

SECTION Q.

NURSERY, GREENHOUSE, AND BULB CROPS

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Site Preparation

Ed Peachey

Revised December 2013

SITE PREPARATION—General

glyphosate (numerous product names)

Rate Consult labels

Time Apply 1 to 4 weeks before planting to allow time for chemical to move completely into the roots of actively growing weeds.

Remarks Use lower rates for annual weeds; consult label for higher rates and application time for perennial weeds. Additional surfactant sometimes is helpful when weeds are less vigorous. Inhibits production of three amino acids and protein synthesis.

Caution If repeat treatments are necessary within the crop, do not exceed 10.6 lb ai/A (10.6 quarts/A) in 1 year.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

soil fumigants

See the current edition of the *PNW Plant Disease Management Handbook* for application details and list of approved materials. Recently, a number of changes have been made on labels regarding new mitigation measures for soil fumigants including:

- Restricted Use Pesticide classification for metam sodium and dazomet
- New mandatory Good Agricultural Practices (GAPs)
- Application rate reductions
- Buffer zones requirements

More information is available from:

- The ODA: oregon.gov/ODA/PEST/docs/pdf/soilfumigation.pdf
- The EPA: epa.gov/pesticides/reregistration/soil_fumigants/

SITE PREPARATION—Can Yards

dichlobenil (Casoron 4G)

Rate 4 to 6 lb ai/A (100 to 150 lb/A Casoron)

Time Apply to mineral soil and incorporate 4 to 6 inches deep before placing containers on treated area.

Remarks Consult label for listed crops. Inhibits cell wall production.

Caution Do not transplant into treated soil. Do not use in greenhouses; volatility of dichlobenil may injure nearby plants.

Site of action Group 20: inhibits cell wall synthesis Site A

Chemical family Nitriole

pendimethalin (Pendulum Aquacap or 2G)

Rate 2.4 to 4.8 quarts/A Aquacap; 100 to 200 lbs/A 2G.

Time Before setting pots and when other vegetation has been removed.

Remarks Will not control emerged weeds but will slow emergence if applied after weed seeds have germinated.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

prodiamine (Barricade 4L)

Rate 0.65 to 1.5 lb ai/A (21 to 48 fl oz/A Barricade 4L)

Time Apply to soil, gravel, or other permeable surface before placing containers.

Caution Minimize disturbance during hand-weeding to maintain herbicide layer. Apply in fall or spring before weeds germinate.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Weed Control in Container-grown Nursery Stock

Ed Peachey

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Sanitation The first step to effective weed management is sanitation. Start with potting mixes that are free from weed seeds. Control weeds that have wind-dispersed seeds around the perimeter of the site. If weeds emerge in containers, remove them before they produce seeds. The more weed seed allowed to contaminate containers, the higher the probability that the weeds will germinate in areas where the herbicide barrier has been weakened or disrupted.

Maintaining a chemical barrier Preemergence herbicides form a chemical barrier over the surface of containers. Though each herbicide controls weeds differently, preemergence herbicides provide control at the point where germinating seeds emerge through the chemical barrier.

If the chemical barrier is incomplete or disrupted, there will be a gap where weed seed can successfully germinate and grow. Several common practices can disrupt the chemical barrier, including but not limited to poking holes in the barrier with fingers or hands while moving containers, dropping containers, and allowing containers to blow over. Minimize all these activities to avoid disrupting the chemical barrier. Teach work crew members about this, because they are typically responsible for moving and working near the containers.

Pulling uncontrolled weeds also creates gaps in the chemical barrier. Pull weeds before they go to seed. Soon after removing weeds from an area, apply a herbicide to create a complete chemical barrier and prevent germination of more weeds.

Selecting preemergence herbicides Preemergence herbicides are applied before weeds emerge, to prevent weed growth. This is in contrast to postemergence herbicides, which kill weeds after they have emerged and are actively growing. Base your selection of herbicides primarily on three criteria: the crop to which the herbicide will be applied, weed species to be controlled, and herbicide solubility. Other considerations include the importance of rotating herbicide chemistry and the choice of granular versus spray-applied herbicides (for more information, see Oregon State University Extension publication *EM 8823, Weed Control in Container Crops*

Crop tolerance of herbicides Selecting a herbicide based on the crop being grown is critical. Every herbicide label describes how the product should be used, and which plants it can be applied to safely based on experimental tests. Chemical manufacturers make every effort to ensure that plants listed on labels can be treated safely. However, not every environmental or cultural situation can be predicted or accounted for when testing products. Therefore, before using a new herbicide, or using a familiar herbicide on a new crop, conduct a small trial to ensure the plant and herbicide are compatible under conditions specific to your production system (regardless of whether or not the plant is listed on the label).

Apply herbicides before weed seed germinates The most important rule for herbicide application timing, the rule that trumps all others, is that preemergence herbicides work best if applied before weed seeds germinate. Most preemergence herbicides will not control weed plants that are present and visible at the time of application. Two notable exceptions are spray-applied Goal (oxyfluorfen) and SureGuard (flumioxazin). These herbicides will kill weeds less than 4 inches tall. However, they are limited to field use, and some container-grown conifers.

Existing weeds in containers must be hand-weeded before application. Weed plants present at the time of herbicide application will continue to grow and produce seed, thus perpetuating the problem. Applying preemergence herbicides to containers where weeds are growing is a waste of the herbicide and the labor needed to apply it (a costly mistake).

Herbicides at potting Herbicides can and should be applied soon after potting. When potting liners or shifting plants into larger containers, before applying a herbicide, irrigate two or three times to settle the substrate (media). For best results, apply herbicides after recently potted crops have received about 1 inch of irrigation or precipitation. When using certain herbicides, wait 2 to 4 weeks before application when potting bareroot plants into containers (check labels for specific instructions).

If herbicides are applied immediately after potting, before settling, macropores in the substrate can allow herbicides to channel and make contact with plant roots, causing injury or stunting. If herbicides are withheld for too long after potting, weed seed may germinate.

Weed control is most effective when herbicides are applied at the proper rate and the proper time, and in conjunction with good sanitation.

CONTAINER-GROWN NURSERY STOCK—Preemergence Weed Control within Containers

covers or mulches designed to prevent weed growth with air pruning

Rate On top of soil, place 0.5 inch of non-decomposable mulch, such as hazelnut shells, sawdust, coco-fiber disks, geotextile disks, or any number of commercially available plastic disks, to prevent weeds from germinating and establishing in wet-dry cycles.

Time During container filling.

Remarks Filling the container with a porous mulch that dries on the container rim prevents weeds from establishing by wetting and drying cycles. This technique requires retooling during the planting operation but can suppress weeds throughout the life cycle of the crop.

Caution Avoid products, including coarse or rigid materials, that might damage the stem of the crops.

dithiopyr (Dimension)

Rate 0.5 lb ai/A (2 quarts/A)

Time Apply to bare ground, or containers before target weeds germinate.

Remarks For best weed control, apply to soil that is free from clods, weeds, and debris such as leaves. Requires activation with 0.5 inch or more of rain or irrigation.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Pyridine

flumioxazin (SureGuard 51WDG)

Rate 0.25 to 0.38 lb ai/A (8 to 12 oz/A SureGuard)

Time Apply to weed-free containers or containers with small weeds (less than 2 inches tall). Apply to established and dormant conifers only (see label for list of approved species).

Remarks Has some postemergence activity on small weeds. Preemergence control is better if applied to weed-free containers. Payload is similar to SureGuard and is labeled for use to maintain bare ground and non-crop areas.

Caution Do not apply over the top of deciduous or broadleaf evergreen crops.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

flumioxazin (BroadStar 0.25G)

Rate 0.375 lb ai/A (150 lb/A BroadStar)

Time Apply to weed-free containers.

Caution Foliage of desirable crops must be dry at the time of application. Wet foliage will trap granules on the leaf surface, disperse the herbicide, and burn the foliage.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

isoxaben (Gallery 75 DF)

Rate 0.495 to 0.99 lb ai/A (0.66 to 1.33 lb/A)

Time Apply to weed-free soil.

Remarks Identify weeds and adjust rates according to charts on label. Chemical stability is adequate when left on soil surface for 21 days.

Caution Do not apply to newly transplanted crops until medium is settled (two to three irrigations).

Site of action Group 21: inhibits cell wall synthesis Site B

Chemical family Benzamide

isoxaben + trifluralin (Snapshot 2.5TG)

Rate 2.5 to 5 lb ai/A (100 to 200 lb/A Snapshot), depending on prevalent weed species; consult label

Time Apply to weed-free soil.

Remarks Soil must be settled with water and free of cracks after transplanting. Activate within 3 days using 0.5 inch of water before weeds begin to emerge. See label for repeat treatments.

Caution Do not apply to unrooted liners or cuttings, bedding plants, or newly planted ground cover.

Site of action (isoxaben) Group 21: inhibits cell wall synthesis Site B; (trifluralin) Group 3: microtubule assembly inhibitor

Chemical family (isoxaben) benzamide; (trifluralin) dinitroaniline

isoxaben + trifluralin + oxyfluorfen (Showcase)

Rate 2.5 to 5 lb ai/A (100 to 200 lb/A)

Time Apply to weed free soil

Remarks Soil must be settled with water and free from cracks after transplanting. Activate within 3 days using 0.5 inch of water before weeds begin to emerge. See label for repeat treatments.

Caution Do not apply to unrooted liners or cuttings.

Site of action (isoxaben) Group 21: inhibits cell wall synthesis Site B; (trifluralin) Group 3: microtubule assembly inhibitor

Chemical family (isoxaben): benzamide; (trifluralin) dinitroaniline; (oxyfluorfen) diphenylether

napropamide (Devrinol 2G or Devrinol 50DF)

Rate 4 ai/A (8 lb/A Devrinol 50DF)

Time Apply any time to weed-free containers, and irrigate immediately with 0.5 inch water.

Remarks Use higher rates on severe weed infestations or if broadleaf weeds predominate. Inhibits root growth.

Site of action Group 15: inhibits very long chain fatty acid synthesis

Chemical family Acetamide

napropamide + oxadiazon (Pre Pair)

Rate 100 to 150 lb/A (4% + 2% formulation, respectively)

Time Postplant after soil settles from first irrigation but before weed seeds germinate.

Remarks Note all precautions, including sensitive crops. Does not control emerged weeds.

Site of action (napropamide) Group 15: inhibits very long chain fatty acid synthesis; (oxadiazon) Group 14: protoporphyrinogen oxidase inhibitor

Chemical family (napropamide) acetamide; (oxadiazon) oxadiazole

oryzalin (Surflan AS)

Rate 2 to 4 lb ai/A (2 to 4 quarts/A Surflan AS)

Time Apply to established plants only in weed-free containers, and irrigate as soon as possible with 0.5 inch water.

Remarks Establish rooted liners in containers at least 2 weeks before treatment. Inhibits cell division or mitosis, primarily in roots.

Caution Do not apply again within 90 days.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

oryzalin + oxyfluorfen (Rout)

Rate 100 lb/A (2% + 1% formulation, respectively)

Time Apply product uniformly, after a 0.5-inch irrigation for potted liners or 3 weeks after potting bareroot liners.

Remarks Irrigate with 0.5 inch water immediately after application. Note all precautions on label. Acts as a contact herbicide, and inhibits cell division or mitosis in roots and shoots, respectively.

Caution Do not apply to wet foliage or plants with whorls where the granules may lodge.

Site of action (oryzalin) Group 3: microtubule assembly inhibitor; (oxyfluorfen) Group 14: protoporphyrinogen oxidase inhibitor

Chemical family (oryzalin) dinitroaniline; (oxyfluorfen) diphenylether

oxadiazon (Ronstar G)

Rate 2 to 4 lb ai/A (100 to 200 lb/A Ronstar)

Time Apply uniformly with granular applicator any time to weed-free containers when plants are dry. Irrigate with 0.25 to 0.33 inch water immediately after application.

Remarks Pink family weeds (chickweed, mouseear chickweed, and pearlwort) are resistant. Controls weed seedlings by contact action during emergence.

Caution Do not use in greenhouses, because injury to plants may result from the deposition of active ingredient on leaf surfaces in condensate.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Oxadiazole

oxadiazon + prodiamine (RegalStar G)

Rate 200 lb/A

Time Apply uniformly before weeds begin germination and emergence, following newly transplanted or established nursery crops.

Remarks Do not apply to wet foliage or inside greenhouses.

Site of action (oxadiazon) Group 14: protoporphyrinogen oxidase inhibitor; (prodiamine) Group 3: microtubule assembly inhibitor

Chemical family (oxadiazon) oxadiazole; (prodiamine) dinitroaniline

oxyfluorfen (Goal 2XL)

Conifers and selected deciduous trees only

Rate 0.5 to 1.5 lb ai/A (2 to 6 pints/A Goal 2XL), depending on use; check label.

Time Apply after transplanting to dormant conifer stock. Irrigate with 0.5 to 0.75 inch water or rain for preemergence control of annual grasses and broadleaf weeds.

Remarks Postemergence applications can control susceptible broadleaf weeds up to 4 inches tall. Acts as a contact herbicide.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

oxyfluorfen + oxadiazon (Regal O-O Herbicide)

Rate 100 lb/A

Time Apply uniformly before weeds begin to germinate and emerge; follow with 0.5 inch irrigation or rain to activate herbicide.

Remarks Avoid application to wet foliage.

Site of action (both) Group 14: protoporphyrinogen oxidase inhibitor

Chemical family (oxyfluorfen) diphenylether; (oxadiazon) oxadiazole

oxyfluorfen + pendimethalin (OH2 Ornamental Herbicide)

Rate 100 lb/A (2% + 1% formulation, respectively)

Time Apply product uniformly using a rotary or drop-type granular spreader either after transplanting potted liners (wait until after two to three irrigations to allow media to settle) or 3 to 4 weeks after planting bareroot liners but before weeds emerge.

Remarks Requires 0.5 to 1 inch water to activate immediately after application. Acts as contact-type herbicide and inhibits mitosis in roots and shoots, respectively.

Site of action (oxyfluorfen) Group 14: protoporphyrinogen oxidase inhibitor; (pendimethalin) Group 3: microtubule assembly inhibitor

Chemical family (oxyfluorfen) diphenylether; (pendimethalin) dinitroaniline

pendimethalin (Corral 2.68G, Pendulum WDG, or Pendulum 2G)

Rate 1.5 to 2 lb ai/A (75 to 100 lb/A Pendulum 2G)

Time Apply only to dry crop foliage, either before weed seeds germinate or after completely removing weeds.

Remarks Requires 0.5 inch of water immediately after application to activate herbicide. For container plants, delay first application to bareroot liners for 2 to 4 weeks. Inhibits mitosis in roots and shoots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pendimethalin + dimethenamid-P (Freehand 1.75G)

Rate 100 to 200 lb/A depending on weed control needed

Time Apply only to dry crop foliage, either before weed seeds germinate or after completely removing weeds.

Remarks Requires 0.5 inch of water immediately after application to activate herbicide. For container plants, delay first application to bareroot liners for 2 to 4 weeks. Very weak on groundsel, but good control of bluegrass and spotted spurge. Inhibits mitosis in roots and shoots.

Caution Allow soil or planting mixes to settle firmly around transplants, making sure that there are no cracks in the soil that would allow Freehand to contact roots directly.

Site of action (pendimethalin) Group 3: microtubule assembly inhibitor; (dimethenamid-P) Group 15: inhibits very long chain fatty acid synthesis

Chemical family (pendimethalin) dinitroaniline; (dimethenamid-P) chloroacetamide

prodiamine (Barricade 4L or RegalKade G)

Rate 0.65 to 1.5 lb ai/A (21 to 48 fl oz/A Barricade 4L)

Time Apply to weed-free site.

Remarks Follow with 0.5 inch rain or irrigation.

Caution Do not exceed maximum rate listed on label in a 12-month period.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

S-metolachlor (Pennant Magnum)

Rate 1.24 to 2.48 lb ai/A (1.3 to 2.6 pints/A Pennant Magnum)

Time Apply any time to weed-free containers for ornamentals transplanted at least 5 days.

Remarks Direct spray toward base of ornamental plant to avoid possible injury. Activate herbicide with brief irrigation. Use lower rates on porous media and reduced weed infestations. Provides approximately 60-day control, less under very wet conditions. Inhibits seedling roots and/or shoots.

Caution Do not exceed 4 lb ai/A per year or per crop cycle (whichever is less), in a given area.

Site of action Group 15: inhibits very long chain fatty acid synthesis

Chemical family Chloroacetamide

sethoxydim (Segment or Vantage)

Washington only

Rate 0.28 to 0.47 lb ai/A (36 to 60 fl oz/A)

Time Apply at optimum growth stage indicated on label.

Remarks For selective postemergence grass control. Identify susceptible grasses. Control often is erratic if grasses are stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed. Inhibits fatty acid production, cell membranes, and new growth.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione

CONTAINER-GROWN NURSERY STOCK—Postemergence Grass Control within Containers

clethodim (Envoy)

Rate 0.095 to 0.25 lb ai/A (13 to 34 fl oz/A)

Time For selective postemergence grass control. Apply postemergence to actively growing annual or perennial grasses as listed on label. Consider environmental and plant growth conditions that affect leaf uptake; see label for guidelines.

Caution Do not exceed 68 fl oz/A per season.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione

fluazifop (Fusilade II or Ornamec Over-the-Top)

Rate 0.25 to 0.375 lb ai/A (1 to 1.5 pints/A Fusilade II)

Time Apply to actively growing grasses or within 7 days after irrigation with 0.25% nonionic surfactant.

Remarks May be used in greenhouses. Applied over the top of nursery plants for selective postemergence grass control. Identify grasses and adjust rates depending on susceptibility and stage of weed growth according to label instructions. Note lists of ornamentals and associated instructions regarding topical versus directed sprays. Results often are erratic on grasses stressed from lack of vigor, drought, high temperature, or low fertility. More

mature grasses and quackgrass can be controlled but may require two applications. Annual bluegrass and all fine fescues resist treatment. Inhibits fatty acid production, cell membranes, and new growth.

Caution Do not tank mix with other pesticides or apply within 5 days of other pesticides. Grazing is prohibited.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Aryloxyphenoxy propionate

CONTAINER-GROWN NURSERY STOCK—Container Growing Areas

dichlobenil (Casoron 4G)

Rate 4 to 8 lb ai/A; 10 lb ai/A for nutsedge (100 to 200 lb/A Casoron; 250 lb/A Casoron for nutsedge)

Time Treat area before containers are set in midwinter, when temperatures are cold and rain is expected immediately after application to activate herbicide and prevent loss by volatility.

Site of action Group 20: inhibits cell wall synthesis Site A

Chemical family Nitrile

glufosinate ammonium (Finale)

Spot or directed spray between and around containers only

Rate 1 to 1.5 lb ai/A (4 to 6 quarts/A Finale)

Time Apply around containers to thoroughly cover actively growing weeds.

Remarks A postemergence, partially systemic herbicide. Avoid all contact with foliage and green bark of desirable crops.

Site of action Group 10: glutamine synthetase inhibitor

Chemical family Phosphinic acid

oryzalin (Surflan)

Rate 2 to 4 lb ai/A

Time Apply any time to weed-free area beneath and around container-grown stock listed on label.

Remarks Inhibits cell division or mitosis primarily in roots. Roots growing from pot drainage holes are pruned without crop injury because the herbicide does not translocate upward in the plant.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pelargonic acid (Scythe)

Rate 3 to 5% solution to control annual weeds, mosses and cryptogams; 5 to 7% solution for burndown of perennial herbaceous plants; 7 to 10% solution for maximum vegetative burndown, edging, or foliar trimming.

Time Apply to thoroughly wet weed foliage as a directed spray around containers. Most effective when temperature is above 65°F.

Remarks Avoid contact with desirable vegetation. Disrupts cell membranes, causing leakage and symptoms of leaf burn.

Site of action Group 26: unknown

Chemical family Carboxylic acid

Weed Control in Field-grown Nursery Stock

Ed Peachey

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Weeds compete with newly planted nursery stock. Deep-rooted perennial weeds can reduce vigor and render a mature product unmarketable due to laws on transporting noxious weeds. Consequently, weeds are controlled with herbicides either broadcast-applied in closely spaced crops, or within the tree or shrub row for wider spaced crops, with alleys being mowed or flailed.

Weed shifts Repeated use of simazine was first demonstrated, in nurseries, to cause a shift within a natural population of common groundsel to a resistant or tolerant biotype. Routine cultural practices also cause such a weed shift. Examples include prostrate weeds that tolerate flailing, deep-rooted or easily spread perennials that tolerate cultivation, and weeds that resist repeated applications of the same or similar herbicide treatments. A significant weed shift noted over the last decade is the rapid increase in marehail or horseweed in many nurseries. Speculation for the cause of this included glyphosate resistance, but recent screening of populations of the Willamette Valley and the Columbia Basin did not find elevated levels of glyphosate tolerance.

Preventing weed shifts Weeds that survive cultivation, mowing or flailing, specific herbicide treatments, or other routine cultural practices must be eliminated before the tolerant species or biotypes become established. Combine a variety of weed control practices or treatments; rotate fields, cultural practices, and herbicides; and spot treat with a hoe or registered herbicide when the weed first appears. Also, clean equipment when moving from an infested field.

Sod covers In specimen tree plantings, manage either native or planted grasses in row middles to reduce soil erosion and improve traffic conditions during wet weather. In addition, soil moisture and nutrient retention are improved along with increased water infiltration rates for many sods. New sod varieties, including dwarf cultivars that respond to minimal management practices such as drought, low fertility, or sublethal rates of postemergence herbicides, are being introduced into various horticultural cropping systems. Consult your local Extension agent, or request recent information about living mulches and their management.

Managing weedy vegetation Successful weed control in nurseries requires a comprehensive, year-round approach that uses and alternates a combination of weed control practices over several years. Developing these strategies requires knowledge of each weed and weed control practice. Weeds must be identified and information gathered about the effectiveness of each weed control practice. Consider costs and select herbicide combinations that may be applied together or in split applications that control all weeds present in the nursery. Note the action of each herbicide or how the chemical works in the plant. Then tank mix and alternate use of these products to reduce the chance of developing resistant species or biotypes. Often a combination of mechanical, herbicidal, and sometimes hand-removal or spot-treatment with herbicide sprays or wipers, will provide the most effective year-round control.

Soil-active (preemergence) herbicides Persistent, soil-applied herbicides can be applied to weed-free soil during winter when rain will activate the chemical; some compounds may be applied throughout the year. Apply lower rates on sandy soils having lower clay, organic matter, or cation exchange capacities. Existing vegetation can be controlled by mixing a postemergence contact or translocated herbicide. Consult label for listed species and duration of expected control.

Postemergence herbicides In nursery production, postemergence weed control requires precision. Postemergence treatments either selectively control susceptible weeds or are applied with selective equipment.

Frequent scouting to identify susceptible weeds and the correct stage of weed growth must be combined with appropriate weather conditions and labeled spray additives to maximize control. Consult labels for numerous precautions or information about crop or cultivar tolerances. Due to the multitude of nursery crops, always verify selectivity on a few plants before treating the entire block or field.

Note Herbicides must be applied at the correct rate and time to selectively control weed growth. For band applications under tree rows, reduce quantity of herbicide applied proportionally to the area within the row actually sprayed.

FIELD-GROWN NURSERY STOCK— Preplant Incorporated and Preemergence

DCPA (Dacthal)

Rate 10.5 to 12 lb ai/A

Time Apply any time to weed-free soil; must be activated with a minimum of 0.33 to 0.5 inch of irrigation or rainfall water, 3 to 5 days after treatment.

Remarks Applications west of the Cascades usually perform poorly. In other areas, can be applied immediately after planting liners. Inhibits cell division or mitosis in roots and shoots.

Caution Do not use on seedbeds.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Phthalic acid

dichlobenil (Casoron 4G)

Established stock only

Rate 4 to 8 lb ai/A (100 to 200 lb/A granular product)

Time Apply midwinter immediately before a cold rain, to reduce volatility and to enhance weed suppression.

Remarks Weigh and distribute exact quantities over precisely measured areas to ensure accurate applications. Avoid applying near tree trunks to reduce possible girdling.

Caution Do not apply for 6 months while roots develop on liners, or until 4 weeks after transplanting stock. Oregon results over 9 years suggest that perennial weeds can be suppressed with 4-, 3-, and 2-lb ai/A rates applied during 3 consecutive years. Grazing livestock is prohibited. Inhibits cellulose and cell wall formation.

Site of action Group 20: inhibits cell wall synthesis Site A

Chemical family Nitrile

dithiopyr (Dimension)

Rate 0.5 lb ai/A

Time Apply to bare ground, before target weeds germinate.

Remarks For best weed control, apply to soil that is free from clods, weeds, and debris such as leaves.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Pyridine

EPTC (Eptam 7E or Eptam 20G)

Rate Consult labels

Time Apply 2 weeks before transplanting balled and canned stock (only), or any time after transplanting or growth on established plants begins in spring.

Remarks Use lower rate and incorporate with nursery cultivator or rototillers to 3 inches for annual weeds, and higher rates to 6 inches for perennial weeds. Inhibits shoots of emerging seedlings.

Site of action Group 8: lipid synthesis inhibitor but not an ACCase inhibitor

Chemical family Thiocarbamate

flumioxazin (SureGuard 51WDG)

Rate 0.25 to 0.38 lb ai/A (8 to 12 oz/A SureGuard)

Time Apply before or after weeds emerge. Kills existing annual weeds if weeds are less than 2 inches.

Remarks Can be used safely on established and dormant conifers. Also can be applied to established deciduous crops (check label) with directed sprays as long as contact with foliage and green bark is avoided. Injury to linden (*Tilia* spp.), which has a thin, green bark when young, has been noted in several Oregon nurseries. Payload is similar to SureGuard and is labeled for use to maintain bare ground and non-crop areas.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

flumioxazin (BroadStar 0.25G)

Rate 0.375 lb ai/A (150 lb/A BroadStar)

Time Apply to weed-free containers.

Caution Foliage of desirable crops must be dry at the time of application. Wet foliage will trap granules on leaf surface and burn foliage.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

isoxaben (Gallery 75 DF)

Rate 0.495 to 0.99 lb ai/A (0.66 to 1.33 lb/A)

Time Apply in late summer to early fall, in early spring, or immediately after cultivation. Apply to debris-free soil surface.

Remarks Identify weeds and adjust rates according to charts on label. Activate with 0.5 inch water or shallow cultivation before weeds emerge. Chemical is stable enough when left on soil surface for 21 days.

Caution Do not apply to newly transplanted crops until media settle.

Site of action Group 21: inhibits cell wall synthesis Site B

Chemical family Benzamide

isoxaben + trifluralin (Snapshot 2.5TG)

Rate 2.5 to 5 lb ai/A (100 to 200 lb Snapshot/A)

Time Apply to soil that is free from weeds and debris.

Remarks Soil must be settled with water and free from cracks after transplanting. Activate within 3 days using 0.5 inch of water or shallow cultivation before weeds begin to emerge. Follow label instructions for repeat treatments.

Caution Do not apply to unrooted liners or cuttings, bedding plants, or new-planted ground cover.

Site of action (isoxaben) Group 21: inhibits cell wall synthesis Site B; (trifluralin) Group 3: microtubule assembly inhibitor

Chemical family (isoxaben) benzamide; (trifluralin) dinitroaniline

napropamide (Devrinol 2G or Devrinol 50DF)

Rate 4 lb ai/A (8 lb/A Devrinol 50DF)

Time Consult label for crops listed. Apply November to February and irrigate if no rain falls within 2 to 3 days; or apply March through October and irrigate within 24 hours to wet soil 2 to 4 inches deep.

Remarks Shallow mechanical incorporation improves performance. Use higher rates if weed infestations are severe or broadleaf weeds predominate. Inhibits root growth.

Site of action Group 15: inhibits very long chain fatty acid synthesis

Chemical family Acetamide

norflurazon (Solicam)

Established stock only

Rate 3 lb ai/A

Time Apply in fall or spring to bare soil after nursery crops are established.

Remarks Rain must be adequate before weeds begin to emerge. Read label thoroughly about site, soil, crop rotation, and mixing precautions. Inhibits yellow pigment formation, bleaching green chlorophyll.

Caution Do not apply to cherry, grape, or caneberry nurseries.

Site of action Group 12: bleaching; inhibits carotenoid biosynthesis

Chemical family Pyridazinone

oryzalin (Surflan AS)

Rate 2 to 4 lb ai/A (2 to 4 quarts/A Surflan AS)

Time Apply any time to bare soil. Activate within 21 days with 0.5 inch water. Wait at least 90 days before repeating application. Apply only to established plantings.

Remarks Inhibits cell division or mitosis, primarily in roots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

oxadiazon (Ronstar G or Ronstar 50WSP)

Rate 2 to 4 lb ai/A (100 to 200 lb/A Ronstar G)

Time Apply uniformly with granular applicator any time to weed-free soil and when plants are dry.

Remarks Irrigate with 0.25 to 0.33 inch water immediately after applying; do not incorporate mechanically. Weeds

in the pink family (chickweed, mouseear chickweed, pearlwort) are resistant. Controls weed seedlings by contact action during emergence.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Oxadiazole

pendimethalin (Pendulum 2G, Pendulum WDG, or Corral 2.68G)

Rate 1.5 to 2 lb ai/A (75 to 100 lb/A Pendulum 2G)

Time Apply at planting or before weed seed germinates. Soil should be loose and free from established weeds.

Remarks Water within a few days to activate herbicide before weeds emerge. Inhibits mitosis in roots and shoots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

prodiamine (Barricade 4L or RegalKade)

Rate 0.65 to 1.5 lb ai/A (21 to 48 fl oz/A Barricade)

Time Apply to weed-free site.

Remarks Follow with 0.5 inch rain or irrigation, or shallow incorporation.

Caution Do not exceed maximum rate on label in a 12-month period. Do not apply to recently planted red maple (*Acer rubrum*) liners; this species is not labeled, and severe girdling has been observed in several Oregon nurseries.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pronamide (Kerb)

Established stock only

Rate 1 to 2 lb ai/A

Time Apply in fall before leaves drop or soil freezes. Or, apply from early to midwinter west of the Cascades to soil relatively free of plant residues.

Remarks Requires soil moisture from rain or irrigation to activate; do not incorporate mechanically. Use lower rates for annual grasses and light-texture soils; higher rates for perennial grasses and heavier soils. Control of established grasses is slow. Degraded by microorganisms in warmer weather. Use on nursery stock established at least 1 year and seedlings that are at least 1 year old. Inhibits root growth.

Caution A restricted-use pesticide.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Benzamide

S-metolachlor (Pennant Magnum)

Rate 1.24 to 2.48 lb ai/A (1.3 to 2.6 pints/A Pennant Magnum)

Time Apply any time to weed-free soil as a spray directed to base of ornamentals transplanted at least 10 days.

Remarks Activate herbicide with light irrigation. Use lower rates on sandy soils and reduced weed infestations. Gives about 60 days control, less under very wet conditions. Suppresses yellow nutsedge when applied preemergence and activated with adequate water.

Caution Do not use on seedbeds or unrooted cuttings. Inhibits seedling roots and/or shoots.

Site of action Group 15: inhibits very long chain fatty acid synthesis

Chemical family Chloroacetamide

simazine (Simazine 4L and others)

Established stock only

Rate 2 to 3 lb ai/A

Time Apply at least 1 year after transplanting to weed-free soil and activate with rain or sprinkler irrigation.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

trifluralin (4HF or 10G products)

Rate 4 lb ai/A

Time Apply to established nursery crops before weeds germinate. Incorporate with 0.5 inch of irrigation or rain within 3 days of application. Inhibits cell division or mitosis, both in roots and shoots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

FIELD-GROWN NURSERY STOCK— Preemergence Premixes

benefin + oryzalin (XL 2G)

Rate 4 to 6 lb ai/A (200 to 300 lb/A XL 2G)

Time Apply before weeds germinate. Incorporate immediately with shallow cultivation (1 to 2 inches) or overhead water.

Remarks Precisely calibrate application equipment, preferably at half rates to enable two perpendicular passes for greater accuracy. Inhibits cell division or mitosis, primarily in roots.

Site of action (both) Group 3: microtubule assembly inhibitor

Chemical family (both) dinitroaniline

oxyfluorfen + oryzalin (Rout)

Rate 100 lb/A (2% + 1% formulation, respectively)

Time Apply uniformly, either in spring before weeds germinate or to weed-free soil.

Remarks Requires 0.5 inch water immediately after application to activate and to wash product from leaves. A contact-type herbicide; inhibits cell division or mitosis in roots and shoots, respectively.

Caution Do not apply to wet foliage or plants with whorls.

Site of action (oxyfluorfen) Group 14: protoporphyrinogen oxidase inhibitor; (oryzalin) Group 3: microtubule assembly inhibitor

Chemical family (oxyfluorfen) diphenylether; (oryzalin) dinitroaniline

oxyfluorfen + pendimethalin (OH2 Ornamental Herbicide)

Rate 100 lb/A (2% + 1% formulation, respectively)

Time Apply uniformly using a rotary or drop-type spreader, either immediately after transplanting new stock or to weed-free soil.

Remarks Requires 0.5 to 1 inch water immediately after application to activate and to wash product from leaves.

Caution Do not incorporate mechanically. A contact herbicide that inhibits cell division (mitosis) in roots and shoots.

Site of action (oxyfluorfen) Group 14: protoporphyrinogen oxidase inhibitor; (pendimethalin) Group 3: microtubule assembly inhibitor

Chemical family (oxyfluorfen) diphenylether; (pendimethalin) dinitroaniline

FIELD-GROWN NURSERY STOCK— Preemergence and Postemergence

atrazine

Conifers only including Douglas-fir, Grand fir, Nobel fir, Sitka spruce, and pine

Rate 2 to 4 lb ai/A

Time Apply October through March when trees are dormant.

Remarks Can be applied after small weeds emerge. Requires rain or sprinkler irrigation to activate. Apply only once per year.

Caution A restricted-use pesticide.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

oxyfluorfen (Goaltender)

Rate 0.5 to 2 lb ai/A (1 to 4 pints/A)

Time Apply to deciduous, field-grown shade trees listed on label; direct the applications toward the soil and tree base. Apply to 2-0 conifers in winter dormancy fall through winter. After transplanting, irrigate with 0.5 to 0.75 inch water or rain for preemergence control of annual grass and broadleaf weeds. Do not exceed 2 lb ai/A per year.

Remarks Postemergence applications control susceptible broadleaf weeds up to 4 inches tall. Goaltender is a contact herbicide. It inhibits cell division (mitosis) in roots and shoots.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

FIELD-GROWN NURSERY STOCK— Postemergence

asulam (Asulox)

Certain juniper and yew species only

Rate 3.34 lb ai/A

Time Apply postemergence treatment only when weeds are between the stages of early seedling and early seed head formation.

Remarks Use at least 20 gal water. Do not use a surfactant. Controls crabgrass, barnyardgrass, and horseweed (*Conyza canadensis*). Inhibits cell division or mitosis.

Caution Do not reapply within 12 months. Labeled for a limited number of ornamental species; consult label before use.

Site of action Group 18: inhibits DHP synthase step

Chemical family Carbamate

bentazon (Basagran T/O)

Do not use on sycamore or rhododendron

Rate 0.75 to 1 lb ai/A

Time Postemergence control of broadleaf weeds, Canada thistle, yellow nutsedge, and musk thistle.

Remarks Direct sprays toward actively growing weed foliage at weed size described on label. Add 2 pints/A crop oil concentrate to enhance activity (see label). Two treatments 7 to 10 days apart may be required for Canada thistle or yellow nutsedge. Temperatures below 55°F, drought, or rain within 8 hours will reduce activity. Inhibits photosynthesis.

Caution Do not apply within 1 year of harvest. Do not exceed 2 lb ai/A per season.

Site of action Group 6: photosystem II inhibitor

Chemical family Benzothiadiazole

clethodim (Envoy Plus)

Rate 0.09 to 0.24 lb ai/A (12 to 32 oz/A Envoy)

Time Apply postemergence to actively growing annual or perennial grasses as listed on label.

Remarks For selective postemergence grass control. Consider environmental and plant growth conditions that affect leaf uptake; see label.

Caution Do not exceed 64 fl oz/A per season.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione

clopyralid (Lontrel Turf and Ornamental)

Rate Consult labels

Time Apply when weeds are small and actively growing. For Canada thistle, apply to rosette stage but before bud stage.

Remarks Apply over the top of labeled crops or as spot treatment to well established plantings.

Caution Do not exceed 1.3 pints/A per season. Avoid drift or treatment near susceptible crops or unlabeled and desirable plants.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

fluazifop (Fusilade II or Ornamec Over-the-Top)

Rate 0.25 to 0.375 lb ai/A (16 to 24 oz/A Fusilade II)

Time Apply to actively growing grasses or within 7 days after irrigation with 0.25% nonionic surfactant.

Remarks For selective postemergence grass control. Identify grasses and adjust rates for susceptibility and stage of growth as on label. Note lists of ornamentals and associated instructions regarding topical versus directed sprays. Results often are erratic if grasses are stressed from lack of vigor, drought, high temperature, or low fertility. More mature grasses and quackgrass can be controlled but may require two applications. Annual bluegrass and all fine fescues resist treatment. Do not tank-mix with other

pesticides. Inhibits fatty acid production, cell membranes, and new growth.

Caution Do not apply within 5 days of other pesticide treatments. Grazing is prohibited.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Aryloxyphenoxy propionate

glufosinate ammonium (Finale)

Spot or directed spray only

Rate 1 to 1.5 lb ai/A (4 to 6 quarts Finale/A)

Time Apply to thoroughly cover actively growing weeds.

Remarks Avoid all contact with desirable foliage and green bark.

Site of action Group 10: glutamine synthase inhibitor

Chemical family Phosphinic acid

glyphosate (numerous products)

Rate Spray: consult label

Time Apply as a directed spray toward base of tree when weeds are actively growing or moving sugars to roots.

Remarks Inhibits production of three amino acids, and protein synthesis.

Caution Do not spray green bark, foliage, or root suckers. If repeat applications are necessary, do not exceed a total of 10.6 lb ai/A (10.6 quarts/A) per year.

Remarks Consult label about rate and time of application, especially perennial weeds.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glyphosate (several products)

Rate Wiper: 33% solution

Time Mix 1 gal product to 2 gal water and wipe weeds, avoiding contact with desirable vegetation.

Remarks In severe infestations, reduce equipment ground speed or apply in two directions to ensure contact with wiper. (See remarks above.)

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

paraquat (Gramoxone Inteon or Gramoxone Max)

Established stock only

Rate Consult labels; formulations differ.

Time Apply as a directed or directed-shielded application when weeds are small (6 inches or less) and actively growing.

Remarks Add a nonionic surfactant or crop oil concentrate according to label specifications, taking care to avoid anionic formulations that react in the tank to form insoluble precipitates. Avoid contact with stems or leaves of crop. Acts as contact; absorbs energy produced by photosynthesis forming peroxides that disrupt living cells.

Caution **A restricted-use herbicide.** Do not ingest or inhale spray mist. Wear protective face shields, respirators, and clothing.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

pelargonic acid (Scythe)

For nursery trees and shrubs

Rate 3 to 5% solution to control annual weeds, mosses and cryptogams; 5 to 7% solution to burn down perennial herbaceous plants.

Time Apply to thoroughly wet foliage, either broadcast to non-crop area, or before ornamental crop emerges; or spot treat and trim around ornamentals, trees, flower beds, paths, etc. Most effective when temperature is above 65°F.

Remarks Controls small, actively growing weeds and weakens established weeds by removing susceptible vegetation. Disrupts cell membranes, causing leakage and symptoms of leaf burn.

Site of action Group 26: unknown

Chemical family Carboxylic acid

sethoxydim (Segment or Sethoxydim SPC)

Rate 0.1875 to 0.47 lb ai/A (36 to 60 fl oz/A)

Time Apply at optimum growth stage listed on label, and rate recommended for targeted grass

Remarks For selective postemergence grass control. Identify susceptible grasses. Results often are erratic on grasses stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues; quackgrass can be suppressed. Inhibits fatty acid production, cell membranes, and new growth.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione

Greenhouse Floors

Ed Peachey

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Diligent sanitation is the key to successful weed control inside greenhouses. Weed control also requires special precautions and the use of herbicides that have little or no chance to vaporize. Consequently, only a few herbicides are registered for use inside entirely enclosed greenhouses. Always turn off ventilation fans while applying postemergence herbicides, and avoid contact with desirable vegetation.

GREENHOUSE FLOORS

clethodim (Envoy)

Rate 0.095 to 0.25 lb ai/A (13 to 34 oz Envoy/A)

Time Apply postemergence to actively growing annual or perennial grasses as listed on label.

Remarks Consider environmental and plant growth conditions that affect leaf uptake (see label).

Caution Do not exceed 68 fl oz/A per season.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione

diquat (Reward)

Rate 0.5 to 1 quart/100 gal water

Time Apply with nonionic surfactant any time weeds are small and actively growing.

Remarks Avoid spray contact with desirable ornamental plants. Acts as a contact herbicide; absorbs energy produced by photosynthesis, forming peroxides that disrupt living cells.

Caution A moderately toxic herbicide that requires protective face shields, respirators, and clothing for handling and application. Do not ingest or inhale spray mist.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

glyphosate (numerous products)

Rate Consult labels

Time Apply to actively growing weeds when desired vegetation is out of greenhouse and air circulation fans are turned off.

Remarks Consult label for specific rates, application times, and species controlled. Honcho requires adding a nonionic surfactant; Expedite Application Equipment contains a specific formulation using small-droplet technology.

Caution Do not exceed 10.6 lb ai/A per year.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted.

oryzalin (Surflan AS)

Open greenhouse-type structures only

Rate 2 to 4 lb ai/A (2 to 4 quarts/A Surflan AS)

Time Prior to weed emergence.

Remarks Inhibits cell division or mitosis, primarily in roots.

Caution Do not apply in enclosed greenhouses or enclosed shade-house type structures.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pelargonic acid (Scythe)

Rate Broadcast: 3 to 10 gal product/100 gal water. Spot spray: 1 to 10% solution (1 to 13 fl oz/gal) to cover 400 sq ft

Time Apply to thoroughly wet weed foliage in and around greenhouse, under benches, or preemergence in seedling beds.

Remarks Avoid contact with desirable plants. Disrupts cell membranes, causing leakage and symptoms of leaf burn.

Site of action Group 26: unknown

Chemical family Carboxylic acid

Conifer Seedbeds

Ed Peachey

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Conifer seedlings are extremely poor competitors during the first 2 years in a seedbed. Consequently, it is imperative to select a site that contains few weeds, or weeds that can be controlled with current technologies. Complete elimination of all perennial weeds and proper seedbed preparation is essential. Constant surveillance coupled with regular and timely weed control practices is required to maintain weed-free seedbeds and nurseries. Consult labels for tolerant crops.

CONIFER SEEDBEDS—Preemergence Control before Conifers Germinate

glyphosate (numerous products)

Rate Consult labels

Time Apply to emerged weeds just before conifer seedlings emerge using similar techniques described on the label under “cropping systems” for various cereal and vegetable crops.

Remarks Also, consult the *Vegetable Crops* section of this handbook for information about the stale seedbed technique. Use lower rates on vigorous annual weeds. Inhibits production of three amino acids and protein synthesis.

Caution Do not exceed 10.6 lb ai/A (10.6 quarts/A) per season.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

oxyfluorfen (Goaltender)

Rate 0.25 to 1 lb ai/A (0.5 to 2 pints/A)

Time Preemergence to weeds and conifers

Remarks Irrigate with 0.5 to 0.75 inch water or rain for preemergence control of annual grass and broadleaf weeds. Goaltender is a contact herbicide with some soil residual activity.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

oxyfluorfen (Goal 2XL)

Rate 0.25 to 1 lb ai/A (1 to 4 pints/A Goal 2XL)

Time Apply after seeding but before conifers emerge; sprinkler-irrigate with 0.5 to 0.75 inch water.

Remarks Use 0.5-lb rate when grass weeds are present, and highest rate when extreme weed infestations are expected. Acts as a contact herbicide when weeds are emerging, with soil residual activity

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

CONIFER SEEDBEDS—Established Crops, After Transplanting, or Preemergence Weed Control after Conifers Germinate

dimethenamid-P + pendimethalin (Freehand 1.75G)

Rate 100 to 200 lbs (1.75 to 3.5 lb ai/A)

Time Apply 3 days after transplanting conifers and prior to weed emergence.

Remarks Conifer species including Douglas-fir, western red cedar and western hemlock. Activate herbicide with brief irrigation. Inhibits seedling roots and/or shoots.

Caution Do not apply to seedbeds.

Site of action (dimethenamid-P) Group 15: inhibits very long chain fatty acid synthesis; (pendimethalin) Group 3: microtubule assembly inhibitor

Chemical family (dimethenamid-P) chloroacetamide and (pendimethalin) dinitroaniline

flumioxazin (BroadStar)

Rate 150 lbs/A

Time Apply after transplanting.

Remarks Irrigate within one hour after application to wash the herbicide from plants and activate the herbicide. Remove weeds and other debris from soil surface before applying.

Caution Do not apply to plants grown from seed unless one year old. Do not apply to moist or wet foliage. Do not apply more than 300 lbs/A per year.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

napropamide (Devrinol 50DF)

Douglas-fir, fir, and hemlock

Rate 4 lbs ai/A (8lb/A Devrinol 50DF)

Time Apply any time to weed-free surface and irrigate immediately with 1 to 2 inches water.

Remarks Does not control emerged weeds. Consider use of several products at low rates to achieve broad spectrum weed control. Inhibits root growth.

Site of action Group 15: inhibits very long chain fatty acid synthesis

Chemical family Acetamide

oxadiazon (Ronstar 2G)

Rate Consult label

Time Apply uniformly with granular applicator any time to weed-free surface. Irrigate with 0.25 to 0.33 inch water immediately after application.

Remarks Pink family (*Caryophyllaceae*) weeds—

chickweed, mouseear chickweed, and pearlwort—are resistant. Controls weed seedlings by contact action during emergence.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Oxadiazole

oxyfluorfen (Goaltender)

Rate 0.25 to 0.5 lb ai/A (0.5 to 1 pints/A) for 5-week-old seedlings; 1 to 2 lb ai/A (2 to 4 pints/A) for 2-0 conifers.

Time Apply at least 5 weeks after emergence. Apply to 2-0 conifers in winter dormancy fall through winter. After transplanting, irrigate with 0.5 to 0.75 inch water or rain for preemergence control of annual grass and broadleaf weeds. Do not exceed 2 lb ai/A per year.

Remarks Postemergence applications control susceptible broadleaf weeds up to 4 inches tall. Goaltender is a contact herbicide with some soil residual activity.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

pendimethalin (Pendulum Aquacap or 2G)

Rate 2.4 to 4.8 quarts/A Aquacap; 100 to 200 lbs/A 2G.

Time After transplanting, when soil has settled.

Remarks Will not control emerged weeds but will slow emergence if applied after weed seeds have germinated.

Caution Do not apply immediately after transplanting. Wait until the field is thoroughly packed and settled around the transplants. Do not apply during bud swell or bud break.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

prodiamine (Endurance)

Rate 0.35 to 0.8 lbs ai/A (1 to 2.3 lb/A)

Time Apply any time after soil has settled around newly transplanted seedlings or liners.

Remarks Activate herbicide with 0.5 inch irrigation within 14 days of application or before weed seeds germinate

Caution Do not exceed 2.3 lb ai/A per year in a given area

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

S-metolachlor (Pennant Magnum)

Rate 1.24 to 2.48 lb ai/A (1.3 to 2.6 pints/A Pennant Magnum)

Time Apply any time to weed-free surface.

Remarks Activate herbicide with brief irrigation. Use lower rates on porous media and reduced weed infestations. Gives about 60-day control, less under very wet conditions. Inhibits seedling roots and/or shoots.

Caution Do not exceed 4 lb ai/A per year in a given area. To minimize potential for crop injury, consider using several products at low rates to achieve broad-spectrum weed control.

Site of action Group 15: inhibits very long chain fatty acid synthesis

Chemical family Chloroacetamide

CONIFER SEEDBEDS—Postemergence Weed Control

clethodim (Envoy)

Consult label for tree species

Rate 0.095 to 0.25 lb ai/A (13 to 34 oz/A Envoy)

Time Apply postemergence to actively growing annual or perennial grasses listed on label.

Remarks Consider environmental and plant growth conditions that affect leaf uptake; see label.

Caution Do not exceed 68 fl oz/A per season.

Site of action Group 1: acetyl CoA carboxylase (ACCCase) inhibitor

Chemical family Cyclohexanedione

fluazifop (Fusilade II or Ornamec Over-the-Top)

Rate Consult label

Time Apply to established ornamental seedbeds as topical or directed sprays according to lists and associated instructions on the label. Apply to actively growing grasses, or within 7 days after irrigation, with 0.25% nonionic surfactant.

Remarks Identify grasses and adjust rates for susceptibility and stage of weed growth as on label. Results often are erratic if grasses are stressed by lack of vigor, drought, heat, or low fertility. More mature grasses and quackgrass can be controlled but may need two applications. Annual bluegrass and all fine fescues resist treatment. Inhibits fatty acid production, cell membranes, and new growth.

Caution Do not tank-mix with other pesticides or apply within 5 days of other pesticide treatments. Grazing is prohibited.

Site of action Group 1: acetyl CoA carboxylase (ACCCase) inhibitor

Chemical family Aryloxyphenoxy propionate

sethoxydim (Segment or Vantage, registered only in Washington)

Rate 0.28 to 0.47 lb ai/A (36 to 60 fl oz/A)

Time Apply at optimum growth stage listed on the label.

Remarks Identify susceptible grasses. Control often is erratic on grasses stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues, whereas quackgrass can be suppressed. Inhibits fatty acid production, cell membranes, and new growth.

Site of action Group 1: acetyl CoA carboxylase (ACCCase) inhibitor

Chemical family Cyclohexanedione

CONIFER SEEDBEDS—Spot Treatments with Selective Equipment

glyphosate (numerous products)

Rate Wiper: 33% solution

Time Apply with selective wiper when weeds are at least 6 inches taller than crop but after active growth stage of conifer, when buds are mature.

Remarks Mix 1 gal product in 2 gal water. Avoid contact with desirable vegetation. Inhibits production of three amino acids and protein synthesis.

Caution Do not broadcast over conifers in nurseries. Although not explicit on the label, this use is included under industrial uses.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glyphosate (several products)

Rate Consult label for rate

Remarks Spot treatments applied with a paint brush or similar device to curly dock, Canada thistle, and horsetail have proven satisfactory if extreme care is taken to avoid contact with conifer seedlings. (See comments above.)

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

oxyfluorfen (Goal 2XL)

Rate 0.25 to 0.5 lb ai/A (1 to 2 pints/A Goal 2XL)

Time Apply in at least 20 gal water at least 5 weeks after emergence or bud break, or while trees are dormant and weeds are less than 4 inches tall.

Remarks Two or three applications may be needed to control some weeds, especially if they have four or more leaves. Allow 24 hours after application for evidence of contact activity before irrigation. Acts as a contact herbicide.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

Ornamental Bulb, Rhizome, Corm, and Tuber Crops Daffodil, dahlia, gladiolus, iris, lily, narcissus, tulip, and peony

Tim Miller

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Crop rotations and cultural practices used to produce each crop influence the weed spectrum in cultivated or tilled fields. Annual weeds that grow and produce seed quickly, or perennials such as yellow nutsedge that are distributed by cultivation and plowing, often predominate in cultivated fields. Also, repeated use of the same or similar herbicides will select for resistant weed species, increase the number of tolerant weed biotypes, and change the population of soil microorganisms that degrade particular herbicides, resulting in shorter soil persistence.

Preventing weed shifts Weeds that survive plowing, cultivation, repeated herbicide treatments, or other routine cultural practices must be eliminated before the tolerant species or biotypes become established. Combine a variety of weed control practices or treatments, rotate practices and herbicides, and spot-treat with a hoe or registered herbicide when the weed first appears. Also, clean your equipment when moving from an infested field.

Weed management in annual cropping systems Successful weed management in annual cropping systems requires a year-round approach using and rotating a combination of weed control practices throughout several years. Developing these strategies requires knowledge of specific weeds that infest your land. Identify and map major weed species and infested patches within each field. With an established point of reference and occasional observations, growers can evaluate weed shifts and adjust crop and weed management strategies before resistant weeds predominate.

Planning weed control options After accurate identification, plan an efficient year-round weed and crop management program by listing previous rotations, possible herbicide residues, and effective control measures for each weed. Consider the

strengths and weaknesses of each control method based on your experience, herbicide labels, and local experts including pesticide dealers, consultants, and Extension agents. Examine the information carefully and select a field, soil conditions, weed infestations, and appropriate control methods compatible with the crop you intend to plant.

Field preparation and planting Eliminate perennial weeds before planting, by designing a selective control program in the previous crop or by controlling the weed during a temporary fallow period. Canada thistle, for example, can be controlled with spot treatments of glyphosate (Roundup or similar product) in other crops; S-metolachlor (Dual Magnum or Pennant Magnum) or halosulfuron (Permit or Sandea) reduces yellow nutsedge infestations in other crops. During field preparation, destroy all weedy vegetation and prepare a reasonably smooth surface for uniform herbicide application. Wet soils or delayed applications following the last soil disturbance often result in erratic weed control.

Early and midseason scouting While assessing crop emergence, soil moisture, disease incidence, and other factors, evaluate the performance of the preplant or preemergence weed control treatments. Note field conditions where gravel or a low spot may have caused abnormal weed control or possible crop injury. About midseason, carefully map each field by identifying individual weeds, including patches of perennial weeds. Determine whether additional control measures such as cultivation, application or spot spraying of a post-emergence herbicide, or hand-hoeing individual weeds will be necessary to achieve a quality product at harvest yet minimize the chance of allowing a weed shift.

Preharvest scouting and postharvest weed control Verify the location of perennial weed infestations on your field map and note additional weed species since your midseason evaluation. Soon after harvest, destroy existing weeds and crop stubble to reduce unnecessary increases in pest populations. If perennial weeds were present, maintain optimum growing conditions so appropriate herbicides can be applied to actively growing weed foliage for maximum control. Consider factors such as timing of herbicide applications and stage of weed growth, herbicide persistence in the soil, crop rotations, and label restrictions for subsequent crops when selecting a postharvest herbicide for perennial weed control. Following the postharvest treatment, consider planting a rotation crop such as winter grains or other crops that require significantly different cultural practices.

Note Herbicides must be applied at the correct rate and time to selectively control weed growth with minimal chance for injury to the crops. Obtain more consistent results by reading the herbicide label and other information about the proper application and timing of each herbicide. Suggested rates listed in this guide are stated as pounds active ingredient per acre (lb ai/A) or pounds acid equivalent per acre (lb ae/A). For band applications over bulb row, reduce quantity of herbicide applied proportionately to the area within the row actually sprayed.

ORNAMENTAL BULB, RHIZOME, CORM, AND TUBER CROPS— Preplant Incorporated

EPTC (Eptam 7E)

Dahlia and daylily only

Rate 5 lb ai/A

Time Apply preplant and incorporate immediately 2 to 3 inches deep for annual weeds and 6 inches deep to suppress growth of certain perennial weeds.

Remarks Rotate fields to reduce degradation by microorganisms that increase with continual use of EPTC.

Site of action Group 8: lipid synthesis inhibitor but not an ACCase inhibitor

Chemical family Thiocarbamate

trifluralin (Treflan EC, Treflan 5G)

Established gladiolus and dahlia only; 5G on bulbous iris, tulip, and narcissus

Rate Apply 0.5 to 1 lb ai/A of 4 lb/gal formulation depending on soil type. Incorporate 2 to 3 inches deep with power-driven rotary equipment; be careful not to disturb the crop. Apply 4 lb ai/A of 5% granular formulation to newly planted gladiolus; activate immediately with overhead irrigation.

Remarks Gladiolus corms smaller than 1 inch diameter may be injured.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

ORNAMENTAL BULB, RHIZOME, CORM, AND TUBER CROPS—Preemergence

benfen + oryzalin (XL 2G)

Bulb iris, tulip, and narcissus

Rate 1.5 to 3 lb ai/A

Time Apply 2 to 4 weeks after planting but before weeds germinate, then incorporate immediately with shallow cultivation (1 to 2 inches) or with overhead water.

Remarks Application equipment must be calibrated precisely. Although registered for commercial plantings, product may perform erratically along ridges where granules may not be distributed evenly.

Caution Do not apply to tulips emerged more than 0.75 in.

Site of action (both) Group 3: microtubule assembly inhibitor

Chemical family (both) dinitroaniline

bensulide (Prefar 4-E)

Field flowers, bulbs, and ornamentals

Rate 5 to 9 lb ai/A (5 to 9 quarts/A)

Time Apply fall through spring to weed-free soil.

Remarks See label for rates for grass species. Can persist up to 18 months. See label for replanting sensitive crops. Inhibits seedling root growth.

Caution Do not exceed 25 lb ai/A per year.

Site of action Group 8: lipid synthesis inhibitor but not an ACCase inhibitor

Chemical family Organophosphorus

diuron (Diuron 80WDG)

Bulb iris and narcissus only

Rate 3.2 lb ai/A (4 lb/A)

Time Apply once after planting but no later than 4 weeks before bulbs emerge.

Remarks Diuron is most effective when applied before weeds emerge; it will not consistently control large, emerged weeds.

Caution Do not replant treated areas to any crop within 1 year after last application. Do not use on sand or loamy sand soils.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

fenoxaprop (Acclaim Extra)

Daylily, iris, and peony only

Rate 0.06 to 0.17 lb ai/A (13 to 39 fl oz/A)

Remarks Apply adjusted rates, depending on number of grass tillers (see label). Ensure thorough coverage to actively growing, susceptible grasses. Repeat after grass begins active growth, but do not exceed 120 fl oz/A per season.

Site of action Group 1: acetyl CoA carboxylase (ACCCase) inhibitor

Chemical family Aryloxyphenoxy propionate

glyphosate (several products)

Iris, tulip, and narcissus

Rate Consult labels.

Time Apply to actively growing weeds at least 2 weeks before bulbs emerge.

Remarks Adding a surfactant improves activity. Consult label for specific rates, times of application, and perennial species controlled.

Caution Do not exceed 8 lb ae/A per year.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

isoxaben (Quali-Pro Isoxaben 75 WG)

Rate 0.5 lb ai/A (0.66 lb/A)

Time Apply to weed-free soil.

Remarks Make single application within 30 days after planting and before bulbs or weeds emerge. Do not exceed 0.5 lb ai/A. Chemical stability is adequate when left on soil surface for 21 days, but must be activated with rainfall or sprinkler irrigation of 0.5 inch or more.

Caution Do not apply to newly transplanted bulbs until soil is settled. Postemergence application to tulip may result in severe injury.

Site of action Group 21: inhibits cell wall synthesis Site B

Chemical family Benzamide

napropamide (Devrinol 50DF)

Lily, iris, narcissus, and tulip

Rate 4 lb ai/A (8 lb/A)

Time Apply after October 15 or final hilling operation, before bulbs or weeds emerge. In spring, apply before summer annual weeds germinate; do not apply to tulips showing more than 2 inches top growth.

Remarks Apply in a minimum carrier of 10 gal/A. Use a lower rate on coarse soils low in organic matter. Allow soil to settle around bulbs after planting before applying herbicide.

Site of action Group 15: inhibits very long chain fatty acid synthesis

Chemical family Acetamide

oryzalin (Surflan)

Bulbous iris, narcissus, daffodil, hyacinth, and tulip

Rate 0.75 to 1.5 lb ai/A

Time Apply in the fall, 2 to 4 weeks after planting and final hilling, but before weeds emerge. Can reapply at 0.75 lb ai/A in early spring (late February to early March) to weed-free soil.

Remarks Herbicide is stable on soil surface up to 21 days but must be activated to be effective. A single rain or sprinkler irrigation of 0.5 inch or more is necessary to activate.

Caution Do not apply to tulip varieties that have emerged 0.75 to 1 inch. Plow deeply before planting any crop.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

paraquat (Gramoxone Inteon)

Iris, narcissus, and tulip; Washington only

Rate 0.47 to 0.94 lb ai/A

Time Apply as a broadcast application prior to bulb emergence.

Remarks Supplemental label for Washington. Foliage emerged at application will be severely injured. Add a nonionic surfactant or crop oil concentrate as label specifies, taking care to avoid anionic formulations that form insoluble precipitates.

Caution A restricted-use herbicide. Identify grasses and adjust rates for susceptibility and stage of weed growth as on label. Do not apply more than twice per season.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

pendimethalin (Pendulum Aquacap)

Lily, iris, narcissus, gladiolus, and tulip

Rate 2 to 3.9 lb ai/A (2.1 to 4.2 quarts/A)

Time Apply after final hilling operation, before bulbs or weeds emerge.

Remarks The product requires 0.5 inch of rainfall or irrigation to incorporate within 30 days of application. Use a lower rate on coarse soils low in organic matter. Allow soil to settle around bulbs after planting before applying herbicide.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

sethoxydim (Segment)

Dahlia, gladiolus, and iris only

Rate 0.28 to 0.47 lb ai/A (2.25 to 3.75 pints/A)

Time Apply at optimum growth stage listed on label.

Remarks Identify susceptible grasses and add 2 pints/A nonphytotoxic crop oil concentrate to improve leaf absorption. Control often is erratic on grasses stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione

S-metolachlor (Pennant Magnum)

Lily, iris, narcissus, and tulip

Rate 1.2 to 2.5 lb ai/A (1.3 to 2.6 pints/A)

Time Apply after final hilling operation, before bulbs or weeds emerge.

Remarks Apply in a minimum carrier of 10 gal/A. Use lower rates on coarse soils low in organic matter and higher rates on fine-texture soils high in organic matter. Allow soil to settle around bulbs after planting before applying herbicide.

Caution A restricted-use herbicide in Washington, to protect groundwater.

Site of action Group 15: Inhibits very long chain fatty acid synthesis

Chemical family chloroacetamide

ORNAMENTAL BULB, RHIZOME, CORM, AND TUBER CROPS—Postemergence

fenoxaprop (Acclaim Extra)

Daylily, iris, and peony only

Rate 0.06 to 0.17 lb ai/A (13 to 39 fl oz/A)

Time Adjust rates depending on number of grass tillers (see label).

Remarks Ensure thorough coverage to actively growing, susceptible grasses. Repeat after grass begins active growth but do not exceed 120 fl oz/A per season.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Aryloxyphenoxy propionate

fluzifop (Fusilade II)

Daffodil only; Washington only

Rate 0.25 lb ai/A (16 fl oz/A)

Time Apply to actively growing grasses.

Remarks Special local needs label WA-130007. Identify grasses and adjust rates for susceptibility, and stage of weed growth as label instructs. Results often are erratic on grasses stressed from lack of vigor, drought, high temperature, or low fertility. More mature grasses and quackgrass can be controlled but may require two applications. Annual bluegrass and all fine fescues resist treatment.

Caution Do not exceed 32 oz/A per season. Do not apply if rain is expected within 1 hour. Rotational grass crops such as corn and cereals may not be planted within 60 days of the last application. Grazing any plant product or residue is prohibited.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Aryloxyphenoxy propionate

pendimethalin (Pendulum Aquacap)

Lily, iris, narcissus, gladiolus, and tulip

Rate 2 to 3.9 lb ai/A (2.1 to 4.2 quarts/A)

Time Apply after bulb emergence, but before weeds germinate.

Remarks If weeds are present, product may be tank-mixed with a labeled postemergent herbicide. The product requires 0.5 inch of rainfall or irrigation to incorporate within 30 days of application. Use a lower rate on coarse soils low in organic matter.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

sethoxydim (Segment)

Dahlia, gladiolus, and iris only

Rate 0.28 to 0.47 lb ai/A (36 to 60 fl oz/A)

Time Apply at optimum growth stage listed on label.

Remarks Identify susceptible grasses and add 2 pints/A nonphytotoxic crop oil concentrate to improve leaf absorption. Control often is erratic on grasses stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues; quackgrass can be suppressed.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione
