

PREVENTING HERBICIDE DRIFT AND INJURY TO GRAPES

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During the past several years, grape acreages have increased significantly in Washington and Oregon (17 percent and 23 percent, respectively, from 1999 to 2002). Unfortunately, herbicide drift can pose a major threat to the growth and success of commercial grape production adjacent to areas of small grain, hay, grass seed, or corn production.

Grapes are especially sensitive to several herbicides used in agronomic crops, pasture, rangeland, forestry, and noncrop areas. When applied to nearby crops, herbicides can drift to vineyards and cause significant injury to grapevines.

Drift is defined as the movement of herbicides off the site where they were applied. Drift can occur either during herbicide application (particle spray drift) or after application to plants and soil when the herbicide volatilizes (vapor drift).

Herbicide drift can injure foliage, shoots, flowers, and fruits. If injury is severe enough, or occurs repeatedly, it can cause reduced yield, poor fruit quality, and, occasionally, vine death. Drift injury can result in a substantial economic loss. In addition, drift to grapes from misapplication of pesticides could result in illegal residues on the exposed crop.

Herbicide injury to grapevines can last several years after the occurrence of the drift; it may reduce vigor, increase susceptibility to diseases, reduce yield and fruit quality, and shorten the life of the vineyard.

Growth-regulator herbicides such as 2,4-D and dicamba are the herbicides most likely to injure grapes. Growth-regulator herbicides mimic auxins, which are plant hormones that regulate growth and development. Grapes are many times more sensitive to growth-regulator herbicides than are corn and wheat. Herbicide concentrations of 100 times below the recommended label rate have been reported to cause injury to grapes. Field observations indicate that drift from growth-regulator herbicides can injure grapes half a mile or more from the application site.

Growth-regulator herbicides are widely used for control of emerged broadleaf weeds (postemergence) in growing wheat, pasture, rangeland, grass seed, and corn. They also are commonly used in turf and by



railroads, utilities, highway departments, and municipalities to control unwanted woody plants and broad-leaf vegetation on rights-of-way. A partial list of common growth-regulator herbicides and other herbicides that can injure grapes is found in Table 1.

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Table 1. Herbicides that have potential to injure grapes.

Growth regulators			ALS inhibitors			
2,4-D	Dicamba	Others	Glyphosate	Sulfonylurea	Imidazolinone	Others
Amine 4	Banvel	Bronate*	Roundup	Ally	Arsenal	Gramoxone
Barrage	Clarity	Crossbow*	Rodeo	Ally Extra	Assert	Aim
Esteron 99	Rave*	Curtail*	Roundup Ultra	Amber	Beyond	Boa
Formula 40		Landmaster*	Roundup	Canvas	Pursuit	
Hi Dep		MCPA	UltraMax	Cimarron	Raptor	
LV-4		RT Master	Roundup	Express	Plateau	
LV-6		Starane	WeatherMax	Finesse		
Saber		Tordon	Landmaster*	Glean		
Salvo		Turflon	Glyphos	Harmony Extra		
Savage		Trimec	Glypro	Harmony GT		
Tricep			RT Master	Oust		
Weedar 64			Touchdown	Peak		
Weed-B-Gon				Rave*		
Weedmaster						
Weedone						

This list is not all-inclusive; other herbicides also may injure grapes.

**A prepackage mixture containing a growth-regulator herbicide as at least one active ingredient.*

Types of herbicides most harmful to grapes

The herbicides of most concern for grape injury are discussed in this publication. Other herbicides with different modes of action also can drift and injure grapes, so care is needed during all herbicide applications.

Growth regulators

The most common growth-regulator herbicides used in the Pacific Northwest are 2,4-D and dicamba. The potential for vapor drift from 2,4-D and dicamba depends on the specific herbicide formulation. For example, vapor from the ester formulations of 2,4-D (e.g., Salvo, Weedone) is more likely to drift than that

from the amine formulations (e.g., Weedar 64). Ester formulations of 2,4-D are widely used because of their lower cost, greater absorption by plant tissues, and effectiveness in weed control. The greater drift potential of ester formulations has led to restrictions on their use in certain areas of Oregon and Washington.

Glyphosate

Glyphosate is the active ingredient in Roundup and similar products. Glyphosate can drift and injure grapes but usually is less of a problem than growth regulators because it is not volatile and grapes are not as sensitive to these herbicides. Nevertheless, glyphosate can drift in windy conditions and, because it is systemic, can translocate within grapevines and kill the growing points.

Glyphosate is applied prior to planting wheat, after harvest, and for maintenance of summer fallow. In addition, it is labeled for use in vineyards. Usually, injury in vineyards results when glyphosate applied under grapevines contacts green tissues of the vines. Glyphosate mist from sprayers also has been implicated in damage resembling that caused by growth-regulator herbicides.

ALS inhibitors

Acetolactate synthase (ALS) inhibitors are systemic and may cause injury similar to that caused by glyphosate. The ALS inhibitors include the sulfonylureas (e.g., Amber, Finesse, Harmony Extra, Peak, Express, Ally) and imidazolinones (e.g., Pursuit, Raptor, Beyond, Arsenal, and Plateau). ALS inhibitors are widely

used in alfalfa, pea, and wheat production, and for noncropland weed control. They are applied both before planting (preemergence) and postemergence at extremely low rates. The high biological activity of ALS inhibitors increases the likelihood of drift injury to grapes, especially if temperature inversions

allow small spray particles to remain suspended in the air for extended periods. However, because of the low volatility of ALS-inhibitor herbicides, injury to grapes from this type of herbicide generally occurs only from nearby applications.

Herbicide drift injury

Spring applications of the herbicides described above often accumulate in the growing points of grapes, where injury symptoms appear first. Fall applications may accumulate in roots. The type and severity of injury to grapes depends on the concentration of the herbicide, time of exposure and corresponding vine growth stage, and grape variety.

Time of exposure is important, as injury is much more severe during periods of rapid grape growth. The potential for injury can be reduced considerably if potentially injurious herbicides are applied in early spring when grapes are still dormant (prior to grape bud break). Bud break generally occurs around early to mid-April.

If exposure occurs between bud break and bloom, during the period of rapid shoot growth, grape injury can be severe. Field observations have indicated that herbicide drift exposure prior to bloom but after bud break can cause flower abortion, curling of shoot tips, cessation of shoot growth, and regrowth of deformed leaves after exposure.

Mid- and late-season exposure usually causes minor leaf deformation since most shoots are fully grown and few developing leaves are present to respond to the herbicide. However, exposure of developing berries to herbicides may greatly delay or even prevent ripening.

The sensitivity of grapevines to herbicide drift also depends on the grape cultivar. Nonetheless, with severe and repeated exposure to herbicide drift, all cultivars are vulnerable.

Figure 1.—2,4-D drift injury symptoms.



Fan-shaped leaves with small puckered spots between veins and sharp points (enations) at leaf margins (photo by I. Dami).



Zigzag shoot growth with shortened internodes (photo by I. Dami).

Growth regulator injury symptoms

Injury from growth-regulator herbicides usually appears within 2 days of the drift incident. Symptoms of 2,4-D injury include characteristic fan-shaped leaves with sharp points at leaf margins, epinasty (downward bending of leaves), leaf strapping with deep sinuses, and leaf puckering with constricted veins that may be slightly chlorotic (Figure 1). Research in Washington with Concord grapes has found that 2,4-D affects fruit quality, including fruit color, sugar levels, and acid content. Dicamba injury usually causes leaf cupping and a distinct marginal band of restricted growth (Figure 2).

Shoot tips seldom resume growth after injury by growth-regulator herbicides, but laterals continue to grow. The result is a very bushy vine with a shade canopy and poor fruit exposure. Growth regulator injury is particularly severe when multiple incidents occur to the same grape planting over a period of years.

Symptoms of fanleaf degeneration, a viral disease, often resemble those caused by growth regulators.

Figure 2.—Dicamba drift injury symptoms.



Leaf cupping downward (photo by I. Dami).



Leaf cupping upward (photo by I. Dami).



Figure 3.—Glyphosate injury symptoms.



Distorted leaves.



Lateral shoot growth with unusual burst of latent buds on nodes, short internodes, and distorted leaves (photo by I. Dami).

Glyphosate and ALS inhibitor injury symptoms

Symptoms vary, depending on the time of application. During the growing season, grape injury from glyphosate and ALS inhibitors usually takes a couple of weeks to appear. The first symptom usually is yellowing of the growing points, followed by necrosis and death of the growing points (Figure 3). As a result, apical dominance may be broken, resulting in growth of numerous lateral shoots (bushy growth). Other symptoms include arrow-shaped, cupped, and upward-curved leaves, shortened internodes, and occasionally interveinal chlorosis (Figures 3 and 4).

Fall uptake of glyphosate may result in symptoms the following year, including stunting of early shoot growth, leaf chlorosis and distortion, very short internodes, abundant lateral shoots, and aborted flowers. These early-spring symptoms may be confused with viral or fungal diseases (e.g., *Eutypa* dieback).

Grape root injury can occur from either glyphosate or ALS inhibitors, although we are uncertain of the potential amount of root injury and its long-term implications. It generally is believed that root injury is more likely from ALS-inhibiting herbicides than from glyphosate.

Protection from herbicide drift injury

Both grape growers and nearby growers of other crops can take steps to reduce the risk of herbicide drift injury to grapevines.

Avoid making herbicide applications during sensitive periods of grape growth and development.

All users of potentially injurious herbicide products should know where grapes are being grown in their vicinity and when grapes are in sensitive developmental stages.

Consider using products with a reduced potential for injury to off-target plants (see Table 2).

These herbicides either affect emerging seedlings or cause contact injury to plants and are not translocated in grapes to growing points or fruit.

Maintain good relations with neighbors. Grape producers should make sure that neighbors in approximately a half-mile radius around the vineyard are aware that vines are very sensitive to herbicides. Communicate the presence of the vineyard to state and county highway departments, utilities, and other agencies that might spray rights-of-way or roadsides. If these areas run through your property, keep them free of weeds so they are less likely to be sprayed. Work with your neighbors by encouraging them to use drift-reduction spray nozzles that produce large droplets and to select herbicides that are less likely to injure grapes (Table 2).

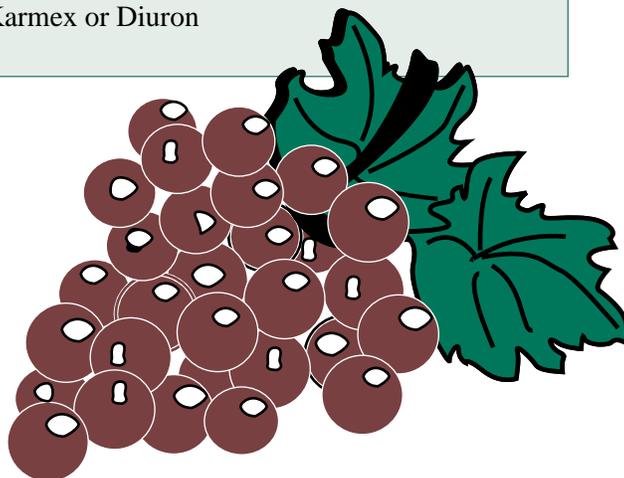
Figure 4.—ALS inhibitor injury symptoms from sulfonylurea herbicide spray drift.



Chlorosis of leaf veins and change in leaf appearance from smooth to crinkled (photo by I. Dami).

Table 2. Alternative herbicides for wheat less likely to injure grapes.

Achieve	Everest	Paramount
Avenge	Hoelon	Puma
Buctril	Maverick	Sencor
Discover	Karmex or Diuron	



Minimize drift injury from herbicides used in the vineyard.

Glyphosate is registered for use in grapes; however, if not applied properly, severe damage can occur. To avoid injury, grape growers should observe the following guidelines.

- Avoid glyphosate contact with any green parts of the vine or by drift.
- If possible, avoid summer and fall application when grapes are most susceptible to injury.
- Avoid glyphosate applications when shoots begin to trail, especially with downward shoot-training systems such as Single High Wire, Geneva Double Curtain, Smart-Dyson, and Scott Henry.
- Use a shield mounted to a wand for a backpack sprayer application or a commercial shielded sprayer such as a dome sprayer.
- Avoid spraying in windy conditions or during totally calm, temperature inversion conditions.
- Use drift-reduction nozzles (e.g., turbo flat-fan and air-atomizing types) that operate at lower pressure (15–30 psi) and produce large droplets, thus reducing the chance of drift.
- Use vine grow tubes to protect first-year vines from herbicide contact with green shoots.
- If chemical weed control is practiced in the vineyard, begin the weed management program with preemergence herbicides (check your local pesticide spray guide) and follow up with postemergence herbicides before bud break.
- In midseason, use a contact herbicide (not systemic) to treat weed escapes.
- If using 2,4-D in your vineyard, apply it before active shoot growth occurs, use low spray pressures, and be extremely careful to avoid treatment when weather conditions favor drift, such as during high temperatures, breezy conditions, and temperature inversions.

Additional herbicide drift resources

For more information about herbicide drift, see the following publications or Web sites.

- Washington Association of Wine Grape Growers Drift Monitoring information (http://www.wawgg.org/index.php?page_id=29)
- Kansas State University Drift Questions & Answers (<http://www.oznet.ksu.edu/library/hort2/MF2588.pdf>)
- Oregon State University Extension publication EM 8737, *Preventing Phenoxy Herbicide Damage to Grape Vineyards* (<http://eesc.oregonstate.edu/agcomwebfile/edmat/html/em/em8737/em8737.html>)

The Oregon Department of Agriculture (503-986-4653) and Washington Pesticide Management Division (Washington Department of Agriculture, 509-225-2647, toll-free 1-877-301-4555) direct investigations on suspected drift incidents in their respective states.

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