UMass Extension
Vegetable Notes
For Vegetable Farmers in Massachusetts since 1975

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In this issue:

Sam Glaze-Corcoran (UMass), Caro Roszell and Julie Fine (American Farmland Trust) organized a great workshop on assessing soil characteristics in the field. They talked about how soil characteristics contribute to crop and weed growth. This old dog learned some new tricks! The group will lead another workshop on August 30th focused on earthworms.

Crop conditions

The big news this week isn't new at all. Drought conditions persist across the state and the Energy and Environmental Affairs Secretary increased the drought level in the Northeast and Central Regions to Level-3 Critical status, while the rest of Massachusetts is in Level-1 or Level-2 drought. Some places did get up to a half-inch of rain in the last week while others got passed right by. One farmer we spoke to noted that the plants in his no-till fields seemed less wilted than those in his tilled fields and were less weedy to boot.

This week's break in the extreme heat has been welcome and makes it a little easier to do all of the running around required with so much irrigating to do and so many crops to harvest. And there are crops to harvest! There's a lot of food out there and it's looking good. So much summer squash and zucchini, brassica greens and cabbage, melons and all the summer fruits—peaches, nectarines, plums and berries. Folks are thinking about harvesting onions and we're seeing potato vines dying back in the earliest plantings. Field tomatoes are coming in and should be in full force in time for the 36th annual Massachusetts Tomato Contest in Boston on August 23rd—see the News section for more information on how to register the prize-worthy fruits of your labor!

If you can spare the time, we've got a couple of in-person programs next week. First, our UMass Research Farm Field Day on Tuesday, August 2nd. We'll be showcasing our current work, including disease-resistance trials on basil and cucumbers, bio- and OMRI-listed fungicides for vegetable crops, and a novel spray additive developed by MIT. The next day, we'll be at the CISA meeting at Warner Farm in Sunderland talking about irrigation. See the Events section for registration info for both programs!

Pest alerts

Alliums

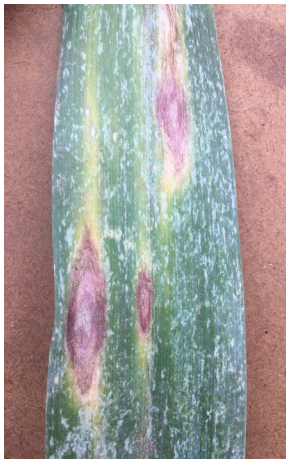
Purple Blotch, a fungal disease caused by *Alternaria porri,* was found in onions in Massachusetts. It is an important disease affecting onions, garlic and leeks in humid climates. Symptoms include purple to brown lesions, often with yellow rings that create a distinctive bull's-eye pattern. Leaves eventually turn yellow/brown and wilt. Yields may be reduced due to undersized bulbs and diseased bulbs may rot in storage. Increasing air circulation (by weeding or harvesting) reduces moisture, which can help to minimize disease spread. To reduce damage, harvest in dry weather and avoid injury to the necks. Allow onions to cure properly before leaf removal. Store at 34-38°F and humidity 65-70% in a well-aerated cooler. Control onion thrips if they are present, as plants weakened by thrips infestation are more

Contact Us:

Contact the UMass Extension Vegetable Program with your farm-related questions, any time of the year. We always do our best to respond to all inquiries. **Office phone:** (413) 577-3976 *We are currently working remotely but checking these messages daily, so please leave us a message!* **Email:** umassveg@umass.edu

Home Gardeners: Please contact the UMass GreenInfo Help Line with home gardening and homesteading questions, at greeninfo@umext.umass.edu.

susceptible to disease. For spray recommendations, see the allium disease section of the New England Vegetable Management Guide.



Purple blotch lesions on leek.
Photo: G. Higgins

Brassicas

Brassica downy mildew was found on transplants in Franklin County. Brassica DM is an oomycete (fungal-like) pathogen that causes yellowing on the top of leaves and forms white, crusty sporulation on the undersides of leaves. Irregular, black, lave-like lines sometimes form within sporulating areas. Potential sources of the pathogen include contaminated seed, overwintered infected plants, oospores in crop debris, and wind-borne asexual spores. For a list of recommended fungicides, see the brassica disease section of the New England Vegetable Management Guide.

We're starting to see **tip burn** on brassicas, including cauliflower and cabbage. Tip burn is a physiological condition caused by inadequate transport of calcium to rapidly growing tissues. Uneven water can interfere with plants' ability to take up and distribute calcium from the soil. Read more about tip burn and other heat-related brassica disorders in the July 14, 2022 issue of Veg Notes.

Chenopods

Cercospora leaf spot was found on beets and chard in Hampshire County. Cercospora is a fungus that causes small circular leaf spots on spinach, beets and swiss chard. Leaf spots are often surrounded by a red halo, although this is not present in yellow or white varieties. When infections are severe, crops can become completely defoliated. To reduce spread, incorporate crop residues promptly and thoroughly after harvest. Resistance to FRAC group 11 fungicides has been reported, so use other materials in fields where group 11 products have been used repeatedly in the past. Other conventional options include Tilt (group 3), Fontelis (7), and Merivon (7+11). Use the highest labeled rate of any product for best control. Tank-mixed Double Nickel and copper provided the best control among OMRI-listed products in Cornell Cooperative Extension research trials.

Brassica downy mildew on broccoli seedlings.
Photo: L. McKeag

Cucurbits

Alternaria leaf spot (*Alternaria cucumerina*) was found on cucurbits across the region this week. *Alternaria* is most common on melons and watermelons, although it can affect most cucurbit crops. The disease can survive for up to two years on diseased plant material in fields and can also be spread by wind or water. Disease severity increases with periods of leaf wetness. Infected leaves have small yellow-brown lesions with a green to yellow halo, that expand into large, brown necrotic areas. Lesions show the concentric rings that are characteristic of *Alternaria* infections. Lesions can coalesce and the leaves develop a cupped appearance and die. Defoliation exposes the fruit to sunscald which reduces fruit quality. Avoid overhead irrigation, if possible. For current information on chemical controls, see the melon disease section in the New England Vegetable

Alternaria leaf spot of cucurbits.
Photo M. McGrath, Cornell

Management Guide.

Plectosporium blight was found on zucchini in Hampshire County. Plectosporium is a fungal disease that causes elongated, white lesions on cucurbit petioles and later, on fruit. The pathogen overwinters on crop residue and spores produced on infected crops are spread to new fields by wind. Fungicides can control this disease if applied when symptoms are first observed; thorough coverage is essential. The strobilurin (QoI) fungicides Flint (trifloxystrobin), Cabrio (pyraclostrobin), and Quadris (azoxystrobin) will control this disease but should not be rotated with each other or the pathogen will develop resistance. Apply a protectant fungicide such as chlorothalonil (Bravo) or mancozeb (Dithane) following a strobilurin.

Plectosporium on zucchini. Photo: G. Higgins

Zucchini Yellow Mosaic Virus (ZYMV) was found on zucchini in Massachusetts. ZYMV is an important virus of cucurbit crops and can cause severe losses. It is seed-borne and vectored by aphids or farm equipment. Infected leaves distort and develop dark green blisters. Plants can be stunted and develop shortened internodes. Fruit can be greatly distorted, with blister-like bumps on the skin. There are no cures or treatments for plant viruses. To control, plant resistant cultivars and destroy affected plants.

ZYMV symptoms on zucchini leaf (left) and fruit (right). Photos: R. Wick

Squash bug nymphs are hatching, and adults continue to lay eggs. For more information on squash bug biology and control, check out the squash bug article in the June 23, 2022 issue of Veg Notes.

Solanaceous

Two-Spotted Spider Mites were found this week on eggplant and tomato. For more information, see the article in this week's issue.

Table 1. Squash vine borer trap captures for week ending July 28	
Whately	0
Leominster	0
Sharon	7
Southampton	10

Early Blight is showing up on tomatoes and potatoes across the region. On potato, it is causing typical symptoms like leaf spots and tip dieback, but on tomato we are seeing more stem cankering than we usually do, without the typical leaf spots we expect to see. We are also seeing **Septoria leaf spot** on tomato foliage though symptoms are not severe, likely due to dry conditions. Even though plants are looking quite good for this time of year, preventive sprays can help stay ahead of disease outbreaks before they get out of control. If rain is forecast or overnight dews are lingering long into the morning, consider starting (or upping) your tomato spray program now.

Potato Virus Y (PVY) was found this week in tobacco. It can spread to potato, where symptoms on foliage can be subtle yet it can cause symptoms on tubers. PVY is an aphid-transmitted virus that affects many crops in the solanaceous family including potato, tobacco, tomato, and pepper, as well as many solanaceous weeds. PVY can cause 50-80% yield losses in heavily infected potato fields, and also causes reduced storage quality and post-harvest tuber death. To manage, reduce areas of bare soil around or within the crop (it interferes with aphids'

Left: Tobacco with necrotic symptoms of PVY. Photo: NCSU.
Right: Yukon Gold tubers with PVY showing necrotic ringspot symptoms. Photo: potatovirus.com

ability to detect the crop), plant an aphid barrier crop around the main crop, control solanaceous weeds and aphids, and rogue out infected plants. In the past, there have been issues with contaminated seed in this region, though seed stock has seemed cleaner in recent years. However, we still see outbreaks from time to time. Check out our PVY fact sheet for more detailed information.

We continue to see **leafhoppers** in potato, though they are probably not causing a ton of economic damage at this stage. Often farmers notice a wave of leafhoppers on potato when other hosts like hay, beans, alfalfa, or strawberries are mowed down. Check out our leafhopper article in the June 16, 2022 issue of Veg Notes for more info.

Blossom end rot is now relatively widespread on tomato and peppers. It is a physiological disorder caused by calcium deficiency in developing fruit, often due to drought conditions or irregular water during fruit development. Read more about blossom end rot and other calcium disorders in the June 16, 2022 issue of Veg Notes.

Sweet Corn

The second **European Corn Borer** flight continues, and trap numbers rose across the state this week. When moths are active during silking, eggs are laid on leaves near the ear and larvae move directly into the ear by tunneling through the husk or down the silk channel. We are starting to see high numbers of **Corn Earworm** in some trapping locations around the state, as moths were likely blown up from southern areas with Monday's cold front and associated storms. Some of our traps were checked before Monday so numbers in those locations are likely higher now than what is reflected in the table, and we recommend growers follow a 4-5 day spray interval across the state, given that ECB numbers are also increasing. **Fall Armyworm** numbers remain low. They are starting to show up in New York State, but we're not seeing many at our trapping locations in Massachusetts yet.

Table 2. Sweetcorn pest trap captures for week ending July 28

Location	GDD[1] (base 50°F)	ECB NY	ECB IA	FAW	CEW	CEW Spray Interval
Western MA						
Deerfield	1540	1	0	0	8.5	*4 days*
Feeding Hills	1597	4	0	0	10	*4 days*
Granby	1554	6	0	0	2	*6 days*
Hatfield	1507	2	2	0	2	*6 days*
Whately	1587	14	3	0	1	*no spray*
Central MA						
Leominster	1518	1	0	0	15	*4 days*
North Grafton	1387	1	0	0	0	*no spray*
Sutton		0	0	0	0	*no spray*
Spencer	1462	0	0	0	1	*no spray*
Eastern MA						
Bolton	1522	4	1	0	0	*no spray*
Concord	1532	8	0	0	3	*6 days*
Haverhill*	1595	0	0	0	0	*no spray*
Ipswich*	1403	4	0	0	6	*5 days*
Littleton	-	10	0	0	11	*4 days*
Millis	-	1	1	-	6	*5 days*
Sharon	1554	1	0	0	31	*4 days*
Sherborn	1573	4	1	0	1	*no spray*
Seekonk	1725	0	0	10	3	*6 days*
Swansea		0	0	-	1	*no spray*

- no numbers reported for this trap
N/A this site does not trap for this pest

[1]GDDs are reported from the nearest weather station to the trapping site
*Trap counts are from the previous week

Various

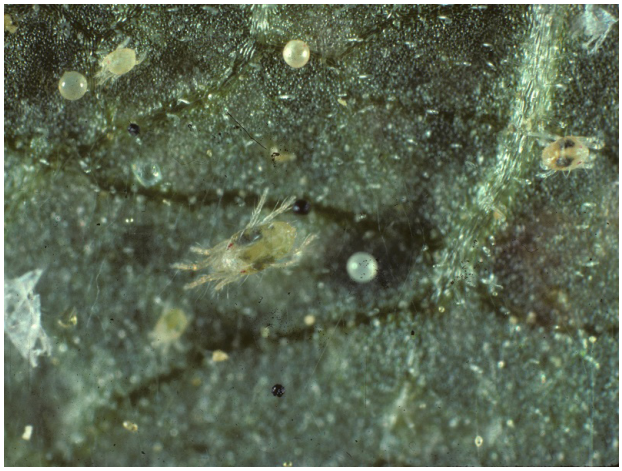
Tarnished Plant Bugs seem to be going gangbusters this month. They usually feed in flower buds (e.g. strawberries and broccoli crowns) but can also damage leafy crops where they feed at leaf tips and petioles causing deformation of leaves and plants. They are often controlled by natural enemies like ladybeetles, spined soldier bugs and insidious flower bugs. If damage is unacceptably high, control with insecticides. Find spray recommendations in the lettuce pest section of the New England Vegetable Management Guide.

Mites in solanaceous crops

Reports of two-spotted spider mite infestations in solanaceous crops across the region have been coming in for a few weeks now, and existing infestations have blown up in the hot, dry weather. Both broad mites and two-spotted spider mites (TSSM) affect solanaceous crops—broad mites are the most heavy hitting on pepper, and TSSM are particularly devastating on eggplant and tomato, though they can both affect a variety of crops, including tomato, eggplant, potato, beans, and vine crops such as melons and cucumbers.

Two-Spotted Spider Mites

TSSM are favored by hot, dry, and dusty conditions, which also aggravate mite injury by stressing the plant. Damage is often underestimated since both the mites and the wounds they cause are difficult to see without inspecting plants closely, or until the problem becomes widespread.



Two-spotted Spider Mite eggs, adults, and nymphs on tomato. Photo: D. Ferro

Description. Adult females are tiny—about a ½ mm long—slightly orange to pale green in color, with two dark spots on their body. They are visible with the naked eye if you know what you're looking for and where to look, but a 10x hand lens is helpful to see them. Initially, mites will feed on the undersides of leaves but in heavy infestations, they will move to the tops of leaves and onto fruit. Large populations will produce visible webbing that can completely cover the leaves. Mites hide under the webbing, making them difficult to reach with sprays.

Life cycle. All mobile life stages—adults, larvae, and nymphs—can feed on plant tissue. Eggs are laid singly, up to 100 per female, during her 3- to 4-week life span. Eggs hatch into larvae in as few as 3 days. Following a brief larval stage, several nymphal stages occur before adults appear. The egg-to-adult cycle can be completed in just 7 to 14 days, depending on temperature, leading to explosions in mite population and damage. All life stages can survive the winter in high tunnels in New England, and adult females will overwinter outside as well.

Two-spotted Spider Mite damage on eggplant. Photo: J. Boucher

Damage. Adult TSSM feed by sucking chlorophyll out of the leaves, creating blotchy pale to reddish-brown spots. Feeding injury often gives the top leaf surfaces a mottled or speckled, dull appearance. Leaves eventually turn yellow and drop. Other symptoms include distorted leaves, overall loss of plant vigor, whitening or spotting of leaves, or abnormalities on stems and fruits. On tomato, mites can damage fruit, causing small whitish spots that render fruit unmarketable.

Broad Mite

Broad mites also have a very wide host range, including many weeds and ornamentals, but cause the most damage within the solanaceous family and are especially damaging on pepper. The source of broad mite infestations in vegetable crops is often ornamentals from greenhouses, or high tunnels where vegetable transplants were grown. Adult broad mites are even tinier than TSSM—only 0.02 mm. They're notoriously tricky to find, even on severely symptomatic plants. Similarly to TSSM, broad mites reproduce very quickly; their life cycle takes only 7 to 8 days at 85°F.

Broad mites differ significantly from TSSM in their feeding habits and damage. Broad mites feed in the growing tip, and inject a toxin as they feed that causes the growing tip to become distorted or die. Plants become severely stunted and twisted and fruit develops an unmarketable gray scar tissue. While plants infested with TSSM can recover from feeding

damage after the pest has been controlled with pesticides, plants will not grow out of broad mite damage. Early in an infestation, if only a few plants are heavily infested, pull and bag those plants and treat the remaining plants.

Cultural control. Outbreaks may be worsened by excess nitrogen fertilization, or by the use of broad-spectrum insecticides that kill naturally occurring mite predators. Overhead irrigation or prolonged periods of rain can help reduce populations. Keep weeds under control. Control broad mites in ornamentals if you grow ornamentals and vegetable transplants in the same structure.

Biological control. Preventative releases of the predatory mite, *Phytoseiulus persimilis*, may suppress TSSM populations in vegetable fields, as they do in strawberry fields. *Amblyseius fallicis* is a predatory mite that is widely used in greenhouses. See the New England Vegetable Guide for Table 18: Scouting and Biological Control Guidelines for Vegetable Transplants.

Chemical control. Early or preventative control is essential for controlling both broad mites and TSSM, as populations can explode quickly. Use selective products whenever possible. Selective products which have worked well in the field include:

- **Agri-Mek** (Group 6, 7d PHI): abamectin, derived from a soil bacterium. TSSM & BM. Must be mixed with non-ionic activator type wetting, spreading,and/or penetrating adjuvant. Labeled for solanaceous and cucurbit crops.
- **Acramite** (Group 25, 3d PHI): bifenazate, a contact nerve poison with a long residual. TSSM only. Labeled for solanaceous and cucurbit crops.
- **Movento** (Group 23, 1d PHI): spirotetramat. Active primarily by ingestion. Systemic. Labeled for control of BM and suppression of TSSM in solanaceous crops. Mainly affects immature stages.
- **Oberon 2SC** (Group 23, 1d PHI for solanaceous, 7d PHI for cucurbits): spiromesifen. Active on contact and by ingestion. Translaminar. TSSM & BM. Mainly affects immature stages. Labeled for solanaceous and cucurbit crops.

Broad mite damage on pepper plant (above) and fruit (below). Photos: S. Ghimire, UConn Extension

Two other selective products are:

- **Kanemite** (Group 20B, 1d PHI): acequincyl. TSSM only. Knockdown and residual control. Labeled for solanaceous and cucurbit crops.
- **Portal XLO** (Group 21A, 1d PHI): fenpyromixate. TSSM & BM. Stops feeding immediately after application. Mites die in 3 to 7 days. Labeled for solanaceous and cucurbit crops.

OMRI-listed products include insecticidal soap (M-Pede) and horticultural oils (e.g. Trilogy, Suffoil X, and Golden Pest Spray Oil). These can be effective, especially if utilized early and regularly and with good leaf coverage. The bioinsecticides Met52, Grandevo, and Venerate (all 0 PHI) are also labeled.

See the New England Vegetable Management Guide for more details on pesticides.

With most miticides (but not bifenazate, which has a long residual), use 2 applications approximately 5 to 7 days apart to help control immature mites that were in the egg stage and protected during the first application. Because mites reproduce so quickly, populations can easily develop resistance to products; alternate between products after 2 applications to help prevent or delay resistance. Check product labels for specific use restrictions.

Sources:

- Watch for Spider Mites in Eggplant, Tomato, and Vine Crops, Ruth Hazzard, UMass Extension

- Two Spotted Spider Mites on High Tunnel Vegetables, Gale Hermenau, Delaware Weekly Crop Update, June 21, 2019
- Significant Crop Losses on Pepper Due to Broad Mites, Judson Reid, Cornell VegEdge, August 7, 2019
- Broad Mites in Fruiting Vegetables, Steve Bogash, Penn State Extension

--Written by Genevieve Higgins, UMass Extension

USING COPPER FUNGICIDES

Copper products play an important role in disease management in both conventional and organic systems. They are the most effective controls for most bacterial diseases. In organic production, copper products are the main protectant fungicide used in the control of diseases caused by destructive oomycete pathogens, such as those that cause late blight and downy mildews, as well as fungal and bacterial diseases. As more copper products become available, it is helpful to understand the differences and benefits of different active ingredients and formulations. Solubility, phytoxicity, human health risks, impact on soil ecology, labeled crops and diseases, and efficacy are important considerations in using particular copper products.

How copper works. When copper (Cu) is mixed with water, copper ions (Cu^{2+}) are released into solution. Modern copper products typically use insoluble or "fixed" forms of copper, creating a suspension of copper molecules in the spray solution. These un-dissolved copper particles persist on plant surfaces after the spray dries and copper ions are released from these deposits each time the plant surface becomes wet. The gradual release of copper ions from the copper deposits provides residual protection against plant pathogens present on the leaf surface. Copper ions kill pathogens primarily by destroying cell membranes and proteins and by disrupting protein synthesis. Since the mode of action of copper targets such fundamental components of living tissues, it affects a wide range of plant pathogens including bacteria, fungi, and oomycetes, but can also damage plant cells and be toxic to humans and other non-target organisms. Achieving the best control without injuring plant foliage and fruit depends on the concentration and rate of release of copper ions on the leaf surface, which is determined largely by the solubility of the copper formulation.

Solubility.

Less soluble (fixed) formulations release copper ions more slowly. This slow-release lowers the risk of phytotoxicity and provides longer residual activity. The following are **low-solubility active ingredients**: copper oxide (e.g., Nordox), copper hydroxide (e.g., Kocide, Champ), copper oxychloride (e.g., COCS and BadgeX2), and copper octanoate, which is copper ions linked to fatty acids to form a soap, (e.g., TennCop, Cueva).

More soluble formulations act rapidly but have higher risk of phytotoxicity and shorter residual activity. Basic copper sulfate and copper sulfate pentahydrate are highly soluble.

Metallic Copper Equivalent (MCE). Product labels list percent active ingredient (eg., 23.8% copper oxychloride or 98% basic copper sulfate), but this doesn't tell you the actual metallic copper by weight, as the formulation also impacts the total copper present. Look for the "metallic copper equivalent" listed below the active ingredients to determine the amount of actual copper by weight. A product with 40% metallic copper has 0.4 lbs metallic copper per lb of product. The range in MCE among products is vast, ranging from under 1.8% to over 50% copper by weight, so it is important to consider the MCE because the effectiveness of a copper spray is highly correlated to the amount of copper applied.

Phytotoxicity. Several crops are sensitive to copper, notably brassicas, lettuce and strawberry. Injury occurs when ionic copper moves into plant tissue and reaches a level the plant species cannot tolerate. Amount of copper uptake into the leaf tissue depends partly on availability of copper on treated leaf tissue. Several factors affect this including pH, Spray Additives, and Weather. We see damage most often when a spreader sticker is used, since this can be a matter of habit when spraying waxy brassicas, but should not be done when spraying copper on brassicas.

- Under acidic conditions, copper solubility and the potential for phytotoxicity increases. Spray solutions should be kept above pH 6-7, depending on the formulation, to prevent excessive amounts of copper ions from being released and possibly damaging fruit and foliage.
- Adding maneb or mancozeb to copper products as a tank mix increases the release of copper ions in solution, which increases the risk of phytotoxicity. There are pre-mixed products available (e.g., ManKocide), or growers can make

their own mixtures. This may be especially helpful for controlling bacterial diseases such as bacterial speck, spot and canker of tomato.

- Using an approved adjuvant or 'sticker' may help the product to be more rainfast. However, when stickers are used with highly soluble copper sulfate formulations, they can cause phytotoxicity, especially on sensitive crops.
- Finely ground compounds will be more active than coarser ground materials because the smaller particles result in better coverage of the leaf and are less likely to be removed from the leaf by wind and rain.
- Copper can accumulate on plant tissue when sprayed repeatedly to cover new growth and there is no rain. In this situation, after a rain event, a large amount of copper ions will be released and may cause phytotoxicity.
- The risk of plant injury increases when the spray solution dries slowly due to cool wet weather, as the duration of active release of copper ions on the leaf is increased.
- For each product, application rates vary with crop and disease. The recommended rate for a given crop may have a 2-fold difference between the high and low rates. Higher rates are recommended when disease pressure is high or conditions are especially favorable but may increase phytotoxicity. Most products are labeled for a wide range of vegetable crops.
- Always read the label instructions. When mixing, follow the tank mix partner instructions.

-- UMass Vegetable Program

MANAGING HEAT STRESS IN VEGETABLE CROPS

This article was compiled by the UMass Extension Vegetable Program from several blog posts written by Gordon Johnson, University of Delaware Extension Vegetable & Fruit Specialist; gcjohn@udel.edu or Gordon Johnson & Emmalea Ernest, University of Delaware Associate Scientist – Vegetable Crops; emmalea@udel.edu. Links to the original posts are at the end of the article.

Recent record-high temperatures in Massachusetts have dampened the productivity of people and plants alike. The week-long heat wave saw temperatures in the 90s and even topping 100 in Boston. This is in keeping with a trend toward more frequent and intense heat waves in the Northeast under our current high-emissions conditions. Providing adequate moisture through irrigation is critical in high heat periods. However, maintaining soil moisture cannot completely compensate for extreme heat.

Heat injury in plants includes scalding and scorching of leaves and stems, sunburn on fruits and stems, leaf drop, rapid leaf death, and reduction in growth. Wilting is the major sign of water loss which can lead to heat damage. Plants often will drop leaves or in severe cases will "dry in place" where death is so rapid, abscission layers have not had time to form. Normally, plant temperature is just above air temperature, but, plant temperature can rise to a critical level under certain conditions. The plant temperature at which tissue dies is around 115°F.

Photosynthesis rapidly decreases at temperatures above 94°F, so high temperatures will limit yields in many vegetables and fruits. Plant stomates will close earlier in the day, thus limiting gas exchange and thereby photosynthesis. Respiration increases with temperature. While daytime temperatures can cause major heat-related problems in plants, high night temperatures can also have great effects on vegetables, especially fruiting vegetables. Hot night temperatures (nights above 75 °F) will lead to greater cell respiration. This limits the amount of sugars and other storage products that can go into fruits and developing seeds. Because of this increased respiration the plant expends stored photosynthates and they do not contribute to yield.

High air temperatures may result in high leaf temperatures, especially where water is deficient. High leaf temperatures result in heat damage to the proteins which allow the plant to photosynthesize and carry out metabolic processes. Very high leaf temperatures result in visible, physical damage to leaves in the form of sunburn and scorching. Sunscald of fruits will increase, especially where leaves wilt and reduce fruit cover.

In flowering and fruiting crops, high heat will affect pollen production [and pollinator activity], often reducing viable pollen numbers. Reproductive parts in plants (anthers, stigmas) may not form properly or function properly. If pollen is transferred to stigmas, pollen germination may be reduced or halted due to heat and desiccation. Reduced pollination can

result in smaller fruit or misshapen fruit.

If pollination is successful, early fruit abortion may occur due to lack of photosynthates or heat damage. In heat-stressed plants, the hormone balance is affected and there is an increase in abscisic acid that is involved in these abortions.

Heat necrosis on pepper stem from excessive temperatures from black plastic mulch. Photo: G. Johnson

High soil temperatures can damage surface roots, limiting water and nutrient uptake, especially potassium. This is particularly an issue in crops grown on black plastic mulch, a common cultural practice. On black plastic mulch, surface temperatures can exceed 150°F. This heat can be radiated and reflected onto vegetables causing tremendous heat loading. This is particularly a problem in young plants that provide limited shading of the plastic. Vegetable transplants are exposed to these high soil temperatures at the soil line around the transplant hole. The stem tissue just at or above the level of the plastic may be killed at these high temperatures and the transplants will then collapse and die. Small transplants do not have the ability to dissipate heat around the stem as roots are not yet grown out into the soil and water uptake is limited. High bed temperatures under plastic mulch can also lead to reduced root function limiting nutrient uptake. This can lead to increased fruit disorders such as white tissue, yellow shoulders, and blotchy ripening in tomato fruits where not enough potassium reaches the fruit, or to blossom end rot in tomatoes or peppers due to a lack of calcium uptake.

Sunscald in chard. Photo: G. Higgins

Strategies for managing heat stress

Transplants. Control stem heat necrosis by hardening off transplants and using larger transplants with thicker stem diameters and more leaves. Make a larger hole when transplanting and water sufficiently in the hole to reduce heat load. Plant in the evening or early in the morning and avoid planting on very hot days or when long stretches of hot weather are forecast. Switch to white plastic mulch for later spring plantings; this can reduce losses significantly (white plastic will be 10-20 °F cooler than black plastic mulch). White particle films (clay- or lime-based) sprayed at the base of plants over the mulch can also reduce plant losses to heat necrosis. Putting a small mound of clean sand around the plant stem will also eliminate this problem.

Irrigation

Overhead irrigation over black plastic mulch can help to reduce heat loads until plants have sufficient canopies to shade over the mulch.

Fixing drip irrigation leaks and clogs. Issues with drip can include plugged emitters; leaks due to insect or animal chewing; leaky connections reducing flow; tape twisting and binding; improper tape selection or improper irrigation timing; limited well capacity; emitter spacing that is too wide for the crop or soil; and beds that are too wide for a single tape (with double rows). Any of these could lead to inadequate water being applied to the crop.

Increasingly deformed cucumbers, caused by high heat. Photo: G. Johnson

Whether using overhead or drip irrigation to water your

crops, monitor fields closely and consider using soil moisture monitoring devices to better understand crop needs and to aid in detecting problems.

Mulching. Increase reflection and dissipation of radiative heat by using reflective mulches or low-density, organic mulches such as straw to reduce surface radiation and conserve moisture.

Shading. Commonly, shade cloth or netting is used for this purpose. This netting comes in black, green, white, and reflective aluminum colors and is commonly used at the 20-30% shade levels. Shading is applied during the hottest periods or periods when the plant is most sensitive to heat (such as tomato fruit development). Research at the University of Maryland by Jerry Brust showed that shading tomatoes during fruiting can improve fruit quality and reduce culls. Research at the University of Georgia on peppers showed similar results with improvement in the number of marketable fruits. Kansas research showed that lettuce production was improved where white shade cloth was used.

University of Delaware research with shading of strawberries for summer production showed mixed effects with shading benefiting in some years but not in others. In 2018 and 2019 University of Delaware vegetable researchers studied the effect of shade cloth on tomato and pepper marketable yield. Treatments were no shade, 30% black, 30% Aluminet, 30% red, 22% white, 40% white. In 2018, shade treatment did not have a significant effect on pepper quality or marketable yield. In contrast, in 2019, shade treatments, especially 30% black shaded plots, produced more marketable peppers than the unshaded plots. Yield of marketable first harvest (early Aug) for 30% black was 18x higher than unshaded. Yield of marketable second harvest (Sep) was 2x unshaded. Shade did not reduce internal white tissue in tomatoes to the point of achieving marketability in the 2018 or 2019 trial. Lettuce trials were conducted with no shade, 30% black, 30% Aluminet, 30% red, 30% blue, 22% white, and 40% white. Shade cloth reduced soil temperatures by 3°C/37.4°F. Shaded lettuce treatments had reduced bitterness in both the 2018 and 2019 trials. For lettuce, the combination of a heat tolerant variety with shade had the greatest effect on reducing bitterness.

To summarize, there is good evidence that 30% black shade cloth applied during the hottest time period (early June through early August) improves bell pepper yield and quality. There is also good evidence that shade cloth reduces bitterness in lettuce, especially when used with a heat tolerant variety. There is some evidence that 30% black shade cloth increases tomato quality.

Original Blog Posts

- G. Johnson, *Expect Heat Damage to Vegetable and Fruit Crops*, July 22, 2022. https://sites.udel.edu/weeklycropupdate/?p=20781
- G. Johnson & E. Ernest, *Heat Stress and Shading for Heat Stress Mitigation in Vegetables and Small Fruits*, June 19, 2020. https://sites.udel.edu/weeklycropupdate/?p=15224
- G. Johnson, *Stem Heat Necrosis*, June 12, 2020. https://sites.udel.edu/weeklycropupdate/?p=15151
- G. Johnson, *Heat Necrosis in Transplants*, June 15, 2018. https://sites.udel.edu/weeklycropupdate/?p=12037
- G. Johnson, *Stress in Vegetables*, July 15, 2011. https://sites.udel.edu/weeklycropupdate/?p=3359

News

New Jumping Worm Resources from UMass Extension

Are you looking for answers to questions about invasive jumping worms (Amynthas and Metaphire spp.)? UMass Extension has a new resource that includes over 70 questions from the audience of our 2022 Jumping Worm Conference. Questions and answers are arranged by topic, including but not limited to: identification, biology, impacts of jumping worms on soil, bioaccumulation of heavy metals, mulch, soil, compost, and plant sales, management research, and more!

Invasive Jumping Worm Frequently Asked Questions

Massachusetts Tomato Contest to be held on August 23rd

The 37th Massachusetts Tomato Contest will be held at the Boston Public Market on Tuesday, August 23rd. Tomatoes will be judged by a panel of experts on flavor, firmness/slicing quality, exterior color and shape. Always a lively and fun event, the day is designed to increase awareness of locally grown produce.

Open to commercial farmers in Massachusetts, growers can bring tomatoes to the market between 8:45 am and 10:45 am on August 23rd or drop their entries off with a registration form to one of the regional drop off locations on Monday, August 22nd. Drop off locations include sites in Great Barrington, South Deerfield, Worcester, Dighton and West Newbury. These tomatoes will be brought to Boston on Tuesday.

For complete details, including drop off locations, contest criteria, and a registration form, click here. Be sure to include the registration form with all entries.

The 36th Tomato Contest is sponsored by the Massachusetts Department of Agricultural Resources, New England Vegetable and Berry Growers Association and Mass Farmers Markets in cooperation with the Boston Public Market.

Questions, contact David Webber, David.Webber@mass.gov.

Events

UMass Research Farm Field Day

When: Tuesday, August 2, 2022, 4-6:30pm

Where: UMass Crop & Livestock Research & Education Farm, 89 River Rd., South Deerfield, MA

Registration: This event is free and open to all. Please pre-register so that we can get a head count for food! Click here to register for this event.

Join UMass Extension for a field day at the South Deerfield Research Farm and hear about the research being conducted at the farm this summer. The farm tour and presentations will be followed by a light dinner and plenty of time for talking with fellow growers and agricultural service providers. There will be 1.5 pesticide credits available at this event. To receive credits, you must sign in at the beginning of the event and stay for the full duration.

Presentations will include:

- Basil downy mildew resistance
- Bio-and OMRI-listed fungicides to control diseases of vegetable crops
- Downy mildew-resistant cucumber varieties
- Developing a new spray additive to improve spray coverage and reduce pesticide use
- The UMass Student Farm
- Dual-use solar for vegetable farms
- Innovative summer forages in the Northeast: upright crabgrass, sudangrass, and pearl millet
- Stem cells in agriculture
- Food as medicine? Bumble bee foraging behavior in response to disease, and consequences for 'medicinal' plants
- Corn and sorghum intercropping to reduces greenhouse gas emissions and fertilizer loss
- Evaluating bumble bee preferences for medicinal and non-medicinal varieties of basil

CISA on-farm Workshop: Irrigation Systems and Management at Warner Farm

When: Wednesday, August 3, 2022, 5:30-7:30pm

Where: Warner Farm, 23 South Main Street, Sunderland, MA

Registration: Workshop fee is $10, waiver available upon request. Register and pay HERE.

Warner Farm, a CSA and wholesale farm as well as the home of Mike's Corn Maze, located in Sunderland, MA, has been developing its irrigation capacity since the late 1970s. The farm's rich sandy loam has been growing fruit and vegetable crops for centuries and as a changing climate brings changing precipitation patterns to New England, Warner Farm is poised to respond effectively in times of drought.

Join CISA and Dave Wissemann of Warner Farm on August 3rd at 5:30pm for an up close look at how they are opti-

mizing their water resources and water distribution systems to ensure the sustainable production of crops throughout the season and in the face of increasingly uncertain growing conditions.

The workshop includes a farm walk to see irrigation equipment and set-up and a detailed explanation of how the farm's systems are designed and maintained. The UMass Vegetable team will be there to discuss water use and food safety. Following the farm walk, join us for further discussion and some locally produced drinks and snacks!

UConn Greenhouse Biological Control Conference

When: Tuesday, August 16, 2022

Where: Jones Auditorium, Connecticut Agricultural Experiment Station, New Haven, CT

Registration: $30. Pre-registration required. Registration includes a bagged lunch. Click here to register.

UConn Extension is sponsoring a Greenhouse Biological Control Conference. The speakers featured at this educational program include:

- *Ron Valentin*, Anatis BioProtection, who will be speaking on **Update on Banker Plants**
- *Suzanne Wainwright Evans*, Buglady Consulting, who will be speaking on **Releasing Natural Enemies, and Grower Case Studies: What's Working?**
- *Michael Brownbridge*, Bioworks, who will be speaking on **Enhancing the Use of Biological Fungicides in a Biologically Based IPM Program**
- *Elwood Roberts*, Plant Products/Biobest, who will be speaking on **Tips on How to Effectively Integrate Biological Controls and Chemical Controls**

Registration or refund questions? Contact Carla Caballero, carla.caballero@uconn.edu.

Program or payment questions? Contact Leanne Pundt, leanne.pundt@uconn.edu.

Disclaimer: Program format is subject to change based on the University of Connecticut and the State of Connecticut's COVID 19 guidelines and policies. If access to the venue or seating capacity changes, the program will be changed to a virtual format.

**This work is supported by the Crop Protection and Pest Management grant no. 2017-70006-27201 from the USDA National Institute of Food and Agriculture.*

Twilight Meeting at Harvest Farm

When: Wednesday, August 24, 2022, 4-6pm

Where: Harvest Farm, 125 Long Plain Rd., South Deerfield, MA 01373

Harvest Farm in Whately/South Deerfield will host us for a twilight meeting covering several post-harvest topics, including the vacuum cooler Harvest Farm recently purchased with a MA Food Security Infrastructure Grant. More information coming soon!

Soil Health in the Field: Earthworm Sampling and Earthworm Indicators

When: Tuesday, August 30, 2022, 9:30am-1pm

Where: UMass Crop & Animal Research & Education Center, 89 River Rd., South Deerfield, MA 01373

Registration: Free! Space is limited. Click here to register.

Earthworms are a favorite field-indicator of soil health. While you might think all earthworms are created equal, earthworms are categorized based on behavior and location in the soil. Learning to identify the earthworms that we sample can enhance our interpretation of this soil health indicator and give us a better understanding of soil processes. This workshop is lead by entomologist Dr. Olga Kostromytska with UMass Extension and earthworm expert Dr. Annise Dobson of Yale University. This workshop is appropriate for complete beginners and experienced samplers alike. We will take samples in row crop, hayfield, and forest soils and practice identification using a key, hand lens, and dissecting microscopes. Earthworm types collected from each of the three fields will be compared, and we will discuss how we can use these findings to interpret the soil health. This is a translatable skillset valu-

able for agricultural service providers, farmers, and scientists.

If you would like to stay for a BYOL picnic (bring your own lunch) please feel welcome to do so. Bring a lawn chair or picnic blanket to sit outside, enjoy the scenery, and chat with soil health minded friends and colleagues. *Coffee and donuts provided in the morning.*

Save the Date - Pollinator Habitat Workshop

When: Thursday, Sept. 22, late afternoon/early evening (exact time TBA)

Where: Just Roots Farm, 34 Glenbrook Dr, Greenfield, MA 01301

Come learn about the nuts and bolts of installing pollinator habitat on your farm, including where to find funding and who to contact for assistance. Includes a short presentation and a meet-and-greet with local service providers. Event is hosted in collaboration with CISA, NOFA, Greening Greenfield and Just Roots.

Thank you to our 2022 sponsors!

Vegetable Notes. Genevieve Higgins, Lisa McKeag, Susan Scheufele, Hannah Whitehead co-editors. All photos in this publication are credited to the UMass Extension Vegetable Program unless otherwise noted.