



UMass  
Extension

# Vegetable Notes

For Vegetable Farmers in Massachusetts since 1975



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## CROP CONDITIONS

Some much needed rain, and then some, came over the weekend, and gray weather and showers have continued throughout the week. In MA, most places got 1-3" of rain but our neighbors to the north got hammered with over 4". Across the region, fields are muddy at best and flooded at worst, with early crops under standing water. The forecast looks good for some drying weather and hopefully we won't see crops and planting dates getting pushed too far behind schedule. These big rain events are becoming more common, and people are already worrying about how wet or dry this season could be and how they will manage water resources on the farm. [The National Weather Service](#) predicts that with El Niño conditions, the next three months are likely to be warmer than normal but with normal precipitation e.g. not drought or flood conditions.

One noticeable effect of the warm spring has been an earlier than normal start to the asparagus season this year. Here is an update from our retired colleague and life-long asparagus grower, Tom Smiarowski of D.A. Smiarowski Farm in Sunderland, MA: General rule of thumb is the start of asparagus harvest is around May 1. We started picking on the farm in Sunderland on April 26 and heard reports of Hadley farmers picking as early as April 20. There was widespread frost on the morning of April 26 but fortunately little to no frost damage occurred. Damaging frost can set the crop back 3-5 days. The location of our fields next to the Connecticut River, which had a good layer of fog that morning, coupled with a slight wind prevented any frost damage to the asparagus fields. Recent cool temperatures have slowed the growth of the crop, but the accompanying rain has been very much welcomed since April was very dry. Demand for the crop is incredible and with the adequate soil moisture and warmer temperatures forecast for next week, the asparagus crop should really take off!



*Asparagus season is here! Photo: Tom Smiarowski*

## PEST ALERTS

### Alliums

[Allium leafminer](#) flies continue to lay eggs on susceptible green foliage of allium crops including chives, scallions, onions, and even garlic. If your crops are not covered **now is the time** to start protecting them with [insecticides](#) to prevent damage from tunneling larvae and later on, brown pupae in the bulbs.

### Brassicas

[Cabbage root maggot](#) emergence has started, with peak flight and therefore the start of egg-laying of the spring generation forecasted for this Friday in the Amherst area—see table 2 in the maggot article below. [Seedcorn maggot](#) continues to be reported in corn and peas. If your crops are not covered **now is the time** to start protecting them with

## 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 **Email:** [umassveg@umass.edu](mailto:umassveg@umass.edu)

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

insecticides to prevent poor stands of transplanted crops and damage to root crops. See the article in this issue for more information.

### Chenopods

[Spinach leafminers](#) are active much earlier than normal in a greenhouse in CT this year. This is a trend we are seeing across the region, with pests emerging earlier than expected in greenhouses and tunnels where GDD accumulate more quickly. We normally expect leafminer egg-laying to start around mid-May in most of MA, but this year we recommend scouting a week or two earlier for the characteristic bright white rice-shaped sets of eggs on the undersides of spinach and Swiss chard leaves. Again, covering susceptible crops during this period of egg-laying can be effective at keeping them out, as long as the flies would not be emerging from underneath the covers, i.e. as long as you rotated fall and spring crops.



*Cabbage root maggot eggs in the soil.*



*Allium leafminer oviposition scars.*  
*Photo: G. Higgins*

### Multiple Crops

**Aphids** in tunnels and greenhouses are widespread where structures were used over the winter or were not adequately disinfested in the fall. Acting preventively is critical to managing aphids successfully—anticipate, have a plan, and don't wait until the population is out of control to act.

[Springtails](#) have been reported chewing small holes in a variety of tender green growth like Swiss chard, spinach, and lettuces. These tiny hopping insects are decomposers and are ubiquitous in soils with high organic matter. They are active when soils are cool and moist and can reach alarming levels in high residue, no-till systems, but usually clear out as soil temps increase and do not cause economic damage.



*Springtails (Folsomia candida).*  
*Photo: UMN extension*

## BE ON THE LOOKOUT FOR SPRING MAGGOT PESTS

There are three maggot fly pests that are active on Massachusetts vegetable farms in early spring: seed corn maggot, cabbage maggot, and onion maggot. The emergence of adult flies from pupae that overwintered in the soil can be predicted

<sup>1</sup>Growing degrees days (GDD) are the number of degrees that the average daily temperature exceeds a base temperature at which a particular organism is dormant.  $GDD = ((T_{max} + T_{min})/2) - T_{base}$ . If the average temperature for a day is lower than the base temperature, then no GDD accumulate. GDD accumulate daily, starting on a specific date, by adding each day's total GDD to the previous tally.

using growing degree days (GDDs)<sup>1</sup> with a base temperature of 40°F. The base temperature for monitoring the emergence of maggot flies is lower than the base temperature for many other vegetable pests because they are active at fairly cool temperatures early in the spring. These three maggot fly pests emerge and reach peak flight at different times throughout the spring (Table 1) and infest different crops. Seed corn maggot reaches peak flight earliest in the spring and has a host range of over 30 crops (including alliums and brassicas). This maggot is a common reason for poor germination of peas or small plantings of sweet corn. Cabbage and onion maggots are host-specific, attacking brassicas and alliums, respectively.

<b>Table 1. Comparison of Maggot Fly Biology</b>			
	<b>Seed Corn Maggot</b>	<b>Cabbage Maggot</b>	<b>Onion Maggot</b>
<b>Host</b>	40 different plants, large germinating seeds, seedlings (including allium and brassica!)	Brassicas	Alliums
<b>First peak flight</b>	360 GDD base 40°F	452 GDD base 40°F	735 GDD base 40°F
<b>Adult</b>	Small: ~ 3mm, 3 stripes on the thorax	Medium: ~5mm, 2 stripes on the thorax.	Large: ~6mm.
<b>Eggs</b>	Hatch in 2-4 days	Hatch in 7-10 days	Hatch in 2-5 days
<b>Larvae (maggot)</b>	Active for 3 wks	Active for 2-4 wks	Active for 2-3 wks
<b>Pupae</b>	In soil for 1-2 wks before next gen adults emerge (last gen pupae overwinter)	In soil for 2-3 wks before next gen adults emerge (last gen pupae overwinter)	In soil for 3-4 wks before next gen adults emerge (last gen pupae overwinter)
<b>Notes</b>	Short, 21-day lifecycle. 3 gen per year. Usually only spring gen is damaging.	Long, 60-day lifecycle. 4 gen per year. Spring and Fall gen most damaging.	Medium, 30-day lifecycle. 3 gen per year. Usually only spring gen is damaging.

Seed corn, cabbage, and onion maggots share many characteristics. There are three to four generations of each of these pests per year. They prefer cooler temperatures, so the spring and fall generations are typically worse than the mid-summer generation(s). All three maggot flies emerge from pupae that overwintered in fields where a host crop was the previous fall. Adults emerge from the soil, mate, and then search for a host plant. Eggs are laid at the bases of host plants or on emerging seedlings. The resulting larvae will feed on host roots, causing the plants to collapse, or, in the case of seed corn maggot, kill seedlings before they emerge. All three flies are attracted to decomposing organic matter, and infestations can be worse in manured, cover-cropped, or composted fields where organic matter is still breaking down. Several consecutive days of soil temperatures above 95°F can kill the larvae. All three maggot fly adults are similar in appearance (small, gray, humpbacked, housefly-like) and size (5-7mm).

Preventive measures are generally most effective for managing these pests as chemical treatment options are limited. These may include using floating row covers or insect netting to protect plants from egg-laying adults, delaying planting susceptible crops until the first emergence has largely passed, or waiting to plant until soil temperatures are high enough to kill larvae. Most labeled pesticides for maggots are labeled only for use pre-plant, at the time of planting or seeding, or immediately after setting transplants. Use pre- or at-plant treatments where damaging populations are expected, such as in fields with high organic matter or a history of infestations. Scouting for adults and eggs can help you understand infestation levels and inform management decisions in future plantings.

Below is more information about each maggot pest, including additional scouting and management recommendations:

**Seed corn maggot** (*Delia platura*): Seed corn maggot adults have likely begun emerging in many fields in Massachusetts where they will lay eggs on the soil surface. Hatching larvae will burrow into the soil in search of food and penetrate seeds as the seed coat splits open, killing the seeds before germination and causing poor stand.

Where possible, delay planting for several weeks in the spring after a cover crop is incorporated to allow for organic mat-

ter to break down. Warmer soils with more decomposed organic matter will mean fewer problems with seed corn maggot. Floating row cover is not as effective in managing seed corn maggot because this pest has many hosts and could have overwintered in virtually any field on your farm. If you cover plants in an infested field, the adults will emerge under the row cover. Organic fertilizers containing seed meals can attract this pest. Other pests and diseases, including wireworms and damping off, can also prevent seedlings from emerging; check for maggots and feeding tunnels inside seeds or stems to confirm what pest you're dealing with. Plant shallowly to promote rapid seed emergence. Among bean varieties, those with a dark seed coat sustain less injury than white varieties. Preventative chemical treatments include commercially applied systemic seed treatments and in-furrow applications of insecticides. Rescue treatments are not effective. If there is enough damage to warrant replanting, wait at least 5

days if maggots are a quarter inch long; if they are smaller than that, wait at least 10 days to make sure they have pupated and will not damage the new seeds.

<b>Table 2. Growing degree day (GDD) accumulation for week ending May 3, 2023</b>	
<b>Location</b>	<b>GDD* (base 40°F)</b>
<b>Western MA</b>	
Deerfield	380
Westfield Arpt	420
Chicopee Falls	415
Amherst	399
South Deerfield	424
<b>Central MA</b>	
Leominster	413
Northbridge	423
Worcester	448
<b>Eastern MA</b>	
Bolton	432
Stow	411
Methuen	426
Ipswich	396
East Bridgewater	524
Waltham	440
Providence, RI	510



*Cabbage root maggot fly*



*Cabbage root maggot egg, pictured on the tip of a pencil.*

**Cabbage maggot** (*Delia radicum*): Cabbage maggot flies are either nearing or just past first emergence across the state depending on the accumulated GDDs in your area (see Table 2 on previous page). A good indicator of the first cabbage maggot peak flight is blooming of the common roadside weed [yellow rocket or wintercress \(\*Barbarea vulgaris\*\)](#). If using row cover, now is the time to make sure it's in place to protect vulnerable brassica crops from egg-laying adults. Row covers can be very effective in the spring against this pest as long as crops are rotated into fields without a history of recent infestation since, as with seed corn maggot, if there are pupae in the soil from the previous season the adults will emerge under the row covers.

Cabbage maggot larvae feed on brassica crop roots, causing stunting, wilting, and plant death. In brassica roots crops like radishes, turnips, and rutabaga, cabbage maggot tunneling renders the crops unmarketable. Inspecting the roots of symptomatic plants may reveal the legless, white maggots, brown oblong pupae, and/or tunnels from maggot feeding.

There can be up to 4 generations of cabbage maggot per year. There is a model for tracking the emergence of cabbage maggot on the Network for Environmental and Weather Applications (NEWA) website: [NEWA Cabbage Maggot Model](#). On the left-hand side of the page, choose a weather station that is close to you. When GDDs indicate peak flight (452 GDDs), or when adult flies are found on sticky cards placed in the field, begin scouting every 3-5 days. A pencil point or knife helps stir the soil to look for eggs. Field scout by checking 25 plants, in groups of 2-5 plants, scattered around the field. Eggs may be more abundant in wetter areas of the field. There are no chemical treatment options at this stage, but again, scouting will help you determine the extent of infestations and whether an at-plant treatment should be applied in

subsequent plantings.

There are more pesticide options for control of cabbage maggot than the other maggot pests. Available products can be found in the [New England Vegetable Management Guide](#). Coragen (chlorantraniliprole) or Verimark (cyantraniliprole) may be applied at planting and Radiant (spinetoram) or Entrust (spinosad) may be applied to leafy (not root) brassicas at planting and in up to two additional applications to seedlings. Other management tips include:

- Delay planting until after first flight is done (usually mid-May, depending on GDDs) or when soil temperatures are high enough to kill eggs (95°F). Planting in late-May into June is generally safer than in the first half of May.
- Cultivate vigorous brassica crops so that soil is brought up around the stem to encourage adventitious root formation. This can help compensate for root loss if maggots are present.
- Natural enemies: soil-dwelling beetles, including carabid ground beetles and staphylinid beetles, feed on cabbage maggot eggs, larvae, and pupae and can cause high levels of mortality. One staphylinid species, *Aleochara bilineata*, also parasitizes maggot larvae and has been shown to respond to chemicals given off by plants that suffer maggot damage. Because these soil-inhabiting beetles are susceptible to insecticides, broadcast soil insecticide treatments should be avoided. Other natural enemies include parasitic wasps and predatory mites.
- Nematodes for biological control: soil application of the entomopathogenic nematode *Steinernema feltiae* has shown efficacy against cabbage maggot in trials even at low soil temperatures (50°F/10°C). Apply by suspending juvenile nematodes in water and treating transplants prior to setting in the field (as a spray or soaking drench), or in transplant water used in a water wheel transplanter, or a combination of pre-plant and post-plant applications. Post-plant treatments are likely necessary if maggot flight begins more than 1 week after transplanting. Rates of 100,000 to 125,000 infective juveniles per transplant have been shown to be needed to achieve reduction in damage. Nematodes need a moist soil environment to survive.



*Yellow rocket (Barbarea vulgaris).*  
Photo: UMass Weed Herbarium

**Onion Maggot (*Delia antiqua*):** This pest begins its flight when cabbage maggots are at peak flight; yellow rocket bloom is an indicator of the *beginning* of onion maggot flight. NEWA also has a pest forecast model for onion maggot emergence: [NEWA Onion Maggot Model](#). Delaying planting is not a practical method of avoiding this pest because onions are typically planted very early in the spring and are in the ground about a month before the onion maggot becomes a problem. In onions, newly hatched larvae crawl behind the leaf sheath, enter the bulb, and feed on the roots, stem, and developing bulb. Feeding damage also allows for entry of soft rot pathogens. Some tips specific to managing onion maggot include:

- Minimize mechanical and chemical damage to onions throughout the season. Onion root systems are not as hardy as brassicas, so hilling them will not encourage more root production or recovery from root feeding. Hilling leeks can be a recommended practice for developing longer stalks though.
- Gather culled bulbs into deep piles as opposed to deep plowing or harrowing after harvest. This will limit fly reproduction to the surface layers of the cull pile.
- Naturally-occurring fungal diseases occasionally will reduce onion maggot numbers, particularly when flies are abundant and relative humidity is high. During a fungal epidemic, dead flies can be seen clinging to the highest parts of plants along field edges.
- As with cabbage maggot, predaceous ground beetles and entomopathogenic nematodes may help reduce maggot numbers. Avoid broadcast insecticide treatments to protect beneficial insects and follow nematode applications recommendations above.
- See the [New England Vegetable Management Guide](#) for pesticide options.

--UMass Vegetable Program

# PRACTICAL NUTRIENT MANAGEMENT TIPS

Managing soil fertility is often overwhelming and expensive for farmers. The following are some take-home messages from a series of nutrient management workshops held by Becky Maden and Laura Johnson of UVM Extension in March 2020. We hope these messages will prevent you from getting bogged-down by stacks of soil tests and in-depth fertility recommendations.

In addition to the concepts discussed in this article, you can consider saving on fertilizer costs in crops grown on mulched beds by applying fertilizer only to the bed tops. Here are two methods for calculating these fertilizer needs: the [Mulched Acres model](#), and the [Linear Bed Feet model](#).

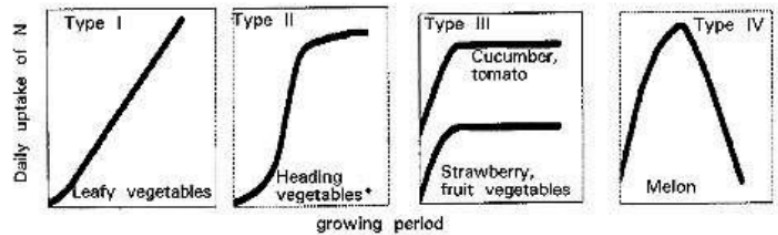
**Pre-sidedress nitrate tests (PSNTs)** are useful tools for dialing in your nitrogen rates every year, either to make sure you're applying the right amount or to try splitting your fertilizer applications. PSNTs measure the amount of plant-available N in the soil at the time of sampling. If PSNT levels are above 30ppm, generally, adding more N will not result in a yield increase. If you split your fertilizer applications this year (put down some at planting and plan to sidedress later), or if you want to try a reduced fertilizer rate, you can take PSNTs to inform your need for sidedressing and time those applications. PSNTs are also a great way to make sure you're not over-applying expensive N throughout the season—if a PSNT taken at the end of the season shows high N levels, you can consider lowering your fertilizer rates for next year. If you are relying primarily on organic forms of N (e.g. from compost, cover crops, soil organic matter, or organic soil amendments), this N is released slowly across many seasons. PSNTs taken monthly can help you evaluate whether this N is becoming available when your crops need it, or if you need to adjust.

## Address the low-hanging fruit first: pH and macronutrients.

**pH.** Optimal pH for most vegetable crops is 6.5-6.8. New England soils naturally become more acidic over time. Nutrients are most available at a neutral pH (7) and start to become unavailable as soil becomes more acidic. At a pH of 5.5, only 77% of N, 48% of P, and 77% of K in the soil is available to plants. Lime your fields to get your pH closer to 7 before you spend lots of money on fertilizers.

**Macronutrients.** Focus on reaching optimal levels of N, P, and K before addressing micronutrient concerns. Micronutrients are present in such small quantities in soils that they are hard to detect precisely with soil testing methods. Instead of trying to increase your soil zinc from 0.8 to 1.0 ppm, keep an eye out for [nutrient deficiencies](#) throughout the season and submit a tissue sample if you suspect a specific micronutrient deficiency. The UMass Soil Lab is still not accepting tissue samples so we recommend using the [UMaine Soil Lab](#).

**Base cation saturation ratios:** The model of soil fertility that all state university soil labs use is based on the proven concept that nutrient levels can be defined for all crop nutrients and below those levels, you will see a yield response in your crop if you add more of that nutrient. This is known as the “sufficiency level of available nutrients” model. There are some private soil labs that use the “base cation saturation” (BCSR) model. The BCSR model focuses on fertilizing soils



Source: Redrawn after Kato (2000)

\* i.e. leaf vegetables which form a head, such as cabbage

Figure 2. Uptake of nitrogen over the growing period of various crops. Figure: Redrawn from Kato 2000.

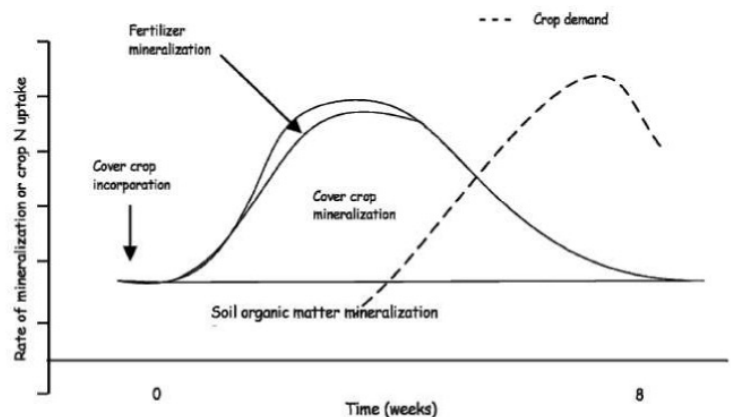


Figure 3. Timing of nitrogen (N) mineralization from soil organic matter, cover crop residues, and organic fertilizer in relation to crop N uptake (from [Gaskell et al., 2006](#)).

based on the ratios of calcium, magnesium, and potassium in the soil, with the goal of achieving “ideal” ratios that will result in a “balanced” soil and maximum crop quality and quantity. This idea of ideal ratios was first proposed in the late 1800s but became popular in the 1970s after it was publicized by the soil scientist William Albrecht. However, the BCSR concept has since been disproved and it has been shown that maximum yields of many crops can be achieved across wide ranges of Ca:Mg and K:Mg ratios, if pH is maintained in an optimum range and sufficient macronutrients are supplied. While Mg and K deficiencies can certainly occur, it is much easier to address those deficiencies once the low-hanging fruit have been addressed. See the “Resources” list at the end of this article for more information about BCSR.

**Prioritize problem fields and/or high-value crops.** While we should strive to achieve the recommended fertility for every crop every year, it is not always realistic or even necessary. Crops respond to added nutrients logarithmically (Figure 1), meaning the initial response to added fertility is huge but there is a point of diminishing return, where adding more fertilizer leads to only small gains in growth or yield. Fertilizer is expensive! So spend your time and money wisely and get “close enough.” Work on dialing in nutrients for fields where you see nutrient problems regularly and for high-value crops where you can’t afford to get less-than-optimum yields. For other crops, you may be happy enough getting less-than-optimum yields and saving money on the fertilizer needed to get that last 5% yield.

**Don’t obsess over soil organic matter—work within the range of your soil type.** Soil organic matter (SOM) includes living (e.g. insects, bacteria, fungi), dead (e.g. dead plants, insects, bacteria, fungi), and very dead (aka humus) material in soil. Organic matter is generally increased by incorporating cover crops or applying organic amendments like manure and compost, most of which have high phosphorous levels relative to crop need. Generally, 2-3% SOM is considered low, and 4-6% is considered good. But it’s nearly impossible to maintain SOM above 3% in a sandy soil, and if you’re adding enough compost that your SOM is increasing above 3%, your phosphorous levels are probably well above optimum. If you have sandy soils, aim to maintain your SOM instead of increasing it. Across all soil types, look at the trend of your SOM and don’t obsess over the value alone. If you’re increasing your SOM without applying excessive phosphorous, great! If you’re maintaining your SOM, great! If your SOM is decreasing, consider making a change.

**Know your phosphorous levels and your environmental risk level before adding organic amendments.** Phosphorous is an essential plant nutrient but can become an environmental pollutant if large quantities enter water sources. This is mainly an issue with large-scale growers who use manure or compost or who are growing on fields that historically had lots of manure put down. When P levels are high, there are no corrective actions except avoiding adding more phosphorous. Most organic amendments—composts and manures—are high in P. Cover crops are great ways to add organic matter without adding P. In high tunnels, where cover cropping is difficult, peat moss and coconut coir are two options for adding organic matter without adding extra P.

Optimal phosphorous ranges from a Modified Morgan soil test is 4-7ppm; above that, your phosphorous levels will be reported as “excessive”. That means a P at 8ppm will look the same on the soil test report as one at 300ppm, even though 300ppm is much worse than 8ppm. Generally speaking, P levels above 50 ppm are alarming. We’ve heard some farmers say that excess P is not a big deal as long as your field is not next to a waterway—not so! There is a growing awareness that long-term over-application of manure and chemical fertilizer contributes to phosphorus movement into the groundwater system, resulting in a significant groundwater source of phosphorus to streams and lakes, as well as potential contamination of the groundwater resources. Further, excessive P can tie up zinc, leading to deficiencies.

**Updated high tunnel fertility and production recommendations.** Research and surveying from several New England states in 2018 resulted in new high tunnel fertility recommendations that are now included in the [Greenhouse & High Tunnel Tomatoes section of the New England Vegetable Management Guide](#). The research is also summarized in this [2018](#)

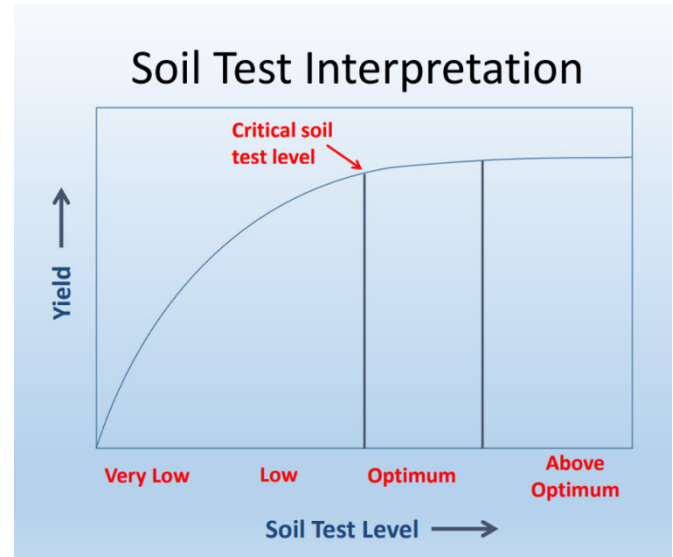


Figure 1. Crop yield response to soil nutrient levels. If a soil contains no nutrients, adding some nutrients will result in a large increase in yield. As soil nutrient levels approach optimum, each incremental addition of nutrients has less and less of an effect on crop yield. Figure: UVM Extension

[High Tunnel Survey Report](#). The take-home message from this research is that high tunnel tomatoes should be fertilized based on the potential yield of the production system: a heated tunnel of indeterminate, hybrid, disease-resistant, grafted tomatoes that are closely spaced and heavily pruned has the *potential* to produce much higher yields than an unheated tunnel of determinate heirloom tomatoes that will be harvested 3 times before they go down to leaf mold. The first scenario requires much more nutrients than the second. The Guide and fact sheet list nutrient recommendations for low, medium, good, and high yields, all of which refer to the *potential* yield of your high tunnel tomato production system.

**Salts can build up in the top two inches of high tunnel soil.** Salts are wicked to the soil surface through evaporation and are not flushed back down because there's no rain. These salts are nutrients, so you don't want to remove them, but they can cause plant damage in high concentrations, so take measures to mix or flush them deeper into the soil. Mix the soil by rototilling or plowing to a >6" depth and/or leave the tunnel plastic off for the winter every time you change it to flush the salts back down.

In conclusion, when you get all 35 of your soil tests back and don't know where to start, remember that you just need to get close enough, start with the low-hanging fruit, and feel free to contact any of us for help making a plan or going through some of the calculations.

#### **Additional Resources:**

- The UVM Extension created a very useful set of fertilizer calculators and other resources, found [here](#). Becky Maden created a Fertilizer Selection Calculator (2<sup>nd</sup> on the list) where you can enter nutrient levels, soil pH, and organic matter levels from a soil test, as well as cover crop information, and the spreadsheet will walk you through how much of a given amendment you should be applying to your field.
- See our fact sheet [Calculating Fertilizer Applications](#) for step-by-step instructions on how to calculate how much fertilizer to apply for your crop.
- [Basic Cation Saturation Ratio System](#), *Building Soils for Better Crops*. Magdoff, F., and van Es, H., pages 321-322 and 338-340.
- [A Review of the Use of the Basic Cation Saturation Ratio and the "Ideal" Soil](#). Kopittke, P., M., and Menzies, N. W.
- [Phosphorous and Groundwater: Establishing Links Between Agricultural Use and Transport to Streams](#). Domagalski, J. L., and Johnson, H.
  - The New England Vegetable Management Guide covers many of these topics:
  - See the [Plant Nutrients](#) section for more information on both macro- and micronutrients
  - See the [Fundamentals of Soil Health and Fertility](#) section for more information on soil organic matter and pH
  - See the [Fertilizer and Soil Amendments](#) section for information on fertilizers as well as manure and compost.

--Written by G. Higgins and S. Scheufele

## **ADJUVANTS 101: WHAT EVERY GROWER SHOULD KNOW**

*By Daniel Bergman, Ph.D., Technical Representative, Nutrien Ag Solutions  
With contributions by Joe Vaillancourt, Adjuvants Product Manager, Nutrien Ag Solutions*

*[Note: This article was originally printed in Cornell Veg Edge in April 2019. Edited by Christy Hoepting, CCE – Cornell Vegetable Program, April 2023]*

If you want to maximize your crop yield every year, you need to understand adjuvants. Defined broadly, **an adjuvant is a product that enhances the ability of another product to work more effectively.** Adjuvants don't contain pesticidal active ingredients; instead, they aid active ingredients in overcoming environmental and equipment-based fail factors to maximize application performance.

Of course, in reality adjuvants are much more complex than that. There are many different types, and it's important to know which types to use in which situations. Using the wrong kind of adjuvant in certain conditions can actually cause more harm than good.



That's why the best advice on adjuvants that I can share with growers is this: **Read the label.** If an adjuvant is recommended for use with a specific product, the label on that product will say so. It will also provide additional important information, such as adjustments to make if you're applying on a very hot day, have the wrong spray-tank pH or if you're dealing with high winds.

Unfortunately, reading the label can sometimes cause additional confusion, especially when you're mixing multiple products into a single tank. That's when a deeper understanding of adjuvants is extremely helpful.

With that in mind, let's talk about what the types of adjuvants are, how they work, and what you need to know.

## Types of adjuvants

There are five main categories of adjuvants. They are:

- **NIS (non-ionic surfactant):** The most commonly used adjuvant, NISs are water-soluble and aid with coverage on the plant as well as with uptake. They're considered the workhorse of the industry because of their leaf-wetting ability and common use recommendations by many pesticide labels.
- **COC (crop oil concentrate):** Mostly used with herbicides, COCs drive active ingredients into plants by helping with uptake and penetration.
- **MSO (methylated seed oil):** Like COCs, MSOs are oils, but they act more aggressively than COCs. In other words, they accelerate the plant's uptake of active ingredients. They're also usually used with herbicides.
- **Organosilicones:** These are silicon-based adjuvant systems that provide extreme wetting and aid in uptake and penetration. You have to be careful with 100% organosilicones products when applying to crops with upright leaves such as onions, because they can run the spray solution off the leaf of the plant and potentially running down into the neck of the onion, causing an excessive accumulation of spray solution. **It's usually better to use silicon blends, which combine organosilicones with an oil or NIS.**
- **Spreader-stickers:** Most adjuvants in this category are more "stickers" than they are "spreaders," so the term is a bit of a misnomer. These are non-ionic adjuvants that impart adhesiveness to the pesticide solution, helping pesticides or fungicides to stay on leaves longer and resist being washed off by rain or irrigation.

## How adjuvants work

Adjuvants work in a few different ways, all of which are designed to help other pesticidal products work more effectively. Adjuvants can:

- **Modify droplet size.** Put simply, adjuvants can make the droplets coming out of your sprayer larger, mid-ranged in size, or smaller. On a windy day, having larger droplets (500+ microns) means less drift, but larger droplets are more susceptible to bouncing or running off the leaf surface. Smaller droplets (< 150 microns), on the other hand, are more susceptible to drift. Most of the time, it's best to strive for a mid-range droplet (150-500 microns) for optimum drift management, leaf retention and coverage.
- **Increase droplet retention.** Droplets that run off the surface of a leaves aren't very effective at delivering pesticidal active ingredients to the plant surface. Adjuvants that retain spray droplets on the leaf surface are best.
- **Improve leaf wetting.** Spray solutions tend to poorly wet the leaf surface and do little good when applied to crops that have very waxy leaf surfaces like onions and cabbage. Adjuvants help lower droplets' surface tension so the pesticidal products cover the leaf more efficiently and gets through the waxy leaf cuticle and into the plant.
- **Promote better uptake.** Adjuvants can increase the rate of pesticide penetration through the plant cuticle and into the leaf surface.

As you can see, there's a lot to know about adjuvants. And while we can only touch on the basics in this article, having at least some level of knowledge comes in handy, because you can better understand what your product's label is telling you. If you're using a pesticide or plant protectant, it'll tell you to use adjuvants to improve penetration and performance. If you have tough weed conditions, labels may ask you to go with an oil-based adjuvant (a COC or MSO). If conditions exist that may cause a higher concern of phytotoxicity, a NIS recommendation may be the right answer.

## Adjuvants and tank mixes

It's entirely possible that a single tank mix will involve multiple pesticide products with each of their own adjuvant recommendation. While that isn't necessarily an **issue, it's on you to determine whether your particular mix will result in adjuvant conflicts**. The first place to start is to go through your full list of label adjuvant instructions and sort them from most to least restrictive. If you give first consideration to your most restrictive instructions and go step by step, you'll be able to avoid most conflicts.

**Sometimes you have instructions on two products that are in direct conflict with each other.** Here's an example involving an herbicide, Chateau® and an insecticide Movento® that you may want to use in very close proximity in onion (we know the this combo should not be tankmixed). Chateau's label tells you not to use an adjuvant, because that will result in the onion taking up too much of it too quickly, resulting in excessive phytotoxicity (e.g. leaf necrosis). Movento, however, says it requires an adjuvant that aids in uptake to achieve maximum performance. Which do you spray first?

The solution: **Apply Chateau as directed, wait three to five days, then come back with Movento combined with an adjuvant** that improves penetration. Be sure to follow the label instructions.

### Check your conditions

**Temperature.** You can have an encyclopedic knowledge of products and adjuvants and still run into issues. That's because pesticide products and adjuvants aren't always the only two variables at play. Heat, for example, is an important factor to consider. **If you're spraying on a hot day, you'll want to avoid high rates of oil-based adjuvants.** Oil-based products tend to have greater wax solubility at high temperature, which can too aggressively dissolve the waxy surface of the leaf. Obviously, that's bad. **Instead, go with an NIS.** It's water-based and more forgiving on a hot day. (This is one of the reasons NISs are considered an industry workhorse; they're the best option in a wide variety of situations.)

**Water hardness.** Another factor that **many growers may overlook is the quality of the water they use in their tank mix.** Many municipalities have hard water, which means it has high levels of calcium, magnesium or iron dissolved in it. These hard water metals bind with pesticide actives and built-in emulsifiers, thus reducing application efficacy.

**Don't underestimate the importance of checking the hardness of your water.** It's an issue that can directly impact your pesticide use efficiency and yield if it isn't addressed properly.

**Water pH.** While not as important or common as water hardness, the pH level of your water is also worth checking. As with hardness, this is easily checked using readily available test strips. **Ideally you want your spray-tank water to be neutral or slightly acidic.** If anything, your water supply is likely to have a higher pH than is ideal, but an acidifier will easily help with that needed adjustment.

**Excessive acidification.** If you're using metal-based fungicides (such as those that include copper or tin), don't use an adjuvant that reduces pH and thus increases the acidity of your mix. If you acidify your tank mix too much, you can end up with too much copper or tin available. This in turn can cause plant phytotoxicity.

### Read the Label!

I said these three little words a few times already, but it's worth repeating: **read the label.** The vast majority of the time, the labels on the products used in your tank mix will tell you everything you need to know about which adjuvants to use and when to use them.

Hopefully you now have a little bit more understanding of adjuvants that you can apply this season and into the future. Best of luck out there this season!

## NEWS

### UMASS EXTENSION IS HIRING!

UMass Extension is pleased to announce that we are now accepting applications for **two Extension Educator positions!** If you or someone you know wants to join our team of educators providing science-based information for Massachusetts growers, please see the job summaries listed below. The default location for all positions is the UMass

Amherst campus, with opportunities for hybrid work arrangements. Candidates who wish to be considered for more than one of the positions below need to **apply for each position individually**. Positions will remain open until filled.

- The **UMass Extension Fruit Team** is currently hiring one **Extension Educator III (MS-level)**. The successful candidate for the Educator III position will have expertise in tree or small fruit crop and pest management and will work with other members of the Fruit Team to provide science-based educational programming and technical assistance to commercial fruit growers in MA and conduct applied research on relevant crop and pest management topics. Special consideration will be given to candidates with expertise in plant pathology and/or small fruit production. For more details please see the full position descriptions linked below.

For more details and to apply:

**Fruit Extension Educator III:** <https://careers.umass.edu/amherst/en-us/job/518181/fruit-extension-educator-iii-umass-extension>

- The **UMass Soil and Plant Nutrient Testing Lab** is hiring a **Soil Health Educator IV** who will develop and deliver recommendations to customers and educational resources relevant to soil fertility and health, with potential for some applied research projects. They will collaborate with Extension professionals across multiple teams in production agriculture, commercial horticulture, and urban agriculture. This is a MS-level position requiring significant experience, with a preference for candidates with expertise in analytical testing and practical recommendations in soil fertility and health. This is a 24-month appointment that may be extended pending funding availability. For more details please see the full position descriptions linked below.

For more details and to apply:

**Soil Health Extension Educator IV:** <https://careers.umass.edu/amherst/en-us/job/518166/extension-educator-iv-soil-health-umass-extension>

## **USDA STILL ACCEPTING 2022 CENSUS OF AGRICULTURE FORMS FROM NEW ENGLAND PRODUCERS**

The U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) is reminding New England farmers and ranchers that the window is closing on the opportunity to participate in the 2022 Census of Agriculture. NASS is encouraging U.S. producers who have not returned their completed ag census questionnaires to do so as soon as possible to avoid additional mail, phone, email, text, and in-person follow-up, which is currently underway. NASS is reminding producers that if they produced and sold \$1,000 or more of agricultural product in 2022, or normally would have produced and sold that much, they meet USDA's definition of a farm. However, federal law requires everyone who received the 2022 Census of Agriculture questionnaire complete and return it, even if they do not currently meet this definition. Producers can respond online at [agcounts.usda.gov](https://agcounts.usda.gov) or by mail.

## **NEW PRODUCE SAFETY RESOURCES FOR HYDROPONIC AND AQUAPONIC OPERATIONS**

The Northeast Center to Advance Food Safety (NECAFS) at the University of Vermont is pleased to share this set of [resources for Produce Safety in Hydroponic and Aquaponic Operations](#). These resources, primarily written for the audience of produce safety educators and regulatory officials, guide readers through produce safety considerations specific to hydroponic and aquaponic operations. They assume a general background in the FSMA PSR and are supplementary to the content of the Produce Safety Alliance Grower Training. The factsheets cover first steps in discussing produce safety with growers and other stakeholders in hydroponics and aquaponics. There are fact sheets on:

- [Cleaning and Sanitizing](#)
- [Fish Health and Handling](#)
- [Harvest and Postharvest Handling](#)
- [Personal Health and Hygiene](#)
- [Wildlife and Domesticated Animals](#)

## **UFW FOUNDATION ACCEPTING APPLICATIONS FOR USDA'S FARM AND FOOD WORKER RELIEF PROGRAM**

[The U.S. Department of Agriculture \(USDA\) Farm and Food Worker Relief \(FFWR\) Grant Program](#) awarded approxi-

mately \$667 million in grants to fourteen nonprofit organizations and one Tribal entity through Consolidated Appropriations Act of 2021 funds. The purpose of this program is to defray worker expenses incurred preparing for, preventing exposure to, and responding to the COVID-19 pandemic. Workers may only receive one \$600 payment per person, and they must have worked in the U.S. during the pandemic.

Farm workers across the U.S. can now apply for the \$600 COVID-19 pandemic relief payments through [UFW Foundation](#). UFW Foundation will be distributing a one-time \$600 relief payment to farm workers affected by the COVID-19 pandemic who qualify. There is no cost to apply for the program. You can only apply once; additional applications will be denied.

Relief payments are available to frontline agricultural workers who worked during the COVID-19 pandemic. For more information on the program, eligibility, and how to apply, visit: <https://www.ufwfoundation.org/ffwr>.

## **APPLICATION PERIOD OPEN FOR USDA RURAL ENERGY FOR AMERICA PROGRAM (REAP)**

The USDA is accepting applications for grants to help agricultural producers and rural small businesses invest in renewable energy systems and make energy-efficiency improvements. USDA is making the \$1 billion in grants available under the Rural Energy for America Program (REAP) funded under the Inflation Reduction Act. For application information, eligibility and deadlines see, [Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Guaranteed Loans & Grants](#).

## **APPLICATION PERIOD OPEN FOR SEVERAL MDAR GRANT PROGRAMS**

The Massachusetts Department of Agricultural Resources (MDAR) is accepting applications from Massachusetts farmers who wish to participate in one of these Department programs. The Request for Responses (“RFR”s) containing program details and the application form is posted on CommBuys and can be accessed through a link on each program website below. If you would like an application mailed to you, contact the program coordinator listed.

*To learn more about these programs, access this video link to the [Recorded Grants Webinar](#) held on March 21, 2023.*

**MDAR is currently accepting applications for the following programs:**

### **[Climate Smart Agriculture Program \(CSAP\)](#)**

The Climate Smart Agriculture Program links MDAR’s water, energy and climate grants together into one application. This includes the Agricultural Climate Resiliency & Efficiencies (ACRE) Program, the Agricultural Environmental Enhancement Program (AEEP), and the Agricultural Energy Grant Program (ENER). By bringing these three grants under one program, MDAR is seeking to simplify the application process for applicants. This program continues the goals of the three individual grants by implementing projects that help the agricultural sector adapt to climate change, mitigate climate change, reducing or preventing impacts to natural resources that may result from agricultural practices, and that improve energy efficiency and facilitate adoption of alternative clean energy technologies.

**Applications are due by 4:00pm on Friday, May 26th, 2023.**

**Questions:** Contact Laura Maul at (617) 626-1739 or [Laura.Maul@mass.gov](mailto:Laura.Maul@mass.gov).

### **[Agricultural Food Safety Improvement Program \(AFSIP\)](#)**

This grant program is for the implementation of practices that prevent or reduce food safety risks for produce or aquaculture operations, meet regulatory requirements, and improve market access.

**Applications are due by 4:00pm on Friday, May 26th, 2023.**

**Questions:** Contact Laura Maul at (617) 626-1739 or [Laura.Maul@mass.gov](mailto:Laura.Maul@mass.gov).

### **[Massachusetts Food Ventures Program](#)**

This grant program funds projects that support food ventures in low or moderate income communities. This includes Gateway Cities and rural communities. Participants selected by the program will be reimbursed up to \$500,000, and the minimum award is \$100,000.

**Applications are due by June 13, 2023.**

**Questions:** Contact Rose Arruda at 617-626-1849 or [Rose.Arruda@mass.gov](mailto:Rose.Arruda@mass.gov).

## **Urban Agriculture Program**

This grant program advances agricultural goals and objectives of Massachusetts. The program funds infrastructure needs, innovative food production, zoning ordinances, technical assistance, land acquisition, and youth leadership development.

**Applications are due by May 22, 2023.**

**Questions:** Contact Rose Arruda at 617-626-1849 or [Rose.Arruda@mass.gov](mailto:Rose.Arruda@mass.gov).

## **Cranberry Bog Renovation Grant Program**

Funding to implement cranberry bog renovations that promote more efficient bogs both in design and production while enhancing the business and environmental sustainability of the cranberry operation.

**Applications are due by 4:00pm on Friday, May 26th, 2023.**

**Questions:** Contact Laura Maul at (617) 626-1739 or [Laura.Maul@mass.gov](mailto:Laura.Maul@mass.gov).

## **SBA LOW-INTEREST DISASTER LOANS REMINDER**

The [U.S. Small Business Administration \(SBA\)](#) is reminding small businesses, small agricultural cooperatives, small businesses engaged in aquaculture, and most private nonprofit organizations that **April 17** is the filing deadline for federal working capital loans in Massachusetts due to drought that began Aug. 9, 2022.

Low-interest disaster loans are available in the counties of **Barnstable, Bristol, Dukes, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk and Worcester in Massachusetts**; Tolland and Windham in Connecticut; Chesire, Hillsborough and Rockingham in New Hampshire; and Bristol, Newport and Providence in Rhode Island. Under this declaration, the SBA's Economic Injury Disaster Loan (EIDL) program is available to eligible farm-related and nonfarm-related entities that suffered financial losses as a direct result of this disaster. Apart from aquaculture enterprises, SBA cannot provide disaster loans to agricultural producers, farmers and ranchers. Nurseries are eligible to apply for economic injury disaster loans for losses caused by drought conditions.

The loan amount can be up to \$2 million with interest rates of 3.04 percent for small businesses and 1.875 percent for private nonprofit organizations, with terms up to 30 years. Applicants may apply online using the Electronic Loan Application (ELA) via the SBA's secure website at [DisasterLoanAssistance.sba.gov/ela/s/](https://DisasterLoanAssistance.sba.gov/ela/s/) and should apply under SBA declaration # 17589. If you have questions, please contact the FOCE Communications Department at 404-331-0333.

## **FOOD SAFETY EMPLOYEE TRAINING WORKSHOP AND RESOURCES**

Remember that food safety best practices and the FSMA Produce Safety Rule dictate that employees should receive training at least once annually on food safety concepts, including proper hygiene and recognizing symptoms of food-borne illness.

For guidance on designing and conducting employee food safety training, consider the resources below!

### **Train the Trainer – The Food Safety Training Kit: PSR 101**

**When:** Thursday, May 11 (English) and Thursday, May 18 (Spanish)

This **Free Virtual Workshop** is hosted by the National Farmers Union, Local Food Safety Collaborative, and Food Safety CTS. It is designed for small- and medium-sized operations and will train instructors/supervisors on how to use the National Farmers Union's Food Safety Training Kit

**Register here** for both sessions: [https://www.foodsafetyets.com/PSR-101-TTT/?fbclid=IwAR0KxIr\\_bmCGk-iTY1a8byV\\_JcgahsjmJETSpZFBzKHK5LozjDZOZIZYojeM](https://www.foodsafetyets.com/PSR-101-TTT/?fbclid=IwAR0KxIr_bmCGk-iTY1a8byV_JcgahsjmJETSpZFBzKHK5LozjDZOZIZYojeM).

### **UMass Food Safety for Farmers website – Worker health, Hygiene, and Training**

<https://ag.umass.edu/resources/food-safety/for-farmers/worker-health-hygiene-training>

Describes general recommendations and FSMA PSR training requirements. Also includes a list of Worker Training Guides and Videos—some in both English and Spanish—that can guide or be incorporated into employee training programs.

# **EVENTS**

## **AGRICULTURAL PRESERVATION RESTRICTION (APR) LISTENING SESSIONS 2023**

There is one remaining session in the 2023 APR Listening Session series, being held by MDAR as part of its triennial review of the APR program. MDAR would like to hear your thoughts on what works well and your concerns or challenges with the program, including: dwellings on APRs, your ability to conduct non-agricultural commercial activities on APRs (Special Permits), alternative energy on APRs, the sale and transfer of APRs, APR eligibility and ranking, the use of ACEP ALE program to leverage APR funding and other APR related issues. Your participation in the meeting is encouraged and welcomed.

A link to existing guidance, policies, procedures and regulations relative to the management and oversight of the Program of APR policies is available on the [APR website](#).

**When:** TODAY! Thursday, May 4, 6-8pm (Registration starts at 5:30pm)

**Where:** Fidelity Bank Community Room, 9 Leominster Connector, Leominster, MA

**Registration:** [Click here to pre-register](#).

Questions? Email [events@discoverasg.com](mailto:events@discoverasg.com).

## **NEW ENTRY FARMER RESOURCE FAIR 2023**

**When:** Friday, May 12, 2023; 11:00am – 2:00pm

**Where:** New Entry Sustainable Farming Project 733 Cabot Street, Beverly MA, 01915

**Registration:** Register [online here](#)

**Vendor Registration:** We are currently accepting vendor applications for the resource fair. [Click here for vendor registration](#).

Are you a beginning or small farmer in eastern MA? Do you need help registering your farm with the USDA Farm Service Agency? Do you want to accept Senior Farmers Market Nutrition and WIC Coupons at your local farmers market? What about SNAP and HIP? Do you have questions for UMass Extension or MDAR representatives?

If you answered “yes!” to any of these questions, register and save the date for the New Entry Farmer Resource Fair. This unique event will bring together essential farm service providers so you can get all your questions answered and register for programs right on the spot! The UMass Extension Vegetable Program will host a crop walk to discuss pests that are active now.

We encourage you to schedule an appointment in advance with the vendors for personal 1:1 support in the application process. We will email you in advance to let you know what documents to bring to your appointment.

More information [here](#).

## **PEST AND DISEASE CONTROL FIELD WALK WITH UMASS EXTENSION & EASTERN MA CRAFT**

**When:** Wednesday, June 21, 4-6pm, Pest and Disease Control with UMass

**Where:** High Road Farm, 186 High Rd., Newbury, MA. Please drive down the private driveway and you’ll see parking options near the barn and greenhouse.

Join Sue Scheufele of the UMass Extension Vegetable Program and Eastern MA CRAFT (Collaborative Regional Alliance for Farmer Training) for a pest walk at High Road Farm in Newbury, MA. We will tour the farm and discuss pests that are currently active, how to scout for them, and how to manage them.

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

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