

# Avoiding 2,4-D Injury to Grapevines



## Quick Facts

- 2,4-D is a commonly used herbicide for broadleaf control in agriculture, roadsides, and lawns
- Grapes are very sensitive to 2,4-D exposure
- Effects of exposure may last one or more seasons
- Several factors determine the extent of injury to grapes exposed to 2,4-D
- Growers and applicators alike can take steps to prevent exposure to 2,4-D
- There are other causal agents to consider when diagnosing herbicide injury to grapes

## Introduction

While grape production represents a small portion of total acreage in agricultural production, Colorado's wine industry is steadily growing. In 1990, there were only five licensed wineries in Colorado. Today, the state claims nearly 100 wineries with an average annual increase in production of 20 percent annually. The annual gross return from the 2009 harvest alone was \$4000 per acre! The industry infuses dollars into the state economy not only through the sale of wine, but contributes through an increasing wine-related tourism as well.

Although the majority of Colorado's vineyard acreage is currently located on the western slope, more hybrids are being planted along the Front Range. This poses a new challenge for the wine growers as many vineyards are located in areas abutting subdivision sprawl and may be interspersed with areas of agricultural production and residential landscapes. Grapevines are very sensitive to certain herbicides and many farmers and homeowners are not aware of the hazard that commonly used herbicides, such as 2,4-D, present to grapes.

## Why is 2,4-D a Problem?

2,4-D belongs to a group of herbicides referred to as Plant Growth Regulators (PGR). PGR are the most common active ingredients in herbicides used to control broadleaf weeds. They affect the plant's natural growth hormones by mimicking auxins, the plant hormones that regulate growth and development. Exposure to PGR can cause abnormal growth of leaves and stems. While PGR herbicides can be absorbed by both roots and leaves, grapes are typically injured through foliar absorption. These herbicides are systemic, which means they move from the site of absorption to areas of rapid growth. This group of herbicides includes very effective broadleaf herbicides used on lawns, golf course, right-of-ways, and agricultural fields. A special family of PGR herbicides is the phenoxy herbicides, which includes herbicides such as 2,4-D. However, many broadleaf plants, not just weeds, are sensitive to the growth regulator herbicides. Grapes are highly sensitive to 2,4-D and it is the most common herbicide causing damage to grapes, primarily through drift.

## How Does Injury Occur?

Non-target "drift" can occur in one of two ways; either as spray drift or vapor drift. Spray drift occurs when small droplets move off the treatment site at or near the time of application. This can happen with any type of herbicide. Vapor drift occurs when the spray material volatilizes or evaporates off the target area and is carried off-site by wind or inversions as a gas or vapor. Vapor drift is not visible and can cause damage to sensitive plants some distance away from the



application site. The potential for vapor drift is chemical specific and based on the herbicides' vapor pressure. Vapor pressure is affected by temperature and relative humidity. Because 2,4-D has a high vapor pressure, it readily volatilizes, especially under higher temperatures and low humidity.

## Types of Injury Symptoms Observed

While grapevines are extremely sensitive to 2,4-D, they are most vulnerable during their early growing season through the bloom period (April to mid-July). In general, younger plants are more susceptible to 2,4-D injury than mature plants, and may be killed even at low exposures.

### Symptoms on actively growing young shoots and young leaves

New shoots are extremely sensitive to 2,4-D exposures. Affected leaves are small, narrow and deformed, and have closely packed thick veins that lack chlorophyll, so they appear 'bleached' out. Sometimes symptoms are referred to as "fingering" (small, narrow and misshapen) that develops along the leaf margin (Picture 1).

### Symptoms further down the stem from the shoots

Typically, damage symptoms are progressively less severe the further you go down the shoot but will still have marked characteristics. These include a distinctive fan-shape appearance with parallel, strap-like clear veins (Picture 2). The leaves sometimes appear cupped, and the leaf margins can terminate in sharp points. Small interveinal spots retain some green chlorophyll and may appear 'puckered' (Picture 3).

### Symptoms on flower clusters

Flower clusters exposed to 2,4-D may have reduced fruit set and delayed maturation. Exposure to 2,4-D may be responsible for the appearance of "buckshot"-size berries in a cluster and berries may ripen unevenly (Picture 4). In severe cases, delayed maturation may exist in a vine for 1 to 3 years.



Picture 1. Symptoms on young shoots



Picture 2. Symptoms on older leaves



Picture 3. Older leaves may appear puckered



Picture 4. Flower clusters affected by 2,4-D

## Factors Affecting the Severity of Injury

It is important to remember that the severity of the symptoms is dependent on how much herbicide exposure the vines had. Generally, more herbicide means more severe symptoms. Vines showing less severe symptoms may not produce any new growth with normal traits for the remainder of the season. Severely injured vines may not recover for two or more years! Vines may also become brittle and have a reduced ability to overwinter successfully. There are several factors which can determine the severity of injury:

- Grape variety - All grape varieties are sensitive to 2,4-D, although expression of visual symptoms (leaf distortion and shoot stunting) varies among varieties.
- Vine growth stage - Because 2,4-D is very mobile in the vine and is transported to growing tips where the highest concentration of auxin occurs, the severity of 2,4-D damage seems to be

- greater during the early part of the growing season when vines are rapidly growing.
- Vine vigor - Young vines are more sensitive to 2,4-D which is likely due to their inability to spread the toxin throughout the vine compared to older vines.
- Concentration of herbicide & exposure time - Higher concentrations of 2,4-D may produce more injury as it overloads the hormonal system of the plant. Longer periods of exposure to 2,4-D drift will produce greater spread and severity of injury.
- Droplet size - Droplets under 150 microns in size pose the greatest drift hazard.
- Environmental conditions - Warm temperatures during or shortly after application can cause 2,4-D to volatilize. Windy conditions can cause vapor or spray drift to be carried off-site.

## How to Prevent Injury: What Grape Growers Can Do

Communication is the first step in preventing injury. Growers can aid their cause by considering the following:

- Growers of sensitive crops should communicate to their neighbors, local commercial pesticide applicators, and landowners the exact location of their susceptible crops that may be affected by off-target movement of herbicides.
- Growers should be especially mindful of neighboring wheat fields, pastures, and rangeland that may receive applications of PGR herbicides, such as 2,4-D.
- Growers should also communicate to county or state highway departments that may spray roadsides with PGR herbicides.
- Lastly, growers should attempt to locate plantings of sensitive grapes away from property borders and other areas that may receive GR herbicides.

## How to Prevent Injury: What Applicators Can Do

- Temperatures - Injury may be increased if temperatures are too high during or shortly after applications. The risk of volatilization is directly related to air temperatures, and as temperatures exceed 85° F, the potential for off-target movement increases. The majority of volatilization occurs within a few days of application with increasing temperatures increasing the potential for volatilization. High temperatures also promote greater absorption.
- Increase droplet size & use low spray pressures - Select nozzles that produce the largest droplet size while providing adequate coverage at the intended application rate and pressure to minimize drift.
- Wind speed - A portion of the herbicide may evaporate from the surface it lands upon and then move from the treated field with wind currents. Avoid applying 2,4-D if wind speeds are lower than 2 mph or greater than 12 mph. Herbicides sprayed in calm (no wind) situations may increase drift potential due to temperature inversions.
- Maintain a buffer - If possible, maintain a buffer from the edge of the field being treated. There are no fixed guidelines as this safe setback distance will depend on wind direction and speed, air temperature, topography, acres treated, etc.
- Choose the right formulation - Like several of the PGR herbicides, 2,4-D is available as an ester or amine formulation. The amine formulations are non-volatile, whereas ester formulations are prone to vapor drift. However, most ester formulations available today are formulated as low-volatile (LVE), which pose less of a risk. The use of highly volatile forms of 2,4-D, such as the older ester formulations, should be avoided around vineyards.
- Properly timed applications - Herbicides should be applied when weed control can be maximized and drift potential minimized. When possible, try to control weeds when the grapes are in less susceptible growth stages, such as prior to bud break or early fall.

## Other causes which mimic 2,4-D injury

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While this brochure focuses on 2,4-D, deformities and leaf spots on grapes can be caused by things other than herbicide drift such as plant diseases and nutrient deficiencies or toxicities.

- Other herbicides - While Glyphosate (ex: Roundup®) is not as volatile as 2,4-D, it can drift and cause injury to grapevines. There are several recognizable characteristics: young shoots injured early in the growing season will produce misshapen, stunted leaves from the point where the herbicide contacted the leaf to the end of the shoot. Leaves are roughly triangular and crinkled with cuplike depressions. Dicamba, another PGR herbicide, is even more volatile than 2,4-D and can drift, causing injuries which may resemble a viral disease.
- Plant diseases - Although viral diseases are not commonly found in Colorado, some symptoms of viral disease can resemble those caused by GR herbicides. However, viral disease symptoms reoccur in successive seasons while herbicide symptoms may not.
- Nutrient deficiencies or toxicities - Toxicities from excessive amounts of copper, applied as a fungicide, may mimic herbicide injury. Sulfur products used for powdery mildew control can burn foliage when applied above 85°F. When vines are deficient in Boron, leaves toward the end of the shoot appear a spotty yellow. Affected leaves tend to be undersized and cupped. Affected clusters may totally abort or develop a few small berries, often with many small, green “shot” berries. Iron, zinc, and manganese deficiencies occur frequently in Colorado soils due to high soil pH with symptoms occurring on the shoots of grapevines. Iron deficient vines have very light yellow leaves near shoot tips that may appear almost white. Extremely fast-growing shoots are more likely to exhibit this symptom. Zinc deficiencies will result in shoots with yellowing leaves and green veins, greatly reduced leaf size, misshapen leaves, and poor fruit set and berry development. Manganese deficiencies will also appear as yellowing of leaves with veins remaining green on the younger terminals of leaves.

## Additional Resources

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- Colorado Department of Agriculture – Pesticides Program [www.colorado.gov/ag](http://www.colorado.gov/ag), look under Division of Plant Industry, Pesticides Program
- Colorado Environmental Pesticide Education Program [www.cepep.colostate.edu](http://www.cepep.colostate.edu)
- Colorado Wine Industry Development Board [www.coloradowine.com](http://www.coloradowine.com)
- Grapevine Problems: Leaf Spots Not Caused by Insects or Disease By Fritz Westover, Texas A&M University, and Jim Wolpert, UC Davis. <http://www.extension.org/pages/31599/grapevine-problems:-leaf-spots-not-caused-by-insects-or-disease> Includes links to other information about abiotic and biotic problems in grapes.
- Industry Task Force II on Research Data for 2,4-D [www.24d.org](http://www.24d.org)
- Western Colorado Research Center, Viticulture Home Page. <http://www.colostate.edu/programs/wcrc/pubs/viticulture/viticulturehome.htm>

*Written by Thia Walker, Extension Specialist - Pesticide Safety Education, July 2011*

*Photos contributed by Dr. Harold Larsen & Dr. Horst Caspari of the Western Colorado Research Center*

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For more information:  
Colorado Environmental Pesticide Safety Education at Colorado State University  
[www.cepep.colostate.edu](http://www.cepep.colostate.edu)  
(970) 491-3947

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