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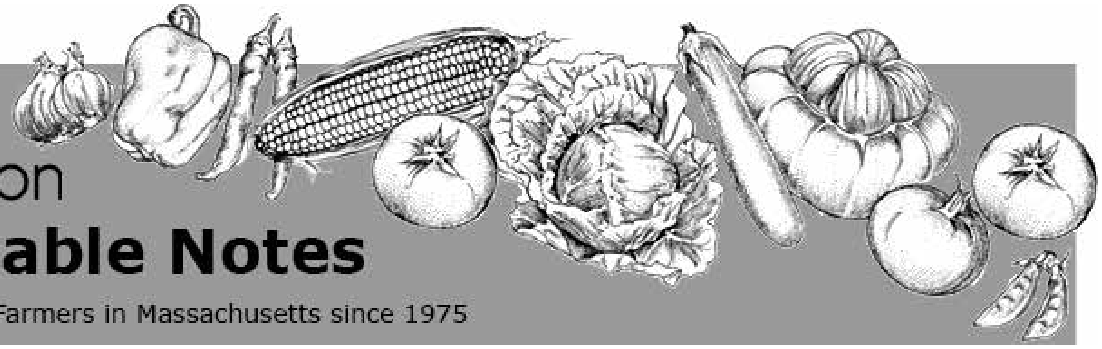
Vegetable Notes

For Vegetable Farmers in Massachusetts since 1975



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In this issue:

Attendees of this week's twilight meeting at Indian Head Farm in Berlin, MA learn how to take tissue samples from tomato plants. Thanks to everyone who came out! Photo: C. Radon

Crop conditions

It's starting to feel like summer, with temperatures reaching into the 90s this week. With some heat and a few good rains, crops are pushing along and looking real nice! Early summer brassicas and leafy greens have done well this year. Corn is tasseling and silking and garlic scapes and the first field cucumbers are being harvested. One grower we've heard from this year uses a greenhouse cucumber variety in the first succession so that he can get a jump on the season. Strawberry fields are full of happy u-pickers, getting ready to make shortcakes for their Fourth of July celebrations next week.

We had a good turnout of farmers and agricultural service providers at the UMass Extension Fruit and Vegetable Twilight Meeting this week at Indian Head Farm. Farmers sampled strawberries while they learned to: monitor for spotted wing drosophila, identify the new invasive spotted lantern fly, set up an 18-zone automated drip-irrigation system on low water pressure, and take a high tunnel tomato tissue sample. NRCS and MDAR representatives shared information on ways to access federal funds (EQIP) and state grants (ACRES) for conservation practices. Farmers shared tips about tomato management—most agreed that field tomatoes should only be pruned once to save time, while high tunnel tomatoes should be pruned as often as they are trellised up. Indian Head grafts their own tomatoes, and we got a chance to compare the vigor of grafted ('Maxifort' rootstock) and non-grafted varieties including Geronimo and Rebelski (both quite vigorous), Jetstar, Ultra Sonic, and various heirlooms, cherries, and grapes. As we escaped approaching rain clouds, one grower noted that in the eastern part of the state, near the coast, growing degree days are about 100 GDD behind those inland, slowing them down considerably. Showers held off till dinner time when we sat in a screened gazebo to learn about transferring farm ownership, developing leases, and other issues related to land tenure from Land For Good. Several farm families were in attendance and listened intently as they considered issues that arise when retirement-age parents want to transfer the farm to their kids. Did you know that Land for Good offers "Farm Transfer School"? For those interested in learning more, join their mailing list.

Pest alerts

Bean:

Mexican bean beetle (MBB) adults are emerging now in Hampshire Co. Adults and larvae of this pest feed on foliage and later generations can damage pods. There are 1-3 generations per year in the Northeast, and populations will increase with each generation, so early control is important. Annual releases of the parasitic wasp *Pediobius faveolatus* can effectively control MBB. Releases should be timed to target egg hatch, which should start a few weeks from now. Pyrethroids used to control potato leafhopper will also control MBB.

Mexican bean beetle adult and early stages of feeding damage. If left unmanaged, these leaves will quickly be skeletonized. Photos: G. Higgins

Cucurbits:

Angular leaf spot on Honeynut squash. Photo: A. Madeiras

Angular leaf spot was diagnosed on 'Honeynut' squash seedlings on two farms in Essex Co., MA this week. In both cases, seedlings in the greenhouse had water-soaked spots on the foliage and quickly rotted. This disease is caused by the bacterium *Pseudomonas syringae* pv. *lachrymans*, which is carried on seed. Suspect samples can be submitted to the UMass Plant Diagnostic Lab. Copper can provide some control of this disease if it's caught early.

Squash bug adults are beginning to emerge and lay eggs, which were found in Hampshire Co., MA this week. Scout undersides of leaves for squash bug adults and eggs and treat if egg masses exceed 1 per plant. Thorough coverage is necessary. Time squash bug sprays to kill young nymphs, which are easiest to control. As this often coincides with the bloom period, treat late in the day to reduce risk to bees and select products with lower bee toxicity. Yellow summer squash, zucchini, Hubbard squash, and pumpkin, (especially thick-stemmed types) are most susceptible to this pest, which feeds on plant sap causing wilting, or dark necrotic patches on leaves. Adults survive the winter in natural and artificially-sheltered sites along field margins or under plant debris within fields—rotating cucurbit crops ¼ mile from previous crop can greatly reduce squash bug issues.

Squash vine borer numbers are still low in MA this week, with just one trap in Franklin Co. reporting 3 moths captured. No eggs have been observed yet. Make 2 to 4 weekly applications if more than 5 moths per week are captured. Timing is very important. Treat base of stems thoroughly to target hatching larvae. Some selective materials used for other caterpillars in squash, such as spinosyns and *Bacillus thuringiensis* subsp. *aizawi*, have demonstrated efficacy in trials.

Striped cucumber beetle numbers are on the rise and folks are wondering if sprays are needed. The most susceptible period is from crop emergence to the 5 true-leaf stage. Scout at least 25 plants to monitor the number of beetles and damage. An action threshold of 1 to 2 beetles per plant is recommended; use the higher threshold for crops with vigorous early growth and lower susceptibility to wilt, such as butternut and pumpkin, and the lower threshold for summer squash. At later growth stages, the crop should be treated if there is significant damage to fruit.

Solanaceous:

Colorado potato beetle larvae are beginning to do damage in eggplant and potatoes. For organic growers using Entrust: spraying is most effective if targeted at small larvae because the product has to be ingested to work, and large larvae will do significant damage before ingesting a lethal dose. If you have a mix of small and large larvae in your field, spraying may still be worthwhile. Many conventional materials are also effective; see the New England Vegetable Management Guide for labeled products.

Bacterial leaf spot was diagnosed on several pepper varieties on one farm in Bristol Co., MA. This pathogen can be seed-borne and can survive on crop residue in fields or greenhouses. Till under crop debris promptly at the end of the season to encourage breakdown, and practice a 3-year rotation for peppers. Practice good greenhouse sanitation: disinfest trays, tools, and bench surfaces, control weeds, and be sure to not bring in infested transplants from other suppliers.

Sweet Corn: See map on next page.

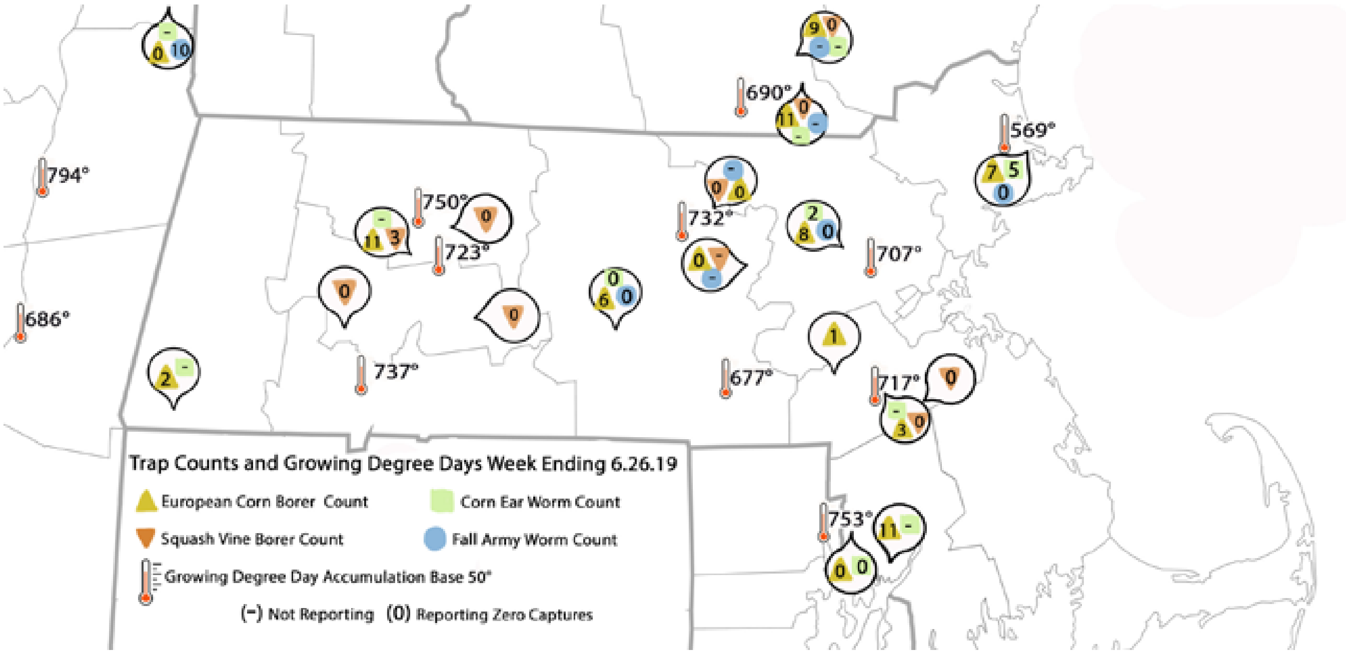
European corn borer: Peak flight of the first generation has passed in most locations in MA. Unlike other corn pests, ECB stays on farms instead of migrating in each year, so some locations have low populations while others have high numbers. Two farms scouted in Worcester Co., MA had no trap captures and no caterpillars, indicating that this area has naturally low ECB populations. Fields in other parts of the state were at threshold. If you sprayed last week after reaching a 15% infestation threshold, you may want to scout again to check the efficacy of your spray.

Corn earworm was captured at two sites in eastern MA this past week, reflecting the pattern of storms coming up from the south. An Essex Co. trap captured 5 moths and a Middlesex Co. trap captured 2. See Table 1 for spray intervals. If you have silking corn, put up traps now.

Table 1. Spray intervals for corn earworm

Moths/Night	Moths/Week	Spray Interval
0 - 0.2	0 - 1.4	no spray
0.2 -0.5	1.4 - 3.5	6 days
0.5 - 1	3.5 – 7	5 days
1 - 13	7 – 91	4 days
Over 13	Over 91	3 days

CEW has developed resistance to some pesticides; see the article in the August 2, 2018 issue of Veg Notes for pesticide recommendations.



Multiple Crops:

The first signs of hopperburn, caused by **potato leafhopper** are being reported, in Franklin Co., MA this week. Keep up with spraying for this pest, as populations can explode quickly and have significant effects on yields in beans, potatoes and eggplants. Use thresholds of one adult per sweep or 15 nymphs/50 leaves on beans or potatoes and 1.5/leaf in eggplant, and consult the New England Vegetable Management Guide for pesticide options.

LEAF DISEASES OF BEETS AND SWISS CHARD

Beets and Swiss chard are susceptible to several foliar diseases—Cercospora leaf spot is the most commonly recognized, but it is important to know that others exist so that outbreaks can be correctly diagnosed and managed. Researchers at Cornell University are looking for samples of all of the foliar diseases described in this article—if you find them in your crops, let us know by phone (413-557-3976) or email (umassveg@umass.edu). Leaf diseases can result in significant losses, particularly in late summer when conditions are favorable (high temperatures, high humidity, and long leaf wetness periods at night) and inoculum builds up. Leafy greens become unmarketable, and beet roots fail to size up when disease is severe. Below are listed a few of the more common diseases and tips for managing them.

Bacterial leaf spot, caused by *Pseudomonas syringae* pv. *aptata*, occurs over a wide temperature range, but thrives between 77-86°F during rainy periods, and usually occurs early in the season. Bacteria cannot directly penetrate leaf tissue—they must enter via stomata, wounds, or at the hydathodes at leaf margins. Lesions are tan (but do not have tiny black dots within their centers), irregularly shaped, and have very dark to black margins. Lesions can coalesce between leaf veins, causing foliage to twist, pucker, and tear. Bacteria are spread by splashing water or mechanical injury. Other hosts include bean, eggplant, lettuce, and pepper.

Bacterial leaf spot. Note the dark, almost black, margins of each spot. Photo: North Dakota State Univ.

Cercospora leaf spot, caused by the fungus *Cercospora beticola*, is far and away the most common disease affecting beets and chard, and typically occurs during the mid- to late-season. Disease is favored by warm conditions (>75°F) and long periods of rain or humidity above 90%. Symptoms start out as small round spots surrounded by a red or purple margin on red cultivars or tan to brown margins on yellow cultivars. Lesions expand and coalesce to cover the whole leaf area. Under humid conditions, you may be able to see tiny black dots (stromata) in the center of the lesions with a hand lens—this is a diagnostic feature. Spores produced in leaf lesions are spread primarily by splashing water. The pathogen can be seed-borne, survives on residues in the soil for up to three years, and can infect lambsquarters, which may allow the pathogen to persist in areas despite a lack of susceptible crop.

Close-up of a Cercospora leaf spot, with stromata. Photo: North Dakota State Univ.

Cercospora leaf spot. Photo: UMass Vegetable Program

Phoma leaf spot, caused by the fungus *Phoma betae*, can be seed-borne and is often introduced into fields this way. Seed infections can cause damping off and poor stands. This fungus can produce foliar lesions that reduce marketability, and can also affect beet roots, producing small sunken spots that enlarge into conical areas of black rot. Rot can develop on beets in the field and in storage. On foliage, lesions are tan-brown with dark, concentric rings forming within—these rings are full of fruiting bodies called pycnidia, where asexual spores form. Spores are then moved around the field by splashing water or workers. The pathogen also produces sexual spores that can be dispersed long distances by wind. This pathogen prefers cooler weather than bacterial or Cercospora leaf spots—temperatures between 57°F and 65°F with high humidity are optimum for disease. Seed treatments—including hot water seed treatment—can help reduce disease incidence. Disease is worse when plants are stressed, so maintaining good irrigation and fertilizer practices is essential.

Phoma leaf spot. Note the concentric rings within each spot. Photo: L. du Toit

Cultural Controls

- **Use 3-year crop rotations** with beets and chard.
- **Use clean or treated seed.**
- **Apply optimal fertilizer** to avoid stress and prevent heart rot.
- **Irrigation:** Use drip in place of overhead irrigation, or use overhead irrigation during mid-day when leaves will dry fully.
- **Increase space between rows and decrease in-row spacing**. Orient rows to increase wind-flow.
- **Manage weeds**, especially lambsquarters, which can be a host to these diseases.
- **Variety selection:** Dr. Sarah Pethybridge of Cornell University has been studying varietal tolerance to Cercospora and Phoma leaf spots. Some results are listed below:

    Phoma leaf spot: Non-red beet cultivars (Avalanche, Boldor, Chioggia Guardsmark) were less susceptible than red cultivars (Falcon, Merlin, Rhonda, Red Ace, and Ruby Queen). Rhonda had the highest disease severity while Chioggia Guardsmark had the lowest.

    Cercospora leaf spot: All table beet varieties were susceptible. Boldor, Detroit, Falcon, Merlin, Rhonda, and Touchstone Gold were of similar susceptibility. Ruby Queen was slightly less susceptible.

Chemical control of Cercospora leaf spot (CLS): Fungicides can effectively control CLS. Resistance to some fungicide groups is a concern, and the Group 11 fungicides (e.g. Quadris, Cabrio, Flint, etc.) are no longer recommended in NY where resistance is well-documented, or in any fields where those products have been used repeatedly to control this disease.

Dr. Pethybridge has also conducted spray trials for CLS. Her research showed that:

- Group 7 fungicides performed poorly when applied alone, but the combination of benzovindiflupyr (Group 7) + difenoconazole (Group 3), e.g. Aprovia Top, was highly and consistently effective in reducing CLS severity and spread.
- Propiconazole (Tilt) was also highly effective.
- For OMRI-approved materials: Cueva (copper octanoate) + Double Nickel LC (*Bacillus amyloliquefaciens* strain D747) resulted in significantly improved disease control in comparison to either product alone and provided equivalent control to conventional fungicides.

Other spray recommendations from Dr. Pethybridge:

- Use the highest labeled rate of any product for control of Cercospora leaf spot.
- For conventional production, she recommends that Tilt be used first in a spray program for best efficacy. It should then be rotated with other fungicide groups, but can be used again later in the program.
- If bacterial leaf spot is also present, copper should be mixed with Tilt or another fungicide.
- Heavy weed pressure **doubled** the incidence of disease, whether or not they were also sprayed with copper. Weeds prevent leaf drying and prevent the fungicide from getting to the leaf!

--Written by Susan B. Scheufele, UMass Extension Vegetable Program

FORCED AIR COOLING ON THE FARM

--Written by Chris Callahan and Andy Chamberlain, University of Vermont Extension

The preservation of quality in fresh market and storage crops on small and medium-sized farms in the Northeast depends on the rapid reduction of pulp temperature and maintenance of relatively low temperatures to slow metabolic respiration.

There is strong foundational work showing that rapidly reducing the temperature at the start of the cold chain increases product quality when delivered to the consumer. Postharvest handling is critical for fresh produce farmers and the markets they sell to. Effort and expense invested in growing fruits and vegetables can be wasted without good handling practices at and following harvest (Gross 2014). Consumers expect the best from fresh produce. Quality and freshness are ranked with high importance among consumers. Farmers market respondents respectively rank quality (63%) and freshness (59%), as highly important factors in their buying decisions. Nearly 87% of the respondents indicated that availability and quality of fresh produce affected their decision about where to purchase (Gorindasamy 2002).

Precooling involves flowing a controlled, chilled fluid (air or water) over the product to improve heat transfer for removal of field heat to depress respiration and initiate the cold chain.

Precooling

One of the most important postharvest factors influencing quality is temperature. Temperature directly impacts the rate of metabolic respiration and associated decay. Produce which is not cooled quickly degrades in quality (Sargeant 1991). Table grapes, for example, deteriorate more in 1 hour at 90 °F then in one day at 39 °F or one week at 32 °F (Thomson *et. al* 2008). Lower quality leads to a decrease in sales, inefficient use of storage space, and wasted labor due to the time taken to grow, clean, and store product that doesn't sell. Coolers are a good addition to most farms but fall short of meeting optimal precooling needs. When produce is packed in boxes, stacked on a pallet and directly placed into a cooler, cooling time will be a minimum of 24 hours and may take many days. (Thompson *et. al* 2008).

One method to reduce cooling time is through forced air cooling (FAC). In FAC systems, refrigeration cools a space and blowers are set in position to actively draw the cold air through the produce. The cooling time drops from 24 hours to 10 hours or less when using a static cold room due to the increased air flow (increased convective heat transfer) (Thompson *et. al* 2008, Boyette 1989).

Attempts have been made at smaller scale pre-coolers to reduce field heat at harvest in absence of coolers (Thompson and Spinoglio 1996). Retrofitting a cargo container with insulation and cooling with a large capacity air conditioner was also explored (Boyette & Rohrbach 1990). This forced-

Key Points of Precooling

- Starts the cold chain by rapidly reducing respiration.
- Reduced respiration leads to higher quality over a longer storage and distribution time.
- Cooling is improved with the combination of active cooling and forced air flow with a blower.
- 1-3 CFM of airflow at 0.5 IWC static pressure per pound of product is the rule of thumb for sizing.
- Ventilated containers (e.g. holes or slats) are necessary to ensure airflow is actually through the product.
- Close up any large openings to prevent short-circuiting air flow.

air cold room offered space for many pallets of produce but it still took many hours to reduce the temperature internally, especially for the boxes on pallets in the center of the container. The key is integrating both cooling and air flow effectively (see Figures 1 & 2).

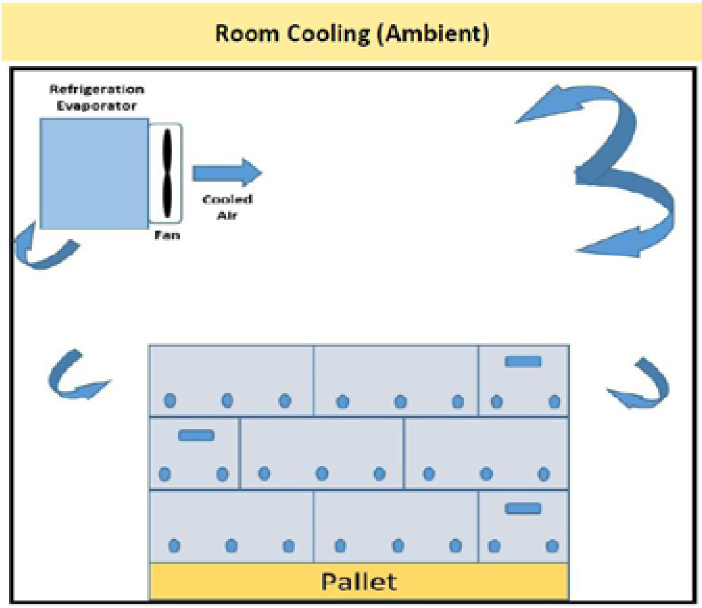


Figure 1. Produce packed in cartons, lugs, or other containers will not cool rapidly even when placed in a cooler. The cold air does not have sufficient velocity or pressure to pass into the center of the pallet or even to the center of a single carton, even when the containers have vented sides. Heat removal from the produce depends on conduction through produce and cartons which is slow. Figure: UVM Extension

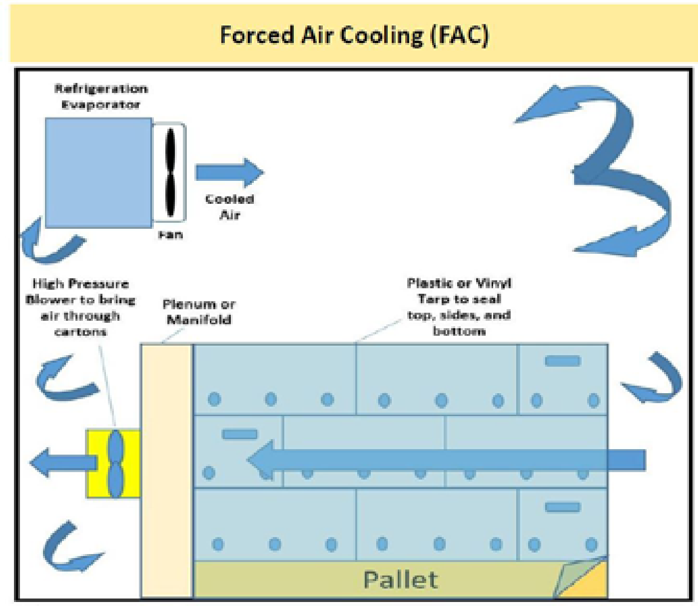


Figure 2. Using a high-pressure blower, cool air can be pulled through cartons of produce to remove field heat and reduce prodcut temperature to storage temperature more quickly. The heat removal rate from the produce is enhanced due to increased convective cooling in addition to conduction. This lowers respiration and leads to improved quality. Figure: UVM Extension

A mobile forced air cold box mounted on a trailer was constructed and demonstrated in Florida (Talbot and Fletcher 1993) aimed at farms growing produce on 5-50 acres. This unit could be self-built. Experiments showed that grapes could be cooled by 15 °F per hour. For denser produce like melons and tomatoes, the cooling times were longer. The construction cost at that time was close to $5,000.

We have built prototype FAC's for a single, fully or partially loaded pallet (figure 2) and also a 1-3 carton (either bulb crate or 1 1/9th bushel box) "counter-top" model. These precooling systems used simple lumber frames, plywood plenums, axial blowers and polyethylene film plastic to direct cold room air directly over produce to remove field heat. The construction details of these units are provided below.

Floor Pallet Model: go.uvm.edu/palletcooler

Counter Top Model: go.uvm.edu/countertopfac

Field Trial Results

Last summer we performed a series of precooling trials using the small-scale forced air coolers described above to cool eggplant, watermelon, strawberries, blueberries, zucchini, and roasting peppers. The forced air cooling was done in parallel with standard room cooling and was shown to result in cooling rates ranging from 1.2 to 2.2 times faster than room cooling. This test demonstrated the feasibility and benefit of simple forced air cooling systems to smaller scale farms.

A floor pallet forced air cooler. Photo: UVM Extension

Methods

A countertop forced air cooler for 1-3 cartons of product. Photo: UVM Extension

As a result of the willingness of partner farms to collaborate in these trials, the following crops were tested: eggplant, watermelon, strawberries, blueberries, zucchini, and roasting peppers.

In each trial, two batches of the crop with roughly equivalent mass were harvested into standard cartons or bins based on the practice of the farm. One batch was cooled using room cooling—allowing the product to cool as it would when simply set in the walk-in cooler or CoolBot room. The other batch was cooled using a forced air cooling system built from one of the two plans referenced above. The batches were cooled in parallel with a target of reaching 7/8 of the optimal storage temperature for each crop ("7/8 temperature").

Product temperature was monitored in each batch using an insertion probe thermocouple and a data acquisition system with a 3 second sampling period. These data were used to fit a cooling rate curve using an exponential decay model and minimizing the error between the model and the actual data. The cooling rate curves were used to estimate 7/8 cooling time for larger, more dense crops or those that did not reach 7/8 temperature during the time allowed for the test.

Results

The table below summarizes the observed cooling rate of each crop comparing room cooling to forced air cooling. The results from each crop are provided in individual PDF files, linked to below.

	Room Cooling		Forced Air Cooling (FAC)		FAC is __ times faster than Room Cooling
Crop	Time to 7/8 Temperature (hr)	Cooling Rate (°F/min)	Time to 7/8 Temperature (hr)	Cooling Rate (°F/min)	
Blueberries	6.9	0.18	1.8	0.39	2.2
Eggplant	3.2	0.32	1.5	0.47	1.5
Peppers	1.6	0.15	0.5	0.19	1.2
Strawberries	5.0	0.18	1.5	0.24	1.3
Watermelons	28.9	0.10	14.4	0.17	1.6
Zucchini	1.9	0.09	0.8	0.15	1.7

Trial Results by Crop	
Zucchini	Watermelon
Peppers	Eggplant
Blueberries	Strawberries

Conclusion

Forced air cooling was demonstrated using two simple systems designed to be built on farm with readily available materials. The method was applied to six crops and demonstrated a cooling rate 1.2 to 2.2 times faster than room cooling achieved. The use of forced air cooling, directing cool room air over packed product, is a common practice in larger production systems and this trial illustrates its feasibility for smaller scale farms.

Acknowledgments

Thanks to **Clear Brook Farm**, **Adam's Berry Farm**, and **Jericho Settlers Farm** for participation in this trial.

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Caterpillars in Brassica Crops

We have been seeing the first caterpillars and feeding damage in brassicas across the state. Though they may all look alike, the four major brassica caterpillar pests are different species and there are important distinctions among them that can affect your management decisions. They differ in size and feeding habits, as well as how susceptible they are to beneficial parasitoid insect species and certain insecticides. Getting acquainted with these pests will help you to know what kind of damage to expect and what to look for when scouting for their different life stages and biocontrols. Feeding damage by any of these caterpillars can reduce yield and marketability of both leafy and heading crops.

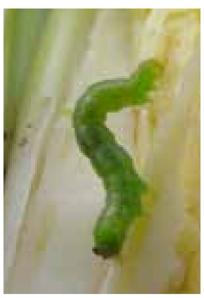
Imported cabbageworm or **cabbage butterfly** (*Pieris rapae*) is a very familiar white butterfly that can be seen during the day fluttering around brassica fields. Each forewing has a dark border and one or two round black spots. Eggs are laid singly on the underside of leaves, standing upright (see photo). They are bullet-shaped, about 1/8 inch in length, and initially pale white, but turning to yellow as they mature. Larvae are gray-green, slightly fuzzy, and sluggish but can be very well camouflaged. Feeding and resting occur on the underside of leaves, and larvae feed more heavily in the head of cabbage or broccoli as they develop. The overwintering stage is the crysalis (pupa), which is green or brown, smooth with three pointed ridges on its back. There are 3-4 generations per year.

Imported cabbageworm. Photo: S. Scheufele

Diamondback moth (*Plutella xylostella*) adults are tiny (<1/2 inch long), light brown, and rest with their wings folded together like a tent. DBM adults may overwinter in some years in the warmest parts of MA, but mainly this pest is blown in every year from warmer areas. Adults are weak fliers, but populations are known to disperse long distances on wind and annually reinvade areas well into Canada. Eggs are laid singly or in small clusters (see photo). Caterpillars go through four instars and are small (<1/2 inch when fully grown), light green, and appear segmented, with a forked end and pointed shape. When disturbed they wiggle vigorously and may drop off the plant on a string of silk. Feeding causes small, round holes that don't break through the top layer of leaf tissue, leaving translucent films across holes (see photo at left). Feeding tends to be spread across the foliage and not necessarily concentrated in the head.

Diamondback moth larva, with window-paned feeding damage. Photo: UMass Extension

Cabbage looper *(Trichoplusia ni)* usually does not survive the winter in New England and arrives in migratory flights from farther south. Generally, populations of cabbage loopers are not high until late-July or August, though some years they are not found at all or earlier flights occur. Adult moths are mottled gray-brown, about 3/4 inch long, with a distinct round silver-white mark on each forewing. Since they fly at night, they are rarely seen unless monitored with pheromone traps. If you want to know when moths arrive, use a wing trap baited with *Trichoplusia ni* lure, placed near the canopy. Eggs are round, pale green or yellow, and are laid singly underneath the foliage (see photo). The cabbage looper caterpillar is light green, smooth, with wavy white or light yellow lines down the back and sides, and prolegs at the tip of the abdomen. Full-grown larvae reach 1½ to 2 inches. Cabbage loopers of any size move like inchworms—by raising the middle of their body in a characteristic "loop" shape. Feeding tends to create large, ragged holes in foliage, on both frame leaves and heads. Cabbage looper also feeds in many non-brassicas including lettuce, celery, spinach, and chard, so when they do arrive, scout those crops as well as brassicas.



Cabbage looper. Photo: K. Campbell-Nelson

Cross-striped cabbageworm (*Evergestis rimosalis*): Formally restricted to the South, this insect is now a serious problem on brassica crops in southeastern New England. One of the major differences between this insect and the other brassica caterpillars is that the eggs are laid in a group (see photo), and caterpillars feed in a group on one plant so that it's covered with big holes like buckshot. CSCW is closely related to European corn borer, and the adults are similar in shape and coloring–straw-colored with a little purple, and crossed by wavy lines. Since the adults flies at night, you will likely only notice the caterpillars and their damage. The clusters of 3 to 25 eggs are yellow, flattened, and attached to the lower leaf surfaces. The caterpillars are light bluish-grey on top and green underneath, with numerous black transverse bands across their backs and a yellow line down each side. Larvae grow to ¾ inch long in 2 to 3 weeks. There are 2 to 3 generations per year, but generally, numbers do not reach damaging levels until late summer. Larvae can produce small holes in leaves until only veins remain, feed in terminal buds and sprouts, or burrow into heads. Plants with larvae are often completely skeletonized. Adjacent plants may be left undamaged.

Cross striped cabbageworm. Photo: S. Scheufele

Field Scouting and Management. It is especially important to check cabbage or broccoli plantings as they begin forming heads. Greens such as collards and kale should be scouted earlier, since all leaves are marketed. Randomly select 25 plants throughout the field and check for caterpillars or fresh feeding damage on the top or underside of leaves. Feeding damage can be found on the underside of leaves or in the center of the plant where heads are forming. Look for black or green frass and tiny feeding holes, clustered together. Often it is easier to spot the frass and feeding damage first, then find the caterpillar. Classify plants as infested (one or more caterpillars present) or non-infested, and calculate the percent of plants infested. In the Northeast, there is generally no need to treat young plants unless weather conditions delay plant development and at least 35% of them are infested with any of these pests. Treat heading crops between the start of heading and harvest if 15-20% or more of the plants are infested. The most critical time to scout and apply controls is just prior to head formation. For leafy crops like kale and collards where all leaves are marketed, a 10-15% threshold should be used. Because cross-striped cabbageworm can be so destructive, a lower threshold should be used—treat when 5% of plants are infested with this pest.

L to R: Eggs of diamonback moth, imported cabbageworm, and cabbage looper. Photo: North Carolina State Univ.

Insecticide applications. Use selective insecticides to protect beneficial insects that keep aphids under control, eat insect eggs and small caterpillars, and parasitize either ICW or DBM. Selective products often are most effective when consumed with foliage, so coverage is important. Use at least 50 gal spray material per acre; higher volumes provide better coverage. Better coverage of lower leaf surfaces can also be achieved by using drop nozzles. Use a spreader-sticker to prevent sprays from rolling off of waxy leaves. The most effective materials include:

Diamides (Group 28) including chlorantraniliprole (e.g. Coragen)

Spinosyns (Group 5) including spinetoram (Radiant) and spinosad (Entrust) - *also effective against flea beetles and onion thrips*

Bacillus thuringiensis (Group 11) including *Bt aizawi* (XenTari) and *Bt kurstaki* (such as Dipel DF and many other products) – *these materials are highly selective and will* ONLY *affect caterpillars*

These materials and the *aizawai* strain of *Bt* will usually provide better control of resistant DBM than older products. See the cabbage/insect control section of the New England Vegetable Management Guide for additional synthetic and naturally derived products and more details.

Cultural and biological controls. Incorporate crop residues shortly after harvest to reduce movement to successive plantings and reduce overwintering populations. Populations are suppressed by a wide range of natural enemies, including several species of parasitic wasps. DBM eggs are parasitized by the ichneumonid wasp, *Diadegma insulare*, which occurs naturally in eastern North America. *D. insulare* females require sources of nectar, so maintain wildflower stands near brassica fields. ICW eggs are parasitized the braconid wasp, *Cotesia rubecula*, which was introduced to New England from China in 1988, and is now established in Massachusetts. You may see their small white cocoons on brassica leaves. The chalcid wasp, *Trichogramma brassicae*, will lay its eggs in many species of caterpillar, including all of the brassica pests above (as well as non-target caterpillars, so be cautious if you *are* maintaining wildflowers that might attract endangered moths or butterflies). These wasps are not found in New England, but can be purchased from several biological control companies for release in brassica fields. The wasps arrive as pre-parasitized caterpillar eggs that are glued to cards that can be distributed throughout the crop. Each card costs around $16-$20, and contains about 100,000 wasps, which is enough for up to 1 acre. According to one source of *T. brassicae* wasps, IPM Labs Inc., some growers will release the wasps in lieu of using any kind of pesticide. Some growers release one card per acre per week for about 4 weeks, while others will release every week for the life of the crop. These biological controls are compatible with many selective and lower impact sprays used for control of caterpillars (*Bt*, oils, soaps), especially because the wasps are protected from sprays when they are inside of host eggs. Another source, Evergreen Growers Supply, notes that *Trichogramma* wasps are more effective against moth species that lay their eggs in clusters, so may be a good option if cross-striped cabbage worm has been a particular problem on your farm.

--Written by R. Hazzard, S.B. Scheufele, and L. McKeag

EVENTS

Sustainable Water Management Practices for Nursery & Greenhouse Operations

When: Wednesday, July 10, 2019, 9am to 3:30pm

Where: University of Massachusetts, Amherst

Registration: Pre-registration required. $60 per person. Includes lunch, morning coffee, and parking. See event page, linked to in title, for registration forms.

Increasing production sustainability is of growing importance for all types of plant production. Improving irrigation practices, understanding water quality, and monitoring nutrients are integral to increasing sustainability. Better management of water and nutrients can improve environmental stewardship as well as your bottom line. Join water and nutrietn management specialists from around the country for this exciting workshop. See event page, linked to in title, for detailed agenda.

Vermont Vegetable & Berry Growers Association On-Farm 2019 Workshop Series

The Vermont Vegetable & Berry Growers Association is holding a series of nine on-farm workshops from June through November this year. For more information on all workshops in this series, please click the linked event title above.

Attendance at these events is free for members of the Vermont Vegetable & Berry Growers Association. The cost is $10 per-person for non-members, payable on-site. Refreshments will be served. Membership in the VVBGA costs $55 per farm, per calendar year. The VVBGA works with University of Vermont Extension to deliver education and applied research for its growers.

Questions? Contact Vern Grubinger, 802-257-7967 x303. To request a disability-related accommodation, contact Dana Rupert, 802-257-7967, three weeks prior to an event so we may assist you.

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