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Accidental Herbicide Damage on Vegetables

by David Trinklein and James Quinn

Modern agronomic practices include the use of more and more non-selective herbicides. RoundUp Ready® crops already are widely planted and are being supplemented with 2,4-D and dicamba resistant crops. The latter were developed in an effort to control weeds that have become resistant to glyphosate. Additionally, copious amounts of non-selective herbicides are being used to chemically "burn down" cover crops before the land they occupy is planted in the spring.

The above presents a problem for vegetable growers located adjacent to crop farmers. During herbicide application, very fine droplets or products of volatilization can find their way to areas where application was not intended and, as a result, vegetables, ornamentals, and trees can show herbicide injury symptoms. Unfortunately, reports of the latter have been on the increase in recent years.

The extent to which an herbicide will drift from its intended target depends on several factors such as the type of herbicide, environmental conditions (e.g. wind speed) at the time of application, and sensitivity of surrounding plants. Anyone familiar with tomato knows it is one of the most sensitive crops grown, and the majority of the aforementioned cases of accidental herbicide damage has involve tomato.

The most common cause of accidental herbicide contamination is particle drift, which occurs when small droplets are blown off-target by the wind. Damage from this type of drift most often is quite proximate to the herbicide application site and largely can be prevented using proper application techniques. Spots from these droplets may be quite obvious and consistent on a selection of plants in the area (see photo one).

Plant damage from products of herbicide volatilization is much less common and harder to diagnose. It is also difficult to prove or consider pesticide misuse*. Damage has been known to occur miles from the application site, depending on the herbicide involved and sensitivity of plants damaged.

Vegetable growers should be aware of what crop is planted in adjacent fields and what kind of herbicide practices might be used for that crop. Since this land often is owned by other farmers, conversations with one's neighbor is an important first step in the prevention of accidental herbicide injury. Producers of agronomic crops often are not aware of the extreme sensitivity of vegetable such as tomato to herbicides. This becomes a somewhat urgent matter as we get into the post emerge weed control chemicals for field crops such corn and soybeans.

If growers suspect accidental herbicide damage to one or more of their vegetable crops, an orderly series of steps should be taken. First, when damage occurs, the damage needs to be documented. The date should be noted and a review of damaged plants should be written down. As quickly as possible, a combination of photos and plant samples should follow. MU Extension and its Diagnostic Lab can help to document symptoms, but do not perform residue testing. Missouri Department of Agriculture can assist with taking plant samples for residue testing; this is only done when filing a formal complaint.

Next, try to determine if other causes of plant stress (e.g. temperature, fertilizer) might be mimicking herbicide injury. Off-target movement of herbicides will cause multiple plants over a large area

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Pest Update

Samples were received at the diagnostic clinic from the counties listed, for the specified crops, and diagnosed with the listed disease.

County	Crop	Disease
Morgan	Pepper	Pythium Root Rot
Morgan	Tomato	Early Blight
Dallas	Tomato	Rhizoctonia Root Rot
Cedar	Tomato	Bacterial Canker

The abnormally cool weather of May 15-20th could cause disease pressure on warm season vegetables in the field during that spell. Root rots associated with *Pythium* are likely, as well as *Rhizoctonia*. If soil conditions remain wet, *Phytophthora* development will also be favored.

Aphids seem to be worse this spring. Growers should be on the lookout for them. The mild winter may aide other insect pests to overwinter in higher numbers than typical.

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to exhibit similar symptoms. Grows should carefully observe leaf margins, new growth and the main stem, as these areas can offer several clues for herbicide damage. The University of Tennessee has developed a helpful publication showing the response of tomato to a number of different herbicides, including those used on forages. The publication can be found at: https://ag.tennessee.edu/herbicidestewardship/Pages/Tomato%20and%20Pasture%20Herbicides.aspx

If herbicide injury is suspected, growers should attempt to narrow down the source of contamination. After ruling out one's own negligence (e.g. use of an herbicide-contaminated sprayer to apply other pesticides) attention should be turned to "off farm" sources. If damage is most severe in plants adjacent to a field recently sprayed by a neighbor, there is fairly strong evidence that the neighbor's action caused the injury. Also, looking for patterns in a planting can help determine the source of contamination. A change in the intensity of symptoms in a field may indicate the direction which the herbicide came.

Unfortunately, herbicide injury cannot be reversed. Even though plants may somewhat recover, yields will be lower which can result in significant economic loss. If there is strong evidence that the action of a neighbor or chemical applicator hired by a neighbor is the cause of herbicide damage to a crop, then normal "economic loss resolution" procedures should be followed.

There are several approaches one can follow for seeking either compensation or, at least, the recognition of the problem. The approach chosen likely will be determined by the severity of the damage, the relationship with the individual who caused the damage, their willingness to acknowledge it, or some combination of these.

These approaches include:

1. Work directly with the neighbor, the pesticide application service acting on their behalf, and/or their insurance provider, for compensation for crop loss (or a promise to be more careful). This, however, does requires the neighbor or service hired to acknowledge they caused the damage. The latter is important if the neighbor or spraying service are to prevent future incidents from occurring.
2. Contact the Missouri Department of Agriculture (MDA) and report the incident. This should be done as quickly as possible following the incident by telephone (573-751-5504). An investigation by the MDA will result. Please note the insert included with this newsletter for complete MDA information (Procedures for investigating possible pesticide misuse*; Pesticide incident report). If the MDA is contacted, an investigator will visit the farm to ask questions and conduct the investigation; there are eight spread across the state. At that time, the grower will have the opportunity to:

A. Ask that formal action is taken. The inspector will then spend time collecting samples. To follow the proper process, this may take several hours. The inspector will advise the grower on a number of issues. A few of special interest include:

i. There is no cost to the grower for the inspector's time or any sample collection and residue testing.
ii. Lab results from residue testing takes about eight weeks.
iii. Case closure generally takes about six months.
iv. Pesticide residue must be detected on sampled tissue to prove accidental damage from nearby herbicide application occurred.
v. MDA does not assist with any aspect of financial compensation for crop loss. Growers are on their own when seeking payment for damages.

B. Decline any formal action. This needs to be done within the first 10-20 minutes of the inspector visit. The declining of formal action often occurs as the inspector verbally reviews what was just presented above.

The preceding does appear to be a lot of trouble, especially in the midst of a busy production season. If herbicide damage is fairly minimal, the question arises if one should even pursue it. A convincing reason to follow up on even mild damage is to try and prevent accidental herbicide damage from occurring in the future. Even good neighbors are not likely to change their farming practices if they do not know anything "bad" happened because of their actions. Notifying the farmers involved when incidents of accidental herbicide contamination occur is the best way to motivate them to be better neighbors to vegetable growers.

* Pesticide misuse can be the result of several actions, such as pesticide drift, personal protection equipment violations, site violations, rate violations, etc.

The authors would like to express appreciation to Darryl Slade (Enforcement Program Coordinator for the Bureau of Pesticide Control of the Missouri Department of Agriculture) for his assistance.

Caption: Buckwheat, cantaloupe and petunia each (L to R) displaying similar spotting from same herbicide particle drift incident.

Two for the price of one: Enhancing disease control during wet weather using copper and other dual purpose products

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Weather in the past few years (following the 2012 drought season) is pretty much dominated by wet summers with monthly precipitations exceeding the normal averages in Missouri. The record high precipitation in decades during some summer months in 2015 has challenged many growers in the state and beyond. Obviously, the impact of a nonstop rain at the peak seasons and the subsequent "little ponds" created on farms for long durations has not only delayed land prep and plantings but also gravely burdened growers by a huge task of frequent weed management. Setting aside these, the excessive precipitation accompanied by windy rain storms has led to increased incidence of diseases on many farms and unfortunately, to the detection of sporadic diseases. One such example was the surprise appearance of cucurbit downy mildew (CDM) after the Labor Day in 2015. CDM was first detected on the sentinel plots at Lincoln University's G. W. Carver farm (http://ipm.missouri.edu/meg/2015/10/Cucumber-Downy-Mildew/) and in few more high tunnels afterwards.

The most frequent diseases in 2015 were those caused by bacteria and the water-loving "fungus-like" organisms (also known as the water molds belonging to the Oomycetes in the Kingdom Protista). This is based on the annual report of the Plant Diagnostic Clinic, frequently asked questions from clientele, and as witnessed by many educators' farm visits in the extension systems of University of Missouri and Lincoln University. Expectedly, extended wet weather equates to a "feast" for this groups of microbes as their livelihood entirely depends on presence of water. Undoubtedly, the continuous warmth and extended periods of wet weather accompanied by an increased relative humidity has also exacerbated the situation and led to a great spike in incidence and severity of many fungal diseases.

The question that comes to everyone's mind is what can be done differently under such circumstances. Growers are highly advised to a) anticipate based on weather predictions, b) monitor in a timely manner, and c) acquire an accurate diagnosis and detection as early as possible before the pathogen infections devastate their crops. At many instances, diseases caused by bacteria and oomycetes could easily cause a total crop failure in a short duration, if left unabated in a timely manner. In addition, chasing each group of pathogen under such a high disease pressure during extended periods of rain becomes extremely challenging. First, it is difficult to get a time window that is enough to get dried plant surfaces prior to sprays and second, it is difficult to keep plants covered by the fungicides for long without being washed away by the frequent rains.

Responsible use of chemistries with dual fungicidal and bactericidal property, as part and parcel of an integrated disease management strategy, inevitably becomes a necessity to save crops during these situations. Understandably, alternating and/or tank mixing different fungicides with different modes of action is essential to avoid or delay pathogen resistance. The purpose of this article is to shed some light on the available chemistries that could simultaneously take care of diseases caused by more than one pathogen group, bacteria, fungi and water molds*.

*These are groups of organisms within the kingdom protista division oomycetes are known to have some sort of motile stages in their life cycles (zoospores) and hence phylogenetically different from true fungi. Common pathogen genera within the oomycetes that are known to cause serious damage on produce include Pythium, Phytophthora, and many others that are responsible for downy mildews. For a long time though, they were grouped under the kingdom fungi, hence the term fungicide is still used for those compounds that kill oomycetes.

The following are few examples of chemistries that are known to have fungicidal and bactericidal properties.

A. Copper products or different formulations of copper are the first group of chemistries with efficacies reported on multiple pathogen groups. The following are examples of two major sub-groups.

i. Copper sulfates which come in different trade names. Just to mention three: 1) Basicop™ whose active ingredient (a.i.) is tribasic copper sulfate monohydrate, 2) Cuprofix® Ultra 40 Dispress® (a.i. basic copper sulfate), and 3) Tri-Base Blue® (a.i. tribasic copper sulfate in the form of a suspension concentrate). For instance, Tri-Base Blue® is registered for a number of bacterial (spot, speck, canker), fungal (early blight, septoria leaf spot) and oomycetous (late blight/phytophthora blight) diseases.

ii. Copper hydroxides which also comes in different trade names as Kocide 2000®, Kocide 3000®, Champion®, Champ® etc. Copper products such as Kocide®, Champ®, Cuprofix® are labelled for bacterial spot of pepper in greenhouses. They also give a fair protection in field applications of pepper for bacterial spot. Similar copper products such as Badge®, Champ®, Cueva®, Cuprofix®, Kentan®, Kocide®, and Nordox® are labelled for greenhouse use to manage bacterial spot and speck on tomatoes. Copper products also reduce spread of bacterial diseases under field conditions. In both cases, however, bacterial strains that are copper-resistant have been detected in the Midwest. To mitigate this and improve efficacy, growers are highly encouraged to use Mancozeb

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products (e.g. Dithane, Manzate, and Penncozeb) with copper products.

Some watermelon growers in boot-heel area have hinted the use of Kocide® alongside chlorothalonil containing products (Bravo®, Equus® or Echo®) as an early preventative spray against most fungal and bacterial diseases of watermelon. In addition to its primarily bactericidal properties, Kocide® is registered for a number of fungal pathogens in cucurbits.

Recently, there are also products such as ManKocide® that contain active ingredients of both Kocide® (46% Copper Hydroxide) and Mancozeb® (15% Manzoceb, a product of zinc ion and manganese ethylene-bis-dithiocarbamate). ManKocide® is labelled for a range of crops and pathogen groups including but not limited to fungi, bacteria and oomycetes.

B. The second groups are those which have a proven efficacy as Plant Defense Inducers. For example, acibenzolar-S-methyl (ASM), also known as Actigard® as a commercial product, belongs to the group P1 according to the 2016 Fungicide Resistance Action Committee (FRAC) mode of action classification (http://www.frac.info/docs/default-source/publications/frac-code-list/frac-code-list-2016.pdf?sfvrsn=2). This is a group known to have a host plant defense induction. On cucurbits, it has a good efficacy against bacterial leaf and fruit blotch but it has to be combined with copper applications for the best outcome. It has a poor efficacy on other fungal diseases (powdery mildew and scab) and downy mildews. On tomatoes, this product has been reported to show a fair efficacy for bacterial spot and speck diseases. In other herbs, such as basil, Actigard® has shown a good control of the recently emerging downy mildew disease in greenhouses.

C. The third group is products with broad spectrum, multi-site actions that are used to manage the two major groups of pathogens, water molds and fungi. One amongst many other examples for this group is Gavel® which contains mancozeb and zoxamide, for instance, has a good efficacy against downy mildew and phytophthora blight as well as the fungal disease alternaria leaf blight of cucurbits as shown on the 2016 Midwest Vegetable Production Guide. Tanos®, a product which combines cymoxanil and famoxadone as active ingredient, has a wide spectrum of activity on many fungal (good performance against Alternaria and Anthracnose), oomycetous and bacterial diseases. The production guide can also be accessed online (https://ag.purdue.edu/btny/midwest-vegetable-guide/Pages/default.aspx) for free.

Overall, products that could simultaneously thwart diseases caused by multiple pathogen groups are economically beneficial as long as the labels are followed. In any case, however, compatibility should be checked if any tank mixing of products is planned. Such a use in both cases not only saves a money and time by half but also makes planning and implementation of sprays very efficient.

N.B. Trade names in this publication are used solely for the purpose of providing specific information. Such use herein is not a guarantee or warranty of the products named and does not signify that they are approved to the exclusion of others. Mention of a proprietary product does not constitute an endorsement nor does it imply lack of efficacy of similar products not mentioned. Do not use any of the products unless registered for the given crop in the state.

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