UMass Extension
Vegetable Notes
For Vegetable Farmers in Massachusetts since 1975

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In this issue:

Hilling with horses, Athol, MA.

Crop conditions

Harvests this week include carrots, beets, squash, beans and the first sweet corn in some locations of the Pioneer Valley. Peas and the first successions of lettuce have wrapped up. Reports of deer damaging crops in Southeastern MA are coming in; they don't seem to be afraid of the farmer, but keep their distance if a dog is present. Scattered thunderstorms and high humidity are increasing the risks of fungal and bacterial diseases in field and high tunnel crops across the state. We gave Ruth Hazzard a rousing send-off this week, celebrating her many accomplishments in song at her retirement party at the perfectly picturesque UMass Cold Spring Orchard in Belchertown. Her friends and colleagues came from all over New England to say their thank-yous and goodbyes. Here are some parting words from her to all of you...

I turned 40 the year that I started working for UMass Extension, and will turn 66 this year – that's long enough for one or two new generations of farmers to establish themselves, which is a clear sign that it's time for me to turn over the reins. Sorting through 25 years of records in my office, I recognize farmers and fields, remembering each place, what was growing there, and the conversations we had. I note that our cropping systems have evolved in 25 years, and it seems that we are more aware of the living complexity of the farms we manage and the markets we work with. We have tackled many problems over these decades, found solutions to some, only to see more coming along. Sustainability will always require a dynamic response to change. Working together and having an eye to the common good are time-tested strategies for resilience, and I have been so fortunate to work with multiple generations of farmers, colleagues and students who have embodied those values and who have been creative, strong, and energetic beyond belief. I'm grateful for all that I've learned from you.

The field work we do in the UMass Extension Vegetable Program and our weekly Vegetable Notes newsletter have always been a team effort. I'm thrilled that Katie Campbell-Nelson, Lisa McKeag and Susan Scheufele have honed their teamwork and skills over two busy growing seasons, and are building collaborations at UMass and across the region to strengthen Extension's ability to provide you with high quality, relevant information. Veg Notes and the Vegetable Program are in good hands. As for me, I do savor the novelty of a Thursday in summer when I can work in my own garden instead of write a pest alert for the region. I'm learning how to grow blueberries and raspberries -- so that I can pick my own sweet berries for morning cereal! Since our 3-year-old home has plenty of room for all the gardens I can manage, is 50 feet from a working farm, a mile from UMass campus and the UMass Student Farm, and overlooks the beautiful Connecticut Valley, I'm definitely not moving anywhere else anytime soon. *-Ruth Hazzard*

Good luck, Ruth. We'll miss you!

Pest Alerts

Vegetable scouting sheets can be found on the UMass Extension Vegetable Program website. When not given here, refer to the New England Vegetable Management Guide for scouting thresholds and treatment options.

Allium: Onion thrips adults and nymphs were found *last week* near threshold of 1 per leaf in Worcester Co., MA; after treatment with Movento (spirotetramat) only adults were found this week, well below threshold. In Washington Co., RI, thrips were near threshold in an untreated field, but crop is looking healthy. Leek moth damage continues to be present in Chittenden Co., VT, but not in other New England States.

Location	Squash Vine Borer 6/24/15 - 7/1/15
MA	
Amherst	29
Deerfield	6
Barnstable	21
NH	
Litchfield	18
Hollis	12
Mason	n/a
Burlington, VT	0
Kingstown, RI	1

Location	Total European Corn Borer 6/24/15 - 7/1/15
Western MA	
Hadley	0
Sheffield	3
S Deerfield	3
Whately	0
Central & Eastern MA	
Leominster	1
Millis	0
Sharon	0
Swansea	2
NH	
Litchfield	0
Hollis	1
Mason	n/a
Burlington, VT	0
Kingstown, RI	0

Basil: No new reports of basil downy mildew this week after the report in Nassau Co., NY last week.

Brassica: Diamondback moth adults and pupae and imported cabbageworm (ICW) eggs and caterpillars found on heading cabbage, kale, broccoli, and recently transplanted brassicas in Worcester Co., MA (mostly ICW eggs) and Washington Co., RI but not above threshold of 1 caterpillar per plant. Flea beetles: high pressure last week in many locations scouted, but lower pressure this week.

Gypsy moth found in CEW trap

Corn: European corn borer trap captures have gone down this week with some locations reporting zero adults. However, fields scouted in Franklin Co., MA, Washington Co., RI and in NH vary in caterpillar pressure of 0-60% infested. Scout fields with tasseling and silking corn now and treat at a threshold of 15% infestation. A simple sequential scouting guide is available at the UMass Vegetable program website here: Sweetcorn IPM Guide. Seven corn earworm were captured in Sharon, MA over the weekend when storms swept across the state. This pest has arrived on the winds of southwesterly storms this season, and it is time to put out CEW traps if you have silking corn (see article this issue for more on CEW management). Look out for imposters; note the feathery antennae on the gypsy moth pictured at right, found in a CEW trap. Fall armyworm traps went out in MA last week and will go out this week in RI, VT and NH; none captured yet.

Sweet corn in Western MA, ready to pick for the 4th of July!

Cucurbit: Alternaria leaf spot and scab were diagnosed on 'Goldie' yellow squash 2 weeks ago in Bristol Co., MA; likely seedborne. Gummy stem blight (black rot) was also diagnosed this week in 2 crops by the MA and NH diagnostic labs. The rainy humid weather we are experiencing is conducive to spread of inoculum, in fields which have rapidly expanding leaves creating even more humid canopies. Harvest affected crops last. Fungicides can protect new growth if cucurbits are vining out since they grow quickly this time of year. Cucurbit downy mildew was reported in Erie Co, NY. Track the arrival of this migratory disease at: http://cdm.ipmpipe.org/. Develop your fungicide programs now as this disease can rapidly cause crop losses once it arrives. See article below for management options. Striped cucumber beetle numbers are lower this week than last in most locations scouted. Squash vine borer are being captured at record numbers in NH

with up to 128 moths per trap in one week. Trap captures vary greatly from one location to the next, so only make treatments based on field scouting or trap captures. Use a threshold of 5 moths per trap in bush varieties and 12 in vining crops. Target sprays to the bases of plants. **Squash Bug** is being reported at low numbers in NH, RI and MA. **Squash beetle** was reported causing damage in Kent Co., RI. This pest has not been reported in other states in New England.

Squash beetle, A. Radin URI

Solanaceous: All stages of **Colorado potato beetle** were present in two organically-managed potato fields scouted in Hampshire Co., MA and Washington Co., RI, with numbers of small larvae at or above threshold. In Franklin and Hampshire Cos., MA growers are reporting poor control with organic pyrethrin and spinosad materials on CPB. Resistance management is particularly important with this pest, but organic growers have limited options for rotations. Many growers rely exclusively on spinosad (Entrust) to control CPB because it is very effective, but overuse will lead to resistance. Spinosad is a great material to use to control 1st generation larvae, but do not apply it to the 2nd larval generation. Azadirachtin products are recommended as alternatives. Azera is a mix of pyrthrins and azadirachtin, and has been shown to have good efficacy against CPB. *Beauveria bassiana* (Mycotrol O, Botanigard) is another option. One grower in Frankin Co., MA has had great success with using field rotation. He has yet to see a single CPB in his potato field after moving this year's potatoes to a field about a mile away from last year's – though he has no other potato growers nearby. See the NYS IPM Publication, Organic Production and IPM Guide for Potatoes for more information on managing resistance using organic methods. In eggplant, the threshold for CPB is 2 small or 1 large larvae per plant until fruiting stage. **Black Leg** was diagnosed at the UMass Disease Diagnostic lab from a sample in Franklin Co., MA. If there are only a few plants affected they can be rogued out of the field. Look for **septoria** and **early blight** in tomato. Humid rainy weather will help the spread of these diseases. **Fulvia leaf mold** and **powdery mildew** reported in greenhouses and tunnels in RI, NH and VT. Few translaminar materials are available for these pathogens, so residual control is difficult. Oils and bicarbonate stop the spread on surface, but must be applied regularly. Remove foliage to increase airflow.

Multiple: **Potato leafhopper** were fewer in Washington Co., RI this week, but higher pressure was found on potatoes in Worcester Co. and Hampshire Co., MA and in high tunnel eggplant in Merrimack Co., NH. Nymphs found last week on beans in RI, but not yet in MA.

CUCURBIT DOWNY MILDEW FORECASTING

Downy mildew of cucurbits (CDM) is a potentially devastating disease to which all cucurbit species are susceptible. *Peronospora cubensis*, the causal organism, overwinters in the deep south and travels north field by field every season with the aid of southerly winds and rainy weather. Greenhouses that produce cucurbits year round may also be a source of inoculum. CDM typically reaches New England in mid to late August, but has been seen as early as late July in recent years. The rate and direction of travel each year depends largely on weather patterns. There are several strains of *P. cubensis* which cause disease on different cucurbit hosts, but all infect cucumber making it the most susceptible crop. As of July 2nd, CDM has been confirmed on cucumber plants in Michigan, Ohio, Ontario, and in Erie County, NY and has been seen on the Eastern seaboard as far north as Delaware, mostly on cucumber but melons, watermelon, and summer and winter squashes have also been affected. Disease development is favored by just the sort of cool, wet conditions we have seen quite a bit of so far this summer.

Fortunately for cucurbit growers, a CDM monitoring and forecasting network can be found online at http://cdm.ipmpipe.org. This site is maintained by the University of North Carolina and provides information about where outbreaks have been confirmed and on which crops, and provides forecasts indicating where and when inoculum might be spread based on forecast storms. There is also information on field identification and control recommendations. You can also sign up for e-mail alerts to be notified when new outbreaks occur in your area. It's an excellent tool that growers can use in making crop protection decisions.

Table 1. Fungicides Recommended Against Cucurbit Downy Mildew

	Tank mix with protectant*	
	No	**Yes**
Program 1: Prevent Before symptoms	chlorothalonil or mancozeb	Zampro
Program 2: Manage After symptoms	Gavel	Ranman or Omega**

**Protectants are chlorothalonil (Bravo, Echo, Equus, and other products) or mancozeb (Manzate, Dithane, Penncozeb, and others).*
***Omega may be used only on watermelon, muskmelon, honeydew, and specialty melons.*

Chemical Control. A protective application on susceptible crops using a broad-spectrum fungicide such as Bravo, Mancozeb, or copper is warranted now, given proximity of the pathogen and conducive weather. Use the forecasting program to determine when to switch to using targeted, downy-mildew specific materials such as Ranman, Gavel (pre-mixed with mancozeb), Curzate, Tanos, Forum or Zampro always in a tank-mix with a protectant fungicide. Once targeted fungicides are called for, alternate modes of action with each spray, keeping a 7-day spray interval (Curzate and Tanos should be followed up with another targeted application at a 5 day interval due to limited residual). It's important to be diligent with managing fungicide resistance development because P. cubensis is known to rapidly evolve resistance to many chemical classes. Resistance is documented for Ridomil and the strobilurin fungicides (e.g. Quadris, FRAC Group 11), and now reduced efficacy of Presidio and Previcur Flex is being reported, indicating resistance to these materials has developed. In organic cropping systems copper products can be effective when used preventatively to protect plants from infection. Copper can be phytotoxic to cucurbits–phytotoxicity is most common during cool, moist conditions, which are also the most favorable for downy mildew. Disease forecasting should be used in any system to avoid unnecessary sprays and ensure protection from imminent infection. See cdm.ipmpipe.org for updated disease reports and forecasts.

-by Angie Madeiras and Sue Scheufele

Corn Earworm Management

Some locations in Massachusetts will be harvesting sweet corn by the 4th of July this year. The hot May helped establish an early crop for those who got corn in under plastic which is now close to harvest. Many 2nd and 3rd successions are now coming into fresh silk and are susceptible to corn earworm that arrived early this week on the storm front that dropped up to 2 inches of rain in some parts of the state. One trap capture in Sharon, MA reported 7 corn earworm over a 2-day period this week. Corn earworm (*Heliothis zea*) moths migrate annually into the Northeast, traveling north on storm fronts, and may arrive anytime from late June through September. Populations usually don't peak until August when trap captures may exceed 90 moths per week, but we may continue to get flushes of them with summer storms. Heaviest numbers are found in coastal areas and up the major river valleys. The severity of infestations varies from year to year and may change suddenly during the season. For example, in 2014, we did not get a lot of Atlantic coastal storms, and CEW populations were low. This year however, we have had two storms already that may have brought in moths.

CEW moth, D. Ferro

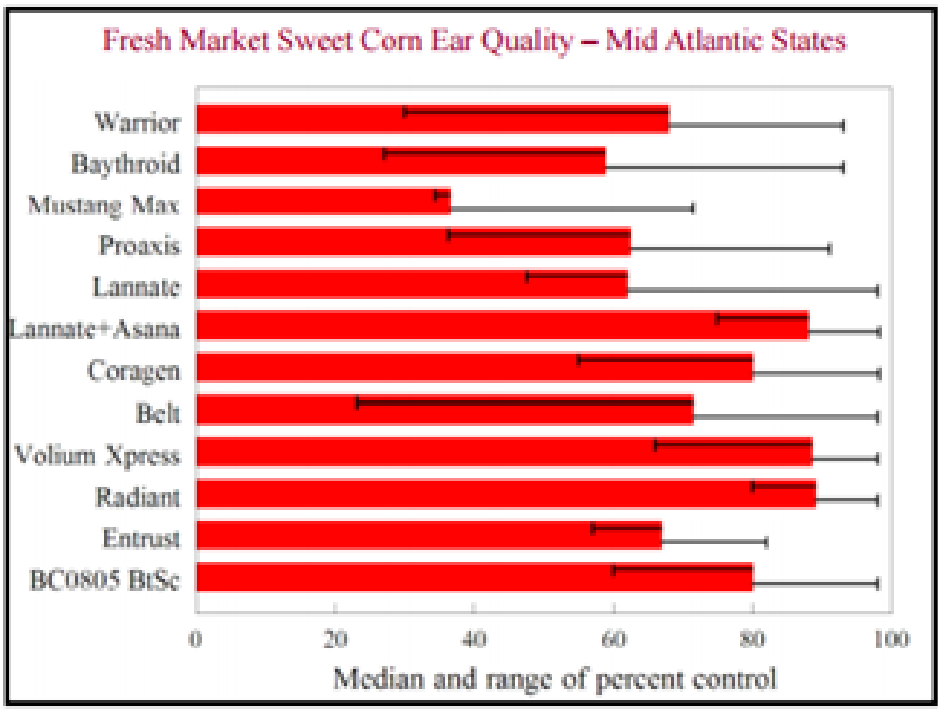
CEW larva, R. Hazzard

Identification. Known as the tomato fruitworm, cotton bollworm, or corn earworm, this lepidopteran noctuid pest feeds on corn, tomato, cotton, green beans, clover, vetch, lettuce, peppers, soybean and sorghum. Sweet corn (especially in silk) is a preferred host in New England, and losses may reach 50% if not managed. Adult moths are light tan with a distinctive dark spot on each forewing, with a dark band near the margin of the hind wing, and a wingspan of 1.2-1.5 inches. Live moths have bright green eyes. Rounded, ribbed eggs less than 1/16th of an inch in diameter are laid directly on fresh silk. Eggs develop a red ring encircling them in 24 hrs, and the black head capsule is visible just before they hatch. Corn earworm larvae may be brown, tan, green, or pink, with light and dark longitudinal stripes. Corn earworm can be distinguished from fall armyworm and European corn borer by the plain, golden brown head capsule and small bumps and spines that give the body a rough texture. The larvae reach 1.5 to 2 inches when full grown.

Lifecycle. Adults arrive in Massachusetts ready to lay eggs. Egg laying takes place mostly in the evening as this is a noctuid moth, and each female is capable of laying 500 to 2000 eggs during her 2-week life span. Even though many eggs may be laid in silking corn, usually only 1 larva is found in the ear because they are cannibalistic. Eggs hatch in 2.5 to 6 days, more quickly at higher temperatures. Caterpillars crawl down the silk channel within one hour of hatching and feed on the kernels at the tip, leaving unsightly frass. In the tip they are protected from insecticide sprays, and control measures must be timed to prevent larvae from entering the ear. Larvae feed for 3 to 4 weeks as they go through 5 growth stages before chewing out through the corn husk and burrowing in

CEW Moths/ Night	CEW 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

the soil to pupate. Two full generations of corn earworm may develop after their first arrival.



Results of trials conducted by Ben Beale and Galen Dively (University of Maryland) and Joanne Whalen (University of Delaware), 2011.

Monitoring. When corn earworm captures in pheromone traps are in excess of 2 per week, we know that a damaging population is present. Monitoring moth flight with pheromone traps is key to season-long control, both to respond quickly to changes in flight and to avoid unnecessary sprays. Reports of moth trap captures at selected locations are provided in most New England states. The most accurate and timely flight information will be obtained by monitoring your own fields. Heliothis net traps baited with Hercon Heliothis zea pheromone lures are commercially available and widely used in the region. The threshold charts are based on this trap/lure combination. Place traps in blocks with fresh silk and move traps to new blocks of fresh silk as needed – these blocks will give you the highest and most accurate counts. Counting moths twice weekly is the most accurate way to monitor and will help you avoid missing a sudden jump in the CEW population on your farm. Calculate the average nightly catch (divide total count by the number of nights since the last count). Replace lures every two weeks.

Control. Control depends upon maintaining insecticide coverage on the silks (unless you are using the Bt hybrids that express the Bt toxin in leaves, silks and kernels. Research has shown that increased use of Bt corn in New England has resulted in reduced pressure from European corn borer, fall armyworm and corn earworm even among those who are not growing Bt corn). Directed sprays to the ear zone provide the best coverage. Repeat applications to silk every three to six days depending on trap captures according to the chart on the previous page. The spray intervals in the chart below assume use of synthetic pyrethroid or carbamate products. Some newer products in the diamide class (Coragen, Belt, or mixtures such as VoliamXpress and Besiege) have a longer residual that should allow the spray interval to be extended by one or two days. If maximum daily temperature is below 85°F for 2 to 3 days, spray intervals may be extended by 1 day. Continue treatments until 5-7 days before final harvest or until silk is completely dry and brown. Use selective materials instead of broad spectrum insecticides to conserve natural enemies of aphids and other pests.

The newer, selective products for corn earworm, fall armyworm and European corn borer provide good control while being easier on natural enemies and bees that are present in the field and safer for applicators to handle. These provide good alternatives to the synthetic pyrethroids (e.g. Warrior) and carbamates (e.g. Lannate) that were the mainstay of corn earworm control for many years. Based on review of published trials, the following products have provided good control:

- **Radiant** (spinetoram): consistently equivalent efficacy with Warrior in trials - highly effective.
- **Belt** (flubendiamide): equivalent efficacy to Warrior in some trials, slightly less in others.
- **Coragen** (chlorantraniliprole): slightly less effective on corn earworm than Warrior but easier on beneficials and people.
- **Besiege** (a mixture of Coragen + Warrior AI's, each at lower rates): highly effective, often better than Warrior.

A rotation of Coragen, Belt and Radiant is recommended to avoid resistance development. Growers we have spoken with who have been trying these products have also reported effective control. The products mentioned above can be mixed with pyrethroids, however, given that there are many beneficial insects in corn that feed on aphids, small larvae and pollen,

and that honeybees move into corn when pollen is released, having the option of using more selective products is welcome.

- **Entrust** (spinosad): In organic fields, this material has been observed to give good control of corn earworm. Foliar sprays of Entrust will be effective for control of European corn borer in the tassel, as well as for control of light to moderate populations of corn earworm. High populations (over 30 per week) may not be fully controlled by this product.

As with other products, control is better when application equipment is set up for good coverage of the ear zone.

-by Katie Campbell-Nelson from the following sources:

- Hazzard, R and Howell, J Eds. "New England Vegetable Management Guide 2014-2015 Ed.": https://nevegetable.org/
- Brown, A, Hazzard, R and Westgate, P. "Sweet Corn Insect Management Field Scouting Guide": https://ag.umass.edu/vegetable/publications/guides/sweet-corn-ipm-scouting-guide-record-keeping-book
- Dively, G. "Regional Impacts of a High-Dose Resistant Crop" Presentation to National Research Council, April 2015: https://vimeo.com/122426527
- Weinzierl, R. "Managing corn earworm, cutworms and armyworms in vegetable crops" presentation, February, 2015: https://web.extension.illinois.edu/mms/downloads/47270.pdf

BLOSSOM END ROT NOW SHOWING UP

-Originally published June 26, 2015 in University of Delaware Cooperative Extension *Weekly Crop Update*

Blossom end rot (BER) is showing up again this year in tomatoes. BER is a disorder where developing fruits do not have enough calcium for cell walls, cells do not form properly, and the fruit tissue at the blossom end collapses, turning dark in color. Calcium moves through cation exchange with water movement in the fruit so the end of the fruit will be the last to accumulate calcium. Larger fruits and longer fruits are most susceptible. With fruits, the rapid cell division phase occurs early in the development of the fruit, the two weeks after pollination, and if calcium accumulation in the fruit is inadequate during this period, BER may occur. Over 90% of the calcium taken up by the fruit will occur by the time the fruit is the size of a nickel. While it may not be noticed until the fruit expands, the deficiency has already occurred and cells have already been negatively affected. We most commonly see signs of blossom end rot on fruits several weeks after the calcium deficiency has occurred.

Understanding blossom end rot also requires an understanding of how calcium moves from the soil into and through the plant. Calcium moves from the soil exchange sites into soil water and to plant roots by diffusion and mass flow. At plant roots, the calcium moves into the xylem (water conducting vessels), mostly from the area right behind root tips. In the xylem, calcium moves with the transpirational flow, the movement of water from roots, up the xylem, and out the leave through stomata. Calcium is taken up by the plant as a divalent cation, which means it has a charge of +2. It is attracted to negatively charged areas on the wall of the xylem, and for calcium to move, it must be exchanged off the xylem wall by other positively charged cations such as magnesium (Mg^{++}), potassium (K^{+}), ammonium ($NH4^{+}$), or other calcium cations (Ca^{++}). This cation exchange of calcium in the xylem requires continuous movement of water into and up through the plant. It also requires a continuous supply of calcium from the soil

In general, most soils have sufficient calcium to support proper plant growth. While proper liming will insure there is adequate calcium, it is not the lack of calcium in the soil that causes blossom end rot in most cases. It is the inadequate movement of calcium into plants that is the common culprit. Anything that impacts root activity or effectiveness will limit calcium uptake. This would include dry soils, saturated soils (low oxygen limits root function), compaction, root pathogens, or root insect damage. In hot weather on black plastic mulch, roots can also be affected by high bed temperatures. Low pH can also be a contributing factor. Calcium availability decreases as pH drops and below a pH of 5.2, free aluminum is released, directly interfering with calcium uptake. Again, proper liming will insure that this does not occur. Apply-

ing additional calcium as a soil amendment, above what is needed by normal liming, will not reduce blossom end rot.

In the plant, there is a "competition" for calcium by various plant parts that require calcium such as newly forming leaves and newly forming fruits. Those areas that transpire the most will receive more calcium. In general, fruits have much lower transpiration than leaves. In hot weather, transpiration increases through the leaves and fruits receive lower amounts of calcium. High humidity will reduce calcium movement into the fruit even more. Excess nitrogen that causes excess foliage will increase blossom end rot. Tissue tests will often show adequate levels of calcium in leaf samples; however, fruits may not be receiving adequate calcium. In addition, in hot weather, there is an increased risk of interruptions in water uptake, evidenced by plant wilting, when transpirational demand exceeds water uptake. When plants wilt, calcium uptake will be severely restricted. Therefore, excess heat and interruptions in the supply of water (inadequate irrigation and/or rainfall) will have a large impact on the potential for blossom end rot to occur. Proper irrigation is therefore critical to manage blossom end rot. This means a steady, even, uninterrupted supply of water in the soil surrounding the plant roots.

In high tunnels, lack of air movement can also be a factor, as transpiration is reduced, thus limiting calcium movement in the plant. In periods where tunnels are closed tight due to adverse weather, this may also increase the potential for blossom end rot. First fruits formed in early planted tomatoes and peppers are the most susceptible to blossom end rot, especially in high tunnels.

As a positive cation, there is "competition" for uptake of calcium with other positive cations. Therefore, if potassium, ammonium, or magnesium levels are too high in relation to calcium, they can reduce calcium uptake. To manage this, do not over-fertilize with potassium or magnesium and replace ammonium or urea sources of nitrogen with nitrate sources.

Applying additional soluble calcium through irrigation, especially drip systems, can reduce blossom end rot to some degree if applied prior to and through heat events and if irrigation is applied evenly in adequate amounts. Foliar applications are much less effective because fruits do not absorb much calcium, especially once a waxy layer has developed, and calcium will not move from leaves into the fruit (there is little or no phloem transport).

In conclusion, the keys to controlling blossom end rot are making sure roots are actively growing and root systems are not compromised, soil pH is in the proper range, and irrigation is supplied in an even manner so that calcium uptake is not interrupted. Supplemental calcium fertilization will only marginally reduce blossom end rot if water is not managed properly.

-by Gordon Johnson, Extension Vegetable & Fruit Specialist; gcjohn@udel.edu

BACTERIAL DISEASES OF TOMATO (AND PEPPER)

Three bacterial diseases commonly affect tomato crops: Bacterial Spot (*Xanthomonas campestris* pv. *vesicatora,* also affects pepper), Bacterial Speck (*Pseudomonas syringae* pv. *tomato*), and Bacterial Canker (*Clavibacter michiganensis* pv. *michiganensis*). Tomato pith necrosis is a less common bacterial disease that can be confused with bacterial canker, but seems to be increasing in prevalence in recent years. These diseases can affect foliage, fruit, and stems and distinguishing between them can be difficult.

In general, bacteria cannot survive well on their own, outside of a host plant or crop debris. Thus, the most common starting place for any bacterial disease is in the seed itself, so starting with clean seed or hot water treating your seed is hugely important. If you are buying transplants, ask your supplier about their bacterial disease control strategies–greenhouses are ideal places for growing and spreading bacteria, as they thrive in warm, moist conditions. Other sources of bacteria are crop residues in the soil, so 2-year rotations are recommended, and on equipment, especially wooden tomato stakes. If you've had bacterial diseases in past years, do yourself a favor and replace your stakes. A third source might be overwintered crops or weeds, but this is less likely in MA, unless a volunteer plant or weed host survives in a greenhouse. Secondary spread of bacterial cells occurs mainly by water or mechanically–this means rain splash or driving rain, wind-driven sand, movement of workers or equipment (tractors, pruning shears etc.) through a wet field, and even in aerosols in humid air. Bacteria infect plants passively, via open stomates and hydathodes, or enter through wounds. Bacteria thrive in warm (around 75-90°F), moist or humid conditions. Management of bacterial diseases is difficult once they are established, so using good sanitation practices such as buying clean seed, hot water treating seeds, maintaining good weed control, sanitizing equipment, and rotating crops is essential to preventing disease.

Symptoms of the most common bacterial diseases of tomato are described below:

Bacterial spot on tomato, R. Wick

Bacterial spot on pepper

Bacterial spot caused by *Xanthomonas campestris* pv. *vesicatora* (Xcv) affects both tomato and pepper and is one of the most devastating diseases of these crops in warm, humid environments. Xcv consists of different strains that vary in their pathogenicity to tomato, pepper, and solanaceous weeds. Some strains infect only pepper, some infect only tomato, and some can infect both pepper and tomato. Pepper cultivars are available with resistance to bacterial spot, however they are usually resistant to specific races of Xcv, so controlling this disease with resistant varieties effectively requires knowing what races of the pathogen are likely to be present.

On leaves, symptoms start as small yellow-green spots that quickly turn brownish-red and may have a greasy, water-soaked appearance. Bacterial spot lesions do not have concentric zones or a prominent halo. When conditions are optimal for disease development, spots can coalesce to form long, dark streaks. On tomato plants, a general yellowing may appear on foliage with many lesions giving the plants a scorched appearance, and the plants may exhibit severe bending and twisting. On pepper plants, affected flowers, fruits, and leaves drop prematurely. This can reduce yield directly or severe defoliation of plants causes sunscald of surviving fruit. On tomato fruit, discrete, minute, slightly raised blisters occur on green fruit only. Initially, lesions have a yellow halo that resembles the birds-eye spot caused by bacterial canker. As fruit lesions enlarge, they lose their halo and become brown, raised, and scab-like on ripe fruit. On pepper fruit, spots begin as pale-green, water-soaked areas, which eventually become raised, brown, and roughened. Spots may provide entrance points for various fungi and bacteria that cause secondary fruit rots. The bacterial spot pathogen alone does not cause fruit rot.

Bacterial speck, OMAFRA

Bacterial speck (*Pseudomonas syringae* pv. *tomato*) causes a fruit spot and foliar blight on tomato only, not pepper. It is found wherever tomatoes are grown but is generally of minor concern. Lesions are indistinguishable from those caused by bacterial spot–small, greasy or water-soaked spots which develop a halo over time. Spots may coalesce, killing large areas of tissue. On fruit, small (1/16 inch), dark spots or specks develop with the tissue around them often more intensely green than unaffected areas. These tiny, dark spots are not raised or scabby at all like those caused by bacterial spot.

Bacterial canker, S. Scheufele

Bacterial canker (*Clavibacter michiganensis* pv *michiganensis*) is one of the most destructive tomato diseases in Massachusetts. Symptoms are different in the greenhouse and field. Infections arising from contaminated seed or seedlings result in systemic spread of the bacteria within the plant, and seedlings can be affected early on in the greenhouse. This type of systemic infection (known as primary) causes stunting, wilting, vascular discoloration, open stem cankers, and fruit lesions. If an infected stem is cut lengthwise, a light brown discoloration may be present in the vascular tissue, most noticeable at nodes and just above the soil line. Secondary infections occur in the field when bacteria are spread from plant to plant by rainsplash, driving winds, workers and equipment, or in aerosols under humid conditions. This type of infection (known as secondary) often results in marginal scorch or "firing" where leaf edges are brown to black with a yellow border on the leaf interior. Spots also occur on green fruit and are very characteristic–white to yellow spots, 3-4 mm in diameter, with raised brown centers and white haloes, known as "bird's eye spots".

Tomato Pith Necrosis is caused by *Pseudomonas corrugata* and other soil-borne species of Pseudomonas. While high tunnels and greenhouses provide ideal conditions for the growth of early season tomatoes, this environment also provides ideal conditions for this emerging disease. Pith necrosis generally occurs on early planted tomatoes growing when night

temperatures are cool, the humidity is high, and the plants are growing vigorously because of excessive levels of nitrogen. The disease is also associated with prolonged periods of cloudy, cool weather. Initial symptoms often appear just as the first fruit clusters reach the mature, green stage, and consist of yellowing and wilting of young leaves. Serious infections can result in yellowing and wilting of upper portions of plants, with brown to black lesions on infected stems and petioles. When stems are cut longitudinally, the center of the stem (pith) may be extensively discolored, hollow, and/or degraded. Stems may be swollen, numerous adventitious roots can form, and infected stems may shrink, crack, or collapse. The epidemiology of this disease is not well understood; it is possible that the bacteria are seed-borne and most certainly survive in the soil in association with infected tomato debris.

Pith necrosis, S. Scheufele

Preventive measures to minimize the occurrence of pith necrosis in high tunnels include: adequate ventilation to avoid high humidity levels (especially during cloudy weather), avoiding excessive nitrogen levels to prevent vigorous plant growth, incorporation of crop debris to speed decomposition of residue and associated bacteria, and crop rotation. There is no effective treatment for this disease. Affected plants may recover if environmental conditions improve (warm, sunny weather) but if not, affected plants should be removed from the field to prevent spread of the disease.

Preventing losses to bacterial diseases:

- Start with certified, disease-free seed or treat seed with hot water, hydrochloric acid, calcium hypochlorite, or other recommended materials. See the fact sheet entitled Managing Pathogens Inside Seed with Hot Water for further details.
- Reduce moisture and increase airflow in the greenhouse and the field through heating and venting, or by increasing spacing and removing lower leaves, respectively.
- Control bacterial populations that may be present on the leaf surface of transplants in the greenhouse. Young transplants may not display symptoms of bacterial diseases. Inspect and remove suspect transplants.
- Use drip irrigation. Irrigate during midday or on sunny days so foliage dries out before going into an overnight dew period.
- Sanitize shears or change gloves at the end of each row if pruning
- Plant into a clean field using sterilized stakes.
- Avoid working in fields when bacterial diseases are present and the fields are wet.
- In general, bacterial diseases of field crops are difficult to control with pesticides. Copper products are most effective, and the addition of mancozeb products can increase their efficacy. Streptomycin (eg., 45Agri-mycin 17) is an effective product that may be used only in the greenhouse before transplanting to the field. When a significant amount of disease is present, pesticides are usually not effective. Biological disease control products that have shown efficacy in some trials on bacterial diseases in tomato include Actigard or Regalia (both plant defense activators).
- Promptly incorporate crop debris after harvest.
- Rotate to a non-host crop before returning to tomato and do not allow volunteer tomato or weed hosts to survive.

-by Sue Scheufele and M. Bess Dicklow, UMass Extension Vegetble Program

Events

IPM Field Walks

In this series, learn to identify and scout fruit and vegetable pests and select integrated pest management strategies that work for you whether you are a beginner, experienced, organically certified or not! We will walk farm fields with Extension Educators and farmers in Massachusetts, Rhode Island, and Vermont to learn how each farm is practicing IPM. Bring a hand lens if you have one. This series is funded in part by a Northeast IPM Center grant.

- **July 22nd, 4-6 pm**
  Waltham Fields Community Farm, 240 Beaver Street, Waltham, MA
  Learn to calibrate a backpack sprayer, select effective OMRI approved materials and calculate the economic threshold of vegetable crops after being trained to scout in the field with farmers Erin Roberts and Zannah Porter and UMass Extension staff Lisa Mckeag, Susan Scheufele and Rich Bonanno. **2 pesticide license contact hours available in the vegetable category.**
- **July 27th, 4-6 pm**
  Simple Gifts Farm, 1089 North Pleasant Street, Amherst, MA
  Come to this field walk to learn how to use pheromone traps to monitor Squash Vine Borer, use a microscope to identify plant pathogens, and learn to scout multiple vegetable crops with farmer Jeremy Barker Plotkin, UMass Extension staff Katie Campbell-Nelson, Lisa McKeag and Plant Diagnostician Angie Madieras. Leave after a discussion of control strategies for these pests on organic farms. **2 pesticide license contact hours available in the vegetable category.**
- **August 25th, 3:30-6pm**
  Hurricane Flats, 975 S. Windsor St. South Royalton, VT
  Join us to learn how to scout for disease and insect pests in the field and discuss effective organic control strategies with farmer Geo Honigford, Ann Hazelrigg and Gabriella Maia (UVM Disease Diagnostic Laboratory) and Katie Campbell-Nelson (UMass Extension Vegetable Program). Sponsored by Vermont Vegetable and Berry Growers Association and NOFA-VT.

Professional Development Soil Health Workshop Series

The University of Massachusetts Extension has been funded by the Sustainable Agriculture Research and Education Professional Development Grant (2014-2017) to provide educational opportunities to Agricultural Service Providers and Farmers in Soil Health topics.

- **July 16th, 3-5 pm**
  Diagnosing Streams: Flood Protection Remedies for Farm and Forested Lands, 89-91 River Rd. South Deerfield, MA
  Christine Hatch, UMass Extension Assistant Professor, Geosciences, and Benjamin Warner, UMass PostDoc, Geosciences will present the latest science on "diagnosing streams" and provide best practices for farm and forest land managers to protect their land from the effects of stream flooding. Their goal is to help agriculture, forestry, and rural communities develop greater resiliency during extreme weather events. Christine and Benjamin are members of a New England "Fluvial Geomorphology" research group. The group has studied successes among restoration responses to Hurricane Irene in Massachusetts and Vermont and will be sharing findings from this work with Agricultural Service Providers in Massachusetts.

- **August 25th, 3:30-6pm**
  Soil Tests for New England and interpreting them for Phosphorous Management, 89-91 River Rd. S. Deerfield, MA
  Tom Morris, University of Connecticut Professor, Plant Science will present methods of different soil extractions and tests, with a focus on those appropriate for New England soils. With his experience in field research on nitrogen and phosphorous, Tom will present Agricultural service providers with a basic understanding of the chemistry of Phosphorous in the soil, how it behaves, how best to assess P status of soil in different growing systems, how to assess potential loading from soil applications of fertilizer, compost or manure, and how to mitigate soil with excess Phosphorous aside from not adding more (e.g., cover crops or other ways to use up or sequester phosphorous to prevent off site movement or contamination.
  Tom Akin, Natural Resource Conservation Service Agronomist will present work on evaluating a new soil extraction method for New England with data from Massachusetts farms. The new Haney Soil Health Test is being tested in Massachusetts to evaluate it's ability to better predict active carbon and other indicators of soil health.

2015 NOFA Summer Conference

When: Friday, August 14 to Sunday, August 16, 2015
Where: UMass Amherst Campus

This year's main conference features 144 individual sessions with 27 different topic areas. Workshops address organic farming, gardening, land care, draft animals, homesteading, sustainability, nutrition, food politics, activism, and more. The theme for this year's Conference is "Healing the Climate, Healing Ourselves: Regeneration through Microbiology".

This year's conference will include sessions with UMass personnel:

- Amanda Brown, Director of the UMass Student Farm; Tour of the UMass Ag Learning Center
- Lisa McKeag, Extension Vegetable Program; Pest Scouting in the Field at Simple Gifts Farm
- Susan Scheufele, Extension Vegetable Program; Integrated Pest Management in Brassicas

THANK YOU TO OUR SPONSORS

Vegetable Notes. Ruth Hazzard, Katie Campbell-Nelson, Lisa McKeag, Susan Scheufele, co-editors.