

Preventing Herbicide Drift and Injury to Grapes

D.A. Ball, M. Corp, and I. Dami

EM 8860 • Revised February 2014

In the Pacific Northwest (PNW), acreage of new, high-value horticultural crops (such as wine grapes) has been increasing in areas traditionally planted with agronomic, agroforestry, or other crops. The introduction and expansion of these new commercial grape crops into traditionally-planted areas require that growers evaluate their neighbors' more established crop production practices to ensure that all crops in an area can be produced without conflict.

In particular, herbicide drift from adjacent areas can pose a major threat to the growth and success of commercial grape production. Grapes are especially sensitive to several herbicides commonly used in agronomic crops (particularly small grain, hay, grass seed, and corn), pasture, rangeland, forestry, and even noncrop tracts. When applied nearby, these herbicides can cause significant injury to grapevines.

To help counter this threat, there are two important things that growers can do:

- Know the herbicides that are harmful to grape production and the symptoms of injury.
- Know how to protect your planting from herbicide drift injury.

About herbicide drift

Drift is defined as the movement of herbicides away from the site where they were applied. Drift can occur at the time of application if herbicides are applied in unfavorable wind conditions (spray particle drift), during a [temperature inversion](#), or after an application if an herbicide volatilizes from plant or soil surfaces (vapor drift).

Herbicide drift can injure foliage, shoots, flowers, and fruits. If injury is severe enough, either from one incident or repeated exposure, it can cause reduced yield, poor fruit quality, and, occasionally, grapevine death. Herbicide injury to grapevines can last several years after the drift incident, reducing vigor, increasing susceptibility to diseases, and shortening the life of the



Fan-shaped leaf with small pucker spots between veins and sharp points (enations) at leaf margins, a symptom of 2,4-D drift injury on grape

[Click on the hyperlink to learn about temperature inversions.](#)

Daniel A. Ball, professor emeritus in weed science, Columbia Basin Agricultural Research Center; and Mary Corp, agriculture agent, Umatilla County; both of Oregon State University; and Imed Dami, viticulturist, The Ohio State University.

vineyard. Also, drift to grapes from misapplication of pesticides could result in illegal residues on the exposed crop. Drift injury can result in substantial economic loss.

Types of herbicides most harmful to grapes

The herbicide types of greatest concern for grape injury are discussed in this publication. However, the herbicides listed here are by no means the only products with potential to injure grapes. Other herbicides with different sites of action also have some potential to drift and injure grapes, so care is needed during any herbicide application.

Growth regulators

Growth-regulator herbicides mimic auxins, which are plant hormones that regulate growth and development. This class of herbicides has a greater potential to injure grapes.

2,4-D, dicamba, MCPA, clopyralid, triclopyr, and a number of other compounds are classed as growth-regulator herbicides (see Table 1, page 3). The most common growth-regulator herbicides used in the PNW are products containing 2,4-D and/or dicamba.

Growth-regulator herbicides are used for control of emerged broadleaf weeds in wheat, pasture, rangeland, grass seed, corn, and turf. They also are commonly used by railroad and utility companies and forestry, highway, and municipal departments to control unwanted woody plants and broadleaf vegetation on rights-of-way.

Certain formulations of these herbicides are volatile and can drift as vapor. The potential for vapor drift from 2,4-D and dicamba depends on climatic conditions after application as well as the specific herbicide formulation. For example, ester formulations of 2,4-D are more volatile, so their vapor is more likely to drift than vapor from amine formulations. Because of these ester formulations' greater drift potential, there are restrictions on their use in certain areas of Oregon and Washington.

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 certain growth-regulator herbicides can injure grapes half a mile or more from the application site.

An array of formulations of growth-regulator herbicides are available for both commercial and homeowner use. Before considering the use of any herbicide product, read the herbicide ingredient label to confirm whether that product contains a growth-regulator herbicide. A partial list of common growth-regulator herbicide trade names, and other herbicides that can injure grapes, is found in Table 1 (page 3).

Find the Washington regulations website here: <http://agr.wa.gov/PestFert/Pesticides/LawsRules.aspx>

Table 1. A partial list of herbicide products that have potential to injure grapes.*

Growth regulators			ALS inhibitors		Glyphosate
2,4-D	Dicamba	Others	Sulfonylurea	Imidazolinone	
Amine 4	Banvel	Bronate**	Affinity	Arsenal	Credit
Barrage	Clarity	Crossbow**	Ally	Beyond	Credit Extra
Cimarron**	Rave**	Curtail**	Ally Extra	Plateau	Gly Star
Formula 40	Rifle	Garlon	Amber	Pursuit	Glyfos 4
Hi-Dep	Vanquish	Landmaster**		Raptor	Glypro
LV 4	Cimarron**	MCPA	Cimarron**		Landmaster**
LV 6		Milestone	Express		Rodeo
Saber		Perspective**	Finesse		Roundup®
Salvo		Starane	Glean		RT 3
Savage		Stinger	Harmony		Touchdown
Weedar 64		Tordon	Harmony Extra		
Weed-B-Gon		Turflon	Oust		
Weedmaster**		Trimec**	Peak		
Weedone			Rave**		

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

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

Glyphosate

Glyphosate is applied prior to planting wheat, after harvest, and for maintenance of fallow. In addition, it is labeled for use in vineyards. Grapes are not as sensitive to glyphosate as they are to the growth-regulator herbicides. However, because glyphosate is systemic, it can translocate within grapevines and kill the growing points. Usually, injury in vineyards results when glyphosate applied as a directed spray to the ground under grapevines unintentionally contacts green tissues of the vines.

Glyphosate usually is less of a problem than a growth-regulator herbicide because it is not volatile. Nevertheless, glyphosate can drift in windy conditions and injure grapes. Glyphosate drift from sprayers also has been implicated in damage resembling that caused by growth-regulator herbicides.

Glyphosate is the active ingredient in Roundup® and similar herbicide products. Different formulations of glyphosate are available; they will be listed on the herbicide ingredient label as one of various salt formulations of N-(phosphonomethyl) glycine. See Table 1 for a list of some products that contain glyphosate.

ALS inhibitors

Acetolactate synthase (ALS) inhibitor herbicides are systemic and may cause injury similar to that caused by glyphosate. The ALS inhibitors include the sulfonylurea herbicides (examples of products are Ally, Amber, Express, Finesse, Harmony Extra, and Peak; see Table 1) and imidazolinone herbicides (examples of products are Arsenal, Beyond, Plateau, Pursuit, and Raptor).

ALS inhibitors are widely used for weed control in alfalfa, pea, clover, and wheat, and for non-cropland weed control. They are applied both before and after planting at extremely low use rates.

The high biological activity of ALS inhibitors increases the likelihood of drift injury to grapes, especially if a temperature inversion allows 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 growth regulators, ALS inhibitors, and glyphosate that move off target may accumulate in the growing points of grapes, where injury symptoms first appear. Fall applications that result in drift 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 possibility for injury can be reduced considerably if potentially injurious herbicides are applied in early spring when grapes are still dormant (prior to bud break); so, be sure you know the timing of bud break in your area to help prevent grape injury. Bud break generally occurs around early to mid-April in the Walla Walla Valley area, but the timing of bud break varies depending on the specific region.

If exposure occurs during the period of rapid shoot growth between bud break and bloom, grape injury can be severe. Field observations indicate that herbicide drift exposure before 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 there are few developing leaves to react to the herbicide. However, exposure of developing berries to herbicides may greatly delay or even prevent ripening.

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

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 (leaf margin indentations), 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, page 5).



Figure 1. 2,4-D drift injury symptoms: (A) Fan-shaped leaf with small puckered spots between veins and sharp points (enations) at leaf margins. (B) Zigzag shoot growth with shortened internodes.

Shoot tips seldom resume growth after they have been injured 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 the same grape planting is exposed to multiple incidents over a period of years.

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

Glyphosate and ALS-inhibitor injury symptoms

Symptoms vary, depending on the timing of the drift incident, and usually take 2 to 3 weeks to appear. The first symptom usually is yellowing of the growing points, followed by necrosis and death of the growing points (Figure 3, page 6). 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, page 6).

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 (for example, *Eutypa dieback*).

Grape root injury can occur from either glyphosate or ALS inhibitors, although the long-term implications of this type of root injury are unknown. It is generally believed that root injury is more likely from ALS-inhibiting herbicides than from glyphosate, since glyphosate is rapidly inactivated when it comes in contact with soil.

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.

Everyone who uses potentially injurious herbicide products should know whether and where grapes are being grown in their vicinity and when grapes are in sensitive developmental stages. (The most sensitive stages of grape development start with bud break in early spring through flowering and fruit set.)

Maintain good relations with neighbors.

Grape producers should make sure that neighbors within approximately a half-mile radius around their vineyard are aware that vines are growing nearby and that they are sensitive to some herbicides. Be sure that state and county highway



Figure 2. Dicamba drift injury symptoms: (A) Leaf cupping downward. (B) Leaf cupping upward.

departments, utility companies, and other agencies that might spray rights-of-way or roadsides know where your vineyard is. If rights-of-way or roadsides run through your property, keep them free of weeds so they are less likely to be sprayed. Encourage your neighbors to use [drift-reduction spray nozzles](#) (nozzles that produce large droplets) and to select herbicides that are less likely to injure grapes.

Minimize drift injury from herbicides used in the vineyard.

Glyphosate is registered for use in nonbearing and bearing grapes as a directed spray. However, if it is 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 through drift.
- If possible, avoid summer and fall applications (when grapes are most susceptible to injury).
- Avoid glyphosate applications when shoots begin to trail, especially with downward shoot-training systems.
- 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 temperature inversions.
- Use drift-reduction nozzles (for example, drift-guard or air induction types) that operate at lower pressure (15 to 30 psi) and produce large droplets.
- Use grow tubes to protect the green shoots of first-year vines from herbicide contact.
- If you practice chemical weed control in your vineyard, begin the weed management program with preemergence herbicides (consult the [PNW Weed Management Handbook](#)) and follow up with postemergence herbicides before bud break.
- In midseason, use a contact herbicide (not systemic) to treat weed escapes. Examples are products such as Gramoxone (paraquat) or Rely (glufosinate).
- If you use 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.



Figure 3. Glyphosate injury symptoms: (A) Distorted leaves. (B) Lateral shoot growth with unusual burst of latent buds on nodes, short internodes, and distorted leaves.



Figure 4. ALS inhibitor injury symptoms from sulfonylurea herbicide spray drift: chlorosis of leaf veins and change in leaf appearance from smooth to crinkled.

Other herbicide drift resources

Diagnosing Herbicide Injury on Garden and Landscape Plants. ID-184-W. Purdue Plant & Pest Diagnostic Laboratory. http://www.extension.purdue.edu/extmedia/ID/ID_184_W.pdf

Leaf Index and Severity Rating, Washington State University. <http://feql.wsu.edu/eb/>

Oregon Department of Agriculture (503-986-4653). Direct investigations of suspected Oregon drift incidents here.

Questions and Answers About Vineyard Injury from Herbicide Drift. Kansas State University. <http://www.ksre.ksu.edu/bookstore/pubs/mf2588.pdf>

Washington Pesticide Management Division (Washington Department of Agriculture, 509-225-2647, toll-free 1-877-301-4555). Direct investigations of suspected Washington drift incidents here.

Use pesticides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label—even if you've used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

All photos in this publication by Imed Dami, © The Ohio State University

Trade-name products and services are mentioned as illustrations only. This does not mean that the Oregon State University Extension Service either endorses these products and services or intends to discriminate against products and services not mentioned.

© 2014 Oregon State University. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties. Oregon State University Extension Service offers educational programs, activities, and materials without discrimination based on age, color, disability, gender identity or expression, genetic information, marital status, national origin, race, religion, sex, sexual orientation, or veteran's status. Oregon State University Extension Service is an Equal Opportunity Employer.

Published March 2004. Revised February 2014.