Specialty Crops at Risk from Dicamba and 2,4-D Drift

North Central IPM Center

PART 1 OF 5

An Overview of Dicamba and 2,4-D Drift Issues

Dicamba and 2,4-D drift damage has captured national attention in recent years. Could your farm be at risk? And if so, what should you know to prevent, prepare, and respond? In this fact sheet—the first in a series—we explore how dicamba and 2,4-D drift has become a threat to specialty crop producers.

Changes in Dicamba and 2,4-D Use

Dicamba and 2,4-D are post-emergence herbicides that have been used for many decades to selectively control broadleaf weeds in corn, hay fields or pastures, small grains such as wheat, and turf. They are also used to destroy existing broadleaf weeds prior to planting agronomic crops.

Starting in 2016, the use of these herbicides changed. Over-dependence on glyphosate has resulted in widespread glyphosate-resistant broadleaf weeds. To improve management of these weeds, new soybean varieties tolerant to over-the-top applications of dicamba (Xtend soybean) or 2,4-D (Enlist soybean) were commercialized in 2016 and 2019, respectively. Widespread adoption of dicamba- and 2,4-D-resistant soybeans has increased use of these herbicides during the months of May, June, and July. (USDA 2019).

Dicamba and 2,4-D have been effective in controlling glyphosate-resistant broadleaf weeds, but their expanded use has increased the risk of drift damage to high-value fruit and vegetable crops, landscape plants, and soybeans that do not carry the trait for dicamba or 2,4-D resistance. In addition to being more phytotoxic than glyphosate for many specialty crops, both herbicides are highly prone to drift. Off-target movement of dicamba, in particular, continues to be well documented in Missouri (Bradley 2017, 2018), Illinois (Illinois DOA), and Indiana (Office of Indiana State Chemist 2019), despite efforts to reduce drift though improved formulations, training, and label restrictions.

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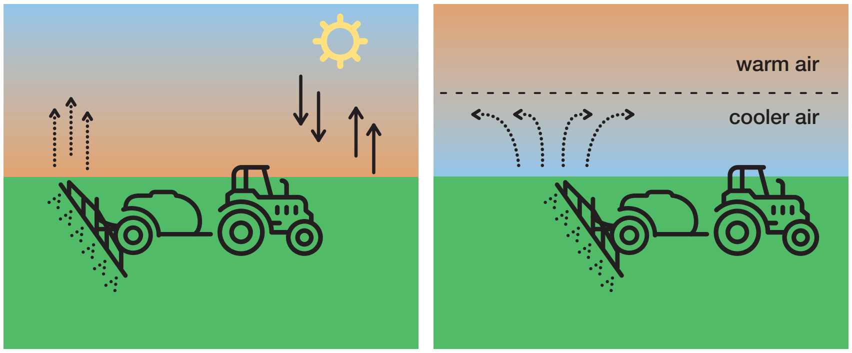


FIGURE 1 | In normal daytime conditions (left), warmer air rises from the earth's surface, while cooler air from higher in the atmosphere sinks, causing a vertical mixing of air. In the absence of substantial horizontal winds, herbicide droplets will hit their target on the ground or vaporize and dissipate into upper air levels.

But during a temperature inversion (right), the air temperature close to the ground is cooler than the air column above it and vertical mixing of air does not occur. In these conditions, small pesticide droplets stay suspended in the denser cold air, settling close to the surface. But the air can still move horizontally, moving these droplets onto neighboring crops.

While concentrations of herbicides in drift are typically low, several crops have shown extreme sensitivity to dicamba and/or 2,4-D. For example, damage has been documented on grapes exposed to 2,4-D and dicamba concentrations as low as 1/800th of the labeled rate. For high-value sensitive specialty crops, a small amount of drift can result in huge losses. Notable lawsuits from producers of honey, peaches, grapes, and tomatoes have recently brought this issue to the attention of specialty crop growers nationwide.

How Drift Happens

Drift is the movement of pesticide from the target field onto nearby sensitive plants. Most drift consists of spray droplets moving downwind during an application. This type of drift (referred to as droplet, physical, primary, or particle drift) can be minimized by following the label recommendations for spray equipment, procedures, and weather conditions.

In addition to wind, temperature inversions have a critical effect on drift. Temperature inversions occur commonly during Midwestern summers (Bish 2019), typically forming in the late afternoon or evening and persisting through 1-2 hours after sunrise. Temperature inversions occur most often under light or calm winds, due to a lack of vertical air movement (See Figure 1). Since inversions are marked by very little wind, it may seem like a good time to spray. It is not. The lack of vertical air movement means spray droplets can become suspended near the ground surface in colder, denser air. Air can move horizontally, like a fog, onto neighboring fields, carrying these spray droplets along. Morning sunlight or stronger winds usually mix the air layers and bring an end to inversion conditions. But applications made during an inversion late in the day may have several hours to move off target.

Dicamba and 2,4-D can also move off-target as a gas. They are among the relatively small number of pesticides that are highly prone to volatilize (turn into a gas). A spike in air temperature can cause these herbicides to turn into a gas even after they have been successfully applied to target surfaces. As temperature inversions form, pesticide vapors lingering in the atmosphere can be pulled back down to the surface where they can cause damage.

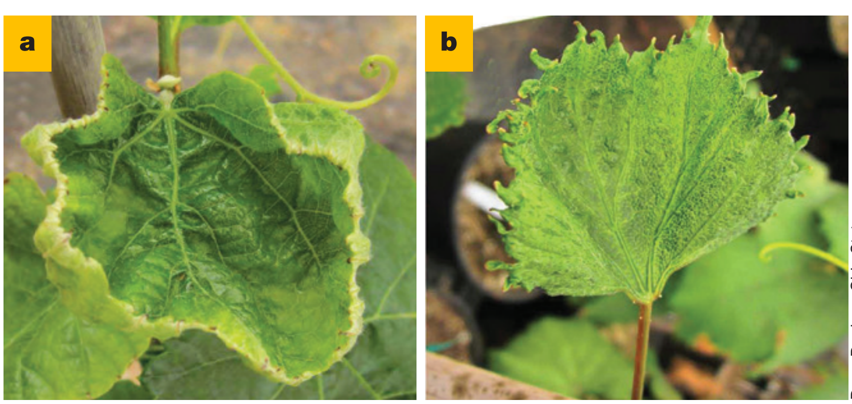
The applicator is legally responsible for checking both current and predicted weather conditions, following all label restrictions, and knowing where neighboring sensitive crops are located.

Off-target plant damage may also result from inadequate cleaning of sprayer equipment, contaminated runoff water, and sometimes from contaminated grass clippings or compost.

How Dicamba and 2,4-D Drift Damages Plants

Dicamba and 2,4-D are the most common members of a group of herbicides that mimic naturally occurring plant growth regulators. These herbicides overload a plant's growth-regulating system. Sensitive crops exposed to drift levels of dicamba and 2,4-D may show distorted growth in the leaves, leaf petioles, or stems. Symptoms of drift damage can show up within hours if plants are growing quickly, or within a few days under slower growing conditions.

The symptoms and severity of dicamba and 2,4-D drift can vary greatly between species. Watch for cupped leaves (Figure 2a and 3) or leaves that become chlorotic (on leaf tissue or veins), narrowed, or develop parallel veination (Figure 2b), stunted growth (Figure 3), necrosis (tissue death), delayed or uneven flowering/ fruit set, (Figure 4), twisted growth on stems and petioles, adventitious root development (Figure 5), and reduced yield.



Doug Doohan, Ohio State

FIGURE 2 | a) Dicamba drift injury causes leaf cupping to grapes
b) 2,4-D damage on grape manifests as chlorosis and distortion in the shape of the leaf and veination.

Mark Loux, Ohio State

FIGURE 3 | Dicamba damage on non-genetically-modified soybeans includes stunted growth, cupped and crinkled leaves.

Doug Doohan, Ohio State

FIGURE 4 | Uneven and aborted fruit set on injured grapes.

Lindsey Orphan, Southern Illinois University Carbondale

FIGURE 5 | Adventitious roots on pumpkin after exposure to a full dose of dicamba.

We've talked about dicamba and 2,4-D together, but they are two distinct chemicals. A plant's response will not necessarily be the same for both.

We've talked about dicamba and 2,4-D together, but they are two distinct chemicals. A plant's response will not necessarily be the same for both. For example, snap beans and lima beans are more sensitive to dicamba than to 2,4-D. In grapes, low concentrations of both herbicides can cause stem twisting and leaf droop, but dicamba more typically causes cupped leaves in grapes, while narrow leaves with parallel veins (strapping) is a symptom of 2,4-D damage in grapes (Figure 2). Other species may show different signs of damage. There is too much variation between species to make broad generalizations. University of California IPM has a searchable photo gallery of common crops injured by sub-lethal doses of herbicides. University of Missouri also has an excellent collection of photos from dicamba and 2,4-D drift sensitivity trials which includes a variety of woody and herbaceous specialty crops. (See Resources.)

While tools like these can be helpful, most growers will need to consult a professional for a final diagnosis. If a state pesticide regulator cannot be consulted quickly, an extension or university employee, crop consultant, or farmer advocacy organization may be able to suggest professionals or laboratories that can help. See our related fact sheet on responding to and documenting suspected drift damage. It is important to review these steps *before* drift damage happens.

Evaluating Your Risk

This fact sheet series is designed to help you consider your level of risk and take action to prevent or respond to drift damage. If you are growing a sensitive crop in an area dominated by conventional agronomic crops, you may indeed be at risk. Additional publications will compare sensitivities among various common specialty crops, answer frequently asked questions, share proactive tips to protect and prepare your operation against drift damage, and review steps to take if you believe drift damage has occurred.

Helpful Resources

Drift Mechanics and Dicamba, 2,4-D History

The Deal with Dicamba
National Agricultural Law Center
Detailed information on dicamba legal developments. nationalaglawcenter.org/the-deal-with-dicamba-part-one/

Air Temperature Inversions Causes, Characteristics and Potential Effects on Pesticide Spray Drift
North Dakota State Online Publication AE1705 (Revised Oct. 2019)
Detailed information about temperature inversions written for applicators. ag.ndsu.edu/publications/crops/air-temperature-inversions-causes-characteristics-and-potential-effects-on-pesticide-spray-drift

Why are temperature inversions important when deciding on whether we should spray?
University of Minnesota Extension Crops
Short video from 2017 which provides a good description of temperature inversions. youtu.be/jG10vCT1POg

Five Things We've Learned about Dicamba
University of Missouri
Recent findings on temperature inversions, pH effects on volatilization, and plant drift injury. ipm.missouri.edu/IPCM/2019/4/dicamba/

Tools for Herbicide Drift Injury Diagnosis

Herbicide Injury Website
North Carolina State Extension
An excellent series of fact sheets and photos on the symptoms of common herbicides on several fruit and vegetable crops. Also includes a handy Injury Site Visit check list. weeds.ces.ncsu.edu/weeds-herbicide-injury/

Herbicide Site of Action Key
University of Wisconsin
Simple but useful 2-page key to identifying herbicide plant injury noticed at emergence or later in the growing season. ipcm.wisc.edu/download/pubsPM/2018_HerbicideInjury_web.pdf

IPM Herbicide Symptoms database
University of California Division of Agriculture and Natural Resources
A searchable gallery of herbicide damage photos for a wide variety of crops and products, plus information on herbicide trade names, active ingredients, and modes of action. herbicidesymptoms.ipm.ucanr.edu

Plant Injury from Herbicide Residue
Virginia Cooperative Extension Service Publication PPWS-77P
Discusses effects and persistence of several growth regulator herbicides, including dicamba and 2,4-D. pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/PPWS/PPWS-77/PPWS-77P-pdf.pdf

University of Missouri Herbicide Drift Injury Trials
Excellent photos of drift damage to key woody and herbaceous plants at various levels of.
Investigations of Sensitivity of Ornamental, Fruit, and Nut Plant Species to 2,4-D and Dicamba weedscience.missouri.edu/2017-2018TreeResults.pdf
Evaluations of Dicamba and 2,4-D Injury on Common Vegetable and Flower Species weedscience.missouri.edu/Vegetable%20Injury%20with%20Dicamba%20and%202,4-D%202018.pdf

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