

VEGETABLE CROPS HOTLINE

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

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From The Editor's Desk

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

What's Inside This Issue

As the growing season winds down, this issue covers both wrapping up this year and getting ready for next year.

High tunnel growers will find two timely reads. Summer heat inside a tunnel can work against the beneficial insects you rely on, and soil-dwelling nematodes may offer a better fit for biological control. Before you close up for the season, take a closer look at your tomato roots, because what's hiding underground could affect next year's crop.

Mint growers can catch up on recent herbicide label changes for Midwest production. If you're interested in soil health and reduced tillage, learn what it takes to grow pumpkins with a cereal rye cover crop, and why planning starts this fall. A strong El Niño is shaping up for this winter, so see what past events have meant for Indiana.

Finally, don't miss two upcoming learning opportunities. One is a free webinar on financing options for farm and food businesses. The other is a low-cost produce safety training held just before the Indiana Horticulture and Small Farm Conference (IHSFC). Save the date: the IHSFC runs January 26-28, 2027, at the Hendricks

County Fairgrounds in Danville.

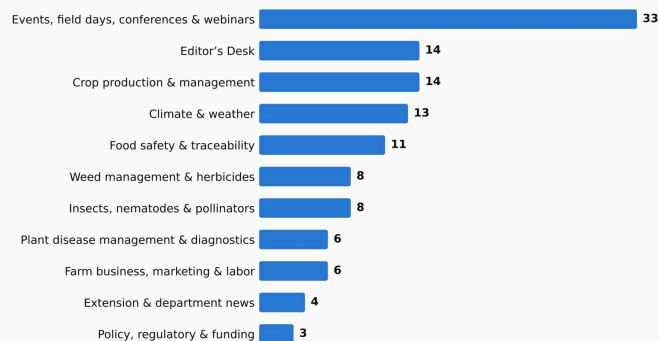
Looking Back at 2026

In 2026, the Vegetable Crops Hotline published 16 issues (Nos. 764-779, February 13 to September 25) with 120 unique articles. Thirty-six authors contributed, and we thank each for sharing their time and expertise.

Events and educational programming were the largest share, about 28% of content. The next largest groups were the Editor's Desk, crop production and management, and climate and weather updates. Multi-author articles focused on pest, nematode, and pollinator research, as well as cut-flower and strawberry production. Among specific crops, cucurbits had the most coverage (watermelon, pumpkin, cantaloupe), followed by tomato, strawberry, and cut flowers.

Vegetable Crops Hotline: 2026 articles by topic

120 articles across 16 issues (Nos. 764-779) by 36 authors



Each article counted once under its primary topic. Source: vegcropshotline.org

Looking Forward

The Purdue Extension team in the Department of Horticulture and Landscape Architecture is combining the *Vegetable Crops Hotline* and *Facts for Fancy Fruit* newsletters into a single publication. This change has been coming for a long time. The two newsletters serve many of the same growers and often cover overlapping topics, such as events, food safety, weather, and pest updates, which has meant duplicated effort on both sides. A combined newsletter will let us consolidate that work and align our content publication with Purdue University's ADA accessibility requirements. Our commitment to timely, research-based information for Indiana's fruit and vegetable growers stays the same. We will share more details about the timeline, format, and

subscription process as they become available. Thank you for your continued readership and support.

Midwest Vegetable Production Guide

The 2026 Midwest Vegetable Production Guide is available now, online or as a downloadable file you can print from your computer. The 2027 edition should be out by January 2027, so watch for an announcement on the Vegetable Crops Hotline website.

Midwest Vegetable Trial Report

Thinking about which vegetable seeds to buy? The Midwest Vegetable Trial Report has many articles to help you choose, along with production-related research results. New trial reports will be published in the fall and winter, so keep an eye out for the latest vegetable trial information as you plan for next season.

Contact Us If You Have a Story to Share

Growers and Purdue Extension educators, your input and expertise make this newsletter a useful resource. If you have hot topics you'd like us to cover, success stories to share, or questions for our Extension specialists, please email [Petrus Langenhoven](mailto:Petrus.Langenhoven@purdue.edu) or contact the [specialist](#) directly. We also welcome high-quality photos of pest problems, unusual symptoms, or new production practices you've tried on your farm.

Extension educators and specialists: This is our last scheduled issue of the season, but we will keep publishing articles on the Vegetable Crops Hotline website until our first issue in February 2027. Please continue sending timely articles, event announcements, and field observations as you have them. We will post them as they come in, so growers have up-to-date information throughout the off-season.

A Look Back at Strong and Very Strong El Niño Winters in Indiana

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

A potentially historic El Niño is developing in the tropical Pacific as we head toward winter 2026–27. You may have heard the term “super El Niño” used to describe it. NOAA’s October 8 outlook gives a combined 97 percent chance of a strong or very strong El Niño during winter (December–February). These [strength categories](#) are based on the three-month Relative Oceanic Niño Index (RONI), which measures central tropical Pacific warming relative to the broader tropical oceans. Weak events have RONI values of +0.5–0.9°C, moderate events +1.0–1.4°C, strong events +1.5–1.9°C, and very strong events +2.0°C or higher. Eight winters have reached a strong or very strong categorization since records began in 1950. El Niño’s warm Pacific waters can influence the jet stream and winter storm tracks, usually meaning warmer and somewhat drier winters in Indiana.

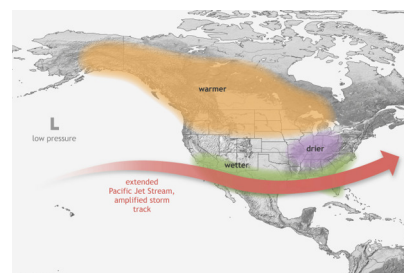


Figure 1. El Niño winter pattern. Source: climate.gov.

We analyzed eight winters (December – February) since 1950 with RONI values of at least +1.5°C, representing strong or very strong El Niño conditions. We compared weather records for South Bend, Fort Wayne, Indianapolis, and Evansville with each area’s 1991–2020 climate normals and used medians (middle values) to summarize the results.

City	Max Temp (°F)	Max Temp Departure (°F)	Min Temp (°F)	Min Temp Departure (°F)	Mean Temp (°F)	Mean Temp Departure (°F)	Precipitation (in)	Precipitation Departure (in)	Snowfall (in)	Snowfall Departure (in)
South Bend	36.9	+2.8	23.3	+3.7	30.3	+3.3	7.5	+6.1	43.3	-9.1
Ft. Wayne	37.3	+1.8	23.6	+2.4	30.5	+2.1	5.9	-1.2	11.3	-14.9
Indianapolis	40.9	+1.8	26.3	+2.3	33.3	+2.1	6.6	-1.9	7.8	-13.5
Evansville	44.8	+6.1	28.9	+1.1	37.1	+9.9	6.9	-1.5	5.9	-3.5

Winters with RONI ≥ 1.5: 1957–1958, 1982–1983, 1997–1998, 2002–2003, 2009–2010, 2014–2015, 2016–2017, 2019–2020, 2023–2024
Departures are relative to 1991–2020 DIF normals

Figure 2. Median winter temperature, precipitation, and snowfall departures during the eight strong and very strong El Niño winters, compared with each area’s 1991–2020 normals.

Station	Max Temp	Min Temp	Mean Temp	Precipitation	Snowfall
South Bend Area	7	7	7	7	1
Ft. Wayne Area	7	7	7	2	0
Indianapolis Area	5	5	5	2	0
Evansville Area	4	4	4	3	3

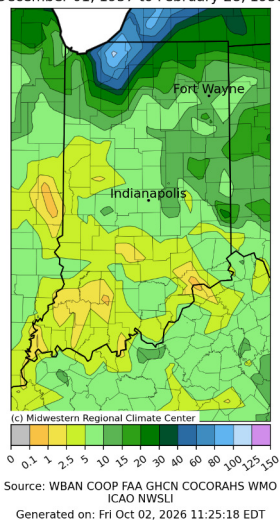
Figure 3. Number of the eight winters with above-normal temperatures, precipitation, or snowfall.

South Bend had the clearest tendency toward warmth. Seven of the eight winters were warmer than normal, and the median temperature was 3.3°F above normal. Precipitation was close to normal, while median snowfall was 9.1 inches below normal. One winter stood out: 1957–1958 brought 72 inches of snow, the only above-normal snowfall total in the group. A strong lake-effect snow signal can be seen in that winter, as indicated in the winter 1957–58 accumulated snowfall map.

Fort Wayne also had seven warmer-than-normal winters, with a median temperature of 2.1°F above normal. Snowfall showed the largest shortfall of the four locations: a median of just 11.3 inches, or 14.9 inches below normal. None of the eight winters had above-normal snowfall. Median precipitation was 1.2 inches below normal.

Indianapolis was warmer than normal in five of the eight winters. The median temperature was also 2.1°F above normal, but median snowfall was 13.5 inches below normal. None of the winters had above-normal snowfall. Median precipitation was 1.9 inches below normal, the largest deficit among the four locations. Only two winters were wetter than normal.

Accumulated Snowfall (in)
December 01, 1957 to February 28, 1958



Evansville’s results were more mixed. Four winters were warmer than normal, with a median temperature of 0.9°F above normal. Median snowfall was 3.5 inches below normal, although three winters had above-normal snow. Median precipitation was 1.5 inches below normal.

Accounting for long-term trends

Because these winters span several decades, we also adjusted the data for long-term climate trends. The findings changed little. Adjusted median temperatures were 1.4–3.7°F above normal, and snowfall was 4.0–13.2 inches below normal. After adjustment, all eight winters were warmer than normal at South Bend and Fort Wayne. South Bend still showed the most warmth, while Fort Wayne and Indianapolis had the largest snowfall deficits. Precipitation remained near normal at South Bend and below normal elsewhere. At all four locations, average lows showed larger warm departures than average highs.

Summary

These eight winters generally brought milder temperatures and less snow to the four Indiana locations. Warmth was most consistent at South Bend and Fort Wayne, while Fort Wayne and Indianapolis had the largest snowfall deficits. Precipitation was near normal at South Bend and generally below normal elsewhere.

A similar winter in 2026–27 would fit that history, but eight winters are a small sample. South Bend’s 72-inch season shows how much snowfall can vary, especially if lake-effect snowfall increases. Other weather patterns will influence storm tracks and cold spells, so even a mild winter can still bring bitter cold and major snowstorms.

Methodology

Only eight December–February winters since 1950 have had a RONI of at least +1.5°C, the threshold for strong or very strong El Niño conditions, in the [Climate Prediction Center’s historical record](#). We examined all eight: 1957–58 (+1.9°C), 1965–66 (+1.5°C), 1972–73 (+1.7°C), 1982–83 (+2.4°C), 1986–87 (+1.5°C), 1991–92 (+2.1°C), 1997–98 (+2.1°C), and 2015–16

(+2.1°C). The analysis used long weather records for South Bend, Fort Wayne, Indianapolis, and Evansville. These ThreadEx records combine observations from nearby sites as observing locations change. We compared each winter with each area’s 1991–2020 climate normals, or 30-year averages. We used medians to summarize the results and reduce the influence of extreme winters. For the trend-adjusted results, we estimated linear trends for each variable and location over 1950–2026 and adjusted values to the midpoint of the 1991–2020 normal period.

Pumpkins in Cereal Rye: Opportunities and Challenges for Indiana Growers

(Emily Kresca, eluc@pruue.edu) & (Mark Evans, mevans@purdue.edu)

Pumpkin and other cucurbit production in Indiana often involves intensive soil preparation to create a warm, weed-free seedbed. However, increasing interest in soil health, cover crops, and reduced tillage has led some growers to consider a different approach: planting pumpkins into a terminated cereal rye cover crop using no-till or strip-till practices. Planning for this production system starts with establishing the fall cover crop.

This system offers several potential advantages for growers. A well-established cereal rye cover crop can protect soil from erosion, suppress weed challenges, conserve soil moisture, and reduce soil disturbance. At the same time, planting a warm-season vegetable crop into heavy rye residue creates challenges to consider before adopting the practice across an entire operation.

Why Cereal Rye in Indiana?

Cereal rye is one of the most used winter cover crops in Indiana. It is relatively inexpensive, establishes well in the fall because it germinates at temperatures as low as 34°F, is winter-hardy, and can produce substantial biomass before terminating in the spring. These characteristics make it particularly useful when the objective is to maintain soil cover during the period of greatest erosion risk.

For pumpkin growers, cereal rye’s primary value is often the residue it leaves behind after termination. Rather than incorporating the cover crop with tillage, growers leave the rye on the soil surface as a mulch, providing a splash barrier for higher-quality, cleaner produce. Termination may occur chemically with herbicide or via roller crimping, allowing full use of the cover crop without tillage.

This can be particularly beneficial on Indiana’s sloping fields and soils susceptible to erosion. The residue protects the soil surface from raindrop impact crusting and can reduce runoff and soil movement during spring and summer thunderstorms. It also provides a protective layer between the developing pumpkin vines and the soil.

Additionally, in terms of water management, the cover crop and reduced tillage provide an environment whereby less moisture evaporates during dry periods and, even more importantly, during

a thunderstorm or bursts of heavy rain in a short time increment, greater water infiltration and percolation can occur for water management and storage for the crop.

Weed Suppression

One of the most promising aspects of planting pumpkins into cereal rye is weed suppression. A dense rye stand can produce enough residue to physically interfere with weed emergence and reduce the amount of light reaching the soil surface.

Rye may also suppress weeds and other pests through allelopathy, in which compounds associated with rye residues can inhibit the germination or growth of certain weed species. However, growers should not expect rye alone to provide season-long weed control.

The amount of rye biomass is an important factor. A thin stand provides little mulch, while a vigorous stand with substantial biomass creates a much more effective barrier. Rye termination timing and method also affect the residue's persistence and effectiveness.

For Indiana growers, this means fall establishment and spring management are key parts of the system. A poor rye stand going into winter is unlikely to suddenly become an effective mulch in the spring.

No-Till and Strip-Till Planting

Planting pumpkins into heavy rye residue requires a planter that can handle high-residue conditions. Conventional vegetable planters may struggle to maintain consistent seed placement when residue concentrates around the seed row.

No-till planters may require adjustments such as residue managers or other high-residue components. The goal is to create a clean enough planting zone to achieve good seed-to-soil contact without disturbing the entire field.

Strip-tillage provides another option for Indiana growers. Instead of planting directly into undisturbed residue, growers till a narrow strip of soil before planting. The strip can provide a warmer, more favorable seedbed while the majority of the soil remains covered with rye residue.

Soil Temperature and Moisture

One trade-off of heavy rye residue is its effect on the soil environment.

The residue shades the soil surface and can reduce evaporation, which may help conserve moisture during dry periods. This can be especially beneficial in summer, when pumpkins have high water needs.

However, the same residue can keep soil cooler and wetter during the spring. Pumpkins are a warm-season crop, and slow soil warming can delay germination and early growth. Strip management systems can be significantly helpful in these situations.

This tradeoff matters in Indiana, where spring planting conditions can vary considerably from year to year. A system that performs well during a warm, relatively dry spring may behave differently during a cool and wet one.

Growers should avoid planting into excessively wet soils simply because the calendar says it is time to plant. Compaction and poor seedling establishment can create problems that persist throughout the season.

Nutrient Management Is Important

Nitrogen management deserves particular attention when pumpkins follow cereal rye cover crops. Cereal rye generally has a relatively high carbon-to-nitrogen ratio, especially when it has produced a large amount of mature biomass. After termination, microorganisms decomposing the residue require nitrogen. As a result, some nitrogen may temporarily become less available to the pumpkin crop if the cover crop is tilled into the soil. However, when the cover remains on the surface, the carbon-to-nitrogen issue will be minimized.

This process, commonly called nitrogen immobilization, can contribute to early-season nitrogen deficiency. For Indiana growers, consider the amount and maturity of rye biomass when developing a fertility program, and also consider the previous crop, manure applications, expected yield, and other sources of available nitrogen.

The timing and placement of nitrogen may be particularly important in a high-residue system. Rather than assuming all nitrogen must be available before planting, growers should consider how fertilizer availability will match pumpkin demand during the growing season.

With clean air regulations, sulfur is less available from the atmosphere. In high-residue and reduced-tilled fields, sulfur responses are more common, and in many cases, an application is required for success.

Managing the Rye Crop

Successful pumpkin production begins with successful cereal rye management. Establish rye early enough in the fall to develop an adequate stand before winter. The planting date depends on the preceding crop, field conditions, and the production system. Hoosier growers often balance the desire for high rye biomass with the need to terminate the cover crop and plant pumpkins on time.

Letting rye grow longer generally increases biomass, which can improve soil protection and suppress weeds. However, more biomass also means more residue to plant through.

Termination timing therefore involves a series of trade-offs. The goal is to produce enough biomass to provide the desired benefits without creating an unmanageable planting environment.

Don't Forget About Pests

A high-residue system can change the habitat in and around the crop. Slugs can sometimes become more noticeable in fields with substantial surface residue, particularly when conditions are cool and wet.

Armyworms may attack green cereal rye plants in the spring, causing considerable concern because of their numbers. However, once the cereal rye dies, armyworms soon die from a lack of food because they do not feed on pumpkins. IMP (integrated pest management) systems and tools are economically important to the grower.

Growers should scout fields rather than assume that residue will either increase or decrease pest problems. Field history, weather, crop rotation, and surrounding vegetation can all influence pest pressure.

Crop rotation remains important as well. Pumpkins and other cucurbits share many diseases and pests, so rotating cucurbits with unrelated crops is an important part of an integrated production system. A cover crop can add biodiversity to a crop rotation.

Start Small and Compare

For growers interested in trying cereal rye before pumpkins, beginning with a small acreage can provide valuable information without committing the entire operation to an unfamiliar system.

Consider establishing a comparison within the field. Measurements such as rye biomass, soil moisture, soil temperature, pumpkin emergence, weed pressure, yield, and fruit quality can help you determine whether the system fits your farm.

It is also useful to record practical considerations often overlooked in replicated research plots: How easily did the planter handle the residue? Did planting take longer? Was additional herbicide needed? Did the rye interfere with irrigation or harvest? Were there problems with fruit sitting on wet residue?

These observations can matter as much as yield when determining whether a production system makes economic sense.

A Tool, Not a One-Size-Fits-All Solution

Cereal rye and no-till or strip-till planting give pumpkin growers another tool to manage soil and water resources. Potential benefits include reduced erosion, improved soil cover, weed suppression, moisture conservation, and reduced soil disturbance.

The system is not without limitations. Cool spring soils, heavy residue, nitrogen immobilization, planting difficulties, and potential pest concerns can complicate production. The right management strategy depends on soil type, field history, available equipment, weather, and the grower's production goals.

For Indiana growers considering this approach, the most useful question may not be whether pumpkins *can* be grown successfully in cereal rye. Rather, it is how the cover crop and

reduced-tillage system can be managed to fit the farm's specific conditions.

As with many changes in production practices, a small-scale trial can provide an excellent starting point. Careful observation and recordkeeping over several seasons can help you determine whether cereal rye and reduced tillage can support both profitable pumpkin production and improved soil management on your farm.



Pumpkin on cereal rye cover (Photo by Mark Evans).



Figure 2. Pumpkin no-till cereal rye cover with Foxtail (Photo by Mark Evans).



Figure 3. No-till pumpkin in cereal rye cover (Photo by Mark Evans).



Figure 4. No-till pumpkin in cereal rye cover at planting (Photo by Mark Evans).



Figure 5. Cereal rye residue (Photo by Mark Evans).

Free Webinar: Financing Your Farm, Food & Agribusiness – October 28

Are you preparing your agribusiness for its next stage of growth? Finding the right capital is often one of the biggest hurdles to growth. A free virtual workshop later this month can help you sort through your options.

The Indiana Small Business Development Center (ISBDC), in partnership with Purdue University's Center for Regional Development and the U.S. Small Business Administration, will host **"Financing Your Farm, Food & Agribusiness"** on **Wednesday, October 28, 2026, from 11:30 a.m. to 12:30 p.m. (EDT)**. The one-hour session is designed for Indiana growers, makers, processors, and small food businesses looking to understand practical financing options for their next stage of growth.

Topics will include:

- Funding paths for farm and food-based businesses
- 2026 updates to key grant and loan programs
- Industry changes that may affect your operation
- Year-end planning and preparing for 2027

The timing is ideal for vegetable growers. With the season winding down, late fall is a good window to review this year's numbers, plan capital investments, and line up funding ahead of the 2027 season.

Bob Warner, Agribusiness Advisor with the Indiana SBDC Agribusiness Initiative, will lead the workshop. You can reach Bob at 317-460-3029, rwarner@isbdc.org, or rjwarner@purdue.edu.

Registration: The event is free, but registration is required. [Registration](#) closes on October 27, 2026, at 2:00 p.m.

Upcoming Produce Food Safety Programming Offered by Safe Produce Indiana

(Tari Gary)

Produce Safety Alliance Grower Training

The Safe Produce Indiana team will host an in-person Produce Safety Alliance (PSA) Grower Training in January, the day prior to the Indiana Horticulture and Small Farms Conference. The program will be held on [Monday, January 25, 2027, at the Hendricks County Fairgrounds](#). The cost of attendance is \$10 and includes a certificate of course completion, the PSA Grower Training manual, and other training materials. This program has been made possible at a reduced cost by grant funding from the Indiana State Department of Agriculture.

The PSA Grower Training is for fruit and vegetable growers and others interested in learning about produce safety, the Food Safety Modernization Act (FSMA) Produce Safety Rule, Good Agricultural Practices (GAPs), and co-management of natural resources and food safety. The PSA Grower Training Course is one

way to satisfy the FSMA Produce Safety Rule requirement outlined in § 112.22(c), which requires 'At least one supervisor or responsible party for your farm must have successfully completed food safety training at least equivalent to that received under standardized curriculum recognized as adequate by the Food and Drug Administration.'



Figure 1. Student Sophia Chiparus harvests produce at the Purdue Student Farm to supply community-supported agriculture (CSA) programs and various campus partnerships in West Lafayette, Indiana (Photo by Joshua Clark, Purdue College of Agriculture).

The trainers will spend approximately seven hours of instruction time covering content contained in these seven modules:

- Introduction to Produce Safety
- Worker Health, Hygiene, and Training
- Soil Amendments
- Wildlife, Domesticated Animals, and Land Use
- Agricultural Water (Part I: Production Water; Part II: Postharvest Water)
- Postharvest Handling and Sanitation
- How to Develop a Farm Food Safety Plan

Growers can learn more and register at the following link:
[Registration link for Hendricks County Training](#)

The Safe Produce Indiana team is in the process of scheduling additional PSA Grower Trainings for the upcoming winter season. Please visit the [Safe Produce Indiana website](#) for an up-to-date list of scheduled training opportunities.

High Tunnel Tomato Production: Dig Out Tomato Roots and Check Root-Knot Nematode Galling at the End of the Season

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

It is time to remove tomato plants from high tunnels. By season's end, plants often harbor pathogens and insect pests, and removing crop residues can reduce carryover into the next growing season. We remember to remove leaves, stems, and fruit, but often overlook the roots.

Roots can harbor several hiding pathogens and pests, including

one of the most damaging: root-knot nematodes. In our previous soil survey, we detected root-knot nematodes in more than half of the high tunnels sampled in Indiana. Although not all infestations are severe enough to cause economic damage to tomatoes, ignoring the pest can lead to significant yield loss later.

What to Check on Tomato Roots

Look for abnormal swellings, or galls (Figure 1). These may appear as large, irregular swellings on the main roots or small, beadlike swellings on fine roots. Such symptoms can indicate root-knot nematode infection. If you are unsure whether the swellings are nematode galls, submit a picture sample or physical root sample to the [Purdue Plant & Pest Diagnostic Lab](#) for confirmation.



Figure 1. A healthy tomato root (left); tomato roots with root-knot nematode galling (middle); and a heavily infested tomato root beginning to decay (right) (Photo by Wenjing Guan).

Why Check Tomato Roots?

Checking tomato roots serves two purposes. First, it provides an opportunity to detect root-knot nematode infestations that might otherwise go unnoticed. Tomatoes are highly susceptible to root-knot nematodes and typically develop visible root galls when infected, making root inspection a useful detection method. You can also take soil samples and perform a plant-parasitic nematode test to detect the problem. Soil samples cannot accurately reflect root-knot nematode population levels and distribution across the entire high tunnel. Depending on where the soil was collected, results might differ dramatically, even between adjacent plants. This is because root-knot nematodes move only short distances on their own in the soil, but their populations can increase dramatically in localized areas where suitable host roots are available. The second reason to dig out tomato roots is to remove infested roots, which helps reduce nematode carryover into the next season. After tomato plants are terminated, roots may remain alive for a time and continue to support nematode reproduction. Even after the roots die, eggs attached to them can survive over the winter, hatch, and infect the next susceptible crop. Removing and properly disposing of infested roots removes many of these eggs and reduces the living root tissue that could support continued reproduction. Although this practice does not eliminate root-knot nematodes in the soil, it is an important step in reducing the population carried over to the next crop or season.

How to Appropriately Dispose of the Infested Roots

Galled roots can carry large numbers of root-knot nematode eggs, which may survive in moist conditions. One costly mistake we have observed is placing infested roots in compost piles that don't reach temperatures high enough to kill the nematodes. When you later apply that compost across the farm, it can spread root-knot nematodes to previously uninfested areas.

For manageable quantities, place roots in sturdy, sealed bags and remove them. Bagged roots may be disposed of through regular trash collection where permitted by local waste disposal regulations and the waste collection service. For larger quantities, burning may be an option where local regulations allow it. During root removal and inspection, minimize soil movement to other beds, tunnels, or fields. Remove soil adhering to shoes and tools before leaving the infested area. Finally, when washing tools and equipment, prevent wash water from running into growing areas.

Taking time to inspect and remove infested tomato roots this time of year helps prevent root-knot nematodes from becoming a damaging issue on the farm. More information about root-knot nematode can be found in this article [Root-Knot Nematodes and Their Populations Identified in Indiana](#)

This project is supported by the USDA National Institute of Food and Agriculture (Specialty Crop Research Initiative grant number 2021-51181-35904 and Organic Transitions Program grant number 2024-51106-43054) and by the North Central Sustainable Agriculture Research and Education (SARE) (project number LNC24-511).

Too Hot to Handle? Entomopathogenic Nematodes for High Tunnel Biological Control

(Julia Wooby, jwooby@purdue.edu) & (Ian Kaplan, ikaplan@purdue.edu)

Temperature regulation is a cornerstone of protected agriculture production. High tunnels trap infrared rays from the sun, keeping temperatures sufficiently warm for production year-round. However, on hot, sunny, summer days, this very function can work against crops by disrupting the pest control services provided by natural enemies.

Insect predators and parasitoids tend to be more susceptible to extreme temperatures than the pests they rely on for prey and hosts. This results in ecological imbalances where pest populations can continue to grow while the natural enemies that keep them at bay decline. Previous research has shown that heat stress can cause lower reproduction rates, reduced feeding, and even death in natural enemies. Additionally, natural enemies released in high tunnels may disperse from the structure when temperatures get too high.

In summer 2025, we deployed data loggers to collect air and soil

temperature data from inside a high tunnel and in the field at the Purdue Student Farm. We found that while air temperatures tended to be consistently higher under high tunnels, soil temperatures were lower overall (Figure 1). Therefore, we hypothesized that entomopathogenic nematodes (EPN), soil-dwelling natural enemies, would be well suited for pest control in high tunnels.

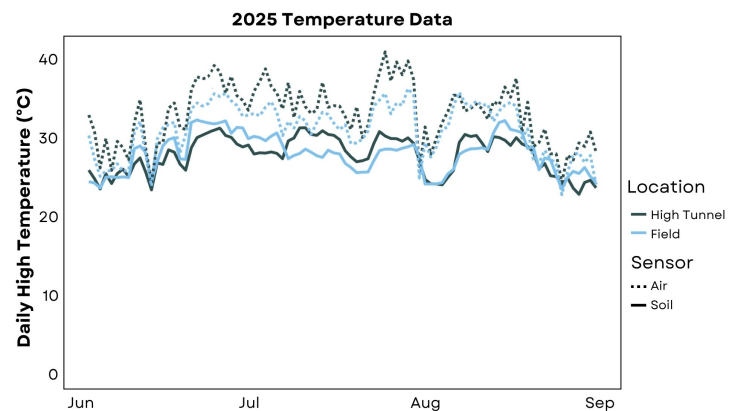


Figure 1. Temperature data collected in 2025 at the Purdue Student Farm show air temperatures were consistently higher than soil temperatures, specifically in the high tunnel (Photo by Julia Wooby).

EPN are available commercially to control pests with soil-dwelling life stages. They live in the soil in their infective juvenile (IJ) life stage, where they seek out, infect, and kill their insect hosts. They are used across diverse agricultural systems because they are highly compatible with various application technologies and are able to be used alongside pesticides (Figure 2). Additionally, EPN can be strategically used to target soil-dwelling life stages missed by foliar insecticide applications or insect biocontrol agents. In the soil, they pose low risk to non-target insects, including other beneficials. Despite their high potential across many systems, there is currently very little research on how protected agriculture microclimates, specifically high tunnels, impact EPN persistence.

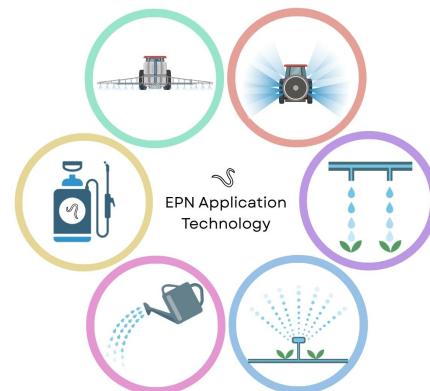


Figure 2. EPNs are compatible with various irrigation and spray technologies to be applied in large-scale field and orchard settings as well as smaller-scale crop production (Photo by Julia Wooby).

To investigate how high tunnel conditions impact the persistence of EPN, we conducted an experiment at the Purdue Student Farm in summer 2025 and 2026. We sourced three products representing the three most common species of EPN from Koppert Biologicals. These products were stored, mixed, and applied according to manufacturer instructions to best illustrate the biocontrol services provided by commercial products available to

growers. EPNs were applied using a watering can at a rate of 500,000 IJ per square meter in identical plots in the high tunnel and field. After application, we collected soil cores from each plot 2-, 5-, 9-, and 14-days post-application, and then weekly until infection rates approached zero. To detect whether EPN were present in the soil, we used waxworms to bait and isolate IJs from the samples (Figure 3).

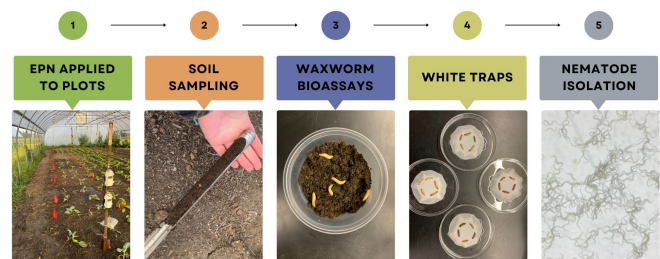


Figure 3. Experimental methods from EPN application to isolation and confirmation of infection (Photo by Julia Wooby).

The data presented here are summarized across the three EPN species applied to the soil. Our data show that, in both years, EPN persisted better in soil under high tunnels than in the field. In 2025, by three weeks post-application, there was very little infection overall in either the high tunnel or field plots (Figure 4). In 2026, EPN persistence was greater overall, with infection occurring six weeks after application (Figure 5).

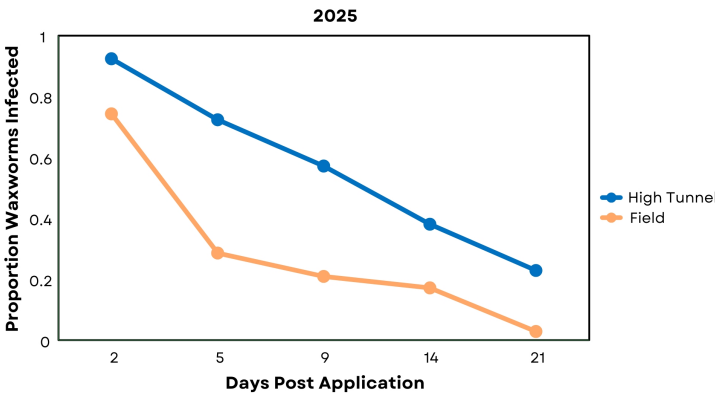


Figure 4. In 2025, EPN remained present in the soil for 21 days post application. Infection rates were higher in soil samples collected from the high tunnel than from the field (Photo by Julia Wooby).

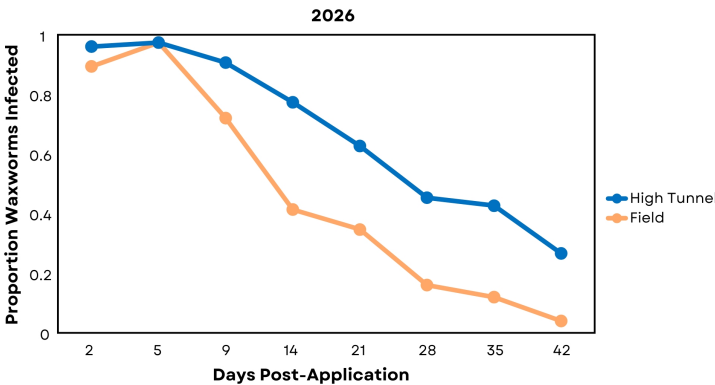


Figure 5. EPN remained in the soil for 42 days post-application in 2026. Infection rates declined more quickly in the field than in the high tunnel (Photo by Julia Wooby).

These data show not only that EPN are able to persist in high tunnels despite high temperatures, but that certain attributes of the high tunnel environment may be more favorable for EPN persistence compared to the field. While sunlight is essential to the functionality of a high tunnel, EPN are very sensitive to UV light. Research has shown that UV exposure can reduce the ability of EPN to infect and kill their hosts, and in extreme cases, lead to mortality. However, the polyethylene cover that traps infrared rays to increase high tunnel air temperatures can filter UV light, protecting EPN in the soil.

In the high tunnel environment, where other commercial natural enemies such as parasitoid wasps and predators may experience diminished efficacy due to high air temperatures, EPN are largely protected and may be a viable option for controlling certain soil-dwelling pests. As protected agriculture grows in popularity, production can be maximized by better understanding how this unique microclimate affects not only crop growth, but all organisms, including beneficials, interacting within the agroecosystem.

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Mint Herbicide Updates: Generic “Zidua®”, Spartan®, Anthem® Flex

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Generic “Zidua®”

Zidua® herbicide has been registered for use in numerous crops in the United States for over a decade. It is a soil-applied, residual Group 15 herbicide containing the active ingredient pyroxasulfone. When Zidua® was registered for use in U.S. mint, the herbicide registrant (BASF) decided to not allow its use in the Midwestern mint-producing states of Indiana, Michigan, and Wisconsin. In 2024, Anthem® Flex (pyroxasulfone plus carfentrazone) was [labeled for use in dormant mint](#), allowing Midwest mint growers to legally apply a pyroxasulfone-containing product for the first time.

At the recent IR-4 Project Food Use Workshop in September, I spoke with the BASF representative about this topic, and she informed me of one newly registered generic formulation of pyroxasulfone. Upon further review, there are now at least five unique pyroxasulfone products on the market. However, not all of them are created equal. (Note: This article focuses on what this means for mint growers. If you use pyroxasulfone in other cropping systems, you will want to review each label to ensure it is registered for your intended crop — do not just assume that all label language from the Zidua® label will be the same on each generic product label.)

One important difference is that each product has different label restrictions related to the states where the product can be applied. The Zidua® SC label has always excluded Midwestern mint-growing states of Indiana, Michigan, and Wisconsin. Some of the newly available generics follow this same language. Novali™ explicitly adds Indiana, Michigan, Utah, and Wisconsin, while Zannis™ adds Wisconsin but excludes Indiana and Michigan. The RedEagle pyroxasulfone product does not include any language restricting the use to certain states, allowing it to be used nationwide. I am hopeful the table below will help you sort all of this out.

Also note that there are now three different formulations of pyroxasulfone represented by these products. The RedEagle product is an 85% wettable granule (WG). The others are water-based suspension concentrates, containing either 4.17 or 6.97 pounds of pyroxasulfone per gallon of product. This matters because it affects the product use rate and the mixing order if you plan to apply these products in a tank mix.

PYROXASULFONE PRODUCTS

Formulations, rates and state availability

Yes No

PRODUCT	FORMULATION	RATE PER ACRE	ID	IN	MI	MT	OR	UT	WA	WI
Zidua® SCa	SC (4.17 lb/gal)	3.0 fl oz	Yes	No	No	Yes	Yes	No	Yes	No
Novali™	SC (6.97 lb/gal)	1.75 fl oz	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RedEagle Pyroxasulfone 85%	WG (85% by weight)	1 to 5 oz	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zannis™ SC	SC (4.17 lb/gal)	3.0 fl oz	Yes	No	No	Yes	Yes	No	Yes	Yes
Vermeso™	SC (4.17 lb/gal)	3.0 fl oz	Yes	No	No	Yes	Yes	No	Yes	No

Abbreviations: SC = suspension concentrate; fl oz = fluid ounces; ID = Idaho; IN = Indiana; MI = Michigan; MT = Montana; OR = Oregon; UT = Utah; WA = Washington; WI = Wisconsin; Y = Yes; N = No.

Always read and follow the product label. State registrations change; confirm before use.

Figure 1. Table of five pyroxasulfone herbicide products showing formulation, rate per acre, and availability in eight states (Photo by Steve Meyers).

Two “special” herbicide labels going away

Spartan® 4F received a [24c Special Local Needs label](#) in 2024 for applications to mint after cutting. This “at renovation” 24c label was allowed to expire by the Office of the Indiana State Chemist because the use was recently added to the Section 3 (nationwide) label.

The Anthem® Flex supplemental label that allows for its use on dormant mint will expire in April 2027. As with Spartan® 4F, this supplemental use has been added to the new Section 3 label.

New containers of Spartan® 4F and Anthem® Flex should include the updated labels. For those using older products, the new labels should be kept on file until all old stock is used up.

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