Preventing Hormonal-Type Herbicide Damage to Kansas Grapes

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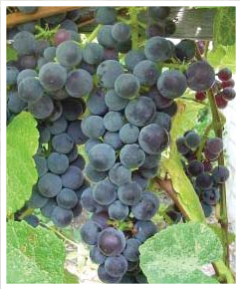

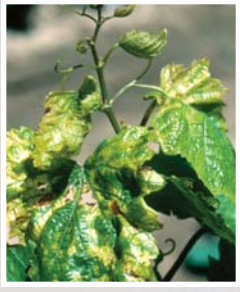

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The long growing season, fertile soil, abundant sunlight, dry weather, and warm summer conditions make Kansas a prime state for grape production. At one time, Kansas was ranked among the top 10 states in wine production. In 1873 a French immigrant named Isadore LaBarriere wrote that Kansas would someday be one of the great winemaking regions of the world. However, the high cost of establishing a vineyard, intense management requirements, and lack of labor discouraged many people from producing grapes in Kansas.

The use of herbicides in Kansas field crops and fallow has contributed to increased agricultural production. However, herbicide use also has resulted in occasional injury to nearby susceptible crops. In Kansas, many vineyards are grown adjacent to field crops and fallow areas. Herbicides used on these crops and fallow may drift onto grapevines and cause serious damage. Research has shown that downwind drift deposits from ground sprayers ranged from less than 1 percent to as much as 8 percent. Damage to grapevines from herbicide drift depends on many factors, including herbicide and formulation, grape variety, vine growth stage and vigor, environmental conditions, droplet size, and spray-boom height.

Hormonal-type herbicides such as 2,4-D, 2,4-DB, MCPA, MCPB, mecoprop, dicamba, clopyralid, triclopyr, fluroxpyr, picloram, and quinclorac are used to control broadleaf weeds in many cropping systems in Kansas. However, some of these herbicides are prone to drift that may cause severe injury to grapevines. They are highly phytotoxic and readily translocated from leaves or roots to growing points. These herbicides kill plants by changing the hormonal balance at the growing point.

Damage to vineyards by 2,4-D has been reported since the herbicide was first commercially introduced in the late 1940s. Grape is considered one of the crops most susceptible to 2,4-D. When 2,4-D is applied near a vineyard under windy or high-temperature conditions, there is potential for grapevine damage. The injury could cause total loss of the crop and vines. A minimum of five years may be required to re-establish the vineyard to full production. This can amount to six years without a crop to harvest.

Risk Factors of Herbicides Drift

Herbicide drift injury to grapevines depends on several factors:

Herbicide properties;

Application methods;

Herbicide behavior in the environment;

Weather conditions;

Susceptibility of grape cultivars;

Grapevine age and vigor; and

Proximity of grapes to herbicide application areas.

Herbicides can be classified as either selective or nonselective. Selective herbicides kill certain weeds with little or no injury to the crop. It is the difference in plant morphology, physiology, and biochemistry that determines the effectiveness of herbicides and safety to the crop. Nonselective herbicides can kill or injure virtually all kinds of vegetation. In general, young and rapidly growing plants that are metabolically active are more susceptible to herbicides than mature plants. In addition, warm and humid weather exacerbates herbicide injury.

The risk of spray drift damage is greatest when applying herbicide with equipment or methods that generate numerous small droplets. Small droplets easily travel long distances with wind. In addition, herbicides applied to soil may move off-target and pose a hazard. Herbicide movement by runoff or soil erosion to nontarget areas is another possibility from a few residual herbicides that can be absorbed via roots and are highly water soluble.

There are three ways herbicides may move to nontarget areas:

Physical spray-particle drift;

Vapor drift; and

Herbicide-contaminated soil.

Physical spray-particle drift is the off-target movement of fine droplets generated during herbicide application. Small droplets are produced when herbicides are applied with small nozzle tips at high pressure and low spray volume. The distance that droplets may travel depends on droplet size, with smaller droplets traveling further than larger droplets.

High wind speed, low relative humidity, high temperatures, and height above the ground where the herbicide is released also may increase herbicide drift. Spray droplets may travel a few feet to several miles from the targeted area, depending on weather, but the potential for drift damage decreases with distance because droplets are deposited or become diluted in the atmosphere.

Vapor drift, or volatility, refers to the ability of a herbicide to vaporize and mix freely with air. The amount of vapor drift varies depending on herbicide, formulation, and weather conditions. Some herbicides are more volatile than others. Volatile herbicides may produce vapors that can be carried great distances from the target area to other crop sites. Vapor drift also may depend on the volatility of formulation. For example, 2,4-D is available in formulations that differ in volatility. The order of 2,4-D volatility is 2,4-D ester (long chain) >2,4-D ester (short chain) >2,4-D amine. MCPA, clopyralid and triclopyr are other hormonal-type herbicides (besides 2,4-D) that are produced in ester forms. Dicamba is another hormonal-type herbicide that may drift in vapor form even though it is formulated as a salt.

Table 1. Family, common and trade names, and uses of hormonal-type herbicides.

Family name	Common name	Trade name	Common uses
Phenoxy-carboxylic-acids	2,4-D	2,4-D, LV-4, LV6, Salvo, Savage, Weedone, and several other names	Corn, sorghum, cereals, fallow, non cropland,pasture, rangeland, lawn, and turf
	2,4-DB	Butyrol, Butoxone, Butyrac	Soybean and alfalfa
	MCPA	MCPA Amine, MCPA Ester, Rhomene, and other names	Cereals, lawn, and turf
	MCPB	Thistrol	Control Canada thistle
	Mecoprop	MCPP	Turf and lawn
Benzoic acids	dicamba	Banvel, Clarity, Distinct, and Vanquish	Corn, sorghum, cereals, pasture, rangeland, fallow, and non cropland
Pyridine carboxylic acids	clopyralid	Stinger, Reclaim, and Transline	Corn, pasture, rangeland, and non cropland
	fluroxypyr	Starane and Vista	Cereals and non cropland
	picloram	Tordon	Pasture, rangeland, and non cropland
	triclopyr	Garlon and Remedy	Pasture, rangeland, and non cropland
Quinoline carboxylic acids	quinclorac	Paramount	Sorghum and fallow

Table 2. Hormonal-type herbicide tank mixes that are commonly used in Kansas.

Common name	Trade name	Use pattern
Triclopyr + 2,4-D	Crossbow and Chaser	Pasture, rangeland, non cropland, and turf
Picloram + 2,4-D	Grazon P & D	Pasture and rangeland
Clopralid + triclopyr	Redeem and Confront	Pasture, rangeland, non cropland, and turf
2,4-D + dicamba	Weedmaster	Pasture, rangeland, fallow, and non cropland
2,4-D + clopyralid	Curtail	Cereals, pasture, rangeland, and non cropland
2,4-D + MCPP + dicamba	Trimec and Mec Amine	Lawn and turf

Herbicide-contaminated soil may drift from a treated site by adhering to soil particles. Herbicide may contaminate soil in several ways: when it is applied directly to the soil, when foliar applications are not intercepted by the foliage, or when herbicide is washed off foliage by rain or overhead irrigation. Subsequent soil disturbance by wind or cultivation may cause soil-adsorbed herbicide to become airborne and be deposited downwind on plant foliage. However, research shows that hormonal-type herbicides might adsorb tightly to soil particles and cause little effect on grapes. The amount of herbicide-contaminated soil deposited on grapes would have to be extremely large to cause injury, so it is unlikely this would occur under field conditions.

Hormonal-Type Herbicides

Hormonal-type herbicides can act at multiple sites in a plant to disrupt hormonal balance and protein synthesis, causing a variety of growth abnormalities. Hormonal-type herbicides consist of four families including phenoxy-carboxylic acids, benzoic acid, pyridine carboxylic acid, and quinoline carboxylic acids (Table 1). Hormonal-type herbicides available to Kansas growers are listed in Table 1. Different hormonal-type herbicides may be combined and are widely used for vegetation management and noxious weed control (Table 2).

The phenoxy herbicides have been most often involved in crop injury by off-target drift. These herbicides are commonly used for broadleaf and brush weed control in grass crops, rangeland, lawns, and non cropland. Phenoxy herbicides are available as ester or amine salt formulations. Esters are more effective in controlling hard-to-kill weeds, but are more hazardous in terms of volatility and risk of drift to sensitive crops. Amine salt formulations are safer to use than esters, especially at temperatures above 80° F. The effects of hormonal-type herbicides, including 2,4-D, have been observed in vineyards several miles from the application site. Avoid the use of any 2,4-D product in the immediate vicinity of grapes when they are growing. Research has shown dicamba to be equally as harmful to grapes as 2,4-D, but picloram caused more damage than 2,4-D. These herbicides also should be avoided around vineyards. No research is available to determine the effect of other hormonal-type herbicides on grape, but they should be treated similar to 2,4-D until proven otherwise.

Symptoms of 2,4-D Injury

While hormonal-type herbicides cause similar injury symptoms, the effect of 2,4-D on grapes is well documented. Therefore, this publication only describes grapevine response to 2,4-D. The intensity and persistence of 2,4-D symptoms on grapes depends on the level of exposure and vine age. Symptoms may range from slight at low exposure, to severe or death from high levels of exposure. Initial 2,4-D symptoms are twisting and leaf curling, which may occur within hours of exposure. Leaves that are not fully expanded at the time of

treatment may be stunted and distorted. Within a week after exposure, general chlorosis may develop at high exposure levels. Leaves will drop and shoot tips may die, followed by stem dieback. Growth may resume depending on the level of exposure. Regrowth is sometimes limited to buds on the lower part of the plants. Regrowth may exhibit severe shoot and petiole twisting, leaf cupping, stunting, curling, strapping, feathering, roughness of the leaf surface, and fingering of the leaf margins. In addition, 2,4-D may discolor veins and make them appear to be joined together and extended to form finger-like projections. These symptoms may appear until the end of the growing season. With high 2,4-D exposure, symptoms may continue to appear in the second year. Severely injured vines may not recover for two years or more. Symptoms of 2,4-D on grape growth and development are shown in Figures 1 through 14.

Injury from 2,4-D may delay fruit ripening. When vines are severely affected, fruits may never mature regardless of season length. Delayed maturity may exist in a vine for one to three years before normal ripening returns. Slight 2,4-D injury may have little or no effect on fruit maturity. If vine growth and fruit maturity are not normal the year following the injury and severe symptoms continue to appear, growers may be advised to remove the vineyard and start a new one. In general, younger plants are more susceptible to 2,4-D than mature plants, and exposure to 2,4-D may kill young plants even at low exposure. Symptoms of 2,4-D on grape clusters are shown in Figures 24 through 26.

Figures 1–12


Figure 1


Figure 2


Figure 3


Figure 4a


Figure 4b


Figure 5


Figure 6


Figure 7a


Figure 7b


Figure 8a


Figure 8b


Figure 9


Figure 10


Figure 11


Figure 12

Figures 13–26


Figure 13


Figure 14


Figure 15


Figure 16


Figure 17


Figure 18


Figure 19


Figure 20

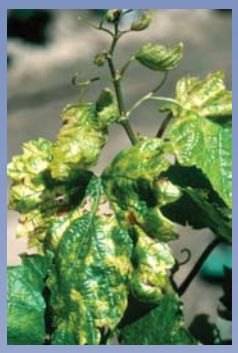
Figure 21


Figure 22

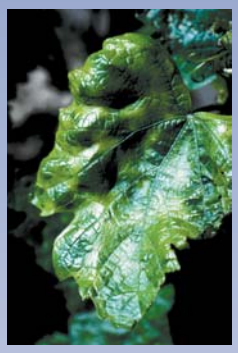
Figure 23


Figure 24a


Figure 24b


Figure 25


Figure 26

Symptoms of 2,4-D exposure are unique and differ from symptoms caused by other herbicides. For example, glyphosate (Roundup) symptoms are leaf shape distortion, interveinal chlorosis, stunting, crinkling, and cupping of developing leaves (Figures 15-17). On the most severely affected plants, mature and new leaves become chlorotic, and margins of new leaves become necrotic. Plants may resume normal growth within one to two months after exposure.

Symptoms of 2,4-D are different than injury symptoms caused by acetolactate synthesis (ALS) inhibitors such as chlorsulfuron (Glean, Telar), Figures 18-20, and thifensulfuron (Harmony), Figures 21-23. Symptoms of ALS inhibitor injury are usually minimal on leaves that are fully expanded before exposure. Fully expanded leaves will appear wilted, crinkled, and chlorotic. Leaves that develop after treatment are chlorotic, crinkled, stunted, and distorted. High exposure may also cause necrotic (brown) leaf margins. ALS inhibitors may stop terminal and lateral growth and cause shoot tips to die. Stems may develop a dark red color with necrotic lesions and cracks. Vine growth will be stunted, and the distance between leaves along the vine will be shorter at high exposure. Normal growth may resume and plants will appear normal within two months after exposure.

Preventing Herbicide Drift Injury

Awareness is the key to preventing damage by hormonal-type and other classes of herbicides. Once applicators are aware

2,4-D injury to grapes.

of the hazards and possible consequences of misuse, they can take several steps to prevent problems:

- Learn the locations of sensitive crops in the area.
- Grape growers should inform their neighbors that grapes are growing in the area. In addition, inform the county noxious weed director and Kansas Department of Transportation about vineyard locations.
- Avoid hormonal-type herbicide application near grapevines. Be a good neighbor and do not trespass with herbicides. You will be held liable for damage even if it is unintentional.
- Leave a buffer zone of at least 350 feet between treated fields and grapevines. The buffer zone will allow larger droplets to settle before reaching grapes. The buffer zone may not be effective in settling small droplets.
- Avoid the use of highly volatile formulations of herbicides in any area near sensitive crops.
- Do not apply herbicides when wind is blowing toward sensitive plants.
- Apply herbicides when a light breeze is blowing away from sensitive crops. High wind and no wind situations may result in serious herbicide drift.
- Spray when temperatures remain below label temperature restrictions to minimize vaporization.
- Use sprayer application techniques that minimize the production of fine droplets. Selecting proper spray tips, lower spray pressures, and using drift-reducing agents will decrease the number of fine droplets. Obtain spray information from sprayer-tip manufacturers to determine the percentage of droplets smaller than 150 micrometers in the nozzle-tip spray pattern. Use nozzle tips with the smallest droplets portion below 150 micrometers.
- Apply herbicides when weed control can be maximized and drift potential is minimized. For example, fall is a good time to treat for musk thistle and field bindweed because grapes are less susceptible to drift damage then.

Resolving Problems

User responsibility: Registration and labeling of a herbicide clearly gives individuals the right to apply the herbicide as long as they follow the directions for use and observe label precautions. The use of a herbicide contrary to the label is a violation of federal law. Misuse of a herbicide may make the user liable and subject to either criminal prosecution, civil proceedings, or both.

Herbicide labels warn applicators to avoid using herbicides in the vicinity of susceptible crops. Therefore, it is important to be aware of any sensitive crops grown close to herbicide application. Although there is no legal obligation for herbicide applicators to consult and cooperate with neighbors in matters of herbicide use, it is advisable to do so. More information about herbicide use and hazards can be obtained through local K-State Research and Extension offices.

Rights of injured parties: Those who grow grapes that may be injured as a result of herbicide misuse, have rights protected by law. Through civil proceedings, injured parties may attempt to regain financial losses or to secure punitive judgments.

Reporting herbicide damage: Two governmental agencies may exercise regulatory powers in situations of herbicide misuse. The Environmental Protection Agency (EPA) functions at the federal level and the Kansas State Department of Agriculture (KDA) acts at the state level to determine if the herbicide label is violated. These agencies may investigate and collect evidence to be used to prosecute violators. However, in practicality all complaints in Kansas are investigated by KDA because EPA redirects complaints to KDA. Injured parties may initiate an investigation by contacting KDA (*http://www.accesskansas.org/kda/Pest&Fert/pest-misuse.htm*).

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Pesticide Division
109 SW 9th St. 3 Floor
Topeka, KS 66612–1281
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Preliminary Herbicide Drift Diagnosis

Investigating herbicide drift cases should start when a grower observes unusual symptoms on their crops or observes nearby spraying during weather conditions that may cause drift. Most of the time, drift cases will result in investigation by KDA or litigation. The following information should be collected to document herbicide drift incidents.

1. Disease, insect, nutrient deficiency, herbicide carryover (residue), and environmental stresses may cause symptoms similar to herbicide drift injury. Consult your local K-State Research and Extension agent, crop consultant, or K-State plant diagnostician to help determine the cause of symptoms. Collect plant samples (by variety) from the injured field that represent a range of symptoms, from no injury

to most severe. Samples should be well preserved and delivered overnight to the plant diagnostic laboratory at:

Kansas State University
Plant Disease Diagnostic Lab
4032 Throckmorton Hall
Manhattan, KS 66506
Phone: (785) 532-5810
Fax: (785) 532-5692
clinic@plantpath.ksu.edu

2. Look for injury symptom patterns in the field and document the severity of injury symptoms. Is there a symptom-intensity gradient across the field? Patterns of injury may help identify the source of the problem.

3. Check to see if other species, especially weeds, develop symptoms similar to injury symptoms on the grapes.

4. If there is open ground or a crop between the damaged field and the sprayed field, check for herbicide symptoms on plants in that area. Draw a map or use GPS to locate injured plants in the field. This will help if you have a complex pattern.

5. Record the date when injury symptoms were first observed in the field.

6. Report the description of injury symptoms and photograph typical symptoms of foliage, roots, and weeds. Continue to report and photograph symptoms through the growing season. Take a large number of quality photos including closeup photos. Record the date and location of each photo. Aerial photos may help to show the pattern and severity of herbicide damage.

7. Plant tissues and soil can be analyzed for herbicide residue. However, growers need to take several precautions when analyzing tissue or soils:

- *Select a reputable laboratory that is certified to conduct GLP (good laboratory practices) analysis. In addition, check the detection level for the procedure used to analyze herbicide residue, and select the laboratory with the most sensitive procedure. The detection level should be at a level below the concentration that causes biological effect. If you select a laboratory that has high detection levels, they may not detect any residue even though you may see injury symptoms.*

- *Sample plant tissue or soil from areas where symptoms are intense. The depth of soil sample is important for herbicide detection. Try not to sample too deep because it may dilute the herbicide residue. Plant tissue or soil samples should be packed in dry ice and sent to the analytical lab immediately after sampling. Laboratories should analyze samples immediately.*

- *Chemical analysis is costly and may not provide a positive identification of some of the herbicides that damage plants because detection levels are not high enough. Some herbicides rapidly degrade in plants and soils and may be gone before the sample is taken and analyzed. Analytical procedures are specific to each herbicide and must be specified. Chemical analysis may determine the presence of herbicide, but cannot determine the source of drift or any yield loss that may be caused by the drift. A chemical analysis may not be as useful for documentation of herbicide symptoms and plant condition.*

8. Try to create a timeline of the drift incident by investigating all events in the surrounding area. Drift is most likely from adjacent areas, but also may occur from further away. Try to determine the date and time of herbicide application, herbicide name, wind speed and direction, temperature during application, name of applicator, boom height, nozzle type, spray pressure, and gallons per acre.

9. Collect and record the crop and herbicide history of damaged fields to prove that damage is not due to your own spray.

10. Contact the Kansas Department of Agriculture immediately after observing herbicide injury symptoms to file an official complaint and arrange for their visit to your field. In addition, contact all parties involved in the drift incident to visit the field including the insurance company and applicator. If you intend to litigate, try to obtain legal advice at early stages of the litigation.

11. Try to estimate the extent of yield loss. EARLY INJURY SYMPTOMS ARE NOT A GOOD INDICATOR OF YIELD LOSS. Crops frequently recover from slight injury symptoms and may yield similar to unaffected fields. Actual yield loss generally is less than expected from early season herbicide injury. The best method to estimate yield loss is to compare the yield from damaged areas to yield of plants that do not show any herbicide injury symptoms. Comparison of yields between years is not reliable because yields fluctuate between years. But, historical yield data will help substantiate normal production levels.

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