

SECTION N.

ORCHARD AND VINEYARD

Vegetation Management in Orchard, Vineyard, and Berry Crops

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Orchard floor management can influence tree health, vigor, and productivity. Weeds compete for soil moisture and nutrients and can host viruses and vertebrate or invertebrate pests. Newly planted orchards are more sensitive to weed competition, but mature orchards are also affected, albeit the competition effects may take longer to be noticeable. Weeds affect irrigation management by depleting soil water and blocking sprinkler distribution. In some instances, weeds can compete for pollinating bees in spring. The common dandelion, for example, blooms about the same time as pears and is a preferred nectar source in spring.

Multiple practices are available for weed management in orchards, but when a single practice is used over time, it may lead to weed shifts or selection of herbicide resistance. A weed shift is a change in the species composition of a weed population in response to the repeated use of a weed management practice. Over time, a few species become dominant in the area, and these weed species are tolerant to the weed management practice. In berry fields and orchards, weeds are controlled by mowing or flailing row middles and applying herbicides within the tree or plant row. Repeated use of the same or similar weed control practices can result in a weed shift to species that tolerate these practices. Examples include prostrate weeds that tolerate flailing, deep-rooted perennials that tolerate cultivation or survive during the summer dry season, and weeds that either resist the herbicide or are selected from a natural population of susceptible biotypes.

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

Herbicide resistance Repeated use of a single herbicide site-of-action selects for weed biotypes that are resistant to the herbicide. The resistant biotypes are present at very low frequencies in the population, and are selected by repetitive use of the same herbicide site of action.

Managing herbicide resistance Repeated use of herbicides, like glyphosate, in orchards and vineyards in western Oregon has selected for a resistant biotype of Italian ryegrass. Over reliance on herbicides with a single mode of action for orchard floor maintenance, or within the grape and berry plant row, increases the risk of selecting for resistance in other weed species. In western Oregon, there are confirmed cases of Italian ryegrass resistant to herbicides of Groups 1, 2, 9, 10, 15 and 22. To reduce the risk of selecting for weeds that are resistant to herbicides, alternate herbicides with different modes-of-action and tank-mix with herbicides that have different modes-of-action. Refer to Section C. “Agrichemicals and Their Properties” and the subsection “Managing Herbicide-Resistant Weeds” in this handbook for more information.

Steps to slow herbicide resistance

1. Use multiple herbicide modes-of-action, including those with residual effects, and tank mixing herbicide with different site of action.
2. Apply herbicides at the recommended stage of weed growth as stated on the label. Smaller weeds are typically easier to control than large weeds if they are glyphosate resistant.
3. Use full rates of the herbicide to delay resistance selection.
4. Include non-chemical methods, like cultivation, mowing, and flame weeding.
5. Do not let weeds produce seed—or even pollen, in the case of Italian ryegrass.

More information is available from <http://ipm.ucanr.edu/IPMPROJECT/glyphosateresistance.html>

Sod covers In many orchards and berry fields, native or planted grasses in row middles are managed by mowing or flailing. Sod, or living mulch, reduces soil erosion on sloping sites, improves traffic conditions in wet weather, and increases water infiltration and drainage. New sod varieties are being introduced into various horticultural cropping systems. They include dwarf cultivars that respond to minimal management practices such as drought, low fertility, or sublethal rates of postemergence herbicides.

Managing berry crops, vineyard, and orchard vegetation Successful vegetation management in orchards, vineyards, and berry fields requires a comprehensive, year-round approach that uses a combination of weed control practices, and alternates them over several years. Developing these strategies requires identifying each weed and gathering information about the effectiveness of each weed control practice. Consider costs and select herbicides that may be applied together, or in split applications that control the weeds in the orchard or berry field. Note the site of action of each herbicide. The site of action indicates how the herbicide works in the plant. The corresponding herbicide group number for each site of action is included for each herbicide entry in this handbook. Alternating herbicide use based on group number may reduce the chance of developing resistant species or biotypes. Often, a combination of mechanical, herbicidal, and sometimes hand removal or spot treatment with herbicide sprays or wipers, will give the most effective year-round control.

Equipment calibration and crop safety In this handbook, we will discuss pesticide rates based on label recommendations for broadcast applications. However, herbicides are often applied via band in tree fruit and nut orchards. Banded applications allow growers to reduce the treated area and pesticides used proportionally. The herbicide rate in the treated area is equivalent to the rate for a broadcast application. DO NOT concentrate the broadcast rates on the treated band. That will likely result in crop damage, illegal pesticide residues, and detrimental environmental impacts.

Soil-active herbicides Persistent, soil-active herbicides can be applied during the winter dormant season, and then activated with rain or sprinkler irrigation if dry conditions persist. Apply lower rates on sandy or gravelly soils, or soils containing lower clay or organic matter contents or cation exchange capacities. Control existing vegetation by mixing with a postemergence contact or translocated herbicide. After establishing an effective weed control program, rotate soil-active herbicides applied in fall and/or early spring to improve year-round weed control and reduce possible crop injury.

Postemergence herbicides Contact herbicides such as paraquat (Gramoxone), glufosinate (Rely 280), tiafenacil (Gamma) and carfentrazone (Aim) can be used to control existing vegetation, but they lack residual control and are nonselective in broadleaf crops. Paraquat is a restricted-use herbicide and requires careful handling and secure storage. Glyphosate (Roundup) controls many weeds but must be applied at the correct stage of weed growth to obtain maximum movement into the roots (see label for details). Avoid applications to green bark, low limbs, tree trunks that are wounded, or suckers with buds that are beginning to open. This is important for translocated herbicides, such as glyphosate, on crops that are very sensitive, such as grapes and raspberries. Green bark is vulnerable to repeated herbicide applications and may need protection in the first 2 or 3 years after planting. Herbicides are more prone to enter through green bark and wounds on stems than through mature bark. White latex paint that is often applied to young orchard trees does not provide adequate protection.

There are at least three nonselective OMRI-listed and NOP-approved organic herbicides now available for use in orchard, vineyard, and berry crops: AXXE (contains ammonium nonanoate), Suppress (a mixture of caprylic and capric acids) and Final-San-O Total Vegetation Killer (contains ammoniated soap of fatty acids). Like the other contact herbicides listed above, these products do not provide residual control of emerging weeds. These herbicides are most effective if weeds are less than 6 inches tall, there is bright sunlight, or air temperatures are 70°F or higher. Shielded or hooded sprayers are needed to prevent contact with leaves and stems of low-growing crops.

Several selective postemergence herbicides are registered in horticultural crops. They usually work best if applied to seedlings less than 4 inches tall. Time the application so the maximum number of seedlings have emerged, but the largest seedlings are not too large to control. Environmental conditions also may influence the crop's tolerance of the herbicide. Hot weather can increase risk of injury from many postemergence herbicides unless conditions are so dry that the plant is not growing vigorously. Conversely, poor growing conditions for weeds often diminish the effectiveness of postemergence herbicides. The grass herbicides sethoxydim (Poast) and clethodim (Select) are more effective when weeds are actively growing before and after the herbicide treatment.

Surfactants can make the difference between good and poor weed control. Crop oils or other non-phytotoxic adjuvants are required on many postemergence herbicides; in specific cases, nitrogen solutions (e.g., 2.5% UAN or AMS) may be required and may improve grass control. Read the label carefully for this crucial information.

Warning Using 2,4-D or similar materials on horticultural farms involves risk to the crop to which it is applied and to crops in nearby fields. However, there may be instances in which guidance in 2,4-D use will enhance weed control with minimal chance for crop injury. Be careful to clean all 2,4-D from your equipment, or use separate sprayers to avoid possible crop injury. Never use a volatile formulation of 2,4-D or similar material. Buy only a product that lists the intended crop on the label.

The information provided in this handbook is not intended to be a complete guide to herbicide use. Before using any chemical, read the label recommendations on the container. Before a chemical can be recommended for a specific use, it must be thoroughly tested. Following the recommendation on the manufacturer's label can prevent many problems arising from the improper use of a chemical. Any use of a pesticide contrary to instructions on the printed label is illegal and is not recommended.

Note To control weeds selectively, and to minimize the chance of injuring trees or berry plants, herbicides must be applied at the correct rate and time. Get more consistent results by reading the label and other information about the proper application and timing of each herbicide. Suggested rates in this guide are stated as pounds of active ingredient per acre (lb ai/A) or pounds of acid equivalent per acre (lb ae/A). See the product label for specific amounts of a particular formulation to apply per treated acre. Numerous tank-mixes are labeled for orchard use. Growers can also assume responsibility for mixing products themselves unless mixing is prohibited by the label. Livestock grazing in orchards and vineyards is often prohibited if herbicides have been applied for weed control.

Tree Fruits and Nuts

Pome fruits: apple and pear

Stone fruits: apricot, peach, nectarine, cherry, prune, plum

Nuts: hazelnut, walnut, and chestnut

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Quick Reference Guide to Herbicides Labeled for Use in Hazelnuts

Active ingredient [WSSA #] (trade name)	Rate pounds ai/A (product)	Max amount per season (product)	Appl. per year/ Reapply (month)	Minimal Age (month)	Replant (month)	Incorporation (IN/day)	PHI (day)
SOIL ACTIVE HERBICIDES							
dichlobenil [20] (Casoron 4G)	4 to 6 lb ai (100 to 150 lb)	6 lb ai (150 lb)	1/(12)	1	12	0.5-1" / 0	30
diuron [5] (Diuron 4L)	1.6 to 2.4 lb ai (see label)	3.2 lb ai (see label)	2/(5)	12	24	0.5"/14	-
fluridone (12) [Brake On!]	0.19 to 0.40 lb ai (21 to 43 fl oz)	0.4 lb ai (43 fl oz)	1/(2 years)	12	3	0.5"/ (-)	30
indaziflam [29] (Alion)	0.04 to 0.06 lb ai (3.5 to 5 fl oz)	0.09 to 0.13 lb ai (7.0 to 10.3 fl oz)	2/3	12	12	-/ 21	14
isoxaben [29] (Trellis SC)	0.5 to 1 lb ai (16 to 31 fl oz)	1.0 lb ai (31 fl oz)	2/(-)	0	0	0.5"/ 21	60
napropamide [15] (Devrinol 50DF)	4 lb ai (8 lb)	4 lb ai (8 lb)	-(12)	0	12	1-2" / 3	-
norflurazon [12] (Solican DF)	1.95 to 3.93 lb ai (2.5 to 5 lb)	3.93 lb ai (5 lb)	-(0)	6	12	0.5-1" / 28	60
oryzalin [3] (Surflan)	2 to 6 lb ai (2 to 6 quarts)	12 lb ai (12 quarts)	-(2.5)	0	0	1" / 21	-

Active ingredient [WSSA #] (trade name)	Rate pounds ai/A (product)	Max amount per season (product)	Appl. per year/ Reapply (month)	Minimal Age (month)	Replant (month)	Incorporation (IN/day)	PHI (day)
pendimethalin [3] (Prowl H2O)	1.9 to 6 lb ai (2 to 6.3 quarts)	6 lb ai (6.3 quarts)	-(1)	0	12	1" / -	60
pronamide [3] (Kerb SC)	1 to 2 lb ai (2.5 to 5 pints)	2 lb ai (5 pints)	2/(1)	0	0	1" / -	nb
pyroxasulfone [15] (Zidua SC)	0.12 to 0.26lb ai (4 to 8.25 fl oz)	0.26 lb ai (8.25 fl oz)	1/(12)	0	0	0.5" /	nb
simazine [5] (generic)	2 to 4 lb ai (see label)	4 lb ai (see label)	2/(3)	0	12	0.5" / -	21
sulfentrazone [14] (Sulfentrazone 4SC)	0.25 to 0.375 lb ai (8 to 12 fl oz)	0.375 lb ai (12 fl oz)	2/(2)	36	1	0.5" / 14	3
trifluralin [3] (Treflan 4L)	0.5 to 1 lb ai (1 to 2 pints)	1 lb ai (2 pints)	n/a	0	0	- / 1	60
SOIL AND FOLIAR ACTIVE HERBICIDES							
clopyralid [4] (Stinger HL)	0.25 to 0.5 lb ai (6.4 to 12.8 fl oz)	0.5 lb ai (12.8 fl oz)	1/(-)	12	18	n/a	nb
flazasulfuron [2] (Mission)	0.03 to 0.04 lb ai (2.14 to 2.85 oz)	0.09 lb ai (5.7 oz)	2/ (3)	36	12	0.5" / 14	130
flumioxazin [14] (Chateau SW)	0.18 to 0.38 lb ai (6 to 12 oz)	0.76 lb ai (24 oz)	-(1)	12	2	0.5" / -	60
halosulfuron [2] (Sandea)	0.03 to 0.06 lb ai (0.6 to 1.3 oz)	0.13 lb ai (2.6 oz)	2/(1.5)	12	9	0.5" / -	1
mesotrione [27] (Broadworks, Motif)	0.09 to 0.18 lb ai (3 to 6 fl oz)	0.36 lb ai (12 fl oz)	3/(1.5 -3)	12	18	- / 21	30
oxyfluorfen [14] (Goal)	1.25 to 2 lb ai (1 to 4 pints)	2 lb ai (4 pint)	-	0	1	0.5" / 21	60
oxyfluorfen + penoxsulam [14 + 2] (Pindar GT)	1.47+0.03 lb ai (1.5 to 3 pints)	2.2 + 0.04 lb ai (4.5 pints)	2/(1)	12	1	0.5" / 21	60
quinclorac [4] (Quinstar 4L)	0.37 lb ai (12.6 fl oz)	0.74 lb ai (25.2 fl oz)	1	-	10	n/a	nb
rimsulfuron [2] (Matrix)	0.03 to 0.06 lb ai (2 to 4 oz)	0.06 lb ai (4 oz)	1-2/(1)	12	12	0.5" / 21	14
FOLIAR ACTIVE HERBICIDES							
2,4-D [4] (various)	0.95 to 1.4 lb ai (see label)	1.9 lb ai (see label)	2/(2.5)	12	1	n/a	60
carfentrazone [14] (Aim EC)	0.01 to 0.03 lb ai (1 to 2 fl oz)	0.079 lb ai (7.9 fl oz)	-(0.5)	0	0	n/a	3
clethodim [1] (Select max)	0.07 to 0.12 lb ai (9 to 16 fl oz)	0.64 lb ai (64 fl oz)	3/(0.5)	0	0	n/a	14
diquat [22] (Reglone)	0.37 to 0.56 lb ai	0.56 lb ai (2 pints)	-(0.5)	12	0	n/a	nb

Active ingredient [WSSA #] (trade name)	Rate pounds ai/A (product)	Max amount per season (product)	Appl. per year/ Reapply (month)	Minimal Age (month)	Replant (month)	Incorporation (IN/day)	PHI (day)
	(1.5 to 2 pints)						
florpyrauxifen-benzyl [4] (Hulk)	0.018 to 0.03 lb ai (10.5 to 21 fl oz)	0.07 lb ai (42 fl oz)	2/(0.5)	1	-	n/a	60
fluazifop [1] (Fusilade DX)	0.25 to 0.37 lb ai (16 to 24 fl oz)	1.125 (72 fl oz)	3/(0.5)	0	0	n/a	nb
glufosinate [10] (generic)	0.88 to 1.5 lb ai (48 to 82 fl oz)	4.5 lb ai (246 fl oz)	0.5	0	6	n/a	14
glyphosate [9] (Roundup Powermax)	0.38 to 3.69 lb ae (11 to 105 fl oz)	7.87 lb ae (224 fl oz)	0.5	0	0	n/a	3
paraquat [22] (Gramoxone)	0.625 to 1 lb ai (2.5 to 4 pt)	5 lb ai (20 pt)	5/(0.5)	0	0	n/a	1
pelargonic acid (Scythe)	3 to 10 % v/v	n/a	n/a	n/a	n/a	n/a	1
pyraflufen [14] (Venue)	0.002 to 0.005 lb ai (2 to 4 fl oz)	0.0085 lb ai (6.8 fl oz)	2/(1)	12	0	n/a	0
saflufenacil [14] (Treevix)	0.04 lb ai (1 oz)	0.13 lb ai (3 oz)	4/(0.7)	1	1	n/a	7
sethoxydim [1] (Poast)	0.19 to 0.47 lb ai (1.5 to 2.5 pt)	1.88 lb ai (10 pt)	-(0.5)	0	0	n/a	15
tiafenacil [14] (Gamma)	0.02 to 0.06 lb ai (0.5 to 1.5 oz)	0.2 lb ai (4.5 oz)	3/(1)	12	-	n/a	nb
SUCKER CHEMICAL PRUNING							
2,4-D [4] (generic)	0.71 to 0.95 lb ai (see label)	1.9 lb ai (see label)	4/(1)	12	1	n/a	45
carfentrazone [14] (Aim EC)	0.03 lb ai (2 fl oz)	0.079 lb ai (7.9 fl oz)	3/(0.5)	0	0	n/a	3
florpyrauxifen-benzyl [4] (Hulk)	0.018 to 0.03 lb ai (10.5 to 21 fl oz)	0.07 lb ai (42 fl oz)	2/(0.5)	1	-	n/a	60
glufosinate [10] (Rely)	1.0 lb ai (56 fl oz)	4.5 lb ai (246 fl oz)	-(0.5)	0	6	n/a	14
NAA [PGR] (Tre-Hold Sprout Inhibitor A-112)	1% ai v/v	2% ai v/v	2/(1)	12	n/a	n/a	nb
paraquat [22] (generic)	0.625 to 1 lb ai (2.5 to 4 pints)	5 lb ai (20 pints)	5/(0.5)	0	0	n/a	1
pelargonic acid (Scythe)	5 to 7 % v/v	n/a	n/a	n/a	n/a	n/a	1
pyraflufen [14] (Venue)	0.002 to 0.005 lb ai (2 to 4 fl oz)	0.0085 lb ai (6.8 fl oz)	2/(1)	12	0	n/a	0
saflufenacil [14] (Treevix)	0.04 lb ai (1 oz)	0.13 lb ai (3 oz)	3/(0.7)	1	1	n/a	7
tiafenacil [14] (Gamma)	0.02 to 0.06 lb ai (0.5 to 1.5 oz)	0.2 lb ai (4.5 oz)	3/(1)	12	-	n/a	nb

¹ WSSA # to Weed Science Society of America herbicide site of action group number.

Abbreviation: PHI – preharvest interval; nb – nonbearing; n/A – not applicable; “–” “no information

Quick Reference Guide to Herbicides Labeled for Use in Pears

Active ingredient [WSSA #] (trade name)	Rate pounds ai/A (product)	Max amount per season (product)	Appl. per year/ Reapply (month)	Minimal Age (month)	Replant (month)	Incorporatio n (IN/day)	PHI (day)
PRE-EMERGENCE HERBICIDE							
dichlobenil [20] (Casoron 4 G)	4 to 6 lb ai (100 to 150 lb)	6 lb ai (150 lb)	1 / 12	12	12	-/0	30
diuron [5] (Diuron 4L)	1.6 to 3.2 lb ai (1.6 to 3.2 qt)	3.2 lb ai (3.2 qt)	2 / 3	12	24	0.5"/(14)	-
fluridone (12) [Brake On!]	0.19 to 0.40 lb ai (21 to 43 fl oz)	0.4 lb ai (43 fl oz)	1/(2 years)	12	3	0.5"/(-)	30
indaziflam [29] (Alion)	0.04 to 0.08 lb ai (3.5 to 6.5 fl oz)	0.09 - 0.13 lb ai (7.0 - 10.3 fl oz)	2 / 3	12	12	-(21)	14
isoxaben [29] (Trellis SC)	0.5 to 1 lb ai (16 to 31 fl oz)	1.0 lb ai (31 fl oz)	2 / -	0	0	0.5"/(21)	nb
norflurazon [12] (Solicam DF)	1.95 to 3.93 lb ai (2.5 to 5 lb)	3.93 lb ai (5 lb)	/ 12	18	18	0.5-1"/(28)	60
oryzalin [3] (Surflan)	2 to 6 lb ai (2 to 6 qt)	12 lb ai (12 qt)	-/ 2.5	0	0	1"/(21)	n/a
pendimethalin [3] (Prowl H2O)	1.9 to 4 lb ai (2 to 4.2 qt)	4 lb ai (4.2 qt)	2/ 1	0	12	1"/(-)	60
pronamide [3] (Kerb 50 W)	1 to 4 lb ai (2.5 to 9.5 pt)	4 lb ai (9.5 pt)	1/ 12	12	0	1-2"/(2)	n/a
simazine [5] (Princep 4L)	2 to 4 lb ai (2 to 4 qt)	4 lb ai (4 qt)	1/ 12	12	12	0.5"/(-)	14
PRE- AND POSTEMERGENCE HERBICIDES							
halosulfuron [2] (Sandea)	0.03 to 0.094 lb ai (0.6 to 2 oz)	0.13 lb ai (2.6 oz)	2 / 1.5	12	9	0.5"/(-)	1
oxyfluorfen [14] (Goal)	0.5 to 2 lb ai (1 to 8 pt)	1.5 to 2 lb ai (6- 8 pt)	1/ -	0	0	0.25/(21)	60
oxyfluorfen + penoxsulam [14 + 2] (Pindar GT)	1.47+0.03 lb ai (1.5 to 3 pints)	2.2 + 0.04 lb ai (4.5 pt)	-/ 1	48	30	0.5/(21)	60
rimsulfuron [2] (Matrix)	0.03 to 0.06 lb ai (2 to 4 oz)	0.06 lb ai (4 oz)	2/ 1	12	12	0.5"/(14)	7
mesotrione [27] (Broadworks, Motif)	0.09 to 0.18 lb ai (3 to 6 fl oz)	0.36 lb ai (12 fl oz)	3/ 1.5-5	12	18	-(21)	30
POSTEMERGENCE HERBICIDES							
2,4-D [4] (generic)	0.95 to 1.4 lb ai (see label)	2 lb ai (see label)	2 / 2.5	12	1	n/a	14
carfentrazone [14] (Aim EC)	0.01 to 0.03 lb ai	0.079 lb ai (7.9 fl)	- / 0.5	0	0	n/a	3

Active ingredient [WSSA #] (trade name)	Rate pounds ai/A (product)	Max amount per season (product)	Appl. per year/ Reapply (month)	Minimal Age (month)	Replant (month)	Incorporatio n (IN/day)	PHI (day)
	(1 to 2 fl oz)	oz)					
clethodim [1] (Select max)	0.07 to 0.12 lb ai (9 to 16 fl oz)	0.5 lb ai (64 fl oz)	- / 0.5	0	0	n/a	nb
clopyralid [4] (Stinger HL)	0.125 to 0.25 lb ai (0.2 to 0.4 pt)	0.25 lb ai (0.4pt)	2 / 1	1	12	n/a	30
florpyrauxifen-benzyl [4] (Hulk)	0.018 to 0.03 lb ai (10.5 to 21 fl oz)	0.07 lb ai (42 fl oz)	2/(0.5)	1	-	n/a	60
fluazifop [1] (Fusilade DX)	0.25 to 0.375 lb ai (16 to 24 fl oz)	1.125 (72 fl oz)	3 / 0.5	0	0	n/a	nb
glufosinate [10] (Rely 280 & generic)	0.88 to 1.5 lb ai (48 to 82 fl oz)	4.5 lb ai (246 fl oz)	3 / 0.5	0	6	n/a	14
glyphosate [9] (Roundup Powermax & generic)	0.38 to 3.69 lb ae (11 to 105 fl oz)	7.87 lb ae (224 fl oz)	-/ 0.5	0	0	n/a	3
paraquat [22] (Gramoxone SL)	0.625 to 1 lb ai (2.5 to 5 pt)	4 lb ai (20 pt)	5 / 0.5	0	0	n/a	28
pelargonic acid (Scythe)	3 to 10 % v/v	n/a	n/a	n/a	n/a	n/a	1
pyraflufen [14] (Venue)	0.004 to 0.005 lb ai (3 to 4 fl oz)	0.0085 to 0.015 lb ai (6.8 -12 fl oz)	2 or 3/ 1	12	0	n/a	0
saflufenacil [14] (Treevix)	0.04 lb ai (1 oz)	0.13 lb ai (3 oz)	3 / 0.7	1	1	n/a	7
sethoxydim [1] (Poast)	0.19 to 0.47 lb ai (1.5 to 2.5 pt)	1.41 lb ai (7.5 pt)	- / 0.5	0	0	n/a	14
<p>This table was developed as a quick reference. Always consult and follow the label recommendations.</p> <p>WSSA # to Weed Science Society of America herbicide site of action group number.</p> <p>Abbreviation: PHI = preharvest interval; nb = nonbearing; n/a = not applicable; "-" = no information</p>							

Remarks Consult label for higher rates and application time for perennial weeds. Additional surfactant or ammonium sulfate fertilizer sometimes improves control when weeds are growing slowly. Inhibits production of three amino acids and protein synthesis.

Caution If repeat treatments are necessary, do not exceed 10.6 lb ai/A (10.6 quarts) in 1 year. Grazing is prohibited. Repeated use of glyphosate has caused resistant biotypes to develop in some cropping systems.

Herbicide resistance management Repeated use of glyphosate in at least one orchard in western Oregon has selected for a resistant biotype of annual ryegrass. Overreliance on herbicides with a single site of action for orchard floor maintenance increases the risk of selecting for resistance in other weed species, and threatens the long-term usefulness of glyphosate for weed control in orchards and other crops. Several alternative, nonselective herbicides, listed below, have different sites of action and can be applied in rotation with glyphosate to reduce the risk of selecting for weeds that are resistant to glyphosate. Refer to “Managing Herbicide to resistant Weeds” in “Section C. Agrichemicals and their Properties” in this handbook for more information.

Steps to avoid or manage glyphosate resistance

1. Use other means to manage weeds such as cultivation and mowing in orchards.
2. Use preemergence herbicides where possible. Consider use of other nonselective herbicides such as glufosinate or paraquat with

PPO inhibitors for burndown control.

3. To delay development of resistance, use higher glyphosate rates and do not cut the rate.
4. If continuing to use glyphosate in orchards or vineyard with resistant weeds, then tank mix glyphosate with other herbicides and make the application when the weeds are small.
5. Do not let weeds go to seed.

Site Preparation

glyphosate (numerous product names)

Rate Read label carefully for crops listed and geographic location.

Time Apply lower rates for actively growing annual weeds.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

Limited to New Plantings

clethodim (Select Max and others)

Rate 0.068 to 0.121 lb ai/A (9 to 16 oz/A Select Max)

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

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

Caution Do not exceed 64 fl oz/A per season. Do not apply directly over the top of fruit or nut crops that may be used for rootstock, because crops may be injured.

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

Chemical family Cyclohexanedione

geo-textiles

Available at agriculture and garden supply stores

Spunbonded fabrics (nonwoven) lightweight, extruded polypropylene fibers. Require mulch cover due to moderate UV light sensitivity. Weed roots and rhizomes can penetrate fabric unless removed before establishment. Cheapest option.

Woven fabrics moderate-weight polypropylene fibers woven into a mat. Can be used without mulch cover due to UV light stability. Weed roots and rhizomes can penetrate fabric, although tightness of weave can prevent some weeds. Moderate cost.

Laminates highly porous, dense poly film bonded to capillary fibers with a pressed, nonwoven bottom layer. The slick surface wets and dries rapidly, which prevents weed establishment, except for perennial rhizomes which can penetrate the laminate. Most expensive geo-fabric.

glyphosate (numerous product names)

Rate Read label carefully for crops listed and geographic location.

Time Apply to actively growing weeds.

Remarks Additional surfactant or ammonium sulfate according to label instructions may improve control of slightly stressed weeds. Adjust concentration depending on equipment, or consult label about rate and time of application, especially for perennial weeds. Select application equipment to prevent crop injury, by directing spray or by using selective applicators.

Caution Do not let spray or mist contact foliage, green bark, suckers, or other parts of trees. Contact with other than natural brown bark can seriously damage crop. Grazing is prohibited. Inhibits production of three amino acids and protein synthesis.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glyphosate (several products)

Rate Wiper: 33% solution

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

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

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glufosinate ammonium (Rely 280)

Rate 0.88 to 1.46 lb ai/A (1.5 to 2.5 quarts/A Rely 280 or generic equivalent)

Time Apply to actively growing weeds as a directed spray or spot treatment according to stage of weed growth.

Remarks Avoid drift onto, or treatment of desirable foliage or green bark during establishment year. Only trunks with calloused brown bark should be sprayed, unless they are protected with grow tubes or waxed containers.

Caution Do not exceed 4.5 lb ai/A per 12-month season. Do not graze or apply within 14 days of harvest.

Site of action Group 10: inhibits glutamine synthetase

Chemical family Phosphinic acid

isoxaben (Trellis SC)

Rate 0.495 to 1 lb ai/A (16 to 31 fl oz/A product)

Time Apply late summer to early fall, in early spring, or immediately after cultivation to debris-free soil surface. Activate with 0.5 inch water or shallow cultivation before weeds begin to emerge.

Remarks Identify weeds and adjust rates according to charts listed on label. Chemical stability remains adequate when left on soil surface for 21 days. Gallery is labeled for nonbearing sites, only.

Caution Do not apply to newly transplanted crops until the soil has settled and cracks disappear.

Site of action Group 29: inhibits cellulose synthesis

Chemical family Benzamide

isoxaben + trifluralin (Snapshot 2.5TG)

Rate 5 lb ai/A (200 lb/A Snapshot 2.5TG)

Time Apply to weed- and debris-free soil that has settled with water and is free of cracks after transplanting.

Remarks Activate within 21 days using 0.5 inch of water or shallow cultivation before weeds begin to emerge.

Caution Follow label instructions for repeat treatments.

Site of action (isoxaben) Group 29: inhibits cellulose synthesis Group 3: microtubule assembly inhibitor

Chemical family (isoxaben) benzamide; (trifluralin) dinitroaniline

napropamide (Devrinol)

Hazelnuts only

Rate 4 lb ai/A (8 lb 50 DF and XT)

Time Apply immediately after transplanting to firmed soil, before weeds emerge. Between November and February, activate with rain or overhead irrigation within 2 weeks; the remainder of the year, activate within 24 hours.

Remarks Where convenient, shallow mechanical incorporation appears to improve activation. Inhibits root growth.

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

Chemical family Acetamide

oryzalin (Surflan)

Rate 2 to 6 lb ai/A (2 to 6 quarts/A Surflan AS)

Time Apply late fall to early spring to firmed soil; activate with rain or overhead irrigation or with shallow cultivation.

Remarks Not suggested for soils with more than 5% organic matter. Use higher rates for longer residual weed control. Avoid exposing transplant roots to treated soil. Inhibits cell division or mitosis, primarily in roots.

Caution Do not apply beneath newly planted trees until soil has settled and there are no cracks.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

oxyfluorfen (Goal 2XL)

Rate 1.25 to 2 lb ai/A (5 to 8 pints/A Goal 2XL or generic equivalent)

Remarks Controls broadleaf weeds pre- and postemergence depending on application rate and weed species.

Time Apply only to healthy and dormant trees. Direct spray toward the base of trees, avoiding direct plant contact. Acts as a contact herbicide, either directly on broadleaf weeds or at the soil surface as weeds emerge.

Site of action Group 14: inhibits protoporphyrinogen oxidase

Chemical family Diphenylether

pendimethalin (Prowl H2O)

Rate Prowl H2O: 1.9 to 6 lb ai/A (2 to 6.3 quarts/A), depending on crop and desired length of weed control. Prowl 3.3 EC: 1.98 to 3.96 lb ai/A (2.4 to 4.8 quarts/A)

Time Apply before weed emergence.

Remarks May be applied pretransplant incorporated, pretransplant surface, post-transplant surface incorporated, or posttransplant surface. Prowl is most effective if incorporated into soil with rain, irrigation, or shallow mechanical incorporation. Apply in single application or sequentially with an interval of 30 days or more. Do not exceed 4 quarts/A per year. Do not feed forage or graze livestock in treated orchards. Preharvest interval is 60 days.

Caution Do not apply over tops of trees with leaves, bud, or fruit. Apply directly to the ground beneath the trees or areas between rows.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pronamide (Kerb 50W)

Pome and stone fruits only

Rate 1 to 4 lb ai/A (2 to 8 lb/A); rate depends on species present and soil texture.

Time Apply in fall, after fruit is harvested.

Remarks Seedling trees must be one year old, fall transplanted trees one year in the ground, and spring transplanted stock 6 months in the ground. Results are optimum if soil is below 55°F and application is followed by rain or irrigation. Requires moisture from overhead irrigation or rain to activate. Inhibits root growth. Poor control of weeds of the Asteraceae (Composite) family.

Caution A restricted-use herbicide. Do not exceed 8 lb/A, or one application per year.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Benzamide

pronamide (Kerb SC)

Pome and stone fruits and nonbearing hazelnuts only (SLN No. OR-210004)

Rate 1 to 2 lb ai/A (2.5 to 5 pints/A); rate depends on soil texture.

Time Apply in fall or winter. It can be applied to newly transplanted trees when soil is settled.

Remarks For preemergence or postemergence control of annual bluegrass, annual ryegrass, Italian ryegrass, perennial ryegrass, tall fescue, orchardgrass, volunteer grains and chickweed, and for preemergence control of susceptible broadleaf weeds. Results are optimum if soil is below 55°F and application is followed by rain or irrigation. Requires moisture from overhead irrigation or rain to activate. Inhibits root growth. Poor control of weeds of the Asteraceae (Composite) family. Pronamide can be applied as a single or split application. Can be applied immediately after transplanting in hazelnuts.

Caution A restricted-use herbicide. Do not exceed 2 lb/A, or two applications per year.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Benzamide

pyraflufen (Venue)

Rate 0.001 to 0.006 lb ai/A (0.7 to 4 fl oz product/A)

Remarks Apply as a directed application to actively growing weeds less than 4 inches high, or rosettes less than 3 inches in diameter. Use lower rate for small weeds and higher rate for larger weeds. Do not exceed three separate applications in-season (bloom to harvest). Do not exceed three separate applications out of season (postharvest to prebloom). Allow at least 30 days between applications. Venue may be applied up to three times in season, and three times postseason. Mixing Venue with another herbicide increases the weed spectrum and is highly recommended. It is recommended to add crop oil concentrate (COC), methylated seed oil (MSO), or organo-silicone for best weed control.

Caution This product is a contact, nonselective, broadleaf herbicide. Avoid contact with desirable foliage, green bark, or fruit.

Action in plant Inhibits protoporphyrinogen oxidase (PPO) that disrupts cell membranes.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Phenylpyrazole

pyroxasulfone (Zidua SC)

(Nonbearing-hazelnut only) OR EPA SLN No. OR-230008

Rate 0.12 to 0.26 lb ai/A (4.0 to 8.25 fl oz product/A)

Remarks Pyroxasulfone can be applied to newly transplanted hazelnut orchard. Apply as a directed application to the tree base in winter when soil is moist and rainfall is expected. A single application per season is permitted. Mixture with pendimethalin extends the spectrum and duration of weed control. Pyroxasulfone effectively controls annual grasses, including Italian ryegrass and annual bluegrass in preemergence.

Caution This product is only labeled for nonbearing orchards. DO NOT use in sand soils

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

Chemical family Isoxazolines

sawdust

Hazelnuts and other crops

Time Apply 3- to 4-inch layer of mulch immediately after planting to suppress weed germination and conserve soil moisture.

Remarks Avoid mounding or thickly layering near tree trunk to reduce crown rot and injury from mice and other vertebrate pests. Lower rates of registered herbicides for new plantings sometimes can enhance weed control if applied before spreading mulch.

sethoxydim (Poast)

Rate 0.28 to 0.47 lb ai/A (1.5 to 2.5 pints/A product)

Time Identify susceptible grasses and apply at optimum growth stage listed on the label.

Remarks Apply 2 pints/A of 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. Inhibits fatty acid production, cell membranes, and new growth.

Caution Preharvest intervals are: 14 days for apple and pear; 25 days for apricot, cherry (sweet and sour), nectarine, and peach; 15 days for nuts; and 1 year for plums and prunes. Maximum seasonal rates from 5 to 7.5 pints/A.

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

Chemical family Cyclohexanedione

trifluralin (Treflan 4EC)

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

Time Apply preplant and incorporate immediately by cross-disking or rototilling.

Remarks If crops are planted between trees, follow directions for both crops. Inhibits mitosis in roots and shoots. Preharvest interval is 60 days.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Established Plantings—Applications that Persist in the Soil

dichlobenil (Casoron)

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

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

Remarks Weigh and distribute over precisely measured area to ensure accurate application. Do not apply until 4 weeks after transplanting. Oregon results over 9 years suggest perennial weeds can be suppressed with 4-, 3-, and 2-lb ai/A rates applied during 3 consecutive years. Inhibits cellulose and cell wall formation.

Caution Grazing livestock is prohibited.

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

Chemical family Nitrile

diuron (Karmex DF and others)

Rate 1.6 to 3.2 lb ai/A (2 to 4 lb/A) depending on crop and time of application.

Time Apply higher rate in late fall, or split applications in spring and fall to bare soil, depending on soil type.

Remarks Add a foliar-active herbicide to control existing vegetation. Consult label for information on rates and soil types. Reduce rates after effective weed control is achieved. Can be rotated with simazine or other herbicides to reduce weed shifts. Inhibits photosynthesis.

Caution Do not apply to sandy or gravelly soils, or to full-dwarf rootstocks. Use only on trees established at least 1 year (3 years for peaches). Do not apply if nuts are on the ground.

Site of action Group 5: photosystem II inhibitor

Chemical family Substituted urea

flazasulfuron (Mission)

Rate 0.033 to 0.045 lb ai/A (2.14 to 2.85 oz/A)

Time Pre- and postemergent to broadleaf and grass weeds up to 4 inches tall, and before grasses tiller.

Remarks Apply as a directed spray to the soil beneath the trees to prevent injury to the foliage and bark. Must be activated with rainfall or irrigation of 0.25 to 0.5 inch for preemergence control; preemergence efficacy will be best if applied to bare soil. Do not disturb the soil after activation. Use an adjuvant for postemergent applications. Apply only to trees 3 years old or older. Protective sleeves are required for third year trees. If weeds are present, tank mix glyphosate or glufosinate to improve burndown and broaden weed control spectrum. Controls many grasses and broadleaf weeds, including annual ryegrass, roughstalk bluegrass, common mallow, clover, and willowherb. Reentry interval is 12 hours.

Caution Do not apply more than two applications at 2.85 oz/A per year. Preharvest interval is 130 days. Minimum retreatment interval (RTI) is 3 months. Do not apply to stony soils. A 25-foot buffer must be maintained between the point of direct application and the closest downwind edge of sensitive terrestrial habitats (forested areas, riparian areas), freshwater habitats (lakes, rivers, sloughs), and estuarine/marine habitats.

Site of action Group 2

Chemical family Sulfonylurea

flumioxazin (Chateau SW)

Rate 0.19 to 0.38 lb ai/A (6 to 12 oz/A Chateau SW). Refer to organic matter, soil types, and rates listed on label to control for various broadleaf weeds.

Time Stone fruit and pear: Between final harvest and budbreak and before weeds emerge. Apple: between final harvest and pink bud. Preferred timing is in fall when rain will activate the herbicide.

Remarks Trees must be established 1 year unless protected from spray with nonporous wraps, grow tubes or waxed containers. Do not allow spray to contact green or immature bark of shoots. Apply to a weed-free surface. Chateau has limited postemergence activity that is enhanced by adding surfactants. Add 0.25% v/v nonionic surfactant or 1% crop oil concentrate to enhance postemergence burndown activity. Tank-mix with herbicides such as glyphosate, glufosinate, or paraquat to kill large weeds. Residual weed control will be reduced if vegetation prevents the spray from reaching the soil. Moisture is necessary to activate the herbicide for residual weed control. Dry weather after application may reduce effectiveness. Do not exceed 12 oz/A product per application or 24 oz/A per year. Use the 6 oz/A rate if soil has significant sand or gravel.

Caution Preharvest interval is 60 days. Do not apply to soils that are susceptible to dispersal by wind. This herbicide can move to susceptible crops on soil particles causing damage. Do not apply within 300 yards of nondormant pears. Do not mow treated areas between budbreak and final harvest. Dust created by mowing may injure susceptible plants. Avoid direct or indirect spray contact with foliage or green bark. Do not apply to trees established less than 1 year.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

fluridone (Brake On!)

Rate 0.19 to 0.40 lb ai/A (21 to 43 fl oz/A Brake on!).

Time Fall to spring as preemergence application.

Remarks If applying less than 32 fl oz/A use preemergence tank-mix partner. PHI 30 days. Requires irrigation for soil incorporation. Application to soil with high organic matter (>3%) may reduce efficacy.

Caution Do not apply to the same orchard more than two years in a row. Apply as once per calendar year at a maximum rate per season is 43 fl oz/A (0.4 lb ai). Ground and surface water advisories. Do not get in eyes or on clothing. Causes irreversible eye damage.

Apply to orchards that are 18 months or older

Site of action Group 12: inhibition of phytoene desaturase

Chemical family Diphenyl ethers

indaziflam (Alion)

Rate 0.046 to 0.085 lb ai/A (3.5 to 6.5 oz/A product), depending on soil texture.

Time Apply in fall to early spring to firmed soil that does not have cracks.

Remarks Apply to stone and pome fruit trees that have been established 3 years and to nut trees that have been established 1 year. Existing vegetation must be controlled with glyphosate or burndown herbicides such as glufosinate or paraquat. Controls annual broadleaf and grass weeds and perennial weeds from seed only. Existing perennial/biennial weeds growing from roots will not be controlled. Rainfall or irrigation of 0.25 inch or more within 3 weeks of application is required for maximum efficacy. Preharvest interval is 14 days.

Caution Avoid direct contact with foliage, green bark, or roots of desired species. Clean spray tanks thoroughly after use. Make sure soil is settled around trees and there are no cracks in the soil. Surface and groundwater advisories are included on the label because of potential to harm nontarget aquatic organisms and potential for runoff and percolation to ground water. A well-maintained and level vegetated buffer strip of 25 ft or more will help reduce runoff. Application of indaziflam 48 hr or more before rain is forecasted will reduce runoff potential.

Site of action Group 29: inhibits cellulose biosynthesis

Chemical family Alkylazine

isoxaben (Trellis SC)

Bearing nuts; nonbearing pome and stone fruits

Rate 0.495 to 0.998 lb ai/A (16 to 31 fl oz/A product)

Time Apply late summer to early fall, in early spring, or immediately after cultivation to debris-free soil surface. Activate with 0.5 inch water or shallow cultivation before weeds begin to emerge.

Remarks Identify weeds and adjust rates according to charts listed on label. Chemical stability remains adequate when left on soil surface for 21 days. Preharvest interval in nuts is 60 days. Gallery limited to nonbearing sites.

Caution Do not apply to newly transplanted crops until the soil has settled and cracks disappear.

Site of action Group 29: inhibits cellulose synthesis

Chemical family Benzamide

napropamide (Devrinol)

Hazelnuts only

Rate 4 lb ai/A (8 lb/A DF and XT formulations)

Time Apply fall through spring before weeds germinate, or mix with foliar-active herbicide to control existing vegetation.

Remarks Irrigation or shallow incorporation is recommended for treatments made November through February if no rain falls within 2 weeks after treatment. Irrigate within 24 hours to wet the soil 2 to 4 inches deep when applied March through October. Results are best if herbicide is mechanically incorporated into the soil immediately after application. Performance is reduced when excessive plant residues are on soil surface. Inhibits root growth.

Caution Do not apply to frozen soil. Do not graze livestock in treated area.

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

Chemical family Acetamide

norflurazon (Solicam)

Rate 1.95 to 3.9 lb ai/A (2.5 to 5 lb/A Solicam)

Time Apply in fall to early spring, before weeds emerge, to soil relatively free of plant residues.

Remarks Activation requires ample irrigation or rain within 2 to 4 weeks. See label for rates and soil types. Orchards must be established at least 18 months except for newly planted apples, which can be treated after soil settles around tree roots. In cherries, use lower rates and rotate with other soil-applied herbicides to reduce chances of phytotoxic carryover. Avoid contact with fruit and crop foliage. Inhibits yellow pigment formation, causing bleaching of green chlorophyll.

Caution Do not graze livestock in treated area.

Site of action Group 12: bleaching; inhibits carotenoid biosynthesis

Chemical family Pyridazinone

oryzalin (Surflan AS)

Rate 2 to 6 lb ai/A (2 to 6 quarts/A Surflan)

Time Apply late fall or early spring to bare soil, or after tillage or a foliar-active herbicide has destroyed existing vegetation.

Remarks Use higher rates for longer residual control. Irrigate with 0.5 inch of water or rain to activate herbicide. Shallow cultivation can control newly germinated weeds without reducing herbicide activity. Inhibits mitosis, primarily in roots.

Caution Grazing is prohibited.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

oxyfluorfen (Goal 2XL)

Rate 1.25 to 2 lb ai/A (5 to 8 pints/A Goal 2XL or generic equivalent)

Time Apply only beneath healthy trees. Direct spray toward tree base, avoiding direct plant contact. Acts as a contact herbicide, either directly on broadleaf weeds or at soil the surface as weeds emerge.

Remarks Controls broadleaf weeds pre- and postemergence depending on application rate and weed species.

Site of action Group 14: inhibits protoporphyrinogen oxidase

Chemical family Diphenylether

oxyfluorfen + penoxsulam (Pindar GT)

Rate 1.47 lb ai/A oxyfluorfen + 0.015 lb ai/A penoxsulam (1.5 to 3 pints/A)

Time Dormant application only, after harvest up to bud swell as an early fall to late winter/early spring application

Remarks Trees must be established 4 years. Apply prior to germination of weeds or as an early postemergence when weeds are small and actively growing. Must be activated with rainfall or irrigation for effective preemergence control. Add adjuvants for postemergence applications. Any cultural practices that disturb or redistribute surface soil following treatment will reduce weed control effectiveness. PHI is 60 days

Caution Do not apply more than 3 lb ai oxyfluorfen per acre per year from any combination of applications of Pindar GT, GoalTender, Goal 2XL or any product containing oxyfluorfen. Do not apply to trees grown in soil that contains less than 20% clay and/or greater than 70% sand. If >70% sand –and– < 20% clay, then do not apply Pindar GT. If <70% sand, then you may apply Pindar GT regardless of clay content. If >20% clay, then you may apply Pindar GT regardless of sand content.

Site of action (oxyfluorfen) Group 14: inhibits protoporphyrinogen oxidase; (penoxsulam) Group 2: acetolactate synthase (ALS) inhibitor

Chemical family (oxyfluorfen) Diphenylether; (penoxsulam) Triazolopyrimidine

pendimethalin (Prowl H2O)

Rate Prowl H2O: 1.9 to 6 lb ai/A (2 to 6.34 quarts/A), depending on crop and desired length of weed control. Prowl 3.3 EC: 1.98 to 3.96 lb ai/A (2.4 to 4.8 quarts/A)

Time Apply before weed emergence.

Remarks May be surface applied preemergence or surface incorporated. Prowl is most effective if incorporated into soil with rain, irrigation, or shallow mechanical incorporation. Apply in single application or sequentially with an interval of 30 days or more. Do not exceed 4 quarts/A per year. Do not feed forage or graze livestock in treated orchards. Preharvest interval is 60 days.

Caution Do not apply over tops of trees with leaves, bud, or fruit. Apply directly to ground beneath the trees or areas between rows.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pronamide (Kerb)

Pome and stone fruits only

Rate 1 to 4 lb ai/A (2 to 8 lb/A Kerb 50W)

Time Apply once a year, in fall after harvest, but before leaves drop and soil freezes.

Remarks Apply to soil relatively free of plant residues. Requires moisture from rain, snowmelt, or irrigation to activate. Use lower rates for annual grasses and susceptible broadleaf weeds; higher rates for perennials such as quackgrass. Use only on orchards established at least 6 mo. Inhibits root growth.

Caution A restricted-use herbicide. Do not graze livestock in treated area.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Benzamide

saflufenacil (Treevix 70% WDG)

Apple, pear, hazelnuts and walnuts only

Rate 0.044 lb ai/A (1oz/A)

Time Directed postemergence.

Remarks Controls annual broadleaf weeds and suppresses growth of some perennials. Does not control grasses. Adjuvants are needed to maximize burndown control. Up to 3 applications allowed each year (3 oz/A). Preharvest interval of 7 days on nuts. Trees must be established for 12 months. Protect bark of young (2-3 years old) trees. Consult label for accepted crop use.

Caution Contact with foliage will cause damage. Causes substantial but temporary eye damage; PPE includes protective eyewear.

Site of action Group 14: Protoporphyrinogen inhibitor

Chemical family Benzamide

simazine (Princep Caliber 90 and 4L)

Rate 2 to 4 lb ai/A (2 to 4 quarts/A Princep 4L; 2.2 to 4.4 lb/A Caliber 90)

Remarks Oregon special local needs label (OR-080038) on sweet cherries for Princep Caliber 90 for use where soils have some buffering capacity by partially adsorbing the herbicide. Tart cherries have a Section 3 label for Princep 4L in Oregon and Washington.

Caution Do not apply on light, sandy, or rocky soils with little organic matter. Trees must be established 2 years or more. Note comments above. Apply 150 days before apple harvest.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

sulfentrazone (Zeus XC)

Rate 0.25 to 0.375 lb ai/A (8 to 12 fl oz/A)

Time Apply as a dormant application in the fall or spring.

Remarks Controls broadleaf weeds, some grasses, and nutsedge. Zeus XC should be applied as a uniform broadcast soil application to orchard floors and furrows or as a uniform band directed at the base of trees. Precipitation of at least 0.5 inches is required for activation and residual control. For enhanced burndown of emerged weeds, carfentrazone, glufosinate, and glyphosate can be added. May be tank mixed with other labeled herbicides to broaden weed spectrum. Apply to trees that have been established for a minimum of 3 years.

Caution Do not apply to frozen soils. Do not apply more than 0.375 lb of sulfentrazone per 12-month period. The 12-month period begins with the initial application. Avoid direct and indirect contact with green foliage or bark. Wrap in nonporous wrap to keep spray solution off of green tissue. Preharvest interval is 3 days.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

terbacil (Sinbar 80)

Apples and peaches, all other uses are for nonbearing fruit trees

Rate 0.4 to 0.8 lb ai/A (0.5 to 1 lb/A), newly established; 2 to 4 lb/A Sinbar, depending on soil type.

Time Apply spring or fall before weeds germinate or when they are in early seedling stage.

Remarks Consult label for rates, soil types, and organic matter contents. Reduce rates after weeds are controlled. Avoid use for 2 years if replanting is anticipated. Grazing is prohibited.

Caution Do not apply to sandy or gravelly soils or to soils with less than 1% organic matter. Use only on orchards established at least 3 years. Should be rotated with other herbicides (except simazine) to reduce weed shifts. Do not contact crop foliage or fruit with herbicide spray. Has greater water solubility than diuron or simazine. Preharvest interval is 60 days. One application per year in Columbia Basin, Washington.

Site of action Group 5: photosystem II inhibitor

Chemical family Uracil

trifluralin (Treflan 4L)

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

Time Apply preemergence for annual and broadleaf weed control, and incorporate with tillage that will not injure the crop.

Remarks Consult label for calibration and application instructions. Use to supplement other weed control practices.

Caution Apply only when wind speed and direction minimize drift to nontarget areas. Avoid contacting fruit and foliage with treated irrigation water. Prevent groundwater contamination by following all requirements of the irrigation system.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

Established Plantings—Postemergence Contact and Translocated Herbicides

2,4-D amine (Saber, Weed Rhap A-4D, or Dri-Clean Herbicide)

Rate 0.95 to 1.4 lb ae/A (2 to 3 pints/A Saber for stone fruits and nuts only); 3 pints/A for Weed Rhap A-4D)

Time Do not apply during bloom. Preferred timing is late autumn, after harvest but before first frost. Apply after irrigation rather than before, to avoid moving the herbicide into the root zone. Apply as a directed spray as needed to young, actively growing weeds in the prebud to early bud stage of growth. Mix in 20 to 50 gal water per acre.

Remarks Apples and pears: Minimize use in pears after fruit set due to possibility of early ripening. Apparently, Gala, Fuji, and Golden Delicious apples are more sensitive to 2,4-D than are other cultivars. Do not allow spray to contact pear leaves, fruit, tree trunks, or root suckers. Preharvest interval is 14 days. Stone fruits and nuts: 2,4-D can be applied up to twice per season. Preharvest interval is 40 days for stone fruits. Hazelnuts: the orchard floor recommendation differs from sucker section. Make up to two applications per season 0.95 to 1.4 lb/A in 20 to 50 GPA using coarse spray droplets and low volume. Pre-harvest interval is 60 days for nuts.

Caution Avoid high pressures or other factors that can increase drift. Reduce possible root uptake by avoiding irrigation or rain within 10 days after application. Do not use on light, sandy, or bare soils. Do not use when temperatures exceed 90°F. Do not graze or feed cover crops from treated areas to livestock.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

clethodim (Select Max, Arrow)

Nonbearing fruit except nectarines, plums, and chestnuts

Rate 0.068 to 0.121 lb ai/A (9 to 16 oz/A Select Max); 0.094 to 0.125 lb ai/A (6 to 8 oz/A Arrow)

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

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

Caution Do not exceed 0.5 lb ai/A per season. Do not apply directly over the top of fruit or nut crops that may be used for rootstock, because crops may be injured.

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

Chemical family Cyclohexanedione

clopyralid (Stinger HL)

Stone fruits, pome fruit

Rate 0.094 to 0.25 lb ae/A (0.15 to 0.4 pint/A Stinger HL)

Time Make 1 to 4 broadcast applications to Canada thistles that have emerged, but to rosettes before bud stage and at least 30 days before harvest.

Remarks Including apples (supplemental label) and stone fruits (apricots, Chickasaw plums, Damson plums, fresh prunes, Japanese plums, nectarines, peaches, plums, plumcots, sweet cherries, and sour cherries). Postemergence control of clover, dandelion, horseweed, nightshade (black and hairy), annual sowthistle, Canada thistle, musk thistle, and vetch. Do not exceed a total of 0.66 pint/A product per year. Apply in 10 gal/A water or more.

Caution Preharvest interval is 30 days.

Site of action Group 4: synthetic auxin

clopyralid (Stinger HL)

Nonbearing hazelnuts only (SLN No. OR-210015)

Rate 0.25 to 0.50 lb ae/A (0.4 to 0.8 pints/A Stinger HL) for broadcast application or 2% v/v for wiper application

Time Make 1 broadcast applications to Canada thistles that have emerged, but to rosettes before bud stage. Make up to 2 wipe treatments per season.

Remarks Clopyralid does not control hazelnut suckers. Contact to desirable foliage may cause transient damage including leaf cupping. Postemergence control of clover, dandelion, horseweed, nightshade (black and hairy), annual sowthistle, Canada thistle, musk thistle, and vetch. Maximum total use of clopyralid from all types of applications must not exceed 21.2 fl oz or 1.33 pints/A per calendar year.

Caution nonbearing only. Clopyralid is soil active and proper sprayer calibration is essential to avoid serious crop damage from over application. Sponge wiper applications are safer to the crop compared to spot spraying.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

flazasulfuron (Mission)

Rate 0.033 to 0.045 lb ai/A (2.14 to 2.85 oz/A)

Time Pre- and post-emergent to broadleaf and grass weeds up to 4 inches tall, and before grasses tiller.

Remarks Apply as a directed spray to the soil beneath the trees to prevent injury to the foliage and bark. Apply only to trees 3 years old or older. Protective sleeves are required for third year trees. Use an adjuvant for postemergent applications. Must be activated with rainfall or irrigation of 0.25 to 0.5 inch for preemergence control; preemergence efficacy will be best if applied to bare soil. Do not disturb the soil after activation. If weeds are present, tank mix glyphosate or glufosinate to improve burndown and broaden weed control spectrum. Controls many grasses and broadleaf weeds, including annual ryegrass, roughstalk bluegrass, common mallow, clover, and willowherb. Reentry interval is 12 hr.

Caution Do not apply more than two applications at 2.85 oz/A per year. Preharvest interval is 130 days. Minimum retreatment interval (RTI) is 3 months. A 25-foot buffer must be maintained between the point of direct application and the closest downwind edge of sensitive terrestrial habitats (forested areas, riparian areas), freshwater habitats (lakes, rivers, sloughs), and estuarine/marine habitats.

Site of action Group 2

Chemical family Sulfonylurea

florpyrauxifen-benzyl (Hulk)

Rate 0.018 to 0.03 lb ai/A (10.5 to 21.0 fl oz/A)

Time Post-emergent to broadleaf, grass, and sedge weeds.

Remarks Apply as a directed spray to the soil beneath the trees to prevent injury to the foliage and bark. Apply only to trees 1 year old or older. Florpyrauxifen-benzyl is a slow-acting herbicide requiring 6 weeks before weed death is observed. A mixture with a quick acting POST herbicide is recommended if a quick burndown is needed. Mixtures of florpyrauxifen-benzyl with glyphosate, glufosinate, and most postemergence herbicides improve weed control. Higher rates (>16 fl oz) improve control of wild carrot and Canada thistle. Mixtures with glufosinate improve control of yellow nutsedge. No control of Italian ryegrass or annual bluegrass was observed. A temporary suppression of field bindweed is observed.

Caution Do not use pure organosilicone adjuvants with this product. Methylated seed oil adjuvant at a rate of 0.5 pints per acre is allowed.

Site of action Group 4

Chemical family 6-Arylpicolinate

fluazifop-p-butyl (Fusilade DX)

Nonbearing in hazelnuts, walnuts, apples and pears; bearing in stone fruit

Rate 0.25 to 0.375 lb ai/A (16 to 24 oz/A Fusilade DX). Refer to specific grassy weeds listed on label.

Time Apply to actively growing grasses or within 7 days after irrigation as a directed spray with 1% crop oil or 0.25% nonionic surfactant.

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

Caution Do not exceed 4.5 pints/A total per season. Preharvest interval is 14 days. Grazing is prohibited.

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

Chemical family Aryloxyphenoxy propionate

glyphosate (numerous product names)

Rate Spray application: read label carefully for crops listed and geographic location.

Time Apply to actively growing weeds.

Remarks Select application equipment to prevent crop injury, by directing spray or by using selective applicators. Adjust concentration depending on equipment, or consult label about rate and time of application, especially for perennial weeds. Avoid treating root suckers in late summer when spraying wild blackberries or other weeds. Additional surfactant or ammonium sulfate according to label instructions may improve control of slightly stressed weeds. Inhibits production of three amino acids and protein synthesis.

Caution Do not treat hazelnut or pear root suckers. Do not spray foliage or green bark. Preharvest interval is at least 14 days. If repeat applications are necessary, do not exceed a total of 10.6 lb ai/A per year. Grazing is prohibited. Repeated glyphosate applications have created resistant biotypes of ryegrass in Oregon. To avoid weed resistance, rotate and mix weed control practices.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glyphosate (several products)

Rate Wiper application: use 33% solution

Remarks Apply 1 gal product with 2 gal water and wipe weeds; avoid contact with desirable vegetation. In severe infestations, reduce equipment ground speed or apply in two directions to ensure wiper contact. See remarks above.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glufosinate ammonium (Rely 280)

Rate 0.88 to 1.5 lb ai/A (3 to 5.1 pints/A Rely)

Time Apply to actively growing weeds as a directed spray or spot treatment according to stage of weed growth.

Remarks Avoid drift to or treatment of desirable foliage or green bark during establishment year. Only trunks with callused, mature brown bark should be sprayed.

Caution Do not exceed 4.5 lb ai/A per 12-month season. Do not graze or apply within 14 days of harvest.

Site of action Group 10: inhibits glutamine synthetase

Chemical family Phosphinic acid

halosulfuron (Sanda)

Pome fruit and nut crops only

Rate Pome fruit: 0.035 to 0.094 lb ai/A (0.75 to 2 oz/A); Nut crops: 0.031 to 0.063 lb ai/A (2/3 to 1 1/3 oz/A)

Time Pre and Postemergence for nutsedge control, apply in spring when nutsedge is not drought stressed.

Remarks Maximize the interval between application and irrigation. Trees must be established at least 12 months. Apply as a directed application at the base of the trees. Sandea also has soil residual activity and controls several broadleaf species, in addition to suppression of yellow nutsedge. For nutsedge control, apply Sandea as a single application when nutsedge is fully emerged (early to

midsummer). Alternatively, two applications can be made. Apply the first application to the initial nutsedge flush when it has reached the 3- to 5-leaf stage. If a second treatment is needed, apply Sandea later in the season directed to secondary nutsedge emergence. Expect poor control if nutsedge has exceeded 12 inches in height.

Caution Take extreme care to avoid applying to stems, leaves, roots, or green bark of trees. Avoid spray drift onto adjacent crops. Clean spray tank carefully.

Site of action Group 2: acetolactate synthase (ALS)

Chemical family Sulfonylurea

mesotrione (Broadworks, Motif)

Rate Stone fruits and tree nut crops: 0.94 to 0.188 lb ai/A (3 to 6 fl oz/A)

Time For preemergence control, apply in fall or spring before germination of weed seed. Rainfall or irrigation 0.25 to 1 inches is required for activation. For postemergence control, ensure good coverage using a minimum of 20 gal in dense foliage. Best control is obtained if postemergence applications are made before weeds reach 5 inches in height, or before germination of seed for preemergence control.

Remarks Broadworks can only be applied in stone fruit and nut trees that have been established for a minimum of 12 months. Maximum rate is 12 fl oz/A per season or 3 applications in 12-month period. Do not exceed 0.188 lb ai/A (6 fl. oz/A product) for the first application. Allow at least 5 months between applications of Broadworks at 6 fl oz/A and at least 6 weeks between applications of 6 fl oz/A and subsequent applications of 3 fl oz/A. Pre-harvest interval is 30 days. Do not use on soils with greater than 20% gravel. Motif can be applied to pome fruits.

Caution To avoid crop injury, apply the spray to the grove or orchard floor and to the weeds, avoiding contact with crop foliage, stems or fruit. Contact of Broadworks with the crop may result in bleaching injury that is typically temporary. Use trunk guards to protect plants until adequate bark has developed.

Site of action Group 27: inhibitor 4-hydroxyphenylpyruvatedioxygenase (4-HPPD)

Chemical family Triketone

oxyfluorfen (Goal 2XL)

Rate 1.25 to 2 lb ai/A (5 to 8 pints/A Goal 2XL or generic equivalent)

Time Apply only to healthy trees. Direct spray toward tree base, avoiding direct plant contact. Acts as contact, either directly on broadleaf weeds or at soil surface as weeds emerge. Weeds must be small for postemergence control.

Remarks Controls broadleaf weeds pre- and postemergence depending on application rate and weed species.

Site of action Group 14: inhibits protoporphyrinogen oxidase

Chemical family Diphenylether

paraquat (Gramoxone SL 2.0, Firestorm)

Rate 0.625 to 1 lb cation/A (2.5 to 4 pints/A Gramoxone, 1.7 to 2.7 pints/A Firestorm)

Time Apply as a directed spray toward tree base; ensure complete wetting when weeds are small.

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

Caution A restricted-use herbicide. Do not ingest or inhale spray mist. Wear protective shields, respirators, and clothing. Do not let spray contact foliage, fruit, or young tree trunks. Do not graze treated areas.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

quinclorac (Quinstar 4L)

Hazelnut only – nonbearing Oregon only (SLN OR-200011)

Rate 0.375 lb ai/A (12.6 fl oz/A Quinstar 4L)

Time Apply in the spring once field bindweed has emerged and shoots are about 4 inches long. Fall applications should be done to actively growing bindweed.

Remarks Use full rate for bindweed control. Activity on field bindweed is mostly through the foliage. Must add methylated seed oil at 1 to 2 pints/A or crop oil at 2 pints/A. Tank mixes with carfentrazone or rimsulfuron will improve efficacy. Suggested not to use quinclorac for two or more years consecutively. Quinclorac does not control hazelnut suckers.

Caution Nonbearing only. Do not exceed two application and 25.2 fl oz/A/season. Sequential application must be at least 30 days apart. Apply to plants that have gone through one growing season.

Site of action Group 4: synthetic auxin

Chemical family Quinoline carboxylic acid.

rimsulfuron (Matrix FNV)

Rate 0.063 lb ai/A (4 oz/A Matrix FNV per year)

Time Applied before or shortly after weed emergence, fall or spring depending on weed species targeted.

Remarks Supplemental label. Apply as a broadcast or banded application, avoiding foliage, fruit, and desirable suckers. One application per year unless banding, then two applications are allowed with a maximum application of 4 oz/A on a broadcast basis. Apply when rain and cool temperatures are expected. Results are best if soil is moist at time of application and with 0.5 inch of rain or irrigation within 2 weeks after application. Postemergence control is best if weeds are small and an adjuvant is used. Preemergence and postemergence control of a number of grasses and summer annuals including puncturevine, dandelion, mallow, and quackgrass; postemergence partial suppression of yellow nutsedge. Preharvest interval is 7 days for pome fruit and 14 days for stone fruit and nuts.

Caution Trees must be established for 12 months. Avoid spray drift onto adjacent crops. Clean spray tank carefully. Minimize contact with fruit or foliage.

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

Chemical family Sulfonylurea

sethoxydim (Poast)

Rate 0.28 to 0.47 lb ai/A (1.5 to 2.5 pints/A Poast)

Time Apply at optimum growth stage listed on the label.

Remarks Identify susceptible grasses and add 2 pints/A of 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. Maximum seasonal rates of 5 to 7.5 pints/A. Inhibits fatty acid production, cell membranes, and new growth.

Caution Preharvest interval is 14 days for apples and pears; 25 days for apricots, cherries (sweet and sour), nectarines, and peaches; 15 days for nuts.

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

Chemical family Cyclohexanedione

saflufenacil (Treevix 70% WDG)

Apple, pear, hazelnuts and walnuts only

Rate 0.044 lb ai/A (1oz/A)

Time Directed postemergence.

Remarks Controls annual broadleaf weeds and suppresses growth of some perennials. Does not control grasses. Adjuvants are needed to maximize burndown control. Up to 3 applications allowed each year (3 oz/A). Preharvest interval of 7 days on nuts. Trees must be established for 12 months. Protect bark of young (2 to 3 year old) trees. Consult label for accepted crop use.

Caution Contact with foliage will cause damage. Causes substantial but temporary eye damage; PPE includes protective eyewear.

Site of action Group 14: Protoporphyrinogen inhibitor

Chemical family Benzamide

tiafenacil (GAMMA)

Nonbearing hazelnut only

Rate 0.02 to 0.06 lb ai/A (0.5 to 1.5 oz/A)

Time Directed postemergence.

Remarks Controls small annual grasses and broadleaf weeds and suppresses the growth of some perennials. Does not control large (>6 inches) grasses. Methylated seed oil and ammonium sulfate are needed to maximize burndown control. Up to 3 applications allowed each year (4.5 oz/A). Trees must be established for 12 months. For controlling Italian ryegrass, a mixture of tiafenacil with glufosinate or clethodim at high rate and adjuvants is required.

Caution Non-bearing only.

Site of action Group 14: Protoporphyrinogen inhibitor

Chemical family N-phenyl-imides

Green Sucker Control in Hazelnuts

2,4-D (Saber, Orchard Master, Unison, Weed Rhap A-4D, Embed Extra)

Rate 0.7 to 0.95 lb ae/A (1.5 to 2 pints/A Saber; 3 to 4.5 pints/A Unison; check labels for specifics)

Time Apply in 100 gal/A water; add nonionic spreader-sticker. Apply to suckers 6 to 9 inches long, but better results are observed when treating suckers less than 3 inches. Limited to four applications per season with at least 30 days between applications.

Remarks Spray to runoff as needed, up to four times per year from April through August. Use large-orifice nozzles to reduce possible drift. Mimics natural plant hormones. 2,4-D drift delays nut abscission. Use of drift reduction nozzles and low volatility formulations is advised. Refrain from treating field when air temperature is expected to exceed 85°F within a few days of application.

Caution Preharvest interval is 45 days. Grazing is prohibited. Poor sucker control is observed when application rate is lower than specified. Application in 100 gal/A are better suited for spot treatments. Better sucker control with broadcast applications observed when following recommendations listed under orchard floor section.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

carfentrazone-ethyl (Aim EC)

Rate 0.031 lb ai/A (2 fl oz/A Aim EC)

Time Direct spray to immature green suckers at base of tree.

Remarks Read label for additional options.

Caution Care must be taken not to allow spray mist to contact desirable fruit, foliage or green stem tissue. Do not apply more than 0.031 lb ai/A (2 fl oz/A Aim EC) per application. Do not apply more than 0.124 lb ai/A (7.9 fl oz/A) per season.

Site of action Group 14: inhibits protoporphyrinogen oxidase

Chemical family Triazinone

florpyrauxifen-benzyl (Hulk)

Rate 0.018 to 0.03 lb ai/A (10.5 to 21.0 fl oz/A)

Time Post-emergent to broadleaf, grass, and sedge weeds.

Remarks Apply as a directed spray to the soil beneath the trees to prevent injury to the foliage and bark. Apply only to trees 1 year old or older. Florpyrauxifen-benzyl is a slow-acting herbicide requiring 6 weeks before weed death is observed. Rates of 16 fl oz or higher provide better sucker control.

Caution Do not use pure organosilicone adjuvants with this product. Methylated seed oil adjuvant at a rate of 0.5 pints per acre is allowed.

Site of action Group 4

glufosinate ammonium (Rely 280)

Rate 1 lb ai/A (1.75 quarts/A Rely 280 and others)

Time Direct spray to cover all sucker foliage.

Remarks Split applications about 4 weeks apart to improve control. Avoid contact with immature or green bark. Do not use adjuvants. Spot spray application to green suckers are not allowed because tree injury may occur. Maximum use per season is 4.5 lb ai/A (246 fl oz of product).

Site of action Group 10: inhibits glutamine synthetase

Chemical family Phosphinic acid

1-Naphthaleneacetic acid NAA (Tre-Hold Sprout Inhibitor A-112)

Nonbearing hazelnuts only

Rate 1 % ai v/v diluted in water (10 fl oz of Tre-Hold Sprout Inhibitor A112 per gallon of water)

Time Apply in 20 to 44 gallons per acre up to twice per season, when suckers are 3 inches or less. Add a nonionic surfactant and ammonium sulfate to spray solution

Remarks NAA is a plant growth regulator and prevents sucker growth for about 3 to 5 weeks. Foliar absorption is important, so apply to actively growing suckers. Direct spray toward green suckers at tree base. Spot treatment of sensor sprays are necessary to limit treatment costs. Tank-mixes with burndown herbicides like carfentrazone or saflufenacil provide better control.

Caution Avoid windy conditions and drift. On. Do not retreat in less than 30 days for best results.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

paraquat (Gramoxone SL 2.0)

Rate 0.625 to 1 lb ai/A (2.5 to 4 pints/A Gramoxone SL 2.0)

Time Apply 3 to 4 times per season, when suckers are 6 to 9 inches long but before they become woody.

Remarks 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. Direct spray toward green suckers at tree base. Acts on contact; absorbs energy produced by photosynthesis, forming peroxides that disrupt living cells.

Caution **Restricted use pesticide** due to acute toxicity for retail sale to and use only by certified applicators – not to be used by uncertified persons working under the supervision of a certified applicator. Do not ingest or inhale spray mist. Wear protective face shields, respirators, and clothing. Do not allow spray to contact foliage or fruit. Avoid windy conditions and drift. Do not graze treated areas. Do not apply when nuts are on the ground. Maximum of 5 applications per year.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

pyraflufen (Venue)

Rate 0.004 to 0.0053 lb ai/A (3 to 4 fl oz product/A)

Remarks Requires thorough coverage for good sucker control. Effective if shoots are young and small. Adjuvants such as a COC, MSO or an OS (Organo-Silicone) are recommended.

Caution Do not apply more than twice in one season. Avoid contact with desirable foliage, green bark, or fruit.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Phenylpyrazole

saflufenacil (Treevix 70% WDG)

Apple, pear, hazelnuts and walnuts only

Rate 0.044 lb ai/A (1oz/A)

Time Directed postemergence.

Remarks Controls annual broadleaf weeds and suppresses growth of some perennials. Does not control grasses. Adjuvants are needed to maximize burndown control. Up to 3 applications allowed each year (3 oz/A). Preharvest interval of 7 days on nuts. Trees must be established for 12 months. Protect bark of young (2-3 year old) trees. Consult label for accepted crop use.

Caution Contact with foliage will cause damage. Causes substantial but temporary eye damage; PPE includes protective eyewear.

Site of action Group 14: Protoporphyrinogen inhibitor

Chemical family Benzamide

tiafenacil (GAMMA)

Nonbearing hazelnut only

Rate 0.02 to 0.06 lb ai/A (0.5 to 1.5 oz/A)

Time Directed postemergence.

Remarks Controls small suckers (<3 inches) better. A mixture with glufosinate improves sucker control when suckers are 6 inches. Retreatment is needed after 3 to 4 weeks.

Caution Non-bearing only.

Site of action Group 14: Protoporphyrinogen inhibitor

Chemical family N-phenyl-imides

Grass Suppression in Row Middles (chemical mowing)

glyphosate (numerous product names)

Rate Read label carefully for crops listed and geographic location.

Time Apply 6 to 8 oz/A to suppress (chemically mow) perennial grass covers between tree rows in orchards.

Remarks Use the 8 oz/A rate to treat tall (coarse) fescue, fine fescue, orchardgrass, or quackgrass covers. For best suppression of these species, add ammonium sulfate at 1.7 lb/10 gal of spray solution. Use the 6 oz/A rate, without ammonium sulfate, when treating Kentucky bluegrass covers. Apply treatments in 20 gal/A spray volumes to actively growing grass covers. For best spray distribution and coverage, use flat fan nozzles. Additional nonionic surfactant may be added at 0.5% concentration when using surfactants with at least 50% ai, or a 1% surfactant concentration for those with less than 50% ai. For best results, mow grass in spring for uniformity, then apply appropriate rate 3 or 4 days after mowing. Low rates will not adequately suppress broadleaf weeds such as dandelion or plantain. If broadleaf weeds infest more than 10% of ground cover, tank mix 2,4-D labeled for orchard use.

Caution Chemical mowing is not recommended if orchard weed management is primarily reliant on glyphosate. Low rates of glyphosate applied multiple times per year may significantly increase the chance of selecting glyphosate resistant populations. Do not treat grass covers under poor conditions such as drought stress (drip irrigation), disease, or insect damage; suppression may be poor.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

sethoxydim (Poast)

Rate 0.09 lb ai/A (0.5 pint/A Poast)

Time Apply to grasses in orchard floor middles one time only, to suppress growth.

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

Chemical family Cyclohexanedione

Abandoned orchards—Treating Unwanted Trees

triclopyr + 2,4-D (Crossbow)

Washington only

Rate Washington special local needs label only (WA-130001). Consult label for mixing and application rate instructions for basal application or hack-and-squirt methods.

Caution Do not replant susceptible broadleaf trees within 12 months of application.

Site of action (both) Group 4: synthetic auxin

Herbicide Effectiveness on Weeds in Tree Fruits

WEED FAMILY ₁	Soil-applied Herbicides											Postemergent Herbicides				
	simazine	diuron	terbacil (Sinbar)	norflurazon (Solicam)	dichlobenil (Casoron)	oryzalin (Surflan)	napropamide (Devrinol)	pronamide (Kerb)	flumioxazin (Chateau)	indaziflam (Alion)	paraquat (Gramoxone)	oxyfluorfen (Goal)	glyphosate (Roundup)	2,4-D (weed-Rhap)	fluzifop (Fusilade)	sethoxydim (Poast)
AMARANTH OR PIGWEED																
Amaranth, Powell <i>Amaranthus powellii</i>	G	G	F		G	G	G		G	G	G		G	G	P	P
Pigweed, redroot <i>Amaranthus retroflexus</i>	G	G	F	F	G	G	G	P	G	G	G	G	G	G	P	P
Pigweed, tumble <i>Amaranthus graecizans</i>	G	G	F		G		G		G	G	G		G	G	P	P
BUCKWHEAT																
Buckwheat, wild <i>Polygonum convolvulus</i>	G	G	G		G				P	P	G	G	G	G	P	P
Dock, broadleaf (P) <i>Rumex obtusifolius</i>		F*	G*		G	P			P	P	+		G	G	P	P
Dock, curly (P) <i>Rumex crispus</i>					G			F	P	P		F			P	P
Knotweed, prostrate <i>Polygonum aviculare</i>	G	F	G	G	G	G	F	F	F	G	+	F	G	F	P	P
Ladysthumb <i>Polygonum persicaria</i>	F	F	G	F	G	F	P		F	G	G	F	G	G	P	P
Sorrel, red (P) <i>Rumex acetosella</i>		G*	G*		G			F	P	G	+	G*	G		P	P
CALTROP																
(Puncturevine) <i>Tribulus terrestris</i>	P	P	F	G	G	F	F		F	F	G		G	G	P	P
CARROT																
Carrot, wild (B) <i>Daucus carota</i>	G	G	G	G	G			P	F	G	G	P	G	G	P	P
COMPOSITE																
Chicory (P) <i>Cichorium intybus</i>					G			P		G					P	P
Cocklebur, broadleaf <i>Xanthium strumarium</i>					F			P				G*	G	G	P	P

WEED FAMILY ₁	Soil-applied Herbicides											Postemergent Herbicides				
	simazine	diuron	terbacil (Sinbar)	norflurazon (Solicam)	dichlobenil (Casoron)	oryzalin (Surflan)	napropamide (Devrinol)	pronamide (Kerb)	flumioxazin (Chateau)	indaziflam (Alion)	paraquat (Gramoxone)	oxyfluorfen (Goal)	glyphosate (Roundup)	2,4-D (weed-Rhap)	fluazifop (Fusilade)	sethoxydim (Poast)
Cudweed, low <i>Gnaphalium uliginosum</i>					G			P					G	G	P	P
Dandelion, common (P) <i>Taraxacum officinale</i>	*	P	F	*	G	P	*	P		P	+	G*	G	G	P	P
Dandelion, false (Spotted catsear) (P) <i>Hypochaeris radicata</i>	*	P	P	*	G	P	P	P		P	+	G*	G	F	P	P
Devil's beggarsticks <i>Bidens frondosa</i>		G	F		G			P							P	P
Goldenrod, western (P) <i>Solidago occidentalis</i>		P	P			P	P	P			P		G		P	P
Groundsel, common <i>Senecio vulgaris</i>	F	F			G	P	G	P	G	G	G	G	G	G	P	P
Hawkbit, hairy (P) <i>Leontodon nudicaulis</i>	*	*	*	*	G	*	*	P			+		G	P	P	P
Hawksbeard, bristly <i>Crepis setosa</i>			G		G		P	G		G	G	G	G	P	P	P
Horseweed (P) <i>Conyza canadensis</i>		F	P		F	P	F	P	G	G	+	P	G		P	P
Knapweed, diffuse <i>Centaurea diffusa</i>					G			P					G	G	P	P
Mayweed or dog fennel <i>Anthemis cotula</i>		G	G		G	P		P	G	G	*	F	G	F	P	P
Pineappleweed <i>Matricaria matricarioides</i>		G	G		G	P	G	P	G	G	*	F	G	F	P	P
Prickly lettuce <i>Lactuca serriola</i>		G	G		G	P	G	P	G	G	G	G	G	G	P	P
Ragweed, common <i>Ambrosia artemisiifolia</i>					G			P	G			*	G	G	P	P
Ragwort, tansy (B) <i>Senecio jacobaea</i>		P	P		G	P	P	P	P	P	*		G	G	P	P
Salsify, western (B) <i>Tragopogon dubius</i>		P	P			P	P	P			F	P		G	P	P
Sowthistle, annual <i>Sonchus oleraceus</i>		F	G		G	P	G	P	G	G		G	G	G	P	P

WEED FAMILY ₁	Soil-applied Herbicides											Postemergent Herbicides				
	simazine	diuron	terbacil (Sinbar)	norflurazon (Solicam)	dichlobenil (Casoron)	oryzalin (Surflan)	napropamide (Devrinol)	pronamide (Kerb)	flumioxazin (Chateau)	indaziflam (Alion)	paraquat (Gramoxone)	oxyfluorfen (Goal)	glyphosate (Roundup)	2,4-D (weed-Rhap)	fluzifop (Fusilade)	sethoxydim (Poast)
Sowthistle, spiny <i>Sonchus asper</i>		F	G		G	P	G	P		G			G	G	P	P
Thistle, bull (B) <i>Cirsium vulgare</i>		G	F		G			P		G	P	F*	G	G	P	P
Thistle, Canada (P) <i>Cirsium arvense</i>		P	P		G	P	P	P	P	P	+		G	F	P	P
EVENING PRIMROSE																
Fireweed (P) <i>Epilobium angustifolium</i>		G	G		F		P		F	G	G	G	G	F	P	P
FIGWORT																
Mullein, common (B) <i>Verbascum thapsus</i>		P			G			P			F		F	F	P	P
Speedwell, birdseye <i>Veronica persica</i>		P	F		G			P		G	G		G	F	P	P
Speedwell, creeping <i>Veronica filiformis</i>					F			P					G	F	P	P
Speedwell, ivyleaf <i>Veronica hederifolia</i>		P	F		F			P		G	G	G	G	F	P	P
Toadflax, yellow (P) <i>Linaria vulgaris</i>		P	P		P		P	p			p			p	p	p
GERANIUM																
Filaree, redstem <i>Erodium cicutarium</i>	P	F	G	G	G	P	G	P	F	G	F	G	G	G	P	P
Geranium, cutleaf <i>Geranium dissectum</i>		G	G		G		G	P	F	G	G		G	F	P	P
Geranium, dovefoot <i>Geranium molle</i>		G	G		G		G	P	F	G	G	F	G	P	P	P
GOOSEFOOT																
Kochia <i>Kochia scoparia</i>		F	G		G	P	P	F		G	F	G	G	F	P	P
Lambsquarters, common <i>Chenopodium album</i>	G	G	G	G	G	G	G	F	G	G	F	F	G	G	P	P
Thistle, Russian <i>Salsola kali</i>		P	F	G	G	F	P	P	G	G	F	G	G	F	P	P

WEED FAMILY ₁	Soil-applied Herbicides											Postemergent Herbicides				
	simazine	diuron	terbacil (Sinbar)	norflurazon (Solicam)	dichlobenil (Casoron)	oryzalin (Surflan)	napropamide (Devrinol)	pronamide (Kerb)	flumioxazin (Chateau)	indaziflam (Alion)	paraquat (Gramoxone)	oxyfluorfen (Goal)	glyphosate (Roundup)	2,4-D (weed-Rhap)	fluzafop (Fusilade)	sethoxydim (Poast)
GRASS, ANNUAL																
Barnyardgrass <i>Echinochloa crustogalli</i>	F	G	F	G	G	G	F-G	P	P	G	G	P	G	P	G	G
Bluegrass, annual <i>Poa annua</i>	G	G	G	G	G	G	G	G	F	G	G	F*	G	P	P	P
Brome, downy <i>Bromus tectorum</i>	G	P	G	G	G	G	F-G	G		G	G	F#	G	P	G	G
Brome, ripgut <i>Bromus rigidus</i>	G	G	G		G	G	G	G		G	G	F#	G	P		
Bromes, annual <i>Bromus</i> spp.				G		G	G	G		G	G	F#	G	P	G	G
Crabgrass <i>Digitaria</i> spp.	P-F	F-G	G	F	G	G		P	P	G	G		G	P	G	G
Foxtail, green <i>Setaria viridis</i>	P-F	F	F	F	G	G	F	F		G	G	F#	G	P	G	G
Foxtail, yellow <i>Setaria glauca</i>		F	F		G	G	G	F		G	G	F#	G	P	G	G
Johnsongrass seedlings <i>Sorghum halepense</i>					G				P	P	G		G	P	G	G
Oat, wild <i>Avena fatua</i>	F	P	G	G	F	P	G	G	P	G	G	G#	G	P	G	G
Ryegrass, annual or Italian <i>Lolium multiflorum</i>	G	G	G		G	G	G	G	P	G	G	G#	G	P	F-G	G
Sandbur, longspine <i>Cenchrus longispinus</i>	F	F	F	F		G	G				F		G	P		
Velvetgrass <i>Holcus lanatus</i>		P	G		G		P	G		G	F		G	P	F-G	G
Witchgrass <i>Panicum capillare</i>		P	G		G	G	G	F	F	G	G		G	P	G	G
GRASS, PERENNIAL																
Bentgrass <i>Agrostis tenuis</i>	*	*	F*	*	G	*	*	G		G	+		G	P	G	G
Bermudagrass <i>Cynodon dactylon</i>		P	P			P	P	P		G	P	G	G	P	G	F-G

WEED FAMILY ₁	Soil-applied Herbicides											Postemergent Herbicides				
	simazine	diuron	terbacil (Sinbar)	norflurazon (Solicam)	dichlobenil (Casoron)	oryzalin (Surflan)	napropamide (Devrinol)	pronamide (Kerb)	flumioxazin (Chateau)	indaziflam (Alion)	paraquat (Gramoxone)	oxyfluorfen (Goal)	glyphosate (Roundup)	2,4-D (weed-Rhap)	fluzafop (Fusilade)	sethoxydim (Poast)
Fescue, red creeping <i>Festuca rubra</i>					F			G		G			G	P	P	P
Quackgrass <i>Elytrigia repens</i>	P	P	F	P	G	P	P	G		P	F	P	G	P	F	P
MADDER																
Bedstraw, catchweed <i>Galium aparine</i>		P	P		G	F		P			P	G*		P	P	P
Bedstraw, corn <i>Galium tricornae</i>				G										P	P	P
MALLOW																
Mallow, common <i>Malva neglecta</i>	F	P	G	F	F	P	G	P		F		P	F	F	P	P
MINT																
Deadnettle, red <i>Lamium purpureum</i>	G	G	F	G	G		P	F			G	G	G	F	P	P
Henbit <i>Lamium amplexicaule</i>	G	G	F	G	G	F	P	F			G	G	G	F	P	P
MORNINGGLORY																
Bindweed, field (P) <i>Convolvulus arvensis</i>	P	P	P		P-F	P	P	P		P	+	+	F-G	F	P	P
MUSTARD																
Bittercress, little <i>Cardamine oligosperma</i>		G	G		G	P	G	P	G	G	G	G	G	G	P	P
Cress, hoary (P) <i>Cardaria draba</i>	*	*			G									F	P	P
Flixweed <i>Descurainia sophia</i>		G	G			P	F	F#				F		G	P	P
Mustard, hedge <i>Sisymbrium officinale</i>	*	*	G		F-G	P		F#	G	G		F	G	G	P	P
Mustard, wild <i>Brassica kaber</i>	G	G	G	G	G	G	G	F#	G	G	G	F	G	G	P	P
Shepherdspurse <i>Capsella bursa-pastoris</i>	G	G	G	G	G	P	P	F#	G	G	G	P	G	G	P	P

WEED FAMILY ₁	Soil-applied Herbicides											Postemergent Herbicides				
	simazine	diuron	terbacil (Sinbar)	norflurazon (Solicam)	dichlobenil (Casoron)	oryzalin (Surflan)	napropamide (Devrinol)	pronamide (Kerb)	flumioxazin (Chateau)	indaziflam (Alion)	paraquat (Gramoxone)	oxyfluorfen (Goal)	glyphosate (Roundup)	2,4-D (weed-Rhap)	fluzifop (Fusilade)	sethoxydim (Poast)
NIGHTSHADE																
Nightshade, black <i>Solanum nigrum</i>	G	G	G	G	G	P	P	F#	E	G	G	G	G	G	P	P
Nightshade, cutleaf <i>Solanum triflorum</i>		G	G		G			F#	E	G	G	G	G	G	P	P
Nightshade, hairy <i>Solanum sarrachoides</i>	G	G	G	G	G	P	P	F#	E	G	G	G	G	G	P	P
PINK																
Chickweed, common <i>Stellaria media</i>	G	G	G		G	G	G	G	G	G	G	P	G	G	P	P
Chickweed, mouseear <i>Cerastium vulgatum</i>	G	G	G		G	G	G	G	G	G	G	P	G	F	P	P
Spurry, corn <i>Spergula arvensis</i>	G	G	G		G	G	G		G	G	G	G	G	P	P	P
PLANTAGINACEAE																
Plantain, broadleaf (P) <i>Plantago major</i>	G	P	G		G			P			G	F*	G	G	P	P
Plantain, buckhorn (P) <i>Plantago lanceolata</i>	G	P	G		G			P			G	F*	G	G	P	P
PURSLANE																
Minerslettuce <i>Montia perfoliata</i>	G	G	G	G	G		P				G	G	G	G	P	P
Purslane, common <i>Portulaca oleracea</i>	G	G	G	F	G	G	G	F	E	G	G	G	G	F	P	P
ROSE																
Blackberry, evergreen (P) <i>Rubus laciniatus</i>	P	P	F		P	P	P	P	P	P	+	P	G	F	P	P
Blackberry, Himalaya (P) <i>Rubus procerus</i>	P	P	F		P	P	P	P	P	P	+	P	G	F	P	P
Blackberry, trailing (P) <i>Rubus vitifolius</i>	P	P	F		P	P	P	P	P	P	+	P	G	F	P	P
SEDGE																
Nutsedge, yellow (P)	P	P	P	F	G	P	P	P	P	P	F	P	F	P-F	P	P

WEED FAMILY ₁	Soil-applied Herbicides											Postemergent Herbicides				
	simazine	diuron	terbacil (Sinbar)	norflurazon (Solican)	dichlobenil (Casoron)	oryzalin (Surflan)	napropamide (Devrinol)	pronamide (Kerb)	flumioxazin (Chateau)	indaziflam (Alion)	paraquat (Gramoxone)	oxyfluorfen (Goal)	glyphosate (Roundup)	2,4-D (weed-Rhap)	fluzifop (Fusilade)	sethoxydim (Poast)
<i>Cyperus esculentus</i>																
SPURGE																
Spurge, leafy (P <i>Euphorbia esula</i>)					G			P	P	P		P		P-F	P	P
Spurge, prostrate <i>Euphorbia humistrata</i>	P	P	G	F	G	F	P		G	P	G		G	F	P	P
St. Johnswort (P <i>Hypericum perforatum</i>)		P	P		G		P		P	P	+		G	F	P	P
SUMAC																
Poison-oak, Pacific (P) <i>Toxicodendron diversilobum</i>		P	P		G		P			P	+		G	F	P	P
TEASEL																
Teasel <i>Dipsacus sylvestris</i>					G					P	G		G	G	P	P
G = good (80-94%) F = fair (60-79%) P = poor (less than 50%)(*) = seedling control only (+) = controls aboveground vegetation only (#) = preemergence only ₁ Weeds not identified as biennials (B) or perennials (P) are considered annuals.																

Sucker Chemical Pruning Herbicide Efficacy as Affected by Sucker Height				
Active ingredient [WSSA #] (trade name)	Rate pounds ai/A (product/A)	Efficacy Rating		
		3"	6"	9"
2,4-D [4] (generic)	0.71 to 0.95 lb ai (see label)	E	E	G
carfentrazone [14] (Aim EC)	0.03 lb ai (2 fl oz)	E	G	F
florpyrauxifen-benzyl [4] (Hulk)	0.018 to 0.03 lb ai (10.5 to 21 fl oz)	E	E	G
glufosinate [10] (generic)	1.0 lb ai (56 fl oz)	E	E	F-G

paraquat [22] (generic)	0.625 to 1 lb ai (2.5 to 5 pints)	E	E	F-G
pelargonic acid (Scythe)	5 to 7 % v/v	NR	NR	NR
pyraflufen [14] (Venue)	0.002 to 0.005 lb ai (2 to 4 fl oz)	-	NR	NR
saflufenacil [14] (Treevix)	0.04 lb ai (1 oz)	E	G	F
tiafenacil [14] (Gamma)	0.02 to 0.06 lb ai (0.5 to 1.5 oz)	E	E	F
WSSA # to Weed Science Society of America herbicide site of action group number. Abbreviations: E – excellent (>90% control); G – good (80-90% control); F – fair (70-80%), NR – not recommended				

Vineyard and Grape

(Note: Some clones may be sensitive to certain herbicides)

Marcelo L Moretti and Ed Peachey

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Weed and Vegetation Management

Floor management practices significantly affect vineyard growth and vigor, and more so in young vineyards. If left uncontrolled, weeds can reduce new vine biomass by more than 80%. Weed control also helps to conserve soil moisture for the grapevines.

Site-specific environmental factors determine vegetation management in vineyards. Weed competition and interference must be minimized within the row while trafficability and soil conservation are required between rows (see “Section L. Vegetation Management in Orchard, Vineyard, and Berries” in this handbook). The choice of floor management practices will differ for the area between the rows or “alleyways” and the area under the vines. Conventionally, alleyways are kept with resident vegetation that is mowed or cultivated.

Cultivation Tillage controls annual weeds and suppresses perennial weeds. Cultivation is required every 3 weeks for 2 years or more to deplete perennial weeds eventually. Soil temperatures are increased by tillage or cultivation that keeps the soil surface bare, especially during grape maturation west of the Cascades. Growers often compromise by tilling every other row in alternate years to ensure trafficability during harvest. Adverse effects of tillage include soil erosion from sloping sites, soil compaction, and reduced water infiltration during winter rains (except in very sandy soils).

Under-vine Weed Control Several types of equipment exist with varying degrees of soil disturbance. On the high soil disturbance spectrum, there are French plows, grape hoes, and rotary tillers. On the low soil disturbance spectrum, there are rotary brushes, finger weeders, and under-vine mowers. No one piece of equipment will provide complete control of weeds, and some are designed to be used in tandem. Other unique types of equipment available for under-vine weed control include pressurized water systems (e.g., Aqua Knife), flamers, electric weeder (e.g., Zasso) and saturated steam applicators (e.g., Weedtechnics), but this equipment is not commonly used in vineyards in the PNW.

The selection of which equipment to use is complex, but a few aspects worthy of consideration are the availability of technical support to ensure replacement parts are available, the required tractor power and hydraulic output in case multiple units are being used, and ease of operation as certain equipment may require a more skilled operator.

Flame weeding Propane burning will sear small broadleaf weeds, but will only reduce vegetative growth of grasses and perennial weeds

since growing points remain protected beneath the soil surface. Metal shrouds or covers conserve fuel by briefly elevating temperatures.

Herbicides Grape roots proliferate in undisturbed, competition-free strips representing one-third to half of the planting area, depending on moisture availability. New plantings require supplemental water or nearly vegetation-free conditions during the first 3 years of establishment. Choose combinations of practices that act together to achieve your desired level of vegetation management.

Managing herbicide resistance Dependence on glyphosate in vineyards is exerting strong selection pressures on weed populations and may ultimately lead to weeds that are resistant to glyphosate. Several alternative, nonselective herbicides, listed below, have different sites of action and can be applied in rotation with glyphosate to reduce the risk of selecting for weeds that are resistant to glyphosate. Refer to “Section C. Agrichemicals and Their Properties” and the subsection “Managing Herbicide-Resistant Weeds” in this handbook for more information.

Steps to avoid or manage glyphosate resistance

1. Use other means to manage weeds, such as cultivation, mowing, and flailing.
2. Use preemergence herbicides where possible. Consider use of other nonselective herbicides, such as glufosinate or paraquat with PPO inhibitors for burndown control.
3. To delay development of resistance, use the full, labeled rate of glyphosate.
4. If continuing to use glyphosate in orchards or vineyards with resistant weeds, then tank mix glyphosate with other herbicides and make the application when the weeds are small.
5. Do not let weeds go to seed. In the case of weeds that outcross, do not let weeds produce pollen.

Mowing or flailing Mowing or flailing grass sods or weedy vegetation in aisles improves trafficability, prevents erosion, and improves soil conditions. Improved turf grass varieties, combined with water and fertilizer management for both the crop and sod, offer long-term advantages in soil management. However, caution is advised during vineyard establishment under nonirrigated conditions where vine growth may be reduced in the first 3 years from competition by most deep-rooted vegetation.

Mulches Organic mulches suppress weeds, conserve moisture, and improve soil tilth. Most polyethylene films last only one or two seasons. Woven or spun-bonded fabrics have controlled weeds for 5 to 7 years if the surface remains free of mulch or leaf debris that encourages weed germination.

Site Preparation

glyphosate (numerous product names)

Rate 0.47 to 4.5 lb ai/A (11 oz to 3.3 quarts/A Roundup Power Max)

Time Apply to weeds at least 10 days before planting the crop.

Remarks Use highest rate on field bindweed. Rain within 6 hours after application may reduce effectiveness. Inhibits production of three amino acids and protein synthesis.

Caution Do not apply if weeds are under stress from drought, weather, or maturity.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

New Plantings, Soil-active Herbicides

isoxaben (Trellis)

Rate 0.495 to 0.998 lb ai/A (0.66 to 1.33 lb/A Trellis)

Time Apply after harvest in fall until 6 months before the next harvest, or immediately after cultivation, to debris-free soil surface.

Remarks Limited to 2 applications per year up to 1.33 lb product per year. Activate with 0.5 inch water or shallow cultivation before weeds begin to emerge. Chemical stability remains adequate when left on soil surface for 21 days. Identify weeds and adjust rates according to charts on label.

Caution Preharvest interval is 165 days. Do not apply to newly transplanted crops until the soil has settled and cracks disappear.

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

Chemical family Benzamide

napropamide (Devrinol)

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

Time Apply after transplanting to firm soil, before weeds germinate.

Remarks The day of treatment, wet soil 2 to 4 inches deep to reduce degradation by sun and to activate herbicide. If convenient, shallow mechanical incorporation may be used to improve activity. Avoid exposure of transplant roots contacting soil. May be applied through irrigation system. Can be tank mixed with broad-spectrum herbicides glyphosate and paraquat. Do not leave on soil surface for more than 3 weeks in winter and 24 to 72 hr in summer. PHI is 70 days.

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

Chemical family Acetamide

oryzalin (Surflan)

Rate 2 to 6 lb ai/A (2 to 6 quarts/A Surflan)

Time Apply after transplanting to firm soil, before weeds germinate.

Remarks Requires sprinkler irrigation, rain, or shallow cultivation (1 to 2 inches) to activate. Rate depends on duration of weed control desired. Inhibits mitosis, primarily in roots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

oxyfluorfen (Goal 2XL)

Rate 1.25 to 1.5 lb ai/A (5 to 6 pints/A Goal 2XL) for preemergence control; as low as 2 pints/A for early postemergence control of susceptible species.

Time Apply only to healthy vines.

Remarks Direct the spray toward the base of vines, avoiding direct plant contact. Acts as contact, either directly on broadleaf weeds or at soil surface as weeds emerge. Controls broadleaf weeds pre- and postemergence depending on application rate and weed species.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

pendimethalin (Prowl H2O, Satellite Hydrocap, Prowl 3.3EC, and other products)

Rate 1.9 to 3.8 lb ai/A (2 to 4 quarts/A Prowl H2O or generic equivalent);

Time Apply before or after planting or to 1-year dormant vines.

Remarks Spray directly on the ground beneath newly planted and 1-year-old vines. Overhead watering or rain is required (usually 0.5 inch is adequate) within 7 days for herbicide activation. Can also be applied before transplanting vines by incorporating into the top 2 inches of soil, or by applying to soil surface. Minimize contact of treated soil with the vine roots when transplanting.

Caution Do not apply over the tops of vines with leaves or open buds. Do not graze treated areas, or apply more than 6.3 quarts/A per year.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

trifluralin (Treflan and several other products)

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

Time Before transplanting, or in established bearing and nonbearing vineyards.

Remarks Apply before times of expected weed emergence or immediately after existing weeds are controlled. Apply as a directed spray to the soil and incorporate with methods that do not injure the crop. Use lower rates on sandy soils or soil containing low organic matter levels. Inhibits mitosis in roots and shoots. Preharvest interval is 60 days.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

New Plantings—Postemergence Contact and Translocated Applications

clethodim (Select Max, Envoy, and others)

Nonbearing crop only

Rate 0.068 to 0.121 lb ai/A (9 to 16 fl oz/A Prism)

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

Remarks Read label carefully for adjuvant instructions and for information about effects of rain within 1 hour, applications of other pesticides, or cultivation. Do not apply to a vine that will bear fruit in 1 year after Prism application.

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

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

Chemical family Aryloxyphenoxy propionate

diquat (Reglone)

Nonbearing only

Rate 0.375 to 0.5 lb ai/A (24 to 32 fl oz/A)

Time Apply to completely cover rapidly growing weed foliage, to facilitate planting. Add a nonionic surfactant.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

fluazifop (Fusilade DX)

Rate 0.25 to 0.375 lb ai/A (16 to 24 oz/A Fusilade) Refer to specific grassy weeds on label

Time Apply to actively growing grasses, or within 7 days after irrigation, as a directed spray with 1% crop oil or 0.25% nonionic surfactant.

Remarks Labeled on bearing grapes. Identify grass weeds and adjust rates, depending on susceptibility and stage of growth, as label instructs. Results often are erratic on grasses stressed from lack of vigor, drought, high temperature, or low fertility. More mature grasses and quackgrass can be controlled but may require two applications. Do not apply more than 24 fl oz/A/ application or more than 72 oz/A/year. Annual bluegrass and all fine fescues resist treatment. Do not apply twice within 14 days. Use recommended adjuvants.

Caution Preharvest interval is 50 days. Grazing is prohibited. Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor
Chemical family Aryloxyphenoxy propionate

glyphosate (numerous product names)

Rate 0.47 to 4.5 lb ai/A (11 oz to 3.3 quarts/A Roundup Power Max)

Time Apply to actively growing weeds either as site preparation or in nonbearing crops 1 year before first harvest.

Remarks Avoid contact with green crop foliage or suckers.

Caution Do not exceed 8 lb ae/A per year. Follow all precautions on label. Repeated glyphosate applications have selected for resistant biotypes of ryegrass in the PNW. To avoid weed resistance, rotate and mix weed control practices.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

sethoxydim (Poast)

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

Time Add 2 pints/A of a nonphytotoxic crop oil concentrate to improve leaf absorption.

Remarks Identify susceptible grasses and apply at optimum growth stage listed on label. 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 50 days. Do not exceed 5 pints/A per season.

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

Chemical family Aryloxyphenoxy propionate

Established Plantings—Preemergent

dichlobenil (Casoron 4G)

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

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

Remarks Weigh and distribute uniformly exact quantities over precisely measured areas to ensure accurate applications. Use in vineyards established at least 4 weeks, preferably the winter after planting. Oregon results over 9 years suggest perennial weeds can be suppressed with 4-, 3-, and 2-lb ai/A rates applied during 3 consecutive years.

Caution Grazing livestock is prohibited.

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

Chemical family Nitrile

diuron (Karmex and several other products)

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

Time Apply in winter as single application, or apply half-doses in October and March. Rainfall or irrigation needed to activate herbicide.

Remarks Reduce rate or rotate with other herbicides after effective weed control is achieved. Use in vineyards established at least 3 years or on vines that have trunks greater than 1.5 inches in diameter. Will control some very small emerged weeds, particularly if applied with an adjuvant.

Caution Do not apply on very sandy or gravelly soils. Can be rotated with simazine or other herbicides to reduce weed shifts.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

fluridone (Brake On!)

Rate 0.19 to 0.40 lb ai/A (21 to 43 fl oz/A Brake on!).

Time Fall to spring as preemergence application.

Remarks If applying less than 32 fl oz/A use preemergence tank-mix partner. PHI 30 days. Requires irrigation for soil incorporation. Application to soil with high organic matter (>3%) may reduce efficacy.

Caution Do not apply to the same orchard more than two years in a row. Apply as once per calendar year at a maximum rate per season is 43 fl oz/A (0.4 lb ai). Ground and surface water advisories. Do not get in eyes or on clothing. Causes irreversible eye damage.

Apply to orchards that are 18 months or older

Site of action Group 12: inhibition of phytoene desaturase

Chemical family Diphenyl ethers

indaziflam (Alion)

Rate 0.046 to 0.065 lb ai/A (3.5 to 5 oz/A product) depending on percent organic matter content of soil.

Time Apply in fall to early spring to firmed soil that does not have cracks.

Remarks Begin applications 3 years after vines have been planted and are exhibiting good growth and vigor. Ensure that the grapes have 6 inches of soil barrier between the soil surface and the root system. Existing vegetation must be controlled with glyphosate or

burndown herbicides such as glufosinate or paraquat. Controls annual broadleaf and grass weeds, and perennial weeds from seed only. Existing perennial/biennial weeds growing from roots will not be controlled. Rainfall or irrigation of 0.25 inch or more within 3 weeks of application is required for maximum efficacy. Lower rates may be sufficiently effective. Preharvest interval is 14 days.

Caution Avoid direct contact with foliage, green bark, or roots of desired species. Do not apply to sand or to soil that is more than 20% gravel. Time between applications is 90 days. Clean spray tanks thoroughly after use. Surface and groundwater advisories are included on the label because of potential to harm nontarget aquatic organisms, and potential for runoff and percolation to ground water. A well maintained and level vegetated buffer strip of 25 ft or more will help reduce runoff.

Site of action Group 29: inhibits cellulose biosynthesis

napropamide (Devrinol DF-XT or 50DF)

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

Time Apply fall through spring before weeds germinate, or apply foliar-active herbicide to control existing vegetation.

Remarks Irrigation or shallow incorporation is recommended for treatments made November through February if no rain falls within 2 weeks after application. Irrigate within 24 hr to wet soil 2 to 4 inches deep if applied March through October. Shallow mechanical incorporation seems to enhance activity. Excessive plant residues on soil surface reduce performance.

Caution Preharvest interval is 35 days for DF formulation, 70 days for DF-XT. Inhibits root growth.

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

Chemical family Acetamide

norflurazon (Solicam)

Rate 0.98 to 3.93 lb ai/A (1.25 to 5 lb/A Solicam) depending on soil type.

Time Apply to weed-free soil in fall to early spring, when soil surface is reasonably free of plant residue. Requires ample rain to activate.

Caution Do not use on grapes established less than 2 years in the field. Do not use on gravelly, sandy, or loamy sand soils. Preharvest interval is 60 days.

Site of action Group 12: bleaching; inhibits carotenoid biosynthesis

Chemical family Pyridazinone

oryzalin (Surflan)

Rate 2 to 6 lb ai/A (2 to 6 quarts/A Surflan) depending on duration of weed control needed. Do not exceed 12 lb/A per year.

Time Apply late fall or early spring to bare soil, or after existing vegetation has been destroyed by tillage or use of a foliar-active herbicide.

Remarks Use higher rates or split treatments and apply in fall and spring for longer residual control. Irrigate with at least 0.5 inch of water or rain to activate herbicide. Shallow cultivation can control newly germinated weeds without reducing herbicide activity. Inhibits mitosis, primarily in roots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

pendimethalin (Prowl H2O)

Rate 3 to 6 lb ai/A (3.2 to 6.3 quarts/A Prowl H2O)

Time Apply any time after fall harvest, during winter dormancy, and in the spring before budbreak.

Remarks Spray directly on ground beneath grape vines, before weeds emerge. Overhead watering or rain is required (usually 0.5 inch is adequate) within 7 days for herbicide activation. Can also apply before transplanting vines, by incorporating into the top 2 inches of soil or by applying to soil surface. Minimize contact of treated soil with the vine roots when transplanting.

Caution Do not apply during or after bud swell in the spring. Do not apply over the tops of vines with leaves or open buds. Do not graze treated areas or apply more than 6.3 quarts/A per year. Preharvest interval is 90 days.

Site of action Group 3: microtubule assembly inhibitor

pronamide (Kerb)

Rate 1 to 4 lb ai/A (2 to 8 lb/A Kerb)

Time Apply only once in fall or winter, preferably October to December when temperature is 55°F or below.

Remarks Use lower rates on annual grasses and light soil textures; higher rates on perennial grasses such as quackgrass and fine textured soils. Requires moisture from rain or irrigation for activation. Clean cultivation before application is preferable but not necessary because Kerb will control some small weeds that have emerged. Use only on vineyards established at least 1 year, or on spring-planted grapes established at least 6 months. Inhibits root growth.

Caution A restricted-use herbicide.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Benzamide

simazine (Princep)

Rate 2 to 4 lb ai/A (2 to 4 quarts/A Princep 4L)

Time Apply in winter as single application, or apply half-doses in October and March.

Remarks Reduce rate or rotate with other herbicides after achieving weed control. Requires surface moisture for activation.

Caution Do not apply on very sandy or gravelly soils. Can be rotated with diuron or other herbicides to reduce weed shifts. Do not use in vineyards established less than 3 years, or crop injury may occur

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

trifluralin (several products)

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

Time Apply before transplanting or prior to periods of weed germination or immediately after existing weeds are controlled.

Remarks Apply and incorporate immediately by thoroughly mixing 1 to 2 inches deep, using equipment that will not injure roots.

Caution Preharvest interval is 60 days. Inhibits mitosis in roots and shoots.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Benzamide

Established Plantings—Pre- and Postemergent Activity

flazasulfuron (Mission)

Oregon and Washington only

Rate 0.033 to 0.045 lb ai/A (2.14 to 2.85 oz/A)

Time Pre- and postemergent to broadleaf and grass weeds up to 4 inches tall, and before grasses tiller.

Remarks Apply as a directed spray to the soil beneath the vines to prevent injury to the foliage and bark of young vines. Must be activated with rainfall or irrigation of 0.25 to 0.5 inch for preemergence control; preemergence efficacy will be best if applied to bare soil. Do not disturb the soil after activation. Use an adjuvant for postemergent applications. Apply only to vines 3 years old or older. Protective sleeves are required for third year vines. If weeds are present, tank mix glyphosate or glufosinate to improve burndown and broaden weed control spectrum. Controls many grasses and broadleaf weeds, including annual ryegrass, common mallow, clover, and willowherb. Reentry interval is 12 hr.

Caution Do not apply more than 2 applications at 2.85 oz/A per year. Preharvest interval is 75 days. Minimum retreatment interval (RTI) is 3 months. A 25-foot buffer must be maintained between the point of direct application and the closest downwind edge of sensitive terrestrial habitats (forested areas, riparian areas), freshwater habitats (lakes, rivers, sloughs), and estuarine/marine habitats.

Site of action Group 2

flumioxazin (Chateau)

Rate 0.188 to 0.38 lb ai/A (6 to 12 oz/A Chateau). Refer to organic matter, soil types, and rates listed on label for various broad-leaf weeds.

Time Pre- or postemergence (weeds up to 2 inches tall). Preferred time is fall, to maximize the potential for rain to activate and set the herbicide. Tank mix with approved herbicides if weeds are large, or if weedy vegetation will keep Chateau from reaching the soil surface.

Remarks Residual or postemergence weed control can be achieved by adjusting rates or using labeled tank-mixes. Use a surfactant to improve postemergence control of small weeds. If grapes are nondormant, only apply before budbreak, and after final harvest, unless using shielded application equipment.

Caution Do not apply during the period after budbreak through final harvest, unless using shielded application equipment and applicator can ensure spray drift will not come in contact with crop fruit or foliage. Do not apply to vines established less than 2 years, unless they are trellised at least 3 ft from the ground, and protected by nonporous wraps, grow tubes, or waxed containers. Do not apply within 300 yards of bearing pears. Do not mow treated area after final harvest. Preharvest interval is 60 days.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

oxyfluorfen (Goal 2XL and Goal Tender)

Rate 1.25 to 1.5 lb ai/A (5 to 6 pints/A Goal 2XL or generic equivalent) for preemergence control in dormant grapes; as low as 1 to 2 pints/A for early postemergence control of susceptible species in nondormant grapes (0.5 to 3 pints/A Goal Tender)

Time Apply after harvest, but before bud-swell in spring.

Remarks Direct the spray toward the base of vines in late winter or spring, avoiding direct plant contact. Controls broadleaf weeds pre- and postemergence, depending on time and rate of application and weed species. Can be tank mixed with glufosinate (Rely) or paraquat (Gramoxone) or other preemergence herbicides such as napropamide (Devrinol), diuron (Karmex), or pronamide (Kerb) to improve residual weed control. Acts on contact, either directly on broadleaf weeds, or at soil surface as weeds emerge.

Caution Do not apply when fruit is present.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

rimsulfuron (Matrix FNV)

Rate 0.063 lb ai/A (4 oz/A Matrix FNV per year)

Time Applied before or shortly after weed emergence.

Remarks Apply uniformly to the vineyard floor, or as a directed application at the base of the vine. Crops must be established 1 year before application. Results are best if soil is moist at time of application and receives 0.5 inch of rain or irrigation within 2 weeks after application. Do not disturb the soil after application, because weed control will be compromised. Two applications separated by 30 days are allowed if applied in bands that cover half of the vineyard. Controls puncturevine, quackgrass, mallow, and common dandelion from seed; suppression of yellow nutsedge; partial control of Canada thistle if plants are small. Preharvest interval is 14 days.

Caution Avoid spray contact with foliage or fruit (except undesirable suckers), and drift onto adjacent crops. Clean spraytank carefully. Minimize contact with fruit or foliage.

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

Chemical family Sulfonylurea

sulfentrazone (Zeus XC)

Rate 0.25 to 0.375 lb ai/A (8 to 12 oz/A)

Time Apply as a dormant application in the fall through bloom, or after bloom with a shielded sprayer.

Remarks Zeus XC, or generic equivalent, should be applied as a uniform broadcast soil application to vineyard floors and furrows or

as a uniform band directed at the base of the vines. Precipitation of at least 0.5 inches is required for activation and residual control. For enhanced burndown of emerged weeds, carfentrazone, glufosinate, and glyphosate can be added. May be tank mixed with other labeled herbicides to broaden weed spectrum. Apply to grapes that have been established for a minimum of 3 years. If applied after bloom, a shielded sprayer must be used. See label for plantback restrictions if removing vineyard or re-planting.

Caution Do not apply to frozen soils. Do not apply more than 0.375 lb of sulfentrazone per 12-month period. The 12-month period begins with the initial application. Avoid direct and indirect contact with green foliage or bark. Wrap in nonporous wrap to keep spray solution off of green tissue. Preharvest interval is 3 days.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

Established Plantings—Postemergent Contact and Translocated Applications

ammonium nonanoate (AXXE)

Rate 6 to 8% solution to control small annual weeds (<1 inch); 8 to 10% solution for burndown of annual weeds 1 to 4 inches tall; 10 to 13% for weeds larger than 4 inches tall; a 15% v/v solution for maximum vegetative burndown for control of perennials or dense weed growth.

Time Apply to thoroughly wet weed foliage as a directed spray around containers. Most effective at temperatures above 60° F.

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

Site of action Group 26: unknown

Chemical family Carboxylic acid

bentazon (Broadloom)

Nonbearing grapes

Rate 0.75 to 1 lb ai/A (1.5 to 2 pints/A)

Time Spring to early summer, depending on growth stage of weeds.

Remarks Useful for suppression and control of yellow nutsedge, Canada thistle, and musk thistle. For Canada thistle apply 2 pints/A when plants are between 8 inches tall and bud stage. Apply a second application 10 to 14 days later if needed. For nutsedge, apply 1.5 to 2 pints/A when plants are 6 to 8 inches tall, and make a second application 7 to 10 days later if needed. Always add a crop oil concentrate. Use no more than 2 lb ai/A per year. Irrigate to make sure plants are actively growing before applying bentazon. Do not cultivate or mow for 5 days after application. Weeds growing under drought conditions may not be adequately controlled.

Caution Apply as a directed spray, away from the crop. Do not apply within one year of crop harvest.

Site of action Group 6: photosystem II inhibitor

Chemical family Benzothiadiazole

carfentrazone-ethyl (Aim EC)

Rate 0.016 to 0.031 lb ai/A (1 to 2 fl oz/A Aim EC)

Time Directed spray and with hooded sprayers within and between rows.

Remarks Preharvest interval is 3 days. Control is enhanced with COC (1%) or NIS (0.25%).

Caution Care must be taken not to allow spray mist to contact desirable fruit, foliage or green stem tissue. Can be used for control of suckers if tissue is young.

Site of action Group 14: inhibits protoporphyrinogen oxidase

Chemical family Triazinone

clove or clove leaf oil (Matratec)

Washington only

Rate 5% to 8% dilution in 25 to 100 gal of water, depending on weed size, temperature, and sunlight intensity.

Time Before weeds are 6 inches tall.

Remarks FIFRA 25(b) exempt pesticide. OMRI listed and WSDA approved herbicide for in-crop use. Apply before crop emerges, or between rows after emergence; avoid contact with desirable foliage. Directed sprays or hooded sprayers are recommended to protect desirable foliage. Works best on annual weeds less than 6 inches. Performance may be erratic depending on environmental conditions. Bright sunlight improves efficacy. No preharvest or reentry interval.

d-limonene (lemongrass oil) (Avenger AG)

Rate 14% dilution rate, 20% for spot treatment of difficult to control weeds.

Time Up to first fruit set, when weeds are less than 6 inches tall.

Remarks Broad-spectrum, nonselective contact herbicide that does not translocate. Spot treatments allowed in bearing crops up to 1 week before harvest. Do not exceed 8.5 gal/A per application in bearing crops. Most effective on annual weeds. OMRI listed, NOP compliant, and WSDA approved organic burndown herbicide for use in crop and noncrop sites. Foliage contacted by Avenger AG will be damaged. Directed sprays or hooded sprayers are recommended to protect desirable foliage. Coverage is very important. Carrier rates of 40 GPA or more are essential for good control. Leaf damage is visible within hours. Cool weather may slow activity. No reentry interval. This herbicide causes rapid wilting or necrosis of the leaves due to removal of waxy cuticle.

glufosinate ammonium (generic)

Rate 0.88 to 1.5 lb ai/A; (48 to 82 fl oz/A depending on weed size)

Time Apply to actively growing weeds as a directed spray or spot treatment according to weed growth stage.

Remarks Avoid drift to, or treatment of, desirable foliage or green bark during establishment year.

Caution Do not exceed 4.5 lb ai/A per 12-month season. Do not graze or apply within 14 days of harvest.

Site of action Group 10: glutamine synthase inhibitor

Chemical family Phosphinic acid

glyphosate (numerous products)

Rate 0.47 to 4.5 lb ai/A (11 oz to 3.3 quarts/A Roundup Power Max)

Time Select application equipment to prevent crop injury by directing spray, or use selective applicators.

Remarks Adjust concentration depending on equipment. See label for rate and time of application, especially for perennial weeds. Adding surfactant or mixing ammonium sulfate according to label may improve control of slightly stressed weeds.

Caution Do not let drift or mist contact green foliage or bark, suckers, or vines and renewals less than 3 years old. Preharvest interval is 14 days. If repeat applications are needed, do not exceed 8 lb ae/A per year. Repeated glyphosate applications have created resistant biotypes of ryegrass in Australian orchards. To avoid weed resistance, rotate and mix weed control practices.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glyphosate (several products)

Rate 0.47 to 4.5 lb ai/A (11 oz to 3.3 quarts/A Roundup Power Max)

Time Wick-wiper: Mix 1 gal product with 2 gal water and apply to weeds.

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

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

pelargonic acid (Scythe)

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

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

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

Site of action Group 26: unknown

Chemical family Carboxylic acid

pyraflufen (Venue)

Rate 0.0015 to 0.006 lb ai/A (1 to 4 fl oz product/A); 3 to 4 oz/A for sucker control.

Remarks Apply as a directed application to actively growing weeds less than 4 inches high, or rosettes less than 3 inches in diameter. Use lower rate for small weeds and higher rate for larger weeds. Do not exceed 6.8 fl oz/A or three applications per season. Allow at least 30 days between applications. Apply after harvest until bloom or in-season for sucker control. Mixing this herbicide with another herbicide increases the weed spectrum and is highly recommended. A spray tank adjuvant is recommended. No preharvest interval.

Caution This product is a contact, nonselective, broadleaf herbicide. Avoid contact with desirable foliage, green bark, or fruit.

Action in plant Inhibits protoporphyrinogen oxidase (PPO) that disrupts cell membranes.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Phenylpyrazole

paraquat (Gramoxone Inteon)

Rate 0.625 to 1 lb ai/A (2.5 to 4 pints/A Gramoxone Inteon)

Time Apply as a directed shielded spray toward base of vines, when weeds are growing vigorously and new growth is 1 to 6 inches high or when sucker growth is no more than 8 inches.

Remarks Add a nonionic surfactant or crop oil concentrate according to label; avoid anionic formulations that react in the tank to form insoluble precipitates. Avoid windy conditions. Acts on contact; absorbs energy produced by photosynthesis forming peroxides that disrupt living cells. Five applications allowed per year. Treat when suckers are less than 8 inches long.

Caution Restricted-use herbicide. Do not ingest or inhale spray mist. Wear protective face shields, respirators, and clothing. Do not allow spray to contact green stem, fruit, or foliage.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

sethoxydim (Poast)

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

Time Identify susceptible grasses and apply at optimum growth stage listed on the label.

Remarks Add 2 pints/A of a nonphytotoxic crop oil concentrate to improve leaf absorption. Control often is erratic on grasses stunted or stressed by 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 50 days. Do not exceed 5 pints/A per season.

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

Chemical family Aryloxyphenoxy propionate

tiafenacil (Gamma)

Rate 0.02 to 0.06 lb ai/A (0.5 to 1.5 oz/A Gamma)

Time Best performance observed on weeds less than 6 inches tall.

Remarks Tiafenacil is a broad spectrum non-selective postemergence herbicides. It controls annual broadleaves and grasses. Methylated seed oil, crop oil concentrate, and ammonium sulfate must be added for optimum results. It can be used in tank-mixes with glufosinate, glyphosate and other herbicides. For controlling Italian ryegrass, use tiafenacil in high rate in tank-mix with glufosinate for best results.

Caution Preharvest interval is 7 days. Do not exceed 4.5 oz/A of Gamma (0.2 lb ai/A tiafenacil) per season. Do not apply to grapes

established less than 2 years.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-Phenyl-imides

Sucker Control in NonDormant Grape

carfentrazone-ethyl (Aim EC)

Rate 0.031 lb ai/A (2 fl oz/A Aim EC)

Remarks Suckers must be young and succulent. Control is enhanced with COC (1%) or NIS (0.25%).

Caution Care must be taken not to allow spray mist to contact desirable fruit, foliage or green stem tissue. Do not use on seedlings.

Site of action Group 14: inhibits protoporphyrinogen oxidase

Chemical family Triazinone

oxyfluorfen (Goal 2XL, Galigan)

Oregon and Washington only, wine and processing grapes only

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

Time Apply as a directed ground spray to suckers growing from plant base up to 12 inches tall.

Remarks Apply to suckers less than 12 inches long. Immature, expanding leaves at time of contact are most susceptible. Complete sucker control requires removing canes by hand. The highest rate, or a second application, may be required for acceptable control or suppression of grape suckers. Not for use on table grapes. Can be tank mixed with glufosinate (Rely) or paraquat (Gramoxone) to enhance sucker control.

Caution Do not exceed 6 pints/A per season. Preharvest interval is 60 days. Can be applied to nondormant grapes up to 3 weeks after bloom.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

pyraflufen (Venue)

Rate 0.004 to 0.006 lb ai/A (3 to 4 fl oz product/A)

Remarks Apply as a directed application to actively growing suckers. A spray tank adjuvant is recommended. Preharvest interval is 0 days.

Caution This product is a contact, nonselective, broadleaf herbicide. Avoid contact with desirable foliage, green bark, or fruit.

Action in plant Inhibits protoporphyrinogen oxidase (PPO) that disrupts cell membranes.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Phenylpyrazole

tiafenacil (Gamma)

Rate 0.02 to 0.06 lb ai/A (0.5 to 1.5 oz/A Gamma)

Time Best performance observed on weeds less than 6 inches tall.

Remarks Tiafenacil is a broad spectrum non-selective postemergence herbicides. Methylated seed oil, crop oil concentrate, and ammonium sulfate must be added for optimum results. It can be used in tank-mixes with glufosinate, glyphosate and other herbicides. Treat small suckers for best results. Wait at least 14 days before reapplying.

Caution Preharvest interval is 7 days. Do not exceed 4.5 oz/A of Gamma (0.2 lb ai/A tiafenacil) per season. Do not apply to grapes established less than 2 years.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-Phenyl-imides

