perennials, bedding plants, bulbs, and cool and warm season grasses.

Weed control strengths: Controls several annual grass and small-seeded broadleaf weeds.

Weed control weaknesses: Does not control a broad spectrum of annual broadleaved weeds.

Notes: Only apply this product to established turf and ornamentals. Do not incorporate this product into the soil. Do not apply this product around ornamental plants that have been weakened or are under stress. Do not make applications when weather conditions favor drift to nontarget areas. This product may injure foliage of nontarget plants. Do not apply this product in enclosed structures and greenhouses. Do not apply another herbicide within 4 weeks of application of this product.

Endurance—see Barricade

Gallery (isoxaben) Producer: Dow AgroSciences

Application rate: 0.5–1 lb ai/A.

Formulation	per acre	per 1000 sq ft
75DF	0.66–1.33 lb	0.25–0.5 oz

Solubility: 1 ppm (very low).

Stability on soil: High. Low leaching potential.

Mode of action: Appears to disrupt root and hypocotyl development, killing susceptible plants prior to emergence from the soil. Very little absorption through foliage.

Crop uses: Established landscape, field, and container-grown woody and herbaceous ornamentals; ground covers; some bulbs; ornamental grasses; and turf.

Weed control strengths: Preemergence control of most broadleaved weeds with some suppression of annual grasses.

Weed control weaknesses: Does not control velvetleaf, mallow, morningglory, cutleaf evening primrose, nutsedge, or annual grasses.

Notes: Apply under mulch. May be applied over the top of many ornamental plants. Do not use on bedding plants. Do not apply to ground covers until they are well rooted. Soil or growing medium must be irrigated and well settled before applying to recently transplanted stock. Do not use on *Euonymus alatus*, lilacs, hydrangea spp, ajuga, iberis, sedum, euphorbia, and mustards. Should be incorporated with cultivation, rainfall, or irrigation within 21 days of application. Snapshot TG is a premixed granular combination of Gallery + Treflan.

Goal 2XL (oxyfluorfen) Producer: Dow AgroSciences

Application rate: 0.25–2 lb ai/A.

Formulation	per acre	per 1000 sq ft
2.0E	1–8 pt	0.4–2.9 fl oz

Solubility: 0.1 ppm (very low).

Stability on soil: Medium to high. Low leaching potential.

Mode of action: Forms a chemical barrier on the soil surface. As weeds grow through it, they are burned off through contact activity. Light is required for activity.

Crop uses: Conifer seedbeds, transplants, container stock, and selected field-grown deciduous trees.

Weed control strengths: Provides excellent control of most broadleaved weeds and many grasses from seed. One of the few preemergence herbicides that can provide very good postemergence control of weeds up to 4 inches tall. Controls mile-a-minute weed.

Weed control weaknesses: Does not provide complete control of emerged grasses or large broadleaved weeds. Does not control horseweed. Annual grasses are the first weeds to begin growing in areas treated with Goal.

Notes: Apply over the top of mulch. Goal needs light to be active. Covering with a mulch or incorporating it will inactivate it. Anything that breaks the chemical barrier (like cultivation) will reduce its effectiveness. Goal can be applied to conifer seedbeds prior to emergence of the conifers. After emergence, wait a minimum of 5 weeks before applying over the top of the conifers. For postemergence control, add 0.25% nonionic surfactant and apply to weed seedlings less than 4 inches tall. Goal can burn the soft growth of broadleaved ornamentals it directly contacts. Premixed combinations include OH2 (Goal + Pendulum), Rout (Goal + Surflan), and Regal O-O (Goal + Ronstar). All are produced as granular formulations. Combine Goal 2XL with Vantage to control broadleaved and grass weed seedlings.

Image (imazaquin)

Producer: BASF

Application rate: 0.4–0.5 lb ai/A.

Formulation	per acre	per 1000 sq ft
70DG	8.7–11.3 oz	0.2–0.26 oz

Solubility: 600 ppm (very high).

Stability on soil: High. High leaching potential.

Mode of action: Inhibits the production of certain amino acids; kills growing points first.

Crop uses: Landscape ornamentals and warm-season turfgrass.

Weed control strengths: Preemergence and postemergence control of broadleaved weeds such as Carolina geranium, henbit, chickweed, and buttercup; wild garlic and onion; yellow and purple nutsedge; and some grasses.

Weed control weaknesses: Not labeled for many ornamental species. Does not control many annual or perennial grasses or some broadleaved weeds.

Notes: Do not apply to unlabeled ornamentals, cool-season turf, annual bedding plants, or container-grown ornamentals. The label warns against use on the following plants: Abelia, Azalea, Ligustrum, Pieris, Viburnum.

Kerb (pronamide)

Producer: Dow AgroSciences

Application rate: 1–2 lb ai/A.

Formulation	per acre	per 1000 sq ft
50W	2–4 lb	0.7–1.5 oz

Solubility: 15 ppm (low to medium).

Stability on soil: Medium to high. Loss through photodecomposition and volatilization is highly dependent on temperature. Leaching potential medium to low.

Mode of action: Absorbed through the roots, translocated upward; inhibits growth. Not absorbed through foliage.

Crop uses: Field-grown woody ornamentals.

Weed control strengths: Preemergence and early postemergence control of winter annual and perennial grasses, such as quackgrass, and some winter annual broadleaved weeds. One of the few preemergence herbicides that provide control of established perennial weeds. Kerb is the best material for controlling fine fescues (red, hard, sheeps, and chewings).

Weed control weaknesses: Does not provide preemergence control far into the spring.

Notes: Apply under mulch. Apply in the fall after the temperature will stay below 55°F but before the soil freezes. Do not apply to seedlings or transplants less than 1 year old. *Kerb is a restricted use product.*

Ornamental Herbicide II (OH2)
(oxyfluorfen + pendimethalin)

Producer: The Scotts Co.

Application rate: 3 lb ai/A.

Formulation	per acre	per 1000 sq ft
3G	100 lb	2.3 lb
(2% oxyfluorfen, 1% pendimethalin)		

Solubility: oxyfluorfen, 0.1 ppm; pendimethalin, 0.275 ppm (both very low).

Stability on soil: Medium to high. Low leaching potential.

Mode of action: Oxyfluorfen acts as a contact herbicide and requires light for activation; pendimethalin inhibits root development.

Crop uses: Field and container-grown woody ornamentals and ground covers.

Weed control strengths: Controls most annual weeds.

Weed control weaknesses: Few.

Notes: Apply over the top of mulch. Do not apply while plants are producing a new flush of spring growth. Do not apply in extreme cold temperatures. Irrigate after application to wash granules from the foliage and activate the herbicide. Soil particles splashed onto low foliage by coarse irrigation or heavy rainfall can carry enough herbicide to severely injure low-growing sensitive plants. Laying down a light mulch prior to the herbicide application will prevent this problem. Not recommended for field liner beds, but may be used on potted bareroot liners 3 to 4 weeks after potting.

Pendulum, Corral
(pendimethalin) Producers: BASF Corp.; The Scotts Co.

Application rate: 2–4 lb ai/A.

Formulation	per acre	per 1000 sq ft
3.3EC	2.4–4.8 qt	1.8–3.5 fl oz
60WDG	3.3–6.6 lb	1.2–2.4 oz
2.68G	74–114 lb	1.7–2.6 lb

Solubility: 0.275 ppm (very low).

Stability on soil: Medium to high. Slight losses from photodecomposition and volatilization. Low leaching potential.

Mode of action: Inhibits root growth through inhibition of cell division and cell elongation.

Crop uses: Field or container-grown woody ornamentals, landscapes, ground covers, herbaceous perennial and annual flowers, ornamental grasses, and turf.

Weed control strengths: Controls most annual grasses and some broadleaved weeds.

Weed control weaknesses: Does not control many annual broadleaved weeds.

Notes: Apply over or under mulch, preferably under. Stains equipment and anything else it contacts. Should be incorporated by cultivation, rainfall, or irrigation within 14 days of application. Delay application to potted bareroot liners 2 to 4 weeks after transplanting. Plants in field liner beds must be well rooted with the soil firmed prior to use. May be used over the top of many ornamental species. OH2 is a premixed granular formulation of Goal and Pendulum.

Pennant Magnum (metolachlor) Producer: Syngenta

Application rate: 1.25–2.5 lb ai/A.

Formulations	per acre	per 1000 sq ft
7.6 EC	1.3–2.6 pts	14–28 ml

Solubility: 530 ppm (high).

Stability on soil: Medium. Volatilization may occur under hot, moist conditions. Medium to high leaching potential. Apply higher rates to fine-textured soils.

Mode of action: General growth inhibitor, especially of root elongation. Germinating monocot seedlings absorb metolachlor through the shoots just above the seed, whereas dicots absorb it through both shoots and roots; may inhibit protein synthesis.

Crop uses: Landscape, field, and container-grown woody and herbaceous perennials; ground covers; bulbs; annual flowers; liner or transplant beds; and nonbearing fruit trees.

Weed control strengths: Best preemergence herbicide for control of yellow nutsedge. Also controls many annual grasses and some broadleaved weeds.

Weed control weaknesses: Does not control many annual broadleaved weeds.

Notes: Apply either over or under mulch. Do not apply to seedbeds or cutting beds before transplanting. Do not make more than two applications per year. Wash from foliage to reduce the chance of injury when applied over the top.

Predict (norflurazon) Producer: Syngenta

Application rate: 2.4 lb ai/A.

Formulation	per acre	per 1000 sq ft
80WP	3 lb	1.1 oz

Solubility: 28 ppm (low to medium).

Stability on soil: Medium. Loss from photodecomposition and volatilization can occur when exposed on the soil surface. Medium to low leaching potential.

Mode of action: Inhibits photosynthesis by interfering with the development of carotenoids, a plant pigment that protects chlorophyll.

Crop uses: Field-grown nursery stock. Not recommended for any conifers except juniper.

Weed control strengths: Controls many annual grasses and broadleaved weeds and suppresses others including nutsedge.

Weed control weaknesses: Few.

Notes: Do not apply until the fall following the first full season of growth in the field after transplanting. Make only one application per year. Use only on medium- and fine-textured soils; do not apply to coarse-textured soil. Apply as a directed spray to avoid contact with foliage. Should be incorporated by cultivation, rainfall, or irrigation within 4 weeks.

Princep Liquid, Princep DF, Princep Caliber 90,
Princep 4L, Simazine, Simtrol (simazine)
Producers: Syngenta; Drexel

Application rate: 2–4 lb ai/A.

Formulation	per acre	per 1000 sq ft
4L	2–4 qt	1.5–3 fl oz
90DF	2.2–4.4 lb	0.8–1.6 oz

Solubility: 3.5 ppm (low).

Stability on soil: High. Low leaching potential.

Mode of action: Absorbed mostly through roots; translocated to leaves and growing points, where it inhibits photosynthesis.

Crop uses: Field or container-grown nursery stock and landscapes.

Weed control strengths: Controls most broadleaved weeds and some annual grasses. Can control annual broadleaved weeds in the dormant rosette stage.

Weed control weaknesses: Does not provide control of annual grasses for long periods. Does not control velvetleaf. After several years of use, resistant types of normally sensitive weeds may develop.

Notes: Apply under or over the top of mulch, preferably under. Use lower rates on coarser-textured soils and soil low in organic matter. Do not apply for 1 year after transplanting. Do not apply to Christmas trees less than 2 years old. Do not apply more than 4 pounds of active ingredient per acre in a year.

RegalKade G—see Barricade

RegalStar G
(oxadiazon + prodiamine) **Producer: Regal Chemical Co.**

Application rate: 2.5 lb ai/A.

Formulation	per acre	per 1000 sq ft
2.5G	200 lb	4.5 lb

Solubility: oxadiazon, 0.7 ppm (very low); prodiamine, 0.013 ppm (very low).

Stability on soil: High. Low leaching potential.

Mode of action: Oxadiazon forms a chemical barrier on the soil surface. As weeds grow through it, they are burned off through contact activity. Prodiamine is a root inhibitor.

Crop uses: Landscape, field, and container-grown woody ornamentals.

Weed control strengths: Preemergence control of annual grasses and broadleaved weeds.

Weed control weaknesses: Few.

Notes: Apply over the top of mulch. Needs light to be active. Covering with a mulch or incorporating it will inactivate it. Anything that breaks the chemical barrier will reduce its effectiveness. Soil particles splashed onto low foliage by coarse irrigation or heavy rainfall can carry enough herbicide to severely injure low-growing, sensitive plants. Laying down a light mulch prior to the herbicide application will prevent this problem. Do not apply to wet foliage or under conditions in which granules will collect on leaves.

Regal O-O
(oxyfluorfen + oxadiazon) **Producer: Regal Chemical Co.**

Application rate: 3 lb ai/A.

Formulation	per acre	per 1000 sq ft
3G	100 lb	2.3 lb

Solubility: oxyfluorfen, 0.1 ppm; oxadiazon 0.7 ppm (both very low).

Stability on soil: High. Low leaching potential.

Mode of action: Forms a chemical barrier on the soil surface. As weeds grow through it, they are burned off through contact activity.

Crop uses: Landscape, field, and container-grown woody ornamentals.

Weed control strengths: Preemergence control of annual grasses and broadleaved weeds.

Weed control weaknesses: Few.

Notes: Anything that breaks the chemical barrier will reduce its effectiveness. Soil particles splashed onto low foliage by coarse irrigation or heavy rainfall can carry enough herbicide to severely injure low-growing, sensitive plants. Laying down a light mulch prior to the herbicide application will prevent this problem.

Ronstar (oxadiazon) **Producer: Bayer Environmental Sciences**

Application rate: 2–4 lb ai/A.

Formulation	per acre	per 1000 sq ft
2G	100–200 lb	2.25–4.5 lb
50WP	4–8 lb	1.5–3 oz

Solubility: 0.7 ppm (very low).

Stability on soil: High. Low leaching potential.

Mode of action: Forms a chemical barrier on the soil surface. As weeds grow through it, they are burned off through contact activity. The sprayable formulation can kill existing weeds if they are thoroughly covered.

Crop uses: Landscape, field, and container-grown woody ornamentals; liners; conifer seedbeds; ground covers; some herbaceous ornamentals; and turf.

Weed control strengths: Preemergence control of annual grasses and broadleaved weeds. The 50WP formulation will control some emerged weeds.

Weed control weaknesses: Does not control spurge or chickweed from seed.

Notes: Apply over the top of mulch. Ronstar needs light to be active. Covering with a mulch or incorporating it will inactivate it. Anything that breaks the chemical barrier will reduce its effectiveness. The WP formulation can cause foliar damage; use as a directed spray only. Soil particles splashed onto low foliage by coarse irrigation or heavy rainfall can carry enough Ronstar to severely injure low-growing, sensitive plants. Laying down a light mulch prior to the herbicide application will prevent this problem. Regal O-O is a premixed granular combination of Goal and Ronstar.

Rout (oxyfluorfen + oryzalin) **Producer: The Scotts Co.**

Application rate: 3 lb ai/A.

Formulation	per acre	per 1000 sq ft
3G	100 lb	2.3 lb
(2% oxyfluorfen, 1% oryzalin)		

Solubility: oxyfluorfen, 0.1 ppm (very low); oryzalin, 2.6 ppm (low).

Stability on soil: Medium to high. Low leaching potential.

Mode of action: Oxyfluorfen acts as a contact herbicide and requires light for activation; oryzalin inhibits root growth.

Crop uses: Field, landscape, and container-grown ornamentals; some ground covers and flowers.

Weed control strengths: Controls most annual weeds.

Weed control weaknesses: Few.

Notes: Apply over the top of mulch. Do not apply to plants with leaves that channel granules to the leaf base. Do not apply 2 weeks before or after leaf bud break; do not apply within 2 months of using other herbicides. Do not apply more than two applications per season. Soil particles splashed onto low foliage by coarse irrigation or heavy rainfall can carry enough herbicide to severely injure low-growing, sensitive plants. Laying down a light mulch prior to the herbicide application will prevent this problem. Cultivation or covering with a mulch will inactivate the Goal component of Rout.

Snapshot
(isoxaben + trifluralin) **Producer: Dow AgroSciences**

Application rate: 2.5–5 lb ai/A.

Formulation	per acre	per 1000 sq ft
2.5TG	100–200 lb	2.3–0.4.6 lb
(0.5% isoxaben, 2% trifluralin)		

Solubility: isoxaben, 1 ppm; trifluralin, 0.3 ppm (both very low).

Stability on soil: Low. No significant losses of isoxaben through photodecomposition or volatilization, but trifluralin can be lost through both. Low leaching potential.

Mode of action: Isoxaben appears to disrupt root and hypocotyl development but this has not been documented; trifluralin inhibits root growth.

Crop uses: Field, landscape, and container-grown ornamentals including ground covers, bulbs, herbaceous perennials, ornamental grasses, and nonbearing fruit trees.

Weed control strengths: Controls most annual broadleaved weeds and grasses.

Weed control weaknesses: Few.

Notes: Apply under mulch. See notes for isoxaben and trifluralin. Applications of 150 lb per acre should not be made less than 60 days apart. Do not apply more than 600 lb per acre in a 12-month period. Do not apply within 3 weeks of enclosing overwintering structures. Users who want to try this product on plants not on the label are permitted by the label to use Snapshot TG on small groups of plants prior to using it on a larger scale. Many growers have found this to be a suitable product for use on a wide variety of herbaceous perennial plants not on the label. However, the user assumes all risk associated with these applications.

Surflan (oryzalin) **Producer: Dow AgroSciences**

Application rate: 2–4 lb ai/A.

Formulation	per acre	per 1000 sq ft
4AS	2–4 qt	1.5–3 fl oz

Solubility: 2.6 ppm (low).

Stability on soil: High. Minimal losses from photodecomposition and volatilization occur. Low leaching potential.

Mode of action: No significant absorption or translocation. Affects physiological growth processes associated with seed germination; inhibits root growth.

Crop uses: Established field, landscape, and container-grown ornamentals, including some ground covers, herbaceous perennials, bulbs, annual flowers, and warm season turf. It may be used to control weeds in the floors of open polyhouses, but not in enclosed structures. Do not apply within 3 weeks of covering polyhouses.

Weed control strengths: Controls annual grasses and some broadleaved weeds.

Weed control weaknesses: Does not control many annual broadleaved weeds.

Notes: Apply over or under mulch, preferably under. Do not use on soils containing more than 3% organic matter; do not use on conifer seed and transplant beds. Do not apply to pots less than 4 inches wide or to newly planted material until the soil or potting mix is settled by packing and irrigation. Do not use on slender deutzia, Douglas fir, Techny arborvitae, eastern hemlock, begonia, or coleus. Premixed combinations include Rout (oxyfluorfen + oryzalin) and XL (oryzalin + benefin). Rout controls both broadleaved weeds and grasses; XL controls most grasses but few broadleaved weeds.

Treflan (trifluralin) **Producer: Dow AgroSciences**

Application rate: 0.5–4 lb ai/A. Use lower rates if mechanically incorporated and higher rates if applied to the surface and watered in.

Formulation	per acre	per 1000 sq ft
5G	80 lb	29 oz
4EC	1 pt –1 gal	0.4–3 fl oz

Solubility: 0.3 ppm (very low).

Stability on soil: Low (photodecomposition and volatility). Low leaching potential.

Mode of action: No significant absorption or translocation. Affects seed germination by inhibiting root growth.

Crop uses: Landscape, field, and container-grown woody ornamentals; liners; herbaceous perennials; ground covers; bulbs; and annual flowers. More annual flowers are on this label than on any other preemergence herbicide label.

Weed control strengths: Controls most annual grasses and some broadleaved weeds.

Weed control weaknesses: Does not control many annual broadleaved weeds.

Notes: Apply under mulch. Not recommended for muck soils. For best results, cover with a mulch or irrigate within a few hours of application. Can be applied and mechanically incorporated prior to planting. Use lower rates (maximum 2 pints) if mechanically incorporated and higher rates if incorporated with irrigation. Typar Biobarrier is made with pellets that slowly release trifluralin into the soil to prevent root growth in certain areas for up to 20 years.

Application rate: 2–3 lb ai/A.

Formulation	per acre	per 1000 sq ft
2G	100–150 lb	2.3–3.4 lb
(1% oryzalin + 1% benefin)		

Solubility: oryzalin, 2.6 ppm; benefin, 0.1 ppm (low).

Stability on soil: oryzalin, high; benefin, medium (photodecomposition). Low leaching potential.

Mode of action: Inhibits root growth.

Crop uses: Established warm season turfgrass; landscape, field, and container-grown ornamentals, including some annual flowers and bulbs and ground covers.

Weed control strengths: Controls most annual grasses and some broadleaved weeds.

Weed control weaknesses: Does not control many annual broadleaved weeds.

Mulch: Apply over or under mulch, preferably under.

Notes: Do not use on the cool season turfgrasses common in the Northeast. Read the notes for Surflan.

Postemergence herbicides

- *Nonselective, translocated herbicides* that are absorbed through the foliage and translocated throughout the plants, killing the tops and roots:
 - Roundup Pro, Glyphos, Rodeo, Touchdown
- *Nonselective, contact herbicides* that provide quick kill of the foliage of weeds but do not kill underground parts of perennial weeds:
 - Finale
 - Reward
 - Scythe
- *Selective herbicides that control grasses* but not broadleaved weeds:
 - Acclaim Extra
 - Envoy
 - Fusilade II, Ornamec
 - Vantage
- *Selective herbicides that control broadleaved weeds* but not grasses:
 - Basagran T/O
 - Garlon 3A and 4E
 - Lontrel
- *Selective herbicides that control nutsedge:*
 - Basagran T/O
 - Manage

The following observations are relevant to any of the postemergence herbicides that are absorbed by foliage and translocated throughout the plant:

1. Intact foliage is needed to absorb the chemical, and intact foliage and root systems are needed for complete translocation. Do not mow or cultivate for at least 2 weeks prior to application or 5 to 7 days following application.
2. Healthy, actively growing weeds are controlled faster and more thoroughly than plants under stress from drought or pest problems. Injury symptoms from contact herbicides develop quickly (from hours to a day or two). Injury symptoms from the translocated products may take 7 to 14 days to develop.
3. The postemergence herbicides in the following list have very little soil activity. Planting can follow application by 3 to 5 days. Though the symptoms of injury from the translocated herbicides develop slowly, once the herbicides have had time to move into weed roots, the soil may be worked.
4. Control of perennial weeds requires higher rates of application than control of annual weeds.
5. A surfactant may be needed to improve coverage of the foliage and absorption into the weeds. Some products include surfactant with them; for others one must be added. A typical amount would be 0.25% v/v (volume to volume). To make a 0.25% solution, add 2 teaspoons to 1 gallon or 1 pint to 50 gallons. The exact amount to add will vary with the brand of the surfactant. Read the label of the surfactant to determine the exact amount needed.

SURFACTANTS

The term *surfactant* is a shortened form of “surface active agent” and refers to a variety of chemicals with several uses. *Wetting agents*, also called *spreaders*, are surfactants that cause spray droplets to spread further and achieve more complete coverage of leaf surfaces. They may intensify the toxicity of a postemergence herbicide and should be used only when recommended. *Spreader-stickers* help hold chemicals on the leaf surface for extended periods of time and are usually used only with insecticides and fungicides, *not* herbicides. *Crop oil concentrates* not only act as spreaders but, more important, they also help chemicals penetrate the waxy coatings of leaves. This results in improved weed control, but also increases the risk of injury to the ornamentals. Use them only as directed on the labels of the herbicide and oil. Surfactants may be nonionic, cationic, or anionic. Use only the type directed on the herbicide label. Different surfactants contain different amounts of active ingredient. For commercial use, purchase only surfactants that contain at least 75% active ingredient.

Wetting agents will improve the effectiveness of the nonselective herbicides Finale and Reward. A wetting agent should not be used with RoundupPro unless the herbicide is being used for site preparation. Wetting agents should also be used with the selective grass herbicides Acclaim Extra, Fusilade II, and Prism.

Any of the surfactants, but especially crop oil concentrates, may cause blue-green conifers to temporarily lose their blue color.



Patches of perennial weeds should be eliminated from a field by spot-treating them with a postemergence, translocated herbicide before they have the chance to spread. The competition from other weeds has been eliminated from around this quackgrass, providing a perfect opportunity for it to spread throughout the field.



Postemergence herbicides that selectively kill grasses are very useful in nursery and landscape plantings. Fusilade was used to kill grass seedlings in the bed on the left.

Acclaim Extra (fenoxaprop-p-ethyl)

Producer: Bayer Environmental Sciences

Application rate: 0.016–0.47 lb ai/A. Use low rates on untiltered grasses and higher rates as the number of tillers increases. For spot treatments apply 0.3–0.5 fl oz/gal.

Formulation	per acre	per 1000 sq ft
0.57EC	3.5–39 fl oz	0.08–0.9 fl oz

Rate of absorption: Allow 1 hour between application and rainfall.

Mode of action: Absorbed through leaves and translocated to growing points above and below ground, where it stops growth, resulting in death of the plant.

Crop uses: Established turfgrass; ornamental trees and shrubs; herbaceous and flowering plants.

Weed control strengths: Postemergence control of most annual and a few perennial grasses.

Weed control weaknesses: Does not control broadleaf weeds, sedges, or some perennial grasses.

Notes: May be used over the top of many ornamentals. The addition of a surfactant will improve coverage of treated foliage. Do not use Acclaim Extra on Bar Harbor juniper, salvia, podocarpus, or pittosporum.

Basagran T/O (bentazon)

Producer: BASF

Application rate: 0.75–1 lb ai/A. Addition of a crop oil concentrate will increase activity. The amount to add varies with the total volume of spray solution applied.

Formulation	per acre	per 1000 sq ft
4L	1.5–2 pt	0.5–0.75 fl oz

Rate of absorption: Allow 8 hours between application and irrigation or rainfall.

Mode of action: Effective mainly through contact action, so weeds must be thoroughly covered with spray solution.

Crop uses: Apply as a directed spray to nonbearing fruit and nut trees, turf, and selected field-grown ornamental trees, shrubs, and ground covers. Over-the-top applications can be made on English ivy, lirioppe, and pachysandra.

Weed control strengths: Controls annual sedges, yellow nutsedge, and some other broadleaved weeds. It suppresses Canada thistle.

Weed control weaknesses: Does not control grasses or many broadleaved weeds.

Notes: Avoid contact with crop foliage, especially conifers. The oil concentrate may cause a slight burn of ornamentals, but new growth following application should be normal, and vigor is not reduced. Injury to ornamentals is more likely to occur under hot, humid conditions.

Envoy (clethodim)**Producer: Valent**

Application rate: 0.1–0.25 lb ai/A. For spot treatments use a 0.5% solution of Prism (0.6 fl oz/gal). Add a nonionic surfactant at 0.25% v/v to all spray solutions (0.3 fl oz/gal or 1 pt/50 gal). Apply to actively growing grasses less than 8 inches tall for best results.

Formulation	per acre	per 1000 sq ft
0.94L	13–34 fl oz	0.3–0.8 fl oz

Rate of absorption: Do not apply if rainfall is expected within 1 hour of application.

Mode of action: Absorbed through leaves and translocated to growing points above and below ground, where it stops growth, resulting in the death of the plant.

Crop uses: Ornamental trees, shrubs, ground covers, and vines; garden flowers; nonbearing fruit trees; and greenhouses.

Weed control strengths: Controls most annual and perennial grasses.

Weed control weaknesses: Does not control sedges, broadleaved weeds, or fine fescues (red, chewings, hard, sheeps).

Notes: 7 to 14 days are required for control of grasses.

Finale (glufosinate-ammonium)**Producer: Bayer Environmental Sciences**

Application rate: 0.75–1.5 lb ai/A. Apply 3–4 qt/A when weeds are less than 8 inches tall; apply 5–6 qt/A when weeds are 8 inches or taller. For spot applications, apply 1.5–4 fl oz/gal.

Formulation	per acre	per 1000 sq ft
1SC	3–6 qt	2.2–4.4 fl oz

Rate of absorption: Allow 4 hours between application and rainfall.

Mode of action: Absorbed into the leaves, but there is little translocation. Kills primarily through contact activity, so thorough coverage of the foliage is necessary.

Crop uses: Landscape, field, and container-grown established woody ornamentals. One of the few herbicides labeled for use in greenhouses, even with plants present.

Weed control strengths: It is a nonselective herbicide that controls a broad spectrum of emerged annual and perennial grasses, broadleaved weeds, and sedges.

Weed control weaknesses: As a contact herbicide, it does not control the underground portions of perennial weeds.

Notes: Avoid all contact with foliage or green tissue of desirable vegetation. The bark of thin-barked trees can be injured if directly sprayed. Do not use to control suckers. When used in greenhouses, air circulation fans must be turned off, and large droplet, low-pressure type nozzles should be used.

Fusilade II, Ornamec**(fluazifop-p-butyl)****Producer: Syngenta, PBI Gordon**

Application rate: 0.25–0.4 lb ai/A. For spot treatments apply 0.75 (2.0 L), 1.5 (1.0 L), or 2.5 (0.5 L) fl oz/gal. Add a nonionic surfactant at 0.25% v/v (0.3 fl oz/gal or 1 pt/50 gal) to all spray solutions.

Formulation	per acre	per 1000 sq ft
0.5L	2–3 qt	1.5–2.2 fl oz
1.0L	1–1.5 qt	0.75–1.1 fl oz
2.0L	16–24 oz	0.4–0.6 fl oz

Rate of absorption: Allow 1 hour between application and rainfall.

Mode of action: Absorbed through leaves and translocated to growing points above and below ground, where it stops growth, resulting in the death of the plant.

Crop uses: Landscape, field, and container-grown woody ornamentals; ground covers; flowers; and Christmas trees. Can be used in greenhouses.

Weed control strengths: Postemergence control of annual and perennial grasses.

Weed control weaknesses: Does not control broadleaved weeds, sedges, rushes, lilies, and other nongrasses. Bluegrass has shown considerable tolerance. Does not control fine fescues (red, chewings, hard, and sheeps).

Notes: Make applications to grasses 2 to 8 inches tall, but before tillering or heading. May be applied over the top of many ornamentals, but a directed spray is specified for some. Injury symptoms of treated grasses develop slowly (7 to 14 days). Do not tank mix with other pesticides or fertilizers.

Garlon 3A and 4E (triclopyr)**Producer: Dow AgroSciences**

Application rate: 0.75–2 lb ai/A.

Formulation	per acre	per 1000 sq ft
3A	2–5 pt	0.7–1.8 fl oz
4E	1.5–4 pt	0.6–1.5 fl oz

Rate of absorption: Allow 4 hours between application and rainfall.

Mode of action: An auxin-type herbicide that is believed to act similar to 2,4-D.

Crop uses: Christmas tree plantings—site preparation prior to planting and directed spray applications after planting; around buildings and in noncrop areas.

Weed control strengths: Postemergence directed spray for hard to control herbaceous annual and perennial broadleaved weeds and woody species such as poison ivy. Is the best nonresidual, postemergence herbicide for controlling woody species.

Weed control weaknesses: Does not control grasses or sedges.

Notes: Apply only in well-established plantations planted at least one full year before application; do not apply when conifers are actively growing. Injury potential is greatest to white pine and Douglas fir. To control unwanted woody species, mix a 10% solution of Garlon 4 in oil (diesel or an oil especially formulated for 'basal bark' applications) and apply to the lower 12 to 18 inches of the woody plants in the dormant season.

Lontrel (clopyralid) **Producer: Dow AgroSciences**

Application rate: 0.09–0.25 lb ai/A.

Formulation	per acre	per 1000 sq ft
3L	4–20 oz	0.1–0.5 fl oz

Rate of absorption: Allow at least 6 hours between application and rainfall.

Mode of action: Absorbed through leaves and translocated to growing points, where it has auxin hormone herbicide-type activity.

Crop uses: Turf and ornamental plantings including sod farms, nurseries, and landscape plantings.

Weed control strengths: Selective postemergence control of certain broadleaf weeds, especially those in the legume (clover, crownvetch) and composite (Canada thistle) families.

Weed control weaknesses: Does not control grasses, sedges, or many broadleaved weeds such as lambsquarter and pigweed.

Notes: Apply before weeds are fully developed. Do not use a surfactant or tree injury may occur.

Manage (halosulfuron) **Producer: Monsanto**

Application rate: 0.031–0.062 lb ai/A.

Formulation	per acre	per 1000 sq ft.
75WG	0.66–1.33 oz	0.4–0.9 g

Solubility: at pH 5, 15 ppm (low); at pH 7, 1630 ppm (high).

Stability on soil: High; very low photodegradation or volatilization. Subject to hydrolysis in moist soils. Medium to low leaching potential, depending on soil pH.

Mode of action: Absorbed by roots and germinating plant shoots; inhibits synthesis of amino acids.

Crop uses: Used as a directed spray around established woody ornamentals.

Weed control strengths: Controls yellow nutsedge and horsetail (*Equisetum*).

Weed control weaknesses: It is labeled for nutsedges and horsetail only.

Notes: Used at extremely low rates—measure carefully. Use 0.5% nonionic surfactant with Manage (1 qt/50 gal; 2 tsp/gal).

Reward, Reward LS (diquat) **Producer: Syngenta**

Application rate: 0.25–0.5 lb ai/A for terrestrial applications; 1–4 lb ai/A for aquatic applications. For spot treatments, apply 2 fl oz per gallon. Add a nonionic surfactant at 0.25%–0.5% v/v (0.3–0.5 fl oz/gal or 1–2 pt/50 gal) to all spray solutions.

Formulation	per acre	per 1000 sq ft
2L, land	1–2 pt	0.4–0.8 fl oz
2L, aquatic	2–8 qt	1.5–6.0 fl oz

Rate of absorption: Allow 1 to 2 hours between application and rainfall.

Mode of action: Contact. Rapidly absorbed by green tissue and interacts with light to produce superoxides which destroy plant cells.

Crop uses: Preplant cleanup for conventional planting and postemergence directed spray in orchards, vineyards, and ornamentals and beneath greenhouse benches. Can be used in industrial, recreational, golf course, commercial, residential, and public areas. Aquatic uses include edges of ponds, lakes, and ditches that have little outflow and are totally under the control of the user.

Weed control strengths: A nonselective postemergence contact herbicide used to control most small annual broadleaved and grassy weeds and to suppress perennial weeds in production nurseries.

Weed control weaknesses: Does not kill below-ground parts of perennial weeds. Some annuals listed on the label are considered difficult to kill.

Notes: Reward kills through contact activity, so thorough coverage of the weed foliage is necessary. Do not allow spray to contact thin bark or green stems of woody ornamentals.

Roundup Pro, Glyphos, Rodeo, Touchdown (glyphosate) **Producer: Monsanto**

Application rate: 1–4 lb ai/A. For spot applications, apply 1.3–2.6 fl oz/gal Roundup Pro or 1–2 fl oz/gal Rodeo. Use 30% solution of Roundup Pro in sponge wick applicators or 50% solution in rope wicks.

Formulation	per acre	per 1000 sq ft
4L	1–4 qt	0.7–3 fl oz
5.4L, Accord	1.5–7.5 pt	0.6–2.8 fl oz

Rate of absorption: Allow 6 hours between application and rainfall.

Mode of action: Absorbed through foliage and green stems and translocated throughout the plant in association with carbohydrates. Since carbohydrate movement is upward during the early stages of regrowth of perennial weeds, best control of perennial weeds is achieved if application is made near the time of flowering, when carbohydrate movement is downward into roots and rhizomes. Interferes with growth, often resulting in death of the plant.

Crop uses: Roundup Pro and Roundup Ultra are used in noncropland, preplant weed cleanup, postplant directed spray in many established woody plants and perennial crops including Christmas trees. Rodeo and Accord can control weeds in or around waterways, including irrigation ponds.

Weed control strengths: Broad spectrum, postemergence control of most herbaceous and woody plants.

Weed control weaknesses: Few.

Notes: Avoid contact with foliage and thin-barked or green stems of desired crops because severe injury or death may result. Bark splitting may occur 1 to 2 years after improper application(s). Foliar injury may be expressed for as long as 5 years after a treatment. Do not use more than 25 gallon spray solution per acre. Do not use to control suckers. Use a surfactant that has an aquatic label with Accord or Rodeo for aquatic weed control.

Scythe (pelargonic acid) **Producer:** Dow AgroSciences

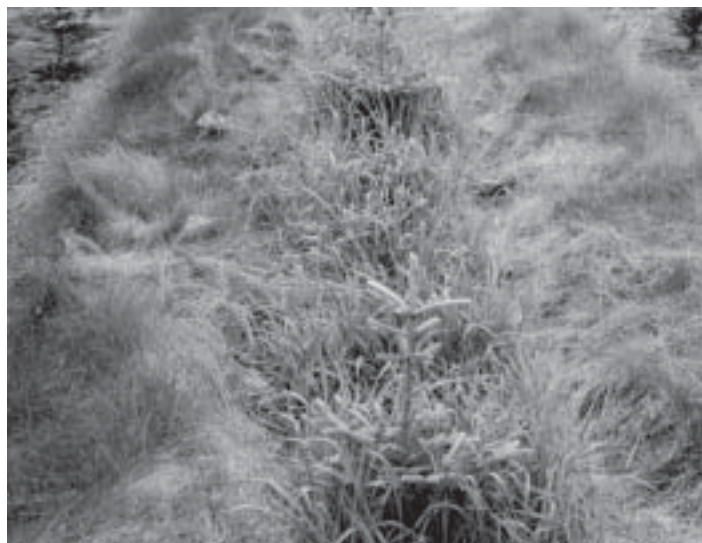
Application rate: 6.5–13 fl oz/gal, applied only as a spot treatment.

Formulation	per acre	spot treatment
18% L	3–27 gal (est.)	6.5–13 fl oz/gal

Mode of action: A contact herbicide that disrupts cell membranes, causing rapid cell desiccation. Thorough coverage of weed foliage is necessary to obtain control.

Crop uses: In and around walks, driveways, flower beds, trees, and shrubs. One of the few materials labeled for use in greenhouses.

Weed control strengths: Postemergence contact herbicide for control of most young, succulent, actively growing weeds.



Combinations of postemergence herbicides may be needed to control all of the weeds in a field. Lontrel alone was applied to the row of conifers in this photograph. The broadleaved weeds are gone, but grasses have filled in the treated area.

Weed control weaknesses: Does not control mature or woody weeds; older annual and perennial weeds may only be suppressed.

Notes: Do not apply using hose-end sprayers. Keep people and pets off treated areas until dry to avoid transfer to desirable vegetation; avoid contact with eyes and skin as irritation can occur. Its odor in enclosed areas is objectionable.

Vantage (sethoxydim) **Producer:** TopPro Specialties

Application rate: 0.3–0.5 lb ai/A. Apply 36 oz/A to grasses up to 6 inches tall; 60 oz/A to grasses up to 12 inches tall. For spot applications, apply 2–3 oz/gal. Vantage includes surfactant; no additional surfactant needed.

Formulation	per acre	per 1000 sq ft
1L	36–60 fl oz	0.8–1.4 fl oz

Rate of absorption: Allow 1 hour between application and rainfall.

Mode of action: Absorbed through leaves and translocated to growing points above and below ground, where it stops growth, resulting in the death of the plant.

Crop uses: Field and container-grown woody ornamentals, ground covers, flowers, and Christmas trees.

Weed control strengths: Postemergence control of annual and perennial grasses.

Weed control weaknesses: Does not control broadleaved weeds, sedges, annual bluegrass, or fine fescues (red, chewings, hard, and sheep).

Notes: May be applied over the top of many ornamentals. Injury symptoms on treated grasses develop slowly (7 to 14 days). Can be used for growth suppression of tall fescue used as a cover crop.



Vantage was applied over the row of conifers in this photograph, controlling the grasses but leaving the broadleaved weeds.

Fumigants

Soil fumigants are used to kill weed seeds and underground plant parts as well as nematodes and disease organisms before planting in areas where high-value crops are to be planted. Fumigation is most commonly used for preparation of seedbeds but is sometimes used to treat potting soil or certain high-value areas in a landscape. Especially careful attention must be given to label directions concerning soil temperatures and preparation, time between treatment and planting, and safety instructions.

Soil fumigation will be most effective if done in late summer or early fall because the soil temperature is relatively high at this time. All fumigants are most effective if the soil temperature is above 55°F at the time of application. Areas that must be fumigated in the spring can be covered with plastic for several days prior to treatment to raise the soil temperature. If needed, the same plastic can then be used to cover the treated area after application of the fumigant.

Proper soil preparation is essential for effective soil fumigation. The soil should be plowed and cultivated to a uniform loose texture to a depth of 6 to 12 inches. At the time of application, the soil should be free of clods and fresh organic debris, moist enough for seed germination, and at a temperature suitable for the product being used.

After fumigation, the grower must wait the length of time specified on the product label before planting. Planting too soon can result in the injury or death of the crop.

Some fumigants kill beneficial soil fungi that form mycorrhizae, a root-fungus association that is needed for normal growth by most plants. The fungi that form the association with most conifers and a few deciduous trees, such as birch and oak, are spread by airborne spores. They reinfest fumigated beds quickly. However, the fungi associated with most deciduous plants produce their spores in the soil. It takes much more time for them to reinfest fumigated soil. Methyl bromide is the fumigant that causes the most damage to populations of mycorrhizae.

Soil fumigants that are commonly used in nurseries include dazomet (Basamid), methyl bromide/chloropicrin (Brom-O-Gas, Dowfume, Terr-O-Gas), and sodium methyl dithiocarbamate (Vapam, VPM).

Basamid Granular (dazomet)

Producer: BASF

Application rate: 347 lb ai/A.

Formulation	per acre	per 1000 sq ft
99G	350 lb	8 lb

Solubility: 2000 ppm (high).

Stability: Easily lost through volatilization.

Mode of action: Degrades to methylisothiocyanate, formaldehyde, hydrogen sulfide, and monomethylamine, which interact in the presence of moisture and disrupt biological functions of soil organisms.

Crop uses: Site preparation for high-value crops, primarily seed or liner beds. Kills weeds, their seeds, and some disease-causing organisms.

Weed control strengths: Soil fumigant for preplant control of most weeds.

Weed control weaknesses: Provides poor control of legumes, sedges from seed, and morningglories.

Use recommendations: Soil temperature must be above 45°F and should be between 55 and 65°F. The seedbed should be prepared prior to application, with adequate moisture for good plant growth for 7 to 14 days before treatment. Germinating weed seeds are more easily controlled than dormant seeds. Seal the surface as soon after application as possible by compacting the surface, irrigating, or covering with plastic. All gaseous residues must be removed prior to planting. Soil moisture, temperature, and structure determine the time required between treatment and planting (normally from 10 to 30 days).

Notes: Do not apply to growing crops. Conduct a germination test of treated soil before planting. Vapors from treated soils may injure plants growing in enclosed structures. Do not apply within 4 feet of growing plants or closer than the drip line of trees and large shrubs. Basamid also has nematicidal, fungicidal, insecticidal, and slimicidal activity.

Brom-O-Gas, Terr-O-Gas (methyl bromide + chloropicrin)

Producer: Great Lakes Chemical Corp.

Application rate: 240–450 lb ai/A.

Formulation	per acre	per 1000 sq ft
98% L	240–450 lb	5.5–10.3 lb

Stability: Highly volatile.

Mode of action: Highly reactive fumes inhibit respiration, resulting in disruption of biochemical processes.

Crop uses: Site preparation for high-value crops, primarily seed or liner beds. Kills weeds, their seeds, and some disease-causing organisms.

Weed control strengths: Controls most broadleaved weeds and grasses.

Weed control weaknesses: Provides poor control of legumes, Carolina geranium, morningglories, bindweed, and sedges.

Use recommendations: Soil preparation is critical for obtaining good results. The seedbed should be prepared prior to application, free of clods and undecomposed organic matter, and with adequate moisture for good plant growth. The chemical must be injected into the soil when the soil temperature is between 50° and 80°F at the injection depth (6 to 8 inches). Do not fumigate when soils are too wet or too cold.

Notes: The liquid chemical is under pressure and extremely hazardous. Chloropicrin is the active ingredient in tear gas and is used as a warning agent. It irritates the eyes and upper respiratory tract. All residues must volatilize from the soil prior to planting. Aerate the soil for at least 2 weeks after uncovering the treated area. Under some conditions, the levels of ammonia nitrogen in the soil may be increased. Use nitrate sources of nitrogen fertilizer until plants are well established and soil is above 65°F to avoid ammonia injury. This is a *restricted use product*.

Vapam, Sektagon (metam-sodium)

Producer: Amvac Chem. Corp.; Tessenderlo Kerley, Inc.

Application rate: 239–318 lb ai/A.

Formulation	per acre	per 1000 sq ft
3.18L	75–100 gal	1.7–2.3 gal

Other formulations may be available. Carefully read the labels of other products to determine the rates of application specified for those products.

Stability: Is not volatile but breaks down to methylisothiocyanate, which is rapidly lost through volatility.

Mode of action: Breaks down into methylisothiocyanate, which disrupts the growth of most organisms that absorb it.

Crop uses: Site preparation for high-value crops primarily in seed or liner beds. Kills weeds, their seeds, and some disease-causing organisms.

Weed control strengths: Controls small seeded broadleaved weeds and grasses.

Weed control weaknesses: Provides poor control of legumes, sedges from seed, and morningglories.

Use recommendations: Soil temperature must be between 45° and 90°F at 3 inches. The seedbed should be prepared prior to application, with adequate moisture for good plant growth for 7 to 14 days before treatment. Germinating weed seeds are more easily controlled than dormant seeds. Use the solution promptly after mixing; do not allow it to stand. Seal the surface as soon after application as possible by compacting, irrigating, or covering with plastic. Activity is increased by the use of a plastic cover. Cultivate 2 inches deep 7 days after treatment to aerate the soil. Do not seed earlier than 21 days after application if a plastic cover is used.

Notes: Do not apply within 4 feet of growing plants or closer than the drip line of trees and large shrubs.



Perennial weeds that are tough to control, especially woody weeds, should be eliminated from a field before planting.

Weed control recommendations

WEED CONTROL PRIOR TO PLANTING

Many weeds that are difficult to control after the crop is planted can be eliminated from a field prior to planting by mechanical or chemical means. Repeated cultivation throughout the growing season will exhaust weed food reserves and result in weed death. This system avoids the use of chemicals but is expensive in terms of fuel and labor, may break down soil structure, and may spread, rather than kill, some tough to control perennial weeds.

Treatment with the chemicals listed below can be less expensive and will maintain soil structure while killing perennial weeds. The postemergence herbicides are most effective when applied from midsummer to early fall because they should be applied to mature but actively growing weeds. Many perennial weeds do not grow and mature early enough in the spring to allow time for application and translocation of the herbicide prior to the time of planting. Do not cultivate soil before applying a translocated herbicide. Cultivation breaks up a plant and its roots and spreads the pieces deeper and over a wider area. Each piece is capable of forming a new plant. These pieces do not all start growing at the same time and it is very difficult to kill all of them. If the plant is intact when treated, the chemical will move throughout the plant and kill all parts of it.

After allowing sufficient time for a systemic herbicide (e.g., Roundup Pro, Garlon) to translocate throughout the weeds, the field can be plowed and replanted without fear of herbicide residue. A cover crop of sudan-sorghum in the summer or ryegrass in the fall will limit weed regrowth, build soil organic matter and structure, and prevent erosion.

Postemergence herbicides

Roundup Pro applied at 2 to 4 lb ai/A is the safest, most effective broad spectrum herbicide available for eliminating weeds from a field prior to planting. Use the low rate for low-density, especially sensitive weeds (grasses) and higher rates for high-density, hard-to-control weeds (e.g., briars, poison ivy, milkweed, Canada thistle, nutsedge).

Garlon applied at 1 to 3 lb ai/A provides excellent control of herbaceous broadleaved weeds and woody weeds such as poison ivy, briars, and brush. It does not control grasses. For broad spectrum control, use Roundup at 1 to 2 lb ai/A plus Garlon at 1 to 2 lb ai/A.

Preemergence herbicides

Dichlobenil (Casoron, Barrier, Dyclomec, Norosac) applied in a granular form at 6 to 8 lb ai/A in late fall will suppress or kill quackgrass, mugwort, dandelion, bindweed. Canada thistle, and some other perennial weeds. Do not plant sensitive plants (fir, hemlock, pine, spruce) the following spring if the 8 lb rate is used.

Kerb applied in late fall or early winter at 1 to 2 lb ai/A is especially effective for controlling perennial grasses such as quackgrass. It provides better control of the fine fescues than any other herbicide.

WEED CONTROL IN NONCROP AREAS

The effectiveness of a weed control program in a landscape or cropping system can be reduced if weeds around the managed area are allowed to grow and produce seeds. The seeds from these weeds will blow into the managed areas and make preventive efforts more difficult. Weeds should be controlled in surrounding unused areas, fields, roadways, drainage ditches, and in and around container-grown nursery stock.

Herbicides

Finale, Reward, or Scythe can be used to control annual weeds in these areas.

Roundup Pro should be used if perennial weeds are present.

Rodeo provides systemic control of weeds in and around ponds or drainage ditches. Reward may be used on the edge of drainage ditches or ponds only if there is no outflow of water from the nursery property.

Princep and Barricade, Pendulum, or Surflan should be included with the postemergence herbicide chosen, to prevent regrowth of weeds.

2,4-D, Garlon, and Lontrel are herbicides that selectively kill broadleaved weeds and should be applied to grassy areas around the crop.

Combinations

The herbicides listed in Table 4 can be combined to kill existing weeds and provide residual control following application. Choose one herbicide from each of the three categories. Mix the amount of herbicide indicated in 1 gallon of water and apply it uniformly over 500 square feet. Weed foliage and bare soil should be lightly, but uniformly covered. Use a marker dye when spot treating to make areas receiving an overapplication clearly visible.

TABLE 4. HERBICIDE COMBINATIONS FOR WEED CONTROL IN NONCROP AREAS.

Category	Amount per acre	Amount per gallon (500 sq ft)	
		(ENGLISH)	(METRIC)
1. Postemergence herbicides			
Finale 1SC	3–6 qt	1.1–2.2 fl oz	33–66 ml
Reward	1–2 qt	0.4–0.75 fl oz	12–22 ml
Roundup Pro	1–4 qt	0.3–1.5 fl oz	9–45 ml
Scythe	3–27 gal	6.5–13 fl oz	190–380 ml
2. Preemergence herbicides best on broadleaves			
Gallery	0.66–1.33 lb	0.13–0.25 oz	4–8 gm
Princep 4L	2–4 qt	0.8–1.5 fl oz	23–45 ml
Princep 90DF	2.2–4.4 lb	0.4–0.75 oz	12–23 gm
3. Preemergence herbicides best on grasses			
Barricade 65WG	1.0–2.3 lb	0.18–0.41 oz	5.4–12 gm
Pendulum 3.3EC	2.4–4.8 qt	0.9–1.8 fl oz	27–54 ml
Pendulum 60WDG	3.3–6.6 lb	0.6–1.2 oz	18–36 gm
Pennant Magnum	1.3–2.6 pt	0.24–0.48 fl oz	7–14 ml
Surflan	2–4 qt	0.75–1.5 fl oz	24–44 ml

WEED CONTROL IN SEEDBEDS

Extreme caution must be used when controlling weeds in seedbeds because the crop itself is very sensitive to mechanical and chemical injury in the seedling stage of development. Providing broadleaf or preemergence weed control in seedbeds of plants other than conifers is still very difficult. Surflan has proven to be especially damaging when applied within 1 or 2 years of germination of some species. Special cultivators and weed brushes developed for use in narrow-row spaced crops can be used in seedbeds that are grown in rows. Though it is an extremely labor-intensive job, hand-pulling of weeds is a common practice in almost all seedling production nurseries. It is best to limit early weed growth by steam pasteurizing or fumigating seedbeds prior to planting.

Pasteurization

Heating the soil to 160°F with steam for 30 minutes will kill most weed seeds and stolons. Steaming at 180°F eliminates most other harmful organisms such as insects, diseases, and nematodes. Steam pasteurization of the soil is economical when high-value plants are grown in a limited area. Portable steam generators can be used for bed preparation.

Fumigation

Fumigants produce results similar to pasteurization if they are properly applied. There are specific instructions for use with respect to covering or sealing for each of the fumigants plus a specific waiting period prior to planting. For a list of fumigants, see page 25.

Cultivation

Special cultivators and weed brushes developed for use in narrow-row spaced crops can be used in seedbeds that are grown in rows. Equipment operators must be especially careful not to cultivate too deeply or too close to the seedlings to avoid extensive damage to the crop. The only nonchemical way to remove weeds from broadcast seeded beds is by handpulling.

Herbicides

Fusilade II and Vantage provide excellent postemergence control of grasses in seedbeds of conifers and deciduous ornamentals. All of the grasses should be growing from seed, so as little as 0.25 lb ai/A of Fusilade II or Vantage will control them at the 4- to 6-inch stage. Higher rates (0.25 to 0.50 lb ai/A) will be needed to control high-density, taller weeds.

Goal provides very good preemergence control and limited postemergence control of broadleaved weeds and grasses in conifer beds. It will severely injure seedlings of broadleaved plants. Apply 0.25 to 1 lb ai/A after seeding but prior to conifer germination. For postemergence control, apply 0.25 to 0.59 lb ai/A after seedlings are at least 5 weeks old. Try to make the first application before emergence of the conifers. If no preemergence application is made, many weeds will develop that are too large to be controlled by the postemergence application. Also, not all of the conifer seeds germinate at the same time, so some

seedlings may still be at a sensitive stage 5 weeks after the first seedlings emerge.

Ronstar is labeled for use on pine seedbeds at 2 to 4 lb ai/A. Apply to seedlings at least 4 weeks old. Ronstar will severely injure emerging or small broadleaved plants.

WEED CONTROL IN LINER BEDS

If the value of the crop is high enough, the soil can be steam pasteurized or fumigated as described in the previous section. Weeds can be controlled with repeated cultivations. As with seedbeds, extreme caution must be used so that the small plants are not torn out of the ground or damaged. One or a combination of the following herbicides can be used to control weeds in liner beds. Alternating an application of a preemergence herbicide with cultivation can reduce the amount of herbicide used and the frequency of cultivation.

Devrinol should be applied at 4 to 6 lb ai/A between late fall or early spring. If applied in warm weather, Devrinol must immediately be incorporated with 1 to 2 inches of water or cultivation. Apply to newly planted stock after the soil has been settled by the first irrigation or rainfall.

Envoy applied at 0.1 to 0.25 lb ai/A will provide postemergence control of annual and perennial grasses.

Fusilade II applied at 0.125 to 0.50 lb ai/A will provide postemergence control of annual and perennial grasses.

Goal applied at 0.25 to 1 lb ai/A provides preemergence and limited postemergence weed control in conifers only. Apply before weed seedlings reach 4 inches in height. Application around small field-grown deciduous liners may result in severe injury. Do not mulch after applying Goal.

Kerb applied at 2 lb ai/A is effective against winter annual grasses, perennial grasses, and some broadleaved weeds. Apply over plants established at least one full growing season.

Pennant Magnum should be applied at 1.25 to 2 lb ai/A at least 10 days after transplanting to control annual grasses, nutsedge, and some broadleaved weeds. Use the 3 lb rate to control nutsedge. Liners should be well rooted before use. Irrigate after application to activate the herbicide and rinse the residue from the foliage.

Regal O-O should be applied at 3 lb ai/A for control of many annual grasses and broadleaved weeds. Application around small field-grown deciduous liners may result in severe injury. Do not mulch after application.

Ronstar should be applied at 3 lb ai/A for control of many annual grasses and broadleaved weeds. Application around small field-grown deciduous liners may result in severe injury. Do not mulch after applying Ronstar. The wettable powder formulation should not be applied during or within the 4 weeks following budbreak.

Treflan 4E is a preplant treatment applied at 1 lb ai/A for all woody plants. It is not effective in soils high in organic matter.

Vantage applied at 0.125 to 0.50 lb ai/A will provide postemergence control of annual and perennial grasses.

WEED CONTROL AT PLANTING AND DURING THE FIRST GROWING SEASON

It is important to eliminate all weeds, especially perennials, prior to planting. If planting is delayed following elimination of weeds, additional weeds may germinate. In fields to be planted with a closely spaced crop like shrubs, weed seedlings should be killed with cultivation or an application of a postemergence herbicide several days prior to planting. In fields to be planted with trees spaced at least 5 feet apart, the postemergence herbicide can be combined with the preemergence application made following planting.

Following planting, cultivation, preemergence herbicides, or a combination of the two methods can be used to control weeds. Cultivation must be done very carefully before weeds get too large, to avoid pulling the newly planted stock out of the ground. Specially designed rotary cultivators with retractor arms can be used to control weeds in tree rows.

Hand weeding and hoeing are often necessary to clean up weeds that have escaped or are the most difficult weeds to control in an area.

With at least 5 feet between tree rows, a cover crop can be planted that will minimize the risk of erosion and pesticide or fertilizer runoff. If it is wide enough, equipment can be operated on it after rain without damaging the soil structure. It also continuously adds organic matter to the soil during the crop cycle.

Newly transplanted ornamentals have limited root systems and will be under stress. Several herbicides that can be safely used on established plants may injure those same plants if applied at the time of transplanting. The following herbicides can be safely applied to labeled newly transplanted stock, with the restrictions noted. For broad spectrum weed control, combine an herbicide that is best on broadleaved weeds with one that is best on grasses or use one of the premixed combinations.

Herbicides for broadleaved weeds

Atrazine should be applied at 2 to 4 lb ai/A only to conifers listed on the label soon after transplanting in fall or early spring.

Gallery should be applied at 0.25 to 0.75 lb ai/A. Delay application to new transplants until the soil is settled by packing or irrigation and no cracks are present.

Goal should be applied at 0.25 to 1 lb ai/A before budbreak or after the foliage has had time to harden off. It can be applied immediately after transplanting, provided budbreak has not occurred. Goal is safe for use around most conifers and also around trees with no foliage within 3 feet of the soil surface.

Ronstar can be applied at 2 to 4 lb ai/A immediately after transplanting. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

Herbicides for grasses

Barricade, Endurance, RegalKade G should be applied at 1 to 1.5 lb ai/A after the soil has been allowed to settle around new transplants.

Devrinol can be applied at 3 to 6 lb ai/A after the soil is settled by 1 inch of rain or irrigation. If applied in warm weather, Devrinol must be immediately incorporated with water or cultivation. In landscape plantings, apply Devrinol and cover it with an organic mulch for best results.

Pendulum can be applied at 3 lb ai/A after the soil is settled by 1 inch of rain or irrigation. Do not apply it over tender new growth.

Pennant Magnum should be applied at 1.25 to 2 lb ai/A at least 10 days after transplanting.

Surflan should be applied at 2 lb ai/A, but should not be applied until 4 weeks after planting. Do not apply on newly transplanted hemlock or Douglas fir.

Treflan 4E should be applied at 1 to 2 lb ai/A prior to planting. Incorporate to a depth of 2 inches with a rotovator immediately after application. Effectiveness is increased if shallow (1.5 to 2 inches) cultivation follows application within 2 to 3 weeks.

XL 2G should be applied at 4 to 6 lb ai/A, but application to new transplants should be delayed until the soil is settled by packing or irrigation and no cracks are present. Use XL 2G as a granular form of Surflan.

Combinations

OH2 can be applied at 3 lb ai/A immediately after planting. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

RegalStar G can be applied at 2.4 lb ai/A after the soil has settled around new transplants. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it.

Regal O-O can be applied at 3 lb ai/A immediately after transplanting. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

Rout can be applied at 3 lb ai/A after the soil is settled by 1 inch of rain or irrigation. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

Snapshot can be applied at 1.5 to 3 lb ai/A to new transplants after the soil is settled by packing or irrigation and no cracks are present. Snapshot TG contains a broadleaf and a grass herbicide for broad-spectrum control.

WEED CONTROL IN ESTABLISHED PLANTINGS

To control weeds throughout the year, herbicides should be applied in the spring, summer, and/or fall as needed. Spring applications of preemergence herbicides should be made prior to weed seed germination. In untreated soil, some weeds start germinating soon after the soil thaws. In soil that received an herbicide application the previous fall, germination can be delayed for up to 8 weeks following thaw. A low rate of postemergence herbicide may be included with early spring applications made before budbreak to kill cool season weeds. Though Roundup Pro will work, it will not provide good control

of perennial weeds when applied at this time. One of the contact herbicides will work just as well.

Fall applications are particularly desirable from two standpoints: labor for applications is usually more available in the late fall, and fall applications prevent weed infestations during the peak digging season in the spring. Winter annuals and the perennial weeds that germinate in September, October, and early spring and crabgrass that germinates in early May can thoroughly infest fields before labor is available for the spring cleanup. While early spring applications of herbicides could prevent most of these problems, most growers experience difficulty in getting the job done properly at this time. Herbicides that can be applied in the fall or winter include atrazine, dichlobenil (Casoron, Barrier, Dyclomec, Norosac), Devrinol, Factor, Gallery, Kerb, Princep, Pendulum, and Surflan.

After herbicides applied in the fall or winter are no longer effective in suppressing weed growth, clean cultivate the soil and make a spring or summer application with one of the following herbicides alone or in one of the combinations recommended on page 13. The combinations remain effective longer and provide a wider spectrum of weed control than a single chemical. More than one application probably will be needed to control weed growth throughout the summer. If a fall cover crop is to be planted, avoid the application of an herbicide that will remain effective past mid-August. Do not use the same preemergence herbicides for both applications in one year. Alternate products so resistant weed populations do not build up. For broad spectrum weed control, combine an herbicide that is best on broadleaved weeds with one that is best on grasses, or use one of the premixed combinations.

Preemergence herbicides for broadleaved weeds

Atrazine should be applied at 2 to 4 lb ai/A between fall and early spring while trees are dormant or soon after transplanting. Apply before weeds are 1.5 inches tall.

Casoron, Barrier, Dyclomec, or Norosac should be applied at 6 to 8 lb ai/A only on *established* plants of the woody ornamentals listed on the label for control of perennial and annual broadleaved weeds and grasses. Hemlock, fir, newly planted spruce, viburnums, and certain hollies are not tolerant. Preemergence control does not last past late spring.

Gallery applied at 0.5 to 1.0 lb ai/A provides control of many broadleaved weeds. Apply in late summer to early fall, in early spring prior to germination of target weeds, or immediately after cultivation. For best control, combine Gallery with one of the herbicides that is best on grasses.

Goal should be applied at 0.5 to 1 lb ai/A to labeled conifers prior to budbreak or after the foliage has had time to harden off. It is especially useful for late spring applications because it will kill weed seedlings up to 4 inches tall.

Princep should be applied at 1 to 4 lb ai/A at any time of the year to control most broadleaved weeds and some grasses. It can be applied alone but works best if combined with an herbicide that is most effective on grasses. The exact rate used will depend on prior Princep applications (the maximum rate is 4 lb ai/A

Princep per year), whether it is being used in combination with another herbicide, and the texture of the soil. Higher rates must be used in heavy clay soils than in light sandy soils.

Ronstar should be applied at 2 to 4 lb ai/A to newly transplanted or established plants for control of annual broadleaved weeds and grasses. Do not mulch after application. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

Preemergence herbicides for grasses

Barricade, Endurance, RegalKade G can be applied to established plants at 0.65 to 1.5 lb ai/A to control many annual grasses and some broadleaved weeds.

Betasan, Lescosan, or Bensumec 4 LF should be applied at 12.5 lb ai/A to control crabgrass and annual bluegrass in *established* plantings. Late winter application is preferable.

Devrinol should be applied at 4 to 6 lb ai/A in the fall or winter to control weed growth until the following summer.

Dimension applied at 0.5 lb ai/A provides control of many small-seeded annual broadleaved weeds and some grasses. This product may be applied as a split application or as a sequential application for weed control in the spring, summer, or fall on established ornamentals. Direct sprays to the soil at the base of the ornamentals, avoiding contact or drift to foliage. Care must be taken that there are no cracks that would allow direct contact of this product to the plant roots.

Kerb applied at 1 to 2 lb ai/A provides excellent control of a variety of grasses, including quackgrass and winter annuals. This preemergence herbicide provides postemergence control of many perennial grasses. Apply with Princep at 1 to 2 lb ai/A on labeled species for broad spectrum weed control. Kerb is best applied in the fall before the soil freezes. When applied alone, it will not control annual weeds invading in May or June.

Pendulum should be applied at 2 to 4 lb ai/A to control annual grasses and some broadleaved weeds. Do not use it over tender new growth.

Pennant Magnum should be applied at 1.25 to 2.5 lb ai/A to established labeled species. To control nutsedge, apply in early spring prior to emergence.

Predict should be applied at 2.4 lb ai/A in the fall or spring to control some grasses and a few broadleaved weeds in nursery plantings. To avoid plant injury, apply as a directed spray, avoiding contact with foliage, and do not apply until the fall following the first full season after transplanting.

Surflan should be applied at 2 to 4 lb ai/A to established labeled species to control annual grasses and some broadleaved weeds.

XL 2G should be applied at 4 to 6 lb ai/A, but application to new transplants should be delayed until the soil has been settled by packing or irrigation and no cracks are present. Use XL 2G as a granular form of Surflan.

Combinations

OH2 should be applied at 3 lb ai/A to control a wide spectrum of annual broadleaved weeds and grasses. Do not mulch after application. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

Regal O-O should be applied at 3 lb ai/A to control many annual grasses and broadleaved weeds. Do not mulch after application. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

RegalStar should be applied at 2.4 lb ai/A for control of annual grasses and broadleaved weeds. It is especially effective on crabgrass, goosegrass, and chickweed. Do not mulch after application. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Application can be made to actively growing or dormant ornamentals.

Rout should be applied at 3 lb ai/A in the fall or spring to control a broad spectrum of annual broadleaved weeds and grasses. Do not mulch after application. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Do not apply to deciduous plants less than 12 inches tall.

Snapshot applied at 2.5 to 5 lb ai/A will control many broadleaf and annual grass weeds in established labeled plantings.

Postemergence herbicides

The postemergence control of annual weeds should be minimized by using one or more of the preemergence herbicides listed in the preceding section. However, with the following exceptions, preemergence herbicides will not control weeds that have started to grow. Atrazine, Casoron, Kerb, and Princep will kill weed seedlings in the early stages of growth, and Goal will kill weeds up to 4 inches tall. Atrazine is currently labeled for use in conifer plantings only.

Since they die at the end of each growing season, annual weeds may be successfully controlled by cultivation or mowing. It is important to control them before they mature and set seed.

Postemergence herbicides can be used in certain situations in the nursery and landscape to eliminate annual and perennial weeds. Application of nonselective postemergence herbicides to established ornamentals entails the risk of plant injury. Perennial weeds should be eliminated prior to planting. Care should be taken not to reintroduce them by planting weed-infested stock.

Finale will kill actively growing annual weeds and burn the above-ground parts of perennial weeds. Repeat applications will be needed to control weeds emerging from underground parts or seeds.

Envoy will kill actively growing annual and perennial grasses. It can be applied over the top of most ornamentals.

Fusilade II will kill actively growing annual and perennial grasses. Read the label to determine which plants can be sprayed over the top and which should receive a directed spray.

Garlon will kill tough-to-control broadleaved weeds and woody weeds such as briars, Virginia creeper, and poison ivy. Garlon is labeled for use in conifer plantings and noncrop areas.

Lontrel will kill weeds in the following families: legume (clover, crownvetch), compositae (thistles), and nightshade (black nightshade).

Manage will control yellow nutsedge and horsetail (*Equisetum*) when applied at 0.031 to 0.062 lb ai/A. Applications should not contact leaves of desirable plants since foliar injury, discoloration, or death may result. Allow 3 months after transplanting before applying this product.

Reward is a nonselective contact material that will control weeds both in and out of water. It is labeled for use in aquatic areas.

Roundup Pro should be applied when weeds are actively growing and ready to flower. Most broadleaved perennials are best controlled in late summer or early fall.

Vantage will kill actively growing annual and perennial grasses. It can be sprayed over the top of all labeled species.

These herbicides can be applied as directed sprays, spot treatments, or with wick applicators. A directed spray involves applying the herbicide so that it hits the weeds without contacting the foliage of the ornamentals. This type of application is most commonly used in plantings of large shrubs or trees. Spot treatments are used to eliminate pockets of weeds scattered throughout a planting. Wick applicators give the most control and allow exact placement of the herbicide on the weeds. There is no chance of drift. This type of applicator is especially useful in situations where weeds are growing above low-growing ornamentals such as ground covers.

Once an area has been cleared of weeds, measures should be taken to prevent immediate regrowth. Apply a mulch or a preemergence herbicide. Otherwise the area will have to be treated again with the postemergence herbicides two or three times during the growing season. To kill existing weeds and prevent emergence of others, apply a preemergence and postemergence herbicide in combination.

WEED CONTROL IN CONTAINER-GROWN PLANTS

As in field nursery and landscape plantings, nurserymen growing plants in containers should have a weed control program. This means planning how to control weeds in the crop *before* it is planted. As mentioned in the introduction, the program has three parts:

1. Eliminating weeds in and around the growing area and killing seeds or vegetative parts prior to planting
2. Preventing weed growth in and around the growing area
3. Eliminating weeds as they appear

Establishing and maintaining the site

Kill all herbaceous and woody perennial weeds in the proposed growing area. Roundup Pro at 2 to 4 qt per acre will kill most weeds. If especially difficult to control broadleaved or woody weeds are present, add 2,4-D, dicamba, or Garlon at 2 qt per acre to Roundup Pro. Applications made from early summer to early fall will be more effective than early spring applications.

For best results, remove 4 inches of topsoil from the site. Lay down a layer of geotextile and cover it with 2 to 4 inches of gravel or shale. This will stabilize the area for the operation of equipment, improve drainage, and minimize future weed problems.

After plants are in the area, eliminate all weeds that grow in and around the production area with Roundup Pro, Finale, Reward, or Scythe before seedhead development to limit the amount of seed that blows into the containers. The rate of application will depend on the type and size of weeds to be controlled.

For preemergence weed control in roadways, along property borders, and around structures; apply Princep plus Surflan *or* Pendulum at 2 to 4 qt per acre of each.

Preemergence herbicides

Start with a potting medium that is free of weeds. It should not contain parts of perennial weeds, and there should be few weed seeds in it. Generally, components such as peat, perlite, and vermiculite are weed-free. Composted products, such as bark or yard waste, will contain some weed seeds, and soil will contain many seeds. If weed-free ingredients are not used, pasteurization or fumigation of the container mix prior to planting will limit the extent of future weed problems.

Protect the components or the prepared medium from contamination with weeds or seeds while it is being stored prior to use. It can be stored indoors or covered with plastic. This will also prevent the leaching of any nutrients that may have been added to the medium.

Preemergence herbicides are commonly used in container production because the alternative, hand weeding, is extremely expensive. Container media provide an ideal environment for weeds, and the frequent irrigations and high organic matter content of the media reduce the length of time herbicides are effective. Three to four applications of herbicide may be required per year for adequate weed control, depending on the chemicals used, the rate, and the length of the growing season.

The first herbicide application should be made right after potting or uncovering overwintering structures in the early spring. Most chemicals require that the medium be firmly settled around roots by irrigation prior to application. This is especially critical for potted bare-root liners. An irrigation (1/2 to 1 inch) after application will wash the herbicide off the foliage of the ornamentals and move the chemical into the medium. If weed seedlings are present at the time of application, hand weed the area before applying the herbicide and follow up with a second hand weeding 7 to 10 days later to ensure elimination of previously germinated seedlings.

The second application should be made 6 to 8 weeks after the first. Wait until a few weeds are seen germinating. Then pull those weeds and reapply. Another application may be needed during the growing season. The last application should be made 2 to 6 weeks prior to placing the plants in their overwintering structures. Again, hand weed prior to application. This final application is needed to control winter annuals that can grow in polyhouses anytime the weather warms up during the winter. No preemergence products are labeled for use in covered houses.

Do not use the same preemergence herbicides for all applications in one year. Alternate products so resistant weed populations do not build up. Rout and OH2 are similar and should not be alternated with each other.

Container growers may have many plants that are not on the labels of any of the herbicides listed. Some products like Gallery, Snapshot, and Surflan allow growers to use these products on plants not found on the label, but the grower must assume all risk of injury to the plants.

Preemergence herbicides for use in container grown ornamentals that are best on broadleaved weeds include Gallery, Goal, Regal O-O, RegalStar G, and Ronstar.

Preemergence herbicides for use in container grown ornamentals that are best on grasses include Barricade, Devrinol, Dimension, Pendulum, Pennant, RegalKade, Surflan (XL), and Treflan.

Premixed granular combinations of broadleaved and grass herbicides include OH2 (Goal + Pendulum), Regal O-O (Goal + Ronstar), RegalStar G (Ronstar + Barricade), Rout (Goal + Surflan), and Snapshot (Gallery + Treflan).

Barricade, Endurance, RegalKade G may be applied to newly transplanted and established container stock at 0.65 to 1.5 lb ai/A as a broadcast, over the top, or directed spray. Irrigation or rainfall soon after application will wash residues off plant foliage and activate the material.

Dimension is effective at 0.5 lb ai/A. Direct sprays to the soil at the base of the ornamentals, avoiding contact or drift to foliage. Care must be taken that the media has settled firmly after planting and that there are no cracks that would allow direct contact of this product to the plant roots.

Devrinol is effective at 4 to 6 lb ai/A. Irrigation immediately following application is essential for optimum control. Repeat applications every 10 to 12 weeks.

Gallery should be applied at 0.5 to 1 lb ai/A to control certain annual broadleaf weeds. To avoid possible injury, do not apply to unrooted liners or cuttings that have been planted in pots for the first time, or to pots less than 4 inches wide.

Goal is for use on conifers only and must be applied at 1 to 2 lb ai/A prior to budbreak or after the foliage has had time to harden off.

Ornamental Herbicide II (OH2) controls a wide spectrum of annual broadleaved weeds and grasses when applied at 3 lb ai/A. Do not apply OH2 to plants in enclosed structures.

Pendulum effectively controls many annual grasses and some broadleaf weeds when applied at 2 to 4 lb ai/A. For container-grown ornamentals, delay the first application to bareroot liners for 2 to 4 weeks.

Pennant Magnum provides excellent control of yellow nutsedge. Apply at 1.25 to 2.5 lb ai/A to control grasses, sedges, and some broadleaf weeds.

Regal O-O should be applied at 3 lb ai/A for control of many annual grasses and broadleaved weeds. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it.

RegalStar should be applied at 2.4 lb ai/A for control of many annual grasses and broadleaved weeds. It is especially effective on crabgrass, goosegrass, and chickweed. Delay application to new transplants until the soil has settled around the plant. Do not apply if the foliage is wet because the granules may stick to the foliage and burn it. Application can be made to actively growing or dormant ornamentals.

Ronstar provides excellent control of annual broadleaved weeds in container crops. Use it to control difficult weeds such as groundsel, galinsoga, and oxalis. Apply at 4 lb ai/A and repeat applications every 10 to 12 weeks. It does not control chickweed.

Rout controls a broad spectrum of annual broadleaved weeds and grasses when applied at 3 lb ai/A. Following planting and prior to herbicide application, irrigate with approximately 1/2 inch of water to settle the potting medium. Allow the foliage to dry. Apply the herbicide and then apply another inch of water to wash any granules off the leaves and to activate the herbicide.

Snapshot applied at 2.5 to 5 lb ai/A provides very good control of both broadleaved weeds and grasses. Irrigate soon after application.

Surflan should be applied at 2 to 4 lb ai/A to control a relatively broad spectrum of weeds for 6 to 8 weeks.

Treflan should be applied at 1 to 2 lb ai/A of the 4E formulation or 4 lb ai/A of the 5G formulation to control annual grasses. Irrigate immediately after application. Repeat application every 6 to 8 weeks.

XL should be applied at 4 to 6 lb ai/A to control certain annual grasses and broadleaved weeds. To avoid possible injury, do not apply XL 2G to unrooted liners or cuttings that have been planted in pots for the first time, or to pots less than 4 inches wide.

Postemergence herbicides

Hand pulling is the weed control method of last resort in container production operations. There are always some weeds that escape preventive measures. If these weeds are not pulled, they will thrive and rapidly spread in the irrigated, nutrient-rich container environment.

The postemergence grass herbicides Fusilade II, Vantage, and Prism can be applied over the top of most ornamentals to eliminate grasses that escape preventive weed control measures. All should be applied to actively growing grasses less than 8 inches tall. Allow at least 1 hour between application and irrigation.

Envoy should be applied at 13 to 34 fl oz per acre. For spot treatments, use a 0.5% solution (0.6 fl oz/gal). Add a nonionic surfactant at 0.25% v/v to all spray solutions (0.3 fl oz/gal or 1 pt/50 gal).

Fusilade II should be applied at 16 to 24 fl oz per acre. For spot treatments, apply 0.75 fl oz/gal. Add a nonionic surfactant at 0.25% v/v to all spray solutions (0.3 fl oz/gal or 1 pt/50 gal).

Vantage should be applied at 36 to 60 fl oz per acre. For spot applications use 2 to 3 oz/gal. Vantage includes a surfactant; no additional surfactant is needed.

WEED CONTROL IN HERBACEOUS PLANTS, FLOWERS, AND GROUND COVERS

The following herbicides are registered for use on annual or perennial flowers or ground covers and vines. The plants for which they are registered are listed.

Preemergence herbicides

Barricade, Endurance, RegalKade G (prodiamine)

Herbaceous plants: Achillea, African Lily, Allium, Anemone, Aqualegia, Artemesia, Aster, Begonia, Bergenia, Boltonia, Campanula, Cassia, Coreopsis, Cranesbill, Delphinium, Dianthus, Echinacea, Fountain Grass, Gaillardia, Gentiana, Gladiolus, Gypsophila, Helianthemum, Hemerocallus, Heuchera, Hosta, Iris, Lavendula, Liliun, Liriope, Lythrum, Mondo Grass, Miscanthus, Narcissus, Osteospermum, Tree Peony, Physostegia, Rudbeckia, Russian Sage, Santolina, Saxifrage, Scabiosa, Sedum, Thalictrum, Trailing African Daisy, Tulip, Veronica, Yucca.

Ground covers and vines: *Euonymus fortunei*, *Hedera helix*, *Lonicera japonica*, *Vinca minor*.

Betasan, Lescosan, others (bensulide)

Herbaceous plants: Alyssum, Aster, Bachelor's Button, Calendula, Campanula, Candytuff, Coral Bell, Daffodil, Dahlia, Daisy, Daphne, Freesia, Gazania, Gladiolus, Marigold, Narcissus, Pansy, Periwinkle, Primrose, Ranunculus, Sedum, Star Jasmine, Stock, Sweet Pea, Tulip, Wall Flower, Wild Strawberry, Zinnia.

Ground covers and vines: Ajuga, Hypericum, Ice Plant, Ivy, Myrtle, Pachysandra.

Devrinol, Hurdle (napropamide)

Herbaceous plants: Ageratum, African Daisy, Aster, Bird of Paradise, Bottle-brush, Chrysanthemum, Dahlia, Daisy, Eucalyptus, Gardenia, Gazania, Geranium, Gladiolus, Heather, Hibiscus, Hosta, Lantana, Nandina, Narcissus, Petunia, Sedum, Zinnia.

Ground covers and vines: Ajuga, Bougainvillea, Carpobrotus, Delosperma, Dichondra, Erysimum, English Ivy, Euonymus, Ice Plant, Liriope, Osteospermum, Pachysandra, St John's Wort, Vinca.

Dimension (dithiopyr)

Herbaceous plants: African Lily, Bee Balm, Begonia, Blanket Blower, Blue Bescue, Bottlebrush, Camellia, Candytuff, Centaurea, Cockscumb, Coleus, Columbine, Coreopsis,

Corn Flower, Daffodil, Daylily, Dianthus, Delphinium, Dusty Miller, Fescue, Fountain Grass, Gardenia, Geranium, Hibiscus, Hosta, Iris, Lilyturf, Marigold, Mondo Grass, Narcissus, Pampas Grass, Pansy, Petunia, Plumosa, Potentilla, Red Cedar, Ribbon Grass, Salvia, Snapdragon, Tulip, Verbena, Yarrow

Ground covers and vines: Ajuga, English Ivy, Ice Plant, Pachysandra, Periwinkle, Sedum

Gallery (isoxaben)

Herbaceous plants: African Daisy, Blue Fescue, Daffodil, Daylily, Fountain Grass, Miscanthus, Gardenia, Gazania, Heather, Hibiscus, Hosta, Hyacinth, Iris, Jasmine, Lantana, Nandina, Ribbon Grass, Tulip.

Ground covers and vines: Ice Plant, English Ivy, Euonymus, Liriope, Pachysandra, Periwinkle, St John's Wort.

The label warns against use on the following plants: Ajuga, Hydrangea, Iberis, Sedum, Yucca. Do not use Gallery on tulip plants that have emerged more than 0.75 inch, gladiolus prior to emergence if the corms are less than 1 inch in diameter, or any bulbs while they are flowering. Do not use it on bedding plants or in areas where bedding plants will be planted within 1 year following application or on ground covers until they are established and well rooted.

Image (imazaquin)

Herbaceous plants: Hosta, Yucca

Ground covers and vines: Asiatic Jasmine, Giant Liriope, Mondo Grass, Pachysandra, Variegated Liriope

OH2 (oxyfluorfen + pendimethalin)

Ground covers and vines: Euonymus, Pachysandra, Vinca.

Pendulum, Corral (pendimethalin)

Herbaceous plants: Ageratum, Anemone, Artemesia, Balloon Flower, Beach grass, Black-Eyed Susan, Blue Fescue, Butterfly Weed, Cabbage (ornamental), Caladium, California Poppy, Canna Lily, Carex, Celosia, Chrysanthemum, Columbine, Coneflower (purple), Coreopsis, Crocus, Daffodil, Daisy (african, shasta, oxeye), Daylily, Dianthus, Dicentra, Dusty Miller, Fountain Grass, Foxglove, Gallardia, Gazania, Geum, Gladiolus, Gypsophila, Hosta, Hyacinth, Hydrangea, Kale (ornamental), Lantana, Liatris, Lily, Marigold, Mondo Grass, Morningglory, Pansy, Pampas Grass, Penstmon, Petunia, Purple Loosestrife, Ribbon Grass, Rose, Sweet Flag, Tufted hair grass, Tulip, Yarrow.

Ground covers and vines: Ajuga, Cape Weed, Euonymus, Gazania, Ice Plant, English and Geranium Ivy, Liriope, Pachysandra, Periwinkle, St Johnswort, Sand Strawberry, Sedum, Verbena, Vinca, Zinnia.

Use no sooner than 4 weeks after transplant: Alyssum, Aster, Begonia, Dahlia, Portulaca, Salvia, Snapdragon, Statice, Vinca.

Pennant Magnum (metolachlor)

Herbaceous plants: African Lily, Ageratum, Allium, Alyssum, Asclepias, Aster, Bellflower, Canna Lily, Carex, Chrysanthemum, Columbine, Coreopsis, Crocus, Daisy, Daylily, Delphinium, Dusty Miller, Gaillardia, Gazania, Geranium, Geum, Gladiolus, Hosta, Hyacinth, Hydrangea, Impatiens, Iris, Leopard's Bane, Lily, Lupine, Marigold, Mondo Grass, Muscari, Narcissus, Obedient Plant (*Physostegia*), Pampas Grass, Pansy, Petunia, Phlox, Potentilla, Primrose, Purple Loosestrife, Queen Anne's Lace, Rose, Scilla, Sedum, Snapdragon, Stachys, Star of Bethlehem, Statice, Sweet William, Tulip, Veronica, Zinnia, Yarrow, Yucca.

Ground covers and vines: Ajuga, English Ivy, *Euonymus fortunei*, Ice Plant, Liriope, Pachysandra, Periwinkle, St John's Wort.

Ronstar 2G (oxadiazon)

Herbaceous plants: African Daisy, Baby's Breath, Carnation, Chrysanthemum, Coreopsis, Dahlia, Dianthus, Gaillardia, Gazania, Gladiolus, Lamb's Ear, Liatris, Peony, Potentilla, Rose, Sedum, Statice.

Ground covers and vines: Ajuga, Algerian and English Ivy, Carpobrotus, Euonymus, Honeysuckle, Iberis, Ice Plant, Lantana, Lily of the Valley, Osteospermum, Pachysandra, Periwinkle, Sedum, St John's Wort.

Rout (oxyfluorfen + oryzalin)

Herbaceous plants: Candytuft, Iberis, Marigold, St John's Wort, Salvia, Verbena.

Ground covers and vines: Bearberry, Bougainvillea, Cotoneaster, Euonymus.

Snapshot (isoxaben + trifluralin)

Herbaceous plants: Beech Grass, Blue Fescue, Daffodil, Daylily, Fountain Grass, Gazania, Hosta, Hyacinth, Iris, Miscanthus, Mondo Grass, Pampas Grass, Plumbago, Ribbon Grass, Snow-in-Summer, Tulip.

Ground covers and vines: Cape Marigold, Carex, Descampsia, Euonymus, Honeysuckle, Ice Plant, Ivy, Japanese Painted Fern, Jasmine, Liriope, Pachysandra, Periwinkle, St John's Wort.

Do not apply to bedding plants or beds where they may be planted within 1 year. Do not apply to Ajuga, Hydrangea, Candytuft, Sedum, or Yucca.

Surflan (oryzalin)

Herbaceous plants: Aster, Astilbe, Baby's Breath, Bellflower, Bird of Paradise, Black-Eyed Susan, Blazing Star, Bleeding Heart, Blue Fescue, Bottle-brush, Caladium, California Poppy, Campanula, Candytuft, Cape Marigold, Carnation, Chrysanthemum, Coneflower, Coreopsis, Cosmos, Daffodil, Daisy, Dahlia, Daylily, Dianthus, Dusty Miller, Fountain Grass, Foxglove, Gaillardia, Gazania, Geranium, Geum, Gladiolus, Hosta, Hyacinth, Impatiens, Iris, Lupine, Marigold, Mondo Grass, Morningglory, Moss Rose, Nandina, Nasturtium, Nicotiana, Pampas Grass, Pansy, Petunia, Phlox, Portulaca, Rose, Sage, Salvia, Sedum, Snapdragon, Stock, Sunflower, Sweet William, Tulip, Yarrow, Yucca, Zinnia.

Ground covers and vines: Ajuga, Euonymus, Gazania, Honeysuckle, Ice Plant, Ivy, Liriope, Pachysandra, Periwinkle, St John's Wort, Sedum, Vinca.

Treflan (trifluralin)

Herbaceous plants: African Daisy, Ageratum, Allyssum, Artemesia, Asparagus Fern, Aster, Astilbe, Baby's Breath, Bachelor's Button, Balsam, Bee balm, Begonia, Bellflower, Black-Eyed Susan, Blue Fescue, Calendula, Calliopsis, Cape Marigold, Chrysanthemum, Coneflower, Coral bells, Coreopsis, Corn Flower, Cosmos, Dahlia, Daisy, Daylily, Dianthus, Dusty Miller, Forget-Me-Not, Foxglove, Fountain Grass, Four O'clock, Gaillardia, Germander, Gladiolus, Hens and Chickens, Impatiens, Iris, Lamb's Ear, Liatris, Lobelia, Lupine, Marigold, Mondo Grass, Morningglory, Moss Rose, Mourning Bride, Nasturtium, Nicotiana, Pampas Grass, Petunia, Phlox, Pink, Poppy, Portulaca, Rose, Russian Sage, Salvia, Sedum, Shasta Daisy, Snapdragon, Snow-in-Summer, Snow-on-the-Mountain, Speedwell, St John's Wort, Statice, Stock, Stoke's Aster, Strawberry, Sunflower, Sweet Alyssum, Sweet Pea, Sweet William, Verbena, Yarrow, Zinnia.

Ground covers: Ajuga, Euonymus, Gazania, Ice Plant, Ivy, Liriope, Periwinkle, Sedum, Vinca.

XL (oryzalin + benefin)

Herbaceous plants: Achillea, Baby's Breath, Bellflower, Bleeding Heart, Bird of Paradise, Blue Fescue, Bottle-brush, Cape Marigold, Cape Weed, Chrysanthemum, Coneflower (purple), Coreopsis, Daisy, Daylily, Dianthus, Eucalyptus, Gardenia, Gazania, Geranium, Geum, Gladiolus, Hibiscus, Hosta, Impatiens, Iris, Liatris, Liriope, Marigold, Mondo Grass, Nandina, Narcissus, Pampas Grass, Pansy, Petunia, Portulaca, Ranunculus, Rose, Rudbeckia, Salvia, Sedum (Stonecrop), Snapdragon, Tulip, Zinnia.

NOTE: Do not apply to tulip plants that have emerged to a height greater than three-fourths inch.

Ground covers and vines: Euonymus, Honeysuckle, Algerian and English Ivy, Ice Plant, Periwinkle, St John's Wort.

Postemergence herbicides

Acclaim Extra (fenoxaprop)

Herbaceous plants: African Daisy, Astilbe, Baby Blue Eyes, Baby's Breath, Begonia, Bellflower, Black-Eyed Susan, Bleeding Heart, Bluebell, Blue Flax, California Poppy, Calliopsis, Candytuft, Catchfly, Chrysanthemum, Coleus, Columbine, Coneflower, Coreopsis, Cosmos, Daisy, Dames Rocket, Daylily, English Wallflower, Forget-Me-Not, Gaillardia, Gayfeather, Gazania, Geranium, Gilia, Hosta, Iris, Leopard's Bane, Liatrus, Lily, Liriope, Maiden Pink, Phlox, Peony, Petunia, Pimpernel, Poppy, Red Yarrow, Rose, Shasta Daisy, Siberian Wallflower, Snapdragon, Snow-in-Summer, Soapwort, Statice, Sundrops, Sweet Alyssum, Sweet William, Wild Thyme, Yarrow, Zinnia.

Ground covers and vines: Ajuga, Ivy, Vinca.

Basagran T/O (bentazon)

Can be applied over the top of the ground covers listed below, but will injure most herbaceous plants contacted.

Herbaceous plants: Dusty Miller

Ground covers and vines: Ajuga, English Ivy, Liriope, Pachysandra.

Envoy (clethodim)

It can be applied over the top of the following plants.

Herbaceous plants: Ageratum, Alyssum, Asparagus Fern, Bleeding Heart, Chrysanthemum, Cinquefoil, Coleus, Coral Bells, Cranesbill, Creeping Fig, Dahlia, Daylily, Dusty Miller, Gazania, Geranium, Hosta, Iris, Jasmine Tobacco, Marigold, Partridgeberry, Petunia, Phlox, Pinks, Portulaca, Salvia, Saxifrage, Sedum, Snapdragon, Sweet William, Touch-Me-Not, Verbena, Violet, Yarrow, Zinnia.

Ground covers and vines: Ajuga, English Ivy, Euonymous, Variegated Yellow Ivy, Variegated White Ivy, Green Liriope, Variegated Liriope, Moneywort, Creeping Charlie, Mondo Grass, Dwarf Mondo Grass, Periwinkle.

Fusilade II, Ornamec (fluazifop-p-butyl)

GROUP 1: It can be applied over the top of plants in this group.

Herbaceous plants: Ageratum, Alyssum, Astilbe, Bellflower, Bird of Paradise, Calendula, Campanula, Candytuft,

Cape Weed, Cassia, Chrysanthemum, Coleus, Coreopsis, Cranesbill, Crownvetch, Daisy, Daylily, Dusty Miller, Eucalyptus, Gardenia, Gazania, Geranium, Hibiscus, Hollyhock, Hosta, Iris, Lantana, Lavender cotton, Liatris, Liriope, Marigold, Mesembryanthemum, Periwinkle, Petunia, Red Fountain Grass, Rose, Salvia, Sedum, Shasta Daisy, Snapdragon, Snow-in-Summer, Statice, Ornamental Strawberry, Sweet William, Yarrow, Yucca, Zinnia.

Ground covers and vines: Algerian and English Ivy, Bougainvillea, Bearberry, Cotoneaster, Euonymous, Grape ivy, Ice Plant, Myrtle, Pachysandra.

GROUP 2: It should be applied as a directed spray to prevent contact with the foliage of plants in this group.

Herbaceous plants: Bleeding Heart, Cinquefoil, Columbine, Gazania, Gladiolus, Green Fountain Grass, Lantana, Mondo Grass, Primrose.

Ground covers and vines: Ajuga, Japanese Honeysuckle, Juniper.

Vantage (sethoxydim)

It can be applied over the top of the following plants.

Herbaceous plants: Alyssum, Asparagus Fern, Aster, Baby's Breath, Begonia, Black-Eyed Susan, Bleeding Heart, Blue Fescue, Butterfly Weed, Camellia, Candytuft, Canna, Cape Weed, Carnation, Chrysanthemum, Cockscumb, Coleus, Coral Bells, Crownvetch, Dahlia, Daisy, Daylily, Dusty Miller, Euonymous, Foxglove, Gaillardia, Gardenia, Gazania, Geranium, Gerbera Daisy, Gladiolus, Heather, Hibiscus, Honeysuckle, Hosta, Hydrangea, Impatiens, Iris, Jack-in-the-Pulpit, Jade Plant, Jasmine, Lamb's Ear, Lantana, Lavender, Liatrus, Lily of the Valley, Liriope, Lobelia, Purple Loosestrife, Marigold, Mondo Grass, Moneywort, Moss Rose, Nandina, Nicotiana, Pampas Grass, Pansy, Pepper (ornamental), Periwinkle, Petunia, Phlox, Plumbago, Queen Anne's Lace, Red Fountain Grass, Sage, Salvia, Sedum, Snapdragon, Speedwell, Statice, Stock, Sweet William, Verbena, Zinnia.

Ground covers and vines: Ajuga, Bittersweet, Bougainvillea, Cape Weed, Grape Ivy, Heather, Honeysuckle, Hypericum, Ice Plant, Ivy, Pachysandra, Periwinkle, Plumbago, St John's Wort, Trumpet Vine, Vinca, Wisteria.



The growth of nursery stock infested with weeds is stunted, and its quality and value are greatly reduced.



When nursery stock is grown in a weed-free environment its survival, growth, and quality are enhanced, and its value increased.



Weeds in landscape plantings around commercial properties affect the image the business projects to its customers.



The property shown in the previous photograph projects an image of neglect, while the property shown in this photograph projects a more professional image.

Appendix I

GENERAL USES OF PREEMERGENCE HERBICIDES

The following uses are listed on the labels of the preemergence herbicides available for nursery and landscape use. An X in the column indicates the herbicide is labeled for use on the site listed.

	Atrazine	Barricade	Betasan	Casoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	OH2	Pendulum	Pennant Magnum	Predict	Princep	Regal O-O	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL	
Woody ornamentals	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Herbaceous perennials		X	X		X	X	X					X	X				X	X	X	X	X	X	X	
Ornamental grasses		X			X	X						X							X					
Ground covers		X	X		X	X	X				X	X	X		X	X	X	X	X	X	X	X	X	
Bulbs		X	X		X	X	X					X	X						X	X			X	
Bedding plants			X		X	X						X	X							X	X		X	
Turf		X	X		X	X	X					X						X			X		X	
Landscape		X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
Field nursery		X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Container nursery		X			X	X	X				X	X	X		X	X	X	X	X	X	X	X	X	
*Newly transplanted field		X			X	X	X				X	X	X		X	X	X	X	X	X	X	X	X	
*Newly transplanted—container		X			X	X	X				X	X	X		X	X	X	X	X	X	X	X	X	

*A waiting period may be required before use on newly planted plants.

Appendix II

WEEDS LISTED ON HERBICIDE LABELS

The following weeds are listed on the labels of the preemergence herbicides available for nursery and landscape use. An X in the column indicates the herbicide is labeled to control the weed listed. Only weeds commonly found in the northeastern United States are listed. Weeds are identified as annual (A), biennial (B), or perennial (P).

		Atrazine	Barricade	Betasan	Casoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	OH2	Pendulum	Pennant Magnum	Predict	Princep	Regal O-O	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL
GRASSES																								
Annual Bluegrass	A		X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Barnyardgrass (Watergrass)	A	X	X	X		X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Bermudagrass	P													X										
Brome (Ripgut)					X	X												X		X		X		
Canary Grass	P									X								X						X
Cheat (Chess)	A				X					X				X	X							X		
Crabgrasses	A	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Downy Brome	A				X					X				X	X								X	
Fall Panicum	A		X	X		X				X		X	X	X	X			X	X	X	X	X	X	X
Foxtails (all)	A	X	X	X	X	X								X	X							X	X	X
Giant Foxtail	A	X	X		X			X				X	X	X	X					X	X	X	X	X
Green Foxtail	A	X	X		X	X						X	X	X	X			X	X			X	X	X
Yellow Foxtail	A	X	X		X	X				X		X	X	X	X				X	X	X	X	X	X
Goosegrass (Silver Grass)	A		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Johnsongrass (from seed)	P		X		X							X	X	X						X	X	X	X	X
Millet	A													X	X						X	X	X	X
Nutgrass (Nutsedge)	P								X				X	X										
Quackgrass	P									X				X										
Ryegrass (annual)	A		X		X	X								X						X	X			X
Sandbur (Burgress)	A				X				X				X	X						X		X		X
Stinkgrass (Lovegrass)	A				X					X										X	X	X	X	X
Sprangle Top			X		X						X					X				X	X	X	X	X
Volunteer grains (barley, oats, rye, wheat)	A									X										X				
Wild Barley	A				X									X						X				
Wild Oats	A	X			X	X		X	X						X			X			X	X	X	X
Witchgrass	A	X	X		X			X				X	X	X	X					X	X			X

Appendix II (continued)

		Atrazine	Barricade	Betasan	Casoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	OH2	Pendulum	Pennant Magnum	Predict	Princep	Regal O-O	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL
BROADLEAF WEEDS																								
Annual																								
Morningglory	A	x					x	x		x				x	x						x	x		
Beggarweed	P																							
Bittercress	P					x	x	x	x		x					x		x	x	x	x	x		x
Carpetweed	A		x		x	x	x	x		x		x	x	x	x			x			x	x	x	x
Chickweed	A		x		x	x	x		x	x	x	x		x	x	x	x			x	x	x	x	x
Clover (from seed)	P						x	x	x								x			x	x			
Cocklebur	A	x						x						x										
Common Groundsel	A				x	x	x	x			x		x	x	x			x		x	x	x		x
Cudweed	B				x	x	x		x		x	x		x		x					x			
Dandelion	P				x		x		x		x					x				x	x			
Deadnettle (Henbit)	A,B		x	x	x		x	x	x	x		x			x						x	x		x
Dogfennel (Mayweed)	A				x		x	x						x							x			
Evening Primrose	B				x		x		x									x		x	x			
Fleabane	A						x				x					x					x			
Fireweed	P							x			x				x	x		x	x					
Galinsoga	A						x						x			x		x			x			
Groundcherry	P	x					x	x													x			
Jimsonweed	A	x					x	x													x			
Knotweed	A		x		x	x	x	x		x		x					x				x	x	x	x
Lambsquarters	A	x	x	x	x		x	x		x		x		x	x			x		x	x	x	x	x
Mallow	A,B					x	x	x		x				x							x			
Marestail (Horseweed)	A					x		x			x					x					x	x	x	
Morningglory	P				x		x	x						x							x	x		
Mugwort (Chrysanthemum Weed)	P																							
Mustards	A	x				x	x	x		x					x						x			
Nettleleaf Goosefoot	A				x		x			x													x	
Nightshade, Bitter	P	x																						
Nightshade, Black	A						x	x		x			x		x						x			
Oxalis	A,P		x		x		x	x			x					x		x		x	x	x		
Pearlwort	P										x					x					x			

Appendix II (continued)

		Atrazine	Barricade	Betasan	Casoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	OH2	Pendulum	Pennant Magnum	Predict	Princep	Regal O-O	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL
BROADLEAF WEEDS (continued)																								
Pepperweed (Peppergrass)	A				x		x	x				x			x	x					x			
Pigweeds (all)	A	x	x			x	x	x				x	x	x	x			x			x	x	x	x
Prostrate Pigweed	A							x														x	x	x
Redroot Pigweed	A			x		x	x	x				x					x		x			x	x	x
Tumble Pigweed	A				x																	x		x
Pineapple Weed	A				x	x		x							x	x						x		
Plantain	P				x			x							x							x		
Prickly Lettuce	A					x		x	x													x		
Purslane	A	x	x		x	x	x	x	x		x		x	x	x			x	x	x	x	x	x	x
Ragweed	A	x			x	x		x							x	x						x		
Red Sorrel	P							x	x	x	x											x		
Shepherdspurse	A		x	x	x		x	x	x		x	x	x	x	x	x		x	x	x	x	x		x
Smartweed (Pennsylvania Smartweed)	A	x			x			x	x		x		x	x				x				x		
Sow Thistle	A					x		x	x		x				x		x		x	x	x			
Speedwell	A		x				x	x	x						x							x		
Spurge, annual	A		x		x		x	x	x		x	x		x		x	x		x	x	x	x		x
Spurge, perennial	P							x				x	x		x							x		x
Thistle, Bull	B				x				x															
Velvetleaf	A	x						x	x			x			x							x		
Wild Buckwheat	A	x							x						x									
Wild Carrot	A				x			x														x		
Yellow Woodsorrel	A,P	x			x		x	x				x	x								x	x	x	x

Appendix III

LIST OF PLANTS ON HERBICIDE LABELS

The following evergreen and deciduous plants are listed on the labels of the preemergence herbicides available for nursery and landscape use. An X in the column indicates the herbicide is labeled for use on the plant listed. Only plants grown in the northeastern United States are listed.

	Atrazine	Barricade	Betasan	Casoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	Oht2	Pendulum	Pennant Magnum	Predict	Princep	Regal O-0	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL
EVERGREENS																							
NARROWLEAF																							
Arborvitae	X		X	X	X	X	X		X			X		X	X	X	X	X	X	X	X		X
Chamaecyparis	X			X		X				X	X				X	X	X	X	X	X	X	X	X
Eastern Red Cedar		X	X	X	X	X	X		X	X	X	X	X	X			X			X	X	X	X
Fir	X			X		X			X		X	X		X	X					X	X	X	X
Fir, Balsam	X			X		X			X		X	X		X						X	X	X	X
Fir, Douglas	X	X		X	X		X		X		X	X		X			X					X	X
Fir, Fraser	X			X	X		X		X		X	X		X							X		X
Fir, White	X	X		X		X			X		X	X		X						X	X	X	X
Hemlock	X			X	X	X	X		X		X	X		X			X			X		X	
Juniper	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pine	X			X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X
Pine, Austrian	X	X		X	X	X	X		X	X	X	X		X	X	X	X			X	X	X	X
Pine, Japanese Black	X			X	X	X			X	X		X		X	X	X	X	X	X	X	X	X	X
Pine, Mugo				X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X
Pine, Red				X					X	X		X		X	X	X	X				X	X	X
Pine, Scotch	X	X		X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X
Pine, White	X			X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X
Spruce				X	X	X	X		X	X	X	X			X		X	X	X	X	X	X	X
Spruce, Colorado (Blue)	X	X		X	X	X	X		X	X	X	X		X			X	X	X	X	X	X	X
Spruce, Norway	X			X	X	X	X		X	X	X	X		X		X	X	X	X	X	X	X	X
Spruce, White				X	X	X	X		X	X	X	X		X			X			X	X	X	X
Yew	X		X	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X
BROADLEAF																							
Boxwood	X	X	X	X	X	X			X	X		X	X		X	X	X	X	X	X	X	X	X
Cherry Laurel	X			X						X		X					X				X	X	X
Euonymus	X		X	X		X			X	X	X	X			X	X	X	X	X	X	X	X	X
Firethorn (Pyracantha)	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X	X	X	X
Holly	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Holly, Japanese	X			X	X	X		X	X		X	X	X	X	X		X	X	X	X	X	X	X
Ivy	X	X	X		X	X					X	X					X			X	X	X	X

Appendix III (continued)

	Atrazine	Barricade	Betasan	Casoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	OH2	Pentulum	Pennant Magnum	Predict	Princep	Regal O-O	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL
BROADLEAF (continued)																							
Japanese Pieris	X				X	X					X	X	X	X	X	X		X	X	X	X		
Leucothoe			X	X	X	X						X	X				X		X	X	X	X	X
Mahonia						X				X	X			X	X		X	X	X	X	X	X	X
Mountain Laurel						X		X		X	X								X	X	X	X	X
Rhododendron	X		X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X	X	X
DECIDUOUS TREES																							
Acacia						X					X				X	X	X		X	X	X		
Ash			X	X	X	X	X	X				X									X	X	
Ash, White			X	X		X	X	X				X		X							X	X	
Bald Cypress				X	X						X	X	X								X	X	
Beech									X								X						
Birch		X	X	X	X	X	X	X	X	X	X	X			X	X	X		X	X	X		
Cherry (nonbearing)				X		X	X	X	X	X		X		X							X	X	X
Chestnut							X														X	X	
Crabapple	X		X	X			X	X	X	X	X	X	X	X			X				X	X	X
Dogwood	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Dogwood, Kousa			X	X				X	X	X	X	X	X	X			X				X	X	
Elm			X		X	X		X		X				X			X		X	X			
Ginkgo						X		X		X	X						X		X	X	X	X	X
Golden Raintree			X																	X			X
Hawthorn	X			X	X	X		X	X			X							X				
Honeylocust				X		X		X		X	X		X						X		X		
Larch				X													X				X		
Linden			X					X				X								X			
Locust			X									X										X	
London Planetree							X	X								X					X		
Magnolia	X		X			X		X	X	X	X	X	X				X		X	X	X	X	X
Maple			X	X	X	X		X	X	X	X	X	X		X		X		X	X	X	X	X
Maple, Norway	X		X	X	X			X	X	X	X				X		X			X	X	X	X
Maple, Red			X	X	X	X	X	X	X	X	X	X	X	X			X		X	X	X	X	X
Maple, Silver			X	X	X	X		X	X			X					X		X	X	X	X	X
Maple, Sugar			X	X	X		X	X	X	X	X	X		X			X		X	X	X	X	X
Maple, Japanese					X																		

Appendix III (continued)

	Atrazine	Barricade	Betasan	CaSoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	OH2	Pendulum	Pennant Magnum	Predict	Princep	Regal O-O	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL	
TREES																								
(continued)																								
Mountain Ash			X						X															
Oak	X	X	X		X	X			X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Oak, Pin	X	X	X	X	X	X	X		X	X	X	X	X			X	X		X	X	X	X	X	X
Oak, Red	X	X			X	X	X		X	X		X		X		X	X		X	X	X	X	X	X
Oak, Scarlet	X	X				X			X	X		X					X				X	X	X	X
Pears	X			X	X	X			X			X		X					X	X	X	X	X	X
Plum (nonbearing)	X			X	X	X			X	X	X	X		X				X			X	X		
Poplar			X	X			X		X			X					X				X	X		
Redbud						X	X		X	X					X				X	X	X	X		
Russian Olive			X	X		X	X					X		X			X		X	X	X	X	X	X
Sourwood					X																			
Sweetgum					X	X	X		X		X	X							X	X	X	X		X
Sycamore					X	X			X		X		X						X	X	X			
Tuliptree							X		X			X										X		
Walnut	X			X	X	X			X		X		X									X		
Willow			X			X			X		X	X							X		X			
SHRUBS																								
Abelia		X		X	X	X				X	X	X			X			X	X	X	X	X	X	X
Arborvitae	X		X	X	X	X	X		X			X		X	X	X	X	X	X	X	X			X
Azalea	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X	X	X	X	X
Azalea, Mollis			X			X									X	X								
Barberry	X		X		X	X			X	X	X	X		X	X			X	X	X	X	X	X	X
Beautybush			X																					
Cinquefoil					X	X			X	X	X	X						X	X	X	X	X		
Cotoneaster	X		X	X	X	X			X	X	X	X		X				X	X	X	X	X	X	X
Deutzia			X			X					X							X		X	X	X		
Euonymus, Winged			X	X		X			X		X	X					X	X			X	X	X	X
Flowering Almond	X		X	X	X	X				X											X	X		
Flowering Quince			X						X															
Forsythia	X		X	X	X	X			X	X	X	X			X	X	X	X	X	X	X	X	X	X
Gardenia	X		X	X		X		X		X		X			X	X	X	X	X	X	X	X	X	X
Hibiscus	X			X	X	X					X	X						X	X	X	X	X	X	X
Honeysuckle	X		X	X	X	X				X		X		X		X	X	X	X	X	X	X	X	X
Hydrangea									X	X	X													

Appendix III (continued)

	Atrazine	Barricade	Betasan	Casoron	Devrinol	Dimension	Gallery	Goal	Image	Kerb	OH2	Pendulum	Pennant Magnum	Predict	Princep	Regal O-O	RegalStar G	Ronstar	Rout	Snapshot	Surflan	Treflan	XL
SHRUBS (continued)																							
Hypericum		X		X		X				X	X	X					X	X	X	X	X	X	X
Lilac			X			X		X	X	X	X	X			X		X		X	X	X	X	X
Mockorange			X		X				X		X						X			X	X	X	X
Nandina	X		X	X	X	X					X	X					X	X	X	X	X	X	X
Nerium		X				X				X		X			X		X	X	X	X	X	X	X
Pachysandra		X		X	X	X		X	X	X	X	X			X	X	X		X	X	X	X	X
Photinia	X		X	X		X		X	X	X	X	X			X	X	X	X	X	X	X	X	X
Potentilla						X				X	X	X					X	X	X	X	X	X	X
Privet	X	X	X	X	X	X			X	X	X	X					X	X	X	X	X	X	X
Rose	X		X	X	X	X					X	X					X		X	X	X	X	X
Spiraea			X		X	X		X	X	X	X	X			X			X	X	X	X	X	X
Viburnum	X			X	X	X		X	X		X	X			X	X	X	X	X	X	X	X	X
Vinca	X	X		X	X				X	X	X	X			X	X	X		X	X	X	X	X
Weigela	X		X			X			X	X	X	X			X	X	X	X	X	X	X	X	X



Weeds reduce the survival, growth, and quality of ornamental plants by competing with them for water, nutrients, and light; increasing the risk of disease and rodent damage; and increasing overall maintenance costs.

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