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Michele Meder (UMass Vegetable Program Departmental Assistant) rototilling weeds in the cucurbit downy mildew sentinel plot at the research farm in South Deerfield where the disease was confirmed on canteloupe and cucumber this week. Photo: S. Scheufele

Crop conditions

Last week, one grower predicted crop shortages this season, and that prediction seems to be coming true in some cases. There is a lull in sweet corn and tomato harvests as several cool nights and cloudy or rainy days have slowed ripening. One grower reports that at this time last year he was harvesting 300 lbs of tomatoes per week and now he is only harvesting 30lbs. There is plenty of dense, beautiful foliage out there, but little fruit coming in yet. With that beautiful foliage in mind, protect your tomato and potato crops from late blight, which was confirmed on tomato in Hampshire Co., MA this week. Downy mildews were also confirmed in cucurbits, basil, and brassicas, so it's officially spray time—regular and preventive sprays are necessary to control these aggressive and pervasive diseases. All that said, crews are busy weeding and harvesting, with eggplant and pepper crops picking up and melon harvest starting too. Next week is National Farmers Market week! Secretary of Agriculture, Sonny Perdue signed a proclamation noting that farmers markets and other direct market outlets contribute approximately $9 billion each year to the U.S. economy. As a relatively small agricultural state, Massachusetts (and Vermont too) are among the top ten states for direct market sales. We hope you all enjoy good turnouts and record sales and continue to connect with consumers to build community around local food!

Pest alerts

Brassica

Black Rot is being reported widely across MA and RI. The most important source of disease is infected seed. The bacteria can persist in infected plant debris for up to two years, but can only survive alone in the soil for 40-60 days. As the disease progresses, the veins of infected tissues turn black and the normal flow of water and nutrients is impeded. Symptoms on root crops may not be visible on foliage, but blackened veins appear in the roots. On leaf crops, infection may spread into the leaves of the head. Black rot is often followed by invasion of soft-rotting organisms. Symptoms may not appear in the seedbed, allowing infected plants to be transplanted into the field. It is spread within the field by splashing water, wind, equipment, people, and insects.

Brassica Downy Mildew on arugula Photo: S. Scheufele

Brassica Downy mildew has been confirmed on arugula in Franklin Co., MA. It was first observed last week, where it was widespread, but not severe. The disease may be present without showing symptoms and then suddenly flare up when conditions become favorable—high humidity, fog, drizzling rains, and heavy dew favor disease development and spread. Optimum conditions for disease development are night temperatures of 46°F to 61°F for 4 or more successive nights, and day temperature about 75°F or lower.

Basil

Basil Downy Mildew was confirmed a few weeks ago in Bristol Co. MA and this week in Hampshire Co., MA. Control weeds and space plants to enhance leaf drying. like other oomycete pathogens (cucurbit downy mildew and late blight), this disease is spread by areal dispersal and recquires a live host. Consider mowing down and incorporating heavily infested basil crops now to reduce the spread of inoculum. Time for pesto!

Cucurbits

Bacterial Wilt is widespread now, affecting multiple cucurbit crops including cucumber, melon, summer squash/zucchini, pumpkin and winter squash. Because this bacterium is transmitted systemically by striped cucumber beetles, spraying for the disease now is not effective—spray programs should target early cuke beetles. You can rogue infected plants now to limit spread. Use crop rotation to reduce beetle numbers in adjacent areas. Spunbonded row covers will exclude beetles.

Cucurbit downy mildew: was diagnosed on cucumber and cantaloupe in Franklin Co., on cucumber and butternut squash in Hampshire Co., and on kabocha squash in Orange Co., NY. This is the first report of this pathogen in MA. All cucurbits should be considered at risk and protectant as well as downy mildew-specific materials should be used at this time. See the June 29th issue of Veg Notes for the most up-to-date fungicide recommendations.

Squash bug nymphs are hatching and many crops are at threshold of more than one egg mass per plant in pumpkin fields across MA. Please spray early in the morning and choose insecticides carefully to protect bees foraging in these flowering crops and if using a neonicitinoid consider applying acetamiprid (Assail 30 SG), which has lower toxicity to bees than other neonicotinoids. Organic growers can apply a mixture of pyrethrin (also medium bee toxicity) and azadiractin (combine separate products or use Azera, which comes pre-mixed).

Squash vine borer trap captures have started to drop in NH and MA. This means that 2nd or 3rd successions should be uncovered if row covers were being used for protection now to encourage pollination.

Striped cucumber beetle adults were at threshold in later successions of cucumber and summer squash in Hampshire Co., MA and larvae were found damaging stem bases of high tunnel cucumbers in Worcester Co., MA, taking down entire plants.

Sweetcorn

Fall armyworm trap captures are increasing in NH and northern parts of MA but decreasing in eastern NY. Combined with the second flight of European corn borer it is time to scout silking corn again.

Corn earworm trap captures have jumped up on the southeast coast of MA, but have stayed lower in other parts of the state. A trap on your own farm is the best way to determine spray intervals for this pest since damage is difficult to scout for.

European corn borer: After a several weeks hiatus, we are starting to catch adults in MA, NY and NH, indicating the second generation flight is here, though at very low numbers in MA and many traps are still not capturing moths (Table 1). The main treatment window for the second generation ECB in peppers and sweetcorn is 1550-2100 GDD base 50F (Table 2). However, scout silking corn now to determine if thresholds of 15% infestation have been reached before spraying since trap captures of CEW, FAW and ECB are fairly low in most inland parts of the state.

Western Bean cutworm larvae have been found in two fields in Hillsborough Co., NH. Moths were trapped at one site but not the other, yet a small number of

Table 1. Sweetcorn pest trap captures for 7.27.17-8.2.17

Location	ECB	FAW	CEW	Spray Interval for CEW
Western, MA				
Sheffield	1	-	0	*no spray*
Whately	4	-	0	*no spray*
Central, MA				
Leominster	2	-	11	*4 days*
Lancaster	2	0	2	*6 days*
Northbridge	3	0	2	*6 days*
Eastern, MA				
Concord	0	5	2	*6 days*
Ipswich	2	3	5	*5 days*
Millis	0	-	7	*5 days*
Sharon	0	-	0	*no spray*
Swansea	0	-	60	*4 days*
Seekonk	0	-	95	*3 days*
Washington County, NY	0	0	0	*no spray*
Albany, NY	0	0	0	*no spray*

European corn borer (ECB), Fall armyworm (FAW), Corn earworm (CEW)

Table 2. Accumulated Growing Degree Days: 1/1/17 – 8/2/17	
Location	**GDD (base 50°F)**
Western, MA	
Amherst	1534
Westfield	1635
South Deerfield	1495
Central, MA	
Leominster	1568
Stow	1650
Eastern, MA	
Sharon	1635
Seekonk	1636
Ipswich	1463
Falmouth	1417
Hollis, NH	1527
Burlington, VT	1570
Newport, RI	1444
Castleton, NY	1669

caterpillars were found in both fields. If your sweet corn being harvested now has unknown caterpillars in them, or if you are spraying based on trap captures and still seeing caterpillars, consider getting your caterpillar diagnosed. See here for an excellent guide for identifying WBC. The highest trap captures of WBC have been in NY this past week (averaging 25 moths/trap). 75% emergence of this moth occurs at 1,536 GDD Base 50F (see Table 2).

Tomato

Bacterial canker: A tomato sample from MA and a major outbreak of this disease has been confirmed in RI in tomato AND pepper. The RI source was likely from the greenhouse with secondary inoculum coming from the field. When the disease is so widespread, diligent sanitation is required such as using herbicide to kill live tissue, and mowing residues to encourage decomposition. If infected plants are present, the movement of bacteria from one plant to another during normal watering, handling, and ventilating activities occurs readily. Copper and macozeb are effective protectants. See article this issue for more information and management tips.

Birdseye symptoms of bacterial canker on tomato (3-4mm diameter ea.) Photo: A. Radin

Bacterial canker on pepper. Photo: A. Radin

Bacterial Speck was found on tomato several weeks ago in Hampshire Co., MA after hail. It was just recently diagnosed this week however. Actigard has demonstrated efficacy in preventing spread of bacterial speck, but not of bacterial canker according to Meg McGrath, Cornell University Plant Pathologist.

Late blight was confirmed on untreated, non-resistant cherry tomatoes in Hampshire Co., MA on Monday. The most common symptoms on tomatoes are sunken, dark green or brown lesions on leaves and brown lesions on stems, with white fungal growth developing under moist conditions. Firm, brown textured lesions develop on tomato fruit. Symptoms are similar on potato, and tubers will be copper colored to purplish beneath lesions. Not all 'leaf blights' of tomato and potato are late blight!
See article this issue for management tips: "Late blight is here, now what?"

Multiple

Spotted Wing Drosophila numbers are increasing rapidly now. Larvae are being found in fruit in MA and NH. Fall raspberries are in full production and SWD management is the most important activity at this time. Harvest frequently and thoroughly and get harvested fruit into refrigeration as soon as possible. Be sure to rotate spray materials and make sure to adhere to label restrictions when only a limited number of applications are allowed.

late blight on top and bottom of tomato leaf Photos: S. Scheufele

LATE BLIGHT IS HERE, NOW WHAT?

Late blight was confirmed on untreated non-resistant cherry tomatoes in a Hampshire County, MA field this week. The disease caught us off-guard this year because the closest report of the pathogen was in Steuben Co., NY (at least 300 miles away). Late blight spores may travel 10-15 miles with each storm, but require a living host to infect. Therefore, we suspect either several unreported incidents in nearby counties, or, a local source of inoculum which could be infested potato tubers planted from table stock. With inoculum present, the weather has been conducive to its spread. While it may seem hot and relatively dry during the day, nighttime relative

humidity has been high in Hampshire Co. (staying around 90% from 10pm - 8am) and nighttime temperatures are dipping down to the 50's and 60's°F resulting in lots of morning dew that lasts long into the day especially within dense plant canopies. Favorable conditions for sporulation and areal dispersal are leaf wetness for more than 10 to 12 hours at moderate temperatures 60°-70°F. Spores survive up to one hour in sunny, dry conditions, and up to 4 hrs in cloudy weather.

Last year, there were no confirmed reports of late blight in MA. In years past, growers who used resistant tomato and potato varieties and/or started spraying fungicides preventatively and kept up regular fungicide sprays were able to maintain their crops despite the presence of disease nearby. This disease progresses rapidly—whole fields can be completely destroyed within weeks of symptom onset—so preventative action and early detection are imperative. The use of late-blight specific fungicides are advised on all tomato and potato crops in MA and adjacent areas of neighboring states at this time. See the New England Vegetable Management Guide for a complete list of materials.

Scout your potato and tomato fields multiple times per week (daily if possible), focusing on low-lying areas, shady field edges, areas prone to morning fog, wet areas next to streams, ponds, or near overhead irrigation rigs, west facing slopes, or any area that is protected from the drying effects of wind and sun. Areas where it is difficult to apply fungicides such as edges and corners, new growth that has not been previously sprayed, or tall plants above the height of spray booms should also be closely examined. Look deep within the dense canopy, where sunlight and wind cannot penetrate, and leaves remain wet through much of the day. Frequent scouting is necessary because the pathogen has a latent period of several days, meaning that the plant can be infected for days or even a week before any symptoms are observed. Once the pathogen begins to produce new spores, the explosive phase of the disease has started. Individual lesions can produce 100,000 to 300,000 sporangia per day, and each sporangium is capable of initiating a new infection that will become visible within three to four days and produce sporangia within another day or two under optimal conditions. Sporangia can germinate directly but in the presence of free moisture they can also produce 1 to 8 zoospores, each capable of initiating an infection, increasing the reproductive capacity of the pathogen up to 8-fold.

Due to its destructiveness and the aerial dispersal of sporangia from field to field and farm to farm, late blight is considered a community disease and everyone needs to participate in preventing its spread. If significant disease is present on your tomato or potato plants, we recommend that you promptly destroy these sources of inoculum and inform neighbors growing susceptible crops so they can take action to protect their plants. Please report outbreaks to the UMass Vegetable Program: umassveg@umass.edu so that we may make confirmations and post reports anonymously by county to the USABlight.org website where others may track the disease. Here we provide information to help you make decisions about how to manage your potato and tomato crops once the disease is present on your farm.

Potato Considerations

According to the University of Maine Potato Program, (updated 2014) the following products offer good or excellent control in potato after signs of the disease are present:

- **cymoxanil (Curzate 60 DF)**: 3.2 oz/A. (14 dh, REI 12h, Group 27). Use only in combination with a labeled rate of a protectant such as manzate, chlorothalonil or triphenyltin hydroxide.
- **famoxadone plus cymoxanil (Tanos)**: 6 to 8 oz/A. (14 dh, REI 12h, Groups 11 & 27). Must be tank mixed with an appropriate contact fungicide with a different mode of action. Do not alternate or tank mix with other Group 11 fungicides.
- **propamocarb (Previcur Flex)**: 0.7 to 1.2 pt/A. (14 dh, REI 12h, Group 28). Must be tank mixed with a contact fungicide. See label for rates and timing.
- **Copper** is the best organic material for this pathogen, but it acts as a protectant only.

It has been several years since we had a late blight outbreak severely affecting potato in MA. Furthermore, many potatoes are in the bulking stage (still requiring foliage) but not ready to harvest, making it difficult to decide how to move forward.

If late blight is present in your potato field, all tubers should be considered at risk, as sporangia produced on leaf and stem lesions can be washed off the plant by water and into the soil where they can infect the growing tubers. In conventional fields where preventive spray programs have been in place, continue spraying according to the late blight decision support system and incorporate the aforementioned targeted fungicides into your spray programs immediately to hold back the disease and protect tubers from infection. On organic farms where disease symptoms are widespread it is advisable to

kill potato vines quickly, as copper is the only fungicide available and will not stop the spread of late blight to tubers once symptoms are widespread. In the case that disease symptoms and sporulation is widespread, **foliage must be killed** as soon as is possible to prevent sporangia spreading to the soil and infecting tubers. The pathogen can survive on any living tissue, so plants should be thoroughly mowed, flamed, or herbicide-killed so that no living tissue remains. If you plan to use herbicides to kill potato vines, two products are labeled for vine kill in potato: **1) glufosinate-ammonium (Rely)** at 3 pt/A (9 dh, REI 12h). NOT for seed. Minimum spray volume of 20 gal/A. This is the same active ingredient as Liberty herbicide. It is rainfast in four hours, acts as a contact, burndown herbicide similar to paraquat, but with a toxicity profile more like Round-up—that is, safer for the handler to use; and **2) diquat (Reglone)** at 1 to 2 pt/A (7 dh, REI 12h). This product is suitable for seed and storage. Always use a spray adjuvant (0.1 to 0.5% v/v NIS). Use a minimum spray volume of 20 gal/A. It is rainfast in 30 minutes. A second application may be made depending on density of vine growth. A five-day interval is recommended between applications and not more than 4 pt/A may be applied in one season. Endothall (Desicate II) is no longer manufactured, and paraquat (Gramoxone) is no longer registered as a vine desiccant.

Wait at least two weeks after vine kill to harvest tubers from affected fields. This will allow infected tubers to rot away in the soil, and uninfected tubers will put on skin tissue that will protect them from wounding during harvest and lower the chances of infection during harvest and storage. Harvest when soil is not excessively wet, and do not wash tubers. Tubers should be dry when placed in storage. Remove any obviously infected tubers before putting them in storage. Infections generally begin in tuber cracks, eyes or lenticels. Infected tuber tissues are copper brown, reddish or purplish in color. Sporulation may occur on the surface of infected tubers in storage or in cull piles. Infected tubers are often invaded by soft rot bacteria.

Late blight in potato tuber. Photo: S. Johnson, UMaine

Tomato Considerations

As with potato, where growers have been keeping up with regular fungicide spray programs and disease is not widespread, continued spray programs can keep the disease at bay. In conventional fields where preventive spray programs have been in place, continue spraying according to the late blight decision support system and incorporate at least one of the targeted fungicides listed below into your spray programs immediately. Always follow label instructions and be careful to rotate different mode of action chemistries (FRAC codes) with each application and tank-mix targeted fungicides with a protectant fungicide such as maneb, mancozeb, or chlorothalonil.

- **Mefenoxam (Group 4) (Ridomil Gold Bravo, Ridomil Gold Copper and Ridomil Gold MZ WG)** are highly effective, systemic materials on late blight strains US-22 and US-23 but other strains have developed resistance to this material. Genotype US-24 was identified in New York in 2014 and has intermediate resistance to this class of fungicide.
- **Propamocarb HCl (Group 28) (Previcur Flex) and fluopicolide (Group 43) Presidio SC** also have systemic action within the plant and will thus protect new growth and unsprayed areas
- **Mandipropamid plus difenoconazole (Groups 40 +3) (Revus Top), dimethomorph (Group 40) (Forum), cymoxanil (Group 27) (Curzate) and famoxadone plus cymoxanil (Groups 11 + 27) (Tanos)** have translaminar activity so are targeted and will move some into the plant but won't give as good control as systemic materials.
- **Strobilurin fungicides (Group 11—includes Quadris Opti, Quadris Top and Cabrio)** are labeled for late blight but are not considered to be as effective as the materials listed above.
- **Cyazofamid (Group 21) (Ranman) and zoxamide plus mancozeb (Groups 22 + M3) Gavel)** should be considered as contact fungicides (like chlorothalonil or mancozeb) when used against late blight

On organic farms where copper has been sprayed regularly to prevent disease onset, continue spraying regularly and follow the recommendations on the late blight decision support system. There are no targeted materials to use for organic growers, but look for copper products with high metallic copper equivalencies to get the best protection. Be sure to get good coverage throughout the canopy and on new growth. Fungicides are recommended on blight-resistant varieties as most resistance is not total and will depend on which genotype is present. Follow these tips for reducing the spread of inoculum.

Rogue out plants by cutting trellising, cutting the base of stems or uprooting the plant. Keep in mind that plants within 100ft. radius may not show symptoms but may already be infected and will exhibit symptoms within 3 days. Placing plants in a trash bag and removing them to a landfill is only practical for home gardeners. For larger areas of staked tomatoes there are several options for removing or destroying the crop:

- Cut strings, remove stakes, mow thoroughly, pull plastic, and incorporate residue
- Use herbicide to kill the crop
- Pile residue and cover with a tarp or large sheet of plastic to prevent further spread of spores and kill the tissue.
- Cut the stem or pull plants, allowing the crop to desiccate in the sun, as strong sunlight will kill spores released into the air.

Late blight lesions on tomato fruit. Photo: R. Hazard

Many growers are tempted to try to continue harvesting seemingly unaffected fruit from plants with late blight infections present. However, once plants are infected all fruit is susceptible and symptoms can develop on fruit even after they are harvested. In previous years, it has not been uncommon to see infected fruit in markets. Infected plants should be promptly removed from the field in order to reduce disease spread throughout your field, prevent spread to your neighbors field, and save your consumers from the experience of taking their tomatoes home only to rot on the counter.

Late blight usually comes later in high tunnels compared to tomato crops in the field, but high tunnels do not guarantee protection. Leaf mold, botrytis and powdery mildew are all quite common in high tunnel tomatoes and symptoms can be confused with late blight. Late blight can occur in high tunnel tomatoes and if found, crop removal is critical. Incorporating residue is not recommended since soils may not freeze, and live tomato tissue may survive winter providing a "green-bridge" and potential source of inoculum the following spring. Open the house to let it freeze deeply. Avoid continuous cultivation at above-freezing levels through the winter after an infected tomato crop.

--Updated by K. Campbell-Nelson, 2017. UMass Extension Vegetable Program with contributions from R. Hazzard, M.B. Dicklow, R.L. Wick, S.B. Scheufele, K. Campbell-Nelson

BACTERIAL DISEASES OF TOMATO (AND PEPPER)

Three bacterial diseases commonly affect tomato crops: Bacterial spot (*Xanthomonas campestris pv. vesicatora*), 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 can also increase incidence of sunscald on fruit as foliage is lost.

In general, bacteria do not 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 very 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, humid conditions. Other sources of bacteria may be infested crop residues in the soil and equipment, especially wooden tomato stakes. If you've had bacterial diseases in past years, do yourself a favor and replace your stakes or invest in metal stakes which are easier to disinfect each year.

Once bacteria are present, they are spread mainly by movement of water or plant sap–this means rain splash or driving rain, wind-driven sand, or by 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.

Below symptoms of the most common bacterial diseases of tomato (and pepper in the case of bacterial leaf spot) are described:

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.

Bacterial spot and copper residue on pepper. Photo: K. Campbell-Nelson

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 (*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 speck on tomato. Photo: OMAFRA

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 secondary infection often results in marginal scorch 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."

Foliar symptoms of bacterial canker. Photo: UMass Extension

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.

Tomato pith necrosis. Photo: 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, or submit seed to the UMass Hot Water Seed Treatment service.
- 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 new or 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.

-- S. Scheufele, and M.B Dicklow, UMass Extension Vegetable Program

SEEDING FOR FALL THROUGH SPRING MARKETS

If you are planning to extend your harvest season into late Fall, or even early next Spring, now is the time to start thinking about seeding, if you haven't already. Depending on what you plan to grow, and for which markets, crops can be grown outside with the possibility of using covers—row covers, low tunnels, caterpillar tunnels—or into high tunnels. Below are some recommendations collected over the years for crops and varieties and recommended seeding dates.

Crops and Varieties

Field: At this point in the season, the options include direct seeding leafy crops or small, fast-growing root crops in the

field. Here are some crops suggested by Danya Teitlebaum of Queens Greens in MA to seed by mid-August for a fall harvest.

- **Roots:** Hakurei turnips, radishes and fast-growing beet varieties for bunching.
- **Leaves:** Lettuce, mustard greens & other Asian bunching greens, arugula, kale, chard, spinach, bok choi.
- **Herbs:** Cilantro, parsley and dill.

For growing outside in the open or with protection from hoops and row cover, seeding and transplanting could be done through around mid-September, depending on your location. Growth rates decline rapidly at this time of year as day length shortens and temperatures gradually drop. These crops would be ready for harvest from October through November.

High Tunnel: For production in high tunnels for late fall, winter, or spring harvest, seeding or transplanting may go even later. Transplanting can give you a 3-week head start which may be needed when a tunnel is occupied with tomatoes until October. When planning your plantings and choosing seed, look for varieties that are specifically labeled to be cold hardy. In winter high tunnels, they will be subjected to sub-freezing temperatures and multiple freeze-thaw cycles. Some crops will only be in the ground for a relatively short time, while others will need longer to mature for harvest. Below are some good variety choices in each category:

Suggestions for shorter residency varieties:

- Spinach: Space, Tyee (see research reports below for other recommended varieties)
- Brassica greens: Red Russian Kale, Tatsoi, Komatsuna, Mizuna, Green Wave
- Bok Choi: Black Summer, Mei Qing Choi
- Lettuce: Tango, Red Salad Bowl, Rouge D'Hiver
- Claytonia

Suggestions for longer residency varieties:

- Radish: Tinto, Cherriette, D'Avignon
- Beet: Red Ace, Merlin, Touchstone Gold
- Chard: Fordhook Giant
- Leek: Tadorna
- Scallion: White Spear
- Turnip: Hakurei
- Carrot: Napoli, Mokum, Nelson
- Kale: Winterbor, Redbor, Toscano, Siberian, Red Russian
- Collards: Champion
- Head Lettuce: Scyphos, Ermosa, Winter Density

Seeding Schedules

"Days to maturity" are longer as the daylight hours get shorter and temperatures drop. The date that crops are seeded, the climate in your growing zone, the microclimate both on your farm and inside of a tunnel, and the severity of the weather in a given year will all affect plant growth and survival. Short intervals between seeding dates become longer intervals between harvest dates. Cutting lettuce and cutting brassica crops need many seeding dates at close intervals. Full-sized kale, chard, collards, spinach - plants where you harvest the outer leaves only - need 1 or 2 dates. Some farmers have had success planting during the period with less than 10 hours of daylight - in New England, this is from around the second week in November to the fourth week in January - but there are also reports of poor germination and early bolting. Good record keeping over the years will help you to develop a fall seeding schedule that is specific for your farm.

Here in Massachusetts, we may experiment with later planting dates as confirmed by research conducted in New Hampshire by Becky Sideman and Kaitlyn Orde (see research reports listed at the end of this article).

Also, Johnny's Selected Seeds has developed a useful tool at http://www.johnnyseeds.com/t-InteractiveTools.aspx to calculate fall seeding dates for your area.

See **Table 1** for seeding date recommendations from Eliot Coleman in Maine. Seeding recommendations for many other crops can be found in this planting schedule chart provided by Robert Hadad at Cornell Extension.

Table 1. Summer-Fall seeding for Winter Markets on a 44th Parallel Vegetable Farm in Maine (Eliot Coleman)

T/D[1]	Crop	Sowing Dates	Notes
D	Arugula	8/29 -9/16, and 9/22-10/2	Sow successions every 2 days until 9/16 for outdoor fall harvest and sow in late September in unheated high tunnel for winter harvest
T	Beets	7/5, 7/19, 7/26, 8/2	Sow early July for storage and later for outdoor harvested baby beets
D	Carrots	7/5, 7/28, 8/4 -8/15	Sow early July for storage and later for fall and winter markets. Cover after November 1st and harvest before February to preserve sweetness
T	Kale	7/16, 8/1, 8/13, 8/27	Sow July for outdoor fall harvest, and mid-late August in high tunnels and greenhouses for winter harvests
T	Lettuce	8/12 -9/9	Sow outdoor and under cover. Baby leaf is available outdoors from sowings made as late as 9/6
T	Onion[2]	8/252	For low tunnel overwintered onions
T	Scallion	7/21, 8/1, 8/8	For fall harvest
D	Spinach[3]	8/16-9/3 and 9/15 -9/213	Sow in August for harvest outdoors until thanksgiving. Sow in September for over wintering in high tunnels
D	Turnip	8/22-9/9 and 9/20 – 10/13	Sow late August and cover with low tunnels for winter harvest. Sow in September-October in greenhouses for harvest until Christmas.

1) T = transplant D = direct seeded.
2) Note: in New Hampshire trials, the highest low tunnel yields came from onions seeded mid-August and transplanted September 15-October1.
3) Note: in New Hampshire trials, transplanting spinach was recommended for August-September high tunnel plantings to overcome VERY poor germination in high heat. Also, planting until late October did not compromise spring yields.

Becky Sideman and her team at the University of New Hampshire have conducted research over the past several years on high tunnel spinach and low and high tunnel onion production. To read the full reports see:

Winter Spinach Production in Unheated High Tunnels

Overwintering Onions for Spring Harvest

--Compiled by K. Campbell-Nelson and Lisa McKeag, from information provided by Danya Teitlebaum, Queens Greens, Hadley MA, Eliot Coleman Four Season Farm, Harborside ME, Becky Sideman and Kaitlyn Orde, University of New Hampshire Extension and Robert Hadad, Cornell Cooperative Extension.

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The application deadline is November 28, 2017. NE SARE provides an excellent guidance video at: http://www.nesare.org/Dig-Deeper/Grant-Workshop-PowerPoints-and-Webinars/Farmer-Grant-narrated-PowerPoint

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