In This Issue

From the Editor's Desk

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

Welcome to the Vegetable Crops Hotline (VCH), Purdue Extension's exclusive newsletter for people in the business of growing vegetables.

Spring arrived, and that included severe storms and tornadoes. Our hearts go out to those families and farms that were affected by last week's storms. This issue contains a lot of information about emergency preparedness and Indiana FSA risk management and disaster resources.

Frequently we include links to websites or publications that are available online. If you can't access these resources, don't hesitate to contact your local Extension office or us to request a hard copy of the information.

Remember that all previous articles published in the VCH newsletter are available on the VCH website.

What are your most important issues on the farm?

Growers, tell us what you would like Purdue Specialists and ANR Educators to write about. I want to ensure we cover your most important issues in our newsletter. We had a very poor response to the first survey, and therefore, I have opened the survey again. It will take you less than 30 seconds to complete. **Click here for the survey**. Or scan the QR Code. **Please complete this survey by April 20, 2023.**

Enjoy reading this issue. Do not hesitate to contact me, Petrus Langenhoven, at plangenh@purdue.edu if you have any questions or suggestions to improve the newsletter.

Emergency Preparedness

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

This Spring has already tested emergency response services. Much of Indiana is experiencing severe weather (thunderstorms, heavy rain, strong straight-line winds, and tornadoes).

Indiana PREPared (www.inprepared.org) has a number of resources about severe spring weather events. Two specific sites to check out are our "Spring & Summer Severe Weather" page and "Flood Resources for Educators & Media."

There is also a site within INPREPared (www.inprepared.org) specific for Tornado Response and Recovery after last weekend's storms:

https://www.purdue.edu/engineering/ABE/INPREPared/tornado-response-and-recovery/

Stormy End to March, Elevated Chances for Above-Normal Temperatures through Mid-April

(Austin Pearson, pearsona@purdue.edu, (765) 675-1177)

Indiana experienced near-normal temperatures for March as the state averaged 40.9°F, despite the record warmth at the beginning of the month (Figure 1). Weather stations in central, southern, and eastern Indiana experienced record-breaking high temperatures during the first week of March (Figure 2). Cold weather returned during the third week, with several daily low maximum and minimum temperature records broken or tied (Figure 3). Southern Indiana saw dormancy break for many woody perennials, which become susceptible to any cold snaps we encounter moving forward.

Climate Division Data by State between Two Dates
From Midwestern Regional Climate Center

Indiana
3/ 1/2023 to 3/31/2023

	Temperature			Precipitation			
cd	temp	norm	dev	prcp	norm	dev	percent
1	37.7	38.6	-0.9	4.12	2.92	1.20	141
2	37.5	37.9	-0.4	4.27	2.78	1.48	153
3	37.6	37.3	0.2	3.96	2.71	1.25	146
4	40.5	40.6	-0.1	5.53	3.36	2.17	165
5	40.3	40.1	0.2	5.93	3.28	2.65	181
6	39.9	39.1	0.9	5.72	3.08	2.64	186
7	45.2	44.8	0.4	7.86	4.23	3.63	186
8	45.0	44.2	0.8	7.18	4.17	3.01	172
9	43.4	43.1	0.3	6.40	3.95	2.45	162
State	40.9	40.7	0.1	5.73	3.40	2.32	168

Midwestern Regional Climate Center
MRCC Applied Climate System
Generated at:
Wed Apr 5 09:17:04 CDT 2023

Figure 1. Indiana climate division and state temperature, normal temperature, temperature departure from normal, precipitation, normal precipitation, precipitation departure from normal, and percent of mean precipitation for March 2023.

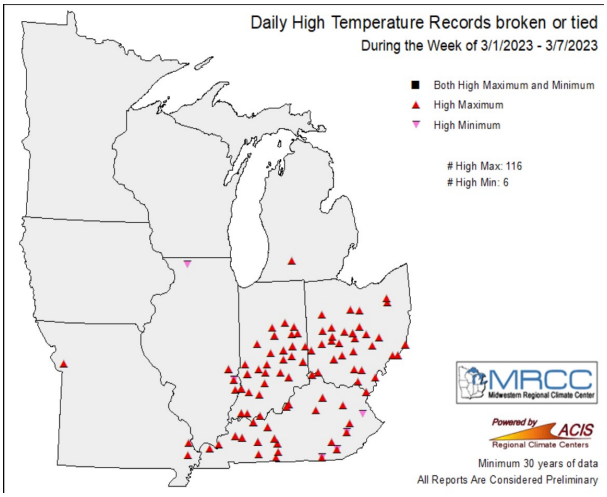

Figure 2. Midwest daily high temperature records broken or tied during the week of March 1-7, 2023.

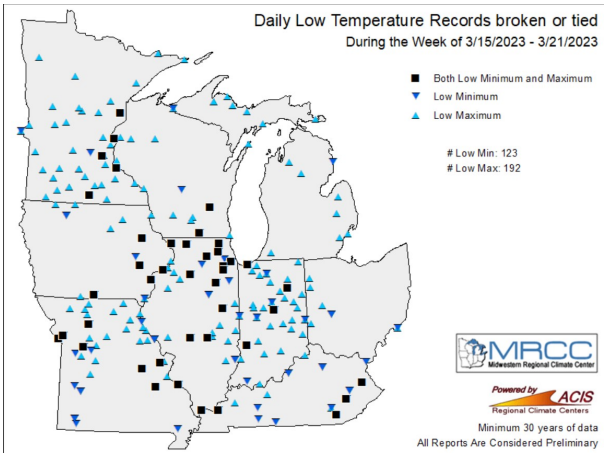

Figure 3. Midwest daily low temperature records were broken or tied during the week of March 15-23, 2023.

The big story for the month was flooding rain, and severe weather. The state averaged 168 percent of normal precipitation for the month, with locally higher percentages in central and southern Indiana (Figure 1). Dearborn County measured 9.38 inches of precipitation in March and had a single-day maximum of 2.85 inches on March 24. River flood warnings hung around for a large portion of the month as stormwater runoff overwhelmed streams and rivers. Localized flooding was also reported in spots.

On March 31st, a cold front associated with a strong low-pressure system caused a severe weather outbreak across the Midwest (Figure 4). As of April 5, there were 22 confirmed tornadoes in Indiana (NWS Indianapolis & NWS Northern Indiana have websites dedicated to the event). EF-3 tornadoes occurred in Grant, Sullivan, Johnson, Owen, and Monroe Counties in Indiana with significant damage. Tragically, five people died in the storms, along with 11 others sustaining injuries. The Indiana State Climate Office would like to express condolences to the families and communities impacted by these events.

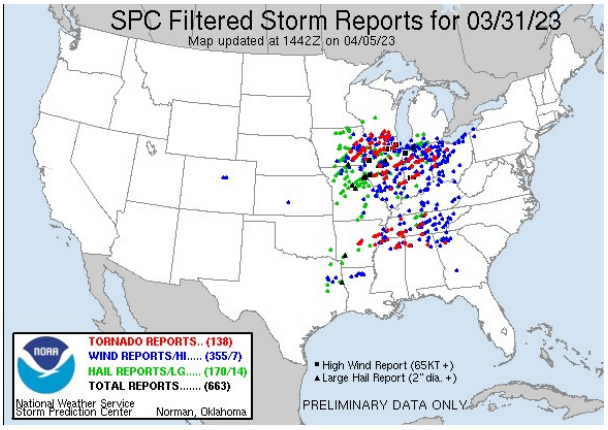

Figure 4. US Storm reports for the March 31, 2023, severe weather outbreak.

Turning attention to the Climate Prediction Center outlooks, mid-April has higher chances of above-normal temperatures and below-normal precipitation (Figure 5 a and b). This could be the pattern shift that is needed to help us dry out enough to begin fieldwork across the state.

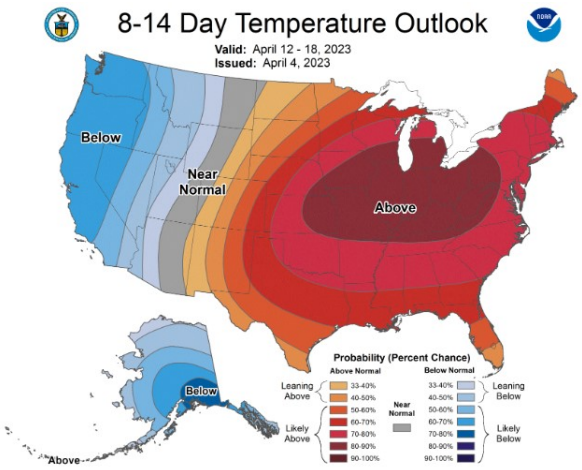

Figure 5a. Climate Prediction Center's 8-14 Day temperature outlook showing high chances for above normal temperatures mid-April.

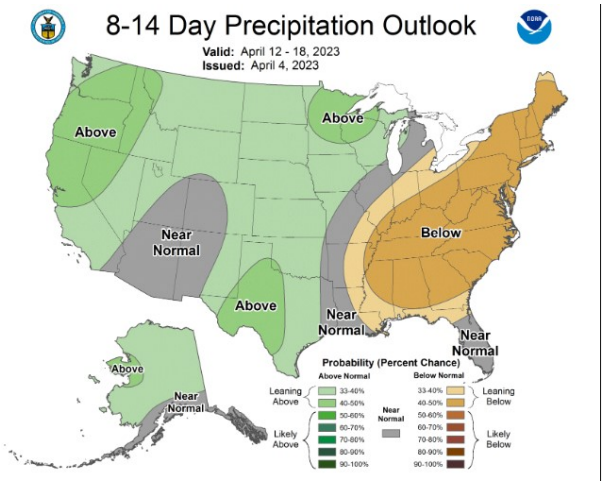

Figure 5b. Climate Prediction Center's 8-14 Day precipitation outlooks showing elevated chances for below normal precipitation mid-April.

Ethylene Damage on Tomato Plants

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

Almost every year, I have a greenhouse tomato grower or two call me about tomato plants that are distorted and don't seem to be growing right. The problem often turns out to be ethylene damage. This year, I have already received my first case of heater problem. Please read the article below to avoid or manage this problem.

Tomato plants with ethylene damage often have leaves that are curled down and stems that are twisted (Figure 1). Stems or leaves that are curled downwards are said to have epinasty (in botanical terms). Epinasty is a common symptom of ethylene damage. Ethylene is a common by-product of incomplete combustion of several different types of fuel. Incomplete combustion is often the result of heaters that are not working efficiently. Tomatoes are very sensitive to ethylene damage; however, other crops may also show ethylene damage.

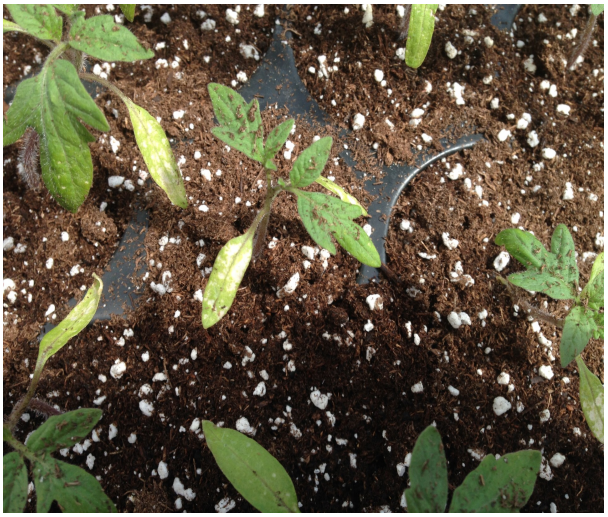

Figure 1. The tomato seedlings above exhibit downward curled leaves (see plant in upper left corner of photo) which maybe a symptom of ethylene damage and yellow seed leaves with lesions, a possible symptom of sulfur damage (Contributed Photo).

The tomato plants in figure 1 also have yellow seed leaves. Ethylene damage does not include yellowing. Furthermore, there is a spotting on the lower leaves that is not typical ethylene damage. I believe that the symptoms on seed leaves were as a result of a different compound, perhaps sulfur dioxide, a heavier than air compound that would remain relatively close to the heater. In fact, the yellowing leaves were observed close to the heater, while the curling leaves, caused by ethylene gas, were spread throughout the greenhouse. The production of sulfur dioxide may also be as a result of incomplete combustion.

While some greenhouses are heated with a furnace attached to the greenhouse, many greenhouses are heated with a standalone unit inside the structure. In the example in figure 1, the grower stated that the heater was of this latter type-a standalone unvented unit. While this type of heating is not recommended, natural gas, propane and kerosene generally burn clean and do not need to be vented. However, even units that burn clean fuels may cause problems if out of adjustment (see citation below).

I cannot prove that the symptoms in Figure 1 above are caused by ethylene. But a few years ago, we witnessed ethylene-like damage at a greenhouse here at the Southwest Purdue Agriculture Center (See article in the November 2007 Vegetable Crops Hotline, Issue 487). Therefore, we were able to confirm that ethylene was the cause of the symptoms shown in Figure 2. Given the similarities of the two examples and the circumstantial evidence, I believe the example given in Figure 1 was due to a heater malfunction. The grower reports that after the heater was serviced, the plants began to look healthier.

Figure 2. These tomato plants are exhibiting epinasty or a downward growth of the leaves in response to ethylene produced from a malfunctioning heater in a greenhouse. The topmost leaves are growing normally because the plants were removed to a separate greenhouse after exposure to ethylene. (Photo by Dan Egel).

Heating specialists should be able to measure ethylene, carbon monoxide and other products of incomplete combustion. The best time to measure incomplete combustion is after a cold night when the heaters have been running. Be sure to make such measurements before venting the greenhouse.

Poorly adjusted heaters can also add water to the greenhouse air- as much as 22 gallons of water a night! This unwanted moisture can lead to disease problems.

To avoid damage from ethylene and other air pollutants:

1. Have unit heaters checked by a professional and follow maintenance recommendations.
2. Assure adequate air supply for complete combustion. For each 2500 BTU's of heater output, 1 sq. in. of vent cross section is needed.
3. Prevent back drafts. Make sure the chimney extends 2 ft. above the ridge of the greenhouse, or 2 ft. above a 10-ft. line to any part of the structure.
4. Install an inexpensive carbon monoxide detector. If carbon monoxide levels rise it's likely ethylene and other pollutants are present also. And if carbon monoxide levels are high it is a significant human health hazard.
5. Scout for possible growth effects of ethylene and investigate right away if you see anything.

Additional Resources

Bartok, J.W. **Problems with Using Unvented Greenhouse Heaters**

Death, Divorce, and Disability: How Can Your Farm Plan for Human Resource Risk?

(Renee Wiatt, reneewiatt@purdue.edu), (Maria Marshall, mimarsha@purdue.edu) & *(Michael Langemeier, mlangeme@purdue.edu)*

This article is the second in a series that covers risks and planning for farms and agribusinesses. The first article, Adapting and Planning for Farm Businesses in Uncertain Times, can be found here.

When you hear the term "human resources", do you automatically envision a large corporation's department that manages benefits for many employees? Surprisingly, if you have an employee on your farm, then you have entered the realm of human resources. As the name suggests, human resources hold the human element, and with that comes a certain amount of inherent risk. Should your farm eliminate all employees and be completely automated? No, you can correctly plan for human resource risk and minimize the effects of many events.

The title of this article suggests death, divorce, and disability as three human resource risks, often referred to as *the 3 D's*. However, there are many other human resource risks for which businesses can plan. Human resource risks include any risks associated with humans, which can range from poor communication on the farm (which could have some minor or major consequences) all the way to death (which could have the most devastating consequences). Some human resource risks that a farm could encounter include:

- Poor communication/people management practices
- Management error/competence
- Illness/injury (temporary or permanent)
- Temporary leave (military, family, other)
- Divorce
- Death
- Disability (temporary or permanent)

The effects of some of the aforementioned risks can be minimized with the training of employees, such as poor communication, poor people management, and management error (Marshall and Alexander, 2005). As an owner of a business, you more than likely understand the importance of clear communication and customer service. However, everyone can always improve upon those skills. The way that you communicate internally to employees, market masters, and vendors can be just as important as how you communicate externally to current and potential customers. Training your employees to be friendly and transparent and to convey only positive comments to those internal and external to your business can pay off tenfold.

Other risks, such as divorce, disability, illnesses, leaves, and death, are more difficult to mitigate. Despite this fact, it is important to prepare for these risks. When someone is on temporary leave, others can step up and help to fill their void for a given amount of time. However, this void can be hard to fill when you are unsure as to what that person actually did or does on the farm. An easy way to remedy this is to have updated job descriptions for everyone in the farm business (yes, even the owner needs this). This job description needs to be updated annually at a minimum.

There are many sample job descriptions that can be found online; there is a publication entitled "Developing Effective Job Descriptions for Small Businesses and Farms" that can be found

on the Purdue Institute for Family Business page on *Management*. If you are unsure as to how or where to start in drafting job descriptions, spend some time each season of a full year keeping record of what every position in the farm does (and be specific). For example, instead of documenting that someone in the business "does machinery maintenance", make it more specific by saying that they "conduct regular inspections of farm equipment, make needed repairs, and provide advice on replacement of machinery" (Dobbins et al., 2021). This not only allows your employees to conduct that job in that person's absence, it also helps to know who to recruit to fill that position if that person leaves permanently.

Other tools that you can implement in your farm are employee policies and an employee handbook. Employee policies are rules that act as guidelines for proper conduct of employees and the business, such as the time employees should report to work, the amount of vacation time the employees receive, personal/sick days that employees can access, pay day when checks are issued or direct deposits are made, and other benefits. An employee handbook contains important information for employees, including answers to frequently asked questions and basic employment matters that all employees should know. However, be sure that employees know that the employee handbook is not an employment contract; be sure to include appropriate disclaimers.

Planning for the future of your business also includes management transfer/succession and associated aspects of that. Especially if you are within 10 years of retirement age, you should start considering who will take over the business when you retire. Some questions that you can ask yourself are as follows:

- Is the older generation ready to bring in a new generation and begin turning over management, control, ownership, and income?
- Is the younger generation committed?
- Do all generations agree on the future direction of the business?
- Has the business identified and agreed upon goals and objectives for the future of the business?
- Have you conducted a management skill assessment for the younger generation to determine where growth may be needed?
- Have you considered how the business can divide management responsibility moving forward?

If you are unsure as to where to start in the management transfer of your business, "The Farm's Legacy: A Guidebook for Intra-Family Succession" has a complete chapter on that exact subject, including articles on *Transferring Business Management, What Makes a Good Partner in Business?, Roadmapping Your Succession Transfer,* and more.

References

Dobbins, C., Ehmke, C., and R. Wiatt. (2021). Developing Effective Job Descriptions for Small Businesses and Farms. *Purdue Extension Publication: EC-728*. Available here.

Marshall, M.I. and C. Alexander. (2005). Planning for the Unexpected: Human Resource Risk and Contingency Planning. *Purdue Extension Publication: EC-736.* Available here.

Incorporating Brambles into a Vegetable Farm in Indiana

(Miranda Purcell, mrpurcel@purdue.edu)

What are brambles?

Bramble crops are from the genus *Rubus* and include blackberries and raspberries. Brambles are among the easiest fruit crops to grow, and the fruit is in high demand due to its exotic flavor and high nutritional value. Raspberries and blackberries can be sold for a greater price per pound than just about any fruit. One of the major challenges with bramble production is that the fruit can be quite perishable. Brambles can be incorporated into a vegetable farm with some key considerations.

Basics

Brambles have perennial root systems and biennial shoot growth (shoots live for 2 years). Brambles require full to partial sunlight and adequate water with good soil drainage to prevent wet feet. The ideal soil is sandy loam with a pH of 6.0-6.5. The desirable range of important nutrients is as follows: Nitrogen (foliar): 2.0-2.8%, Phosphorus: 20-30 ppm and Potassium: 120-180 ppm. Different types of raspberries include red, black, yellow, and purple varieties. Blackberries are categorized by their growing habit (erect, semi-erect, or trailing) and whether or not they have thorns.

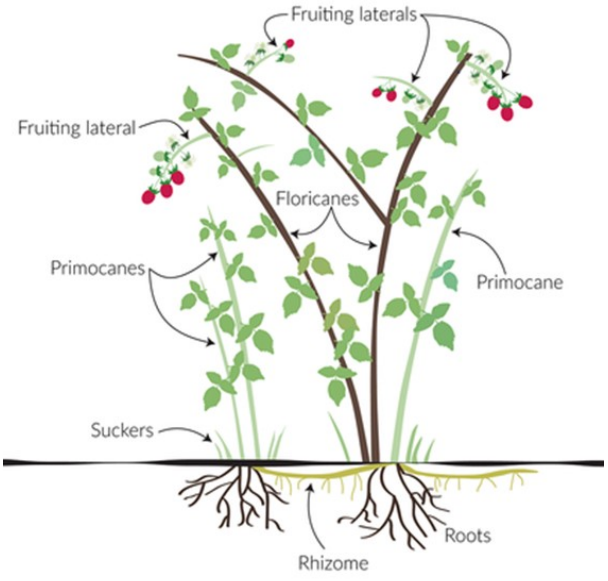

Figure 1. Primocanes (1-year-old shoots) and floricanes (2-year-old shoots) on raspberry plant. (Photo by University of Minnesota Extension.)

Raspberries

Raspberries produce fruit on 2-year-old canes (floricanes). Each

year, raspberries produce new shoots (called primocanes), which do not flower or produce fruit until year 2 (when they are floricanes). However, some red raspberry varieties are known as ever-bearing or primocane fruiting types, and they produce a crop in the late summer on floricanes and a second crop in the fall on primocanes. Remove bearing canes (floricanes) each year after harvest. Remove weak, diseased, or damaged canes in early spring. Black raspberries require tip pruning in the summer to encourage branching.

Raspberries are cold hardy, with most varieties well-suited to the Midwest. Red raspberries are the hardiest, although late Spring freeze damage can still occur, especially with extreme temperature fluctuations. Purchase certified virus-free plants and plant in the Spring. Expected productivity is 5-8 years. Raspberries are self-fertile, and the yield is typically 1-1.5 quarts per plant.

Blackberries

Blackberries can produce fruit on 1-year-old wood (primocane-fruiting types) or 2-year-old wood (floricane-fruiting types). Remove bearing canes (floricanes) after harvest each year. Tip pruning in summer is required to encourage branching. Remove weak, diseased, or damaged canes and shorten lateral branches in early spring. For easy management, trellis semi-erect varieties. For primocane-fruiting types, cut canes to the ground in the Fall after frost. New primocanes will grow in Spring (canes will grow, flower, and fruit in one season).

Most blackberries can only withstand -10°F, although new primocane fruiting varieties are slightly more cold hardy. Blackberries are most well-suited to Southern Indiana but can be planted in Northern Indiana with careful site and variety selection. Blackberries are self-fertile. Yield varies from 1 quart per 1-2 row feet for thornless erect types, 1-2 quarts per 1-row foot for thornless erect types, and 4-8 quarts per plant for thornless semi-erect types.

Figure 2. Simple trellis for blackberries with floricanes tied to the frame and primocanes growing up in the middle. (Photo by Bruce Bordelon.)

Considerations for Interplanting Brambles & Vegetables

When deciding whether brambles are compatible with their overall operation, growers must consider land, labor, capital, equipment use, time commitment, seasonality, and management skills. Bramble production requires a high initial investment, and slow returns are expected at first. Regarding labor, brambles can be an ideal crop for both small and large farms. However, large farming operations may require additional labor during pruning and harvest. Brambles ripen in late summer and may be ideal for a farm that grows and markets early-to-mid-summer maturing vegetables.

Space availability will determine plant type. Red raspberry plants should be spaced 2 ½ to 3 feet apart, and purple and black raspberries should be spaced 3 to 4 feet apart. Blackberry bushes should be planted 4-6 feet apart (closer spacing for erect and semi-erect types, wider spacing for trailing types). The distance between rows will depend on the equipment but typically ranges from 6 to 12 feet.

Avoid planting brambles where tomatoes, potatoes, eggplant, strawberries, or other crops susceptible to Verticilium wilt have been grown in the previous 4-5 years because the fungus that causes Verticilium wilt can remain in the soil for several years. Also, only plant brambles after field crops if there is no history of using herbicides with long residual activity.

Varieties for Indiana

Blackberries

- Erect Thornless: Ponca, Osage, Apache, Ouachita, Natchez, Arapaho
- Semi-erect Thornless: Triple Crown, Chester
- Thorny: Shawnee
- Primocane-fruiting: PrimeArk45, Black Magic, Freedom, Traveler

Raspberries

- Black Raspberries: MacBlack, Jewel, Bristol, Niwot (primocane-fruiting)
- Red Raspberries-
    - Summer: Nova, Titan, Prelude
    - Fall: Heritage, Autumn Bliss, Caroline

Additional Resources

Midwest Fruit Pest Management Guide

Raspberries | Purdue Extension HO-44

Blackberry Production Systems in Ohio

Small Fruit Cold Hardiness – Winter Injury in Brambles

UMass Small Fruit Management Guide – Brambles

Soil and Water Data is Critical for High Tunnel Growers

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

High tunnels are essential for every vegetable grower as they can modify the growing environment for crop earliness, protect the crop against environmental stress, reduce disease and insect pressure, and extend the growing season. Growing in a high tunnel is like growing crops in an irrigated desert. Natural rainfall is unavailable inside your high tunnel, and therefore, all your plant's water needs are satisfied through an irrigation system. The lack of precipitation inside the high tunnel impacts production management processes, particularly soil fertility management. In this article, I will discuss why analyzing your irrigation water source and soil is critical.

Figure 1. High tunnel soil prepped for planting (Photo by Petrus Langenhoven).

Test your soil and water

Soil and water test results are crucial to designing a management plan that ensures long-term soil health and high productivity. Do soil sampling before seedlings are set, preferably at the same time every year, in case you want to do a comparative analysis in the future. If your water source is a well or pond, I strongly recommend submitting a sample for analysis to your closest laboratory. Water composition at the beginning of the growing season can differ significantly from water tested later in the growing season. In this case, doing an analysis several times during the production season will be appropriate.

Water alkalinity

One of the significant issues with well water in Indiana is that it is sometimes very alkaline. Alkalinity (as $CaCO_3$) measures the combined amount of carbonate, bicarbonate, and hydroxide ions in the water, and it describes the ability of water to neutralize acids. In other words, it buffers water against pH changes. Water that helps to buffer against pH changes is excellent, but too-high alkalinity will increase the incidence of dripper clogging and increase root zone pH over time. The combination of high alkalinity and pH can cause plant nutritional disorders. Usually, the optimum alkalinity range for plants is between 30 to 60 ppm (or $mg \cdot L^{-1}$) (can be a source of calcium and magnesium), and the desired content for irrigation water is 0 to 100 ppm. Some laboratories report alkalinity in milli-equivalents ($meq \cdot L^{-1}$). Alkalinity of 50 ppm $CaCO_3$ is equal to 1 $meq \cdot L^{-1}$. Always include alkalinity and pH in your irrigation water test. pH by itself is not indicative of alkalinity.

Managing high alkalinity

Amending your water alkalinity and pH while you irrigate is the fastest and most cost-effective method to manage soil pH. Acid injection into irrigation water (to pH 5.8) or using an acidic fertilizer can help remedy the situation. Although fertilizers with a high potential acidity usually contain a high percentage of ammonical nitrogen and urea. A few sources of acid are available on the market: sulfuric acid is very affordable (adds sulfur), phosphoric acid can potentially add a lot of phosphorus, and nitric acid (adds nitrate) is very acidic and has harmful fumes. Exercise caution when working with acids. Also, consider that the source of acid used can provide specific nutrients. Citric acid (approved for organic growers) is the only source that does not supply additional nutrients.

A handy tool to calculate how much acid is needed is ALKCALC. All you need to complete the form is the water's pH and alkalinity content, the type of acid you want to use, and your target alkalinity level. When using drip irrigation, the pH between rows will remain high. To affect the entire high tunnel, use sprinkler irrigation to flood the whole tunnel when no crops are present. If you want to acidify your soil slowly with an organic amendment, apply elemental sulfur at 10 to 15 lb/1000 sq. ft. of bed area for each 0.5 pH unit drop needed (Mickelbart and Stanton, 2012; Sideman, 2018).

Other important water quality issues

Make sure that iron, manganese, and sulfate concentrations in the water are within acceptable ranges. Iron levels above 5 ppm could be toxic to the plant and result in iron precipitates forming at the emitter, plugging your irrigation system. Similarly, manganese levels above 1.5 ppm and sulfate levels above 240 ppm could cause emitter blockage. Keeping track of the sodium and chloride levels in the water is also essential. High levels (>50 ppm Na and >70 ppm Cl) can increase soil salinity, especially in the top 2-4 inches, and therefore must be managed carefully. Particularly given the high tunnel cover preventing natural rainfall from washing or leaching excess soluble salts from the soil.

Soil testing

The optimum values reported below can differ for different vegetable crops.

The optimum pH varies by crop. Still, it is generally accepted that the ideal pH range for organic and mineral soils is 5.3 to 5.8 and 6.0 to 7.0, respectively. In mineral soils, nitrogen, phosphorus, potassium, calcium, magnesium, boron, and molybdenum are most available when the pH is between 6.0 and 7.0. With a soil pH below 6.5, zinc, manganese, iron, and copper are the most available. It is, therefore, desirable to maintain mineral soil pH between 6.0 and 6.5. The available aluminum increases as the

mineral soil pH decrease, especially below 5.5. The increasing aluminum concentration can further contribute to soil acidification and aluminum toxicity, which inhibits root growth. The lower pH range is acceptable for organic soils (5.3 to 5.8) because aluminum levels are very low (Warncke et al., 2004).

The capacity of soil to hold exchangeable cations is measured and reported as the cation exchange capacity (CEC) of the soil. This value is a good indicator of soil fertility. Good soil has a CEC between 5 and 35 meq/100g soil. Generally, sandy soils have a low CEC, and soils with a high CEC are likelier to have a high clay or organic matter content. The optimum soil organic matter content for vegetables is 3% to 6% or higher.

Two tests are performed to determine the phosphorus levels, P1 (weak Bray) and P2 (strong Bray). The P1 test is an indication of the phosphorus that is readily available to plants (20 to 50 ppm is adequate), and the P2 test confirms the level of phosphorus that is available and part of the active reserve in the soil (40 to 60 ppm is a desirable level).

Potassium should be in the range of 150 to 300 ppm, calcium 1000 to 2500 ppm, and magnesium >50 ppm.

Soluble salt results are presented as the electrical conductivity (EC) of the soil and are measured in mmhos/cm. An EC <1.0 (<640 ppm salt) is considered good, and an EC >2.5 (>1600 ppm salt) is unsuitable for crops.

Percent base (cation) saturation indicates what proportion of the CEC is occupied by cations such as Ca^{2+}, Mg^{2+}, and K^{+}. Optimum ranges for Ca^{2+}, Mg^{2+}, and K^{+} are 40-80%, 10-40%, and 1-5%, respectively.

Micronutrient ranges for vegetable crops are between 1 to 3 ppm Zn, 1 to 5 ppm Mn, 11 to 16 ppm Fe, 0.5 to 1.5 ppm Cu, 0.7 to 1.0 ppm B, and 0.11 to 0.20 ppm Mo.

Soil salinity

The lack of rainwater to flush soluble salts can increase soil salinity. An increasing salt concentration in the soil also leads to increases in alkalinity. This can affect crop growth negatively and can be prevented and managed through a carefully planned soil fertility plan. Soluble salts can be introduced through irrigation water and soil amendments such as fertilizer (sodium nitrate, calcium nitrate, potassium nitrate, potassium chloride, etc.), composts, and manures. Dependent on the feedstocks used to make the compost, it can contain high amounts of salts and phosphorus. High tunnels tend to elevate soil temperatures inside the tunnel, which could increase soil microorganism activity, releasing nutrients from organic materials such as manures and composts faster into the root zone. The over-application of soil amendments leads to excess nutrients that are leached through the soil profile or build up in the root zone or near the soil surface.

Figure 2. High tunnel soil affected by surface level salinity (Photo by Petrus Langenhoven).

How does soil salinity affect plants?

Plant sensitivity to salinity differs. Some plants are more tolerant or sensitive than others (Figure 3). Sensitive plants could exhibit scorched leaf margins, leaf tip burning, or yellowing. Leaf tissue analysis can help to confirm whether these symptoms are due to salinity or other nutrient imbalances. Yield loss is of great concern in saline soils.

Vegetable	Soil		Irrigation Water	Rating [2]
	Threshold [1] ($dS \cdot m^{-1}$) EC_e	Slope (% per $dS \cdot m^{-1}$)	Threshold [2] ($dS \cdot m^{-1}$) EC_W	
Asparagus	4.1	2.0	2.7	T
Bean	1.0	19.0	0.7	S
Broccoli	2.8	9.2	1.9	MS
Carrot	1.0	14.0	0.7	S
Cauliflower	-	-	1.9	MS
Celery	1.8	6.2	1.2	MS
Eggplant	1.1	6.9	0.7	MS
Lettuce	2.0	13.0	0.9	MS
Muskmelon	1.0	1.0	-	MS
Okra	1.2	-	-	S
Onion	1.2	16.0	0.8	S
Pea	1.5	14.6	-	MS
Pepper	1.5	14.0	1.0	MS
Potato	1.7	12.0	1.1	MS
Purslane	6.3	9.6	-	MT
Red beet	4.0	-	2.7	MT
Spinach	2.0	7.6	1.3	S
Strawberry	1.0	33.0	0.7	S
Tomato	2.5	9.9	1.7	MS

[1,2] Adapted from Maas and Hoffman [37], Maas and Grattan [46] and Grattan [44]—Data not available. EC_e—electrical conductivity (EC) of saturated paste extract of soil. EC_W—electrical conductivity (EC) of irrigation water.[2] S = sensitive, MS = moderately sensitive, MT = moderately tolerant, T = tolerant

Figure 3. Soil Salinity: Effect on Vegetable Crop Growth. Management Practices to Prevent and Mitigate Soil Salinization (Machado, R. and R. Serralheiro, 2017).

Prevention and remediation

Limit the amount of soil amendments (composts, manures, nitrogen-based fertilizers) applied to the soil. Use the soil test results and expected yield (plant nutrient removal) to calculate appropriate application rates. Split application rates and use fertilizer sources with a low salt index (Figure 4). If possible, add cover cropping to your rotation in the tunnel. Cover crops are great tools to improve soil organic matter (instead of using compost) and scavenge nutrients (Figure 5). Think about what you want to improve or remediate in the high tunnel and select cover crops that can assist in achieving that goal. Water management is a great and easy way to manage and improve soil salinity. Use overhead irrigation to irrigate the entire soil surface in the high tunnel. Apply as much as 12 inches of water. An even easier solution might be to leave the tunnel uncovered during the rainy season. Every 4 to 5 years, you have to replace the plastic

cover on the high tunnel. Plan to leave the cover off during the rainy season. Consider doing this during the fall/winter when growing anything in the tunnel is hard.

Material and analysis	Salt Index: Per equal wts of materials	Salt Index: Per unit of nutrients*
Nitrogen/Sulfur		
Ammonia, 82%N	47.1	0.572
Ammonium nitrate, 34%N	104.0	3.059
Ammonium sulfate, 21%N, 24%S	68.3	3.252
Ammonium thiosulfate, 12%N, 26%S	90.4	7.533
Urea, 46%N	74.4	1.618
UAN, 28%N (39% a. nitrate, 31% urea)	63.0	2.250
32%N (44% a. nitrate, 35% urea)	71.1	2.221
Phosphorus		
APP, 10%N, 34%P_2O_5	20.0	0.455
DAP, 18%N, 46%P_2O_5	29.2	0.456
MAP, 11%N, 52%P_2O_5	26.7	0.405
Phosphoric acid, 54%P_2O_5		1.613[3]
72%P_2O_5		1.754[3]
Potassium		
Monopotassium phosphate, 52%P_2O_5, 35%K_2O	8.4	0.097
Potassium chloride, 62%K_2O	120.1	1.936
Potassium sulfate, 50%K_2O, 18%S	42.6	0.852
Potassium thiosulfate, 25%K_2O, 17%S	68.0	2.720

[3] Salt index per 100 lbs of H_3PO_4 *One unit equals 20 lb.

Figure 4. Calculating Salt Index (Mortvedt, J.J., 2001).

Figure 5. Hard Red winter wheat is used as a cover crop (Photo by Petrus Langenhoven).

In summary

1. Test your soil and irrigation water.
2. Ask the lab to provide recommendations or calculate your fertility needs.
3. Amend your irrigation water according to test results.
4. Select fertilizer salts carefully and limit the amount applied at one time.
5. Use caution when applying manure-based compost.
6. Plan to include cover crops in your crop rotation.
7. Plan not to limit irrigation through drip lines only. Apply overhead irrigation to leach excess salts.
8. Select crops that are tolerant to specific salinity conditions.

Resources

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USDA in Indiana Stands Ready to Help Indiana Farmers Recover from Recent Storms

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

This article was adapted from an Indiana FSA newsletter dated April 4, 2023. For more information about storm damage and disaster relief, read the newsletter.

USDA offers several programs to help with recovery from the storms that have impacted farmers in several Indiana counties.

Risk Management

For producers who have risk protection through Federal Crop Insurance or the Noninsured Crop Disaster Assistance Program (NAP), we want to remind you to report crop damage to your crop insurance agent or the local Farm Service Agency (FSA) office.

If you have crop insurance, contact your agency within 72 hours of discovering damage and be sure to follow up in writing within 15 days. If you have NAP coverage, file a Notice of Loss (also called Form CCC-576) within 15 days of loss becoming apparent, except for hand-harvested crops, which should be reported within 72 hours.

Disaster Assistance

USDA also offers disaster assistance programs, which is especially important to livestock, fruit and vegetable, specialty and perennial crop producers who have fewer risk management options.

First, the Livestock Indemnity Program (LIP) and Emergency Assistance for Livestock, Honeybee and Farm-raised Fish

Program (ELAP) reimburses producers for a portion of the value of livestock, poultry and other animals that died as a result of a qualifying natural disaster event or for loss of grazing acres, feed and forage.

Next, the Tree Assistance Program (TAP) provides cost share assistance to rehabilitate and replant tree, vines or shrubs loss experienced by orchards and nurseries. This complements NAP or crop insurance coverage, which cover the crop but not the plants or trees in all cases.

For LIP and ELAP, you will need to file a Notice of Loss for livestock and grazing or feed losses within 30 days and honeybee losses within 15 days. For TAP, you will need to file a program application within 90 days.

Documentation

It's critical to keep accurate records to document all losses following this devastating event. Livestock producers are advised to document beginning livestock numbers by taking time and date-stamped video or pictures prior and after the loss, maintaining purchase, production, vaccination records, bank and loan documents and by having third party certifications.

Other Programs

The Emergency Conservation Program and Emergency Forest Restoration Program can assist landowners and forest stewards with financial and technical assistance to restore damaged farmland or forests.

Additionally, FSA offers a variety of loans available including emergency loans that are triggered by disaster declarations and operating loans that can assist producers with credit needs. You can use these loans to replace essential property, purchase inputs like livestock, equipment, feed and seed, or refinance farm-related debts, and other needs.

Meanwhile, USDA's Natural Resources Conservation Service (NRCS) provides financial resources through its Environmental Quality Incentives Program to help with immediate needs and long-term support to help recover from natural disasters and conserve water resources. Assistance may also be available for emergency animal mortality disposal from natural disasters and other causes.

Additional Resources

Additional details – including payment calculations – can be found on our NAP, ELAP, LIP, and TAP fact sheets. On farmers.gov, the Disaster Assistance Discovery Tool, Disaster-at-a-Glance fact sheet, and Farm Loan Discovery Tool can help you determine program or loan options.

While we never want to have to implement disaster programs, we are here to help. To file a Notice of Loss or to ask questions about available programs, contact your local USDA Service Center.

Midwest Vegetable Trial Reports. A Great Resource for Growers.

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

The Midwest Vegetable Trial Report series includes reports of applied research relevant to vegetable and melon production in the midwestern U.S. The purpose of the series is to publish results and document the annual results of vegetable and melon research projects. In 2022, 16 trial reports from Indiana, Illinois, Michigan, and Minnesota were published. Variety research reports on bell pepper, chili pepper, specialty pepper, pickling cucumber, summer squash, pumpkin, standard and personal-sized triploid watermelon, hydroponic butterhead lettuce, and strawberry production are now available. These reports will help you decide which variety to select for the upcoming growing season. The reports also contain detail about the production methods used. The reports are listed below.

- No-till Sweet Corn after Winter Rye Cover Crop, Northern Indiana
- No-till Pumpkin after Winter Rye Cover Crop, Northern Indiana
- Colored Sweet Bell and Tapered Pepper Cultivar Evaluation for High Tunnel Production in West-Central Indiana
- Personal-sized Triploid Watermelon Cultivar Evaluation in Indiana
- Standard-sized Triploid Watermelon Cultivar Evaluation in Indiana
- Solid-Green Watermelon Cultivar Comparison
- High Tunnel Fresh Market Determinate Tomato Cultivar Trial for Southern Illinois
- Dixon Springs Agricultural Center High Tunnel Bell Pepper Variety Trial
- Chile Pepper Variety Evaluation
- Summer Squash Cultivar Trial

Bell Pepper Cultivar Trial

- Seedless Pickling Cucumber Cultivar Trial
- Butterhead Lettuce Variety Performance Trial in a Hydroponic NFT System
- Strawberry Production in an Elevated Bench Growing System inside a High Tunnel in Southern Indiana

Webinar Series – Scaling up Your Small and Medium-sized Farm

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

Dr. Betty Feng's lab within the Department of Food Science at Purdue University is hosting a series of webinars this March and April. The webinars are free to anyone who wishes to participate and will cover various topics, including on-farm food safety and agriculture soil management.

Good Agricultural Practice

April 11 -The Importance of Produce safety, Agricultural Water, Soil Amendments
April 13 – Wildlife and Domesticated Animals, Worker Health, Hygiene, and Training, Putting it all together

Interested in attending?

Register here
https://purdue.ca1.qualtrics.com/jfe/form/SV_6rn6bs82DoHjQPQ
Or email the webinar coordinator Autumn Stoll at
stoll6@purdue.edu

Purdue Fruit and Vegetable Field Day – July 20, 2023

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

Purdue Extension presented its first Fruit, Vegetable and Hemp Field Day post-pandemic at the Meigs Ag Center in July 2022. Extension Specialists and Graduate Students presented specialty crop research to 45 attendees. Attendees had only good things to say about the event. " Great information and research." "Great variety of experiences and knowledge." "I felt welcomed and it was in an educational environment with like-minded people." "It was such a great informative event to learn about Purdue's current research." "Quality and variety of information." "The speakers seemed to give good context to their subjects." Below are some of the production topics presented at the field day and we expect to have a similar lineup for the 2023 field day.

- Cold Hardy Grape Varieties for Indiana
- Apple Disease Management and IR4 Trial
- Management of Dwarf Apple Trees
- Managing Caterpillars with Homeowner Products on Swiss Chard and Collard Green Varieties
- Planting Vegetables into Cover Crops
- Vegetable Weed Management Research
- Row Covers for Insect Management on Leafy Greens
- Sweetcorn Insect Management
- Mite Management in High Tunnel Cucumbers
- Two-system Approach to Vegetable Farming
- Cannabinoid Hemp Variety Trial / Hemp Propagation Study

We are happy to announce that Purdue Extension is presenting its annual Fruit and Vegetable Field Day on July 20, 2023, at the Throckmorton/Meigs Horticulture Farm, Lafayette, IN.

More information about the upcoming field day will be available in May 2023.

Contact Lori Jolly-Brown or Petrus Langenhoven if you have any questions.

Small Farm Education Field Day, July 27, 2023

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

The 2022 Purdue Small Farm Education Field Day was a big success. Nearly 72% of attendees reported that they learned something new. Nearly half indicated they plan to adopt recommended practices for diversified farming systems, and over a third (36.0%) plan to adopt recommended practices for creating, improving, or strengthening their business. Half (52.0%) indicated they plan to adopt practices for horticulture and the environment or practices that reduce negative environmental impact due to horticultural operations. Nearly half plan to adopt practices/technologies for the conservation of resources (48.0%) or increased efficiencies (44.0%).

Attendees commented ……

- 'Diversity of information presented.
- Great field day. Jam-packed with information and experts. Lots of opportunities to question the experts.
- Great people and resources!
- I believe the diversity accurately represented many
- aspects of Indiana agriculture for large and small-scale operations.

- I recently got into the urban farming industry in Fort Wayne, Indiana, and this program has helped me get the wheels in my head turning.
- I think it was a great event to learn about small farms and different practices or crops. It was also a great networking event.
- I think it was a very informative event. Lots of good resources and networking as well as practices. Very educational.
- I thought the field day was well organized.
- New information presented in an understandable format by very competent professionals.
- The event was educational, local, had very knowledgeable presenters, helpful exhibitors, good handouts, and I got a free frozen treat.
- Up-to-date practices, evidence-based knowledge, concrete
- Very informative to see a high-volume production set up, including plant training systems and watering/fertigation systems, applied to a wide variety of crops.'

The event was held at the Purdue Student Farm located in West Lafayette, Indiana. The field day featured an array of "demonstration stations" on the farm where participants learned about a variety of topics:

- Student farm packhouse tour and overview of good agriculture practices (GAPs)
- Weed identification and understanding of thresholds
- Summer cover crops for weed suppression
- Infield soil diagnostics and soil health
- Vegetable disease, prevention, identification, and management
- Scouting for mites in high tunnel crops
- Black soldier fly composting
- Caterpillar tunnels
- Beans, onion, sweet pepper, eggplant, and tomato varieties in various production

Save the date for the next field day – July 27, 2023

Educational topics for the 2023 field day will be available in May. To learn more about the field day, visit our webpage at www.purdue.edu/hla/sites/studentfarm/events/ or contact Lori Jolly-Brown or Petrus Langenhoven.

Figure 1. Small Farm Education field day announcement.

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