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.

In this issue, we highlight pest issues and provide an update on herbicides. We also discuss the current Canadian fire and related smoke issues. There is another article in the cover crop series. NEW to this issue is vegetable pricing. We are tracking Clearspring Auction pricing. Included are lots of information about educational opportunities at the Throckmorton/Meigs Purdue Agricultural Center (July 20), the Purdue Student Farm (July 27), Pinney Purdue Agricultural Center (August 10 and August 24). We have saved a place just for you. Register now to reserve your spot. Registration links are available in this issue and on the EVENTS tab of the Vegetable Crops Hotline Newsletter webpage. Registration for the Pinney Ag Center field days will be provided at a later date.

Are you interested to learn more about Soil Health?

Purdue Extension is part of a North Central Region Soil Health Nexus team dedicated to increasing access to research-based soil health knowledge. Their website is packed with information. There is a white paper on the connection between Soil Health and Water Quality, and it includes a Soil Health Nexus Matrix Decision Tool and a Soil Health Toolbox. The latest post on their blog (April 19, 2023) shares a recording of a presentation about the 'Top 10 Impacts of Cover Crops for Soil Health. If you want to know more about soil health at Purdue, contact Walt Sell (wsell@purdue.edu) and Bryan Overstreet (boverstr@purdue.edu).

Website links

Frequently we include links to websites or publications that are available online. If you can't access these resources or can't see the web address, 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 vegcropshotline.org.

We would like to hear from you

ANR Educators and Growers, reach out to us if you are experiencing a vegetable production-related issue you think other growers need to know of. Remember, we have a great Horticulture Team that can assist you. A complete list is available HERE.

Send us pictures of success stories, activities, or issues in your county or on your farm. Please include a description and provide the name of the person that needs to get credit for the picture. These pictures could be used in future *Vegetable Crops Hotline Newsletter* articles. Submit your stories HERE.

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

Enjoy reading this issue!

Smoke Not a Problem for Vegetables

(Steve Reiners, sr43@cornell.edu)

Steve Reiners, Professor in Horticulture, Cornell University, Cornell AgriTech

Canadian wildfires are impacting air quality here in the Northeast. Smoke has filled the sky, and warnings have been issued for outdoor activities. This is making many growers and gardeners worried about the potential impact the smoke will have on field-grown vegetables. The good news is the impact will be minimal at worst.

Smoke-filled skies (Figure 1) decrease sunlight and reduce photosynthesis, but to a small degree and temporarily. Despite the shade, there is still enough diffused light penetrating the smoke to maintain growth. Smoke typically does not block the pores in the leaf (stomata) where photosynthesis happens. The most important thing you can do is maintain good soil moisture by optimizing irrigation. This will keep the pores open and clean. The droughty conditions this spring are likely to cause more of a problem than the smoke.

Figure 1. Vincennes, IN, June 28, 2023 (Photo by Petrus Langenhoven).

Concerns that leafy greens and other commodities will pick up a smoky flavor are unwarranted. Recent research done in California after wildfires there showed leafy greens had no issues with flavor or possible volatile chemicals on or within the leaves. The smoke we're seeing does not contain dangerous chemicals.

The smoke we are experiencing is nearly 100% from the burning forests — not plastics, buildings or chemicals, as seen in recent train derailments. The rain that falls through this smoky layer is also not dangerous to plants, people, or animals. Unlike acid rain which forms from the burning of high sulfur fuels, the rain will be near neutral pH or just slightly acidic.

Pollinators will likely stay close to their hives when it's smoky. It's a little early in the season for pollination of squash and other fruiting crops, so this should not be a problem. Even if the crop has flowers, bees will become active again as soon as the smoke clears.

You may notice a bit of burning/spotting/bronzing on leaves, looking a bit like mite damage. This is a symptom of ozone injury that can be made worse by contaminants in smoke. It is caused by the reaction between sunlight and air containing hydrocarbons and nitrogen oxides. We often see this in midsummer when stagnant air and high temperatures cause the problem. Plants will recover from this damage as new leaves should be fine.

Mask up when you're outside tending to your plants, as the smoke is dangerous to you and me. But the vegetables should be fine. Keep them well-watered, and you should be enjoying a normal harvest later this summer.

Rely® 280 Added to Row Middle Weed Control Arsenal in Select Crops

(Stephen Meyers, slmeyers@purdue.edu, (765) 496-6540)

Earlier this year, Rely® 280 was registered for use in transplanted cantaloupe, cucumber, pepper, summer squash, tomato, and watermelon with a supplemental label. The registration allows for the use of Rely® 280 for pre-plant burndown and post-directed applications to row middles. Previously, postemergence burndown and row middle options were limited to glyphosate (Roundup®), carfentrazone (Aim®), paraquat (Gramoxone®), and pelargonic acid (Scythe®). Before this registered use, the plant-back restriction for these crops was 180 days following a Rely® 280 application, making its use impractical.

About the herbicide

The active ingredient in Rely® 280 is glufosinate. Although the name sounds similar, *glufosinate* is not the same as *glyphosate* (commonly known as Roundup®). Unlike glyphosate, glufosinate is mostly a contact herbicide with little movement through plants. However, just like glyphosate, glufosinate is not selective, and you must use caution to avoid spraying or drifting onto your crop or other desirable plants. Glufosinate is a Group 10 herbicide and should help to manage some weeds that are resistant to glyphosate (a Group 9 herbicide). Sprayed plants typically yellow or wilt 3 to 5 days after treatment and brown after 7 to 10 days. Symptoms from an intentionally sprayed watermelon plant are in Figure 1.

Figure 1. Injury to watermelon foliage following a reduced rate application of glufosinate at the Pinney Purdue Agriculture Center in 2022 (Photo by Jeanine Arana).

Making row middle applications

Apply 29 to 62 fluid ounces per treated acre. Up to two row middle applications can be made, but do not exceed a total of 62 fluid ounces per acre per season. Allow at least 14 days between applications. Apply in a hooded sprayer. If a hooded sprayer is not available, precision-directed spray application equipment can be used as long as the nozzles are adjusted to prevent spray drift from contacting the crop foliage and/or fruit. For crops grown on flat ground (not raised beds), do not spray within 6 inches of the crop.

Pre-harvest intervals

Allow at least 14 days between the last application and harvest for cucumber and summer squash and 30 days for cantaloupe, pepper, tomato and watermelon.

Tips for success

-For the best herbicide activity, apply on warm, sunny days with high humidity.

-If hard water is used, include ammonium sulfate to condition the spray solution.

-Target weeds less than 4 inches tall or wide. Smaller weeds require a lower use rate for effective control. When weeds are larger, they can have an overlapping canopy which reduces spray coverage resulting in reduced weed control. Some larger weeds and perennial weeds may regrow following application.

-Allow 6 hours of rain-free weather following application.

-Rely® 280 can foam during agitation. To combat this, you can add an anti-foaming agent.

Where can I find the supplemental label?

The label is so new that it has not yet been published on many of the pesticide label databases. However, the approved registration is available on the Office of Indiana State Chemist's Special Registrations webpage: Pesticide Section – Pesticide Products & Devices. There are separate supplemental labels for the cucurbit crops (cantaloupe, cucumber, summer squash, and watermelon) and fruiting vegetables (pepper and tomato). This link also includes supplemental labels for figs, hops, and avocados. Information for these additional registered uses was recently added to the online *Midwest Vegetable Guide* database available at Midwest Vegetable Production Guide (mwveguide.org).

Glimpse into the Current Market – Clearspring Produce Auction

(Jeff Burbrink, jburbrink@purdue.edu) & *(Petrus Langenhoven, plangenh@purdue.edu, (765) 496-7955)*

The Clearspring Produce Auction was founded in the 1990s by members of the Plain Community in LaGrange County, Indiana. The primary building was patterned after similar produce auctions that appeared in Plain Communities in Pennsylvania. Located just 2 miles south of US 20 in Clearspring Township in the Heart of the LaGrange-Elkhart Amish Settlement, it is within easy driving distance of the towns of Shipshewana, Topeka, Emma and LaGrange.

Figure 1. Tomatoes sold at the auction (Photo by Jeff Burbrink).

Produce is sold 3 days a week throughout most of the growing season (Tuesday, Thursday, Friday), with a hay sale on Saturdays. Office hours are Monday and Wednesday, 1 to 4 pm, and Tuesday, Thursday, and Friday, 8 am to 4 pm. An auction report can be heard by calling (260) 463-4131. Besides the produce and hay auctions, Clearspring has an equipment and supply business operating onsite for growers.

Figure 2. Strawberries, tomatoes, lettuce, etc., sold at auction (Photo by Jeff Burbrink)

Are you curious about vegetable pricing?

In an effort to communicate more market information, we are publishing Clearspring Auction prices for the past two weeks. You will be able to view June 27, 2023, HERE, June 22-23, 2023, HERE, and June 15 prices HERE.

Drought-busting Summer Nitrogen Fixer? Look No Further Than Cowpea

(Ashley Adair, holmes9@purdue.edu)

Drought tolerance is top of everyone's mind this year. Dry conditions and cover crops don't always mix – they use precious moisture in dryland agriculture that's rarely returned in a timely fashion. In irrigated agriculture, the expense of irrigating them might not be justified. However, there are cover crops that tolerate dry conditions and still give back, like cowpea.

Cowpeas (*Vigna unguiculata*) were likely first domesticated in Africa, though little is known about their exact origin. They get their English name from its history as a cattle fodder crop, but humans have been cultivating and eating cowpea for at least a few thousand years. Many cultivars exist, including the conspicuous black-eyed pea, which is primarily white with a circle of black coloration surrounding the seed's hilum. Cowpeas spread throughout the world from West Africa. The slave trade introduced cowpea to North America. Cowpea production in the US peaked in the late 30s, with nearly 5.7 million acres planted nationwide. Today, production has fallen drastically to just under 13,000 acres. The drop in production is likely the result of myriad factors, including difficulty with pests, disease, plant architecture, and profitability. However, cowpea's abilities to improve soil should not be ignored!

Cowpea (Figure 1) is adapted to hot and dry conditions. It can produce an impressive eight feet long taproot, which helps it access water in dry areas. It's one of the most reliable summer legume cover crops, capable of fixing 100-150 lbs N/acre. It performs well even in sandy soils, potentially a big help to vegetable producers farming in the sandier parts of Indiana. You can start planting cowpea as soon as the soil warms to about 65F, which is similar to when you might sow your first round of sweet corn. Sowing at half an inch deep will provide reliable emergence and gives you flexibility on which tools you choose to sow with. You might choose to plant cowpea alone or with other summer cover crops, like sorghum-sudangrass, buckwheat, or sunn hemp. Planted alone, 1-1.5 lbs per 1000 square feet will provide sufficient cover. Cowpea often struggles to emerge in crusted soils, so if your soils tend to harden up, plan to irrigate the seedbed after cowpea has been planted until they fully emerge.

Figure 1. Cowpea as seen on June 8th, 2023. Seeded on May 19th. Notice another plant in-frame with 2nd trifoliate unfolding (Photo by Ashley Adair).

Many cover crop cowpeas are sold VNS (variety not stated), but named varieties are also available. A commonly used named variety is Iron and Clay, which is actually a combination of two varieties with slightly different architecture. Iron and Clay will produce a cowpea crop with a mix of viny and upright growth habits, which provides better soil cover and erosion prevention than either one alone. Regardless of the variety used, cowpea cover crops reach heights of 2-3 feet.

In the crop rotation, you can use cowpea between early spring and fall cash crops or use it as a component of a green-fallow year. It also fills a niche as a high-tunnel tolerant cover crop, thriving in the heat and still air that high tunnels can create in the summer. Cowpea germinates within 3-4 days and can be terminated when needed, but allowing it to reach flowering will ensure the maximum amount of nitrogen fixation. Flowering occurs roughly 40 days after seeding. This means that cowpea makes a nice companion for buckwheat, which also establishes and reaches flowering quickly, sometimes in as few as 21 days (see the Cover Crop Species Spotlight on Buckwheat for more information: https://vegcropshotline.org/article/cover-crop-species-spotlight-buckwheat/).

Mowing followed by incorporation results in the most effective termination. Due to cowpeas' indeterminate growth habit, mowing alone is usually not enough to fully terminate. Cowpeas frost-kill in our area, so some circumstances that call for Mother Nature to terminate will see a successful kill when late fall rolls around.

The primary drawback of using cowpea as a cover crop is intolerance of waterlogged soils. Wet years on heavy clay will result in poor cowpea performance. Cowpeas also have some issues with disease that, while not typically an issue for subsequent crops, can affect the establishment and health of the cover crop itself. Cowpeas are not resistant to root rot or damping off, and some may attract nematodes or stink bugs. Just to be

safe, try not to plant a legume cash crop after a cowpea cover crop.

Chris Adair, Purdue Student Farm Manager, seeded cowpea with buckwheat (Figure 2) in one of the vegetable beds this summer at the Purdue Student Farm with a Field Tuff farm seeder. While there are still some thistles and grass weeds in the field, cowpea and buckwheat form a thick and competitive understory and upper canopy.

Figure 2. Cowpea (understory) and buckwheat (flowering upper canopy) planted at the Purdue Student Farm 6-26-23 (Photo by Chris Adair).

This article is the third in a new series of articles for the Vegetable Crops Hotline called "Cover Crop Species Spotlight." Make sure to look for more species spotlights in future editions of the VCH!

For more information on cover crops and their use on vegetable farms, please consult the following:

- Crop Rotation on Organic Farms: A Planning Manual – available as a free PDF download from SARE.org
- Managing Cover Crops Profitably (3rd) – available as a free PDF download from SARE.org

Other references for this edition's article

- Fery, R.L. 1990. The cowpea: Production, utilization, and research in the United States. Horticultural Reviews 12:197-222.
- Osipitan, O. Adewale, JS Fields, Lo S, and Cuvaca I. Production Systems and Propsects of Cowpea (Vigna unguiculata (L.) Walp.) in the United States. Agronomy 2021; 11(11):2312. https://doi.org/10.3390/agronomy11112312

Corn Earworm in Early Plantings

(Laura Ingwell, lingwell@purdue.edu, (765) 494-6167)

This has been a tough, dry year for all of us. I know my early planting of sweet corn at the research farm, seeded on April 27, has been slow and required irrigation (Figure 1).

Figure 1. Progress of two different sweet corn plantings at the Meigs Horticulture Farm in Lafayette, IN (Photo by Laura Ingwell).

However, those of you that may be at the tassel or silking stage should keep a close eye on the state-wide trapping and monitoring program for corn earworm adults (Figure 2), found here. Traps have been placed at 11 locations throughout the state, and catches last week are already exceeding thresholds at some locations in the state.

Figure 2. Corn earworm adult on silk. (Photo by John Obermeyer).

This moth, like many, is active at night, flying around looking for a mate or suitable host plants. Eggs are laid individually on the developing silk of corn. They hatch within 2-5 days, and the larvae follow the silk channel down into the developing ear to feed (Figure 3). Once inside the ear, they are protected from most foliar sprays. Therefore, monitoring and spray coverage is key. Please refer to Extension bulletin E-31 to learn more about corn earworm identification and management.

Figure 3. Corn earworm larvae inside a mature ear (Photo by Laura Ingwell).

In our landscape, we have a lot of resources for these moths to choose from. Therefore, when it comes to protecting your valuable sweetcorn ears, we need to consider the population pressures (how many moths are on the landscape) AND the amount of resources (how much yummy corn is available). This is why we have variable recommendations for when to spray. Early and late plantings of sweetcorn have a lower threshold of moth presence because they are often the only resource on the landscape that is in the optimal stage attractive to the females, the silk stage. At this time of year, if you are catching one moth per day in a trap near your farm and there is no field corn at the silk stage, we recommend that you treat your sweetcorn. However, when the field (dent) corn begins to silk, the number of moths per night increases to 10. This is because the population pressure is spread across a larger resource base.

How often should you spray? This will depend on the product that you choose and the growth rate of the crop. In our hot dry weather, if you are not irrigating your crop, growth is likely slow. If you irrigate or are getting ample rain, then silk production can happen quickly. To protect the developing ear, you need a lethal dose of the chemical present on the silk when the eggs of the caterpillar hatch. It is in those first few bites that you have an opportunity to control them. Once they are inside the ear, they are protected.

Some of the products that we have labeled for sweetcorn have translaminar activity, meaning that even though they are applied as a foliar spray, they move through the plant and into plant parts that were not directly covered. This includes diamides. Using one of these products will increase your spray window, meaning you can increase your spray interval to 5-7 days or more. If you use a product like one of the foliar spray formulations of Bt or a pyrethroid, only the material that was sprayed is protected. If your crop is growing quickly, you may need to re-apply every 3-5 days to get adequate protection. For conventional growers, we recommend using Coragen® in rotation with Radiant®. Coragen® is a diamide and can offer protection for a longer window between sprays (7 days or more). It does come at a higher price compared to the standard pyrethroids that are used. However, you make fewer applications which means less time in the sprayer and less fuel in the tractor! For certified organic growers, Bt foliar sprays offer good control but reapplication may be frequent. See the Midwest Vegetable Production Guide for a complete list of spray recommendations. Be sure to search the database for the crop: sweet corn and the pest: caterpillars.

Indiana's Winners and Losers with Recent Precipitation

(Beth Hall, hall556@purdue.edu)

While drought has been on many people's minds lately, Indiana has had several rain events pass through that brought much-needed moisture. Unfortunately, the entire state has not benefited evenly from these events. True to most summertime precipitation, where and when the rain falls can be quite spotty. Periodically, a nice front will pass through, but even those tend to only favor some areas leaving others wondering when they'll get a good rain shower. Figure 1 shows how much rain has fallen over the last 14 days (i.e., June 16-29, 2023). While the southeastern and northern counties received over 1.5 inches during this period, other counties, such as those along western and southwestern Indiana, received less than a quarter of an inch. Figure 2 compares these amounts to what has fallen during that same 14-day period from 1991-2020. Clearly, much of the state is still receiving less than the normal amount (where 100% would be normal) for this time of year. This has led the U.S. Drought Monitor (Figure 3) to continue categorizing much of the state as Abnormally Dry (D0), Moderate Drought (D1), or Severe Drought (D2).

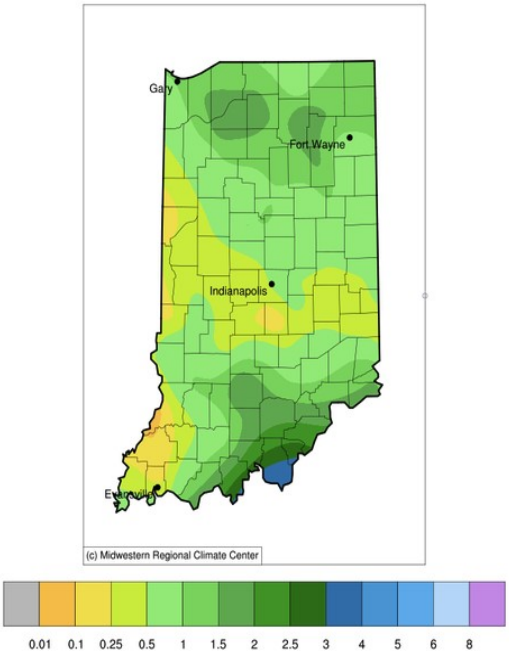


Figure 1. Accumulated precipitation (in inches) from June 14-27, 2023.

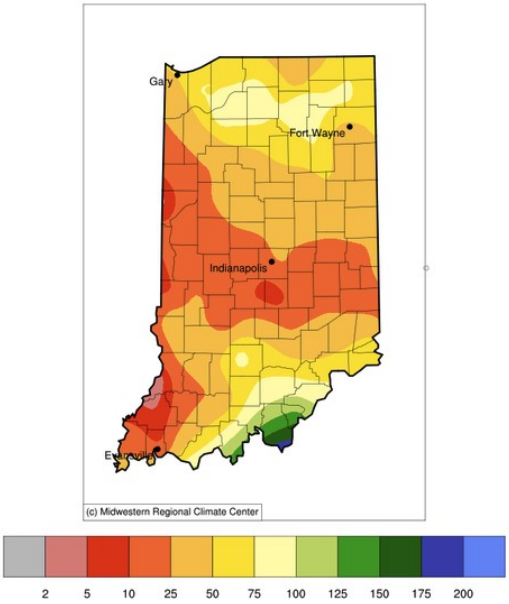


Figure 2. Accumulated precipitation from June 14-27, 2023, compared to the climatological normal amount for that same 7-day period that fell from 1991-2020.

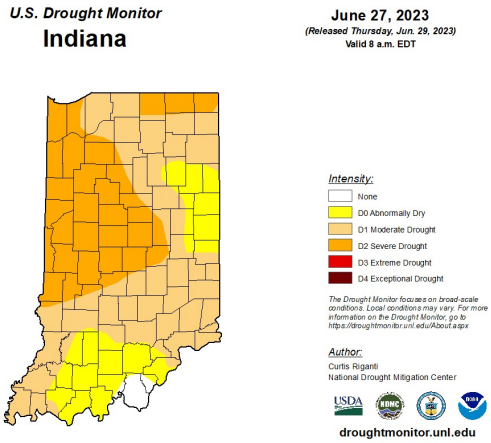


Figure 3. U.S. Drought Monitor representing conditions through June 27, 2023

Fortunately, the last few weeks have seen temperatures that have averaged 1-3 degrees below normal. This has kept evapotranspiration relatively moderate for this time of year. This has also meant that accumulated growing degree-days have stayed less than normal across the state for an accumulation start date of April 15 (see Figures 4 and 5).

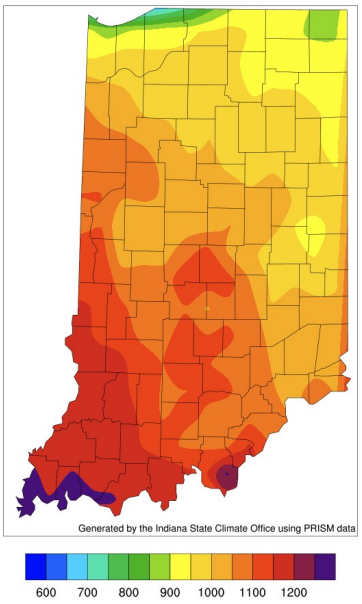


Figure 4. Modified growing degree day (50°F / 86°F) accumulation from April 15-June 28, 2023.

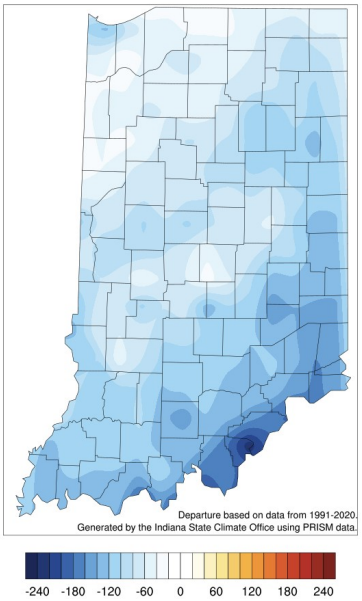


Figure 5. Modified growing degree day (50°F / 86°F) accumulation from April 15-June 28, 2023, represented as the departure from the 1991-2020 climatological average.

The short-term forecast is calling for increased rainfall amounts of around 1.5 to over 4 inches across much of the state over the next 7 days (Figure 6). Unfortunately, there can be a lot of uncertainty given the type of storm patterns producing these rainfall events. Many forecast products may be offering a probability of precipitation around 50%, indicating ambiguity in the timing and location of impact. Beyond the next 7 days, climate outlooks are favoring above-normal temperatures and above-normal precipitation over the next few weeks. Confidence for above-normal precipitation is greater after July 8th. This is extraordinarily promising news for our current drought outlook. Stay cautiously optimistic, however, since there is still likely to be much variability in rainfall locations, intensity, and amount. In other words, we may be continuing to see areas across Indiana that are winners, with other areas begging for something to help

the crops, lawns, and water supplies.

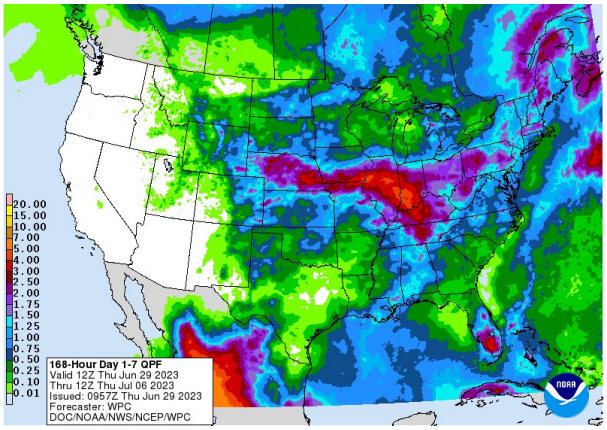


Figure 6. Forecasted rainfall amounts (in inches) for June 29 through July 6, 2023.

Farmers Shared Experiences in Plasticulture Strawberry Production

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

Strawberries are traditionally grown with a matted-row system in Indiana. Plasticulture is relatively new. It brings market opportunities and potentially high profit. However, growing strawberries in plasticulture is much more expensive than the matted-row system. Farmers need a good understanding of the system to avoid significant economic loss.

In the Strawberry Chat Podcast episodes, you will hear interviews with two Indiana strawberry growers, Calvin Beasley at Beasley's Orchard and Richard Ritter at Ritter's Farms. Their farms vary in size, and they sell through different markets. After many hard lessons learned over the years, they have adapted the plasticulture strawberries in their farming business. In these interviews, they generously shared their experiences, thoughts, and ideas, which can be extremely valuable for others interested in growing this crop.

Strawberry Chat

Japanese Beetles are Here, and Hungry!

(Laura Ingwell, lingwell@purdue.edu, (765) 494-6167)

Last week I encountered my first adult Japanese Beetle of the 2023 season. It was at my home, and I was keeping my fingers crossed that it was just an unlucky stray individual, but hoping I had more time before their devastation would arrive. Well, I was wrong.

Over the weekend, I found a few more in my black raspberries, and then when visiting our high tunnels at the Meigs Horticulture Research Farm in Lafayette on June 26, reality set in. This year we have some fun companion plants in our high tunnel tomato project and one of which happens to be basil. I don't know why, but I will agree with the beetles that basil is tasty! Unfortunately, they don't share well. As you can see, the plants are being devoured (Figure 1).

Figure 1. Japanese beetles devouring a basil plant (Photo by Laura Ingwell).

While this beetle, in its adult stage, is known to feed on over 250 different plants, there always seem to be a few horticultural crop favorites. Depending on the plant, the damage may be tolerable. For instance, if the feeding is restricted to the vegetation on a fruiting crop we can still get some harvest. However, when they are feeding on the foliage that we also want to eat, it becomes unappetizing quite quickly. This species undergoes complete metamorphosis, meaning the immature stage looks nothing like the adult. In fact, they feed in very different habitats and host plants. The immature larva, or grub as they are called, feeds on the roots of turf grass species. They pupate in this substrate, and when the adults emerge, they travel great distances. This is where they become a problem of a different sort. Rather than killing patches of lawn, they destroy food and landscape plants.

Management of the adult stage is difficult. No matter what, we do not recommend trying to catch them with Japanese beetle traps. The smell is so enticing that you will actually pull from your neighbors, which I don't think you want. Regardless of how hard you try to be the 'good neighbor', no one is that nice. For more information on how to manage this pest in turf and on ornamentals, read Extension Bulletin E-75. In vegetables, our best tool is pyrethroids, but this only offers temporary knockdown. Alternatively, there are some organophosphates labeled for particular crops, but these are highly toxic compounds that I don't recommend. This pest still has all of us pulling our hair out! I get satisfaction in my own garden pulling them off and throwing them into a bucket of soapy water!

A Case Study: Irrigation Management in High Tunnel Tomato Production

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

I often receive questions on how much water should apply to high tunnel tomatoes. Even the most experienced tomato growers

could sometimes lose yield because of overlooking irrigation management. In this article, I describe a case study of how we use soil moisture sensors for irrigation management in a high tunnel tomato production system. This irrigation schedule is not likely to apply to all situations. Still, I hope the general trend and how we make decisions could help tomato growers be more comfortable in irrigation management.

This project is conducted in a high tunnel at Southwest Purdue Ag Center in Vincennes, IN. The soil is sandy with less than 1% organic matter. We planted six rows of tomatoes in a high tunnel on black plastic-covered beds with one drip tape for each bed; the tomato rows are about 65 feet long. Eight tomato cultivars, including six slicer tomatoes and two cherry tomatoes, were transplanted on Apr. 13, 2023. The flow rate of the drip tape is 0.67 gpm/100'. The total length of drip tape for the tomato beds is about 400'.

The beds were well irrigated at transplanting. In the first three weeks after transplanting, we irrigated the plants only when we felt the top soil was dry. At this point, we feel comfortable irrigating by feeling because the roots are shallow, and we can tell soil moisture levels at the root zone. Small plants do not need much water, and relatively cool weather in the early season changes soil moisture levels slowly.

We started automatic irrigation control in the first week of May and set the irrigation program for 10 mins at each event twice daily. The program applied 54 gallons of water daily to the tomatoes. On May 24, we installed soil moisture sensors measuring volumetric water content in three beds at 12'' soil depth inside the high tunnel.

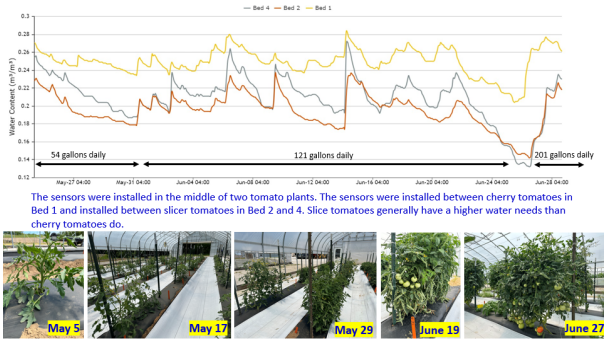
The water content at the 12-inch depth declined from 0.23 to 0.18 cm^3/cm^3 from May 24 to May 31, although the system applied 54 gallons of water daily. The sensor readings raised the alarm that we were short irrigating. We then changed the irrigation program to three daily irrigation events and 15 mins for each event. The new schedule applied 121 gallons of water daily to the tomato plants. The soil water content at the 12-inch depth was maintained between 0.18 to 0.24 cm^3/cm^3 until around June 23. After June 23, we no longer see the soil moisture content respond to irrigation events. The water content constantly dropped to around 0.14 cm3/cm3. Again, the readings raised the alarm that we were short on irrigation. We adjusted the program again and set up irrigation for four events for 20 mins each on June 27. The new schedule now applies 201 gallons of water daily to the system.

So far, we have been adjusting irrigation based on soil water content. When the readings started to decline, we increased the irrigation amount. But how do we decide how much to increase? We need a good idea of how much water the plant needs to answer this question. An excellent way to estimate plant water needs is to use the reference crop evapotranspiration method (ETc = ETo × Kc). This publication describes the method in detail. Assume ETo = 0.2 (in.) on a sunny summer day, and Kc = 0.9 at full plant growth, then ETc = 0.2 × 0.9 =0.18 (in.). You may have heard that most fruiting vegetables require 1-1.5 inches of water per week at peak production. The above calculated number times seven is where the 1-1.5 inches come from.

The next question is what the 0.18 (in.) mean for the tomato system? I included my calculation below, which leads to 224 gallons of water per day.

0.18 x (400 X 5 / 43560) X 27154 = 224 gallons per day (400 feet is the total bed length; 5 feet is the spacing between beds; 1 acre =43,560 ft^2; 1-inch acre = 27,154 gallons)

Our current irrigation program is applying slightly less amount of water daily compared to this number. We are at the beginning of harvest. The plants look healthy and loaded with fruit. We have not seen tomato blossom end rot, indicating we have been doing an adequate job in irrigation management.



A case study high tunnel tomato irrigation management.

Here are a few take-home messages from this case study:

1. Soil moisture sensors are a great tool to guide irrigation management, especially for high tunnel production. Reliable soil moisture sensors and timely data access are indeed expensive investments, but seeing soil water content change at a depth that is hard to reach by hand is critical for timely irrigation adjustment and avoiding yield loss. However, be aware that soil moisture sensors may not always work nicely as we expected. We will write another article to share our experience using soil moisture sensors and what could go wrong that affect our decisions.

2. Combined use of soil moisture sensors and evapotranspiration method provides a more comprehensive picture than using each method alone. As stated above, soil moisture sensors tell us the soil conditions responding to the irrigation application, which help us make timely adjustment to the irrigation schedule. Evapotranspiration gives us a general idea of plant water needs at different growth stages. It can serve as a guide on how much we should increase or decrease the irrigation amount.

3. The plants grow vigorously, have large canopies, and have a lot of fruit sets. All these factors make us confident that the plants are at their highest water need for the particular growth stage. However, the water need should be adjusted accordingly if plants suffer disease, insect pests, or plant growth is stunted because of environmental stresses.

4. In this study, the soil is sandy with good drainage, and we do not have concerns about diseases often associated with wet soil, so we feel comfortable applying water to meet plants' needs. One should be more cautious in irrigation management if certain soilborne diseases are present.

5. This project did not consider soil wetting patterns and how the irrigation design affects nutrient management. These articles, Water Affects Efficacy of Soil-incorporated Fertilizers and Amendments and Understanding Wetting Patterns in Drip Irrigation, provide insights into these questions.

Please do not hesitate to contact me, Wenjing Guan (guan40@purdue.edu), if you have questions or need further discussion.

Funding for the project *Improve Drip Irrigation Management for Vegetables and Melon Production in Indiana* was made possible by the Indiana State Department of Agriculture through grant A337-22-SCBG-21-003. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the ISDA.

Sustainable Agriculture Research and Education (SARE) News

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

New Book: Farming With Soil Life: A Handbook for Supporting Soil Invertebrates and Soil Health on Farms

This article was first published on June 20, 2023, by SARE Outreach.

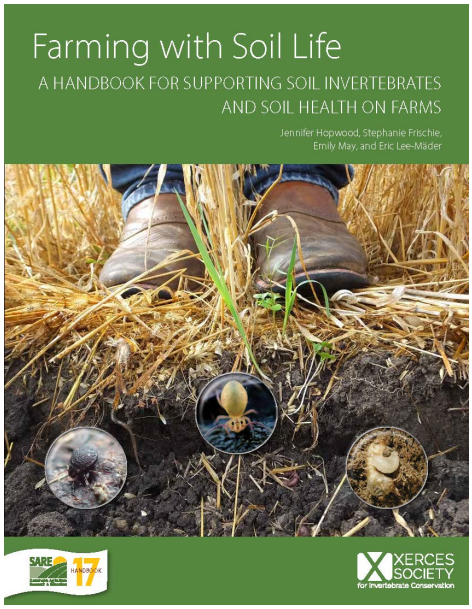


Figure 1. Farming with Soil Life is now available. Click to download.

Smart farmers know that healthy soil hosts a flourishing and diverse ecosystem of bacteria, fungi, and invertebrates. But the complex relationships between soil life, productivity, and resilience are not well understood. Now available from the Xerces Society and SARE, *Farming with Soil Life: A Handbook for Supporting Soil Invertebrates and Soil Health on Farms* is a user-friendly guide to identifying, understanding, and better managing soil life to improve the sustainability of your farming system.

Written by the Xerces Society and published by SARE Outreach, *Farming with Soil Life* features photograph-filled profiles that outline how to observe and identify 73 soil organisms. Each profile includes the identification, description, ecological role, habitat, diet, and life cycle of the highlighted species.

Farming with Soil Life also examines how producers can boost life in the soil using buffers, no-till cropping, cover cropping, crop rotations, and other practices that encourage soil flora and fauna communities to thrive. Minimizing tillage, synthetic fertilizer use, and some pesticides and insecticides may also benefit soil biology.

Understanding the relationships between soil, soil life, and crop production is key to defining and achieving goals within a sustainable production system. “Soil is a living, dynamic habitat for a great diversity of animals and plants. It supports the global carbon and nitrogen cycles. Healthy soils sequester carbon, helping to mitigate climate change. The more we learn, the more we understand that soil is an irreplaceable part of life.”

Farming with Soil Life: A Handbook for Supporting Soil Invertebrates and Soil Health on Farms was written by Jennifer Hopwood, Stephanie Frischie, Emily May, and Eric Lee-Mader. Download for free or order a print copy at https://www.sare.org/soil-life.

New Purdue Extension Northern Indiana Soil Conservation Coordinator

(Bryan Overstreet, boverstr@purdue.edu)

Bryan Overstreet

Bryan Overstreet is the new Purdue Extension Northern Indiana Soil Conservation Coordinator / Conservation Cropping System Initiative Northern Indiana Conservation Agronomist. Bryan has been the Jasper County Extension ANR educator for the past 18 years. Prior to that, he worked for a local Co-op as an agronomist for 15 years.

Included in his new duties will be working with local farmers to

increase their use of soil conservation and helping them improve the soil health on their farms. He will promote the 4 principles of soil health; 1) Maximizing continuous living roots, 2) Minimizing Soil Disturbance, 3) Maximize Soil Cover, and 4) Maximizing Biodiversity.

If you are interested in having a conversation with Bryan about your operation, please get in touch with him via email at boverstr@purdue.edu

Purdue Fruit and Vegetable Field Day – Register Now!

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

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.

Registration is now open. To register your spot, visit https://cvent.me/5zevYD

A complete schedule of demonstrations is now available on the Vegetable Crops Hotline webpage. Look under the EVENTS tab.

Contact Lori Jolly-Brown at ljollybr@purdue.edu or Petrus Langenhoven at plangenh@purdue.edu if you have any questions.

Small Farm Education Field Day – Register Now!

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

The Purdue Small Farm Education Field Day is presented on July 27, 2023, at the Purdue Student Farm in West Lafayette, IN.

Registration for the field day is now open. To reserve your spot, visit https://cvent.me/ewWN3b.

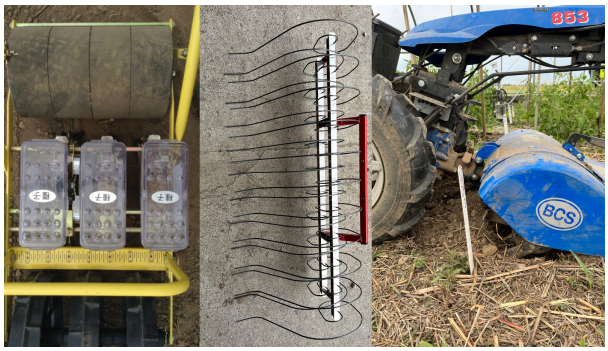
Students register for free! Please contact Lori Jolly-Brown to receive the discount code for student registration.

Visit the Purdue Student Farm webpage https://www.purdue.edu/hla/sites/studentfarm/events/ for more information.

Contact Lori Jolly-Brown at ljollybr@purdue.edu or Petrus Langenhoven at plangenh@purdue.edu if you have any questions.

Vegetable Equipment Demonstration, Produce Safety, and ServSafe for Home Based Vendors at Pinney Purdue Ag Center August 10th

(Liz Maynard, emaynard@purdue.edu, (219) 548-3674)



(Photo by Liz Maynard)

Vegetable equipment for small farms will be demonstrated on August 10, from 9 a.m. to 12 p.m. Central Time, at the Pinney Purdue Agricultural Center. Market gardeners, urban farmers, home and community gardeners are invited to attend and learn about equipment and tools for seeding, planting, weed management, and tillage. Demonstration equipment will include a Jang seeder, paperpot transplanter, wheel hoe, tine weeder, tilther, BCS walk-behind tractor, and more. Lunch sponsored by Johnny's Selected Seeds and Safe Produce Indiana will follow the demonstration.

Attendees may stay for the afternoon Food Safety Day from 1 p.m. to 4 p.m. and learn about testing water used in vegetable growing and Good Agricultural Practices, or attend a ServSafe program and get a certificate required for Home Based Vendors.

There is a fee for the ServSafe program but no charge for the morning program or other afternoon programs.

To register or if you have other questions, please get in touch with Rebecca Koetz at busser@purdue.edu or (219) 755-3240.

Vegetable Twilight Meeting at Pinney Purdue Ag Center on August 24th

(Liz Maynard, emaynard@purdue.edu, (219) 548-3674)

(Photo by Liz Maynard)

Pumpkins, peppers, sweet corn, compost, tomatoes, and more will be discussed at the August 24th Vegetable Twilight Meeting at Pinney Purdue Ag Center, 5 to 8 p.m. Central Time. Vegetable farmers, market gardeners, urban farmers, and home gardeners are invited to tour trials and hear from researchers and educators about weed management in pumpkins; key tips for pepper production; no-till sweet corn; compost and its interaction with soil micro-organisms, plant disease, and plant nutrition; managing insects in high tunnels/hoophouses; and managing diseases of pumpkins and tomatoes. There will be sweet corn tasting after the program. Pinney Purdue Ag Center is located at 11402 S. County Line Rd., Wanatah, Indiana.

To register or if you have other questions, please get in touch with Nikky Witkowski at (219) 365-3555 or nikky@purdue.edu. Please register by Monday, August 21, 2023.

(Photo by Liz Maynard)

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