High and Dry

Growing Vegetables in Northern New England High Tunnels

THE UNIVERSITY OF VERMONT EXTENSION

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WELCOME to the second 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 focuses on the transition from winter to spring. It is critical to get organized before the summer growing season gets going. We share construction tips for new tunnels, guidance on soil testing in tunnels, disease management in late winter greens, how to create a biocontrol plan, and information about habitat plantings.

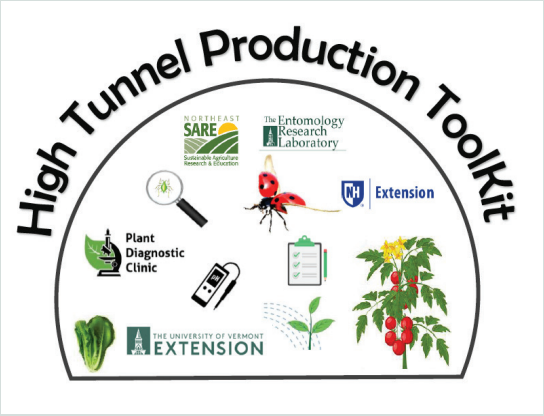
This is a collaborative effort among the University of Vermont (UVM),the University of New Hampshire (UNH), and others to support high tunnel growers — especially new ones who are still learning the ropes of this technology. Our goal is to provide information and resources to help your high tunnel crops thrive! Don't hesitate to reach out to the team listed on page 11 with any questions or ideas for future topics. This work is funded by the Northeast Sustainable Agriculture Research and Education (NE-SARE) program and the Extension programs of UVM and UNH.

The High Tunnel Production Toolkit

Visit the High Tunnel Production Toolkit online! The website is geared for new high tunnel producers across the Vermont, New Hampshire and Maine, tri-state region, but growers of all experience levels will benefit from these resources.

The project is funded by Northeast SARE and led by the University of Vermont in collaboration with the University of New Hampshire.

The toolkit has factsheets and presentations; lists workshops, seminars and events; and provides a list of resources from other institutions and agencies.



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

Announcements & Events

The New England High Tunnel Conference, held December 6–7, 2023, was a success with over 160 attendees! Thanks to the organizers, presenters, and growers who made it possible.

The Vermont Vegetable and Berry Growers' Association has hosted several a webinars on high tunnel topics. Recordings may be found on the VVBGA YouTube channel, including webinars on winter greens, high tunnel pests, and high tunnel ventilation.

Purdue University recently launched a High Tunnel Production website. Check it out! https://ag.purdue.edu/department/entm/extension/scri/

New Video Series on Greenhouse and High Tunnel Construction

Heather Bryant, UNH Extension Field Specialist

At the recent High Tunnel Production Conference we received a number of requests for additional education on siting and building a high tunnel, and choosing the right tunnel for the operation. This is exciting as it means many of you are considering adding a tunnel to your operation.

To get you started, we recommend watching the "Constructing a Greenhouse or High Tunnel" video series put together by UNH Extension Field Specialist Jonathan Ebba in collaboration with Rimol Greenhouse Systems, ATTRA, and the Northeast Extension Risk Management Education Center.

This video series is thorough and allows you to see the process as it's being described. It covers siting the structure, site preparation, layout and ground posts, assembling the frame, constructing end walls, covering the house, and assembling the roll-up sides.

This is material based upon work supported by USDA/NIFA under Award Number 2021-70027-34693.

(L) High tunnel construction and (R) skinning a high tunnel. (Photos: Becky Maden, UVM Extension)

Time to Sample High Tunnel Soils

Becky Maden, UVM Extension Vegetable Nutrient Management Specialist

Why should you use a different soil test for high tunnels?

Management of high tunnel soils differs from field soils, largely because of the lack of rainfall and because higher rates of amendments are needed to achieve yield potential in high tunnels. In addition, certain nutrients (e.g., phosphorus) and soluble salts may accumulate to excessive levels over time so it is important to measure both nutrient levels and soluble salts. Further, fertilizer recommendations that accompany field soil tests are often insufficient for tunnel crops, which typically have a longer season and higher yield potential than field crops. Fertilizer recommendations should be adjusted to support these high yields. For more information on amendments and cultural practices, visit https://nevegetable.org/cultural-practices/high-tunnels.

Dana Ruppert, UVM Extension, taking high tunnel soil samples in southern Vt.

How to sample high tunnel soil

High tunnels should be sampled in a manner similar to field soils. Collect an aggregate sample several weeks prior to the time you intend to apply fertilizers. Collect at least 10 to 15 sub-samples per tunnel to a depth of 5 to 8 inches, where most roots grow. Do not mix samples from areas that have had significantly different rates of fertilizers or soil amendments applied previously — keep these areas separate. A soil auger is best for collecting an equal amount of soil from top to bottom of the sampling depth. If using a spade or trowel to sample, remove a wedge of soil and leave a smooth edge to sample from. Then trim off a 1-inch ribbon of soil that evenly represents the sample from top to bottom. Collect sub-samples in a "W" pattern from production areas. To get an accurate measurement of available N, collect soil that has been warm and moist for a couple of weeks. Mix the subsamples in a clean bucket, break up clods and remove any debris. Pack 2 cups of the aggregate sample into a plastic bag and label clearly with farm name, tunnel name, and date taken. Keep the sample in a cool or refrigerated place until ready to mail. If possible, mail early in the week to avoid weekend delays.

What type of soil test should you request?

For tunnels that are newly constructed (less than 3 years in production), UMaine offers a "basic high tunnel package" for $25 that uses the routine field soil analysis (modified Morgan extract). This analysis measures nutrients in "reserve" that are predicted to be plant-available over the course of the season. In addition, the basic high tunnel test analyzes soils for nutrient salt buildup and nitrate availability/carryover.

For tunnels that have been in production for more than three years, the lab offers a "long term high tunnel package" ($30). This test uses two analyses: a field soil test (modified Morgan extract) to monitor all essential nutrients, and a "saturated media extract" (SME) to measure "nutrient intensity" or the level of water-soluble nutrients immediately available for plant uptake. The SME includes measures of available nitrogen and nitrate and ammonium, and soluble salts. Available nitrate-N is important to get transplants off to a good start as excess ammonium-N can damage plants. Soluble salts may accumulate due to lack of rain and snowfall in tunnels and can damage plant roots. Salts usually accumulate near the soil surface so tillage prior to sampling may provide a more accurate measurement.

Based on the results of your soil's nutrient analysis, UMaine also provides nutrient (fertilizer) recommendations aimed at meeting the high nutrient demand of tunnel crops. Visit the UMaine soil testing service for forms and updated information. Reach out to Becky Maden (rebecca.maden@uvm.edu) for additional support.

Send samples to:

Analytical Lab & Maine Soil Testing Service
5722 Deering Hall
Orono, Maine 04469-5722

Diseases on Late Winter & Spring Tunnel Greens

Ann Hazelrigg, UVM Extension Associate Professor/
Plant Diagnostic Clinic Coordinator

Many Vermont farms with high tunnels plant leafy greens after tomatoes have been harvested to increase profits. Growing high tunnel winter greens can be tricky. Although tunnels protect greens from low temperature damage and extend the season, fluctuating winter temperatures and the use of row covers can promote high humidity and leaf wetness, resulting in a lot of foliar disease problems.

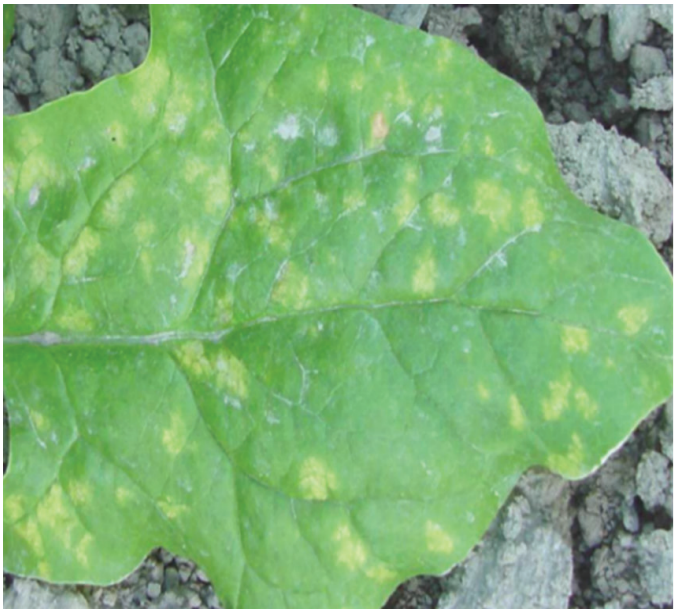
The most important way to avoid issues in your winter greens is to scout your crops regularly and be proactive; know the diseases and associated symptoms that can occur. Be aware that the diseases found in high tunnels may differ from those found in the field on the same crop. Your biggest enemy in high tunnels is high humidity and the goal is to take advantage of all the ways to AVOID the disease in the first place because rescue fungicides are not usually effective.

Pathogens in high tunnel greens can be challenging due to consumers' low tolerance for disease symptoms (or residues) on the crop. All these pathogens can destroy the crop, do well in cooler temperatures, and tend to prefer prolonged periods of leaf wetness or high humidity. The low light and short days in the winter create extended periods of time for pathogens to produce spores and the plastic covering of tunnels protects the pathogens from exposure to damaging UV radiation.

Cladosporium leafspot is the most common disease on fall/winter high tunnel spinach. Symptoms include tan-colored 1 to 3 mm leafspots that can coalesce. In time, velvety green sporulation is visible within the spots. The fungus thrives in cool, wet conditions with relative humidity over 80 percent and can grow at 41°F. The pathogen overwinters on crop residue for several years and spores are spread easily by splashed water, wind, workers, and equipment. Since the pathogen can be seedborne, spinach seed should be hot water treated at 104°F / 40°C for 10 minutes to eliminate disease without impairing germination. This can be done by the seed company, a university-provided service, or by the grower with the right tools and time for it. Till under infected crops as there is no rescue with fungicides once infected. Use drip irrigation on sunny days so that foliage will dry quickly. Manage row covers and ventilation so moisture does not build up. Do not cover crops when wet! There is some variation in cultivar susceptibility so keep track of the best cultivars for your operation.

Cladosporium in spinach. (Photo credit: G. Higgins, UMASS)

Spinach downy mildew is on the rise due to the increase in the use of tunnels and the potential "green bridge" effect of overlapping summer and fall field crops with tunnel crops. Symptoms of downy mildew show up as yellow discoloration on the upper leaf surface with brown/purple velvety spores on the leaf undersides. The downy mildew pathogen *(Peronospora effusa)* has many "races" but all ONLY attack spinach. The pathogen will not survive on dead tissue so does not overwinter on refuse. The fungus-like organism prefers cool moist conditions with high humidity and can explode when conditions are conducive. Seed treatment does not work for this pathogen. The best way to manage/avoid downy mildew is to



Yellowing on upper leaf surface with velvety purple/brown spores on the leaf undersides. (Photo credit: UVM Plant Diagnostic Clinic)

choose disease resistant cultivars. Races recently detected in the northeast include 12, 13, 14 (most cases), 15, 16, 17, and a novel race.

Choose cultivars with the widest range of race resistance and grow multiple cultivars with differing gaps of resistance. Select varieties with resistance to at least races 12 and 14, which are the most common in New England. Once infected, there is no rescue treatment and it is best to till the crop under. Never apply row covers to wet leaves. It is critical to destroy all high tunnel and overwintering spinach crops infected with downy mildew at least 2 weeks before the start of spring field spinach production to avoid infecting the new crop. Downy mildew can also be found on kale, lettuce, arugula, and other brassicas but those downy mildew pathogens are specific to those crops. You may see downy mildew on different crops at the same time because all downy mildew pathogens like the same high humidity conditions.

Arugula bacterial leafspot is a new disease caused by the bacteria *Pseudomonas cannabina* pv. *alisalensis*. The pathogen is most likely seedborne and can survive in plant debris for up to two months. Hot water seed treatment is not feasible in arugula, so using

(L) Bacterial leafspot on arugula. (Photo credit: L. DuToit); (R) Bacterial leafspot of arugula. (Photo credit: C. Bull)

good cultural practices and removing/destroying all crop debris between plantings is critical. There are few effective controls for bacteria, but copper and hydrogen dioxide may give fair control if applied early in the disease cycle and repeated at regular intervals.

Powdery mildew in kale, brassicas, and lettuce causes superficial white growth on both leaf surfaces. Like downy mildew, powdery mildew also has a narrow host range and is specific to each individual plant type (i.e., the kind that attacks kale is *not* the same one that attacks lettuce). The pathogen only lives on live tissue and prefers drier conditions with no free water only high humidity. There are several good organic controls for the pathogen including sulfur, JMS Stylet-oil and other mineral oils, MilStop and other potassium bicarbonates but to be effective these must be applied early and repeated.

There are also abiotic (non-infectious) issues that can be common in spinach including glandular trichomes and edema.

Glandular trichomes are plant hairs emerging from the spinach leaf epidermis and can be easily seen with a hand lens. They are often mistaken for fungal spores or insect eggs but are of no concern. In some cultivars the trichomes may be more noticeable than in others.

Edema can be a common occurrence in spinach when the plant takes up a lot of soil moisture and yet does not transpire the water due to cloudy cool conditions. The liquid builds up in the cells until they burst producing corky lesions often seen along the ribs on the leaf undersides. When favorable conditions return, the plant will grow out of the damage.

In summary, it is best to avoid these spinach diseases rather than try to rescue the plants. Minimize disease occurrence by selecting resistant cultivars when available. And grow more than one! In the case of pathogens that evolve rapidly like downy mildew, be aware that a cultivar that worked last year may not be resistant to new races the next year. Use hot water treated seed where applicable. Locate field plantings as far away as possible from the same crop grown in tunnels. Destroy field and tunnel plantings immediately after harvest. Avoid cool and moist or humid conditions and never cover wet foliage with row covers. If reusing covers, clean at the end of the season. Promote rapid drying in tunnels with fans. Vent high tunnels as often as temperature permits. Routinely check plants for disease symptoms. Manage weeds inside and around tunnels as some can be alternate hosts for pathogens and insect pests, and inside they contribute to humidity. For more information on high tunnel greens diseases check out "Diseases Occurring in Winter Greens and Their Management" Remember, all land-grant universities have Plant Diagnostic Clinics to help identify your winter greens diseases through pictures or samples!

(L) Glandular trichomes in spinach. (Photo credit: UNH); (R) Raised lesions due to edema in spinach. (Photo credit: Pop Vriend Seed Co., Holland)

NOW is the Time to Prepare a Biocontrol Plan for Aphids in Your High Tunnel Vegetables

Somaiyeh Ghasemzadeh, Post Doctoral Associate
Cheryl Frank Sullivan, Research Assistant Professor/Entomologist, UVM Entomology Research Laboratory
Margaret Skinner, Research Professor/Extension Entomologist, UVM Entomology Research Laboratory

Though winter snow covers the ground around high tunnels, aphids don't take a break. These tunnels create a cozy space for aphids, allowing them to continue to reproduce and create problems. That is why it is important throughout the year to scout crops and weeds because they are "aphid hotels"!

Damage from aphids is easy to spot. Usually young leaves are curled up, and aphids may be hiding inside deformed leaves. If you see a sheen on the leaves, it may be honeydew secreted by aphids (FIG. 1A). If there is blackish fungal growth on the leaf surface, it might be sooty mold which grows on the honeydew. They also leave behind white cast skins (FIG. 1B).

Fig. 1. Aphid-infested lettuce head with honeydew (sheen) on the foliage (A) and an aphid's cast skin (B).

Many different species of aphids can be found in high tunnel crops, so get them identified by a specialist, especially if releases of biological controls are planned. Some may be effective against one aphid species but not another. While green peach aphid *(Myzus persicae)* is common, don't assume that is what they are. Looking at their body color is not a reliable way to determine their species. Potato aphids *(Macrosiphum euphorbiae),* foxglove aphids *(Aulacorthum solan),* melon aphids *(Aphis gossypii),* and turnip aphids *(Lipaphis pseudobrassicae)* are other common aphids in high tunnels.

Some of these also can have a pinkish tinge and the populations of all of them can explode with little warning. The IPM motto "Start Clean to Stay Clean" should always be heeded. Managing aphids in greenhouses where transplants are started, inspecting plant materials purchased from other farms upon receipt and reducing aphids on remaining crops during partial tunnel turnover reduces pest issues later in the year. A biocontrol supplier can help select and create a schedule for natural enemy releases to help keep aphids at bay if started early in the crop cycle, before populations get too high.

Aphid populations may appear to be low in winter, but as soon as the days get longer and temperatures inside the high tunnel rise, their activity and rate of reproduction increases and a few individuals rapidly turn into a major outbreak. Early action is important, particularly if using biocontrol agents because it takes time for the bios to build populations high enough to reduce pest numbers. Many options exist for managing aphids with biocontrol, including predators and parasites. These beneficials act like an army to keep pest populations in check, but selecting which one can be complicated. Some work on one particular aphid species while others are generalists and many have specific day lengths or temperature conditions to be effective. Several species of parasitic wasps (FIG. 2) are effective against aphids, especially at higher temperatures. Releasing them in summer crops or in early fall after transitioning to winter greens may reduce aphids later in winter. Because some species of parasitic wasps are only effective against one aphid species, knowing what aphid is in the high tunnel is important before ordering. Many species are also naturally occurring if you give them a good home.

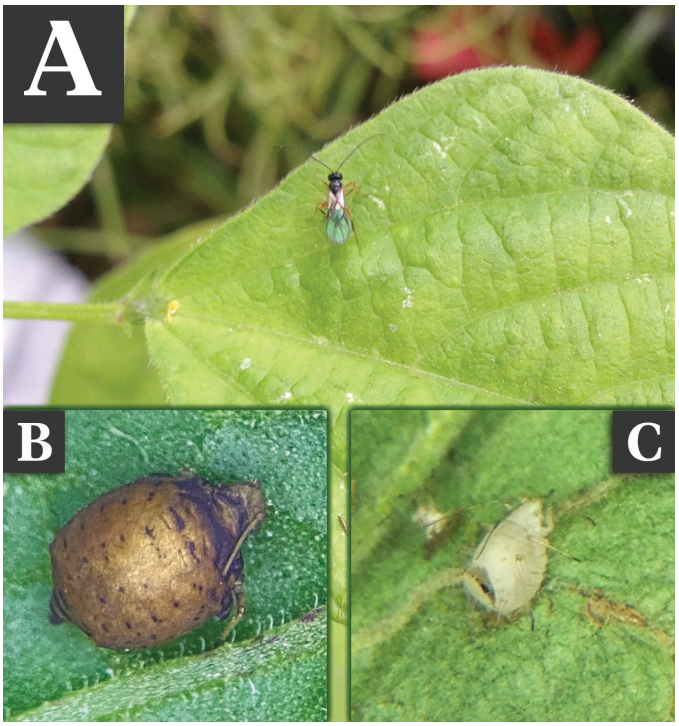


Fig. 2. Parasitic wasps (A) lay eggs in the aphid. After the larva hatches, it feeds on the aphid and kills it. A mummy forms, which is the wasp pupa (B). Adult wasps emerge by chewing an exit hole in the mummy (C).

A fly midge, Aphidoletes aphidimyza, is an effective larval predator (FIG. 3). The good thing about this beneficial is it is adaptable, and feeds on most aphid species. The downside is they hibernate when day lengths are short and are most effective late spring-early fall. Be aware that when their populations are high, they swarm on warm evenings and look like fungus gnats.

Fig. 3. Larvae of a predatory midge feeding on an aphid.

Everyone knows the cheery adult lady beetle, Family Coccinellidae (FIG. 4), but less familiar are the larvae, that look like tiny lizards. There are many species, all with slightly different colors and markings. Hippodamia convergens is available commercially and occurs naturally outside the high tunnel. They can consume hundreds of aphids daily. They tolerate the cool temperatures in high tunnels better than most parasitic wasps and survive under row covers during winter.

Fig. 4. Lady beetle adult (top) and larva (bottom) feasting on aphids.

Ladybugs love company! Planting diverse crops attracts ladybugs and other natural enemies, and limiting pesticide use is crucial to protect them. There are several other useful beneficial insects and mites that occur naturally.

Check out these useful websites to learn more:

Crop Recommendations (Applied Bio-nomics)

IPM Solutions for Crop Pests (IPM Laboratories, Inc.)

Biobest Solutions for Aphids

Aphid & Disease Management for Winter Greens in Tunnels presentation by Cheryl Sullivan & Ann Hazelrigg (UVM)

Specific crop management recommendations (i.e., pesticides) are found within the New England Vegetable Management Guide

Using Pest Fighting Plants in High Tunnels: Awesome Alyssum

Cheryl Frank Sullivan, UVM Research Assistant Professor/Entomologist, UVM Entomology Research Laboratory
Margaret Skinner, Research Professor/Extension Entomologist, UVM Entomology Research Laboratory

Plant-mediated integrated pest management (IPM) systems use plants in combination with other suppression tactics (i.e., scouting, natural enemy releases, and spot sprays) to manage arthropod pests. These systems are developed to:

1. improve early pest detection (indicator or sentinel plants);

2. attract pests off the crop where they are then targeted for management with biological control/ natural enemies, chemical insecticides or by removing and destroying them (trap crop); and/or

3. provide habitat, food, and shelter for biological control agents (habitat, insectary, banker, or guardian plants).

One example is using alyssum to attract and sustain wild or released natural enemies. Alyssum *(Lobularia maritima)* is often selected as a habitat/insectary plant to attract hover/syrphid flies *(Syrphidae)* and other beneficials that combat aphids and other pests. It has shown great promise as an insectary/habitat plant in a variety of agroecosystems. Alyssum is also a recommended beneficial insectary plant by the Xerces Society.

We recently received a USDA NRCS VT Conservation and Innovation grant to evaluate alyssum habitat plantings as an IPM tool to attract and sustain natural enemies for high tunnel vegetables. We believe alyssum habitat plants grown outside high tunnels will attract natural enemies and enhance the diversity and population density of the natural enemy complex

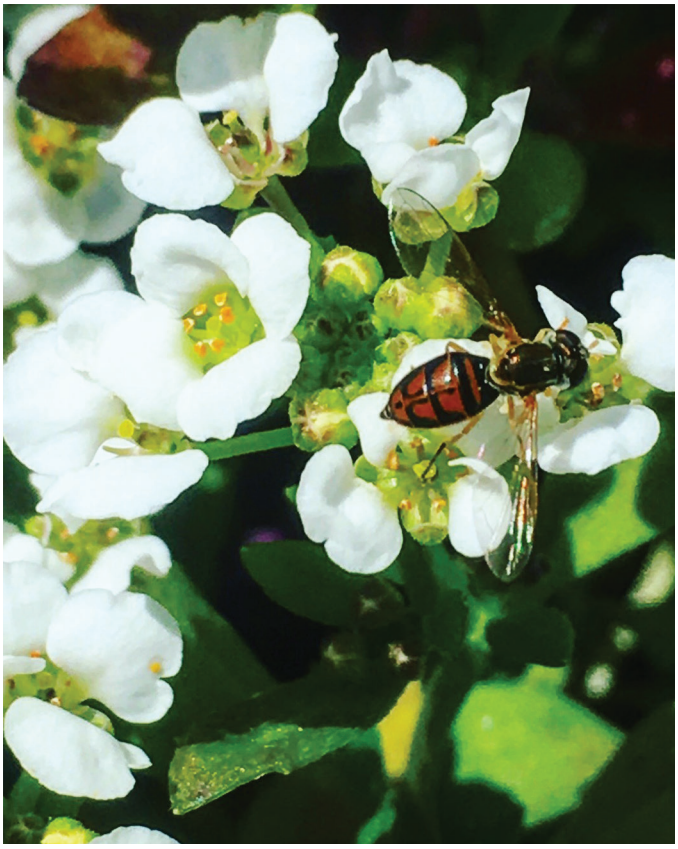
that will combat pests on crops produced within the tunnel. This project builds on our past work using habitat plants within high tunnels. For that work different combinations of flowering annuals were tested, including marigolds, dill, and borage. Our results showed alyssum was superior to other plants within the simultaneous plantings for attracting natural enemies, particularly in summer crops. When regular inspections were made, natural enemies were present on 89 percent of the habitat plantings over the summer and 37 percent of the natural enemies observed were on alyssum.

Planting alyssum habitat plants in unused space between high tunnels could be an innovative way for growers to save money by attracting wild natural enemies that provide pest management services. By establishing the strips outside, there is no loss of productive growing space within tunnels. These plantings could reduce the need to purchase natural enemies. This IPM tool may also reduce pesticide applications, and thus increase overall ecosystem health by protecting non-target organisms (i.e., bee pollinators, farmworkers, consumers).

Visit the High Tunnel Habitat Plantings webpage and check back as we progress on this exciting new project!

If you would like to learn more about other pest-fighting plants, visit the High Tunnel ToolKit website resources page and read the "Using Pest Fighting Plants in High Tunnels" factsheet. There is also a data recording form to help you scout these plants for beneficials and pests. Give a few of these plants a try this summer and let us know how they worked!

Alyssum habitat planting in high tunnel tomatoes (above). Syrphid fly on alyssum (below).



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