Integrated Pest Management
University of Missouri

OCTOBER 2024

Missouri Produce Growers *Bulletin*
A Publication of University of Missouri

FDA Finalizes the Pre-harvest Water Rule! What Does it Mean for Produce Growers?

By Juan Cabrera-Garcia

Earlier this year the FDA issued a final rule related to the pre-harvest agricultural water requirements for covered produce stipulated in the Food Safety Modernization Act (FSMA) Produce Safety Rule. For those unaware, the Produce Safety Rule (PSR) sets the minimum regulatory standards to ensure that normally eaten raw fruits and vegetables are safe for human consumption. The main purpose of the PSR is to prevent microbiological contamination of produce coming from farms. The rule sets standards for growing, harvesting, packing, and holding produce for human consumption. Agricultural water is one of the major components of the PSR. Please contact your local extension agent if you are interested in attending a produce safety training.

The rule makes a distinction between water used to grow the crops (pre-harvest water) and the water used during harvesting and post-harvesting activities (post-harvest water). This article focuses on the final ruling made by the FDA on pre-harvest water. The post-harvest water requirements of the rule remain unchanged.

What changed for the pre-harvest water requirements?

Initially, the PSR required growers to build a water quality profile by testing their water source as part of their risk assessment and management requirements. The final rule replaces the microbial water quality profile requirements with a systems-based assessment to identify hazards and managing risks related to pre-harvest agricultural water. Although the water quality profile is no longer needed, testing can still be used as a tool when building the assessment and mitigation plan.

Through the agricultural water assessment, growers must provide documentation (evidence) that they identified conditions that can introduce known or foreseeable hazards and which corrective/mitigation measures must be taken to minimize risks of using pre-harvest water. There are two components to the agricultural water assessment, first is an evaluation of the known and foreseeable risks and second are the risk correction/mitigation strategies based on the outcomes of the evaluation.

How do I make a pre-harvest agricultural water assessment?

FDA has an online tool that growers can use to build their agricultural water assessment https://agwaterassessment.fda.gov/. Alternatively, you can use the following guide to build your pre-harvest agricultural water assessment.

Part 1: Risk Evaluation

1.1-Evaluating the agricultural water system: this assessment will generate outcomes that will inform the mitigation and corrective strategies suitable for your farm.

- Water source: are you using surface or groundwater? If you've taken the PSR training, you know that surface water tends to have higher risk of contamination than groundwater and municipal water sources. Groundwater sources can become contaminated if wells are not installed and maintained properly.
- Irrigation water distribution system: did you inspect your irrigation system? Check for any leaks that may be a source of contamination. Also, municipal or groundwater become surface water if you are holding them in open containers/tanks.
- Potential sources of contamination to your water source and distribution system: did you observe any sources of contamination in the vicinity of your water source and distribution system? Examples could include animals (wild and domesticated), neighboring farms, storage of biological soil amendments of animal origins, among others.

Also in this Issue:

1.2-Evaluating the agricultural water management practices

- Irrigation method: Is the irrigation system exposing the edible portions of the plants to contaminated water? Localized irrigation systems, such as drip irrigation, have lower risks compared to overhead irrigation systems. For example, you can safely use pond water to irrigate tomato crops if you use drip irrigation and provide evidence that the driplines are in good condition. However, you can still use overhead irrigation, but you need to demonstrate that the water is safe or pose no risk to human health, or you waited some time to lapse between irrigation and harvest.
- Application interval: Microbes that land on a surface can die over time due to solar radiation or desiccation. Microbial die-off period is a mitigation strategy not a corrective strategy, meaning that it is only an option if the outcome from the previous evaluation indicate that the water is safe. You must first mitigate any conditions that lead to water contamination prior to implementing microbial die-off as a mitigation strategy.

1.3-Crop characteristics: some crops have higher risks of contamination than others because of plant growth habits, produce surface characteristics, or incidence of cracks and bruises. For example, a strawberry crop will have higher risk than a blueberry crop because it has a creeping growth habit as opposed to a bush. Another example is that cracked tomatoes have wounds were pathogens can get into the fruit.

1.4-Envrionmental conditions and other factors: identify and record any other risk that my impact the pre-harvest agricultural water. Is your farm in a flood zone, did you notice wildlife activity near your irrigation pond, do neighbors have access for recreational activities in your pond?

Part 2: Outcomes-based Corrective and Mitigation Strategies

Determine if corrective or mitigation strategies are necessary to reduce the risks for potential contamination that were identified in Part 1. Every farm is different and will deal with a variety of risks, so it is difficult to summarize mitigation strategies in this guide. Please contact your local extension agent if you need assistance when developing and implementing corrective or mitigation strategies.

It is required that you regularly inspect and adequately maintain your water system at least once a year. We recommend that you update your pre-harvest agricultural water system assessment every year and when you make changes to your water management practices (such as using corrective or mitigation strategies).

Exemptions

Farmers can be exempt from conducting a pre-harvest agricultural water assessment if they provide records and evidence of:

- The pre-harvest agricultural water meets the requirements that apply for harvest and post-harvest agricultural water of no detectable E. coli. This includes not using untreated surface water.
  - o A grower can implement a water treatment system and keeps records of water test reports that demonstrate that the treated water meets the harvest and post-harvest agricultural water requirements. The grower keeps additional records to demonstrate that the water treatment technology es effective such as the concentration of active ingredient according to product label, contact time, and other water quality parameters that may impact the efficacy of the treatment technology. For example, the optimum pH for chlorine is between 6.5 and 7, therefore a grower using chlorine treatment should keep records of the pH of the water.
  - o A grower uses water from a public supply and the grower has records from the supplier demonstrating that the water meets the harvest and post-harvest agricultural water requirements.
- It is reasonably likely that any management practices made on water that meets the harvest and post-harvest agricultural water requirement will not change the quality of the water prior to being used as agricultural water. Growers may have systems in place to store and move water that can introduce risks of contamination. For example, a hydroponic farm that uses municipal water to grow lettuce using a deep-water culture (floating raft on a pond) is not exempt. The use of open ponds introduces risks that cannot guarantee that the quality of the municipal water will remain intact.

What is the deadline to comply with the agricultural water rule?

- Pre-harvest water
  - o Large farms (average annual monetary value of produce sold during the previous 3 years is more than $500,000): April 7th, 2025
  - o Smal farms (average annual monetary value of produce sold during the previous 3 years is between $250,000 and $500,00): April 6th, 2026
  - o Very small farms (average annual monetary value of produce sold during the previous 3 years is between $25,000 and $250,000): April 5th, 2027
- Harvest and post-harvest water
  - o Large farms: January 26th, 2023
  - o Smal farms: January 26th, 2024
  - o Very small farms: January 26th, 2025

Please reach out to your local extension agent if you have any questions regarding produce safety. You can also send us a letter to:

Attention: Juan Cabrera-Garcia
110 Waters Hall
University of Missouri
Columbia, MO 65211

Tales from the Field: Phytophthora

By Katie Kammler

I recently received a call from a commercial vegetable producer in east central Missouri about continued problems that the farm experiences every year: phytophthora. Phytophthora can infect all cucurbits including pumpkins, squash, melons, cucumber, as well as beans and solanaceous crops like peppers, tomatoes, eggplants. The farm has a history of phytophthora infections because it can remain in the soil a long time and is driven by moisture. It travels through water, so planting in well-drained fields and raised beds can improve drainage. Phytophthora blight causes fruit rot, rapid wilting, and plant death. At my farm visit, we saw plant death in squash and peppers. This problem was more prominent in low lying areas that can experience flash flooding from a creek that wanders through the entire farm.

Phytophthora blight is caused by the water mold *Phytophthora capsici* (*https://ag.umass.edu/vegetable/fact-sheets/phytophthora-blight*). Spores from the disease resemble powdered sugar on the plants. The "powdered sugar" is made up of millions of spores that release smaller swimming spores in water. The spores can be moved long distances through water. Movement can be through standing water from heavy rain with poor drainage, flash flooding, irrigation, or even between plants from wind-blown rain. The swimming spores are attracted to plant roots as they move through the water, spreading the infection. They can also be moved from field to field in soil on tillage equipment or tires. We can also aid in its spread by transporting infected plant material from place to place. I made sure I cleaned my boots and washed my hands before I went home after that farm visit!

What should you do to prevent phytophthora from becoming a problem on your farm? Never dump cull fruit or plants in production fields, and if you use compost, obtain it from a trusted source. Promote good drainage and do not over irrigate, used raised beds, plant tolerant varieties, and rotate plantings. If you have confirmed that phytophthora is present on your farm, prevent it from spreading around the farm and into irrigation sources, dispose of infected plants, harvest early from infected fields, and use fungicides according to the label. For more info on cucurbit fungicides, please visit *https://www.vegetables.cornell.edu/pest-management/disease-factsheets/phytophthora-blight-and-its-management-in-cucurbit-crops-and-other-vegetables/fungicides-for-managing-phytophthora-blight-in-cucurbits-and-other-vegetables/*.

Interesting observations from the farm visit include that butternut squash plants (*Cucurbita moschata*) did not show signs of severe infection evident in acorn squash (*Cucurbita pepo*). It also was more of a problem in hot peppers than bell peppers.

You can contact your local MU Extension horticulture specialist for assistance or submit a plant sample to the MU Plant Diagnostic Clinic: *https://extension.missouri.edu/programs/plant-diagnostic-clinic*.

Healthy Butternut squash (left) and empty rows of acorn squash (center and right)

The progression of symptoms of phytophthora is visible in this row

Close-up of infected acorn squash plants

Distribution of infection visible across the entire field

Using Enterprise Budgets to Make Informed Decisions

By Ryan Milhollin

As the production season on horticulture farms starts to slow later this year, it is a good time to reflect on the growing season. Was I able to sell my crops for the prices I wanted this year? What was my cost of production for each crop? Did I make a profit? What should my farm do in 2025 to be more profitable?

Enterprise budgets are one method of evaluating individual enterprises (or crops) within a farm business. Each enterprise has income and expenses, which can be used to estimate profitability. Budgets are usually framed on a per-unit basis, such as per 100-foot row, per square foot or per acre. Use of budgets can help you evaluate your alternatives and make sound business decisions, both for existing and new crops.

Framework for enterprise budgets is in three parts.

First, **income** is what you expect to grow (yield or quantity of units) times the average selling price (dollars per unit sold). The result gives you an estimate of the income you can expect for the enterprise. For example, you might plan to grow 30,000 pounds of pumpkins on an acre and sell them for $0.20 per pound (which generates $6,000 in income). Other income streams related to the enterprise, like byproducts or government payments, can be included as well.

Second, **variable or operating costs** are expenses that change with production. For the most part, these costs tend to be cash costs (such as seed, chemical, fertilizer, hired labor, plastic mulch, etc.). But noncash opportunity costs such as operator labor or operating interest (if you had to finance some inputs) are often shown in enterprise budgets and can be added or removed, depending on your situation. Variable costs tend to detail out the activities associated with planting, growing, harvesting and marketing and their respective expenses for that specific enterprise.

Third, **fixed or ownership costs** are expenses that do not vary with level of production and result from farm asset ownership. These costs would include land, machinery, equipment and overhead expenses (taxes, insurance, etc.), and are often referred to as sunk costs into the business. Fixed costs may be cash or noncash. Depreciation (noncash) is used to allocate machinery and equipment costs evenly over the useful life of the asset. Interest (average investment times interest rate) is also included to factor in if you would have invested in something else (opportunity cost) or had debt financing for your farm assets. If machinery or equipment are used on multiple enterprises or cover multiple acres, you can allocate or adjust the fixed cost amounts by percentage of use. For example, if you own a mulch lifter and you use it on five different enterprises, adjust the depreciation number down to 20% for the enterprise budget scale (per acre, etc.) you are looking at. The other 80% will be allocated to the other enterprises using that piece of machinery.

Sometimes, it is debatable whether an expense is variable or fixed (for example, do repairs fit into variable or fixed costs?). The key is to make sure the expense is placed in one category or the other so that it is factored into your cost of production. Careful accounting over the course of the year is important for successfully recording and understanding costs and income. If expenses and income are tracked accurately from year to year, operators can set benchmarks for an enterprise to evaluate its performance over time.

University of Missouri Extension is adding more enterprise budget templates that growers can use as a starting point to customize for their own operation. You can download these budgets from MU Extension (*http://muext.us/MissouriAgBudgets*) or connect with your local MU Extension horticulture or ag business specialist, who can help you find the budget templates you need. Recent additions include high tunnel tomatoes, beekeeping, hydroponic lettuce, microgreens and cut flowers. Enterprise budgets for other fruit, tree nuts and vegetable crops are expected later in 2024 and into 2025. If MU Extension does not have a template, look to nearby state universities for examples.

Below is an example of high tunnel tomato budget recently developed by MU Extension. It is based on a 2,000-square-foot high tunnel system with 226 plants yielding 11 pounds per plant. The budget assumes selling tomatoes in retail market channels but can be easily adjusted to look at wholesale or a combination of both channels. All MU Extension budgets have a spreadsheet available for you to customize in Excel or to print and pencil in your own estimates.

Table 1. Missouri high tunnel tomato budget for 2024.

	Unit	Quantity	Price per unit	Total per 2,000 square feet	Total per square foot	Your estimate
Income						
Tomatoes *(wholesale)*	pound	0	1.75	0.00	0.00	
Tomatoes *(retail)*	pound	2,486	2.75	6,836.50	3.42	
Total income				6,836.50	3.42	
Operating costs						
Soil test	each	1	15.00	15.00	0.01	
Plastic mulch	feet	400	0.06	24.96	0.01	
Drip tape	feet	400	0.05	18.40	0.01	
Transplants	each	226	0.44	99.44	0.05	
Vertical supports	each	56.5	2.20	124.28	0.06	
Fertigation	ounce	360	0.32	115.20	0.06	
Insecticide	ounce	90	1.09	98.40	0.05	
Fungicide	ounce	4	2.00	8.00	0.00	
Packing boxes *(25 pound)*	box	100	3.31	331.00	0.17	
Labor	hour	111	20.00	2,220.00	1.11	
Marketing	% of sales	10		683.65	0.34	
Repairs	% of capital	1		102.50	0.05	
Miscellaneous	total			0.00	0.00	
Operating interest	percent	8.5		81.62	0.04	
Total operating costs				3,922.44	1.96	
Ownership costs						
Depreciation on capital investments				887.50	0.44	
Interest on capital investments	percent	8.5		476.00	0.24	
Real estate charge				25.00	0.01	
Overhead, taxes and insurance	% of capital	1		205.00	0.10	
Total ownership costs				1,593.50	0.80	
Total costs				5,515.94	2.76	
Income over operating costs				**2,914.06**	**1.46**	
Income over total costs				**1,320.56**	**0.66**	

Tales from the Field: It's Going Viral... Tomato Spotted Wilt Virus

By Justin Keay

I spotted a very strange looking tomato plant in a high tunnel on a farm in Pike County, it stood out like a sore thumb amongst a stand of very healthy tomatoes. It lacked any of the common symptoms I come across amongst the plethora of bacterial and fungal diseases found on tomato plants. There were also no signs of insects or insect damage. The plant was stunted but had still managed to grow to about 3 feet tall, it was short and stout with a thick stem, good plant structure and abundant foliage. It had only managed to produce two very small fruits, the ripening of which appeared to be stalled. The foliage was yellowed overall, and some was turning a strange purple color. Some leaves showed purple veination, some leaves showed purple mottling. The other strange thing was that the stem had an abundance of large adventitious roots. All that being said, it was not pulling its weight in the high tunnel, an expensive structure to build and maintain.

I hadn't come across this problem before, but these symptoms all align with infection by **tomato spotted wilt virus**, AKA *TSWV*. The even stranger thing, one day later a grower sent me an email with pics of large tomato fruit showing signs of *TSWV*. This grower's plants were large and looked rather healthy, with symptoms of a disorder only appearing in the fruit. The plants had abundant fruit that was sizing up nicely, however they had strange circular rings present on the fruit surface, characteristic of a *TSWV* infection. The unique thing about some plant viruses is that their symptoms can manifest in different ways in the same vegetable crop. My guess is that the first plant I saw was infected early, and the second wasn't infected until it was fairly large. There is no cure for *TSWV*, so the best thing to do is prevent infection. But how did they get infected?

TSWV as with many plant viruses, is vectored by insects. In this case it is vectored solely by thrips. Western flower thrips are a problematic insect found in most high tunnels, their populations can explode quickly as it only takes 2-3 weeks to produce a second generation, and then a third… The virus itself exists in many common weeds but can only be transmitted to crop plants via thrips. Managing thrips is a challenge. One cultural practice growers should employ is to remove weeds both inside and outside of the high tunnel. You should create a buffer around your high tunnel by laying down landscape fabric and covering it with gravel if available. If this is not an option, keep grass mowed on a weekly basis, and weedwack those hard-to-reach spots. Manage weeds within the high tunnel during the growing season, and make sure you go into the fall and winter with a clean high tunnel.

There are also tomato varieties (*https://www.vegetables.cornell.edu/pest-management/disease-factsheets/disease-resistant-vegetable-varieties/disease-resistant-tomato-varieties/*) that have been bred for resistance to *TSWV*, resistance is a helpful tool to have in your toolbox. It is important to scout and monitor for thrips before applying an insecticide. You can use blue-sticky cards to monitor thrips or perform a visual inspection of plants. Many insecticide options are available to control thrips, make sure to rotate modes of action or resistance will build in populations. Use the online or print version of the Midwest Vegetable Guide (*https://mwveguide.org/*) to search for insecticides labeled for a given crop and insect. Plants infected with *TSWV* should be rogued from the planting and destroyed, as they will serve as a host for the disease. You can contact your local MU Extension horticulture specialist for assistance or submit a plant sample to the MU Plant Diagnostic Clinic: *https://extension.missouri.edu/programs/plant-diagnostic-clinic*.

Tomato plant with Tomato Spotted Wilt Virus symptoms

Purple veination of infected foliage

Adventitious roots symptomatic of TSWV

Tomato fruit with concentric rings symptomatic of TSWV

New MU/LU Urban Entomologist

By Emily Althoff

Hi all! My name is Emily Althoff, and I am the new Assistant Professor of Urban Entomology and State Extension Specialist for the University of Missouri and Lincoln University. I am from the other side of the river, Belleville, IL. and am so excited to be back and to serve the public near the community I grew up in.

I have a background working on insect identification as an undergraduate at the Illinois Natural History Survey's Insect Collection as well as the Hymenoptera (ants, wasps, bees) unit at the Smithsonian Museum of Natural History. I completed my M.S. here at the University of Missouri focusing on how environmental and genetic variation in soybean plantings impacts insect damage and my Ph.D. focusing on the chemical ecology of forest insects. Throughout my entomological journey, I have enjoyed teaching and education most of all. I have previously served as an outreach coordinator between insect organizations and the public, worked with groups such as Skype a Scientist to expand access to educational resources, and taught multiple undergraduate courses on insect identification and ecology.

If you have a question about an insect in your home or garden, you can send me an email at *emilyalthoff@missouri.edu* or drop off your sample with your county extension office for submission to the lab. However, it is important to consider the following when submitting your sample:

Via email:

1. Take clear, focused, and well lit images
2. Ensure you include images from multiple distances and angels
3. Include context. What day/time/location did the observation occur at? What was this insect consuming? Is there any damage?
4. Email me at: *emilyalthoff@missouri.edu*

Via physical samples:

1. Include multiple samples
2. Store the samples in a well sealed container with ethanol (If the sample is a butterfly or moth keep the sample dry instead).
3. Include context. What day/time/location did the observation occur at? What was this insect consuming? Is there any damage?
4. Send the sample with a note explaining the context of the sample to:

Emily Althoff
700 Hitt Street
3-22i Ag Building
Columbia, MO 65201

WHO'S WHO

Juan Cabrera-Garcia, *Editor*
State Vegetable Specialist
573-882-0567
Jcabrera-garcia@missouri.edu

Katie Kammler
Horticulture Field Specialist
Ste. Genevieve County
573-883-3548
kammlerk@missouri.edu

Ryan Milhollin
Assistant Extension Professor,
Agribusiness Management
573-882-0668
ryan.milhollin@missouri.edu

Justin Keay
Horticulture Field Specialist
Pike County
314-400-7388
justin.keay@missouri.edu

Emily Althoff
State Extension Specialist
of Urban Entomology
emilyalthoff@missouri.edu

Extension County Specialists

Adair: Jennifer Schutter, 660-665-9866
Bates: Ramón Arancibia, 660-679-4167
Henry: Travis Harper, 660-885-5556
Morgan: Joni Harper, 573-378-5358
St. Francois: Kate Kammler, 573-883-3548
Webster: Patrick Byers, 417-859-2044
Cole: Dhruba Dhakal, 573-634-5463
Carroll: Kathi Mecham, 660-542-1792

Send a letter to the editor:

110 Waters Hall
University of Missouri
Columbia MO, 65211

The Missouri Produce Growers (MPG) bulletin is published by the University of Missouri with funding support from the U.S. Department of Agriculture's Agricultural Marketing Service (grant AM22SCBPMO1152) and the USDA NIFA (National Institute of Food and Agriculture) CPPM – Extension Implementation Program and CPPM Program through the North Central IPM Center (2022-70006-38001). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the USDA.