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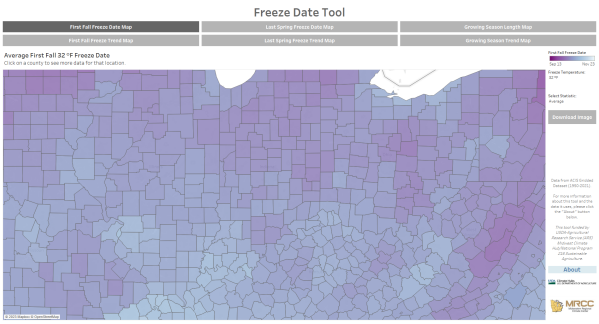
From the Editor's Desk

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

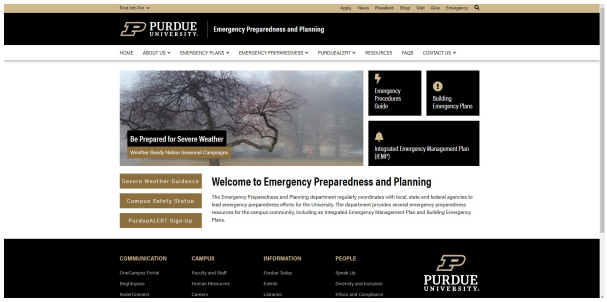
Welcome to the *Vegetable Crops Hotline* (VCH), Purdue Extension's exclusive newsletter for people in the business of growing vegetables.

It almost felt like summer for the past 10 days. That is until we got the cold weather again on April 16. It's just a reminder that we should not get too eager to plant tender vegetable crops yet. And if you plant, be ready to protect your crop against frost. The Midwestern Regional Climate Center has a great interactive tool with freeze maps https://mrcc.purdue.edu/freeze/freezedatetool.html.



Freeze Date Map https://mrcc.purdue.edu/freeze/freezedatetool.html

In our last issue, we had a lot of information about emergency preparedness in Indiana. Familiarize yourselves with the resources on the Purdue Emergency Preparedness and Planning website https://www.purdue.edu/ehps/emergency-preparedness/



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 https://extension.purdue.edu/anr/_teams/horticulture/our-team.html

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 vegcropshotline.org.

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.

Setting Your Transplants Up for Success

(Petrus Langenhoven, plangenh@purdue.edu, (765) 496-7955) & *(Liz Maynard, emaynard@purdue.edu, (219) 548-3674)*

As we approach warmer days in May and June, it's time to prepare for transplanting warm-season vegetable crops such as tomatoes, peppers, eggplant, and squash. Growers preparing vegetable transplants should plan for the process of hardening or conditioning their transplants to outdoor temperatures, light, and soil moisture conditions. By now, you should have started your transplants indoors. Greenhouse growing conditions are very different from outdoor conditions. Reduced light transmission

(because of the glazing material) and controlled climatic and soil moisture conditions indoors lead to transplants that are poorly adapted to harsher outdoor growing conditions. A gradual introduction to outdoor growing stresses will result in higher carbohydrate levels in the plant, prompt additional root development, and thicken plant cell walls. Firmer and harder transplants will result in a higher transplant-establishing rate. This article will discuss the process of transplant hardening/conditioning and best practices for transplant establishment.

Figure 1. Processing tomato seedlings delivered and ready for transplant (Photo by Liz Maynard).

Hardening or Conditioning of Transplants

1. Purpose

- The intention is to slow plant growth, not stop plant growth.
- To reduce transplant shock by slowing transplant growth.
- To build up carbohydrate and nutrient reserves in the seedling.
- To get the plant physiologically adapted to higher light and lower soil moisture levels.
- To lower the humidity.
- To adapt the plant to temperature swings and lower temperatures.

2. When is it needed?

- Needed for transplants destined for open field settings.
- Might not be needed for transplants planted in a high tunnel.
- Depends on where the transplants were grown.
    - Glass greenhouse-grown transplants need to be hardened.
    - Transplants grown in a heated poly greenhouse need to be hardened.
    - Transplants grown in an unheated high tunnel do not have to be hardened when transplanted into a high tunnel but will require some hardening for field setting.

3. Managing nutrients, irrigation, sunlight, and temperature

- Begin conditioning your transplants 4-8 days before setting the plants in the field.
- Move plants outdoors during the day to a shady spot when temperatures are at least 50°F (Figure 2).
- Progressively increase the amount of sunlight the plants receive.
- Move the transplants indoors at night if temperatures below 50°F are expected.
- Don’t move tender plants outdoors when windy or temperatures are below 50°F.
- During the last 2-3 days of hardening, plants can be left outside permanently in direct sunlight.
- While adjusting plants to outdoor light conditions, reduce the amount or frequency of water plants receive. Do not let plants wilt.
- Do not over-fertilize seedlings during hardening.

Figure 2. Transplant hardening area covered with shade cloth and lattice on the side. Lattice and shade cloth can be removed towards end of hardening period. (Photo by Liz Maynard).

4. Practical examples of how to do it

- Keep in mind that this is a general guide. Adjust according to your local weather conditions and timeline budgeted for hardening. Manage the conditioning process by observing your plants regularly for signs of stress.
- Below is a process growers may follow if they decide to use a shade house with different shade levels. The shade house should also protect the plants against excessive wind.
    - Initially, place plants under 50% shade for 3 hours. You may choose to only use 20% shade.
    - Increase the light and total time spent outside by 1-2 hours per day.
    - On day 3, move the plants to 20% shade.
    - During this process, return plants to the greenhouse every day. To make this easier, place plants on a wagon or cart that can easily be moved to the greenhouse or shed during the night.

        - On day 6, move plants permanently outside in the full sun.
        - On day 8, transplants are ready to be planted.
    - Cold frames are ideal for conditioning plants and might be a cheaper solution on a small scale than a shade house.
    - If you do not have a shade house, move the plants into the shade of a tree. Gradually introduce more sunlight, as mentioned above. The shady spot under the tree might change during the day. Move the transplants so that direct sunlight does not fall on them during the first few days.
    - While introducing the plants to more light and variable temperatures, gradually decrease the irrigation frequency and volume.
        - Monitor plants regularly. Don't allow plants to wilt.
        - Don't withhold water to the point of seedling stress.
        - Depending on your watering schedule, reduce the irrigation duration or frequency. When irrigating, wet all the substrate in the plug cell.
    - Your seedlings are now conditioned and ready for transplanting.

Holding transplants

1. Purpose

When weather or other events don't permit transplanting at desired growth stage, prevent plants from overgrowing yet keep them in good condition for transplanting.

2. Managing fertility, irrigation, and sunlight

Manage irrigation and fertility the same as during the conditioning process. However, be sure to monitor for nutrient stresses. Add fertility as needed.

3. Holding area requirements

Preferably, hold transplants in a well-ventilated shade house.

Fertilizer at Planting Time, Starter Fertilizer

- Provide readily available nutrients close to seedling roots.
- Traditionally most important in cool soils low in P.
- In systems relying on organic N, some readily available N may be helpful in cool soil.
- Apply after conditioning when seedlings are still in flats, apply in transplant water, or apply in/near the transplant hole.

'Starter' fertilizer is applied at the time of transplanting so that nutrients will be available near the roots of young plants. This enables the plant to take up enough nutrients to establish quickly without requiring a lot of root growth to access nutrients spread through the soil profile. Typically, it represents a small amount of the total nitrogen and potassium required by the plant and a larger proportion of the phosphorus. This is because plants do not need as much phosphorus as nitrogen and potassium, phosphorus does not readily move towards roots, and root growth is slow in cool soils.

Crops are most responsive to starter fertilizer when the soil is cool and wet and soil nutrient levels are low. This is especially true for the response to phosphorus. If the soil is warm and soil tests indicate a high level of phosphorus, less benefit from phosphorus is likely. Under these conditions, a starter fertilizer with only nitrogen could be used. In systems that rely on organic nitrogen, the cool soils of spring can lead to inadequate nitrogen availability because microbes responsible for releasing nitrogen from organic materials are not very active. Under these conditions, applying a starter organic fertilizer that contains some soluble nitrogen is likely to benefit the crop.

Starter fertilizers can be applied in several ways. One option is to fertigate seedlings while still in the flats shortly before transplanting. Another is to include fertilizer in the solution used to water in the transplants. A method appropriate for hand transplant systems is to mix solid fertilizer into the transplant hole at the time of transplanting. The table below provides examples of materials and amounts for use as starter fertilizers.

Material	Amount per 1 gal	Amount per 50 gal	Notes
Soluble fertilizer 9-45-15	1 tablespoon	2.5 lb.	Apply 8 fl. oz. per plant after transplanting
Liquid 10-34-0	1 tablespoon	2 pints	
Calcium nitrate 15.5-0-0		2.5 lb.	
Fish emulsion, 3-2-2	2 fl. oz.	6.25 pints	
Fish emulsion, 2-4-1	3 fl. oz.	10 pints	
	Amount per plant	**Amount per 100 plants**	
Blood meal 13-0-0	1 teaspoon	1 pint or 0.6 lb.	Mix well into soil in planting hole and water after planting
Alfalfa meal 3-1-3	2 to 4 tablespoons	6 to 12 pints or 1.5 to 3 lb.	

Table. 1. Example materials and rates for starter fertilizer application to vegetable seedlings at the time of transplanting.

Best conditions for transplanting

- Minimum air temperature is 40°F for cool season and 50°F for warm season crops.
- Soil temperature is 50°F for cool season and 60°F for warm season crops.
- Humid, overcast, calm.
- Adequate soil moisture.
- Protection from strong winds and frost is available if needed (see Protect Early Planted Warm Season Vegetables in VCH Issue 672).

Transplants will establish best if air and soil temperatures are optimum for growth, the soil is moist, and it is overcast, humid, and not windy at the time of transplanting. Of course, it's not usually possible to wait for ideal conditions. Air temperature should at least be above the minimum for growth, which is about 40°F for cool season and 50°F for warm season crops. To minimize risk, plant frost-tender plants after the likelihood of frost has passed if they won't be protected by row cover. If riskier early plantings are part of the plan, consider planning for frost protection as well. For more detailed frost/freeze records, refer to

A Look at the Freeze Date Tool from Midwestern Regional Climate Center from VCH Issue 713.

Soil temperature is also important. For cool season crops, 50°F is desired, and for warm season 60°F. Use a soil thermometer to check, or make use of measurements from the Indiana Mesonet. Hourly soil temperatures lag behind air temperature, so the minimum occurs mid to late morning and the peak late afternoon to early evening each day.

Figure 3. Tall tomato transplants exposed to wind could be damaged (Photo by Liz Maynard).

Soil moisture will be provided by the water you apply after transplanting, but existing moisture is important to consider as well. If too moist, the soil structure is likely to be damaged during the planting process. If too dry and rain or irrigation does not come soon, root growth may be restricted.

Windy conditions lead seedlings to lose water more quickly, and without an established root system, they can easily become stressed (Figures 3, 4 and 5). Windblown sand can create tiny wounds in leaves that open the plant to disease. Windbreaks of snow fences, strips of cover crops left standing (that can be terminated later if desired, or other vegetation can help to protect seedlings.

Figure 4. Wind damage on tomato seedling: leaves desiccated and main stem broken off, 2 weeks after transplanting (Photo by Liz Maynard).

Figure 5. Tomato seedling with dead growing point and desiccated leaves from wind damage, 2 weeks after transplanting (Photo by Liz Maynard).

At the time of transplanting

- Equipment is available for many scales and types of systems.
- Water transplants thoroughly before taking them to the field and water trays in the field as needed.
- Handle seedlings with care.
- Set equipment for proper planting depth.
- Assure contact of the root ball with soil and good coverage of root ball and pot (if present).
- Water in thoroughly.

Transplanting equipment varies with farm type and scale. It may be a trowel or Hori Hori garden knife, hand-held plant setter, paperpot (Figure 8), waterwheel (Figure 6), or mechanical transplanter. Dibbles, single or rolling, don't actually transplant but create holes for setting by hand. Whatever the method, key points apply.

Figure 6. Waterwheel transplanter (Photo by Kelley Freeman).

Before taking seedlings to the field, water them thoroughly to saturate the growing media. Be prepared to water the trays again in the field if they dry out before they get transplanted.

It's best to handle the seedling by the root ball and/or leaves – not

the stem. A stem pinched too hard will recover with difficulty, while a torn leaf will soon be replaced with another.

Adjusting the depth of planting for the size and type of seedling is important. For all crops, plant deep enough to fully cover the root ball, the growing medium, and if the seedling is in a fiber or paper pot, the top edges of the container. If growing medium or container edges are left uncovered, they will dry out and wick water away from the root zone. Tomatoes form roots readily along the stem and can be buried up to the first true leaf or, if lower leaves have fallen off, up to the first healthy true leaf. Peppers should be covered at least to the cotyledon and may be buried up to the first true leaf. Cucurbits can be buried up to, but not over, the cotyledons or seed leaves (Figure 7). Be careful not to plant too deep when using grafted plants – the graft union should be above ground.

Figure 7. Transplant set and watered in. Substrate covered with soil (Photo by Kelley Freeman).

Especially with mechanized planting, it is important to check that plants end up planted at the correct depth and are properly covered (Figure 9). In some situations, it is worth having someone walk behind the transplanter to double-check. That person can also set plants in spots that might have been missed.

Figure 8. Spinach being transplanted with a paper pot transplanter (Photo by Liz Maynard).

Figure 9. Spinach transplanted with a paperpot transplanter. Note how the edges of paperpot are visible above the soil surface: they should be covered so that they do not wick moisture away from roots. (Photo by Liz Maynard).

When planting into plastic mulch, take care that the seedling stem is not constantly rubbing against the edge of the mulch hole. Especially with more tender seedlings, the stem can be seriously damaged. Windy conditions and/or high temperatures in combination with black plastic increases the likelihood of injury to plant stem from the plastic mulch.

Water in each plant with 8 fl. oz. of starter solution or plain water right after transplanting. Use more if it is hot, windy, and dry, and consider reducing the concentration of fertilizer in the starter solution.

Check plants in the days after transplanting. It may take a few days for them to start growing. Scout for pests that may be causing damage, for instance, cutworms. If some plants don't survive, try to figure out why. Replace them within a week to minimize crop delay. If dry conditions prevail, irrigation may be needed. Your observations and notes can be used to increase success in the future.

In summary, what are the best practices?

1. Harden off to reduce transplant shock.
2. Use a starter fertilizer just before or at transplanting.
3. Take weather and soil conditions into account when selecting the transplant date.
4. Water well before transplanting.
5. Handle seedlings carefully.
6. Plant at the correct depth: not too deep or too shallow.
7. Water in thoroughly.
8. Be prepared to protect the transplants from frost, strong wind, and windblown sand, if needed.
9. Check plants in a few days; note observations; replant within a week if needed.
10. Plan to manage plant stress during the first 1-2 weeks after transplanting.

Threats to Early Seedlings

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

The warm weather of late did not only pull us out of our winter slumber but definitely awoke some of our overwintering pests as well. Cucumber beetles and seedcorn maggots are likely on the hunt for food, and your early-season crops may be exactly what they are looking for.

Striped cucumber beetles (Figure 1) are looking for any plant in the family Cucurbitaceae, and they are hungry. Squash, and maybe some high tunnel cucumber plants, are likely what they will find on our farms. While some of these individuals may be harboring bacterial wilt (the disease they transmit), the greatest threat at this point is shear defoliation of our small plants. A soil drench of a systemic insecticide, at the lowest label rate, will give you early-season protection and minimize impacts on beneficial insects. Remember, though, the lowest rate is effective. Apply it when the plants go into the field, not when starting seeds in the greenhouse. If you are growing on smaller acreage, a physical barrier, like low tunnels, can be installed and are effective until your crop begins to bloom.

Figure 1. Striped cucumber beetle in squash flower (Photo by Laura Ingwell)

The other threatening pests are seedcorn maggots or, less commonly, onion maggots (Figure 2). These pests will impact early onion production and potentially other young, transplanted crops. The adults overwinter and are now flying around, looking for fields with high organic matter and young plants to deposit their eggs. The eggs will then hatch, and the larvae (maggots) feed below ground on the roots. If you see wilting plants in the field, loosen the soil around the plant and pull the plant and remaining roots up from the ground. Investigate the roots from small, white to translucent maggots and reduced root systems. This pest is then likely the culprit. You can check out this Youtube video about maggot damage on onions.

Figure 2. Seedcorn maggot in garlic bulb (Photo by Laura Ingwell)

Consult the latest *Midwest Vegetable Production Guide* for pest management recommendations. The Guide can be found online at mwveguide.org.

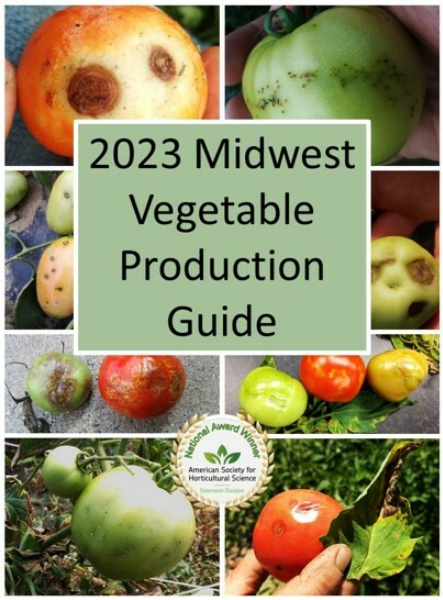
Hopefully, the cold we are experiencing now upsets the pests as much as it has us!

How to get Fungicide Information for Vegetables

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

Vegetable growers will begin thinking about fungicide applications in a few weeks. Many growers will have already purchased fungicides for the 2023 season. Where can Indiana vegetable growers go for fungicide information?

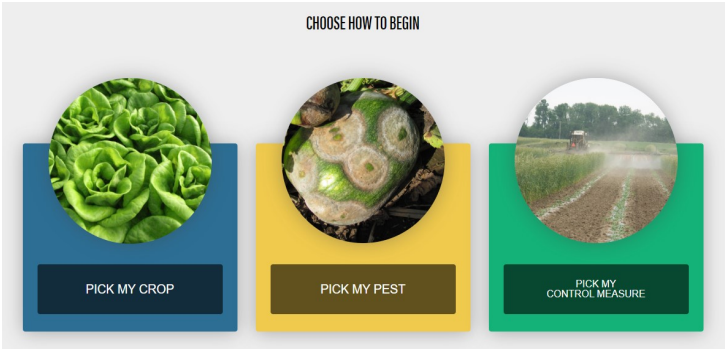
To find recommended fungicides for vegetable fungicides, one may want first to study the *Midwest Vegetable Production Guide*. One can find this Guide, also known in Indiana as the ID-56, in two places. One, go to mwveguide.org. The online Guide is searchable. When one brings up the home page, one can search for the vegetable crop and disease, insect, or weed pest of choice. The data for the webpage are kept up-to-date constantly. If a change is made to the Guide, the online version will be changed almost instantly.



Let's conduct an example search on mwveguide.org.

1. Pretend our crop is watermelon. Click on the pick my crop icon. One can type in watermelon or pick watermelon from a drop-down menu (note that if one starts typing in a crop, the name will be autocompleted).

2. Once one has selected a crop, say watermelon, one will be asked to choose a pest (pest includes disease, insect, or weed pest). Let's choose gummy stem blight.



2. A list will be generated of recommended fungicides. Note that not all fungicides labeled for gummy stem blight are generated. For example, fungicides in FRAC (FRAC=Fungicide Resistance Action Committee) group 11 are not listed because isolates of the gummy stem blight may be resistant to group 11's (Quadris Opti® and Quadris Top® have group 11 active ingredients but also contain active ingredients that should be effective against gummy stem blight). Similarly, FRAC group 7 fungicides are not listed here.

3. Expand any products listed here to get more information about rates, etc. Note that pest information and non-pesticide options are also listed here.

4. One can also limit the search by greenhouse uses, PHI interval, etc.

5. These searches can be accomplished on desktop computers, laptops, tables, and data phones (The website is responsive).

6. An orange button at the bottom of the list says 'export as .pdf'. In this way, saving the search and even printing it out for later use is possible.

The Midwest Vegetable Production Guide website also has all the chapters in PDF format that can be downloaded. The first portion of the Guide has information such as fertility and soil recommendations.

Contact the author if you would instead like to purchase the *Midwest Vegetable Production Guide* as a book for $10. Only the searchable website is updated during the season.

Fungicide information about cucurbits, in particular, can be found on the Southwest Purdue Ag Program website https://ag.purdue.edu/department/arge/swpap/index.html. Go to resources and then to cucurbit resources. One fungicide schedule is posted for cantaloupe and watermelon and another for pumpkins. These can be downloaded as PDFs. Or one can contact the author for hard copies. These schedules are updated at least annually. The link for the cantaloupe and watermelon schedule is https://ag.purdue.edu/department/arge/swpap/melon-fungicide-schedules_egel-20232.pdf.

The link for the pumpkin fungicide schedule is https://ag.purdue.edu/department/arge/swpap/pumpkin-fungicide-schedules_egel-march-2023-copy.pdf.

Regardless of where one obtains fungicide information, check the label. The crop and rate information that must be followed is always on the label. If there is any conflict between the information described above and the fungicide label, the label information must be followed.

Pollination Services in Tomatoes

(Eleanor Stroh, stroh2@purdue.edu) & *(Ian Kaplan, ikaplan@purdue.edu)*

The importance of bees for providing pollination is a regularly discussed topic in many fruit and vegetable production systems. Although tomatoes are often pollinated by wind, they too can benefit from bee pollination. Recent research suggests that tomato flowers visited by bees have a larger fruit set and produce heavier fruits. An ongoing study in Indiana is investigating which species of bees are important pollinators for two major tomato production systems: fresh-market high tunnel tomatoes and processing field tomatoes. This study aims to describe the pollinator communities in each system and evaluate to what extent they are providing pollination services. Preliminary results shed light on the importance of wild, native bee species for pollinating both high tunnel and field tomatoes.

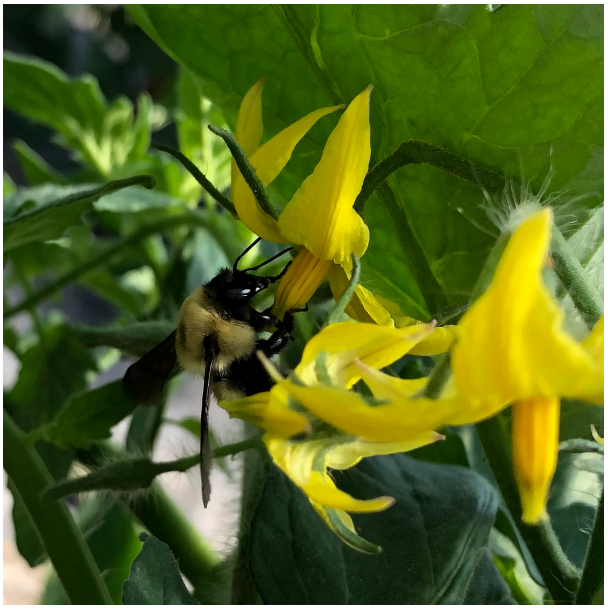


Figure 1. Common Eastern bumble bee (Bombus impatiens) visiting a high tunnel tomato flower (Photo by Ella Stroh).

Buzz Pollination

Tomato flowers have poricidal anthers; their pollen is concealed within an anther cone and can be difficult for bees to access. Some bee species exhibit a behavior called "buzz pollination", where they generate vibrations (or "buzzes") that dislodge pollen from the anther cone and increase pollination success. Only some bees are capable of this behavior– for example, bumble bees buzz

pollinate, but honey bees do not. Indiana is home to over 400 species of native bees, many of which are capable of buzz pollination. Tomatoes that are buzz pollinated have higher fruit set and weight than those that are not. Thus, the presence of buzz-pollinating species like bumble bees in tomato production can supplement or improve the pollination provided by wind.

Bees in High Tunnels

Preliminary results indicate that a variety of bees, including bumble bees and sweat bees, pollinate tomatoes in Indiana high tunnels. Bumble bees performed 61% of bee visits to tomato flowers, and 39% by sweat bees. Tomato pollinators were evaluated in high tunnels at several farms throughout the state. While bees were observed in high tunnels at some farms, they were uncommon or absent at others. It is possible that the plastic walls and hot summer temperatures in high tunnels provide potential barriers to entry for would-be tomato pollinators, and this can prevent bees from visiting high tunnels.

Pollination experiments were carried out in high tunnels to evaluate how much bees contribute to pollination and identify yield gaps caused by inadequate pollination. Some flowers were covered with mesh bags to prevent bee visits and allow for wind pollination. Other flowers were pollinated using a vibrating tomato wand to simulate a maximum pollination scenario. The fruit set and weight from each treatment were compared to a control treatment, where flowers were left open for bees to visit.

Flowers that were bagged to exclude pollinators had a significantly lower fruit set than flowers that were left open for bee visitation, suggesting that bees help to increase fruit set in high tunnel tomatoes. There was no statistical difference between fruit set or fruit weight between open flowers and supplementally pollinated flowers, suggesting inadequate pollination is not a limiting factor for high tunnel tomato yield.

Bees in Field Tomatoes

Field tomatoes are often visited by bumble bees, which comprised 93% of all observed flower visits in tomato fields across Indiana. The species most often observed was *Bombus* griseocollis– the Brown-belted bumble bee (pictured below). It is a widespread species in Indiana, although not the most common bumble bee species in the state overall. The apparently disproportionate number of brown-belted bumble bees in field tomatoes suggests that they are particularly important pollinators of field tomatoes. Research is ongoing to investigate whether this trend is sustained across multiple growing seasons.

Pollination experiments identical to those in high tunnels were also performed in tomato fields throughout the state. Fruit set and fruit weight were compared between pollinator-excluded flowers, manually pollinated flowers, and “open-pollinated” control flowers. Pollinator-excluded flowers had a lower fruit set than open-control flowers, and manually pollinated flowers had a higher fruit set. These results suggest that bee pollination currently contributes to fruit set in field tomatoes and that there is further potential to increase fruit set with additional pollination by bees. There was also an increase in fruit weight from the control flowers to the manually pollinated flowers. It is possible that increased pollination by bees could benefit field tomato yields by increasing average fruit weight in addition to fruit set.

Figure 2. Pollinator-excluded flowers (Photo by Ella Stroh).

Improving Tomato Pollination

There are several options available for those who want to improve pollination services to their tomatoes. One approach is to encourage bee visitation by improving the habitat for bees in and around high tunnels or fields. Bees visit tomatoes for pollen, but they must visit other flowers to access nectar. Increasing the availability of other flowering plants in areas adjacent to tomato cultivation will draw in a larger number of bees. Bees also require appropriate nesting habitats to build their nests and colonies. When providing nesting habitat, a “leave it alone” approach is often the most effective. Consider leaving some areas of land undisturbed– avoid removing leaves, frequent mowing or weeding, and heavy foot traffic. These undisturbed areas will provide nesting habitats appropriate for a variety of different bee species.

Another factor to account for when encouraging bee pollination is the frequency and timing of pesticide applications. Pesticides can have both lethal and sublethal effects on bees and often discourage them from visiting flowers. Consider timing pesticide applications around peaks in bee activity, which occur from mid-morning throughout the afternoon. Early morning or evening applications can minimize the impact pesticides have on bees. When possible, reducing the overall frequency of pesticide applications is also beneficial for encouraging bee pollination.

Want to help with tomato pollinator research?

The tomato pollination study is ongoing, and we are currently recruiting tomato growers to participate in the 2023 growing season. If you are a producer of high tunnel or field tomatoes located in Indiana and would like to hear more about participating in the project, please reach out to Ella Stroh in the Purdue Entomology department: stroh2@purdue.edu.

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Even Minimal Herbicide Use Can Reduce Hand-Weeding Time

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

Onions are poor competitors with weeds. Their narrow leaves do not compete well for light, and their shallow root system makes them poor competitors for water. Tight in-row and between-row plant spacing make mechanical weed control, including hand-weeding, difficult. Chemical weed control can be effective and reduce the amount of time required to hand-weed onions. However, many small farm operators are reluctant to use herbicides because of potential crop injury, carry-over to subsequent crops, and drift. Others cannot justify the use of herbicides on a small acreage because herbicides are packaged in sizes that greatly exceed small farm needs. Any herbicide used on small farms should have a broad label with documented crop safety for many vegetable crops. It should have limited soil persistence and limited rotational restrictions for vegetable crops grown in rotation on the farm. A few products fit this description, including Dual Magnum®.

Dual Magnum® is labeled nationwide for use in a limited number of vegetable crops for pre-emergence control of annual grasses and small-seed broadleaf weeds. It also provides suppression of yellow nutsedge. In Indiana and numerous other states, Dual Magnum® also has a 24C Special Local Need registration which greatly expands its use to dozens of vegetable and fruit crops, including green onions, bulbing onions, and garlic.

In 2022, the Horticulture Crops Weed Science Lab conducted trials with Dual Magnum® in onions at the Purdue Student Farm. On April 22, ‘Hamilton’ and ‘Venecia’ onions were transplanted into raised beds in a triple-row configuration. Our plots were 10 feet long. One week later, we broadcast-applied 1.3 pints of Dual Magnum per acre over the planted beds. At 4 weeks after transplanting, we applied a grass-selective herbicide, clethodim, with 0.25% non-ionic surfactant to control emerged grasses. Half of the herbicide-treated plots were hand-weeded at 7, 9, and 12 weeks after transplanting. Throughout the study, we rated for weed control and recorded the amount of time required to hand-weed plots. On August 3, we harvested and weighed the onions and weeds in each plot.

Figure 1. Weedy control one week after treatment (Photo by Stephen Meyers).

Figure 2. Dual Magnum one week after treatment (Photo by Stephen Meyers).

Season-long Dual Magnum®-treated plots had 63% weed control. The hand-weeding-only plots required 19.9 minutes/season to remove weeds. Plots receiving a Dual Magnum® application required only 7.2 minutes/season. Onion bulb number and yield was statistically similar in our hand-weeded control plots and those receiving Dual Magnum®. Overall, the net income of the hand-weeded control was $32.09 per plot. Statistically, this was similar to Dual Magnum® followed by hand-weeding ($27.39 per plot) and both treatments were greater than the weedy control ($15.13).

In this study, the application of one pre-emergence herbicide and one application of a grass-selective herbicide reduced hand-weeding labor time by 64% and freed up the farm crew to spend their time on other tasks. Chemical weed control may not be in line with every small farm, but its judicious use can contribute to more efficient crop production- even on a small scale.

For more information on weed control in onions and other vegetable and herb crops, visit the *Midwest Vegetable Production Guide* at mwveguide.org. To view and download Indiana 24C pesticide labels, visit the Office of the Indiana State Chemist's website at https://oisc.purdue.edu/pesticide/special_state_registrations.html

Return to Below-Normal Precipitation, Variable Temperatures, and Enhanced Freeze Risk

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

Through the first 18 days of April, temperatures ran 5.5˚F above normal statewide (Figure 1). The largest deviations occurred in central and northern Indiana. Despite the wet start to the month, wind, abundant sun, low humidity and reduced precipitation accounted for drying conditions across the state. Statewide, precipitation averaged 69 percent of normal.

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

Indiana
4/ 1/2023 to 4/18/2023

	Temperature			Precipitation			
cd	temp	norm	dev	prcp	norm	dev	percent
1	52.7	46.9	5.8	1.41	2.16	-0.75	65
2	52.8	46.3	6.4	1.41	2.19	-0.77	65
3	52.6	45.8	6.7	1.23	2.10	-0.87	59
4	54.3	49.0	5.3	1.34	2.27	-0.94	59
5	53.8	48.3	5.5	1.32	2.35	-1.03	56
6	52.8	47.3	5.5	1.32	2.28	-0.96	58
7	57.3	52.6	4.7	2.22	2.49	-0.27	89
8	57.0	51.9	5.1	2.07	2.56	-0.50	81
9	55.4	50.8	4.6	2.03	2.48	-0.46	82
State	54.4	48.9	5.5	1.59	2.32	-0.73	69

Midwestern Regional Climate Center
MRCC Applied Climate System
Generated at:
Wed Apr 19 09:48:36 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 April 1-18, 2023.

Surprisingly, tillage, fertilizer and herbicide applications, and planting kicked up a lot of dust and goes to show that it does not take a lot to dry out the upper soil profile. Through April 16, the USDA NASS reported 3 percent of corn and 2 percent of soybeans were planted statewide. Modified Growing Degree Days (MGDDs) continued to run above normal statewide (Figure 2) as a result of the warm temperatures.

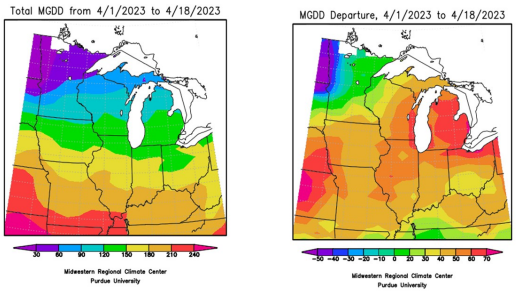

Figure 2. Total Accumulated Midwest Modified Growing Degree Days (MGDDs) April 1-18, 2023 (left) and Total Accumulated MGDDs represented as the departure from the 1991-2020 climatological normal (right).

Much of Indiana has been subjected to frost/freeze advisories over the last few days as well. Temperatures fell below freezing in many spots and can confirm that we had patchy frost on multiple occasions. All Indiana vegetation is now susceptible to freeze damage, which has triggered National Weather Service frost/freeze alerts this last week. Most plants are okay for light frosts, but damage can result from prolonged exposure to 28˚F or colder temperatures. Parke and Tippecanoe Counties recorded 26˚F and 27˚F, respectively, on April 18; many other locations experienced lower than 30˚F (Figure 3). Rush County recorded a minimum temperature of 27˚F on the morning of April 19. Warm temperatures resurged during the afternoon on April 19, but are not expected to last long as cooler temperatures are forecasted to return by the weekend.

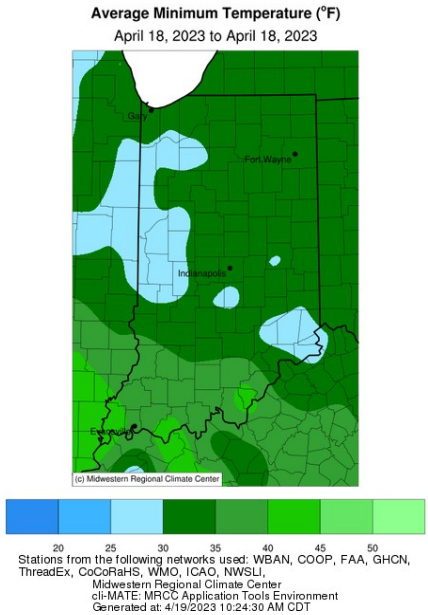

Figure 3. Average minimum temperatures for Indiana on the morning of April 18, 2023.

Seven-day precipitation forecasts, as of April 19th (Figure 4), blanket the entire state with at least 0.5 inches of precipitation, with heaviest amounts in southern Indiana (1.25-2.50 inches). The Climate Prediction Center has high confidence in below-normal temperatures and near-normal precipitation through the end of April.

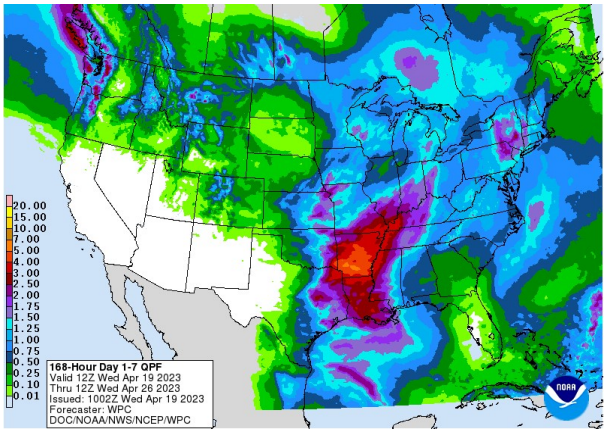

Figure 4. NWS Weather Prediction Center 7-day quantitative precipitation forecasts for the continental United States.

What could this mean for frost/freeze risk? The Climate Prediction Center has already issued a slight risk of much below normal temperatures from April 26-May 2, 2023 (Figure 5), which is indicative of increased freeze risk over. Purdue Extension has a

helpful article titled "Effects of Cold Weather on Horticultural Plants in Indiana" that discusses the impact of freeze events on these crops.

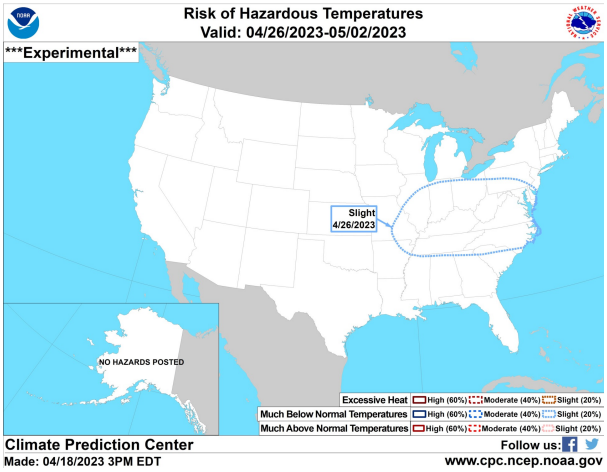

Figure 5. Climate Prediction Center's 8–14-day hazard map depicting a slight risk for much below normal temperatures on April 26, 2023.

Strawberry Podcasts on Spring Weed and Disease Management

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198) & (Miranda Purcell, mrpurcel@purdue.edu)

The most recent two podcast episodes of the Strawberry Chat focus on spring weed and disease management.

Spring Weed Management Podcast

Kevin Schooley and Stephen Meyers joined the discussion to talk about weeds and weed management in matted-row and plasticulture strawberry production. Steve spoke about weeds commonly seen in strawberry fields and gave us a broad overview of the different types of herbicides. Kevin shared years of practical knowledge in controlling weeds using herbicides at the different crop stages. They also discussed options for weed control using non-chemical approaches. Here is the supplier of the tool Kevin mentioned in the discussion.

Spring Diseases and Management Podcast

Dr. Janna Beckerman joined our discussion to talk about Spring Diseases and Management. Our discussion focused on Anthracnose fruit rot and Botrytis fruit rot. Janna described the biology of the pathogens and provided cultural and fungicide recommendations for managing these diseases. The fungicide recommendations can be found in the Midwest Fruit Pest Management Guide. Additional recommendations can be found in the Midwest Home Fruit Production Guide

SAVE THE DATE for the Purdue Fruit and Vegetable Field Day

(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.

More information about the upcoming field day will be available beginning May 2023. Registration will open soon!

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

SAVE THE DATE for the next Purdue Small Farm Education Field Day

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

Educational topics for the 2023 field day will be available beginning May. Registration will open soon.

To learn more about the field day, visit our webpage at www.purdue.edu/hla/sites/studentfarm/events/ o r contact Lori Jolly-Brown ljollybr@purdue.edu or Petrus Langenhoven plangenh@purdue.edu.

SAVE THE DATE for Southwest Purdue Agricultural Center Field Day

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

We are excited to announce that the Southwest Purdue Agricultural Center Field Day is scheduled for June 28, 2023, at the Southwest Purdue Agricultural Center (SWPAC), 4669 N. Purdue Rd. Vincennes, IN.

Purdue researchers and NRCS representatives will present their current research and demonstration projects in fruit and vegetable production conducted at SWPAC. The topics include a cover crop demonstration, high tunnel tomato cultivar evaluation, high tunnel tomato and cucumber disease and insect management, benefits of companion plants, strawberry production, irrigation management, weed management in organic sweet potato, soil health and pepper production, the effect of cover crops on pest and beneficial insects in watermelon production and more! Don't miss the opportunity to learn from fruit and vegetable production experts.

More detailed information about the field day and registration will be announced soon.

We are currently looking for sponsors for the field day. If you are interested, please get in touch with Barbara Joyner (joynerb@purdue.edu).

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