

VEGETABLE CROPS HOTLINE

A newsletter for commercial vegetable growers prepared by the Purdue University Cooperative Extension Service



Issue: 685
March 25, 2021

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Fungicide Applications During Rainy Weather

(Dan Egel, egel@purdue.edu, (812) 886-0198)

This evening’s schedule calls for applying fungicides to your watermelon. Everything is ready for the application, but now you aren’t sure. The weather report forecasts rain tomorrow. Will the rain tomorrow wash off the fungicide application? Should you wait to apply the fungicide until after it rains?

This question or similar questions are among the most common questions I receive. A similar question would be “Yesterday I applied a fungicide and it rained this morning. Should I re-apply the fungicide?”

Let’s take the question about applying a fungicide before it rains first. The short answer is that it is usually best to apply a fungicide before it rains. Why? Because rain causes leaf surfaces to be wet, a requirement for most foliar diseases, and rain may splash spores from leaf to leaf and from plant to plant. Therefore, if one is able to coat plants with fungicides prior to a rain, the plant is better protected from disease. In short, periods of wet weather are when a plant is most vulnerable to foliar disease. Fungicides, properly applied, may help to prevent or slow the initiation of disease and the spread of disease which commonly occurs during or shortly after a rain.

But let’s look at this question in a bit more detail.

What most growers are worried about is that a rain that falls shortly after a fungicide application will wash off the fungicide.

That is, the grower wonders if the fungicide will be rainfast. Rainfast may be defined as: the effectiveness of a fungicide application after a rain event. The best answer to the question of whether a fungicide is rainfast is to read the label. Unfortunately, most labels do not specify whether they are rainfast. See the list below to find some of the labels for which I was able to find rainfast information. Be aware that the information that you find on the product in your possession may differ from what I have written below. And my list is not exhaustive—be sure to check your label.

Table 1: Rainfast information given on the label of selected fungicide labels.

Fungicide	Rainfast info
Approach®	1-hour
Champ DP®, Kocide 3000®	8-hours*
Curzate 60DF®, Cymbol®	2-hours
Endura®	Yes
Fontelis®, Vertisan®	1-hour
Monsoon®, Onset®, Toledo®	2-4 hours
Orondis Ultra®	30-minutes
Presidio®	2-hours
Pristine®	Yes
Propimax®	Dry before rainfall
Quilt xcel®	Dry before rainfall
Quilt®	Dry before rainfall
Quintec®	1-hour
Rhyme®	2-hours
Tanos®	1-hour
Tilt®	Dry before rainfall

*This rainfast period was listed only for use on Ginseng.

This list may bring a few questions to mind. For example, what does the word ‘dry’ mean in the table above. I believe it means that the fungicide is rainfast after it has dried on the plant surface. What does ‘yes’ mean? This is less clear. But presumably the manufacturer is willing to stand by the product as rainfast under at least some conditions. A length of time listed indicates that the product is rainfast if applied that period of time before a rain. If a fungicide is not listed, it means I did not find the term rainfast on the label. It is interesting to me that some well-known products with trade names that include rainshield or weather stick have no mention of rainfast on the label. So, it pays to search the label carefully (I have obtained the PDF’s of labels and searched for the term ‘rainfast’ as a way of searching for information).

The amount of rainfastness a fungicide has may be, at least in part, dependent on whether the product is contact or systemic. Contact products such as chlorothalonil (e.g., Bravo®, Equus®,

Echo®) or mancozeb (e.g., Dithane®, Manzate®, Penncozeb®) remain on the surface of the plant after application. Such products are more likely to be washed off after a rain. But read on for much more detail. Systemic fungicides move into the plant after application. This characteristic makes these products, in general, more likely to be rainfast. But more detail can be found below.

When I failed to find much information from the label, I looked in the scientific literature. Below, I have listed some of the take home messages from what I found. The format I have used is to list the trade name, the crop and disease investigated and the conclusion of the authors and finally the citation of the publication. My thoughts are given in italics.

Contact products:

Daconil® (chlorothalonil); creeping bent grass and dollar spot; best to apply product 8-24 hours before rain. J. Inguagiato, K. Miele Crop Protection 83 (2016) 48-55

Bravo® 500 (chlorothalonil); potato; rainfall on the day of application resulted in the greatest loss of residue. Later rainfall did not result in as much residue loss. There was some redistribution of fungicide residue from top to bottom of plant with rain. *Thus, rain does not necessarily remove fungicide residue from the plant, but may redistribute the fungicide. Applications of chlorothalonil 24 hours before a rain will probably be effective.* Bruhn & Fry Phytopath. 72:1306-1312 1982

Dithane Ultra WG® (mancozeb); apple; recommend drying time of at least 4 hours. *That is, application of Dithane® 4 hours before a rain will probably be effective.* Hunsche et al. crop prot. 2011 30:495-501

Copper hydroxide-copper oxychloride; apple; 0.2 inches of rain washed off 80% of copper. *Most copper applications are probably not as rainfast as other contact fungicides.* Hunsche et al. crop prot. 2011 30:495-501

Spray adjuvants

The addition of an agriculturally registered surfactant to sprays of Dithane F-45 Rainshield® will improve initial spray deposits, fungicide redistribution and weatherability. Read the label and use adjuvants recommended by manufacturer.

Systemic products

Quadris F® (azoxystrobin); fall fescue and brown patch; effective 15 min after rain; recommend 1-hour rainfast. Butler et al. Crop, Forage and Turfgrass mgmt Sept 2019

Quadris F® (azoxystrobin); grapes; 1-day old residue; 2-inches of rain did not reduce effectiveness; Interestingly, the same 2-inches of rain reduced residue, but did not reduce effectiveness. This information is from Annemiek Schilder at Michigan State University in an extension article.

General guidelines

Apply most fungicides on 7-14 day schedule. More frequent applications should be made during or right after rainy weather.

MELCAST, a weather-based disease forecasting program for cucurbit growers takes weather into consideration when

recommending fungicide application intervals.

For most crops, use a 14-day minimum. After 14 days, the fungicide may have weathered considerably and new growth will warrant a new application.

Apply contact products 24 hours before a rain if possible. As the information above suggests, an application of a protectant even 8 hours before a rain may be effective.

Apply systemics 1-2 hours before a rain. This is a general guideline. Some products labels have specific information.

Check label for more info. Above I have listed several fungicides that have specific rainfast information on the label. Nevertheless, check your label carefully. If a rainfast guideline is given, great. If a specific adjuvant is given, follow that information carefully.

Let's return to the question I proposed at the beginning of this article. Should I wait until it rains before I apply a fungicide?

In most cases, one should apply a fungicide before it rains. We've seen how rain is important in creating leaf wetness and spreading spores from leaf to leaf. Contact products will probably be effective if applied 24 hours before a rain, perhaps even 8 hours before a rain. Systemic products will probably be effective if applied 1-2 hours before a rain. Again, read the label for specifics.

I applied a fungicide yesterday and it rained 1 inch today. Should I reapply the fungicide as soon as possible? In most cases, no. However, it might make sense to schedule the next fungicide application a bit sooner than scheduled. After the rainfastness period (24 hours for contact, 1-2 hours for systemics) older reduces are more likely to need application than more recent applications. Contact products are more likely to need reapplication than systemic products.

In summary, it is best to apply fungicides before a rain if at all possible. If a heavy rain occurs shortly after a fungicide application, it usually makes more sense to shorten the interval before the next fungicide application than to make a second application immediately after the rain.

Fungicide Information for 2021

(Dan Egel, egel@purdue.edu, (812) 886-0198)

As vegetable growers get ready for the 2021 season, one question might be to find up-to-date information about fungicides and how to apply them. Some possible resources are listed below.

- The *Midwest Vegetable Production Guide for Commercial Growers* offers recommendations for fungicides and other pesticides and practices that have been updated for the 2021 season. The guide, which is searchable online, can be accessed at mwveguide.org. Although official hard copies of the guide are not being sold through Purdue University this year, if you have questions about how to get a hard copy of the guide contact Dan Egel.
- Fungicide schedules for cucurbit growers can be found at the links below. This information has been updated for the 2021 season. Melon and watermelon information can be found [here](#). Pumpkin information can be found [here](#). If

you have trouble accessing these sites or you would like a hard copy, contact Dan Egel.

- Purdue has a weather-based disease-forecasting system, known as **MELCAST**, developed by Rick Latin and run by Dan Egel. **MELCAST** lets growers schedule fungicide applications for cucurbits based on the weather. A table of what areas of Indiana are covered by **MELCAST** is located at [info](#). An extension bulletin about how to use **MELCAST** can be found [here](#). A record sheet to keep track of **MELCAST** information can be found [here](#). If you need hard copies of any of this information, contact Dan Egel.
- A presentation given by Anthony Keinath of Clemson University at 2021 Southwest Indiana Melon and Vegetable Growers Spring Meeting describes fungicides used to manage gummy stem blight and anthracnose of watermelon. See article in this issue for presentation.

Questions or comments may be addressed to Dan Egel at (812) 886-0198; egel@purdue.edu.

The Purdue Plant and Pest Diagnostic Lab – Ready to Serve You

(Tom Creswell, creswell@purdue.edu)

The Purdue University Plant and Pest Diagnostic Laboratory (PPDL) specializes in the identification of plant diseases, insects and plants, as well as in the diagnosis of plant-health related problems. The PPDL is a partner in the national Plant Diagnostic Network (<http://www.npdn.org>), a national consortium of diagnostic laboratories dedicated to enhancing the work of diagnostic labs through professional development.

We work to solving your plant problems with rapid and accurate diagnoses and identifications, including:

- Fungal, bacterial and viral plant diseases
- Insects and other arthropods
- Unknown plants
- Vertebrate pests
- Environmental or cultural injury to plants

We serve as a source of unbiased information regarding pest management strategies and provide training for diagnosis of plant and pest related problems.

Sample handling fees for routine diagnosis: \$11 for Indiana samples and \$22 for samples originating outside of Indiana. An additional \$25 fee is charged for ELISA or ImmunoStrip (virus) testing. Tests requiring molecular (PCR) work are typically \$25-75. For more information on our fees and services and to download forms see our website at:

<https://ag.purdue.edu/btny/ppdl/Pages/default.aspx>

Ten Tips for Collecting and Submitting Samples:

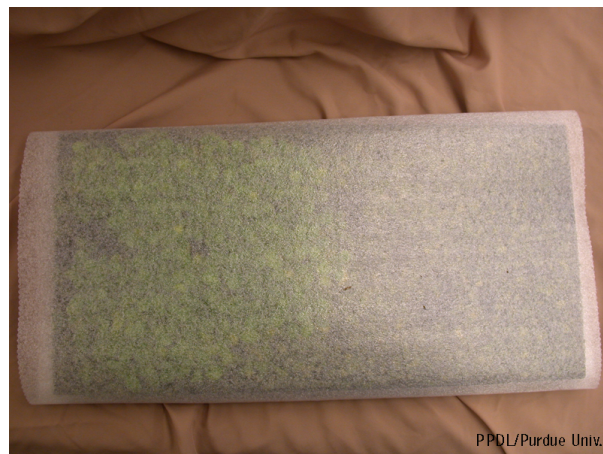
1. **Time is money:** Don't wait until the problem is widespread to send a sample. Many diseases and insects are manageable if caught early.
2. **Dead plants tell no tales:** Plants which are totally dead,

dry or rotten are useless for diagnosis. Collect samples from declining plants but not completely dead ones.

3. **What's bugging you?** For insect ID collect several examples, just in case some are damaged, or if both males and females are needed. Most small insects can be shipped in vials with 70% alcohol. For more details on how to send other insects visit:

<http://www.ppdl.purdue.edu/PPDL/physical.html>

4. **More is better:** The main concern may be overlooked if you send only one plant, one insect or a single branch. Send plenty of material, including whole plants when practical. Make sure samples are representative of what you are seeing.
5. **Get to the root of the problem:** Many plant problems are related to the roots and soil. For annuals and perennials in the landscape where the whole plant appears to be dying please dig up the entire plant to submit, rather than pulling them up. This will keep roots intact. For plants that are not removed please include a sample of the smallest diameter roots and at least a cup of soil. For problem plants in containers or plug trays, if possible, submit entire pots and plug trays to help maintain the integrity of the plants. We provide pH and EC readings of most soil samples submitted with a plant but for complete soil nutrient analysis you'll need a commercial lab. (Email us at ppdl-samples@purdue.edu to request a list of labs in the region)



Seedling tray covered in light foam material for shipping.

6. **A place for everything:** If soil gets on the leaves during shipment it can mask symptoms or even create a "disease" that wasn't there when the sample was collected. Keep soil around roots so they don't dry out. Bag the roots and soil and tie at the main stem or secure roots and soil within a double layer of heavy-duty aluminum foil. Wrap foliage in newspaper lightly then place a plastic bag over the rest of the plant and tie the top to keep foliage from drying out. Make sure foliage is dry before packaging.



Dig plants and contain soil and roots in plastic bag secured around base of stem.

7. **The devil is in the details:** The more you tell the diagnostic lab about the situation the better. Please give complete information; including name of plant, location, percent affected, symptoms of concern, distribution, soil type and drainage; and fertilizers or pesticides used recently. For Plant or Weed ID please give full details requested on submission form.
8. **Fresher is better:** Mail or deliver samples as soon as you can. Store samples in a cooler on hot days until you can deliver or ship them. Avoid mailing samples late in the week since most plants will start to rot after being in transit over a weekend. A next day delivery service is needed for urgent samples or those that may rot quickly in shipment.
9. **Fragile, handle with care:** Padded mailing envelopes may be used for samples that are not fragile, such as ears of corn, but sturdy cardboard boxes with crumpled newspaper for padding are preferred in most cases (essential for young and tender plant material). Insect vials must be padded to prevent breakage in shipment.



Packaging of plants in pots.

10. **A picture is worth a thousand words:** Photos are very helpful for Plant ID and Weed ID and critically important for diagnosis of tree, shrub and turf problems. See our guides for taking good photos of trees and turf and find links to our photo upload tools at our website (<https://ag.purdue.edu/btny/ppdl/Pages/digitalimages.aspx>)

). Photos can also be emailed to ppdl-samples@purdue.edu. We prefer you not send print photos unless they have been printed on a photo printer or at a store kiosk. The sample handling fee covers working with both photos and a physical sample.

Critical sample on the way?: Email us at ppdl-samples@purdue.edu to let us know you are planning on sending samples that may require special handling.

Our shipping address:

Plant and Pest Diagnostic Lab – Purdue University
915 West State Street, LSPS Room 116
West Lafayette IN 47907-2054

Have You Selected Your Sweet Pepper Varieties Yet?

(Petrus Langenhoven, plangenh@purdue.edu, (765) 496-7955)

There is still time to select sweet pepper varieties for this summer. During the 2020 growing season, I evaluated a new batch of five sweet bell pepper varieties. I also evaluated five sweet tapered pepper varieties for a second season. All varieties (Table 1, Figures 1 & 2) were grown in a high tunnel at the Purdue Student Farm, West Lafayette IN. Peppers were seeded April 23, 2020, and transplanted into a 30' x 96' high tunnel on May 21, 2020, with an in-row spacing of 1.5 feet and between-row spacing of 4 feet. (7,260 plants per acre). Plant nutrient management was done according to soil test results.

Table 1. Colored sweet bell and tapered pepper cultivar characteristics*.

Cultivar	Type	Days to Maturity	Immature Fruit Color	Mature Fruit Color
King Arthur	Bell Pepper	72	green	red
Goliath Gold Rush	Bell Pepper	75	green	yellow
Flavorburst	Bell Pepper	87	lime green	golden yellow
Socrates	Bell Pepper	75	dark green	red
Midas	Bell Pepper	80	dark green	yellow
Marcato	Tapered Pepper	70	green	red
Carmen	Tapered Pepper	80	green	red
Escamillo	Tapered Pepper	80	green	golden yellow
Mattadores	Tapered Pepper	70	deep green	red
Giubileo	Tapered Pepper	80	dark green	yellow

*Data obtained from seed company listed information



Figure 1. Fruit of sweet bell pepper varieties.



Figure 2. Fruit of sweet tapered pepper varieties.

All varieties evaluated performed well under high tunnel conditions (Figures 3 & 4), despite issues with the trellising system that resulted in plant lodging. Flavorburst (yellow bell), one of the most consistent performers in our variety trials, once again produced the highest number of marketable fruits per plant. Flavorburst is a sturdy relatively compact plant and continues to produce fruit all season long. This variety is also the least affected by blossom end rot (BER) (Figure 7). Midas (yellow bell pepper), a variety evaluated for the first time in 2020, was the surprise of the season. The fruit was very uniform, elongated, and weighs about 10 oz. This variety is a top performer producing a marketable yield of 106,000 fruits per acre, weighing 67,500 lb. Most of the Midas unmarketable fruit (70.2%) was culls due to BER (Figure 7), but the abundance of large fruit made up for the loss in marketable fruit. If you are looking for a red bell pepper, then I would suggest Socrates (Figure 3). Socrates produced less BER culls than King Arthur (Figure 7). Goliath Gold Rush produced a disappointing yield (49,232 lb./A). This blocky pepper is very prone to getting BER and also suffered from other disqualifying quality issues. The fruits were at times covered in necrotic spots with cracks on the fruit's shoulders.

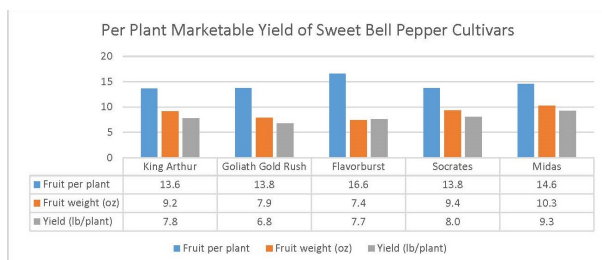


Figure 3. Marketable yield of colored sweet bell pepper cultivars.

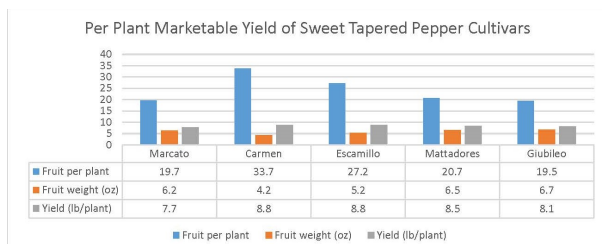


Figure 4. Marketable yield of colored sweet tapered pepper cultivars.

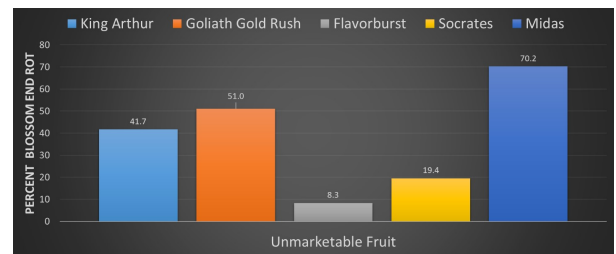


Figure 7. BER of colored sweet bell pepper cultivars showed as a percent of total unmarketable fruit.

Carmen (red tapered) and Escamillo (yellow tapered counterpart to Carmen) outperformed all other tapered pepper varieties in terms of marketable fruit numbers, 244,723 and 197,109 fruit per acre, respectively (Figure 4). I regard Carmen as an industry standard and therefore include it every year in the variety trials. The tapered pepper varieties did not differ significantly in terms of marketable yield production. However, Carmen and Escamillo produced the highest marketable yield (about 64,000 lb./A). In 2019, Carmen and Escamillo produced on average 17.6% and 23% higher marketable yields, respectively, compared to 2020 (Figures 5 & 6). In fact, all tapered pepper variety marketable yields were higher in the 2019 season. The comparative yields indicates that growing conditions during a specific season can have a major impact on yield, positive or negative.

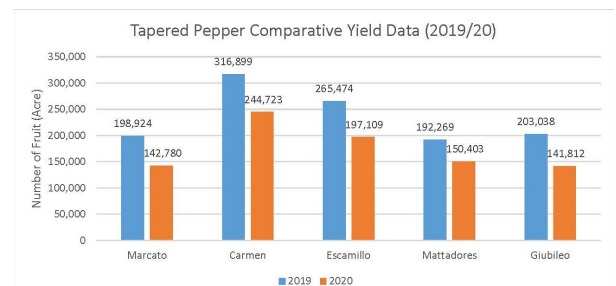


Figure 5. 2019 and 2020 comparative fruit yield (number/acre) of sweet tapered pepper cultivars.

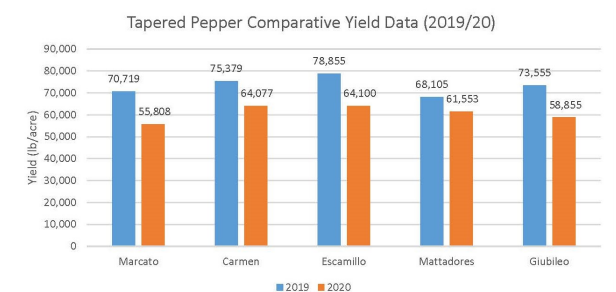


Figure 6. 2019 and 2020 comparative fruit yield (lb/acre) of sweet tapered pepper cultivars.

On average Carmen and Escamillo produced fruit that is 7.5 inches long. If you are interested in growing very long tapered peppers, then you would appreciate Giubileo (yellow, 10 inches long) and Mattadores (red, 9 inches long). However, Giubileo is also very prone to getting BER. Eighty-six percent of the total unmarketable fruit was BER culls (Figure 8). Marcato (red tapered) was the most affected by BER. These varieties produced beautiful fruit but the extra-long fruit (>9 inches) makes them prone to BER under suboptimal growing conditions. Despite the challenges all tapered pepper varieties experienced with BER, they still produced some of the highest yields in the variety trial.

Assess your market and choose varieties accordingly.

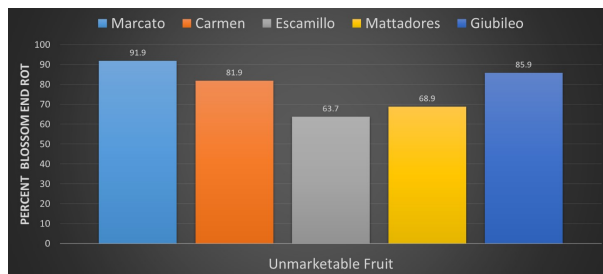


Figure 8. BER of colored sweet tapered pepper cultivars showed as a percent of total unmarketable fruit.

Purdue Specialists

(Dan Egel, egel@purdue.edu, (812) 886-0198)

As vegetable growers get ready for the 2021 season, it might be a good idea to keep the list below handy. Most of the names one would need to contact during the season are listed along with their contact information.

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Farmers may Benefit from Additional Financial Assistance

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

The USDA is establishing new programs and efforts to bring financial assistance to farmers, ranchers and producers who felt the impact of COVID-19 market disruptions. The USDA Pandemic Assistance for Producers announced recently include: Investing \$6 Billion to Expand Help & Assistance to More Producers; Adding \$500 Million of New Funding to Existing Programs; Carrying Out Formula Payments under CFAP 1, CFAP 2, CFAP AA; Reopening CFAP 2 Sign-Up to Improve Access & Outreach to Underserved Producers. The USDA will re-open sign-up for of CFAP 2 for at least 60 days beginning on April 5, 2021. For more information about this announcement, please visit

<https://www.usda.gov/media/press-releases/2021/03/24/after-identifying-gaps-previous-aid-usda-announces-pandemic>

Self-employed farmers may benefit from the Paycheck Protection Program. The application deadline is March 31. If you are interested, please look at this article published through Michigan State University Extension

<https://www.canr.msu.edu/news/farms-with-no-employees-can-still-benefit-from-the-paycheck-protection-program>

Grower Survey to Assess Herbicide Drift Damage in the North Central U.S.

(Cassandra Brown, brown.1844@osu.edu), (Doug Doohan, doohan.1@osu.edu), (Stephen Meyers, slmeyers@purdue.edu, (765) 496-6540) & (Bill Johnson, wgj@purdue.edu, (765) 494-4656)

A special project group of the North Central Integrated Pest Management (IPM) Center wants to learn about your concerns and experiences with herbicide drift. The group is surveying growers of fruits, vegetables, and other specialty crops in the upper Midwest.

To truly understand the frequency, severity, and economic impact

of herbicide drift on specialty crops, we need to hear from growers: growers who have experienced drift damage, growers who can share their concerns around this issue, and even growers who have not dealt with drift but who grow sensitive crops in drift-prone regions. Survey responses are needed to establish herbicide drift as a serious economic and regulatory concern in Indiana and across our region.

Please complete the survey at go.osu.edu/drift10.

Who should take this survey?

The study is for commercial growers of fruits, vegetables, and other specialty crops in IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, or WI. Even if you have never experienced herbicide damage, we would still like to hear from you if you grow specialty crops in one of these states.

Why is this survey necessary?

Dicamba and 2,4-D drift damage has made headlines in recent years, but no study to-date has attempted to quantify the overall impact drift has on the specialty crop industry. While all states have a way for growers to file a drift complaint, the process and requirements are inconsistent and may involve time and information that a grower does not have. In most states, for instance, the source of the drift must be identified. Research has found that dicamba and 2,4-D both have the potential to travel for miles in specific weather conditions, making source identification difficult.

What good will this survey do?

This study is designed to assess the potential and actual frequency of drift damage, along with the severity and economic impact of such damage. The survey includes questions on grower awareness, experience, actions, and decisions related to herbicide drift and drift-risk management. The responses will help establish needs for research on drift mechanisms, prevention, and remediation; and/or the need to review current policy and reporting requirements.

How long will it take?

The survey takes 5-20 minutes to complete, depending on your experience with drift damage.

How will this data be shared?

Summarized survey data will be shared broadly with regulatory agencies, university educators and researchers, agricultural policy makers, grower support organizations, and the general public using news articles, report summaries, and peer-reviewed journal articles. While this study is administered by The Ohio State University, it was planned in partnership with industry experts across the region who will assist with sharing results. Participants may also request a copy of the study summary.

How will my data be used and protected?

Your privacy is important. No individual survey data will be released or shared beyond the limited group of project staff. The survey questions and procedures have been reviewed by the institutional review board at The Ohio State University and are designed to protect your data and identity. Additional details on

privacy and confidentiality are provided at the beginning of the survey.

How can I learn more?

The North Central IPM Center's special project group created a series of fact sheets on herbicide drift especially for specialty crop growers. The series includes: Overview of Dicamba and 2,4-D Drift Issues, Frequently Asked Questions, Preparing for Drift Damage, and Responding to Drift Damage. Fact sheets and more information about our special project group and study are available at go.osu.edu/ipm-drift.

This study is facilitated by The Ohio State University and is funded by the USDA National Institute of Food and Agriculture through agreement 2018-70006-28884. This study is being conducted in cooperation with regional universities and non-profit grower organizations, including Purdue University.



A Study of Herbicide Drift in the North Central US: Drift Damage and Grower Responses

This study will survey specialty crop growers to...

- assess frequency, severity, and other details of herbicide drift damage.
- measure related grower concerns, actions, and experiences.
- collect data to inform policy, research, and educational priorities.

Please watch your inbox for this survey or respond now at: go.osu.edu/drift10



This work will be administered by The Ohio State University with funding from the USDA National Institute of Food and Agriculture, Crop Protection and Pest Management Program through the North Central IPM Center (2018-70006-28884).

Winter Webinar Recordings

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

A wide range of topics related to vegetable production was covered in our winter meetings. Recording of these meeting are available on-line now. If you missed these presentations, or want to visit them again, please follow the links to Purdue Extension Youtube Channel, where you will find a playlist for each of the meetings that include all the presentations. If you aren't able to access these recorded presentations, and would like to have the presentation slides, please contact me (guan40@purdue.edu) or a local extension office.

Purdue Extension Vegetable Farming Webinar Series

<https://www.youtube.com/playlist?list=PLtXSf1tu3Jd9lvllPnaZmrKcWVT9DCJRX>

2021 Southwest Indiana Melon and Vegetable Growers Spring Meeting

<https://www.youtube.com/playlist?list=PLA2ifyAEXAzdiWlnBwCK7UBQTYn5LwGfm>

Great Lakes Vegetable Producers Network's Broadcast is Back

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

The Vegetable Beet is a live weekly interview and discussion focused on vegetable production challenges and opportunities brought to you by the Great Lakes Vegetable Producers Network.

We grow more together.

JOIN US LIVE!

We will be broadcasting live via Zoom at 12:30 ET/11:30 CT every Wednesday from the first week of March to the first week of

September.

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