High and Dry

Growing Vegetables in Northern New England High Tunnels



Extension College of Agriculture and Life Sciences

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WELCOME TO THE SIXTH ISSUE of *High and Dry: Growing Vegetables in Northern New England High Tunnels*, a quarterly newsletter linking growers, researchers, and agricultural service providers to enhance protected crop production. This issue focusses on summer crop production specifics, as well as pests and diseases you may encounter this growing season. We are also very excited to announce the 5th biennial High tunnel Conference, this December in New Hampshire. See the Save the Date announcement below.

This online newsletter is a collaborative effort among the University of Vermont (UVM), the University of New Hampshire (UNH), and others to support high tunnel growers — especially new ones who are still gaining experience with this technology. Our goal is to provide information and resources to help your high tunnel crops thrive!

Don't hesitate to reach out to the team listed on the last page with ideas for future topics, feedback, or questions. This work is funded by the Northeast Sustainable Agriculture Research and Education (NE-SARE) program and the UVM and UNH Extension programs.

Save the Date!

New England's 5th Biennial High Tunnel Conference, "Enhance Your Tunnel Vision" will be held on December 10–11, 2025 at the Fireside Inn in West Lebanon, NH. This conference is geared towards beginning and experienced commercial high tunnel vegetable and cut flower growers. Topics covered include ventilation, soil fertility, pest and disease management, and tunnel economics. There will also be a tour to see high tunnel production at a nearby farm. **Announcements & resources:**

It's summer workshop season! Don't miss out on these opportunities to learn from other growers.

Vermont Vegetable and Berry Growers' Association (VVBGA) summer workshop:

TUESDAY OCTOBER 14, 3:00-5:30 P.M. High Tunnels For Year-Round Organic Vegetable Production

Intervale Community Farm, 281 Intervale Rd, Burlington, VT 05401

UNH Extension is hosting a monthly webinar series with excellent greenhouse and high tunnel specifics, including pest management, climate control, and watering. Find previous recordings and sign up for upcoming webinars at:

https://extension.unh.edu/blog/2025/01/2025-webinar-series-greenhouse-nursery-garden-center-professionals

The Vermont Vegetable and Berry Growers' Association hosted a webinar series with some great information on high tunnel growing — check out "Tips for improving organic high tunnel tomato yields" and "Moving water away from fields and tunnels". Click here for a full list and links to all VVBGA webinars.



Stay tuned for a full agenda and registration details.



Tomato Pith Necrosis

Ann Hazelrigg, UVM Extension

EARLY SEASON ISSUES IN HIGH TUNNEL TOMATOES are caused by abiotic (non-infectious) factors such as cold injury, ethylene damage (usually from poor combustion from greenhouse heaters), and edema (caused by the buildup of too much water and reduced transpiration during cool and/or cloudy periods). However, there are two primary infectious problems that can cause problems high humidity, and vigorous plant growth due to excess nitrogen cause stresses that favor the pathogen. Excess irrigation and drastic temperature fluctuations can also contribute to the development of the disease.

Disease incidence is most common when fruit is nearing mature green. The first symptoms are yellowing and wilting of leaves and the development of excess adventi-



Adventitious roots along stem due to tomato pith necrosis. Rob Wick, University of Massachusetts



Vascular discoloration of stem tissue due to tomato pith necrosis. Rob Wick, University of Massachusetts

in May and June: damping off (due to root rot pathogens) and tomato pith necrosis.

Tomato pith necrosis is caused by several soilborne bacteria mainly in the genus Pseudomonas. This disease is common in the early part of the season since the cool night temperatures, extended cloudy weather conditions, tious roots along swollen stems. Dark brown streaks can appear along the stem, and when cut longitudinally the interior (pith) is dark brown/black, and often hollow. The plant can die if the damage is severe, but with improved conditions the plant can recover and grow out of the damage. ∞

Grasshoppers in May? What's Going On?

Margaret Skinner and Becky Maden, UVM Extension

USUALLY, WE THINK OF GRASSHOPPERS as a summer or fall vegetable pest. That is why we were surprised to hear from a grower who had a plague of them in his Vermont high tunnel in early May (PHOTO 1). This grower had never noticed grasshoppers in the spring before but this year



Photo 1: Immature grasshopper responsible for damage in young high tunnel vegetable plants.

the succulent new growth of his high tunnel cucumbers has been reduced to lacy shadows of their former selves (PHOTO 2). Other growers have also reported grasshoppers in their high tunnels in spring, which likely have built up over several years of not tilling the soil. These grasshoppers have been observed on grass edges of the tunnels in early spring as tiny grasshoppers, growing larger over the course of the summer, damaging early-planted cucumbers and tender leafy crops like basil. There are at least 83 different species of grasshoppers in Vermont alone, though it is unknown what species was responsible for the damage these growers noticed. However, it is likely the special microenvironment within a high tunnel can lead to unique pest issues not encountered in field production.

Grasshoppers are in the order Orthoptera, and include what we commonly call locusts, katydids, crickets and grasshoppers. There are over 20,000 known species of orthopterans worldwide. They have gradual or incomplete metamorphosis, with the immatures (nymphs) hatch-





Photo 2: Grasshopper damage on cucumber seedlings in May in a VT high tunnel.

ing from an egg looking similar to the adult stage. Over multiple molts they gradually grow wing pads that form wings when they reach adulthood. They have chewing mouthparts that can consume large amounts of foliage in a short time. They continue feeding throughout all life stages except the egg, making them a persistent pest over an extended period. Most grasshopper species overwinter as eggs in the soil and emerge as nymphs when the temperature rises. The common signs of grasshopper damage are leaves that are skeletonized or with ragged or tattered edges and fruit with chewing pits. The good news is they don't seem to cause too much damage on tomatoes, and once the cucumbers begin to gain some height, the problem seems to subside. Grasshoppers seem to do most of their damage at the ground level, so the upper plant canopy and plants growing on the benches may be less attractive.

It is impossible to know the life cycle of the damaging grasshopper without a species determination. However, some general assumptions can be made. It is likely the grasshoppers in the Vermont high tunnels overwintered as eggs in the high tunnel, in the egg stage. An individual female grasshopper can lay an average of 10–400 eggs, and they don't need a male grasshopper for reproduction. That means even one or two adults in the high tunnel in the fall can lead to hundreds of young ones in the spring.

What other options are there for this pariah?

CULTURAL CONTROL. Because the eggs overwinter in the soil, tilling the soil thoroughly in the fall may destroy the eggs. Weeds around the high tunnel in the summer and fall also may serve as a food source for grasshoppers, so removing them could reduce the adult population that will lay eggs before winter. Theoretically, particularly sensitive plants could be protected by careful screening, but grasshoppers are known to chew through cloth screening and once under the screen, they benefit from the protection and their damage may go unnoticed. When the population isn't too high, hand picking them and dropping them in a container of soapy water and rubbing alcohol can help (a great activity for kids!). If the population is reduced early, the plants can outgrow the damage.

INSECTICIDES. Several types of insecticides are labeled for use against grasshoppers, though their efficacy can't be confirmed. Some growers report spraying Pyganic[®], a pyrethrin-based biological insecticide, known to provide a quick knockdown and kill for a broad array of pests, including grasshoppers. To maximize on efficacy, it

advised to make applications in the evening when grasshoppers are less likely to hop away (ensuring contact with the best) and pollinators are less likely to be active (protecting them from unintentional harm). Targeting the early nymphal stage is best as they are more sensitive to the treatment, and their exoskeleton is softer and more likely to be penetrated by the spray. Spraying along the edges of the tunnel is important as they may hide in crevices when not feeding on plants. More than one application may be needed because the overwintering eggs hatch over several weeks. Here are a few of control options:

- Neem-based products (e.g., AzaGuard, active ingredient: azadirachitin)
- Insecticidal soaps
- Beauveria-based products, (e.g., Botaniguard[®] EC).
- Diatomaceous earth (e.g., Perma-Guard[™])

Baits containing a protozoan, *Nosema locustae*, were developed several years ago, but are no longer available commercially. These baits, when available, take 2–4 weeks to be effective, and in the spring that is too slow for protecting young plants.

The Take Home Message

Grasshoppers are yet another emerging pest invading the high tunnel environment. Growers are turning to high tunnel protection to reduce the impact of extreme weather events on their crops. Sadly, insects have also figured out that high tunnels are a perfect overwintering habitat. Thorough tilling of the soil between plantings may contribute to disrupting vulnerable pest stages without significantly impacting beneficials.

Other resources:

W.S. Cranshaw and R. Hammon, "Grasshopper Control in Gardens and Small Acreages", Colorado State University Extension

https://extension.colostate.edu/topic-areas/insects/grasshopper-control-in-gardens-small-acreages-5-536/

"Grasshoppers — How to Protect Your Garden and Farm with Eco-Friendly Tactics", Arbico Organics https://www.arbico-organics.com/category/pest-solver-guide-grasshoppers-crickets

Semaspore Bait by Planet Natural

https://www.planetnatural.com/product/semaspore-grasshopper-control/ ∞

The Do's and Dont's of Tomato Trellises for Tunnels

Heather Bryant UNH Extension

HAVE YOU EVER HAD AN ENTIRE ROW of basket weave tomatoes tip over in a windstorm, or a string break leaving an entire tomato plant on the ground with tomato puree splattered in a six foot radius? I'm sure a lot of us have. Hopefully you have not had the experience of your tomatoes getting so heavy they start to bend the endwalls or cross pieces (aka trusses or cross members) of your tunnel. If you have, don't feel bad, I've done it too.

If you are relatively new to tunnel tomatoes and you want to avoid these unfortunate scenarios, let's talk about do's and don'ts!

Basket weave in a high tunnel?

For me this is **something of a don't** because it creates a hedge row inside your tunnel and that can lead to ventilation problems and subsequent disease issues. However, depending on what your market demands, you may find yourself forced to grow determinate varieties in a tunnel. In this case, you need to basket weave. For a great step by step guide to basket weaving including diagrams <u>check out this factsheet by Becky Sideman at UNH</u>.

In a tunnel keep in mind your plants will have more lush growth which means they will be heavier than outdoor tomatoes. Consequently, **do focus on building a sturdy trellis.** The factsheet above recommends driving the stakes in at least 6". In my tunnel, the soil is fairly sandy and I like the extra security of driving the stakes 10–12". Adding a rope staked down at an angle from the top of the stakes at the end of the rows can also add strength (think tent stake).

Overhead trellises

These are by far the most common systems I see in high tunnels. They are great for indeterminate tomatoes which keep growing taller throughout their lifespan. Again, for a step-by-step guide including diagrams see the factsheet above.

A typical indeterminate tomato plant at peak production can easily weigh 50 pounds or more. Multiply that by the number of plants in your tunnel and clearly you need to think about how much pressure you are putting on your tunnel structure. Occasionally, I see tunnels where the trellising system is built by running high gauge wired from endwall to endwall. You **don't** want to do that. Rather you want as much of the weight of your plants to rest on the cross pieces as possible. That transfers the weight to the bows of your structure which typically are much sturdier than the endwalls. In my tunnel I use metal conduit and lay it over the cross pieces and secure it with zip ties. See PHOTO 1.



Photo 1: Metal conduit resting on cross pieces and secured with zip ties.

I **do** also add bracing that goes from the floor to the cross piece to keep it from bending under the weight of tomatoes. See PHOTO 2. Fortunately, most of my clients have not had the issue of the cross pieces bending! I have found that I **don't** need to do this if I'm growing cucumbers in that tunnel. A good rule of thumb is that each tunnel/crop combination is going to be different, so it pays to keep an eye on your cross pieces and your endwalls.

The potential solutions to trellising issues are limited only by your creativity. In <u>this Iowa State video</u> you can see the growers have built a trellis system on the ground to protect the structural integrity of the tunnel and are using the lean and lower technique since the trellis is only about 5–6' tall.Note the extra bracing at the ends of the rows.



Photo 2: Extra bracing for tunnel tomatoes.

And finally, what about reusing clips and twine? As one of my colleagues says "we all do it" but is it a good idea? **Do** reuse clips, but first wash them in a 10% bleach solution. Eventually, they will wear out and you will have to replace them, but in my experience, you can easily get 2–3 crops out of the clips. Conversely, I say re-using string is a **don't**. Plastic photodegrades and tomato twine is not expensive compared to the tomatoes you could lose if the string breaks. Ann Hazelrigg with UVM said if you have had severe bacterial canker, **don't** reuse the twine, otherwise the risk of spreading disease via the twine is relatively low. On the other hand, chiropractors are also expensive and climbing up and down ladders hundreds of times isn't fun. I leave the strings up at the end of the season and the next season tie the new strings to the old ones and pull the new strings up and over the conduit from the ground. I also use the sturdiest twine I can find. Typically, it's available in one or two-ply. Extension isn't allowed to name brand preferences but ask around, I'm sure all farmers have an opinion on this one!

At the end of the day, the do's and don'ts are pretty varied depending on who you talk to. **Don't** hesitate to figure out what works best in your system! ∞



Growing Upwards: Trellising Peppers and Eggplants in Tunnels

Becky Maden, UVM Extension

GROWING PEPPERS AND EGGPLANTS IN TUNNELS has the potential to diversify early summer crop offerings and improve fruit yield and quality compared to field production. The greenhouse industry in many other parts of the world have been cultivating eggplant and peppers in protected culture for decades, but adoption has been slow in the U.S., especially among small scale growers here in the



Photo Credit: Cheryl Frank Sullivan

Northeast, where the majority of tunnels are unheated. However, in the past decade, greenhouse specific varieties have become available through seed companies that sell to market gardeners, opening up new opportunities for growers eager to improve tunnel pepper and eggplant production.

There is an overall lack of information available to growers about cultivating high tunnel vegetables, and in particular, pepper and eggplant cultivation in unheated tunnels. Thankfully, Dr. Becky Sideman and other colleagues at UNH (including high tunnel team member, Heather Bryant) have been tackling these questions for the past few years. Over a <u>three-year trial</u> comparing greenhouse bell pepper varieties with field cultivars, they found that the high-tech cultivars produced significantly higher marketable yield than field varieties, with better plant vigor and crop quality (Sideman, 2020). However, research examining high tunnel eggplant, led to a different set of conclusions: in their two-year trial, field varieties performed as well as greenhouse varieties. They also found that pruning eggplant in unheated tunnels did not improve yield (Sideman et al., 2024). <u>Read more about</u> <u>their findings here</u>.

The UNH team also explored pruning and trellising systems in their research, making the important distinction that in unheated tunnels, some labor investments do not pay off in the long run (for example, pruning and trellising eggplant). However, these varieties are still quite new to our region, so growers continue to explore and modify techniques. Described below are a few recommended trellising systems that can be used for peppers and eggplant. If you are a grower looking to try something new, test out some new varieties and systems —let us know how it goes!

Trellising to Overhead Lines

This method is best suited to hybrid greenhouse varieties that will produce for a long season, ideally in a heated greenhouse. Peppers and eggplant can be pruned to 2–4 main leaders and either gently twisted around twine or clipped to it. These can be planted in two rows per bed with two parallel wires over the bed. Stems should be about 6 inches from each other. Vegetative "suckers" are pruned off peppers and eggplant as with tomatoes; however, for eggplant, let the suckers develop and cut off the shoot right above the flower cluster.

Basket Weave

This method is best suited to bells or other heavy fruited peppers or large eggplant varieties grown in unheated tunnels to prevent lodging. A good description of basket weaving can be found at Johnny's Seeds Growers' Library. This method is fairly quick to maintain, but be careful not to squish immature pepper fruit between lines of twine.

Hortonova Netting

This is system is suitable for small-fruited peppers like lunchbox, shishito, or hot peppers. It is set up with two lines of square Hortnova netting stretched vertically on either side of the pepper plants. This allows the plants to stay contained, but doesn't squish the fruit, requires little maintenance once it is set up, and allows for easy picking.



Photo Credit: Cheryl Frank Sullivan

All of these systems require expenses and time. We'd love to hear from you — what have you tried for peppers and eggplant? What varieties do you grow? Send your feedback to rebecca.maden@uvm.edu.

References

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Johnny's Selected Seeds (2024). Bell Pepper Greenhouse Production. https://www.johnnyseeds.com/growers-library/vegetables/peppers/ peppers-bell-greenhouse-production.html



Photo Credit: Becky Maden



Photo Credit: Becky Maden

Johnny's Selected Seeds (2016). Greenhouse Eggplant Production. https://www.johnnyseeds.com/growers-library/vegetables/eggplant/eggplant-greenhouse-production.html

Johnny's Selected Seeds (2016). Basket-Weave Trellising Instructions. https://www.johnnyseeds.com/growers-library/methods-tools-supplies/pruning-trellising/tomatoes-peppers-basket-weave-trellising-instructions.html

What's That Bug? Lacewings

Cheryl Sullivan, University of Vermont Entomology Research Laboratory

WHEN YOU HEAR 'LACEWING' AS A NATURAL ENEMY, a "green" insect with pronounced delicate-looking wings might immediately come to mind. However, there are also "brown" lacewings, and they are some of the best aphid predators around! Brown lacewings (Hemerobiidae) and green lacewings (Chrysopidae) are natural enemies of numerous pests. Lacewings develop through four life stages: egg, larva, pupa and adult. Both somewhat resemble each other in appearance in most of their different life stages, pupate in silken cocoons and their alligator-looking larvae are cannibalistic when food is scarce. Although there are some similarities between them, there are several important differences:

Green Lacewings

- · Predatory as larvae
- Adults consume nectar, honeydew, and pollen
- Adults often green but can be shades of brown-gray
- Eggs laid singly on stalks
- Performs best in warm weather

Brown Lacewings

- Predatory as adults and larvae
- Adults predatory at night
- Adults usually shades of brown and gray
- Eggs laid singly on foliage
- Can perform well in cool weather

There are many lacewing species that occur in the wild. *Micromus variegatus* (brown) and *Chrysoperla rufilabris* and *C. carnea* (green) are commercially available.

For more information about lacewings, visit the following links:

- Brown Lacewings & Green Lacewings (UC IPM)
- Common Green Lacewing (Cornell)
- Micromus variegatus (Applied Bio-nomics)





Brown lacewing (Micromus variegatus) adult and egg (Dr. Dave Gillespie of AgCanada from Applied Bio-nomics); brown lacewing sp. larva (Jacy Lucier, Wikimedia)



Green lacewing adult (Judy Gallagher, Flickr); eggs (Cheryl Sullivan, UVM); larva (C. camea) (Koppert)

Accurate Pest and Disease Identification: The First Line of Defense

Margaret Skinner & Cheryl Frank Sullivan, University of Vermont Entomology Research Laboratory

IN LATE MAY A GROWER NOTICED LARGE NUMBERS of little yellowish bugs on her strawberry foliage and sent a picture (PHOTO 1). She didn't see any damage, but was concerned it might be potato leafhopper, Empoasca fabae. The action threshold for this pest is an average of 2-3 nymphs/ leaf, and her population far exceeded that. She wondered if she should spray something to protect her plants and the crop. This pest sucks the sap out of the leaves, causing marginal yellowing and stunting. They can also transmit diseases during feeding. They are not known to overwinter in northern locations but are blown in from the South. It was a bit early to see these leafhoppers, but the general color and shape seemed to fit (PHOTO 2). The grower was advised to either send samples to the UVM Diagnostic Lab or take a closeup and resend it. With a higher magnification lens the grower was able to solve the mystery. It wasn't a leafhopper at all, but a springtail/collembola, Deuterosminthurus nonfasciatus, which feeds mostly on fungal spores and decaying organic matter and isn't a pest (рното 3). She even found a video by David Attenborough about this creature: https://www.youtube.com/watch?v=OwOL-MHcQ1w



Photo 1: Tiny yellowish insects on strawberry leaves in May.

The take-home message

Know the insects on your plants. That saves growers from making unnecessary sprays or natural enemy releases. When in doubt send a picture or specimens to your state diagnostic lab. It is worth the effort. Here are the steps to follow:

- 1. Estimate the problem, i.e., percent damage, pest population numbers, extent of the infection, location in the high tunnel
- 2. Determine which crops are affected
- 3. Take **clear** pictures of the damage and the insect, ideally a closeup
- 4. Send images to the diagnostic lab in your state
- 5. Collect 2–5 infested/infected leaves with insects if present and place in sealed plastic bag
- 6. Keep samples in a cool, dark place, but don't refrigerate them
- 7. Send specimens in a crush-proof container with completed sample forms within 24 hours
- 8. If sending plugs, wrap root zone with a paper towel so foliage doesn't get covered in dirt.



Photo 1: Immature potato leafhopper. Credit A. Sisson, Iowa St. Univ. Bugwood.org



Photo 3: Springtail/collembola on strawberry foliage

https://go.uvm.edu/high-tunnel

Diagnostic Labs in Northern New England

MAINE

Maine Pest Management Unit, extension.diagnosticlab@ maine.edu, 207-581-3880 or 800-287-0279 (in Maine), https://extension.umaine.edu/diagnostic-lab/

New Hampshire

UNH Plant Diagnostic Clinic, unh.pdl@unh.edu, 603-862-3043,

https://extension.unh.edu/agriculture-gardens/pest-disease-growing-tools/ plant-diagnostic-lab

UNH Insect & Other Arthropods Identification, 603-862-3200,

https://extension.unh.edu/agriculture-gardens/pest-disease-growing-tools/ insect-other-arthropods-identification

Vermont

UVM Plant Diagnostic Clinic, Ann Hazelrigg, Ann. Hazelrigg@uvm.edu, 802-656-5421, https://www.uvm.edu/extension/plant-diagnostic-clinic

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Found a tick on yourself, a loved one, or a pet? Don't Panic—Get It Tested!

If you enjoy the outdoors in the Granite State, you're more likely to come into contact with ticks—and potentially, tick-borne illnesses like Lyme disease.

Now there's a fast and reliable way to find out if a tick that bit you is carrying disease-causing pathogens. Tick testing from the University of New Hampshire is now available to the public through UNH Extension.

In just 2–5 business days, you'll receive results that can help you and your doctor make informed decisions about next steps and treatment, if needed.

Order your test online, send in the tick with your code, and get results within a few days—simple, secure, and science-backed.

Learn more and order your test here:

https://unh.how/tick



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