

SECTION P.

VEGETABLE CROPS

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Introduction

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Weed management in annual cropping systems Successful weed management in annual cropping systems requires a year-round approach, employing a combination of weed control practices that are rotated over 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, you can evaluate weed shifts and adjust crop and weed management strategies before resistant weeds predominate.

Preventing weed shifts and introductions Annual weeds that grow and produce seed quickly often dominate in cultivated fields. Routine cultural practices and repeated use of the same, or similar, herbicides enhance selection for resistant species or weed biotypes. Repeated use of the same herbicide also can modify some microorganisms that degrade herbicides, resulting in shorter soil persistence and poor weed control.

Weeds that survive plowing, cultivation, repeated herbicide treatments, or other routine cultural practices must be eliminated before tolerant species or biotypes become established. Combine a variety of weed control practices or treatments, rotate practices and herbicides, spot-treat with registered herbicides, or remove weeds manually when they first appear.

Clean your equipment when moving from an infested field. Puncturevine seeds have been transported from eastern Oregon and have invaded vegetable production areas in the Willamette Valley (<https://pnwhandbooks.org/weed/problem-weeds/puncturevine-tribulus-terrestris>).

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 wiper applications of glyphosate (Roundup) in certain crops if 10% or less of the acreage will be treated (see label). Soil fumigation also might be considered for high-value vegetables if potential losses from soilborne diseases, nematodes, or possibly perennial weeds, such as yellow nutsedge, would justify application costs. (See the current edition of the *PNW Plant Disease Management Handbook* for soil fumigation details and approved materials.)

During field preparation, destroy all weedy vegetation and prepare a reasonably smooth surface for uniform herbicide application. Wet soils or delayed applications after the last soil disturbance often result in erratic weed control.

Effective use of preemergence herbicides Three principles should guide the use of preemergence soil-applied herbicides.

1. **Apply the herbicide before the weed seed germinates.** Many herbicides are not effective if applied after weed seeds germinate. The radicle of the seed emerges first, then quickly grows down and away from the herbicide-treated zone. If the herbicide is not active when the radicle emerges, the weed seedling may survive. Herbicides such as Dual Magnum (S-metolachlor), Outlook (dimethenamid-P), and Treflan (trifluralin) provide very poor control if the weed seeds have germinated. This is not the case for all soil-applied herbicides, including Goal (oxyfluorfen) and Chateau (flumioxazin); but even in these cases, the smaller the seedling, the better the

efficacy. To ensure proper preemergence herbicide efficacy, till the soil, then apply and incorporate the herbicide before weed seeds have a chance to germinate.

2. **Activate the herbicide.** Activation of soil-applied herbicides distributes the herbicide so that it comes in contact with the weed seed. Water usually works best to activate preemergence herbicides, but tillage is required in some situations, such as with Eptam (EPTC) because of herbicide volatility or because the herbicide is very insoluble and is difficult to incorporate with irrigation or rainfall (Treflan). Water carries the herbicide down into the soil and distributes the herbicide throughout the soil. Most weed seeds germinate, and seedlings emerge from 0.25- to 1-inch depths. If the herbicide is not in contact with the seed when it germinates, the first emerging root may get a foothold, and the seedling will survive.
3. **Preserve the chemical barrier.** Properly applied and activated herbicides present a barrier to weed seeds. Too much irrigation water or rain on a soluble herbicide such as Dual Magnum or Eptam will destroy the chemical barrier; the herbicide gets washed too far down and becomes diluted at the soil surface. Incorporating the herbicide too deeply into the soil is another way to diminish the effective chemical barrier. Mechanical disturbance also can destroy this barrier and allow weed seedlings to escape. Goal (oxyfluorfen), Cobra (lactofen), and Chateau are preemergence herbicides that kill some weeds on contact, when weed seedlings grow into the chemical barrier at the soil surface. If the herbicide concentration is lessened at the soil surface because the surface layer has been moved (by cultivation, tillage, or foot traffic), the herbicide barrier will be broken or diminished and weed control will suffer.

Scouting Evaluate the effectiveness of preplant or preemergence weed control treatments as you assess crop emergence, soil moisture, disease incidence, and other factors during the growing season. Note whether gravel or low spots may have caused abnormal weed control or possible crop injury. Map weed problem areas in fields, including patches of perennial weeds. Determine whether additional control measures such as cultivation, application or spot-spraying of a postemergence herbicide, or hand-hoeing individual weeds will be necessary to achieve a quality product at harvest yet minimize the chances of allowing a weed shift.

Postharvest control Soon after harvest, destroy weeds and crop stubble to reduce pests and minimize weed seed production. Weed seed production is often at its peak when short-season crops such as beans are harvested in mid- to late-summer. Harvest procedures do not always kill weeds, and seeds will continue to develop and mature. Steps to control weeds after harvest contribute to an overall weed management strategy that minimizes the amount of seed that will go back into the soil. If weeds are perennials, maintain optimum growing conditions so appropriate herbicides can be applied to actively growing weed foliage for maximum control. Consider factors such as application timing and weed growth stage, herbicide persistence in soil, crop rotations, and label restrictions for subsequent crops when selecting a postharvest herbicide for perennial weed control. After postharvest treatment, consider planting a rotation crop, such as winter grain or a small-grain cover crop that requires significantly different cultural practices.

Herbicide persistence and crop rotations Many herbicides used in vegetables persist or have residual activity in soil. Some of the longer rotational intervals are required following the use of Sandea (halosulfuron), Raptor (imazamox), and Reflex (fomesafen) herbicides. Carryover from persistent herbicides will often have an

impact on *Brassica* crops and sugar beets. Over-application or unusually dry or freezing weather may prolong herbicide persistence. If herbicides persist into the next crop cycle, those crops may be injured, or harmful residue might accumulate in the food product. Managing persistent herbicides requires careful planning of crop rotations according to waiting periods specified on the label.

Accuracy, precision, and food safety Herbicides must be applied at the correct rate and time to selectively control weeds with minimal risk of injuring vegetables. If the label is not followed accurately, illegal pesticide residues may be found in harvested crops and may cause the crop to be removed from the market. Risks of endangering the food supply with pesticide residues can occur when herbicides are applied without label approval for each crop, when excessive quantities are applied, or when harvest occurs before the preharvest interval (PHI) expires. Avoid possible residues in edible crops by plowing the field if a mistake involving a nonregistered pesticide occurs, by verifying mathematical calculations with other knowledgeable persons to ensure accuracy, and by noting the preharvest interval at the time of application to ensure food quality standards are met or exceeded.

Read the label and other information about properly applying and timing each herbicide. Suggested rates in this guide are stated as pounds active ingredient per acre (lb ai/a) or pounds acid equivalent per acre (lb ae/a). Many tank-mixes are listed on herbicide labels. Growers or applicators may accept liability and mix materials unless specifically prohibited on one of the labels. Select products that are compatible and complementary in their weed control.

Important Preharvest Intervals (PHIs) for Vegetables

Vegetable	Herbicide	PHI (days)
Bean	bentazon (Basagran)	30
	clethodim (Select Max)	30 dry; 21 snap
	clomazone (Command)	45 snap
	fomesafen (Reflex)	30
	halosulfuron (Sanda)	30
	imazamox (Raptor)	0 for snap or dry
	lactofen (Cobra)	55 for snap beans, Oregon only
	quizalofop P-ethyl (Assure II)	15 for snap bean; 30 dry bean; 60 lentils
Beet, table	sethoxydim (Poast)	15 for snap beans; 30 dry
	clethodim (Select)	30
	clopyralid (Stinger)	30
	ethofumesate (Nortron)	30
	phenmedipham (Spin-Aid)	60
	phenmedipham + desmedipham (Sugarbeet Mix)	50
Broccoli, Brussels sprout, cauliflower, leafy brassicas	triflurosulfuron (Upbeet)	30
	clethodim (Select)	14 leafy brassica crops; 30 others
	clopyralid (Stinger)	30
	S-metolachlor (Dual Magnum)	60
	sethoxydim (Poast)	30; 15 for leafy greens
Cabbage	clethodim (Select)	30
	clomazone (Command)	45
Carrot	clethodim (Select)	30
	ethofumesate (Nortron)	30
	fluzifop (Fusilade DX)	45
	linuron (Lorox)	14
	metribuzin (Glory)	60
	pendimethalin (Prowl H ₂ O)	60
	sethoxydim (Poast)	30
Celery	linuron (Lorox)	67
Coriander, Cilantro	linuron (Lorox)	21
	prometryn (Caparol)	30
	sethoxydim (Poast)	15
Corn, sweet	clethodim (Select)	14
	clomazone (Command)	30
	dimethenamid-P (Outlook)	90 on Golden Delicious squash
	halosulfuron (Sanda)	30 squash, cucumber, and pumpkin; 57 melon
	sethoxydim (Poast)	3 cantaloupe; 14 others
	clopyralid (Stinger)	30 ears and forage; 60 stover
	clomazone (Command)	45
	dimethenamid-P (Outlook)	50 ears; 40 forage
	foramsulfuron (Option)	45
	fluroxypyr (Starane)	31 ears and forage

Vegetable	Herbicide	PHI (days)
Dill	linuron (Lorox)	21
Edamame	bentazon (Basagran)	30
	fomesafen (Reflex)	30
	pendimethalin (Prowl)	85
	S-metolachlor (Dual Magnum)	120 for hay; 60 for forage
Garlic	bromoxynil (Buctril)	112
	clethodim (Select)	45
	dimethenamid-P (Outlook)	30
	fluzifop (Fusilade DX)	45
	oxyfluorfen (GoalTender)	60
	paraquat (Gramoxone)	60
	pendimethalin (Prowl)	45
	sethoxydim (Poast)	30
Lettuce and leaf crops	clethodim (Select)	14
	pronamide (Kerb)	55
	sethoxydim (Poast)	15 leaf; 30 head
	triflurosulfuron (UpBeet)	60 for endive and chicory
Onion	clethodim (Select Max)	45 bulb only
	dimethenamid-P (Outlook)	28
	ethofumesate (Nortron)	30
	fluzifop (Fusilade)	45 bulb only
	oxyfluorfen (Goal)	45 bulb only
	oxyfluorfen (GoalTender)	60
	paraquat (Gramoxone)	60
	sethoxydim (Poast)	30
trifluralin (Treflan)	60 bulb only	
Pea (green or English)	metribuzin (Glory)	50
	quizalofop P-ethyl (Assure II)	30
Pepper, bell	pendimethalin (Prowl H ₂ O)	70
	S-metolachlor (Dual Magnum)	60
	sethoxydim (Poast)	7
Rhubarb	clethodim (Select)	30
	S-metolachlor (Dual Magnum)	62
	mesotrione (Callisto)	21
	pronamide (Kerb)	38
	quinclorac (Quinstar)	30
	sethoxydim (Poast)	30
Spinach	sulfentrazone (Zeus)	80
	clethodim (Select)	14
	phenmedipham (Spin-Aid)	21
	sethoxydim (Poast)	15
Tomato, eggplant	clethodim (Select)	20
	metribuzin (Glory)	7
	paraquat (Gramoxone Inteon)	30 tomato
	pendimethalin (Prowl H ₂ O)	21 tomato; 70 eggplant
	rimsulfuron (Matrix)	45
	sethoxydim (Poast)	20 tomato and eggplant
	S-metolachlor (Dual Magnum)	90

Site Preparation, Stale Seedbeds, and Burndown Applications

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Site Preparation

soil fumigants

See the current edition of the *PNW Plant Disease Management Handbook* for application details and approved materials.

glyphosate (several product names)

Rate Consult labels

Time Apply to actively growing weeds with site preparation, or preemergence to crops listed on label.

Remarks See label for specific rates, application times, and perennial species controlled. Use higher rate if annual weeds are more than 6 inches tall. Inhibits three amino acids and protein synthesis.

Caution Do not exceed 8 lb ai/a per year.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

metham sodium (several brands)

Rate 63 to 317 lb ai/a (15 to 75 gal/a product)

Time Apply preplant when conditions will enhance moving from liquid to gas phase in soil.

Remarks Cultivate soil 7 to 10 inches deep before preparing a uniform seedbed using equipment that leaves a smooth surface. Soil moisture must be adequate for seed germination but below field capacity. Apply when temperatures exceed 50°F, with a boom mounted on the front of a rototiller. Incorporate 3 to 4 inches deep; seal surface of soil with a smooth roller power-driven to travel at same speed as tractor. Soil surface must be smooth without cracks where fumigant may escape.

Delay planting until soil is free of metham, usually 14 to 21 days. Plant radish seeds or transplant radish seedlings while protecting from wind and bright sun. Observe for 12 to 24 hours for wilting. Before planting, till the soil surface (3 to 4 inches) while breaking the compacted layer formed during incorporation of metham using a small shank within the seed row.

Caution Wear protective face shields, respirators, and clothing. Metham sodium is dissolved in water for application. Activity depends on several soil factors that enhance conversion and movement from the liquid to gas phase. Avoid mixing soil from beneath the treated layer. Do not contaminate water, runoff water, or fish habitat. Disrupts cell membranes.

Stale and False Seedbeds

Several herbicides are registered for use in vegetable crops as burndown products in stale and false seedbed systems. False seedbeds are prepared well in advance of vegetable seeding, and weed seedlings are encouraged to emerge before the crop is seeded. Cultivation, herbicide application, or flaming are used to destroy the emerged seedlings.

Stale seedbeds sometimes are used for vegetable production when other selective weed control practices are limited or unavailable. The soil is tilled, vegetables are planted and weed seedlings are

killed using herbicides, flames, or blind tillage before the crop emerges. Use of tillage is only possible with large seeded vegetable crops that are planted far enough below the soil that precision tillage implements can avoid contact with the crop seed. Success of these systems depends on controlling the first flush of emerged weeds before crop emergence, and on minimal soil disturbance, which reduces subsequent weed flushes while the crop establishes. After establishment, other weed control practices including cultivation or other herbicides can be used. Stale seedbed steps are:

1. Prepare a seedbed, preferably 2 to 3 weeks before planting, to achieve maximum weed seed germination near the soil surface. Soil temperatures and moisture must be reasonable, or results will be erratic.
2. Plant the crop with minimum soil disturbance to avoid exposing new weed seed to favorable germinating conditions.
3. After planting (depending on herbicide or strategy), but before crop emerges, treat the field by flaming or with herbicide to kill all germinated or exposed weeds.

carfentrazone (Aim EC)

Rate Up to 0.031 lb ai/a (2 fl oz Aim EC)

Time Preplant interval varies by crop. See PREPLANT BURNDOWN section of the product label for instructions.

Remarks The use of a nonionic surfactant, crop oil concentrate, or methylated seed oil is required. A high-quality sprayable liquid nitrogen fertilizer may be used at 2% to 4% v/v or AMS at 2 to 4 lb/a in addition to the nonionic surfactant, COC, or MSO. Tank mixes with other herbicides increase spectrum of control. Apply to actively growing weeds not more than 4 inches tall, or rosettes 3 inches in diameter. Thorough coverage is essential for good control.

Caution Do not apply to desirable vegetation.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazolinone

flame weeding

Use liquid propane or similar fuel-burning equipment to quickly sear weeds. Use the thumb pressure test to determine effectiveness: press a weed leaf between thumb and forefinger; if the leaf collapses and a thumb print remains, sufficient heat was applied to kill the leaves. There may be no other noticeable change in the plant immediately after flame is applied. The objective is to disrupt cell membranes, not to char the plant.

glyphosate

Rate 0.5 to 2 lb ae/a

Time Apply to seedbeds before or shortly after the crop is planted, but before the crop emerges.

Remarks Refer to the table “Registered Uses of Glyphosate” in this chapter for general guidelines; read the label carefully to determine proper timing and which product can be applied to each crop.

Caution Some crops may be injured by glyphosate if the soil is extremely sandy, or if the planter did not properly close the seed

row. Do not allow glyphosate to contact seeds or any part of the seedling, as crop failure will result.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

paraquat (Gramoxone Max) or diquat (Reglone)

Rate Consult label

Time Apply during or after planting but before crop emerges.

Remarks Use paraquat if grasses are present. Add a nonionic surfactant or crop oil concentrate according to label specifications; take care to avoid anionic formulations that react in the tank to form insoluble precipitates. Exposed crop plants will be killed. Acts as contact; absorbs energy produced by photosynthesis, forming peroxides that disrupt living cells.

Caution Paraquat is a restricted-use herbicide. Do not ingest or inhale spray mist. Wearing protective face shields, respirators, and clothing is advised. Do not apply preplant or preemergence to soils lacking clay minerals, such as peat, muck, pure sand, or artificial planting media. Paraquat can be used in these crops (not an exhaustive list): beans, lima and snap; broccoli; cabbage; Chinese; cantaloupe; carrots; cauliflower; collards; corn, sweet; cucumber; eggplant; garlic; lettuce; melons, musk; onions, green and dry bulb; peas; peppers; squash; tomatoes; turnips; watermelon.

Site of action (both) Group 22: photosystem I electron diversion

Chemical family (both) Bipyridilium

Postemergence-directed, shielded or hooded sprayers, harvest aids

caprylic plus capric acids (Suppress)

Rate 3% to 9% dilution in 25 to 100 gal of water, depending on weed size, temperature, and sunlight intensity.

Time Preemergence or any time during the crop growing season to control weeds in row-middles or to burn down unwanted crop vegetation.

Remarks OMRI approved burndown. Not selective in broad-leaf vegetable crops, and crop will be injured any time the spray contacts plant tissue. Do not apply to weeds when wet from dew, rain or water. Do not water within 2 hours after application. Do not apply if rainfall is expected within 2 hours of spray. For mature weeds up to 6 inches tall, use the higher rates in up to 100 gal of water/a.

carfentrazone (Aim)

Rate Up to 0.031 lb ai/a (up to 2 fl oz/a)

Time Preemergence or any time during the crop growing season to control weeds in row-middles or to burn down unwanted crop vegetation (e.g., in hops).

Remarks The EPA classifies carfentrazone as a low-risk herbicide, and it is therefore registered on many crops as a post directed-application. Refer to the table “Registered Uses of Aim” in this chapter for labeled uses of this herbicide in the Pacific Northwest.

Caution This herbicide is not selective in broadleaf vegetable crops, and crop will be injured any time the spray contacts plant tissue. Spray equipment clean-out: Aim herbicide is active at very low rates; ensure that spray tanks are thoroughly cleaned before pesticides are applied to other crops. Clean the spray tank as soon after use as possible with recommended cleaning procedures on the label.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

clove leaf oil (Matratec EC)

Rate 5% to 10% dilution in 25 to 100 gal of water, depending on weed size, temperature, and sunlight intensity.

Time Before weeds are 6 inches tall.

Remarks OMRI-listed and WSDA-approved herbicide for in-crop use. Apply before crop emergence, or between rows after emergence, avoiding contact with desirable foliage. Directed sprays or hooded sprayers are recommended. Works best on annual weeds less than 6 inches. Performance may be erratic depending on environmental conditions. Bright sunlight improves efficacy. No preharvest interval or reentry interval.

d-limonene or lemongrass oil (Avenger AG)

Rate 13% to 25% dilution depending on weed size and species.

Time When weeds are less than 6 inches tall.

Remarks OMRI-listed, NOP-compliant, and WSDA-approved organic burndown herbicide for use in crop and noncrop sites. Foliage contacted by Avenger will be damaged. Directed sprays or hooded sprayers are recommended. Coverage is very important. Leaf damage is visible within hours. Cool weather may slow activity. No reentry interval. Fast wilting or necrosis of the leaves may occur due to removal of waxy cuticle.

glyphosate (Roundup and many others)

Rate 0.5 to 2 lb ae/a

Time Apply to seedbeds before or shortly after the crop is planted or emerges.

Remarks Refer to the table “Registered Uses of Glyphosate” in this section for general guidelines; read the label carefully to determine proper timing and which product can be applied to each crop.

Caution Glyphosate may injure some crops if the soil is extremely sandy, or if the planter did not properly close the seed row. Do not let glyphosate contact seeds or any part of the seedling, as crop failure will result.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

paraquat (Gramoxone SL 2.0) or diquat (Reglone)

Rate Consult label

Time Many crops and situations, including weed control in row middles after crop establishment; consult labels.

Remarks Apply between rows in vegetable crops. Use paraquat if grasses are present. Add a nonionic surfactant or crop oil concentrate as label specifies. Take care to avoid anionic formulations that react in the tank to form insoluble precipitates. Exposed crop plants may be killed if these herbicides contact sufficient living tissue.

Caution Paraquat is a restricted-use herbicide. Do not ingest or inhale spray mist. Wearing protective face shields, respirators, and clothing is advised. Both herbicides act on contact; they absorb energy produced by photosynthesis, forming peroxides that disrupt living cells.

Site of action (both) Group 22: photosystem I electron diversion

Chemical family (both) Bipyridilium

Crop Rotation Intervals (months) for Common Soil-active Herbicides Used in Vegetables and Other Rotational Crops*

Herbicide	Beans (snap)	Beets (table)	Broccoli & Cauliflower	Carrot	Collard	Corn (sweet)	Cucumbers	Eggplant	Lettuce	Onions & Leeks	Pea	Pepper	Pumpkins & Squash	Spinach	Swiss chard	Tomato	Cereal
Accent	10 24	10/18 ¹ 24	10/18 ¹ 24	10/18 ¹ 24	10/18 ¹ 24	10 24	10/18 ¹ 24	10/18 ¹ 24	10/18 ¹ 24	10/18 ¹ 24	10 24	10/18 ¹ 24	10/18 ¹ 24	10/18 ¹ 24	10/18 ¹ 24	10/18 ¹ 24	NSP ² 24
Alion	0	0	4	4	4	4	4	4	4	4	0	4	4	4	-	4	-
Assure	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Buctril	18	18	18	18	18	0	18	18	18	18	18	18	18	18	18	18	3
Callisto	12	8	12	5	5	5	12	12	12	8	5	12	12	12	12	12	12
Caparol	0/9	16	9/16 ³	16	16	9/12 ⁴	0/9 ⁵	16	16	16	0/9	0/9 ⁶	0/9 ⁷	16	16	9/12 ⁸	12/16 ⁹
Command	-	8/13 ¹⁰	-	-	-	-	0	-	-	-	-	-	0	8/13 ¹¹	-	-	8 ¹²
Curbit	8	8	0	8	0	8	8	8	8	8	8	8	8	8	0	8	8
Dacthal	0	0	NSP ¹³	NSP	NSP	0	NSP	NSP	NSP	NSP	0	NSP	NSP	NSP	NSP	0	4.5
Dual Magnum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eptam	2	2/3 ¹⁴	4	3	4	10	3/4 ¹⁵	4	3/4 ¹⁵	6	2	3/4 ¹⁵	3/4 ¹⁵	4	4	1/4 ¹⁶	10
Goal	9 ^{16a}	18	18	18	18	0	18	18	18	18	9	18	18	18	18	18	3
Impact	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Karmex31	10	18	18	18	18	0	18	18	18	18	10	18	18	18	18	10	4
Laudis	12	12	12	0	12	0	12	12	12	12	12	12	12	12	12	12	12
Lorox	6/12 ¹⁷	0	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	6/12 ¹⁷	0/12 ¹⁷
Norton	FS ¹⁸	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	0/4 ¹⁹
Outlook	4 ²⁰	-	0	0	0	4 ²⁰	0	0	0	4 ^{20,21}	4 ²⁰	0	0	4	4 ²⁰	-	4 ²⁰
Prefar	0	12/14 ²²	NS/24 ²³	NS/24 ²³	NS/24 ²³	NS/24 ²³	NS/24 ²³	NS/24 ¹⁸	NS/24 ²³	NS/24 ²³	0	NS/24 ²³	NS/24 ²³	NS/24 ²³	NS/24 ²³	NS/24 ²³	NS/24 ²³
Prowl	4	40	40	40	40	18	40	40	18	40	4	40	40	40	40	40	4/10 ²⁴
Pursuit	FS ¹⁸	0	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	-	FS	-
Pyramin	10	10	10	24	10	10	10	12	10	10	10	10	10	10	10	24	10
Quinclorac	0	26	18	18	18	8.5	18	18	9	9	0	18	9	18	18	18	3/4/18 ²⁵
Raptor	0	18	18	18	18	10	0	18	18	18	10	18	0	18	18	18	4
Reflex	9	24	18	15	18	3	9	12	18	18	9	10	9	24	-	8	2
Sandea	12	18	12	0	12	4	12	12	12	12	8	12	12	12	12	4	4
Sencor	9	12	9	12	9	0	9	12	12	12	9	12	9	12	12	9	4
Shieldex	12	36	12	12	12	18	12	12	12	12	0/2 ²⁶	12	12	12	12	12	4/12 ²⁷
Spartan/Zeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Spin-Aid	12	0	12	18	0	0	12	12	18	12	18	12	12	0	12	18	12
Stinger	0	12/14 ²⁸	0	0	0	5	5	5	5	5	-	0/5 ²⁹	5	12/14 ²⁸	5	0/5 ²⁹	12/14 ³⁰
Treflan	2 wk	2 wk	2 wk	2 wk	2 wk	3 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk
Upbeet	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk	2 wk

* Footnotes: See next page.

*** Footnotes: Crop Rotation Intervals (months) for Common Soil-active Herbicides Used in Vegetables and Other Rotational Crops**

Aim, Basagran Gramoxone, Poast, Ro-Neet, Roundup, Select, and Touchdown: No rotation restrictions listed for these crops.

¹ pH < 6.5 = 18 months

² NSP = next spring

³ cabbage 9 months if transplanted; 16 months for all direct-seeded brassica crops or >2 pints/A

⁴ corn is 9 months if <2.67 pints/A; 12 months if >2.67 pints/A

⁵ 0 months if <1.3 pints/A; 9 months if >2 pints/A

⁶ 9 months at 1.25 lb ai/A

⁷ pumpkins, 0 months if <1.3 pints/A; winter squash, 0 months if <2 pints/A; other cucurbits = 9 months

⁸ direct-seeded tomato is 12 months

⁹ wheat 12 months, all others 16 months

¹⁰ 8 months if >1.3 pints/A

¹¹ 13 months if >3 pints/A; 8 months if <3 pints/A and moldboard plowed

¹² oats

¹³ NSP = next spring

¹⁴ 3 months if >1 pint/A

¹⁵ 4 months if >1 pint/A

¹⁶ transplanted, 1 months; seeded, 2 months at 1 pint/A, 4 months >1 pint/A

^{16a} ¾ oz rate only

¹⁷ 12 months if >12 oz; 0 months for ryegrass

¹⁸ FS = following spring

¹⁹ 0 months for sorghum

²⁰ 4 months; soil must be tilled to 4 inches

²¹ 4 months on dry bulb in Willamette Valley, with soil tilled to 4 inches; 0 months in other areas

²² 12 months after spring application; 14 months after fall application

²³ NS (next spring crop) if <2 lb ai/A; otherwise, 24 months

²⁴ 4 months for wheat and rye; 10 months for barley

²⁵ 3 months for wheat; 4 months for rye; 9–18 months for barley depending on rainfall and pH

²⁶ 0 months for dry shell peas

²⁷ 4 months for wheat

²⁸ 12 months after spring application; 14 months after fall application

²⁹ 5 months before seeding; 0 months before transplanting

³⁰ 12 months after spring application; 14 months after fall application for cereals and grasses

³¹ diuron, following grass seed; 12 months following oats.

Artichoke (Globe)

Ed Peachey

Revised March 2020

clethodim (Select Max)

Rate 0.068 to 0.12 lb ai/a (9 to 16 fl oz/a) depending on growth stage of grass.

Time Usually before weeds are 4 to 8 in tall, but depends on grass species present. Apply to actively growing grasses that are not stressed by drought

Remarks Annual and perennial grass control. The preharvest interval is 5 days. Always add crop oil concentrate at 1% v/v. Apply no more than 16 fl oz/a in a single application and no more than 64 fl oz/a (0.49 lb ai/a) per season. Make repeat applications with at least a 14-day interval.

Caution Do not tank mix with nitrogen fertilizers

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

Chemical family Cyclohexanedione

diuron (Karmex 80DF)

Rate 1.6 to 3.2 lb ai/a (2 to 4 lb/a)

Time Apply to established plants in late fall or early winter, after last cultivation and before weed seedlings emerge.

Remarks Direct spray to cover area between rows and around the base of artichoke plants. Avoid spray contact with plants. Make a single application per year.

Caution Crop injury may result if soil organic matter is <1%.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

flumioxazin (Chateau SW)

Rate 0.13 to 0.19 lb ai/a (4 to 6 oz/a product) depending on whether annual or perennial artichokes

Time Annual varieties: apply to artichoke beds no later than 2 days prior to transplanting. Irrigation or rainfall after transplanting is necessary to activate after transplanting, but do not irrigate before transplanting. Perennial varieties: applied to artichokes after cut back of mature plants. Make applications within 2 days after cut back and prior to artichoke emergence. Application after the artichokes have begun to crack, or are emerged, will result in crop injury. Application should not be made when artichokes have begun to emerge (cracking).

Remarks Minimize soil movement during transplanting to maximize weed control.

Caution Do not apply more than 6 oz/a during a single growing season. Application to artichoke foliage may result in unacceptable crop injury.

Site of action Group 14: inhibits protoporphyrinogen oxidase (PPO)

Chemical family N-phenylphthalimide

halosulfuron-methyl (Sandea)

Rate 0.047 to 0.094 lb ai/a (1 to 2 oz/a)

Time Apply when nutsedge has 3 to 5 leaves.

Remarks Apply between the rows of perennial artichokes as a directed spray to avoid contact with foliage. If plastic is used on

the planted row, adjust equipment to keep the application off the plastic. Due to the risk of crop damage, all such use is at the end user/grower's risk.

Caution Application of Sandea may cause significant, temporary stunting and delay maturity of artichokes if sprayed directly.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

oxyfluorfen (Goal 2XL and Tender)

Rate 1 to 1.5 lb ai/a (4 to 6 pints/a 2XL)

Time Apply as a directed treatment or during midsummer dormant and renovation period, either preemergence or early postemergence, as a single treatment or in split applications 8 to 10 weeks apart. Acts as a contact herbicide, either directly on broadleaf weeds or at soil surface as weeds emerge.

Caution Do not exceed 6 pints/a per year. Preharvest interval is 5 days.

Site of action Group 14: inhibits protoporphyrinogen oxidase (PPO)

Chemical family Diphenylether

paraquat (Gramoxone SL 2.0, Firestorm, and others)

Rate 0.625 to 1.0 lb ai/a (2.5 to 4 pints/a Inteon; 1.7 to 2.7 pints/a Firestorm)

Time Directed spray to plants large enough to avoid injury.

Remarks Maximum 3 applications and 8 pints/a per season. 7 days between applications. Preharvest interval is 24 hr.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

pendimethalin (Prowl H₂O)

Rate Up to 8.2 pints/a (3.9 lb ai/a) as a broadcast spray.

Time Pre-transplant to artichoke, 1 to 2 days before transplanting.

Remarks Preharvest interval is 60 days for 3 pt/a rate and 200 days for rates greater than 3.1 pints/a

Caution Do not apply over the top of, or to foliage of artichokes because crop injury may occur. Do not apply more than 8.2 pints/a Prowl per season.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

sethoxydim (Poast)

Rate 0.47 lb ai/a (2.5 pints/a)

Time Apply to actively growing grasses. Always add crop oil concentrate.

Remarks May be applied by air. Feeding restriction.

Caution Do not exceed 5 pints/a per year. Preharvest interval is 7 days.

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

Chemical family Cyclohexanedione

Asparagus

Rick Boydston

Revised March 2020

Seedbeds and Early Establishment

See “Site Preparation, Stale Seedbeds, and Selective Postemergence Applications” at the beginning of Section P for additional options for weed control during asparagus establishment.

clethodim (several trade names)

Rate 0.07 to 0.12 lb ai/a

Time Apply to actively growing grasses at the time specified on the label. Add nonionic surfactant, at 0.25% v/v, to spray mix.

Remarks Adjust rate for target weeds. Use the higher rates for perennial grasses.

Caution Do not harvest within 1 day of treatment. Do not exceed 16 fl oz/a of product per application or 64 fl oz/a (0.5 lb ai/a) per season. Allow at least 14 days between treatments.

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

Chemical family Cyclohexanedione

fluazifop (Fusilade DX)

Rate 0.09 to 0.375 lb ai/a (6 to 24 oz/a product)

Time Apply to actively growing grasses as a directed spray with 1% crop oil or 0.25% nonionic surfactant. Results often are erratic on grasses stressed from lack of vigor, drought, high temperature, low fertility, grass stage of growth, or environmental factors. More mature grasses and quackgrass can be controlled but may require two applications. Annual bluegrass and all fine fescues resist treatment.

Remarks Identify grasses and adjust rates for susceptibility and stage of weed growth according to label instructions.

Caution Do not exceed 24 oz/a product per application or 48 oz/a product per season. Grazing is prohibited.

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

Chemical family Aryloxyphenoxy propionate

halosulfuron (Sanda, Stadia)

Rate 0.023 to 0.073 lb ai/a (0.5 to 1.5 oz/a product)

Time For nursery and transplanted crowns. Do not apply sooner than six weeks after fern emergence.

Remarks Controls several broadleaf weeds and yellow nutsedge. A surfactant is not recommended as increased asparagus injury may result. Spray on asparagus ferns may cause temporary yellowing; minimize crop injury by using drop nozzles to direct spray below the ferns. Do not use nonionic surfactant.

Caution A maximum of 2 applications may be made per crop cycle. Do not exceed 1.5 oz ai/a (2 oz/a product) per 12 month period. Use a minimum of 15 gallons of water per acre. Consult the label for crop rotation restrictions.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

linuron (Lorox DF)

Rate 1 to 2 lb ai/a (2 to 4 lb/a product)

Time Preemergence: Apply after planting seed 1 to 1.5 inches deep and spraying a 1-inch band of activated charcoal on soil surface directly over row. The activated charcoal will adsorb and inactivate herbicide.

Remarks Sprinkler irrigation or rain (0.5 to 1 inch) is required for herbicide activation.

Caution Do not use on sands, loamy sands, or soils with less than 1% organic matter. Weed control will be reduced in soils with high organic matter (greater than 5% and peat or muck). See label for replanting instructions if initial planting fails.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

linuron (Lorox DF)

Rate 0.5 to 1 lb ai/a (1 to 2 lb/a product)

Time Postemergence: On direct-seeded or newly planted crowns. Apply once or twice when ferns are 6 to 18 inches tall, and weeds are less than 4 inches tall.

Caution Do not use a surfactant or fertilizer solution. Do not exceed 2 lb ai/a per year (see remarks above).

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

pendimethalin (Prowl H₂O, Satellite Hydrocap)

Rate 1.14 to 3.9 lb ai/a (2.4 to 8.2 pints/a). On sandy soils: 2.4 pints/a maximum.

Time Apply preemergence to newly planted crowns.

Caution Do not apply to direct-seeded asparagus. Assure that crowns are fully covered with 2 to 4 inches of soil.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

sethoxydim (Poast and several trade names)

Rate 0.19 to 0.47 lb ai/a

Time Apply at optimum growth stage as directed on label. Add 2 pints/a nonphytotoxic crop oil concentrate to improve leaf absorption. Control often is erratic on grasses stressed by drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues; quackgrass can be suppressed.

Remarks Identify susceptible grasses and adjust rates for susceptibility and stage of weed growth according to label instructions.

Caution Do not harvest within 1 day of treatment. Do not exceed two applications or 5 pints/a per season. Allow at least 14 days between sequential applications.

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

Chemical family Cyclohexanedione

terbacil (Sinbar WDG)

Rate 0.8 to 1.6 lb ai/a (1 to 2 lb/a product)

Time Apply after planting seed 1 to 1.5 inches deep and spraying a 1-inch band of activated charcoal on soil surface directly over row. The activated charcoal will adsorb and inactivate herbicide.

Remarks Sprinkler irrigation (0.5 to 2 inches) or rain is required to activate herbicide.

Caution Do not use on soils containing less than 1% organic matter or on gravelly soils. See label for replanting instructions if initial planting fails. Inhibits photosynthesis.

Site of action Group 5: photosystem II inhibitor

Chemical family Uracil

Established Plantings, Bearing Crop**2,4-D (several trade names)**

Rate 1.4 to 1.9 lb ae/a

Time Apply on actively growing weeds, usually in April or May, using a ground sprayer with drop nozzles to reduce contact of spray with crop.

Remarks Workers are not allowed into treated areas until 48 hours after application. Consult your processor or buyer before using these products during the cutting season. If allowed, treat immediately after a cutting. Cut and discard malformed spears appearing after application to avoid off-flavors. Allow at least 6 weeks between applications when re-treatment is required.

Caution Do not apply more than twice per year. Postharvest treatments are suggested to suppress field bindweed and Canada thistle. Use drop nozzles for postharvest treatments to avoid spraying ferns. Mimics natural plant hormones.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

clethodim (Select and several trade names)

Rate 0.07 to 0.12 lb ai/a

Time Apply to actively growing grasses at the time specified on the container label. Add nonionic surfactant to spray mix, at 0.25% v/v.

Remarks Adjust rate for target weeds. Use the higher rates when controlling perennial grasses.

Caution Preharvest interval is 1 day. Do not exceed 16 fl oz/a of product per application or 64 fl oz/a (0.5 lb ai/a) per season. Allow at least 14 days between treatments.

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

Chemical family Cyclohexanedione

clomazone (Command 3ME)

Rate 1 lb ai/a (2.6 pints/a product)

Time Apply to soil surface before weeds and asparagus spears emerge to control of susceptible annual grass and broadleaf weeds. If spears have emerged, make an application after a clean harvest. Cover any exposed plants with soil prior to application. Apply at least 14 days prior to asparagus harvest.

Remarks Apply in a minimum of 10 gal of water per acre. Do not exceed 2.6 pints/a of product per year. Make only one application per year.

Caution Do not allow particle or vapor drift. Off target movement of spray drift or vapors of clomazone can whiten or yellow some plants. Avoid spraying within 1,200 feet of sensitive desirable plants. Note crop restriction intervals on label.

Site of action Group 13: inhibits DOXP synthase

Chemical family Isoxazolidinone

clopyralid (Agristar Spur, Bite, Clean Slate, Stigmata)

Rate 0.1875 to 0.25 lb ae/a (0.5 to 0.66 pints/a product)

Time Apply before or during asparagus cutting season or after harvest, but before fern growth for postemergence control of some broadleaf weeds. Malformed ferns may result from application when spears are longer than 3 inches, or have open seed-heads. Make postharvest (layby) applications as soon as possible after harvest, provided weeds are in the proper growth stage.

Remarks Controls only selected broadleaf weeds; check label. A second application may be made, but do not exceed 0.25 lb ae/a (0.66 pint/a) during the growing season. Consult the label for crop rotation restrictions. Not all clopyralid products are labeled for use in asparagus, so make sure you have a label allowing use on asparagus.

Caution Preharvest interval is 48 hours. Allow at least 2 weeks before cultivating. When applied during the cutting season, some spears may crook (twist). Do not apply during cutting season if crooking cannot be tolerated. Clear-cutting spears just before applying may reduce crooking. Spot-spraying perennial weed patches without accurate calibration can result in overapplication and injury to asparagus.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

dicamba (Vision and several trade names)

Rate 0.25 to 0.5 lb ae/a

Time Apply immediately after a harvest and at least 24 hr before next cutting, when broadleaf weeds are growing actively during harvest season.

Remarks Multiple applications may be made, but do not exceed 1 lb ae/a (16 oz/a product) per growing season.

Caution Sprayed spears may be slightly crooked. Discard malformed spears. Mimics natural plant hormones.

Site of action Group 4: Synthetic auxin

Chemical family Benzoic acid

diuron (Karmex and several trade names)

Rate 0.8 to 3.2 lb ai/a

Time Apply either once, within 4 weeks before spears emerge and no later than the early cutting period, or in split applications with the second immediately following final harvest.

Remarks If irrigated in Washington, apply 3.2 lb ai/a in a single treatment. Use higher rates on soils high in clay or organic matter content. Incorporate in top 1 to 2 inches of soil either mechanically or with sprinkler irrigation.

Caution Do not exceed 2.4 lb ai/a per application in split treatments. See label restrictions on planting sensitive crops within 2 years of last application. Rotate with simazine or other herbicides to reduce weed shifts and minimize soil residues. Inhibits photosynthesis.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

fluazifop (Fusilade DX)

Rate 0.09 to 0.375 lb ai/a (6 to 24 oz/a product)

Time Direct spray to actively growing grasses with 1% crop oil or 0.25% nonionic surfactant.

Remarks Identify grasses and adjust rates depending on susceptibility and stage of weed growth according to label. Results often are erratic if grasses are stressed from lack of vigor, drought, high temperature, or low fertility. More mature grasses and quack-grass can be controlled but may require two applications. Annual bluegrass and all fine fescues resist treatment. Space sequential applications a minimum of 14 days apart.

Caution Preharvest interval is 1 day. Do not apply more than 48 oz/a per season to bearing asparagus.

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

Chemical family Aryloxyphenoxy propionate

flumioxazin (Chateau SW and several others)

Rate 3 oz ai/a (6 oz/a of 51% active ingredient products)

Time Apply to dormant asparagus at least 14 days prior to spear emergence.

Remarks Use for preemergence weed control and to aid post-emergence burndown of many annual and perennial weeds where established asparagus is dormant. For enhanced control of emerged weeds, tank mix with paraquat. Tank-mixes applied to assist in controlling emerged weeds must be applied with a non-ionic surfactant. A spray-grade nitrogen source may be added to increase herbicidal activity. Flumioxazin controls susceptible broadleaf weeds better than grasses.

Caution Do not exceed 3 oz ai/a (6 oz/a product) per growing season. Do not apply within 14 days of spear emergence. Application to nondormant asparagus may result in unacceptable crop injury.

Site of action Group 14: inhibits protoporphyrinogen oxidase (PPO)

Chemical family N-phenylphthalimide

glyphosate (several trade names)

Rate Consult labels.

Time Apply at least 1 week before spears emerge, or after final harvest and removal of all spears, or wait until ferns develop and apply as a directed or shielded application.

Remarks Spot treatment in season: apply immediately after clean cutting, before new spears emerge.

Caution Do not treat more than 10% of total field area to be harvested. Preharvest interval is 5 days. Consult label for specific rates, times of application, and perennial species controlled. Do not contact ferns, stems, or spears because crop may be seriously injured. Do not exceed 8 lb ai/a per year. Inhibits three amino acids and protein synthesis.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

halosulfuron (Sanda, Stadia)

Rate 0.023 to 0.073 lb ai/a (0.5 to 1.5 oz/a product)

Time Apply before, during, or after harvest.

Remarks Controls several broadleaf weeds and yellow nutsedge. A nonionic surfactant is not recommended for applications

made before or during the harvest season. Spray contacting asparagus ferns may cause temporary yellowing; minimize crop injury by using drop nozzles to direct spray below the ferns. Use a nonionic surfactant or crop oil concentrate with postharvest applications.

Caution Do not apply more than twice per crop cycle or 12-month period. Do not exceed 0.094 ai/a (2 oz/a product) per season. Consult the label for crop rotation restrictions.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

linuron (Lorox DF)

Rate 1 to 2 lb ai/a (2 to 4 lb/a product)

Time Apply any time during dormancy season before spring harvest begins. Apply immediately after a cutting. In fern stage, make a single application of 2 lb ai/a (4 lb/a product) as directed spray to base of plants. Do not exceed 4 lb/a, or four applications per season.

Remarks Sprinkler irrigation or rain (0.5 to 1 inch) is required to activate herbicide.

Caution Preharvest interval is 1 day. Do not enter treated areas for 24 hours after applying unless wearing protective clothing. Do not use on sand, loamy sands, or soils with less than 1% organic matter. See label for crop rotation restrictions West of the Rockies.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

mesotrione (Callisto and several trade names)

Rate 0.09375 to 0.24 lb ai/a (3 to 7.7 fl oz/a product)

Time Apply in spring before spears emerge, or after final harvest, or both.

Remarks Use low rate to control emerged weeds. Use higher rate range for preemergence control. For best preemergence control in spring, apply after mowing, disking, or other tillage but before spears emerge. In spring, if weeds are emerged, adding crop oil concentrate or nonionic surfactant plus a spray-grade UAN or AMS fertilizer will enhance weed control.

Caution Do not exceed 0.24 lb ai/a (7.7 fl oz/a product) or two applications per year. In postharvest applications, using an adjuvant increases the risk of crop injury.

Site of action Group 28: inhibits 4-hydroxyphenylpyruvate-dioxygenase (4-HPPD)

Chemical family Triketone

metribuzin (Tricor DF and several trade names)

Rate 1 to 2 lb ai/a (1.33 to 2.66 lb/a 75DF; 1 to 2 pints/a 4F)

Time Apply once per season or split treatment with 0.5 to 1 lb ai/a in spring + 0.5 to 1.5 lb ai/a after final harvest but before ferns emerge. Make spring treatment at least 14 days before first harvest.

Remarks Apply in spring prior to spear emergence. Do not apply over the top of emerged spears or injury will result. Do not harvest less than 14 days after application. Can apply with ground sprayers or a center pivot but must sprinkler-irrigate to activate if rain is lacking. Use lower rate on soils with low organic matter content. Do not exceed 0.5 inch irrigation water after application. May also apply after the last harvest of the season but prior to any emergence.

Caution Do not exceed 2 lb ai/a per year. Injury has been reported in Washington when used on coarse soils with sprinkler irrigation. See label for restrictions on planting sensitive crops within 18 months. Inhibits photosynthesis.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

napropamide (Devrinol 50 DF, Devrinol DF-XT, Devrinol 2-XT)

Rate 4 lb ai/a (8 lb/a 50DF)

Time Apply either before harvest in early spring or during winter dormancy to weed-free soil.

Remarks Requires sprinkler irrigation or rain to wet soil 2 to 4 inches deep immediately after application from March through October or within 2 weeks from November through February. Research in the Pacific Northwest shows immediate, shallow mechanical incorporation enhances weed control.

Caution Inhibits root growth.

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

Chemical family Acetamide

norflurazon (Solicam DF)

Rate 1.97 to 3.93 lb ai/a (2.5 to 5 lb/a Solicam DF)

Time Apply once per season to established crowns in late fall or early spring, preferably before weeds begin to germinate.

Remarks Adjust rates, depending on soil texture and organic matter.

Caution Do not apply to fields with shallow crowns. Preharvest interval is 14 days. Control is weak on lambsquarters and pigweed. Norflurazon persistence or carryover has shown up in crops that follow norflurazon-treated asparagus. Consult the label for crop rotation restrictions. Inhibits yellow pigment formation, bleaching green chlorophyll.

Site of action Group 12: bleaching; inhibitor of carotenoid biosynthesis

Chemical family Pyridazinone

paraquat (several trade names)

Rate 0.62 to 1 lb ai/a

Time Apply before asparagus emerges and/or after last harvest to fields established at least 2 years.

Remarks Add nonionic surfactant or crop oil concentrate as directed on the product label. Asparagus emerged at the time of application will be severely injured.

Caution A **restricted-use herbicide**. Do not ingest or inhale spray mist. Wear protective face shields, respirators, and protective clothing. Preharvest interval is 6 days. Acts as contact herbicide; absorbs energy from photosynthesis, forming peroxides that disrupt living cells.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

pelargonic acid (Scythe)

Rate Apply in a total water volume of 75 to 200 gal/a. Apply as a 3% to 5% (v/v) solution on young, small, annual weeds and 5% to 7% (v/v) solution on perennial herbaceous weeds or annual

weeds over 6 inches tall. For difficult to control weeds and maximum vegetation control use 7% to 10% (v/v).

Time Apply before asparagus emerges to control winter annual or early emerged weeds. Apply during or after asparagus harvest season, but don't allow spray to contact emerged asparagus spears or fern. Small weeds are easier to control than larger weeds. Warm weather promotes rapid activity on plants.

Remarks Apply as a spot treatment or as a directed and shielded spray avoiding contact with all desirable vegetation. Contact of spray or spray drift with emerged asparagus will damage spears or fern. Repeat applications required to control new weeds emerging from seed or underground vegetative parts. Broadleaf weeds are generally controlled better than grass weeds and repeated use may select for grasses.

Caution Pelargonic acid is a nonselective herbicide; any spray contacting desirable vegetation will likely result in damage.

Site of action Group 26: unknown. Disrupts cell membranes, causing leakage from the cells and rapid wilting.

Chemical family Carboxylic acid

pendimethalin (Drexel Aquapen, Prowl H₂O, Satellite Hydrocap)

Rate 1.14 to 3.9 lb ai/a (2.4 to 8.2 pints/a). On sandy soils: 2.4 pints/a maximum.

Time Apply preemergence at least 14 days prior to first harvest of spears, or after seasonal harvest of spears is completed. Remove any early emerged spears prior to application.

Caution Do not apply more than 2.4 pints/a on sandy soils. Do not apply more than 8.2 pints/a per season. Do not apply postemergence over the top of emerged spears. Not labeled for chemigation application.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pendimethalin + metribuzin (Tripsin ZC)

Rate 2.6 to 3.9 lb ai/a pendimethalin and 1 to 1.5 lb ai/a metribuzin (116 to 172 fl oz/a). On sandy soils: 50 fl oz/a maximum.

Time Apply preemergence at least 14 days prior to first harvest of spears or after the last harvest of season. Do not apply over the top of emerged spears or severe injury will result. Remove any emerged spears prior to application.

Caution Do not apply more than 172 fl oz/a per season. Not labeled for chemigation or aerial application.

Site of action Group 3 and 5: microtubule assembly inhibitor and photosystem II inhibitor

Chemical family (pendimethalin) Dinitroaniline and metribuzin (Triazinone)

quinclorac (QuinStar 4L)

Rate 0.375 lb ai/a (12.6 fl oz/a product)

Time Apply after the last harvest of the season and prior to the first frost as a broadcast application. Time application so that field bindweed or other target weeds have emerged and before the asparagus fern has grown substantially and filled in. Adequate spray coverage on the target weeds may be difficult with later applications once the asparagus canopy is full and later applications have not been tested in the PNW.

Remarks Only one application up to 12.6 fl oz/a is allowed per calendar year. Apply in a minimum of 10 gal of water per acre. Crop oil concentrate may be included in the spray mixture to improve activity. Controls or suppresses field bindweed (morningglory), Canada thistle, perennial sowthistle, common lambsquarters, and Russian thistle. Also controls barnyardgrass, green foxtail, and large crabgrass.

Caution Do not allow spray drift or apply when wind speed is greater than 10 mph. Do not apply by air. Note crop rotation restriction intervals on the label, which for some crops is 24 months. Only wheat or grain sorghum can be replanted for 10 months following application.

Site of action Group 4: synthetic auxin

Chemical family Quinoline carboxylic acid

S-metolachlor (Dual Magnum)

Washington only

Rate 1.25 to 1.9 lb ai/a (1.33 to 2 pints/a Dual Magnum)

Time Apply to dormant established asparagus in spring at least 16 days before spears emerge, or after harvest season.

Remarks SLN label WA-080007. For use only by growers who agree, by signature, to waive Syngenta Crop Protection from all liability and indemnification. Adjust rate to soil type. Apply in at least 20 gal/a of water. Will not control emerged weeds.

Caution Preharvest interval is 16 days. Do not exceed 1.9 lb ai/a (2 pints/a product) or one application per year. Not labeled for chemigation application.

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

Chemical family Chloroacetamide

sethoxydim (several trade names)

Rate 0.19 to 0.47 lb ai/a (1 to 2.5 pints/a product)

Time Apply at optimum growth stage listed on the 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.

Caution Preharvest interval is 1 day. Do not exceed two applications, or 5 pints/a of product per season. Allow at least 14 days between sequential applications.

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

Chemical family Cyclohexanedione

sulfentrazone (Aquesta 4F, Shutdown, Sulfentrazone 4SC)

Rate 0.14 to 0.375 lb ai/a (4.5 to 12 fl oz/a product)

Time Apply in spring prior to spear and weed emergence.

Remarks Apply only to crowns that have been established at least 12 months and are healthy and vigorous. Adjust rates based on soil texture, soil organic matter content, and pH according to label guidelines. Apply in 10 to 40 gal of spray solution per acre. Apply only one application in a 12 month period.

Caution Preharvest interval is 14 days. Do not use on soils classified as sands and with less than 1% organic matter content. Use lowest rate labeled for your soil type to avoid crop injury. See plant back and crop rotation restrictions on label.

Site of action Group 14: inhibits protoporphyrinogen oxidase (PPO)

Chemical family Triazinone

sulfentrazone + metribuzin (Aquesta MTZ, Willowood Sulfentrazone MTZ DF)

Rate 0.14 to 0.37 lb ai/a sulfentrazone and 0.21 to 0.56 lb ai/a metribuzin (12.5 to 33.3 oz/a product)

Time Apply in spring prior to spear and weed emergence.

Remarks Apply only to crowns that have been established at least 12 months and are healthy and vigorous. Adjust rates based on soil texture, soil organic matter content, and pH according to label guidelines. Apply in 10 to 40 gal of spray solution per acre. Apply only one application in a 12 month period.

Caution Preharvest interval is 14 days. Do not use on soils classified as sands and with less than 1% organic matter content. Use lowest rate labeled for your soil type to avoid crop injury. See plant back and crop rotation restrictions on label.

Site of action Group 5 and 14: photosystem II inhibitor and protoporphyrinogen oxidase (PPO) inhibitor

Chemical family Triazinone

terbacil (Sinbar WDG)

Rate 1.2 to 2.5 lb ai/a (1.5 to 2.5 lb/a product)

Time Apply prior to spear emergence, or immediately after clean cutting all spears.

Remarks Sprinkler irrigation (0.5 to 2 inches) or rain is required to activate herbicide. Use the lower rate on coarse textured soils, and the higher rate on fine soils.

Caution Preharvest interval is 5 days. See rate restrictions on label for coarse textured soils with low organic matter in Columbia Basin. Crop injury may result if used on diseased or low vigor asparagus. Use lowest rate labeled for your soil type to avoid crop injury. Terbacil is persistent in soil; plant back to most crops requires 2 or more years. See label for crop rotation restrictions.

Site of action Group 5: photosystem II inhibitor

Chemical family Uracil

trifluralin (several trade names)

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

Time Apply either total amount before first harvest or after final harvest, or split treatments and apply half before first harvest and half after final harvest.

Remarks Chop and thoroughly mix crop and weed residue into soil before application. Mechanically incorporate the herbicide within 24 hours after application to reduce volatilization.

Caution Consult label for application rates, depending on soil type and organic matter content. Inhibits mitosis in both shoots and roots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Bean (Snap)

Ed Peachey

Revised March 2020

General Weed Management Strategy

According to USDA standards and processor quality control, harvested beans must be free of nightshade berries, Canada thistle buds, pigweed stems, and mustard pods. Crop rotations, close row spacings, early season weed control, and cultivation (except in rocky or clod soils) are combined with herbicides to minimize weed competition and contamination of product.

Site Preparation, and Stale Seedbeds

See "Site Preparation, Stale Seedbeds, and Selective Postemergence Applications" at the beginning of Section P. in this handbook.

paraquat (Gramoxone Inteon; 2 lb paraquat cation/gal)

Stale seedbeds

Rate 0.50 to 1 lb cation/a (2 to 4 pints/a); use higher rates for heavy weed infestation.

Time Apply just before crop emerges to emerged weeds only. Add a nonionic surfactant or crop oil concentrate as label specifies, taking care to avoid anionic formulations that react in the tank to form insoluble precipitates.

Remarks Acts on contact; absorbs energy produced by photosynthesis, forming peroxides that disrupt living cells.

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

Site of action Group 22: photosystem 1 electron diversion

Chemical family Bipyridilium

Preplant Incorporated

EPTC (Eptam 7E and 20G)

Not adzuki, cow peas, lima beans, or flat-podded beans, except Romano

Rate 2 to 4 lb ai/a 7E (2.25 to 4.5 pints/a); 3 to 4 lb ai/a 20G (15 to 20 lb/a)

Time Apply preplant to soil dry enough for thorough mixing; incorporate 2 to 3 inches deep immediately by cross-disking, rototilling, or subsurface application. For Eptam 20G, apply and incorporate just before planting, immediately after planting, or at the time of last cultivation.

Remarks Beans can be planted immediately; controls grasses and suppresses nightshade with no activity on smartweed. Inhibits shoot growth. For Eptam 20G: If applied before planting, rotary hoe during or shortly after emergence of the beans to break any crust which occurs. Do not exceed 15 lb/a on green beans grown on coarse textured soils.

Caution Suppresses quackgrass and yellow nutsedge growth but does not kill nutsedge tubers. In the Willamette Valley, experience suggests rates may be reduced to as low as 1.5 lb ai/a when mixed with trifluralin.

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

Chemical family Thiocarbamate

halosulfuron-methyl (Sanda)

Rate 0.023 to 0.047 lb ai/a (0.5 to 1 oz/a Sandea)

Time Apply with Eptam and incorporate immediately, to approximately 2 inches deep.

Remarks Suppresses nutsedge and improves control of broad-leaves such as pigweed and lambsquarters.

Caution Read the label carefully to understand risks of using this product. Crop growth may be stunted briefly after emergence and maturity may be delayed. Consult label for rotation crops, interactions with soil-applied organophosphate insecticides that may increase crop injury, and other precautions. Do not exceed 2 oz/a herbicide per year.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

S-metolachlor (Dual Magnum) or metolachlor (Cinch, Dual, Me-Too-Lachlor, or Parallel)

Recommended S-metolachlor rates (pints/a)			
	Soil texture		
Soil OM	coarse	medium	fine
<3%	1–1.33	1.33–1.67	1.33–1.67
>3%	1.33	1.33–1.67	1.67–2

Rate 0.98 to 1.95 lb ai/a (1 to 2 pints/a S-metolachlor). Products containing S-metolachlor, the more active isomer, require about 33% less product to achieve results comparable to metolachlor.

Time Apply preplant within 14 days of planting, and mechanically incorporate into top 2 inches of soil.

Remarks May delay maturity and/or reduce yield if soil is cold and wet, or if heavy rains fall after planting. Controls many summer annual grasses, pigweed other broadleaf weeds, but is weak on mustard weeds and nightshade. Inhibits roots and shoots.

Caution Do not graze crop residue or feed canning wastes to livestock for 6 weeks after treatment. Do not exceed 2 pints/a Dual Magnum per year.

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

Chemical family Chloroacetamide

trifluralin (Treflan)

Rate 0.5 to 0.75 lb ai/a (1 to 1.5 pints/a), depending on soil type

Time Apply preplant and incorporate 2 to 3 inches deep within 24 hr, by cross-disking or by using a power take-off (PTO) rotary tiller. Spray only once and avoid overlapping.

Remarks Controls grasses and some broadleaf weeds such as lambsquarters, but nightshade is very tolerant. Erratic plant growth, enlarged stems below the soil surface, and poor root growth have been observed when maximum labeled rates were applied uniformly in fields with slight variations in soil type. Inhibits mitosis in shoots and roots.

Caution Consult label for planting sensitive crops within 12 to 20 months, especially cereals and grass seed.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Preemergence Soil-applied

clomazone (Command 3ME)

Rate 0.15 to 0.25 lb ai/a (0.4 to 0.67 pints/a Command 3E) Use lower rate on coarse soils and the higher rate on fine soils.

Time After planting and before weed emergence.

Remarks A microencapsulated (ME) formulation is registered for use, but experience in snap beans is lacking in the Pacific Northwest. Therefore, experiment on a small scale before treating whole fields. This formulation is designed to minimize drift and injury to adjacent fields and sites.

Caution Clomazone has a residual or carryover of up to 16 months that severely restricts crop rotations in the Pacific Northwest; see label for rotation crops before applying. Also, crops on sandy soils in other regions have been injured. Allow 300 ft between the application site and desirable crops. Do not apply upwind of sensitive crops such as berries and ornamentals.

Site of action Group 13: inhibits DOXP synthase

Chemical family Isoxazolidinone

fomesafen (Reflex)

Oregon only SLN OR-150018.

Rate 0.5 to 1 pint/a (0.125 to 0.25 lb ai/a Reflex) depending on soil type

Time Preplant surface and postplant surface.

Remarks Must be activated with rainfall or irrigation of 0.5 inch or more and before weed seeds germinate for best efficacy. Failure to activate the herbicide before snap bean seedlings emerge increases the risk of damage to the crop if there is a heavy downpour and soil is splashed onto leaves. Reflex effectiveness will be reduced if later cultural practices expose nontreated soil. Preharvest interval is 32 days. Controls pigweed and nightshade; suppression of nutsedge; good puncturevine control; poor grass control.

Caution Do not exceed 1 pint/a of Reflex per season. Do not apply to a field more than once every 2 years. Snap beans, squash, and potatoes can be planted immediately after application. Wheat, perennial ryegrass, and tall fescue can be planted 4 months after application; sweet corn 10 months after application. Bentgrass rotation interval is 12 months. Beets, brassica crops, and all other crops not listed on the label cannot be planted until 18 months after application. Do not apply after snap beans have emerged or injury may be serious. REI 24 hr.

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

Chemical family Nitrophenylether

halosulfuron-methyl (Sanda)

Rate 0.023 to 0.047 lb ai/a (0.5 to 1 oz/a Sandea)

Time Apply after planting but before soil cracks. Adjust rates, depending on soil texture and organic-matter content.

Remarks Do not exceed 2 oz/a herbicide per year.

Caution Crop growth may be stunted briefly after emerging. See label for rotation crops, interactions with soil-applied organophosphate insecticides that may increase crop injury, and other precautions. Application after beans have emerged will temporarily stunt growth and cause yellowing.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

lactofen (Cobra)

Supplemental label, Oregon only

Rate 0.125 to 0.19 lb ai/a (8 to 12 fl oz/a Cobra)

Time Apply within 48 hr after planting, followed by 0.25 to 0.5 inch rain or irrigation before beans crack soil and emerge.

Remarks Controls pigweed and nightshade but is weak on lambsquarters and does not control grasses and smartweed.

Caution and restrictions Hard-driving rain at emergence may splash Cobra-treated soil onto snap beans, and this may damage emerging seedlings. In most cases, this crop response is temporary, and beans quickly outgrow it without negative effects to yield or quality. Severe crop response can be aggravated if beans are already under stress at emergence. Avoid field conditions that do not favor quick snap bean emergence, including soil temperatures below 60°F, planting depth below 1.5 inches, and using rollers after planting that compact and seal the soil surface. Flat, sealed soil surfaces increase water ponding and splashing of treated soil during thunderstorms, splashing Cobra-treated soil directly onto plant leaves. Avoid use of big guns that may increase splashing of treated soil onto bean leaves. Read ground-water advisory on label. Preharvest interval is 55 days.

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

Chemical family Diphenylether

S-metolachlor (Dual Magnum or Cinch) or metolachlor (Me-Too-Lachlor or Parallel)

Rate 0.95 to 1.9 lb ai/a (1 to 2 pints/a S-metolachlor). See table above under Preplant Incorporated.

Time Apply preemergence after planting and activate with 0.5 inch overhead irrigation or rain.

Remarks May delay maturity and/or reduce yield if soil is cold and wet, or if heavy rains fall after planting. Controls many summer annual grasses, pigweed and other broadleaf weeds, but is weak on lambsquarters, mustard weeds and nightshade. Inhibits roots and shoot growths.

Caution May delay maturity and/or reduce yield if soil is cold and wet or if heavy rains fall after planting. Preharvest interval is 120 days for hay. Excess rainfall or irrigation will significantly impair weed control.

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

Chemical family Chloroacetamide

Postemergence

bentazon (Basagran 5L)

Rate 0.5 to 1 lb ai/a (0.8 to 1.6 pints/a Basagran 5L)

Time Apply to small, rapidly growing annual broadleaf weeds after first trifoliolate bean leaf is fully expanded. Not effective if temperature drops below 50°F at night and in daytime does not exceed 70°F. Adjust rate depending on expected weather conditions: more for cold days, less for hot days.

Remarks Controls some broadleaf weeds, including smartweed; suppresses nutsedge. Leaves may be temporarily yellow, bronzed, speckled, or burned, but beans usually continue growth with minimal delay in pod maturity. Add nonionic surfactant/crop oil concentrate/methylated seed oil and urea ammonium nitrate/ammonium sulfate. Refer to label for approved bean types. Apply to beans after first trifoliolate has expanded, but before flower bud formation. Apply when weeds are small and actively growing. Rainfast in 4 hr. Two applications 10 days apart will suppress or control Canada thistle and nutsedge.

Caution Required tankmix with Raptor. May also be tank-mixed with clethodim (Select) and sethoxydim (Poast). Do not exceed 3.2 pints/a per season Basagran 5L. Preharvest interval is 30 days. Applying with crop oil concentrate may increase potential of injury, particularly in hot weather.

Site of action Group 6: photosystem II inhibitor

Chemical family Benzothiadiazole

clethodim (Select Max at 0.97 lb ai/gal; Section Three at 3 lb ai/gal; Intensity at 2 lb ai/gal)

Rate 0.068 to 0.12 lb ai/a (9 to 16 oz/a Select Max on annual grasses; 12 to 32 oz/a on perennial grass weeds)

Time Apply to actively growing grasses at recommended weed heights.

Remarks Recommended surfactant is nonionic surfactant at 0.25%; do not add ammonium sulfate. Can be tank mixed with bentazon (Basagran) at 9 to 16 oz/a and with imazamox at 9 to 12 fl oz/a, but expect reduced grass control. Use crop oil concentrate (1%) plus AMS (2.5 lb/a) with bentazon and NIS (0.25%) plus AMS (2.5 lb/a) with imazamox.

Caution Do not exceed 32 fl oz/a per year. One application allowed per year. Allow at least 14 days between applications. Preharvest interval is 21 days.

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

Chemical family Cyclohexanedione

imazamox (Raptor) + bentazon (Basagran 5L); Varisto is a premix

Rate 0.031 lb ae/a (4 oz/a) Raptor; 0.188 to 0.50 lb ai/a (4.8 to 12.8 oz/a) Basagran

Time Apply to snap beans in the first to second trifoliolate leaf stage when most weeds are growing actively and less than 3 inches tall.

Remarks Label requires application of imazamox with 4.8 to 12 oz/a of Basagran 5L. Tankmixing imazamox with more bentazon than the recommended amount will reduce grass control. Adding Basagran as a tank-mix reduces the potential for crop injury. Follow label carefully for best results. Add a nonionic surfactant or crop oil. Use of a nitrogen-based fertilizer to improve weed control will improve grass control but must be measured

against the potential for increased crop injury. If applying during very hot weather, it is best to eliminate nitrogen-based adjuvants and to use nonionic surfactant rather than crop oil concentrate. Avoid repeat applications to minimize chances of developing resistance to this family of herbicides. Do not apply to drought-stressed bean plants or plants with poor root development. Varisto is a premix of Raptor and Basagran applied at 16 to 21 fl oz/A (0.023 to 0.03 lb ai/a imazamox and 0.5 to 0.66 lb ai/a bentazon)

Caution Injury symptoms such as shortened internodes and/or temporary yellowing may appear soon after treatment but disappear within several days as long as plants are not stressed. Do not tank mix with any insecticide or fungicide. Avoid tank-mixes with other herbicides, such as Select and Poast, in most cases. Consult label for rotational crops and food or feed restrictions; this herbicide may persist for 26 months. Moldboard plowing may slow breakdown of imazamox and increase chance or carryover.

Site of action Group 2: acetolactate synthase (ALS) inhibitor (imazamox); Group 6: photosystem II inhibitor (bentazon)

Chemical family Imidazolinone and benzothiadiazole

quizalofop P-ethyl (Assure II)

Rate 0.034 to 0.08 lb ai/a (5 to 12 fl oz/a Assure II) depending on species and growth stage.

Time Apply to annual or perennial grasses listed on label at optimum use rates based on weed size.

Remarks Always use either a nonionic surfactant at 0.25% (1 quart/100 gal), or a petroleum-based crop oil at 1% (1 gal/100 gal of water). Grass control may be reduced if applied with Basagran. Increase Assure II rate by 2 oz/a if tank mixing with Basagran to compensate for expected loss of grass control. Wait 7 days between applications.

Caution Do not exceed 14 fl oz/a per season. Preharvest interval is 15 days. Do not graze livestock in treated areas or feed forage or hay to livestock.

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

Chemical family Aryloxyphenoxy propionate

sethoxydim (Poast)

Rate 0.14 to 0.28 lb ai/a (0.75 to 1.5 pints/a), depending on species, growth stage, and region. Do not exceed 0.47 lb ai/a (2.5 pints/a) per application or 0.75 lb ai/a (4 pints/a) per year.

Time Apply at optimum growth stage listed on the 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. Grass control may be reduced if applied with Basagran. Inhibits fatty acid production, cell membranes, and new growth. To control crabgrass or witchgrass, add 2.5 lb AMS or 4 to 8 pints UAN/a.

Caution Preharvest interval is 15 days.

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

Chemical family Cyclohexanedione

Herbicide Effectiveness on Weeds in Snap Beans

Weed	Soil applied								Postemergent			
	EPTC (Eptam)	fomesafen (Reflex)	lactofen (Cobra)	S-metolachlor (Dual Magnum)	trifluralin (Treflan)	S-metolachlor (Dual Magnum) + EPTC (Eptam)	S-metolachlor (Dual Magnum) + lactofen (Cobra)	EPTC (Eptam) + lactofen (Cobra)	bentazon (Basagran)	imazamox + bentazona	quizalofop (Assure)	sethoxydim (Poast)
Annual Broadleaf Weeds												
Groundsel <i>Senecio vulgaris</i>	G	F	F	G	G	G	G	G	F	F	N	N
Knotweed <i>Polygonum</i> spp.	P	F	VP	G	G	G	G	G	G	P	N	N
Lambsquarters <i>Chenopodium album</i>	G	G	F	P	G	G	E	G	F	G	N	N
Mayweed (Dog fennel) <i>Anthemis cotula</i>	G	G	E	G	V	G	G	G	F	P	N	N
Mustard <i>Brassica</i> spp.	G	G	G	G	P	G	G	G	F	E	N	N
Nightshades <i>Solanum</i> spp.	G	E	E	P	VP	F	E	E	F	E	N	N
Pigweed (Powell amaranth) <i>Amaranthus powellii</i>	F	E	E	G	G	G	E	E	P	E	N	N
Puncturevine <i>Tribulus terrestris</i>	P	E	P	P	P	P	P	P	G	G	N	N
Purslane <i>Portulaca oleracea</i>	G	E	G	G	G	G	G	G	G	G	N	N
Smartweed <i>Polygonum</i> spp.	VP	G	VP	P	F	P	F	VP	E	G	N	N
Sowthistle <i>Sonchus</i> spp.	F	G	G	F	P	G	G	G	P	F	N	N
Annual Grasses												
Barnyardgrass <i>Echinochloa crus-galli</i>	E	P	VP	G	G	G	G	G	VP	G	E	E
Crabgrass <i>Digitaria</i> spp.	G	P	VP	E-G	G	G	G	G	VP	P	G	G
Wild proso millet <i>Panicum miliaceum</i>	G	VP	VP	F	G	F	P	G	VP	G	E	E
Troublesome Perennials												
Bindweed <i>Convolvulus</i> spp.	F	N	F	F	F	P	P	F	F	F	N	N
Canada thistle <i>Cirsium arvense</i>	VP	N	VP	VP	VP	P	VP	VP	G	—	N	N
Nutsedge <i>Cyperus</i> spp.	P	F	VP	G	P	F	F	P	P	P	N	N
Quackgrass <i>Elytrigia repens</i>	G	VP	VP	P	G	G	P	G	VP	P	G	G

E = excellent G = good F = fair P = poor VP = very poor N = no control (—) Information lacking

* Label requires that bentazon be tank mixed with imazamox to improve crop safety and broaden weed control spectrum.

Beet (Red or Table)

Ed Peachey

Revised March 2020

Site Preparation, Stale Seedbeds, and Selective Postemergence Applications

See "Site Preparation, Stale Seedbeds, and Selective Postemergence Applications" at the beginning of Section P. in this handbook.

Preplant incorporated

cycloate (Ro-Neet 6E)

Rate 3 to 4 lb ai/a (0.5 to 0.66 gal/a)

Time Apply preplant to soil dry enough for thorough mixing and, within minutes after application, incorporate 2 to 3 inches deep by cross-disking or using a rotary tiller.

Remarks Use on mineral soils only. Seed may be planted immediately. Inhibits shoot growth.

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

Chemical family Thiocarbamate

Preemergence

ethofumesate (Nortron SC, Ethotron)

Washington and Oregon only

Rate Preemergence: 1.875 lb ai/a (60 fl oz/a); early postemergence: maximum rate is 5.25 fl oz/a at 2- and 4-leaf stage, and 10.6 oz/a at 6- to 8-leaf. Weed control diminishes in fine-texture soils and soils with high organic matter.

Time Apply after planting and activate with at least 0.5 inch water.

Remarks Do not use smaller than 50 mesh screen and avoid overlaps that may increase risk of crop injury. For postemergent applications, rain or irrigation within 6 hr after application reduces weed control. Controls black nightshade but may need to tank mix with Spin-Aid (phenmedipham) to control hairy nightshade postemergence.

Caution May cause temporary leaf fusion, distortion, and stunting when used according to label directions and under normal growing conditions. If crop is lost due to unfavorable growth conditions after application, do not plant anything except sugar beets, table beets, onions, garlic, shallots, or ryegrass.

Site of action Group 16: unknown

Chemical family Benzofuran

5-metolachlor (Dual Magnum) www.syngenta-us.com/labels/indemnified-label-result

Oregon only

Rate 0.64 lb ai/a (0.67 pints/a Dual Magnum)

Time Make a single broadcast application of Dual Magnum to soil surface after planting but before weeds or crop emerge. For effective weed control, Dual Magnum must be applied to clean-tilled soil.

Remarks Make uniform applications in at least 15 gal/a of water. A band application also may be used. Irrigate after application to activate the herbicide if rain is not expected. If the crop is irrigated, use 0.5 inch of water shortly after planting to incorporate herbicide. Excessive irrigation before crop emerges may increase risk of crop injury.

Tank mixing Nortron with Dual Magnum can substantially improve hairy nightshade control. Tank-mixes that have performed well in field studies are Dual Magnum at 0.5 to 0.67 pint/a + Nortron at 1 pint/a.

Caution Do not use this herbicide if some injury cannot be tolerated. May reduce table beet emergence if application is followed by cold and rainy weather. Do not mechanically incorporate Dual Magnum. Do not use Dual Magnum if the planting operation creates a furrow or trough over the seed row into which rain or irrigation water will collect, and thus concentrate the herbicide over the row. Do not use on coarse soils with less than 1.5% organic matter. Do not use on soils with greater than 10% organic matter. Do not exceed 0.67 pint/a of Dual Magnum in any single application or in total applications per crop.

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

Chemical family Chloroacetamide

Postemergent broadleaf control

clopyralid (Stinger)

Rate 0.093 to 0.187 lb ae/a (4 to 8 oz/a)

Time Apply when beets are in the cotyledon to eight-leaf stage, and when weeds are actively growing.

Remarks Target weeds are hairy and black nightshade. Preharvest interval is 30 days.

Caution Clopyralid will cause leaves to turn red with occasional epinasty. Use caution if tank mixing with other herbicides. Crop-rotation intervals: 12 months for sweet corn; up to 18 months for *Brassica* (cole) crops, peas, potatoes, and tomatoes.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

phenmedipham (Spin-Aid)

Rate 0.24 to 0.5 lb ai/a (1.5 to 3 pints/a)

Time Apply to beets at 2-leaf (1.5 pints/a), 4-leaf (1.5 to 2.3 pints/a) or 6-leaf (2.3 to 3 pints/a). Results are best when weeds are at two-true-leaf stage.

Remarks Avoid applying if weather may change rapidly from cool and cloudy to warm and sunny, or if beets are stressed from insect, disease, or cultivation injury. Tip burn or temporary growth retardation and chlorosis are possible, although plants usually recover within 10 days. Repeat applications can be made 5 to 7 days later, or after another flush of weed emergence. May be tank mixed with UpBeet or Stinger herbicide.

Caution **Restricted-use herbicide** due to dermal irritation. Preharvest interval is 60 days. Avoid diluting herbicide more

than 1 quart to 7 gal water in spraytank because chemical may precipitate.

Site of action Group 5: photosystem II inhibitor

Chemical family Phenylcarbamate

phenmedipham + desmedipham (Betamix, Sugar Beet Mix Herbicide)

Rate 2-leaf beets: 1.5 pints/a. 4-leaf beets: 1.5 to 2.3 pints/a. 6-leaf beets, 1.5 to 3 pints/a.

Time 2- to 6-leaf beets.

Remarks No longer available, but existing stock can be used. Avoid applying if weather may change rapidly from cool and cloudy to warm and sunny, or if beets are stressed from insect, disease, or cultivation injury. Tip burn or temporary growth retardation and chlorosis are possible, although plants usually recover within 10 days.

Caution Preharvest interval is 14 days for tops and 50 days for beets (roots). Do not apply when plants are wet with dew. Irrigation or rain within 6 hr may reduce efficacy.

Site of action Group 5: photosystem II inhibitors

Chemical family Phenylcarbamate

triflurosulfuron methyl (UpBeet)

Rate 0.0156 lb ai/a (0.5 oz/a)

Time Apply when table beet seedlings have 2 to 4 true leaves. Use at least two sequential applications for best results. Apply 5 to 10 days apart, depending on weed size.

Remarks Supplemental label. Apply to small, actively growing weeds. Nonionic surfactants and crop oil concentrates should be used at 0.25% v/v but may increase risk of crop response. Up to 3 applications are permitted with a total of 1.5 oz/a per crop. Controls pigweed, kochia, shepherdspurse, and velvetleaf. Can be tank mixed with Spinaid and Stinger to improve weed control.

Caution Discoloration may be noted in some cases but effects are temporary. Do not contaminate water bodies, or rinse or flush spray near roots of trees and desirable plants, or injury may result.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

Postemergent grass control

clethodim (Select Max at 0.97 lb ai/gal; Select 2EC; Section Three at 3 lb ai/gal; and other products)

Rate 0.094 to 0.125 lb ai/a (6 to 8 fl oz/a Select 2EC), depending on whether annual or perennial species dominate.

Time Apply to actively growing grass weeds, including annual bluegrass, at growth stages on label.

Remarks Read label carefully for adjuvant instructions, typically 1% crop oil concentrate without nitrogen solution. Note effects of rain (within 1 hour, application), other pesticides, and cultivation on efficacy.

Caution Nitrogen source fertilizer spray adjuvants are not recommended. Preharvest interval is 30 days.

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

Chemical family Cyclohexanedione

sethoxydim (Poast)

Rate 0.19 to 0.47 lb ai/a (1 to 2.5 pints/a)

Time Apply at optimum growth stage listed on the 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.

Caution Preharvest interval is 60 days. Do not exceed 2.5 pints/a per application or 5 pints/a per season.

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

Chemical family Cyclohexanedione

Brassicacea

Ed Peachey

Revised March 2020

Site Preparation, Stale Seedbeds, and Selective Postemergence Applications

See “Site Preparation, Stale Seedbeds, and Selective Postemergence Applications” at the beginning of Section P. in this handbook.

Quick Reference for Herbicides Labeled for Brassicaceae¹

(See entries below for description of uses)

Ingredient (Product example)	Head and stem Subgroup 5A ¹						Leafy Brassica Greens Subgroup 5B				Root Vegetable Subgroup 1A			
	Broccoli	Chinese broccoli	Brussel sprouts	Cabbage	Cauliflower	Kohlrabi	Chinese cabbage	Collard	Kale	Mustard greens	Radish	Rutabaga	Turnip	Horseradish
SOIL ACTIVE (PPI OR PRE)														
Bensulide (Prefar)	x	x	x	x	x	x	x	x	x	x	x	x	x	
Clomazone (Command)	x			x										
DCPA	x	x	x	x	x	x	x	x	x	x	x		x	x
Dimethenamid-p (Outlook)														x
Linuron (Lorox)														x
Oxyfluorfen (Goal)	x			x	x									x
Napropamide (Devrinol)	x		x	x	x			x	x	x				
S-metolachlor (Dual Magnum)				x			x				x	x	x	x
Sulfentrazone (Zeus)				x										x
Trifluralin (Treflan)	x		x	x	x	x	x	x	x	x	x		x	
POSTEMERGENCE														
Clethodim (Select)	x	x	x	x	x	x	x	x	x	x	x		x	x
Clopyralid (Stinger)	x	x	x	x	x	x	x	x	x	x			x	
Paraquat (Gramoxone)				x	x		x	x						
Pendimethalin (Prowl)	x		x	x	x	x								
Pyraflufen-ethyl (Venue)	x	x	x	x	x	x		x	x	x	x	x	x	x
Sethoxydim (Poast)	x	x	x	x	x	x	x	x	x	x	x	x	x	x

¹ Subgroups as defined by U.S. Environmental Protection Agency § 180.41

Preplant-incorporated

bensulide (Prefar 4-E)

Excluding rutabaga, radish, and horseradish

Rate 5 to 6 lb ai/a (5 to 6 quarts/a)

Time Apply preplant and incorporate 1 to 2 inches deep simultaneously or immediately after application by cross-disking or using a power take-off rotary tiller.

Remarks Consult label for planting sensitive crops after treatment. Does not control nightshade.

Caution Do not exceed one application every 12 months. (Inhibits seedling roots)

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

Chemical family Organophosphorus

sulfentrazone (Zeus)

Cabbage only, pre-transplant only

Rate Depends on soil type and pH. On coarse soils with less than 1% organic matter: apply 0.07 lb ai/a (2.25 fl oz/a). To fine soils with more than 3% OM: apply 0.375 lb ai/a (12 oz/a). Use higher rates when soil pH is less than 7.0, and lower rates when pH is greater than 7.0.

Time Fall or early spring preplant surface or preplant-incorporated.

Remarks Apply in fall or spring up to transplanting, starting 60 days prior. Preplant incorporate to 2 inches.

Caution For use only by individuals or firms certified and/or licensed as pesticide applicators. Do not use on soil with less than 1% OM. Observe rotational guidelines, which may be as long as 24 months for some crops.

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

Chemical family Triazinone

sulfentrazone (Spartan 4F)

Horseradish only

Rate 0.07 lb ai/a (2.25 oz/a Spartan 4F) on coarse soil to 0.25 lb ai/a (8 oz/a) on fine soil. Rate also depends on OM content. Use higher rates for soils of pH less than 7.0 and lower rates for pH greater than 7.0.

Time Fall or early spring preplant or preplant-incorporated.

Remarks Apply in fall or spring to suppress weeds up to 60 days before planting horseradish. Preplant-incorporate to 2 inches. Can apply preemergence to soil surface shortly before transplanting or within 5 days after transplanting. Do not exceed 8 oz/a in a 12-month period that begins with the first application. Do not apply directly to emerged crop, or if crop sprouts are near the soil surface.

Caution Observe rotational guidelines, which may be as long as 24 months for some crops.

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

Chemical family Triazinone

trifluralin (Treflan 4L)

Excluding horseradish and rutabaga

Rate 0.5 to 1 lb ai/a (1 to 2 pints/a Treflan 4L), depending on whether the crop is direct-seeded or transplanted, and on soil texture and organic matter content.

Time Apply as a preplant soil-incorporated treatment before planting or transplanting.

Remarks Direct-seeded crops may be stunted if rates exceed limits for soil type and organic matter content, or if soil texture varies greatly within a field. Chinese cabbage and kohlrabi may be particularly sensitive. Consult label for soil type, OM content, and application instructions.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Preplant or Postplant Surface-applied

bensulide (Prefar 4-E)

Excluding horseradish

Rate 5 to 6 lb ai/a (5 to 6 quarts/a)

Time Apply before crop and weeds emerge, preferably soon after planting; follow with 1 inch of sprinkler irrigation.

Remarks For furrow irrigation, thoroughly saturate bed top. Sometimes the first flush of weeds must be controlled with cultivation before herbicide begins to control grass. Does not control nightshade.

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

Chemical family Organophosphorus

clomazone (Command 3ME)

Broccoli and cabbage only

Rate 0.25 lb ai/a (0.67 pints/a) on seeded cabbage; 0.25 to 0.49 lb ai/a (0.66 to 1.33 pints/a) on transplanted cabbage; 0.25 lb ai/a (0.67 pints/a) on transplanted broccoli).

Time **Direct seeded cabbage: After planting, prior to emergence**

Transplanted cabbage: Prior to transplanting

Transplant broccoli: Within 48 hours of transplanting

Remarks Before using: note crop-rotation restrictions, weeds controlled, and possible injury symptoms for several days after treatment or when applied to sandy soils. The ME formulation is designed to minimize volatilization, movement off site, and potential injury to adjacent fields and sites.

Caution Clomazone may persist in soil up to 16 months. Consult label on rotational crop guidelines before applying.

Site of action Group 13: inhibits DOXP synthase

Chemical family isoxazolidinone

DCPA (Dacthal W75 or 6F)

Excluding rutabagas

Rate 4.5 to 10.5 lb ai/a (6 to 14 pints/a 6F)

Time Apply after seeding or transplanting to most *Brassica* leafy vegetables. Do not apply after transplanting kale, collards, turnip

greens, mustard greens, and turnips. Can be preplant-incorporated for some crops.

Remarks Can be sprayed directly over transplants of broccoli, cauliflower, cabbage, and Brussels sprouts. Performs erratically west of Cascades. If weeds have emerged, clean-cultivate or weed soil before applying. Results improve with rain or overhead irrigation immediately after application.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Phthalic acid

dimethenamid-P (Outlook, Slider)

Horseradish only

Rate 0.56 to 0.84 lb ai/a (12 to 18 fl oz/a Outlook) on coarse soils and 0.84 to 0.98 lb ai/a (18 to 21 fl oz/a) in medium-textured or fine soils. May be applied in a single application. Do not exceed 21 fl oz/a per season.

Time Apply postemergence from the 2-leaf to 8-leaf stage of plant development.

Remarks Postemergence by ground, chemigation, aerial, or impregnated onto dry bulk fertilizer. Application must be to clean-tilled soil or with other herbicides that control emerged weeds. Make chemigation applications only through center pivot, lateral move, solid set, or hand move irrigation systems. Make applications in volume minimums of 0.33 to 0.67 inch of water, using the lower volume on coarser soils and the higher volume on finer soils. Applications in more than 1-inch volume may reduce weed control. Refer to the EPA-approved labels for specific application methods and requirements. Preharvest interval is 40 days.

Caution Replanting (recropping) of horseradish is not recommended if Outlook has been applied.

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

Chemical family Chloroacetamide

linuron (Lorox 50DF)

Horseradish only

Rate Up to 1.5 lb ai/a (3 lb/a Lorox 50DF) depending on soil type

Time Apply as a dormant application, after planting horseradish or when plants are dormant and no leaves have emerged in the spring.

Remarks Both soil residual and contact weed control. Lorox must be activated within 2 weeks of application for optimum control with rain or irrigation of 0.5 inch or more. Add a surfactant to increase contact activity. Do not exceed a total of 3 lb Lorox/a.

Caution Do not apply through irrigation systems. Note ground and surface water advisories on main label. Toxic to fish and aquatic invertebrates. Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark.

Site of action Group 7: photosystem II inhibitor

Chemical family Urea

napropamide (Devrinol 50DF)

Rate 1 to 2 lb ai/a (2 to 4 lb/a Devrinol 50DF), depending on soil texture

Time Direct seeded and transplanted crops, preplant incorporated or as a surface spray after planting. For direct-seeded crops, apply to soil surface immediately after planting and sprinkler-irrigate within 24 hr to wet soil 1 to 2 inches deep, or mechanically incorporate not exceeding the seed depth.

Remarks Selectivity is based on placement above seed or transplant depth. Can be applied with shallow incorporation before transplanting seedlings. Rotational crops listed on the label require deep moldboard plowing. Inhibits root growth.

Caution Do not plant other crops until 12 months after application. Preharvest interval is 60 days.

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

Chemical family Acetamide

oxyfluorfen (GoalTender, Goal 2XL or Galigan 2E)

Transplanted broccoli, cabbage, cauliflower

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

Time Apply soon after final soil preparation and before transplanting through the treated layer with minimal soil disturbance.

Remarks Select lower rate for coarse soils with less than 1% organic matter. Leaves that contact treated soil may be temporarily injured. Injury may be severe if transplants are stressed by temperature, disease, fertilizer salts, nematodes, insects, pesticides, and storage conditions or if planting small transplants grown in 1-inch cells. After transplanting, apply at least 0.25 inch overhead moisture. Plant only crops listed on the label within 10 months after treatment. Grazing crop residue of treated fields is prohibited.

Caution Acts as a selective contact herbicide that disrupts cell membranes. Late summer transplanted cauliflower is occasionally injured if weather becomes unseasonably hot after transplanting. Do not apply in the same season as Group 15 herbicides. Do not exceed 2 pints/a per season.

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

Chemical family Diphenylether

oxyfluorfen (GoalTender or Goal 2XL)

Horseradish only

Rate 0.5 lb ai/a (1 pint/a GoalTender); (2 pints/a Goal 2XL)

Time Apply after transplanting roots but before new shoots emerge. Plant tissue exposed at application will be injured.

Remarks Do not exceed 0.5 lb ai/a per year.

Caution Acts as a selective contact herbicide that disrupts cell membranes.

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

Chemical family Diphenylether

S-metolachlor (Dual Magnum)

Oregon only, for direct-seeded turnip, rutabaga, radish and daikon radish only

Rate 0.64 lb ai/a (0.67 pints/a Dual Magnum)

Time Make a single broadcast application of Dual Magnum to soil surface after planting but before weeds or crop emerge. For effective weed control, Dual Magnum must be applied to clean-tilled soil.

Remarks Special local needs indemnified label for turnip, rutabaga, radish, and Daikon radish (OR-060012). The label is available through the Syngenta website (<https://www.syngenta-us.com/labels/indemnified-label-search>) which must be accessed to digitally sign the indemnification agreement or product liability waiver. See "Beets (Red or Table)" in *Section N. Vegetable Crops* in this handbook for how to acquire the label. Make uniform applications in at least 15 gal/a water. A band application may also be used. Irrigate after application to activate the herbicide if rain is not expected.

Caution Excessive irrigation before the crop emerges may increase the risk of crop injury. Do not mechanically incorporate Dual Magnum. Do not use Dual Magnum if the planting operation creates a furrow or trough over the seed row into which rain or irrigation water will collect and thus concentrate the herbicide over the row. Do not use on coarse soils with less than 1.5% organic matter. Do not use on soils with greater than 10% OM. Do not exceed 0.67 pint/a Dual Magnum in any single application or in total per crop year. Preharvest interval is 60 days.

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

Chemical family Chloroacetamide

S-metolachlor (Dual Magnum)

Oregon only, transplanted cabbage only, including Chinese (napa and bok choy)

Rate 0.48 to 1.27 lb ai/a (0.5 to 1.33 pints/a)

Time Prior to transplanting, or broadcast postemergence application within 48 hr after transplanting.

Remarks Special local needs indemnified label for cabbage (OR-070006). The label is available through the Syngenta Farm Assist website (<http://www.farmassist.com>), which must be accessed to digitally sign the indemnification agreement or product liability waiver.

Caution In general, the risk of crop injury from the use of Dual Magnum is lower for post-transplant than pre-transplant applications, and the risk of crop injury is lower with post-directed than from over-the-top post-transplanting applications. Applying Dual Magnum before bed formation may result in crop injury due to the incorporation and/or concentration of Dual Magnum directly near the transplanted crop's root system. Chinese varieties are more sensitive to injury from Dual Magnum. Preharvest interval is 60 days.

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

Chemical family Chloroacetamide

S-metolachlor (Dual Magnum)

Horseradish

Rate 0.95 to 1.27 lb ai/a (1.0 to 1.33 pints/a)

Time Prior to horseradish emergence in spring

Remarks Use lower rate on coarse soils and higher rates on fine soil.

Caution Do not exceed 1.33 pints/a or one application per crop. Harvest horseradish at normal timing.

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

Chemical family Chloroacetamide

sulfentrazone (Spartan 4F)

Cabbage only, pre-transplant only

Rate Depends on soil type and pH. Apply 0.07 lb ai/a (2.25 fl oz/a) on coarse soils with less than 1% organic matter, and 0.375 lb ai/a (12 oz/a) to fine soils with more than 3% OM. Use higher rates when soil pH is less than 7.0 and lower rates when pH is greater than 7.0.

Time Fall or early spring preplant surface or preplant-incorporated.

Remarks Apply in fall or spring from 60 days prior to and up to transplanting. Preplant incorporate to 2 inches.

Caution For use only by individuals or firms certified and or licensed as pesticide applicators. Do not use on soil with less than 1% OM. Observe rotational guidelines, which may be as long as 24 months for some crops

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

Chemical family Triazinone

sulfentrazone (Spartan 4F)

Horseradish

Rate 0.07 lb ai/a (2.25 oz/a) on coarse soil to 0.25 lb ai/a (8 oz/a) on fine soil Rate also depends on OM content. Use higher rates for soils of pH less than 7.0 and lower rates for pH greater than 7.0.

Time Fall or early spring preplant or preplant-incorporated.

Remarks Apply in fall or spring to suppress weeds up to 60 days before planting horseradish. Preplant-incorporate to 2 inches. Can apply preemergence to soil surface shortly before transplanting or within 5 days after transplanting. Do not exceed 8 oz/a in a 12-month period that begins with the first application. Do not apply directly to emerged crop or if crop sprouts are near the soil surface.

Caution Observe rotational guidelines, which may be as long as 24 months for some crops.

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

Chemical family Triazinone

Postemergence

clethodim (Select 2EC or others)

Rate 0.094 to 0.125 lb ai/a (6 to 8 fl oz/a Select), depending on whether annual or perennial species dominate.

Time Apply to actively growing grass weeds, including annual bluegrass, at growth stages on label.

Remarks Read label carefully for adjuvant instructions, typically 1% crop oil concentrate without nitrogen solution. Note effects of rain within 1 hour, application of other pesticides, and cultivation.

Caution Consult labels for maximum rates per application and season. Preharvest interval is 14 days for leafy *Brassica* greens, 30 days for head or stem *Brassica* vegetables.

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

Chemical family Cyclohexanedione

clopyralid (Clopyr-AG, Spur, Stinger)

Except rutabaga, radish and horseradish

Rate Apply 0.093 to 0.188 lb ae/a (0.25 to 0.5 pints/a) with ground equipment in 10 to 40 gal/a total spray volume.

Time Apply to wild buckwheat at the one- to three-leaf stage of growth, before vining begins. Apply to common ragweed and sweet clover from weed emergence up to the five-leaf stage of growth. To suppress sowthistle, apply from rosette up to bud stage.

Remarks Controls wild buckwheat, sweet clover, prickly lettuce, common ragweed, and galinsoga. Suppresses sowthistle and nightshade. Preharvest interval is 30 days. Make one broadcast application per crop per year.

Caution Experience is lacking with this product on many of these crops in the PNW.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

pendimethalin (AquaPen 3.8)

Leafy Brassica greens, WA and ID only

Rate 1.0 lb ai/a (1.05 qts/a).

Time Broadcast when Brassica greens have 4 to 5 leaves.

Remarks **Direct-seeded or transplanted. Preemergent weed control; will not control emerged weeds. Apply after cultivation or hand weeding to extend weed control**

Caution Do not apply within 21 days of harvest and do not apply more than 1.05 quarts/year. Do not apply pre-plant, pre-transplant, or pre-emergence or severe injury will occur.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

sethoxydim (Poast)

Rate 0.19 to 0.28 lb ai/a (1 to 1.5 pints/a)

Time Apply at optimum growth stage listed on the 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.

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

Caution Preharvest interval is 14 days for mustard greens, 30 days for all other crops. Do not exceed 1.5 pints/a per application or 3 pints/a per season.

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

Chemical family Cyclohexanedione

Carrot, Celery, Parsnip, and Celeriac

Ed Peachey

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Site Preparation, Stale Seedbeds, and Selective Postemergence Applications

See “Site Preparation, Stale Seedbeds, and Selective Postemergence Applications” at the beginning of Section P. in this handbook.

Preplant Incorporated

bensulide (Prefar 4-E)

Celery only

Rate 5 to 6 lb ai/a (5 to 6 quarts/a)

Time Preplant-incorporate to the optimum depth of 1 inch; deeper than 2 inches reduces weed control.

Remarks For furrow irrigation, thoroughly saturate bed top. Sometimes the first flush of weeds must be controlled with cultivation before herbicide begins to control grass. Replant is 120 days for all crops not listed on the label.

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

Chemical family Organophosphorus

EPTC (Eptam 7E)

WA only, SLN-160002

Rate 3.1 lb ai/a 7E (3.5 pints/a)

Time Preplant or chemigated.

Remarks Apply preplant to soil dry enough for thorough mixing and incorporate 2 to 3 inches deep with tillage or with irrigation. In semiarid areas of Eastern Washington, application must be made to a dry soil surface (at least 1/2 inch deep) free from dew and incidental moisture and incorporated within 36 hr following application. Earlier incorporation is recommended if soil is moist. Suppression or control of nutsedge, but does not kill tubers. Controls quackgrass.

Caution 120 day PHI. Do not apply more than a total of 7 pints per acre per crop.

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

Chemical family Thiocarbamate

trifluralin (Treflan 4L)

Carrots and celery only

Rate 0.5 to 1 lb ai/a (1 to 2 pints/a), depending on soil texture.

Time Apply from 3 weeks to immediately before planting, and incorporate 2 to 3 inches deep within 24 hr by cross-disking or using a power take-off rotary tiller.

Remarks Spray only once and avoid overlaps.

Caution Consult label for restrictions on planting sensitive crops within 12 mo. (Inhibits mitosis, primarily in shoots.)

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Postplant and Post-transplant Surface

ethofumesate (Nortron SC, Ethotron)

Carrots only, in Oregon and Washington only

Rate Coarse soils: 1.5 lb ai/a (48 fl oz/a). Medium-texture and fine soils: 2 lb ai/a (64 fl oz/a)

Time Apply after planting and activate with at least 0.5 inch water. If sufficient water will not be available to incorporate the herbicide, incorporate it mechanically before or at planting.

Remarks Do not use smaller than 50 mesh screen and avoid overlaps, which may increase risk of crop injury.

Caution May cause temporary leaf fusion, distortion, and stunting when used as label directs and under normal growing conditions. If crop is lost due to unfavorable growth conditions after application, do not plant anything except sugar beets, table beets, carrots, onions, garlic, shallots, or ryegrass.

Site of action Group 16: unknown

Chemical family Benzofuran

linuron (Lorox DF, for carrot, celery, and parsnip; or Linex 4L, for parsnip only)

Rate Carrots: 0.5 to 1 lb ai/a (1 to 2 lb/a Lorox); celery and parsnips: 0.75 to 1.5 lb ai/a (1.5 to 3 lb/a Lorox)

Time Apply before crop and weeds emerge.

Remarks Use lower rates on light soils, but do not use on extremely sandy soils or soils with less than 1% organic matter. Plant seed at least 0.5 inch deep and apply preemergence only once per season. Carrots and celery may be followed by post-emergence applications, but do not exceed 3 lb/a per season.

Caution Consult label for planting sensitive crops within 4 months.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

pendimethalin (Prowl H₂O)

Carrots only; supplemental label

Rate 0.95 lb ai/a (2 pints/a)

Time Postplant, before crop and weeds emerge (within 2 days of planting), and at layby.

Remarks May be applied by air, ground, or chemigation post-plant, but only by ground equipment at layby. Do not apply over the tops of carrots, because crop may be injured.

Caution Note the crop-injury disclaimer on this label. BASF recommends testing this herbicide on a small part of the target crop to determine whether damage is likely. Do not exceed 2 pints/a per season. Preharvest interval is 60 days.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

prometryn (Caparol 4L)

Carrots, celery, and celeriac

Rate 1 to 2 lb ai/a (2 to 4 pints/a Caparol per application) Up to 3 applications on carrots but only PRE or POST on celery and celeriac).

Time Apply after planting through 6-leaf stage of carrot; for celery, after planting or after 2-3 leaf stage; for celeriac, apply after transplanting at 6-8 leaf stage.

Remarks Do not exceed 8 pints/a of Caparol 4L per crop cycle. Use in at least 20 gal/a spray volume. Use adjuvants only with layby applications. PHI is 30 days for carrot, 40 days for celery, and 60 days for celeriac.

Caution Do not exceed 8 pints/a per crop. Consult label for rotational restrictions, which typically exceed 5 months after application for sensitive crops. Within the rate ranges given, use the lower rate on relatively coarse-textured soils and soils low in organic matter; use the higher rate on relatively fine-textured soils and soils high in organic matter. Apply before weeds are 2 inches tall.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

S-metolachlor (Dual Magnum)

Carrots and parsnips only; Oregon only

Rate 0.64 lb ai/a (0.67 pints/a)

Time Make a single broadcast application of Dual Magnum to soil surface after planting but before weeds or crop emerge. For effective weed control, soil must be clean-tilled.

Remarks Special local needs indemnified label (OR-060012). This label is available only through the Syngenta Farm Assist website (<http://www.farmassist.com>), and may be accessed as described in the "Beets (Red or Table)" section above.

Make uniform applications in at least 15 gal/a of water. A band application also may be used. Irrigate after application to activate the herbicide if rain is not expected. If the crop is irrigated, use 0.5 inch of water shortly after planting to incorporate the herbicide. Excessive irrigation before the crop emerges may increase the risk of crop injury.

Caution Do not mechanically incorporate Dual Magnum. Do not use Dual Magnum if the planting operation creates a furrow or trough over the seed row into which rain or irrigation water will collect, and thus concentrate the herbicide over the row. Do not use on coarse soils with less than 1.5% organic matter or on any soil with greater than 10% organic matter. Do not exceed a total of 0.67 pint/a of Dual Magnum in any single application nor in total applications per crop.

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

Chemical family Chloroacetamide

Postemergence

clethodim (Select 2EC; Prism in Oregon only; or Select Max)

Rate 0.094 to 0.125 lb ai/a (6 to 8 fl oz/a Select 2EC; 9 to 16 fl oz/a Select Max). Consult label for rate required to control different grasses.

Time Apply to actively growing grasses at recommended weed heights.

Remarks Add crop oil concentrate as described on label. Do not exceed 8 fl oz/a per season.

Caution Consult labels for maximum rates per application and season. Preharvest interval is 30 days.

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

Chemical family Cyclohexanedione

ethofumesate (Nortron SC)

Carrots only, in Oregon and Washington only

Rate 2 lb ai/a (64 oz/a) to carrots with two to four true leaves

Time Apply after planting and activate with at least 0.5 inch water.

Remarks Do not use smaller than 50 mesh screen and avoid overlaps, which may increase risk of crop injury. Rain or irrigation within 6 hr after irrigation may reduce weed control. Do not cultivate more than 2 inches deep.

Caution May cause temporary leaf fusion, distortion, and stunting when used according to label directions and under normal growing conditions. Nortron may cause stand loss if the crop is under stress. Apply in evening if air was warmer than 80°F during the day. If crop is lost due to unfavorable growth conditions after application, do not plant anything except sugar beets, table beets, carrots, onions, garlic, shallots, or ryegrass.

Site of action Group 16: unknown

Chemical family Benzofuran

fluazifop (Fusilade DX)

Carrots only

Rate Refer to label for rates on specific grasses

Time Apply to actively growing grasses as a directed spray with 1% crop oil or 0.25% nonionic surfactant. 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.

Remarks Identify grasses, and adjust rates, depending on susceptibility and stage of weed growth according to label instructions. Inhibits fatty acid production, cell membranes, and new growth.

Caution Preharvest interval is 45 days. Do not exceed 48 oz/a per year. Grazing is prohibited.

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

Chemical family Aryloxyphenoxy propionate

linuron (Lorox DF)

Carrots, transplanted celery, celeriac

Rate 0.75 to 1.5 lb ai/a (1.5 to 3 lb/a Lorox DF)

Time Apply postemergence when carrots are 3 inches tall, or when celery and celeriac are established after transplanting but are less than 8 inches tall.

Remarks Treat grass weeds less than 2 inches tall and broadleaf weeds less than 6 inches tall. Do not exceed 40 psi spray pressure. Weed control may be poor if daytime high temperature is below 50°F. Crop may be injured if herbicide is mixed with surfactants, nitrogen, or fertilizer solution, or if temperatures exceed 85°F. Repeat applications on carrots may be made but do not exceed a total of 3 lb/a product.

Caution Carrot varieties differ in their resistance; determine tolerance to linuron before applying to prevent possible crop injury. Do not apply on sand, loamy sands, gravelly soils, or soils with less than 1% organic matter. Do not apply by air. Consult label for planting rotation crops within 12 months. Preharvest interval is 14 days for carrots, 67 days for celery. REI Is 8 days for handset irrigation in celeriac,

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

metribuzin (Metribuzin 75DF and 4L)

Carrots only

Rate 0.25 lb ai/a (0.33 lb/a of Metribuzin 75DF or 0.5 pints/a Metribuzin 4L)

Time Apply after carrots form five to six true leaves but before weeds are 1 inch high or wide.

Remarks Earlier applications will result in excessive crop injury.

Caution If needed, repeat application after at least 3 weeks, but do not exceed 0.5 lb ai/a per year. Preharvest interval is 60 days. Do not apply within 3 days of any other chemical or within 3 days after periods of cool, wet, or cloudy weather or on very hot days. Leaf tissue may be temporarily chlorotic or burned. For carrots with unknown tolerance, treat only a small area to determine crop safety.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

prometryn (Caparol 4L)

Carrots, celery, and celeriac

Rate 1 to 2 lb ai/a (2 to 4 pints/a Caparol per application). Up to 3 applications on carrots but only PRE or POST on celery and celeriac).

Time Apply after planting through 6-leaf stage of carrot; for celery, after planting or after 2-3 leaf stage; for celeriac, apply after transplanting at 6-8 leaf stage.

Remarks Do not exceed 8 pints/a of Caparol 4L per carrot crop cycle, or 4 pts/a for celery or celeriac. Application may be made over the crop. Use in at least 20 gal/a spray volume. Apply before weeds are 2 inches tall. Use crop oil if weeds are larger than 2 in. PHI is 30 days for carrot, 40 days for celery, and 60 days for celeriac.

Caution Do not exceed 8 pints/a per crop. Rotation intervals are 5 months for cabbage, carrots, celeriac, celery, corn, dill, fennel, and peas, 8 months for onions and red beets, and 12 months for all other crops.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

sethoxydim (Poast)

Rate 0.5 lb ai/a (2.5 pints/a) for carrots and parsnip; 0.28 lb ai/a (1.5 pints/a) for celery

Time Apply at optimum growth stage listed on the label.

Remarks Identify susceptible grasses, and add 2 pints/a nonphytotoxic crop oil concentrate to improve leaf absorption. Results often are erratic on grasses stressed from lack of vigor, drought, high temperature, 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.

Caution Preharvest interval is 14 days for parsnip, 30 days for carrots and celery. Do not exceed 5 pints/a for carrots or 3 pints/a for celery per season.

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

Chemical family Cyclohexanedione

Cucurbit and Vine Crops

Cantaloupe, cucumber, pumpkin, squash, and watermelon

Ed Peachey

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Site Preparation, Stale Seedbeds, and Selective Postemergence Applications

See "Site Preparation, Stale Seedbeds, and Selective Postemergence Applications" at the beginning of Section P. in this handbook.

Preplant Incorporated, Preplant, or Preemergence

bensulide (Prefar 4-E)

Cantaloupe, cucumber, winter and summer squash, and watermelon

Rate 5 to 6 lb ai/a (5 to 6 quarts/a Prefar)

Time Apply preplant and incorporate 0.5 to 1 inch deep simultaneously or immediately after application, by cross-disking or using a power take-off rotary tiller. Or apply soon after planting before weeds emerge. For preemergence applications follow with sprinkler irrigation to wet soil 2 to 4 inches deep.

Remarks For furrow irrigation, thoroughly saturate bed top. Germinated or seedling weeds must be cultivated before application. Consult label for planting sensitive crops after treatment.

Caution Do not apply more than once every 12 months.

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

Chemical family Organophosphorus

clomazone (Command 3ME)

Preplant surface, pretransplant surface, and postplant surface; Cucumber, winter and summer squash, pumpkin, and watermelon

Rate 0.15 to 0.75 lb ai/a (6.4 to 32 oz/a Command) depending on crop: cucumbers 6.4 to 16.2 fl oz (0.15 to 0.38 lb ai/a); melons 6.4 to 10.7 oz/a; summer squash 10.7 to 21.3 oz/a; winter squash including processing pumpkin 10.7 to 32 oz/a.

Time Apply using a boom mounted on front of incorporation equipment to ensure immediate incorporation at 1 inch.

Remarks See label for crop-rotation restrictions for up to 16 months after treatment. Plant crop seed below treated layer. The ME (microencapsulated) formulation is designed to reduce or minimize drift but requires moisture to activate. Avoid overlaps in spraying and in treating very sandy soils. Inhibits chlorophyll development. PHI is 30 days.

Caution May discolor fruit of some orange varieties. Do not use on NK530, NK580, "Turk's turban," "Golden Delicious," all banana types and all other *Cucurbita maxima* that have a pink or burnt-orange color at harvest. Do not use on jack-o-lantern pumpkins. Clomazone may inhibit development of orange pigments. Before applying, check adjacent properties and avoid spraying within 300 to 1,200 ft of desirable plants. Sensitive crop and sites include landscapes, orchards, vegetable gardens, berry patches, and property lines. Do not graze cover crops or harvest food or feed within 9 months of applying or allow livestock to

graze treated plants. Crop rotation interval for corn and snap beans is 9 months.

Site of action Group 13: inhibits DOXP synthase

Chemical family Isoxazolidinone

dimethenamid-P (Outlook)

Winter squash (var. "Golden Delicious," Oregon and Washington only)

Rate 0.56 to 0.84 lb ai/a (12 to 18 fl oz/a)

Time Apply postplant, preemergence, and irrigate with 0.5 inch water to activate herbicide.

Remarks Preharvest interval is 90 days. Planting at 1.5 inches or below will help to mitigate potential crop injury.

Caution Do not apply more than 21 fl oz/a per year. Replanting winter squash is not recommended if there is a crop failure. Other labeled crops can be planted immediately; cereals can be planted within 4 months of the Outlook application. Excessive rain after planting may temporarily injure crop. Failure to 'activate' the herbicide with irrigation or rainfall before the crop emerges may cause injury and desiccation of first true leaves, and slow crop growth.

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

Chemical family Chloroacetamide

ethalfuralin (Curbit EC)

Cucumber, winter and summer squash, pumpkin, and watermelon

Rate 1.13 to 1.69 lb ai/a (3 to 4.5 pints/a Curbit EC)

Time Apply preemergence surface and activate with 0.5 inch of irrigation within 2 to 5 days, or cultivate soil surface above seed. Crop may be injured with excessive rain or irrigation or if seeding is too shallow.

Remarks Adjust rates depending on soil texture and organic matter content.

Caution Do not graze or apply to wet or cloddy soils. Note replanting restrictions for sugar beets and red beets listed on label. (Inhibits mitosis, primarily in shoots.)

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

ethalfuralin + clomazone (Strategy)

Cucumber, winter and summer squash, pumpkin, and watermelon

Rate 2 to 6 pints/a product, depending on soil texture (see label)

Time Apply only as a postplant surface treatment before crop and weeds emerge. Activate with 0.5 inch of irrigation within 2 to 5 days, or cultivate soil surface above seed. Crop may be injured with excessive rain or irrigation or if seeding is too shallow.

Remarks Adjust rates depending on soil texture and organic matter content. Do not preplant-incorporate, as crop will be

injured. Inhibits mitosis, primarily in shoots. The clomazone in Strategy herbicide is not microencapsulated (ME) and therefore, more prone to movement than the clomazone formulation used in Command herbicide.

Caution Avoid drift onto neighboring plants. Clomazone will make affected plants turn white. Will occasionally “lift” from fields after application in the spring under certain conditions, and will cause adjacent crops to turn white for a short period of time. Use with caution within 300 ft of high value crops. Do not graze or apply to wet or cloddy soils. Note replanting restrictions for sugar beets and red beets listed on label. Clomazone in this premix is not microencapsulated (ME)

Site of action (ethalfluralin) Group 3: microtubule inhibitors; (clomazone) Group 13: inhibits DOXP synthase

Chemical family (ethalfluralin) dinitroaniline; (clomazone) isoxazolidinone

fomesafen (Reflex)

Winter and summer squash

Rate 0.125 to 0.25 lb ai/a (0.5 to 1 pints/a Reflex) depending on soil type

Time Postplant surface or pre-transplant

Remarks Must be activated with rainfall or irrigation of 0.5 inch or more and before weed seeds germinate for best efficacy. Failure to activate the herbicide before squash seedlings emerge increases the risk of damage to the crop if there is a heavy downpour and soil is splashed onto leaves. Reflex effectiveness will be reduced if later cultural practices expose nontreated soil. Preharvest interval is 32 days.

Caution Do not use Reflex on butternut squash (including Dickinson and other buckskin types) unless some injury can be tolerated. Do not exceed 1 pint/a of Reflex per season. Do not apply to a field more than once every 2 years. Snap beans, squash, and potatoes can be planted immediately after application. Wheat can be planted 4 months after application; sweet corn 10 months after application. Beets, brassica crops, and all other crops not listed on the label cannot be planted until 18 months after application.

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

Chemical family Nitrophenylether

glyphosate (Touchdown HiTech, Roundup)

Winter squash, Oregon only

Rate 0.39 to 0.78 lb ai/a (10 to 20 fl oz/a product)

Time Apply to emerged annual weeds after planting winter squash in spring but before crop emerges. May be mixed with residual herbicides.

Remarks Oregon special local needs label OR-050006 in Benton, Lane, Linn, and Marion counties for Touchdown. Syngenta no longer markets Touchdown (glyphosate) as a stand-alone, but label extends to 2020 and existing stock may be used on squash.

Caution Do not apply if crop seeds are exposed because of poor row closure during planting. Do not apply if the radicle has emerged or if soil covering the seeds is cracking. Do not use on soils with less than 1% organic matter.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

halosulfuron-methyl (Sanda)

Rate 0.023 to 0.047 lb ai/a (0.5 to 1 oz/a) for cucumbers and other cucurbits approved for directed applications in row-middles; 0.023 to 0.036 oz ai/a (0.5 to 0.75 oz/a) for processing winter squash and pumpkins. Consult label for the diversity of rates recommended depending on crop and method of planting.

Time Apply before emerging crop cracks the soil, before transplanting, or before seeding or transplanting under plastic mulch.

Remarks For control of broadleaf weeds and nutsedge. Adjust rates, depending on soil texture and organic-matter content. Can be applied preemergence surface as a tank-mix with Outlook (dimethenamid-P) in processing squash to enhance control of lambsquarters control. To avoid crop stunting, if tank mixing with Outlook and if wet, cold soil conditions are expected, use 0.5 oz/a.

Caution Crop growth may be stunted briefly after emergence. Consult label for rotation crops, soil-applied organophosphate insecticides, and other precautions. Do not exceed 1 oz/a herbicide per year. Preharvest interval is 30 days for squash, cucumbers, and pumpkin, 57 days for melons.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

S-metolachlor (Dual Magnum)

Pumpkin, inter-row or inter-hill only

Rate 0.95 to 1.27 lb ai/a (1 to 1.33 pints/a)

Time Apply preemergence or postemergence before weeds germinate or yellow nutsedge emerges.

Remarks Leave 1 ft of untreated area over the row, or 6 inches to each side of the planted hill and/or any emerged pumpkin foliage (inter-row or inter-hill means not directly over the planted seed or young pumpkin plants). Use the lower rate on soils light in texture (loamy sand or lighter) and low in soil organic matter (less than 3%).

Caution Consult label for specific rates, depending on soil texture and especially organic matter, or for restrictions on planting sensitive crops within 4 to 5 months. Inhibits roots and shoots. Preharvest interval is 30 days.

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

Chemical family Chloroacetamide

terbacil (Sinbar)

Watermelon only

Rate 0.1 to 0.2 lb ai/a (2 to 4 oz/a, to a maximum of 4 oz/a per year)

Time Apply before transplanting or before crop emerges, if direct-seeding watermelon.

Remarks Supplemental label for watermelon only. Moisture is required to activate the herbicide and should arrive within 2 wk of planting. May be applied preemergence under plastic mulch. Preharvest interval is 70 days.

Caution Do not use on sand or gravel soil types. Use with caution if soil organic matter is less than 1%. Do not replant any crop for 2 years after applying terbacil.

Site of action Group 5: photosystem II inhibitor

Chemical family Uracil

Postemergence

clethodim (Prism; Select 2C in Oregon only)

Rate Consult label for rate required to control different grasses.

Time Apply to actively growing grasses at recommended weed heights.

Remarks Add crop oil concentrate as described on label.

Caution Consult labels for maximum rate per application and season. Preharvest interval is 14 days.

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

Chemical family Cyclohexanedione

halosulfuron-methyl (Sanda)

Broadcast sprays on cucumbers, cantaloupe, processing winter squash, and pumpkins only; directed sprays allowed on other cucurbit crops

Rate 0.023 to 0.047 lb ai/a (0.5 to 1 oz/a) for cucumbers and other cucurbits depending on soil type; 0.023 to 0.035 lb ai/a (0.5 to 0.75 oz/a) for processing winter squash and pumpkins.

Time Apply postemergence to seeded or transplanted crops that are well established and that have two to five leaves (preferably four to five leaves), and before the first female flowers appear.

Remarks Results in the Pacific Northwest indicate potential for crop injury or delayed flowering with broadcast postemergence treatments. Primary use is nutsedge suppression. Applications are allowed for most cucurbit crops if spray is directed to row middles after planting or transplanting, or if applied with shielded sprayers that prevent herbicide contact with the crop. Avoid irrigation or rain within 4 hr after treatment.

Caution Crop growth may be stunted or become yellow briefly after treatment. Consult label for rotation crops, soil-applied organophosphate insecticides, and other precautions. Do not exceed 2 oz/a herbicide per year. Preharvest interval is 30 days for squash, cucumber, and pumpkin, 57 days for melons.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

sethoxydim (Poast)

Rate 0.19 to 0.28 lb ai/a (1 to 1.5 pints/a Poast)

Time Apply at optimum growth stage listed on the 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. Inhibits fatty acid production, cell membranes, and new growth.

Caution Preharvest interval is 14 days (3 days for cantaloupe). Do not exceed 3 pints/a per season.

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

Chemical family Cyclohexanedione

Postemergence Layby Treatments

DCPA (Dacthal W-75)

Melons (all types) only

Rate 4.5 to 10.5 lb ai/a (6 to 14 lb/a Dacthal W-75)

Time Apply after plants have four to five true leaves, after cultivation and weeding but before any new weeds become established.

Remarks Performs poorly in western Oregon and Washington. Results improve with rain or overhead irrigation immediately after application. Consult label for restrictions on planting sensitive crops within 8 months. Inhibits mitosis.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Phthalic acid

ethalfuralin (Curbit)

Cucumber, pumpkin, summer and winter squash, watermelon

Rate 1.13 to 1.69 lb ai/a (3 to 4.5 pints/a Curbit)

Time Apply in bands between rows after planting or transplanting. Activate with 0.5 inch of irrigation within 2 to 5 days or cultivate soil 1 to 2 inches deep.

Remarks Adjust rates depending on soil textures and organic matter.

Caution Do not graze or apply to wet cloddy soils. Note replanting restrictions on label for sugar beets and red beets. (Inhibits mitosis, primarily in shoots.)

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

trifluralin (Treflan 4L or HFP)

Rate 0.5 to 1.0 lb ai/a (1 to 2 pints/a product)

Time Apply as a directed spray between rows when crop has three to four true leaves.

Remarks Incorporate 2 to 3 inches deep, using rolling cultivators set to throw soil toward plants in row. Spray only once per year. Consult label for restrictions on planting sensitive crops within 12 months. (Inhibits mitosis, primarily in shoots.)

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Edamame

Ed Peachey

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Preplant and Preemergence

clomazone (Command 3ME)

Rate 0.5 lb ai/a (1.3 pints/a Command 3E). Use lower rate on coarse soils and the higher rate on fine soils.

Time After planting and before weed emergence.

Remarks A microencapsulated (ME) formulation is registered for use. This formulation is designed to minimize drift and injury to adjacent fields and sites.

Caution Clomazone has a residual or carryover of up to 16 months that severely restricts crop rotations in the Pacific Northwest. Refer to label for rotation crops before applying. Crops on sandy soils in other regions have been injured. Allow 300 ft between the application site and desirable crops. Do not apply upwind of sensitive crops such as berries and ornamentals. One application per year.

Site of action Group 13: inhibits DOXP synthase

Chemical family Isoxazolidinone

linuron (Lorox DF50)

Rate 0.5 to 1 lb ai/a (1 to 2 lb/a Lorox) depending on soil texture and OM content

Time Preemergence or up to 30 days before planting

Remarks Make only a single preemergence application of Lorox DF per season and do not exceed 2 lb of Lorox DF in any application. Lorox must be activated within 2 weeks of application for optimum control with rain or irrigation of 0.5 inch or more. Tankmix with other herbicides such S-metolachlor to broaden spectrum. Add a surfactant if burndown of emerged weeds is required, but do not apply over the top of emerged edamame seedlings.

Caution Do not exceed 2 lb of Lorox DF in any application. Soybeans planted too shallow have increased potential for injury. Do not feed treated forage to livestock.

Site of action Group 7: photosystem II inhibitor

Chemical family Urea

fomesafen (Reflex)

Oregon only

Rate 0.25 to 0.375 lb ai/a (1 to 1.5 pints/a Reflex) depending on soil type

Time Preplant, postplant surface, or postemergence (at least one fully expanded trifoliate leaf)

Remarks Must be activated with rainfall or irrigation of 0.5 inch or more and before weed seeds germinate for best efficacy. Treated soil that is splashed onto newly emerged seedlings may result in temporary crop injury, but plants normally outgrow these effects and develop normally. Proper activation of herbicide before seedlings emerge will minimize risk of injury. Preharvest interval is 32 days.

Caution Snap beans, squash, and potatoes can be planted immediately after application. Wheat and other cereals can be planted 4 months after application; sweet corn 10 months after application. Beets, Brassica crops, and all other crops not listed on the label cannot be planted until 18 months after application.

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

Chemical family Diphenylether

pendimethalin (Satellite HydroCap)

Rate 0.71 to 1.43 lb ai/a (1.5 to 3.0 pints/a) depending on application method, soil type, and soil OM content.

Time Preplant surface: apply within 15 days of planting. Preplant incorporated: apply within 60 days of planting and incorporate. Preemergence: apply at planting or up to 2 days after planting.

Remarks Apply only by ground. Apply to a firm seedbed, free of clods if applying preemergence.

Caution Do not apply within 85 days of harvest and do not exceed one application per crop season at the highest rate per acre for any given soil type and application method.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

S-metolachlor (Dual Magnum)

Rate 0.98 to 1.95 lb ai/a (1 to 2.0 pints/a) depending on soil texture and soil organic matter.

Recommended Dual Magnum rates (pints/a)			
Soil OM	Soil texture		
	coarse	medium	fine
<3%	1-1.33	1.33-1.67	1.33-1.67
>3%	1.33	1.33-1.67	1.67-2

Timing and Application Methods Preemergence: Apply during (behind planter) or after planting but before weeds or crops emerge. Rainfall or irrigation is needed to activate herbicide and maximize efficacy. If water cannot be applied, or rainfall is not expected, preplant incorporate Dual Magnum. Preplant surface (minimum-tillage or no-tillage only): applied up to 45 days before planting. Disturbance in the row during planting will reduce weed control. Preplant incorporated: incorporate uniformly into the top 2 inches of soil within 14 days before planting.

Remarks Do not apply through any irrigation system.

Caution Preharvest interval is 60 days for forage and 120 days for hay. Do not exceed 2 pints/a per year.

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

Chemical family Chloroacetamide

sulfentrazone (Willowood Sulfentrazone 4SC)

Rate 0.1875 lb ai/a (2.25 to 6 fl. oz./a) depending on soil texture and pH

Time Preemergent

Remarks See label for plantback restrictions. Rotational interval is 18 months for canola and 36 months for sugarbeets.

Caution Do not use on soils with <1% organic matter (sand). Do not incorporate into the soil. Experience lacking with this herbicide in the PNW.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

trifluralin (Treflan 4L)

Rate 0.5 to 1 lb ai/a (1 to 2.0 pints/a) depending on soil texture.

Time Apply before planting in spring or fall.

Remarks Cool weather early in growing season may result in reduced stand. Consult label for special restrictions in reduced tillage or no-till systems.

Caution Do not exceed one application (2 pints/a) per year.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Postemergence

bentazon (Basagran 5L)

Rate 0.5 to 1 lb ai/a (0.8 to 1.6 pints/a) depending on size of weed

Time Apply to small, rapidly growing small annual broadleaf weeds. Not effective if temperature drops below 50°F at night and if daytime does not exceed 70°F. Adjust rate depending on expected weather conditions: more for cold days, less for hot days.

Remarks Controls some broadleaf weeds, including smartweed; suppresses nutsedge. Some leaf-speckling may occur under certain conditions but it is generally outgrown 10 days after treatment. The addition of oil adjuvants may increase the severity of leaf-speckling. Use lower rates in hot weather to avoid crop injury.

Caution Do not tank mix with other herbicides. Do not exceed 4 pints/a per season. Preharvest interval is 30 days.

Site of action Group 6: photosystem II inhibitor

Chemical family Benzothiadiazole

clethodim (Intensity One)

Rate 0.07 to 0.12 lb ai/a (9 to 16 oz/a Intensity One)

Time Apply to actively growing grasses at recommended weed heights.

Remarks Recommended adjuvant is nonionic surfactant at 0.25% v/v, without ammonium sulfate.

Caution Preharvest interval is 21 days. Do not use more than one application per year.

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

Chemical family Cyclohexanedione

imazamox (Raptor)

Rate 0.031 lb ai/a (4 oz/a Raptor)

Time Apply after emergence and before the 4th trifoliolate and before weeds are 3 inches tall.

Remarks Apply to actively growing weeds. Use a nonionic surfactant at 1 gt/100 gal. Avoid repeat applications on the same site to minimize chances of developing resistance to this family of herbicides.

Caution Do not apply after flowering begins. Do not make more than one application per year. Consult label for rotational crops and food or feed restrictions; this herbicide may persist for 26 months. Moldboard plowing may slow breakdown of imazamox and increase chance of carryover.

Site of action Group 2: acetolactate synthase (ALS) inhibitor (imazamox)

Chemical family Imidazolinone

Garlic

Ed Peachey

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General Weed Management Strategy

Garlic requires nearly perfect weed control because it emerges slowly and matures in 10 to 11 months, and its short vertical leaves never form a canopy. Growers, therefore, often control all weedy vegetation immediately before the crop emerges (often in wet weather), applying a selective soil-applied herbicide for winter weed control and adding treatments in spring, depending on specific weed infestations.

Site Preparation, Stale Seedbeds, and Selective Postemergence Applications

See "Site Preparation, Stale Seedbeds, and Selective Postemergence Applications" at the beginning of Section P. in this handbook.

Preemergence

ethofumesate (Ethotron SC)

Rate Preemergence: 0.5 to 1 lb ai/a (16 to 32 fl oz/a) depending on soil texture. Weed control diminishes in fine-texture soils and soils with high organic matter.

Time Apply after planting and activate with at least 0.5 inch water.

Remarks Supplemental label. Do not use smaller than 50 mesh screen, and avoid overlaps, which may increase risk of crop injury. No more than a total of 96 oz/a of ETHOTRON SC should be applied in a single growing season.

Caution May cause temporary leaf fusion, distortion, and stunting when used as label directs and under normal growing conditions. If crop is lost due to unfavorable growth conditions after application, do not plant anything except sugar beets, table beets, onions, garlic, shallots, or ryegrass.

Site of action Group 16: unknown

Chemical family Benzofuran

flumioxazin (Chateau, Tuscany, Warfox)

Rate 0.019 lb ai/a (6 oz/a Chateau WDG and SW)

Time Prior to garlic emergence.

Remarks Application should be made within 3 days of planting, and before weeds emerge.

Caution Toxic to aquatic invertebrates. Do not apply directly to water. Clean spray tank carefully before applying other herbicides. Maximum 6 oz/a per growing season.

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

Chemical family Diphenylether

paraquat (Gramoxone Inteon; 2 lb paraquat cation/gal)

Rate 0.63 to 1 lb cation/a (2.5 to 4 pints/a); use higher rates for heavy weed infestation or wild oat control.

Time Apply just before crop emerges to emerged weeds only. Add a nonionic surfactant or crop oil concentrate as label specifies, taking care to avoid anionic formulations that react in the tank to form insoluble precipitates.

Remarks Acts on contact; absorbs energy produced by photosynthesis, forming peroxides that disrupt living cells.

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

Site of action Group 22: photosystem 1 electron diversion

Chemical family Bipyridilium

pendimethalin (Prowl H₂O and 3.3EC)

Rate 0.71 to 1.42 lb ai/a (1.5 to 3.0 pints/a Prowl H₂O)

Time Apply either preemergence soon after planting, postemergence when garlic has one to five true leaves, or split the treatments but do not exceed 3.6 pints/a product per crop except for dodder control (see label).

Remarks Adjust rates for soil texture and organic matter. Existing weeds must be destroyed; rain or overhead irrigation must be within 7 days to activate. Inhibits mitosis in both shoots and roots.

Caution Do not feed or graze field residues. Preharvest interval is 45 days.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Postemergence

bromoxynil (Buctril 4EC or Broclean)

Rate 0.375 to 0.5 lb ai/a (0.75 to 1 pint/a Buctril 4EC)

Time Apply postemergence to weeds less than 4-leaf and 2 inches tall, preferably to weeds in the cotyledon stage.

Remarks Finish treatments before garlic is 12 inches tall. Use higher rate on larger weeds. PHI 60 days.

Caution Do not ingest or inhale spray mist. Prevent contact with skin. Wear protective face shields, respirators, and clothing. Preharvest interval is 112 days. 1 pint/a per season.

Site of action Group 6: Photosystem II inhibitor

Chemical family Nitrile

carfentrazone (Aim)

Rate up to 0.031 lb ai/a (0.5 to 2 fl oz/a Aim EC) per application in at least 10 gal/a of finished spray.

Time Apply with hooded sprayer between rows of emerged crop.

Remarks See the table of approved uses on vegetable crops under “Selective Postemergence Applications” at the beginning of “Section N. Vegetable Crops” in this handbook.

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

Chemical family Triazinone

clethodim (Select 2EC; or Prism in Oregon only)

Rate 0.094 to 0.25 lb ai/a (6 to 16 fl oz/a Select)

Time Apply to actively growing grass weeds, including annual bluegrass, at growth stage listed on label.

Remarks Read label carefully for adjuvant instructions, and effects of rain within 1 hour, application of other pesticides, or cultivation..

Caution Do not chemigate. Preharvest interval is 45 days.

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

Chemical family Cyclohexanedione

dimethenamid-P (Outlook)

Rate 0.56 to 0.84 lb ai/a (12 to 18 fl oz/a) on coarse soils and 0.84 to 0.98 ai/a (18 to 21 fl oz/a) in medium- or fine-texture soils. May be applied in a single application only. Do not exceed 21 fl oz/a per season.

Time Apply postemergence from the two-true-leaf stage until at least 30 days before harvest.

Remarks Postemergence by ground, chemigation, aerial, impregnated onto dry bulk fertilizer, or layby (including postemergence-directed).

Caution Applying before the two-true-leaf stage may significantly injure the crop.

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

Chemical family Chloroacetamide

ethofumesate (Ethotron SC)

Rate 0.5 lb ai/a (16 fl oz/a) with up to four evenly spaced sequential applications

Time Postemergence

Remarks Supplemental label. Do not use smaller than 50 mesh screen and avoid overlaps, which may increase risk of crop injury. In postemergent applications, rain or irrigation within 6 hr after applying may reduce weed control.

Caution May cause temporary leaf fusion, distortion, and stunting when used as label directs and under normal growing conditions. If crop is lost due to unfavorable growth conditions after application, do not plant anything except sugar beets, table beets, onions, garlic, shallots, or ryegrass.

Site of action Group 16: unknown

Chemical family Benzofuran

fluazifop (Fusilade DX)

Rate Refer to label directions for specific grassy weeds.

Time Apply to actively growing grasses as a directed spray with 1% crop oil or 0.25% nonionic surfactant.

Remarks Identify grasses, and adjust rates for susceptibility and stage of weed growth as on label. 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 Preharvest interval is 45 days. Do not exceed 48 fl oz/a per year. Grazing is prohibited.

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

Chemical family Aryloxyphenoxy propionate

oxyfluorfen (GoalTender)

Rate 0.12 to 0.25 lb ai/a (0.25 to 0.5 pints/a GoalTender)

Time Apply postemergence to garlic with two fully developed true leaves.

Remarks Multiple treatments may be required as new weeds emerge, but do not exceed 0.5 lb ai/a per season. Use a clean sprayer and do not mix with oils, surfactants, or other agricultural chemicals. Acts as a selective contact that disrupts cell membranes.

Caution Do not apply to garlic under any stress. Leaves may curl slightly, and young plants sometimes become prostrate on the soil surface for 1 to 2 days, but yields have not been reduced. Preharvest interval is 60 days.

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

Chemical family Diphenylether

sethoxydim (Poast)

Rate 0.19 to 0.28 lb ai/a (1 to 1.5 pints/a Poast) depending on target grass species

Time Apply at optimum growth stage listed on label.

Remarks Control is often 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. Add 2 pints/a nonphytotoxic crop oil concentrate or methylated seed oil to improve leaf absorption and efficacy. Inhibits fatty acid production, cell membranes, and new growth.

Caution Preharvest interval is 30 days. Do not exceed 4.5 pints/a per season.

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

Chemical family Cyclohexanedione

Leaf Crops

Ed Peachey

Revised March 2020

Site Preparation, Stale Seedbeds, and Selective Postemergence Applications

See "Site Preparation, Stale Seedbeds, and Selective Postemergence Applications" at the beginning of Section P. in this handbook.

Quick Reference for Labeled Herbicides in Leafy Vegetables

Ingredient	Leafy Greens Group 4						Leaves of roots and tuber crops Group 2	Herbs Group 19			
	Lettuce	Endive	Spinach	NZ spinach	Swiss chard	Arugula	Chicory leaves	Cilantro/coriander	Dill	Fennel	Parsley
PREEMERGENCE											
Benefin	x										
Bensulide	x	x				x	x			x	x
Clomazone								x	x		
Cycloate			OR, WA								
Linuron								x	x		x
Prometryn								x	x	x	x
Pronamide	x	x									
Trifluralin		x					x				
POSTEMERGENCE											
Clopyralid			x								
Imazamox							x				
Clethodim	x	x	x	x	x	x	x	x	x	x	x
Pendimethalin	ID, WA										
Sethoxydim	x	x	x	x	x	x	x	x	x	x	x
Triflurosulfuron methyl		x					x				

Preplant Incorporated or Postplant Surface

benefin (Balan)

Lettuce only, direct-seeded and transplanted

Rate 1.2 to 1.5 lb ai/a (2 to 2.5 lb/a Balan)

Time Apply from 10 weeks to just before planting; incorporate within 8 hr by cross-disking or with a power-takeoff rotary tiller.

Remarks May apply through center-pivot and lateral-move irrigation systems. Spray only once; avoid overlapping. See label about planting sensitive crops within 10 to 12 months. Control is poor for many broadleaf weeds. Inhibits mitosis in shoots and roots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

bensulide (Prefar 4E)

Lettuce, endive, cilantro (coriander), red chicory and arugula only; will severely injure spinach, New Zealand spinach, and Swiss chard

Rate 5 to 6 lb ai/a (5 to 6 quarts/a Prefar 4E)

Time Preplant or postplant surface

Crops Lettuce and other leafy vegetables including but not limited to arugula, *Brassica* leafy vegetables (see label), cardoon, celery, chicory, Chinese celery, chervil, cress, dock, endive, Florence fennel, and parsley. Do not use on spinach or Swiss chard.

Remarks Incorporate before planting in top 1 to 2 inches of soil by cross-disking or using a power take-off rotary tiller; or apply preemergence soon after planting, before crop and weeds begin germination, and activate with 1 inch overhead moisture. Sometimes the first flush of weeds must be controlled with

cultivation before herbicide begins to control grass. See label for planting sensitive crops after treatment. Inhibits roots of seedlings.

Caution Do not apply more than once per year. Primarily a grass herbicide.

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

Chemical family Organophosphorus

clomazone

Cilantro and dill weed

Rate 10.7 fl oz/a Command 3ME Microencapsulated Herbicide (0.25 lb ai/a clomazone)

Time Broadcast treatment after seeding and prior to crop and weed emergence.

Remarks Make application at least 50 days prior to harvest. Do not apply more than 10.7 fl oz Command 3ME Microencapsulated Herbicide (0.25 lb ai clomazone) per acre per application. Do not make more than one application per year.

Caution Note crop rotation restrictions. Clomazone may persist in soil up to 16 months. Do not apply more than 10.7 fl oz Command 3ME Microencapsulated Herbicide (0.25 lb. ai clomazone) per acre per year.

cycloate (Ro-Neet)

Spinach only, Oregon and Washington only

Rate 2 to 3 lb ai/a (2.7 to 4 pints/a Ro-Neet)

Time Apply preplant to soil dry enough for thorough mixing; incorporate 2 to 3 inches deep immediately by cross-disking or using a rotary tiller within minutes after application.

Remarks Use on mineral soils only. Seed may be planted immediately after incorporation. Inhibits shoot growth. SLN labels OR-140010 and WA-150005.

Caution Preharvest interval is 45 days.

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

Chemical family Thiocarbamate

linuron (Lorox)

Cilantro, dill, and parsley

Rate 0.5 to 1 lb ai/a (1 to 2 lb/a Lorox)

Time Apply before crop and weeds emerge or after planting when cilantro has at least 3 leaves.

Remarks Use lower rates on light soils, but do not use on extremely sandy soils or soils with less than 1% organic matter. Plant seed 0.5 inches deep. Activate with 0.5 inch water. Maximum 3 lb/a per year west of the Rocky Mountains. PHI is 21 days.

Caution Cilantro and dill varieties may differ in tolerance to linuron. Do not apply to sandy or sandy loam soils to avoid injury. Consult label for planting sensitive crops within 4 months.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

prometryn (Vegetable Pro Herbicide)

Dill only; Washington and Oregon only

Rate 0.75 lb ai/a (1.5 pints/a product)

Time Preplant or postplant surface

Remarks SLN labels WA-090018 and OR-090023. Apply 1.5 pints before planting and incorporate with water followed by 1.5 pints after planting (before weeds are 2 inches tall) and incorporate with water. Use in at least 20 gal/a spray volume.

Caution Preharvest interval is 48 days. Do not use on sand or loamy sand. Do not apply if dill is under water stress. Do not apply within two weeks after an application of any tank-mix containing an oil-based adjuvant.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

prometryn (Caparol 4L)

Cilantro, fennel, and parsley

Rate Cilantro and fennel: 1 to 1.6 lb ai/a (2 to 3.2 pints/a Caparol 4L); Parsley: 0.5 lb ai/a (1 pint/a Caparol 4L)

Time Postplant, preemergence

Remarks Supplemental label. Use in at least 20 gal/a spray volume. See label for crop rotation restrictions. Use lower rates on coarse soils, or if low organic matter. Use higher rate on fine soils with high organic matter.

Caution Preharvest interval is 30 days. Do not use on sand or loamy sand. Do not exceed 3.2 pints/a per crop cycle.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

pronamide (Kerb 50W)

Head lettuce and endive only, direct-seeded and transplant

Rate 1 to 2 lb ai/a (2 to 4 lb/a Kerb 50W)

Time Apply preplant and incorporate thoroughly 2 to 3 inches deep, or apply preemergence at or soon after planting, and activate with surface moisture to reduce loss of herbicide.

Remarks See label for some sensitive varieties and for planting sensitive crops within 12 months. Primarily for grass control. Inhibits mitosis.

Caution **Restricted-use herbicide.** Preharvest interval is 55 days. Do not apply to leaf lettuce.

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

Chemical family Chloroacetamide

trifluralin (Treflan, Agristar Trifluralin 4EC)

Endive and chicory only

Rate 0.5 to 1 lb ai/a (1 to 2 pints/a product) depending on soil type and organic matter content (see label)

Time Apply preplant and incorporate in top 1 to 2 inches of soil by cross-disking or using a power take-off rotary tiller.

Caution Consult label for lengthy crop rotation restrictions when using this product.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Postemergence

clethodim (Select or Prism)

Rate 0.094 to 0.125 lb ai/a (6 to 8 oz/a Select), depending on target weed species and growth stage.

Time Apply to actively growing grass weeds, including annual bluegrass, at growth stages indicated on label.

Remarks Read label carefully for adjuvant instructions, and note effects of rain within 1 hour, application of other pesticides, and cultivation.

Caution See labels for maximum rates per application and season. Preharvest interval is 14 days.

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

Chemical family Cyclohexanedione

clopyralid (Stinger)

Spinach only

Rate Apply 0.063 to 0.124 lb ae/a (0.16 to 0.33 pints/a Stinger) with ground equipment in total spray volume of 10 gal/a or more.

Time Apply at the two- to five-leaf stage of spinach. Stinger controls wild buckwheat when applied in the one- to three-leaf stage of growth, before vining begins. Apply Stinger to clover from weed emergence up to the five-leaf stage of growth. To suppress sowthistle, apply Stinger from rosette up to bud stage.

Remarks Controls wild buckwheat, sweet clover, prickly lettuce, common ragweed, and galinsoga. Suppresses sowthistle.

Caution Preharvest interval is 21 days. Make one to two broadcast applications per crop per year, not to exceed 0.5 pint/a. Note crop rotational intervals on label.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

imazamox (Raptor)

Chicory only

Rate 0.031 lb ae/a (4 oz/a Raptor)

Time Apply to chicory that has at least 2 and no more than 4 true expanded leaves when weeds are growing actively and less than 3 inches tall.

Remarks Add a nonionic surfactant or crop oil. Use of a nitrogen-based fertilizer will improve grass control but must be measured against the potential for increased crop injury.

Caution Apply grass herbicides before applying Raptor. Consult label for rotational crops and food or feed restrictions; this herbicide may persist for 26 months.

Site of action Group 2: acetolactate synthase (ALS) inhibitor (imazamox); Group 6: photosystem II inhibitor (bentazon)

Chemical family Imidazolinone and benzothiadiazole

pendimethalin (AquaPen 3.8)

Lettuce only; WA and ID only

Rate 1.0 lb ai/a (1.05 qts/a)

Time Broadcast when lettuce has 3 or more leaves.

Remarks Direct-seeded or transplanted lettuce. Preemergent weed control and will not control emerged weeds.

Caution Do not apply within 20 days of harvest and do not apply more than 1.05 quarts/year. Do not apply pre-plant, pre-transplant, or pre-emergence or severe injury will occur.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

phenmedipham (Spin-Aid)

Spinach only

Rate 0.49 to 0.98 lb ai/a (3 to 6 pints/a Spin-Aid)

Time Apply any time spinach is past four- to six-leaf stage and before weeds are at the two-leaf stage.

Remarks Avoid applying if weather may change rapidly from cool and cloudy to warm and sunny, or if spinach is stressed from insect, disease, or cultivation injury. Tip burn or temporary growth retardation and chlorosis may occur; plants usually recover within 10 days.

Caution Restricted-use herbicide. Preharvest interval is 40 days. Avoid diluting herbicide more than 1 quart to 7 gal water in spray tank, which can cause the chemical to precipitate.

Site of action Group 5: photosystem II inhibitor

Chemical family Phenylcarbamate

sethoxydim (Poast)

Rate 0.188 to 0.28 lb ai/a (1 to 1.5 pints/a Poast)

Time Apply at optimum growth stage listed on the 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. Inhibits fatty acid production, cell membranes, and new growth.

Caution Preharvest interval is 15 days for spinach and leaf lettuce, 30 days for head lettuce. Do not exceed 3 pints/a per season. Avoid applying when temperatures exceed 90°F or when relative humidity exceeds 60%.

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

Chemical family Cyclohexanedione

triflurosulfuron methyl (UpBeet)

Supplemental labels in the PNW for endive and chicory only

Rate 0.0156 lb ai/a (0.5 oz/a UpBeet)

Time Apply when endive or chicory plants have developed one true leaf (two cotyledons and one true leaf). Use at least two sequential applications for best results. Apply 5 to 10 days apart, depending on weed size.

Remarks Apply to small, actively growing weeds. Nonionic surfactants may be used at 0.25% v/v but may increase risk of crop injury. Crop oil concentrates are not recommended. Controls pigweed, kochia, shepherds-purse, and velvetleaf.

Caution Discoloration may be noted in some cases but effects are temporary. Do not contaminate water bodies, or rinse or flush spray near roots of trees and desirable plants, or injury may result.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

Onion

Dry bulb and green onions, leeks, shallots, and spring onions

Joel Felix

Revised March 2020

Site Preparation, Stale Seedbeds, and Selective Postemergence Applications

See "Site Preparation, Stale Seedbeds, and Selective Postemergence Applications" at the beginning of Section P. in this handbook.

Preplant

bensulide (Prefar 4-E)

Not for use in Willamette Valley of Oregon; garlic, dry bulb onions and shallots only (Idaho and Oregon only)

Rate 5 to 6 lb ai/a (5 to 6 quarts/a)

Time Fall application, during bed construction: apply after markout when soil temperature is below 60°F. Prepare a good, flat seedbed following standard cultural practices. Apply Prefar 4-E in the fall in 10 to 50 gal of water in 10- to 12-inch bands and bed-up, throwing soil from the furrows over the sprayed band of Prefar 4-E. Allow to remain undisturbed until spring. Prior to planting in spring, drag-off the bed tops being careful not to drag off soil below the level of Prefar 4-E application. Plant in the center of the bed. Do not apply more than 6 lb ai/a per season.

Remarks Shallow mechanical incorporation can be substituted to maintain the herbicide above the onion seed. If mechanically incorporated, use spike-tooth harrow, smizer roller, or similar equipment to maintain shallow and uniform layer of herbicide within the upper 1 inch of soil for sandy soils or the upper 0.5 inch for loam soils. Use low rates on sandy soils. Will not control germinated weed seedlings. Inhibits roots of emerging seedlings.

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

Chemical family Organophosphorus

S-metolachlor (Dual Magnum and various other trade names)

Fall preplant for yellow nutsedge control in dry bulb onions; Oregon and Idaho only

Rate and Time **Oregon** East of the Cascades: apply 1.27 to 1.9 lb ai/a (1.33 to 2 pints/a) in fall after crop harvest but before freeze-up. Washington and Idaho: apply up to 1.27 lb ai/a (1.33 pints/a). Follow main label recommendations for light textured soils. Fall applied Dual Magnum works best if applied soon after wheat harvest (preferably mid- August to early September) and thoroughly incorporated into the soil, followed by plowing, fumigation, and bedding in October. Fall surface application of Dual Magnum East of the Cascades will invariably result in onion injury. Recent experience at the OSU Malheur Experiment Station indicates onions may be injured if fall applied Dual Magnum is not sufficiently incorporated in the soil, and if weather remains cold and wet after onions are planted in spring. Similarly, chances of crop injury increase if the weather during winter and spring remains dry. To reduce risk of crop injury, apply at least 120 days before planting onion seed, sets, or

transplants. West of the Cascades: apply 1.27 lb ai/a (1.33 pints/a) of Dual Magnum in fall. Use low rate on mineral soils and high rate on muck soils. Apply before fall rains begin or after the first light rain. Do not incorporate Dual Magnum with tillage, as this will reduce yellow nutsedge control. To reduce risk of crop injury, apply at least 130 days before planting onion seed, sets, or transplants. Fall preplant application should not exceed 2 pints/a. Total preplant and postemergence applications should not exceed 2.5 pints/a.

Remarks Indemnified SLN labels OR-040009 and ID-9900016 available at farmassist.com. Dual Magnum inhibits roots and shoots formation.

Caution Risk of crop injury is greater on light-textured soils and at higher application rates. Tank-mixes with other pesticides may increase potential of crop injury. Only one application in fall is recommended. No more than 2 pint/a in a single fall preplant application. Avoid areas with shallow groundwater and directly applying to water.

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

Chemical family Chloroacetamide

Preemergence, Delayed Preemergence, Early Postemergence

DCPA (Dacthal Flowable)

Onions [dry bulb onions, dry bulb shallots and green onions (green onions, leeks, spring onions or scallions, Japanese bunching onions, green shallots or green eschalots)]

Rate 4.5 to 10.5 lb ai/a (6 to 14 pints/a)

Time Apply after planting to soil surface before weeds germinate and onions emerge. A layby application can be made on onions either alone or in addition to a Dacthal Flowable preemergence treatment up to 14 weeks after planting at rates up to 14 pints/a on any soil type. Dacthal Flowable can be sprayed directly over transplants without injury.

Remarks Performs erratically west of the Cascades. In eastern Oregon and Washington, if overhead irrigation is not available, apply and shallowly incorporate herbicide with a nailboard. Rain after incorporation improves weed control. Preplant incorporation is not recommended for onions. Results improve with overhead irrigation immediately after application. Consult label for planting sensitive crops within 8 months. In sandy loam soils, a maximum preemergence rate of 10 pints/a is recommended. Where onion emergence is expected to be slow due to cold and wet soil condition, delay application until seed begins to germinate to reduce the risk of crop injury. Preplant incorporation is not recommended for onions. Inhibits mitosis.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Phthalic acid

dimethenamid-P (Outlook)

Onions (dry bulb and green), garlic, and dry bulb shallots

Rate 0.56 to 0.84 lb ai/a (12 to 18 fl oz/a) on coarse soils and 0.84 to 0.98 lb ai/a (18 to 21 fl oz/a) in medium-texture or fine soils. May be applied in a single application. Do not exceed 21 fl oz/a per season.

Time Apply postemergence from the two true-leaf stage until at least 30 days before harvest.

Remarks Split applications of 10 to 14 oz/a followed by 7 to 14 oz/a are permitted but cannot exceed a total of 21 oz/a. If split applications are made, maintain a minimum of 14 days between sequential applications. Refer to the EPA-approved labels for specific application methods and requirements.

Caution Applications before the two true-leaf stage may significantly injure the crop. Aerial applications must leave a 150-ft untreated buffer between treatment area and endangered plant populations. Ground applications must use low-pressure nozzles that produce only medium to coarse or very coarse droplets and leave a 35-ft untreated buffer between treatment area and endangered plant populations.

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

Chemical family Chloroacetamide

dimethenamid-P (Outlook)

Dry bulb onions (yellow only) applied through the irrigation drip system (OR and ID).

Rate 0.328 to 0.656 lb ai/a (7 to 14 fl oz/a) on medium to heavy soils. May be used in a single application up to 14 fl oz/a or in split applications of 7 to 14 fl oz/a followed by the remaining 7 to 14 fl oz/a in sequential applications. Do not exceed 21 fl oz/a per season.

Time Apply postemergence to onion with two fully developed true leaves but NOT later than six leaf stage.

Remarks When split application rate is >7 fl oz/a, separate sequential applications by at least 14 days. When split application rate is 7 fl oz/a or less, separate sequential applications by at least 7 days. Do not exceed a total of 21 oz/a per season or apply beyond the six leaf stage. For best results, dilute the herbicide in enough water to last for 10 to 12 hr of chemigation. Refer to the SLN OR-160004 for Oregon (Malheur County only) and SLN ID-160001 for Idaho (Ada, Canyon, Gem, Owyhee, Payette, and Washington Counties). DO NOT apply with any other pesticides, fertilizers, adjuvants, or other products. Refer to EPA-approved labels for specific application methods and requirements.

Caution Applications before the two true-leaf stage may significantly injure the crop. User must have the SLN label and the entire Outlook container label in possession at the time of pesticide application. Do not apply more than a cumulative maximum amount of 21 fl oz/a through drip tape chemigation and/or foliar spray in a single season.

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

Chemical family Chloroacetamide

ethofumesate (Nortron SC, Ethotron SC and various other trade names)

Dry bulb onions and shallots only

Rate Preemergence: 0.5 to 1 lb ai/a (16 to 32 fl oz/a) depending on soil texture. Weed control diminishes in soils with fine texture

or high organic matter. Postemergence: 0.5 lb ai/a (16 fl oz/a) with up to four evenly spaced sequential applications, with last application 28 to 32 days before harvest.

Time Apply after planting, and activate with at least 0.5 inch of water, or apply after crop emerges.

Remarks Do not use smaller than 50 mesh screen, and avoid overlaps, which may increase risk of crop injury. For postemergence applications, rain or irrigation within 6 hr after application may reduce weed control. On coarse soils; do not exceed 48 fl oz/a of product per season. On medium and fine textured soils; do not exceed 96 fl oz/a of product per season. For postemergence applications, do not retreat within 10 days. Do not apply more than 4 split applications per year.

Caution May cause temporary leaf fusion, distortion, and stunting when used as label directs and under normal growing conditions. If crop is lost due to unfavorable growth conditions after application, do not plant anything except sugar beets, table beets, onions, garlic, shallots, or ryegrass. If crop is lost due to unfavorable growth conditions following application of Nortron SC herbicide or tank mixes, do not replant with crops other than sugar beets, table beets, carrots, dry bulb onions, shallots, or ryegrass in treated land during the same year.

Site of action Group 16: unknown (but there is strong evidence that it interferes with biosynthesis of fatty acids and lipids in the newly developing shoot).

Chemical family Benzofuran

oxyfluorfen (GoalTender, Goal 2XL, or Galigan 2E, Galigan H₂O, Collide)

Dry bulb onion, green onions (via sprinkler application)

Rate 0.12 to 0.25 lb ai/a (0.25 to 0.5 pint/a GoalTender and Galigan H₂O) in direct-seeded and transplanted onions. The rate for Goal 2XL and Galigan 2E use 0.125 to 0.25 lb ai/a (0.5 to 1 pint/a).

Time Apply postemergence to onions with two fully developed true leaves, while broadleaf weeds have fewer than four true leaves. Goal applications are allowed on green onions through sprinkler irrigation systems (Special local needs label OR-020027). Read and precisely follow label instructions regarding irrigation interval and all chemigation specifications to minimize environmental hazards.

Remarks Multiple treatments may be required as new weeds emerge, but do not exceed 0.5 lb ai/a (maximum of 2.5 pints/a per use season). Use a clean sprayer and do not mix with oils, surfactants, or other agricultural chemicals. Apply when susceptible weeds are in the two- to four-leaf stage and actively growing. Acts as a selective contact herbicide that disrupts cell membranes.

Caution Do not apply to onions that are under any stress. Leaves may curl slightly, and young plants sometimes become prostrate on the soil surface for 1 to 2 days, but yields have not been reduced. Preharvest interval is 45 days. Goal damages some onion varieties more easily than others; "Walla Walla" sweet onions are very sensitive. Check with your seed supplier for information regarding the variety you wish to plant.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

pendimethalin (Prowl H₂O or Satellite HydroCap and various generic names)

Dry bulb onions and shallots only, direct-seeded or transplanted

Rate 0.475 to 1.42 lb ai/a (1 to 3 pints/a Prowl H₂O) depending on soil texture.

Time Delayed preemergence for dry bulb onion only (after onion seed germinates but before it emerges); and after onions emerge (two- to nine-true-leaf stage). Delayed preemergence: apply Prowl H₂O when 75% of dry bulb onion seed radicals have emerged. Determine radical status by digging onion seedlings at random locations in a field, and noting radical length. Plant onions at least 1 inch deep to mitigate risk of injury. Apply Prowl H₂O as a broadcast treatment when dry bulb onions or dry bulb shallots are between the flag leaf to 9th true-leaf stage. Prowl H₂O may be used at 3.0 to 4.0 pints per acre for dodder control on medium-texture and fine-texture soils. DO NOT apply Prowl H₂O using chemigation at the dodder control rate. See restrictions and limitations on the label.

Remarks Prowl H₂O is a selective delayed preemergence herbicide for controlling most annual grass weeds and certain broadleaf weeds as they germinate. Prowl H₂O will not control established weeds. SLN labels are available for delayed preemergence for Prowl H₂O (OR-060008, WA-070004, and ID-060009) from several grower associations in western and eastern Oregon, Washington, and Idaho. Adjust rates according to soil texture. Rain or overhead irrigation is needed within 10 days for activation. Inhibits mitosis, both in shoots and roots.

Caution Adjust rates according to soil texture. Do not apply preplant incorporated, or preplant. For use under SLN labels in OR, WA, and ID. Do not apply delayed preemergence through any type of irrigation system or by air. Be aware of crop-rotation restrictions, including for sugar beets, winter wheat, and winter barley. Do not exceed the maximum rate per acre, per crop season regardless of application timing.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pendimethalin (Prowl H₂O and various generic names)

Green onion crop subgroup: chives (fresh leaves), leeks, spring onions, scallions, Japanese bunching onions, green shallots, and green eschallots

Rate 0.95 lb ai/a (2 pints/a)

Time Preemergence, postemergence at two- to three-leaf stage, or as a split application.

Remarks Apply 2 pints/a per application. Two applications per season are allowed with 30 days between applications. Preharvest interval is 30 days.

Caution Onion seed must be covered with soil to prevent injury. **Do not apply to soils with less than 3% organic matter.**

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

S-metolachlor (Dual Magnum and other trade names)

Early postemergence for yellow nutsedge control in dry bulb onion; Oregon, Idaho, and Washington

Rate and Time Apply at two true-leaf stage of onions at 0.67 to 1.33 pints/a (0.64 to 1.27 lb ai/a). Another application of 0.67 to 1.33 pints/a may be made 21 or more days after the first, if needed, provided Dual Magnum was not applied preplant in fall.

Remarks Indemnified special local need labels OR-040009 and ID-9900016 are available at farmassist.com. The Washington SLN label (WA-990023) is distributed only by the Walla Walla Sweet Onion Growers Association. Excessive rain or cold, wet conditions after application may reduce plant stand and cause stunting and yield loss. Onion tolerance to Dual Magnum increases with increasing onion size.

Caution **A restricted-use herbicide in Washington.** 1. Do not apply within 60 days of harvest. 2. Do not harvest green onions. 3. Do not apply this product through any type of irrigation system. 4. Do not graze animals on green forage or stubble. If a fall preplant application of Dual Magnum was used for nutsedge, only one postemergence application at a maximum rate of 1.33 pints/a is allowed. Do not apply more than 2.68 pints/a to dry bulb onions as a combined total across all application timings and use patterns to produce that crop.

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

Chemical family Chloroacetamide

Postemergence

bromoxynil (Buctril, Broclean, Brox 2EC, or Buctril 4EC)

Idaho and east of the Cascades, dry bulb onions only

Rate 0.25 to 0.38 lb ai/a (1 to 1.5 pints/a) for Buctril, Broclean, and Brox 2EC. Use 0.25 to 0.375 lb ai/a (0.5 to 0.75 pints/a) for Buctril 4EC.

Time Apply in 50 to 70 gal water for thorough coverage when onions have two to five true leaves. Apply on sunny days when plants are dry and humidity is low.

Caution Do not ingest or inhale spray mist. Prevent contact with skin. Wear protective face shields, respirators, and coverall clothing over long-sleeved shirt and long pants. Do not apply west of the Cascades or when protective waxy cuticle on onion leaves may be thin or damaged. Do not add adjuvants. Injury can sometimes occur, even under ideal conditions. Read the label on precautions and restrictions.

Site of action Group 6: photosystem II inhibitor

Chemical family Nitrile

carfentrazone (Aim)

Rate Up to 0.031 lb ai/a (0.5 to 2 fl oz/a Aim EC) per application in at least 10 gal/a of finished spray

Time Apply (postemergence only) with hooded sprayer between rows of emerged crop.

Remarks See the table of approved uses on vegetable crops under "Selective Postemergence Applications" at the beginning of Section P. Vegetable Crops in this handbook. Hooded sprayers must prevent spray from reaching green stem tissue, foliage, blooms, or fruit of the crop. Do not use for preplant burndown on fields intended for bulb vegetables.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

clethodim (Select Max or Select 2EC)

Dry bulb onions, garlic, and shallots only

Rate Consult labels for information on dry bulb onion and shallots.

Time Apply to actively growing grass weeds, including annual bluegrass, at growth stage on label.

Remarks Carefully read label for adjuvant instructions and about effects of rain within 1 hour, applying other pesticides, or cultivation. Application should be made in a minimum of 20 gal of spray solution per acre. May be applied to onions and garlic using sprinkler irrigation systems. Do not apply using chemigation in ID, OR, and WA.

Caution Consult labels for maximum rates per application and season. Preharvest interval is 45 days for dry bulb onions, garlic, and shallots. Applications to dry bulb onions or shallots should be made in a minimum of 20 gal of spray solution per acre.

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

Chemical family Cyclohexanedione

fluzifop (Fusilade DX)

Dry bulb onions only

Rate 0.125 to 0.376 lb ai/a (8 to 24 oz/a) depending on target weed species and growth stage.

Time Apply to actively growing grasses with 0.5 to 1% crop oil, or 0.25 to 0.50% nonionic surfactant. Results often are erratic on grasses stressed from lack of vigor, drought, high temperature, or low fertility. Do not apply more than 48 fl oz/a in total per season. Maintain a minimum of 14 days between applications. Use sufficient spray volume (20-40 gal/a) to ensure complete coverage of target grasses. When grass foliage is dense, use a minimum of 20 gal/a.

Remarks Identify grasses; adjust rates depending on susceptibility and stage of weed growth as label instructs. 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 Preharvest interval is 45 days. Do not exceed 3 pints/a per year. Grazing is prohibited.

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

Chemical family Aryloxyphenoxy propionate

fluroxypyr (Starane Ultra or Obtain EC)

Dry bulb onions only

Rate 0.125 lb ae/a (0.35 pints/a product)

Time Apply broadcast postemergence from the two true-leaf stage though the six-leaf stage. Weeds should be 4 to 8 inches tall.

Remarks SLN labels OR-080026, ID-080007, and WA-080008 (Starane Ultra) for control of kochia, volunteer potatoes, common purslane, and other susceptible broadleaf weeds. Adjuvants are not recommended. Heavy flushes of weeds can be controlled with two sequential applications at 10- to 14-day intervals. Do not exceed 0.7 pint/a, or two applications, per year.

Caution Crop injury may occur with some onion varieties. Do not broadcast after the six-leaf stage. Applications after the six-leaf stage should be made as a directed spray with drop nozzles (consult the label for the warning). Do not apply through any type of irrigation system. Preharvest interval is 42 days.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

paraquat (Gramoxone Inteon, Gramoxone SL 2.0 and 3.0)

Rate 0.63 to 1 lb cation/a (2.5 to 4 pints/a)

Time Apply before, during, or after planting but before crop emerges, to control emerged weed seedlings only.

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. Acts as contact; absorbs energy from 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 clothes. Do not exceed 4 pints/a per season. Preharvest interval is 60 days.

Site of action Group 22: photosystem 1 electron diversion

Chemical family Bipyridilium

pendimethalin (Prowl H₂O or Prowl 3.3EC and other trade names)

Dry bulb onion and shallots, direct-seeded and transplanted

Rate 0.6 to 1.24 lb ai/a (1.5 to 3.0 pints/a Prowl H₂O) or 0.74 to 1.49 lb ai/a (1.8 to 3.6 pints/a Prowl 3.3EC) depending on soil texture. May be applied at 1.42 to 1.9 lb ai/a (3 to 4 pints/a Prowl H₂O) or 1.48 to 1.98 lb ai/a (3.6 to 4.8 pints/a Prowl 3.3EC) for dodder control on medium- and fine-textured soils in Oregon, Idaho, and Washington. The indicated rate is for all uses, regardless of application timing (delayed preemergence (Prowl H₂O only) or postemergence).

Time Apply Prowl 3.3EC between the flag leaf to ninth true-leaf stage. DO NOT apply Prowl 3.3EC using chemigation at the dodder control rate. Do not irrigate in excess of 0.5 inch of water.

Remarks Prowl H₂O and Prowl 3.3EC may be applied by ground, air, or chemigation (only to direct-seeded, transplanted dry bulb onions and shallots). May be applied through sprinkler irrigation systems (only to direct-seeded, transplanted onions and shallots). Follow all directions, special instructions, and precautions about chemigation in the spraying instructions section of the main labels. Adjust rates according to soil texture. Rain or overhead irrigation is needed within 10 days of application. Inhibits mitosis in shoots and in roots.

Caution Be aware of crop rotation restrictions, including those for sugar beet, winter wheat, and winter barley. Do not apply within 45 days before harvest. Do not exceed the maximum rate per season regardless of application timing (delayed preemergence or postemergence).

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pyroxasulfone (Zidua SC)

Dry bulb onion (direct-seeded and transplanted) and leeks (transplanted only)

Rate 0.065 to 0.09 lb ai/a (2 to 2.75 fl oz/a Zidua SC) depending on soil texture. Only to be used on medium to fine textured mineral soils and muck soils (greater than 20% organic matter) to control annual grassy weeds, sedges, and annual broadleaf weeds. The indicated rate is only for postemergence application to dry bulb onions (direct-seeded and transplanted) and leek (transplanted only).

Time Apply Zidua SC postemergence only at the two leaf to sixth true-leaf stage. Zidua SC does not control emerged weeds.

Remarks Use of Zidua SC may result in temporary growth suppression, leaf burn, and/or other injury or stand reduction to dry bulb onions or leek under stressful conditions including inadequate or excessive moisture, extended periods of water saturated soil conditions occurring during early transplant growth and development, cold and hot temperatures, compacted soils, injury from other pesticides, disease or other pest damage, mechanical injury, nutrient imbalances, or other conditions known to cause plant stress. Zidua SC may be tank mixed or applied sequentially with other postemergence herbicides registered for use in dry bulb onions or leek for a broader spectrum of control and/or control of emerged weeds. Follow the adjuvant directions for the tank mix partner of Zidua SC. Adjust rates according to soil texture, but do not use on coarse textured soils. User must possess the supplemental label and the main Zidua SC herbicide container label at the time of application.

Caution Do not apply within 60 days before harvest of dry bulb onion or leek. Do not apply Zidua SC to direct-seeded leek. Do not exceed the maximum rate of 2.75 fl oz/a per season. Do not use on coarse textured soils.

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

Chemical family Chloroacetamide

sethoxydim (Poast)

For dry bulb onion and green onions, garlic, leek, and shallots

Rate 0.19 to 0.28 lb ai/a (1 to 1.5 pints/a) depending on target grass species and growth stage

Time Apply at optimum growth stage as on label.

Remarks Identify susceptible grasses, and add 2 pints/a nonphytotoxic crop oil concentrate to improve leaf absorption. Results often are erratic if grasses are stressed from lack of vigor, drought, high temperature, 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. Do not exceed 4.5 pints/a per season.

Caution Preharvest interval is 30 days. Do not exceed 4.5 pints/a per season.

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

Chemical family Cyclohexanedione

trifluralin (Treflan TR-10 and other trade names)

Dry bulb onions only

Rate 0.38 to 0.63 lb ai/a (3.75 to 6.26 lb/a broadcast rate)

Time Apply at layby as a directed spray to the soil between rows, and incorporate immediately with sweeps or rolling cultivators. Avoid applying directly to the tops or exposed bulbs of onion plants.

Remarks Use proportionately less when treating area between rows only. Inhibits mitosis in shoots and roots.

Caution Do not apply to soils with more than 3.5% organic matter, because effectiveness will be reduced. Do not apply preplant or preemergence. Preharvest interval is 60 days. Remove emerged weeds before applying. See label for planting sensitive crops within 12 months.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Sprout Inhibition

maleic hydrazide (Royal MH-30)

Rate 2 lb ai/a (1.33 gal/a)

Time Apply when bulbs are fully mature, with soft necks and five to eight green leaves, or when about 50% of the tops have fallen but are still green.

Remarks Apply at temperatures below 80 to 85°F to avoid crystallization on leaf surfaces. Using a spray adjuvant is suggested in arid regions west of the Rocky Mountains. Avoid early sprays, before maturity, to reduce spongy onions. Apply in a minimum of 30 gal of water per acre.

Caution Do not treat seed onions.

Site of action Not well understood

Chemical family None generally accepted

Pea (Green or English)

Ed Peachey

Revised March 2020

General Weed Management Strategy

Peas are drilled in closely spaced rows early in spring, which limits weed emergence and species diversity. Most growers apply herbicides to suppress or eliminate weed competition, or potential contamination of harvested product. Subsequent crop rotations during the same season limit herbicide choices to those exhibiting brief soil residuals.

Stale Seedbed Method

Refer to “Stale Seedbeds” in Section P. Vegetable Crops for information on the following options:

- acetic acid
- ammonium nonanoate, ammonium salts of fatty acids
- carfentrazone
- caprylic and capric acids
- clove oil, peppermint oil, rosemary oil, thyme oil
- decanoic acid, octanoic acid, pelargonic acid
- flaming
- glyphosate
- d-limonene
- paraquat (restricted-use herbicide in Idaho and Oregon for acute toxicity)
- pyraflufen

Preplant Incorporated

imazethapyr (Pursuit)

Rate Consult labels.

Time Apply only once per year. Preharvest interval is 6 days for peas. See label about planting rotation crops.

Remarks Registered only in certain eastern Oregon and Washington counties, and in Idaho.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

pendimethalin (several trade names)

Rate 0.7 to 1.4 lb ai/a (1.5 to 3.0 pints/a Prowl)

Time Apply and incorporate up to 60 days before planting. Rate depends on soil texture.

Remarks Thoroughly mix previous crop residue into soil 4 to 6 inches before applying.

Caution Do not apply more than once per season. Do not apply to pea forage, pea silage, pea hay, or pea straw grown for livestock feed.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

saflufenacil (Sharpen)

Supplemental label (Oregon, Washington, Idaho)

Rate 0.017 lb ai/a (0.75 fl oz/a Sharpen)

Time Apply early preplant, preplant incorporated or preemergence for limited residual broadleaf weed control.

Remarks There are no university data for use of this product in the PNW. Sharpen controls mainly broadleaf weeds. Methylated seed oil (MSO) or crop oil concentrate (COC), at 1% v/v + ammonium sulfate (AMS) at 8.5 to 17 lb per 100 gal, are required for satisfactory control of emerged weeds. An early preplant application of Sharpen at 0.75 fl oz/a can be made prior to PPI or preemergence application. Sequential applications must be at least 30 days apart.

Caution Do not substitute a nonionic surfactant for MSO or COC as control of emerged weeds will suffer. Do not exceed 2.0 fl oz/a during the cropping season. Do not apply when the peas have reached the cracking stage, or after emergence, because severe crop injury will occur. Legume forage may be fed or grazed 65 or more days after application.

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

Chemical family Uracil

trallate (Far-Go)

Rate 1.25 to 1.5 lb ai/a (2.5 to 3 pints/a)

Time Apply within three weeks of planting. Incorporate immediately, using a disk or spike-tooth harrow.

Remarks Controls wild oat and annual ryegrass. See label for crop rotation restrictions.

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

Chemical family Thiocarbamate

trallate (Far-Go) + trifluralin

Rate 1.25 lb ai/a + 0.375 lb ai/a, respectively

Time Apply within three weeks of planting. Incorporate within 24 hr, using disk or spike-tooth harrow.

Remarks Provides better control of wild oat at a lower rate of trifluralin.

Caution Do not use foliage from treated peas for feed or forage. Peas may show leaf crinkling and delayed maturity, particularly on heavy soils.

Site of action (trallate) Group 8: lipid synthesis inhibitor but not an ACCase inhibitor; (trifluralin): Group 3: microtubule assembly inhibitor

Chemical family (trallate) thiocarbamate; (trifluralin) dinitroaniline

triallate + trifluralin (Buckle)

Rate 10 to 12 lb/a granular

Remarks Follow label directions and note comments above.

Site of action (triallate) Group 8: lipid synthesis inhibitor but not an ACCase inhibitor; (trifluralin): Group 3: microtubule assembly inhibitor

Chemical family (triallate) thiocarbamate; (trifluralin) dinitroaniline

trifluralin (several trade names)

Rate 0.5 to 0.75 lb ai/a (1 to 2 pints/a), depending on soil texture

Time Apply preplant, and incorporate 1 to 2 inches deep within 24 hr, by cross-disking, rototilling, or cross-tilling with a field cultivator.

Remarks Spray only once per season. Avoid overlapping. Use lower rate on coarse soils. Peas have been stunted when maximum labeled rates were applied uniformly in fields with slight variations in soil type. Consult label for planting sensitive crops within 12 months.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Preemergence Soil-applied**clomazone (Command 3ME)**

Rate 0.5 lb ai/a (1.3 pints/a)

Time Apply to soil before or after seeding but before crop emerges.

Remarks See label for crop rotation restrictions and application requirements to avoid crop injury or vapor drift to sensitive plants. Some temporary chlorosis of green peas may occur. Avoid overlaps while spraying.

Caution Do not mix or apply within 1,000 ft of landscapes, orchards, vegetable gardens, berry patches, or property lines to prevent chemical trespass. Evidence west of the Cascades suggests that lower rates of 0.25 to 0.33 lb ai/a (11 to 14 fl oz/a) controls susceptible weeds in early spring. Do not graze cover crops, or harvest food or feed within 9 months of application. Do not allow livestock to graze on treated pea vines or vine trash.

Site of action Group 13: inhibits DOXP synthase

Chemical family Isoxazolidinone

halosulfuron-methyl (Sandea)

Rate 0.023 lb ai/a (0.5 oz/a)

Time Preemergence

Remarks Do not apply more than 0.5 oz of Sandea per acre per year. Not all pea varieties have been tested for tolerance. Under adverse growing conditions, maturity of the treated crop may be delayed, affecting harvest date, yield, and quality. For untested varieties, a small area of the field should be sprayed to determine potential sensitivity to its use. See label for significant crop rotation restrictions for this herbicide.

Caution Application of halosulfuron may cause significant, temporary stunting and delay maturity of peas resulting in delayed harvest. This product is available to the end-user/grower solely to the extent that the benefit and utility, in the sole opinion of the end-user/grower, outweigh the extent of potential injury

associated with the use of this product. Due to the risk of crop damage, all such use is at the end-use/grower's risk.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

metribuzin (several trade names)

Rate 0.19 to 0.38 lb ai/a (6 to 12 oz/a metribuzin 4F)

Time Apply once per season, soon after planting, and incorporate with irrigation or cross-harrow to ensure uniformity within top 1 to 2 inches of soil.

Remarks Adjust rates for soil texture and organic matter.

Caution Restricted-use herbicide in Washington. Do not use on coarse, sandy, or shallow soils, or on soils with less than 1.5% organic matter. Crop may be injured if heavy rain follows application. Do not apply more than 0.5 inch of irrigation within 1 month after metribuzin application, to avoid crop injury. Experience is lacking in western Oregon; try small areas before treating large acreages. Crop may be injured if plants are stressed by cold weather, poor soil fertility, and disease or insect damage. Will not control weeds resistant to triazine (atrazine) herbicides. Grazing is permitted 40 days after treatment. Certify that pea variety, location, and irrigation conditions are listed on the product label you purchase.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

S-metolachlor (Dual Magnum)

Rate 0.95 to 1.91 lb ai/a (1 to 2 pints/a Dual Magnum), depending on soil texture

Time Apply preemergence behind planter and activate with moisture.

Remarks May delay maturity and/or reduce yields if soils are cold and wet after planting.

Caution Restricted-use herbicide in Washington to protect surface and groundwater. Preharvest interval is 120 days for hay.

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

Chemical family Chloroacetamide

saflufenacil (Sharpen)

Supplemental label (Oregon, Washington, Idaho)

Rate 0.017 lb ai/a (0.75 fl oz/a Sharpen)

Time Apply early preplant, preplant incorporated, or preemergence for limited residual broadleaf weed control.

Remarks There are no university data for use of this product in the PNW. Sharpen controls mainly broadleaf weeds. Methylated seed oil (MSO) or crop oil concentrate (COC), at 1% v/v + ammonium sulfate (AMS) at 8.5 to 17 lb per 100 gal, are required for satisfactory control of emerged weeds. An early preplant application of Sharpen at 0.75 fl oz/a can be made prior to PPI or preemergence application. Sequential applications must be at least 30 days apart.

Caution Do not substitute a nonionic surfactant for MSO or COC as control of emerged weeds will suffer. Do not exceed 2.0 fl oz/a during the cropping season. Do not apply when the peas have reached the cracking stage, or after emergence, because severe crop injury will occur. Legume forage may be fed or grazed 65 or more days after application.

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

Chemical family Uracil

sulfentrazone (Aquesta, Willowood Sulfentrazone 4SC)

Rate 0.07 to 0.19 lb ai/a (2.25 to 6.0 fl. oz/a) depending on soil type and organic matter content

Time Pre-emergence

Remarks There is limited university data for use of this product in the PNW. Sulfentrazone controls mainly broadleaf weeds. In coarse-textured soils with < 1.5% organic matter, wait a minimum of 7 days after application before seeding. Do not incorporate into the soil. Do not apply if peas have emerged. Do not apply in extended periods of dry weather. Do not apply more than 0.1875 lb ai (6.0 fl oz) per acre per year.

Caution Use rate is inversely dependent upon soil pH. Use higher rates within the specified rate range with lower pH (< 7.0) and lower rates within the specified rate range with higher pH (> 7.0). Rotational restriction of 18 months for corn and 24 months for canola.

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

Chemical family Triazinone

Postemergence

bentazon (Basagran)

Rate 0.75 to 1 lb ai/a (1.5 to 2 pints/a)

Time Apply as pea tolerance increases, as waxes develop on leaf surfaces.

Remarks Apply to peas having at least three pairs of leaves (four nodes) but prior to flowering. Temporary foliar injury may occur under conditions that result in the cuticle of pea leaves allowing too much herbicide to be absorbed, including temperatures over 80°F, or application on a sunny day immediately after several cloudy days. Small, newly emerged broadleaf weeds can be controlled in early spring, at cool temperatures (75°F day, 55°F night), by adding a highly refined nonphytotoxic oil concentrate (see label). Do not apply to peas under stress from root rot.

Caution Do not tank mix with spray additives or pesticides except MCPA and MCPB (without crop oil). Preharvest interval is 30 days. Do not exceed 2 lb ai/a (4 pints/a) per season.

Site of action Group 6: photosystem II inhibitor

Chemical family Benzothiadiazole

clethodim (Select Max and other trade names)

Rate 0.068 to 0.12 lb ai/a (9 to 16 oz/a Select Max on annual grasses; 12 to 16 oz/a on perennial grass weeds)

Time Apply to actively growing grasses at recommended weed heights.

Remarks Recommended surfactant is nonionic surfactant at 0.25%; do not add ammonium sulfate.

Caution Do not exceed 32 fl oz/a per year. Allow at least 14 days between applications. Preharvest interval is 21 days.

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

Chemical family Cyclohexanedione

halosulfuron-methyl (Sanda)

Rate 0.023 to 0.046 lb ai/a (0.5 to 1 oz/a)

Time Postemergence

Remarks Apply as a directed spray when peas have 2 to 4 trifoliolate leaves and before flowering. Directed sprays are recommended to limit crop injury. Make one broadcast application with ground equipment in a minimum of 15 gallons of water per acre. Use a nonionic surfactant at 0.25% (v/v) with post-emergence applications. Not all pea varieties have been tested for tolerance. Under adverse growing conditions, maturity of the treated crop may be delayed, affecting harvest date, yield, and quality. For untested varieties, a small area of the field should be sprayed to determine potential sensitivity to its use. See label for significant crop rotation restrictions for this herbicide.

Caution Application of halosulfuron may cause significant, temporary stunting and delay maturity of peas resulting in delayed harvest. This product is available to the end-user/grower solely to the extent that the benefit and utility, in the sole opinion of the end-user/grower, outweigh the extent of potential injury associated with the use of this product. Due to the risk of crop damage, all such use is at the end-use/grower's risk.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

imazamox (Raptor)

Rate 0.023 lb ae/a (3 fl.oz/a)

Time Postemergence

Remarks Make one application when peas are at least 3 inches tall, but before 5 nodes and before flowering. The use of trifluralin before imazamox treatment may increase the likelihood and severity of crop injury. Use a nonionic surfactant at 0.25% (v/v) with postemergence applications. For enhanced grass activity, add crop oil concentrate at 1% (v/v) instead of nonionic surfactant. Mixing with bentazon may lessen potential for crop injury. See label for significant crop rotation restrictions for this herbicide.

Caution Use of this product may lead to crop injury, loss, or damage. BASF recommends that the user and/or grower test this product to determine its suitability for such intended use. Reduced crop growth, quality and yield, temporary yellowing and/or delayed maturity may result from an imazamox application to pea. Because crop maturity may be delayed, timing of harvest may need to be adjusted accordingly. Do not apply imazamox if planting is delayed and a chance of frost before maturity is likely. Growers should check with the seed company regarding the safety of imazamox to their variety. Rotational restrictions of 18 months for many vegetables and 24 months for canola and beets.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

imazamox+ bentazon (Varisto)

Rate 0.023 lb ai/a imazamox and 0.5 lb ai/a bentazon (1 pint/a)

Time Apply as pea tolerance increases, as waxes develop on leaf surfaces.

Remarks There are no University data for use of this product in the PNW. Apply to peas at least 3-inches tall but prior to 5 nodes before flowering. Temporary foliar injury may occur

under conditions that result in the cuticle of pea leaves allowing too much herbicide to be absorbed, including temperatures over 80°F, or application on a sunny day immediately after several cloudy days. Avoid applying this product during prolonged periods of cold weather (day temperature below 75°F and night temperature below 55°F for 2 to 5 days) because weed control may be reduced. An adjuvant must be used with this product, although adjuvants with or without nitrogen fertilizer may increase injury and reduce yield. Do not apply to peas under stress from root rot. See label for significant crop rotation restrictions for this herbicide.

Caution In-furrow treatments of insecticides or nematicides or use of trifluralin may predispose English pea to injury from this product. Preharvest interval is 10 days. Do not apply more than once per season. Rotational restrictions of 18 months for many vegetables and 24 months for canola and beets.

Site of action Group 6: photosystem II inhibitor

Chemical family Benzothiadiazole

MCPA (several trade names)

Rate 0.125 to 0.375 lb ae/a (0.25 to 0.75 pint/a)

Time Apply postemergence to control small broadleaf weeds or prevent flowering in larger weeds such as nightshade when peas exceed 4 to 6 inches.

Remarks Adjust rates for expected temperatures; see label.

Caution Do not apply if temperature may exceed 90°F within 24 hr. Maintain spray pressure below 40 psi to minimize drift from target field. Do not feed treated peas or vines to livestock.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

MCPB (Thistrol)

Rate 0.5 to 1.5 lb ae/a (2 to 6 pints/a)

Time Apply at six- to twelve-node stage for peas, and to Canada thistle during stem elongation but before 8 inches tall. Higher rate required during cool weather.

Remarks Prevents development of Canada thistle buds and contamination of harvested product. Some evidence exists that early-morning applications are safer to crop than afternoon applications.

Caution Do not feed treated peas or vines to livestock. Do not spray when air exceeds 90°F or when peas are moisture stressed.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

metribuzin (several trade names)

Rate 0.125 to 0.25 lb ai/a (4 to 8 fl oz/a)

Time Apply only once per season, to susceptible broadleaf weeds less than 2 inches tall or wide.

Remarks Do not apply more than 0.5 inch of irrigation within 1 month after metribuzin application because crop may be injured. In western Oregon, try small areas before treating large ones. Warm weather or tank-mixes with bentazon have caused injury west of the Cascades. Preharvest interval is 50 days; grazing is permitted after 40 days. Ensure peas, location, or irrigation conditions are listed on product label.

Caution Restricted-use herbicide in Washington to protect surface and groundwater. Do not apply to wet crop foliage, or to very moist soil surface. Do not apply within 3 days after cool, wet, or cloudy weather or within 24 hr of other pesticide applications (except tank-mixes specified on label) to minimize risk of crop injury. Do not use on coarse, sandy, or shallow soils or on soil with less than 1.5% organic matter.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

quizalofop (Assure II)

Rate 0.04 to 0.08 lb ai/a (5 to 10 oz/a)

Time Apply at optimum growth stage listed on label.

Remarks Identify susceptible grasses, and add 4 quarts crop oil concentrate or 1 quart nonionic surfactant/100 gal of spray mix. Grass control may be reduced if applied immediately before or after a broadleaf herbicide.

Caution Do not mix with, or apply with, any other pesticide except as specified on label. Do not apply to plants stressed from lack of moisture, cold, or injury from herbicides, insects, or disease. Preharvest interval is 30 days. Do not exceed 0.1 lb ai/a per season.

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

Chemical family Aryloxyphenoxy propionate

sethoxydim (Poast)

Rate 0.19 to 0.375 lb ai/a (1 to 2 pints/a) depending on species, consult label.

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. Tolerant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed.

Caution Do not mix or apply with any other pesticide, additive, or fertilizer except as specified on label. Preharvest interval is 15 days. Do not exceed 0.75 lb ai/a (4 pints/a) per season.

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

Chemical family Cyclohexanedione

Rhubarb

Ed Peachey

Revised March 2020

Winter Applications to Dormant Rhubarb

carfentrazone (Aim EC)

Rate Up to 0.031 lb ai/a (2 fl oz/a Aim EC)

Time After crop emergence, but only to row middles. Use hooded and shielded sprayers.

Remarks Tank-mixes with other herbicides increase spectrum of control. Apply to actively growing weeds not more than 4 inches tall, or rosettes 3 inches in diameter. Coverage is essential for good control.

Caution Will burn crop if contacted; use only in row middles with hooded sprayers at slow speeds (less than 5 mph). Do not exceed 0.031 lb ai/a (2 fl oz/a Aim EC) per crop season.

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

Chemical family Triazinone

dichlobenil (Casoron 4G)

Rate 2 lb ai/a (50 lb/a Casoron)

Time Apply to dormant rhubarb when temperatures are low (45°F) and rain is expected immediately after application, to activate herbicide and prevent loss by volatility.

Remarks Provides residual control of summer annuals at 50 lb/a product; suppresses some perennials. Even coverage is important for good weed control. Inhibits cell wall production.

Caution Experience is lacking in the PNW with this product. Treat small areas initially.

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

Chemical family Nitrile

glyphosate (many products)

Rate Consult label.

Time Broadcast before crop emerges; after crop emerges use hooded and shielded sprayers in row middles, and wiper application in row middles.

Remarks Can apply in winter or early spring before rhubarb shoots or leaves emerge. Over-the-top wipers and directed applications are not permitted once the crop emerges. Treatment with other selective equipment (hooded and shielded sprayers) must be 14 days before harvest.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

halosulfuron-methyl (Sanda)

Consult "Use Precautions" and "For Optimum Results" sections of the EPA registered label for important usage information.

Rate 0.023 to 0.047 lb ai/a (0.5 to 1 oz/a Sanda)

Time Apply to dormant rhubarb.

Remarks Apply as late as possible to maximize efficacy, but do not apply after rhubarb has begun to grow in the winter. Use a nonionic surfactant if labeled weeds have begun to grow.

Caution End-user or grower accepts any crop injury as a risk of application to this crop. Application of Sanda to rhubarb may slow growth. Start with lower rates to determine potential sensitivity of rhubarb to Sanda on your soil types and in your production system. Do not exceed 1 oz/a per year.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

linuron (Lorox 50DF)

Rate up to 1.5 lb ai/a (3 lb/a of Lorox)

Time Apply as a dormant application, before rhubarb leaves emerge from the ground.

Remarks Both soil residual and contact weed control. Lorox must be activated within 2 weeks of application for optimum control with winter rains or irrigation. Add a surfactant to increase contact activity. Do not exceed a total of 3 lb/a Lorox.

Caution Note ground and surface water advisories on main label. Toxic to fish and aquatic invertebrates. Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark.

Site of action Group 7: photosystem II inhibitor

Chemical family Urea

mesotrione (Callisto)

Rate 0.188 lb ai/a (6 fl oz/a Callisto)

Time Apply to dormant rhubarb before spring green-up.

Remarks Provides preemergence and postemergence weed control. Add crop oil concentrate at 1% v/v or nonionic surfactant at 0.25% to spray solution if weeds have emerged.

Caution Applying Callisto to nondormant rhubarb may result in a temporary bleaching. Rain or irrigation after application may increase risk of injury to emerging rhubarb. Preharvest interval is 21 days. Do not exceed 6 fl oz/a or one application per year.

Site of action Group 27: inhibits 4-hydroxyphenylpyruvate-dioxygenase (4-HPPD)

Chemical family Triketone

napropamide (Devrinol 50DF)

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

Time Apply to weed-free soil surface in winter, to dormant rhubarb, before weeds begin to germinate. Inhibits root growth.

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

Chemical family Acetamide

paraquat (Gramoxone Inteon, 2 lb paraquat cation/gal)

Rate 0.625 to 1 lb ai/a cation (2.5 to 4.0 pints/a)

Time Apply during dormant season before buds in crown begin to grow.

Remarks Add nonionic surfactant at 8 fl oz/100 gal spray mix. Acts as contact; absorbs energy produced by photosynthesis, forming peroxides that disrupt living cells.

Caution Restricted-use herbicide. Do not ingest or inhale spray mist. Wear protective face shields, respirators, and clothing and personal protective equipment (PPE) as specified on label. Add a nonionic surfactant or crop oil concentrate as specified on label; take care to avoid anionic formulations that form insoluble precipitates in the tank. Do not exceed two applications or 3 pints/a per season.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

prometryn (Caparol 4L)

Rate 1 to 1.6 lb ai/a (2 to 3.2 pints/a Caparol on coarse-textured soil, 3.2 to 4 pints/a on fine-textured soil)

Time Dormant rhubarb, before leaves have emerged from the crown.

Remarks Burndown, and soil residual herbicide. Supplemental label. Use in at least 20 gal/a spray volume. Triazine resistant weeds will not be controlled.

Caution Preharvest interval is 40 days. Crop rotation interval ranges from 5 to 12 months. Use nonionic surfactant (0.5%) or crop oil concentrate (1%) if weeds have emerged.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

pronamide (Kerb)

Oregon and Washington only

Rate 1 to 2 lb ai/a (2 to 4 lb/a)

Time Apply in fall or winter to established rhubarb for grass and chickweed control. Results are best if soil temperature is below 55°F, and rain or irrigation follows application.

Remarks Requires moisture from overhead irrigation or rain to activate. Inhibits root growth. Poor control of weeds in the Asteraceae (Composite) family.

Caution Restricted-use herbicide. Do not apply to newly transplanted rhubarb or to rhubarb that is actively growing. Preharvest interval is 38 days. Do not exceed 2 lb ai/a per year.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Benzamide

S-metolachlor (Dual Magnum)

Rate 0.63 to 1.27 lb ai/a (0.66 to 1.33 pints/a)

Time Broadcast on soil surface before crop emerges.

Remarks Do not exceed 1.33 pints/a or one application per crop. Use lower rates on light-textured soils, higher rates on fine-textured soils. Dual Magnum will not control emerged weeds.

Caution Preharvest interval is 62 days.

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

Chemical family Chloroacetamide

sulfentrazone (Zeus XC)

Oregon only

Rate 0.14 to 0.375 lb ai/a (4.5 to 12 oz/a Spartan) depending on soil organic matter content and soil texture. Use higher rates for soils with pH less than 7.0 and lower rates for soils with pH greater than 7.0.

Recommended sulfentrazone rates (oz/a)			
	Soil texture		
Soil organic matter	coarse	medium	fine
<1.5%	4.5–6.0	6.0–8.0	8.0
1.5% to 3%	6.0–8.0	8.0–10.0	10.0
>3%	8.0–10.0	10.0–12.0	12.0

Time Apply to dormant rhubarb.

Remarks Indemnified special local needs label. Rhubarb crowns must be established 1 year or more. Preemergence control of annual broadleaf weeds; postemergence control of susceptible weeds seedlings. Controls nutsedge. Irrigation or winter rainfall is needed to activate this herbicide.

Caution Before applying Zeus XC to rhubarb, users, producers, and/or applicators must read and follow the information presented under TERMS OF SALE OR USE section of the label. Significant rotation intervals for some crops, including 24 months for canola and 36 months for sugar beets.

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

Chemical family Triazolinone

Postemergence to nondormant rhubarb

clethodim (Select Max)

Oregon and Washington only

Rate 0.068 to 0.121 lb ai/a (9 to 16 oz/a). Use higher rate for perennial grasses.

Time Apply to actively growing grass weeds, including annual bluegrass, at growth stages on label.

Remarks Read label carefully for adjuvant instructions; note effects of rain within 1 hour of applying other pesticides and of cultivation. Wait 14 days to repeat application with no more than 64 oz/a per year.

Caution See label for maximum rates per application and season. Preharvest interval is 30 days.

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

Chemical family Cyclohexanedione

quinclorac (QuinStar 4L)

Oregon and Washington only

Rate Up to 0.374 lb ai/a (up to 12.6 fl oz/a QuinStar 4L)

Time **Fall or spring** as a foliar application to control field bindweed and hedge bindweed.

Remarks Works best for bindweed control if applied in the fall before a killing frost. Apply in a minimum of 10 gal/a water at 20 to 30 psi. Bindweed plants must be actively growing and shoots at least 4 inches long. Wait 30 days if the soil was tilled. Crop oil concentrate at 2 pints/a should be added to the mix. Controls or suppresses crabgrass, barnyardgrass, dandelion, prickly lettuce, sowthistle, clover, and lambsquarters. Consult label for restrictions on application method and tank mixing. Preharvest interval is 30 days.

Caution Do not allow drift onto sensitive crops. Will injure sensitive crops including, but not limited to, tomato, pepper, eggplant, carrot, and green bean. Do not allow livestock to graze. Do not exceed 0.75 lb ai/a (25.2 fl oz/a QuinStar) per year. Consult label for important crop rotation restrictions.

Site of action Group 4: synthetic auxin

Chemical family Quinoline carboxylic acid

sethoxydim (Poast)

Rate 0.28 lb ai/a (1.5 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, heat, or low fertility. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed.

Caution Do not mix or apply with any other pesticide, additive, or fertilizer except as specified on label. Preharvest interval is 30 days. Do not exceed 3 pints/a per season. Inhibits fatty acid production, cell membranes, and new growth.

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

Chemical family Cyclohexanedione

Tomato, Pepper, and Eggplant

Ed Peachey

Revised March 2020

General Weed Management Strategy

These three crops are members of the Solanaceae family, and can be either direct-seeded or planted as transplants. Although these crops are closely related, some herbicides are registered for use in one crop but not the others. For example, “Tomatoes only, must be established” means that particular herbicide is registered only for use on tomatoes, and only if the plants are beyond the 5- to 6-leaf stage. Always consult the label for rate and timing specifics.

Pretransplant, Preemergence, or Post-directed

carfentrazone (Aim EC)

Transplants only

Rate Up to 0.031 lb ai/a (2 fl oz Aim EC)

Time Apply up to 1 day before transplanting.

Remarks Tank-mixes with other herbicides increase spectrum of control. Apply to actively growing weeds not more than 4 inches tall or rosettes 3 inches in diameter. Contact activity only. Coverage is essential for good control.

Caution Do not exceed 0.031 lb ai/a (2 fl oz Aim EC) per crop season.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

clomazone (Command 3ME)

Peppers only, but not on banana peppers

Rate 0.25 to 1 lb ai/a (0.66 to 2.66 pints/a). Use lower rates on coarse soil, higher rates on fine soils.

Time Preemergent soil-applied, before transplanting.

Remarks Place roots below the chemical barrier when planting. Do not use on banana peppers.

Caution Clomazone has a residual or carryover of up to 16 months. Therefore, consult label for rotational crops before applying. Do not apply next to sensitive crops when there is potential for drift. The microencapsulated (ME) formulation is designed to minimize drift and injury to adjacent fields and sites.

Site of action Group 13: inhibits DOXP synthase

Chemical family Isoxazolidinone

DCPA (Dacthal)

Tomatoes and eggplant only

Rate 4.5 to 10.5 lb ai/a (6 to 14 lb/a), depending on soil type.

Time Apply 4 to 6 weeks after transplanting to moist, weed-free soil; apply more water to activate.

Remarks Performs poorly in western Oregon and Washington. Consult label for planting sensitive crops within 12 months. Results can be improved with overhead irrigation immediately after spraying. Inhibits mitosis.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Phthalic acid

halosulfuron (Sandea)

Consult label for crop-specific instructions

Rate 0.023 to 0.047 lb ai/a (0.5 to 1 oz/a)

Time In tomatoes: apply pretransplant on bare ground or under plastic mulch, 7 days before transplanting. Post-transplant before tomato bloom.

Remarks Controls nutsedge and other broadleaf weeds. Postemergence applications are usually more effective than preemergence applications on nutsedge. May be used under plastic mulch in tomatoes. May only be applied between rows for pepper and eggplant.

Caution Sandea-treated soil in transplant hole may injure crop. Note crop rotation intervals. Not all pepper varieties have been tested.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

imzasulfuron (League 75DG)

Tomatoes and bell and non-bell peppers

Rate 0.19 to 0.3 lb ai/a (10.7 to 32 oz/a)

Time Tomatoes: pretransplant 1 day before transplanting with or without mulch; over the top of direct-seeded tomatoes that have 4 to 5 leaves; and broadcast post-transplant

Peppers: row middles in plasticulture, or as directed spray.

Remarks Controls purslane, nightshade, pigweed, lambsquarters.

Caution Crop rotation interval for many vegetables is 8 months, 9 months for cabbage and squash, and 18 months for corn and wheat.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

metribuzin (Tricor 4F)

Tomatoes only, but not direct-seeded

Rate 0.25 to 0.5 lb ai/a (0.5 to 1 pint/a)

Time Preplant incorporate before transplanting.

Remarks Use lower rates on soils with 0.5% to 2% organic matter, but do not use on soils with less than 0.5% organic matter. Inhibits photosynthesis.

Caution Do not exceed 1 lb ai/a per season.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

napropamide (Devrinol)

Tomatoes and pepper: direct-seeded or transplant; Eggplant: transplant only

Rate Tomatoes and peppers: 1 to 2 lb ai/a (2 to 4 lb/a Devrinol 50DF); Eggplants: 1 to 2 lb ai/a (2 to 4 quarts/a Devrinol 2-XT)

Time Apply to a weed-free soil surface and incorporate uniformly 1 to 2 inches deep before transplanting. Use lower rates on light, sandy, or coarse soils.

Remarks After harvest, plow deeply with moldboard or disk plow before planting succeeding crops. Inhibits seedling roots.

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

Chemical family Acetamide

pendimethalin (Prowl H₂O only)

Rate 0.475 to 1.43 lb ai/a (1 to 3 pints/a) depending on soil type.

Time Preplant incorporate before transplanting; preplant surface apply before transplanting; or post-directed application to transplanted or established direct-seeded tomatoes, peppers, and eggplant.

Remarks Spray only once and avoid overlaps. Use lower rates on light or coarse soils low in organic matter. Consult label for planting crops within 12 months. Direct sprays to soil beneath transplants if applying postemergence. Inhibits mitosis, primarily in shoots. Preharvest interval is 21 days for tomatoes and 70 days for peppers and eggplant.

Caution Do not apply to direct-seeded tomatoes or over the top of tomatoes, as injury will be severe. Consult crop injury disclaimer on label before using.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

rimsulfuron (Matrix)

Field-grown tomatoes only

Rate 0.5 to 1 oz ai/a (2 to 4 oz/a) preemergence

Time Apply after seeding or transplanting.

Remarks Must be activated by rainfall or irrigation (0.5 to 1 inch) within 5 days, regardless of soil moisture at planting. If activation with water is not possible, it may be best to wait until weeds have emerged to apply Matrix postemergence. Tomato varieties may differ in tolerance to rimsulfuron; apply to a small test area before treating whole fields.

Caution Consult label for adjuvant recommendations.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

S-metolachlor (Dual Magnum, Charger Basic, or Brawl)

Supplemental label; tomatoes only

Rate 0.95 to 1.9 lb ai/a (1 to 2 pints/a) depending on soil texture and organic matter content

Time Pretransplant incorporated, pretransplant on the surface, or postdirected to transplanted tomatoes at least 4 inches tall.

Remarks If applied pretransplant, incorporate but no less than the depth of transplanting. Postdirected applications to transplanted tomatoes should be after the first irrigation or settling rain. S-metolachlor will not control emerged weeds.

Caution Do not apply to varieties or cultivars with unknown tolerance to S-metolachlor. S-metolachlor may damage transplants weakened for any reason. Do not plant under wet, cool, or unfavorable growing conditions. Preharvest interval is 90 days if single application rate ≥ 1.33 pints/a; 30 days if < 1.33 pints/a. Use of adjuvants is prohibited in tomatoes.

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

Chemical family Chloroacetamide

S-metolachlor (Dual Magnum)

Transplanted bell peppers, Oregon only.

Do not apply to direct-seeded crops

Rate Before transplanting: 0.48 to 0.96 lb ai/a (0.5 to 1 pint/a Dual Magnum); after transplanting: 0.96 to 1.6 lb ai/a (1 to 1.67 pints/a Dual Magnum). Use lower rates on coarse soil and higher rates on fine-texture soil. In most Willamette Valley soils, if used according to label, 1 pint/a gives acceptable weed control with minimal phytotoxicity concerns.

Time Before and after transplanting (do not incorporate).

Remarks Special local needs label OR-070004. Transplanted bell peppers are very tolerant to over-the-top broadcast applications of S-metolachlor. Do not add adjuvants of any kind. Will not control emerged weeds; till the soil 2 to 3 days before applying to destroy weeds that may have emerged. Weed control is best if applied after transplanting and if about 0.5 inch of irrigation water is applied shortly after transplanting (up to 2 days).

Caution Ensure that S-metolachlor-treated soil is not concentrated near bell pepper roots during transplanting, by minimizing the amount of S-metolachlor-treated soil allowed into the furrow during planting. S-metolachlor may injure crops if plant roots directly contact treated soil. Muck soils (more than 20% organic matter) normally require the higher rate (1 pint/a); however, weed control may be reduced on muck soils. Apply only once per crop; do not exceed 1 pint/a. Do not apply and incorporate S-metolachlor before transplanting. Preplant-incorporated applications may injure the crop. Tank mixing with other herbicides may increase the chance of crop injury. Preharvest interval is 60 days.

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

Chemical family Chloroacetamide

sulfentrazone (Spartan)

Transplanted tomatoes only

Rate 0.125 to 0.25 lb ai/a (3.25 to 8 oz/a Spartan) depending on soil OM and soil texture class.

Time Apply pre-transplant, and prior to weed emergence.

Remarks Irrigation or rainfall is needed to activate this herbicide. Irrigation of 0.5 to 1 inch is typically sufficient and will occur. Excess irrigation should be avoided. Do not use on coarse, sandy soils with less than 1% organic matter. Experience lacking in the PNW for this use.

Caution Note significant rotation intervals, including 24 months for canola and 36 months for sugar beets.

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

Chemical family Triazolinone

trifluralin (Treflan)

Transplants only

Rate 0.5 to 1 lb ai/a (1 to 2 pints/a) depending on soil type and crop

Time Apply before transplanting peppers and before or after transplanting tomatoes or eggplant. Incorporate within 24 hours by cross-disking or by using a power take-off (PTO) rotary tiller.

Remarks Spray only once and avoid overlaps. Use lower rates on light or coarse soils low in organic matter. Consult label for planting crops within 12 months. Direct sprays to soil beneath transplants if applying postemergence. Inhibits mitosis, primarily in shoots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Postemergence

clethodim (Prism or Select)

Rate For tomatoes, 0.094 to 0.188 lb ai/a (6 to 12 oz/a Select); for peppers and eggplants, 0.094 to 0.125 lb ai/a (6 to 8 oz/a Select). Also depends on weed growth stage.

Time Apply to actively growing grass weeds, including annual bluegrass, at growth stage as on label.

Remarks Consult labels for maximum rates per application and season. Read label carefully for adjuvant instructions and for information about effects of rain within 1 hour, applications of other pesticides, and cultivation. Preharvest interval is 20 days.

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

Chemical family Cyclohexanedione

halosulfuron (Sandea)

Consult label for crop-specific instructions

Rate 0.023 to 0.047 lb ai/a (0.5 to 1 oz/a)

Time Tomatoes: Apply broadcast to actively growing transplanted tomatoes with four leaves or more, 14 days or more after transplanting, but before first bloom. May also be used as spot treatment when weeds have broken through plastic mulch. Eggplant and pepper: apply to row middles or furrows only, avoiding herbicide contact with the planted crop.

Remarks Repeat application may be required to control nightshade species, but do not exceed 2 applications (2 oz/a Sandea) per year.

Caution Observe crop rotation restrictions carefully.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

metribuzin (Tricor 4F)

Tomatoes only, must be established

Rate 0.25 to 0.5 lb ai/a (0.5 to 1 pint/a)

Time Apply postemergence as a single treatment or a split application, with at least a 14-day interval, to tomatoes with at least five to six true leaves, but before weeds are 1 inch tall.

Remarks Use lower rates on soils with 0.5% to 2% organic matter, but do not use on soils with less than 0.5% organic matter. Up to 2 pints/a can be applied if application is directed and spray does not contact foliage. Inhibits photosynthesis.

Caution Do not use surfactant or tank mix with other pesticides. Do not apply within 24 hours of other pesticide applications. Preharvest interval is 7 days. Do not apply within 3 days after cool, wet, or cloudy weather. Do not exceed 1 lb ai/a per season. Carefully note other precautions on label. Does not control nightshade or other related weeds

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

paraquat (Gramoxone Inteon, 2 lb paraquat cation/gal)

Rate Preplant and preemergence: 0.5 to 1 lb ai/a cation (2 to 4 pints/a Inteon). Postemergence directed: 0.5 lb ai/a cation (2 pints/a Inteon).

Time Apply as a directed spray between rows after crop is established, but before emerged weeds reach 6 inches tall.

Caution A restricted-use herbicide due to acute toxicity. Do not exceed three applications per season. Preharvest interval is 30 days. Do not graze animals.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

rimsulfuron (Matrix)

Field-grown tomatoes only

Rate 0.25 to 0.5 oz ai/a (1 to 2 oz/a) postemergence

Time Apply when weeds are less than 1 inch tall or wide and crop is at the cotyledon stage.

Remarks Use a nonionic surfactant at 0.25% v/v. Sequential applications 7 to 14 days apart may improve black nightshade control. Tomato varieties may differ in tolerance to rimsulfuron; apply to a small test area before treating whole fields.

Caution Using adjuvants at more than 0.25% v/v may result in temporary chlorosis. Consult labels for rotational intervals. Preharvest interval is 45 days.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

sethoxydim (Poast)

Rate 0.28 lb ai/a (1.5 pints/a)

Time Apply at optimum growth stage listed on the 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 heat, or low fertility. Resistant grasses include annual bluegrass and all fine fescues; quackgrass can be suppressed.

Caution Preharvest interval is 20 days. Do not exceed 4.5 pints/a per season. Inhibits fatty acid production, cell membranes, and new growth.

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

Chemical family Cyclohexanedione