Winter Rain/January Thaw: Some of you may have already finalized your seed orders and are busy preparing for the spring in other ways... but for those who are still deciding, please have a look at the variety trials that have been conducted at URI over the last several years: http://digitalcommons.uri.edu/riaes_bulletin/.

Don’t forget to look into the Rhode Island Farm Energy Program. You can find an application at the following link, and remember the Deadline is March 16: http://www.rifarmenergy.org/ri-ag-ep.htm.

Also, the new round of Local Agriculture and Seafood Act (LASA) has been announced by RIDEM: http://www.dem.ri.gov/programs/agriculture/grants-lasa.php. Deadline for applications is March 1.

The newest edition of the New England Vegetable Management Guide (and the also the latest Tree Fruit and Small Fruit Guides) is available from URI Cooperative Extension in hard copy. These books are amazingly cheap and well worth the expense. BUT you can also find them online. Please let us know if you need one of these books.

How can we help? URI Cooperative Extension exists to support your valuable work. Tell us what’s important. Can you help organize a listening meeting within your area of RI? - Grange Halls Preferred! Contact Andy: 401-874-2967/andy_radin@uri.edu.

So you’ve built a high tunnel! How do you prepare your soil for many years of profitable growing?

The land inside of your high tunnel is a precious resource. There are good reasons to baby it. How much, though, and with what ingredients?

First, consider how high tunnel soil is unique.

Unlike a big field, the tunnel’s footprint is a tight, defined space that you can manage at a high resolution. You can keep a very accurate map from year to year, and even put permanent marker stakes or pipes to mark off distinctly managed areas.

Soil under cover does not receive the qualities of direct rainfall. This is a big advantage for plants in that foliage does not remain wet for extended periods of time, so there is less disease of foliage, at least for certain pathogens. As for the soil, rainfall has some important qualities. According to Jose Amador, URI Soil Scientist, rainwater in the northeast can supply as much as 10 lbs of nitrogen per year. In addition to feeding plant growth, rainwater stimulates soil microbial activity over a broad area. Steady soaking rains penetrate evenly down into the rooting zone of annual crop plants, right where it’s needed. Rainfall leaches excessive concentrations of nutrients at the soil surface further down into the soil profile.

Irrigation in high tunnels is much more targeted to the crop plants themselves. With respect to conservation, this is a positive, particularly where water is scarce or it is being metered. It also reduces watering of weedy areas. But the lack of penetrating rainfall means that nutrients stay shallow in the soil profile and can build up to toxic levels, particularly in shallow-rooted salad greens. In fact, take a look at the figure (page 2) that shows salt accumulation down to 6 inches (figure courtesy Bruce Hoskins, UMaine). Remember that a salinity of >1.0 mmhos/cm is considered moderately toxic. Since conditions are warm and ventilated in the summer, there is an upward wicking of soil water due to surface evaporation, which also contributes to less downward movement of nutrients. (One of several reasons to maintain a surface mulch, particularly an organic one like straw or leaf mold.)
If moisture is not widely distributed, biological activity of roots and microbes is only in a concentrated area around the crop plants, since moisture is essential for microorganisms. This is something that probably hasn’t been studied: the size of the area of influence of microbial activity on crop growth. Study of the Rhizosphere is becoming an ever more important area of research, particularly as growth enhancing microorganisms are discovered and developed into inoculation products. [See box on Fusarium/Trichoderma project.] Anyone up for a PhD project?

Microbial activity (and thus, nutrient availability, especially N and P) is a function of soil temperature, which is one reason why very early greens in the field take some time to start growing quickly, and why P deficiency in warm season crops is often seen in cold soils. High tunnel soil warms up early in April and stays warm into October. That means that the potential for mineralization (conversion from organic forms to ionic, plant-usable forms) is huge over the course of the season. Organic nutrient sources can function very well in the spring because of this, unlike in the field when we are wishing for more vigorous growth. (It also means that excessive nitrate and other salts can build up, and this can remain into the winter, when greens like spinach, chard and lettuce will take up excessive amounts, uncontrollably. This isn’t good for human health.)

Warmer soil year-round (often along with green living host plants) provides a more dependable refuge for pest insects. This set of conditions can be especially favorable for aphids, thrips and whiteflies.

One more difference between tunnel and field: if managed properly, soil compaction, a major detriment to crop productivity, can be reduced with use of permanent beds that receive no foot traffic. Furthermore, compaction of footpaths can also be reduced with a long-lasting organic mulch, like arborist woodchips.

Making new beds: Choosing amendments for increasing soil organic matter

The number one amendment that springs to mind is compost, and lots of it. Without question, this is of great benefit when initially preparing a bed. But it’s important to remember that composts vary. Yard waste (YWC) composts (higher C:N) are very good for providing a big slug of organic matter, because they are usually low in concentrated nutrients (actually, all composts are relatively low on that scale) and higher in lignin-containing organic matter. Manure-based (MC) composts are more nutrient rich and can supply considerable nutrients to high tunnel crops over the long season.

One strategy is heavy enrichment of beds at the time of their formation with a sizable quantity of YWC, and then a yearly “maintenance” application of MC, if available. Additional nutrients can be supplied with more specific amendments.

There are people who invest (one time) in many bales of peat moss, which they incorporate into permanent beds. The great benefit is that peat moss has a very high C:N, which means that it breaks down very slowly, and so, provides it’s organic matter benefits for a long time. Among these are: aiding in formation of soil “crumbs” or aggregates; providing negatively charged surface area that holds nutrient cations (improved cation exchange capacity); absorbing and holding water, which maintains consistent soil moisture; and providing microbial habitat. One could argue that there is a negative sustainability factor to consider: peat is a mined product, and a relatively stable form of sequestered carbon. But also bear in mind that most potting media is still composed of peat, though coir is now in many mixes.
Should you just plant and go?

There is, of course, the option of not amending with any great quantities of incorporated organic matter. If your soil is already in excellent condition, your first season may go just fine. But bear in mind that the long season of warm soil, nutrient input and regular soil moisture can “burn” up your organic matter quickly. If you’ve turned in sod, you will get a big flush of nutrients as the old roots and thatch decompose, but that will be short lived. Begin maintaining organic matter immediately.

A commonly employed physical treatment is “broadforking”. It may be valuable to do this on a compacted soil, and it’s not uncommon for a new high tunnel’s soil to be compacted following the construction phase. (For this reason, consider maintaining the sod ground cover at your site until you are ready to work in the soil: the foot and machine traffic required during construction can really compact soil that had been tilled prior to construction.) If you have done an initial broadforking and you are planning to avoid foot traffic on your beds, annual broadforking may not be necessary. Tillers are commonly used inside of tunnels to incorporate organic matter and nutrients, but it may make sense to avoid tillage more than once per year, again to minimize compaction and maintain good structure.

Testing High Tunnel Soil

The differences between tunnel soils and field soils pointed out above have intrigued Bruce Hoskins of the University of Maine Soil Testing Laboratory to the extent that he has developed a test designed specifically for the highly enriched soils in high tunnels. If you choose to use their service, it would be good to stick with them from year to year; using the same lab over and over gives you a better ability to make relative comparisons between years. You can find the forms for soil testing here: https://umaine.edu/soiltestinglab/home/forms/. You’ll see additional check-off boxes on the form all the way to the right, where you can choose the high tunnel options.

Featured Grower’s Practices: Roots Farm in Tiverton

Mike and Kelli Roberts, who have been growing in Tiverton for 8 years, were kind enough to share their high tunnel soil management routine. Here it is:

“Since we grow in moveable tunnels, and we grow just as intensively on our plots while they are outdoors as when they are covered with the tunnel, we don’t do anything different for high tunnel plots. If we’re putting up a new tunnel over ground we’ve already been planting, we just keep doing what we’re doing.

Right now our typical planting program for a ~46 foot bed (fits inside a 48’ tunnel) is 3 wheelbarrows of compost (we use Smith-fied Peat), 2 lb alfalfa meal, 1 lb ground crab shell, 1 lb blood meal, 0.5 lb feather meal, 0.5 lb bone char, and a bit of Solubor, manganese, zinc, and magnesium. We also do an annual application of 500 lb/ac greensand and 300 lb/ac each azomite and kelp meal. [Editorial comment: this is yardwaste compost, so they are mainly supplying plant nutrients with the other amendments.]

Beds are 30” wide with 12” paths. We fit 8 beds in a 30’ wide tunnel.

The process for bed prep is:
1. Rake out crop debris.
2. Apply amendments and compost, rake smooth.
4. Power harrow.
Research Project: Use of a fungal biocontrol agent and grafting against Fusarium wilt (*Fusarium oxysporium*) on Tomato

Last summer, we did a mini-study with a grower, Dan Geer, in North Smithfield (who, alas, after many years in RI, has retired to his Tennessee farm). We had determined the year before that his plot of land had areas infested with *Fusarium*, and because his space was limited, we wanted to figure out how he might be able to live with this disease present in his soil, that being because giving up tomatoes as a key business enterprise was out of the question. It was his idea to look at both grafting and the use of RootShield WP to see if the disease could be suppressed.

**Experimental Setup.** Dan produced about 40 ‘San Marzano’ tomato plants (known to be susceptible to *Fusarium*), half of which were grafted onto ‘Maxifort’ roots. While the plants were still in cells, he treated half of the grafted plants and half of the non-grafted plants with RootShield, which is the biocontrol fungal organism known as *Trichoderma harzianum*. This is what is known as a 2X2 factorial experiment: two treatments (grafting, RootShield) by two levels (with and without), making a total of 4 treatments. These were randomly transplanted into a row of the field which was known to be totally infested with *Fusarium*. Note that while randomly assigned to locations in the row, the treatment identities were only documented in a field map but not marked.

**Sampling.** Plants were rated for disease severity (1=sick, 5=healthy) on three dates, starting Aug 1. Yield for each individual plant was also documented; there was a total of 6 harvest dates, starting in late August and ending in early October.

**Analysis.** Not every one of the 40 slots ended up with a ‘San Marzano’ plant, or even any plant at all. Originally, there was supposed to be 10 plants of each of the 4 treatments, but in the end, the number of replications of each treatment was “unbalanced.” That’s OK, it’s still possible to get statistically meaningful results, which we did using a procedure known as Analysis of Variance (ANOVA) with unbalanced replication. XLSTAT was used for computing the statistical analysis.

**Results.** A word on statistical analysis: It’s important that we subject our assessments of various products and practices to replicated experiments with statistical testing of results. Agricultural settings are very complex and there are potential random effects from factors unaccounted for, like for instance, very wet patches of soil along the 80 feet of row used for the experiment.

Yield differences between any of these treatments was not statistically detectable. There is clearly a trend in yield, though: +graft+tricho>+graft-tricho>+graft+tricho>−graft+tricho. This is a hint that the treatments may have some influence, which is why we also collected disease rating data.

Plants were visually rated for disease severity on three dates: Aug 1, Aug 24 and Sept 7. There were statistically significant differences on all three dates. It was clear that as the season progressed, differences between the treatments showed more strongly, and grafted plants were most resistant to disease, either with or without the *Trichoderma* treatment, on all three rating dates. Statistical testing did not reveal synergistic nor antagonistic effects using the combined treatments.

It’s unfortunate that RootShield seemed to have no effect. In some settings, this product has clearly proven to be beneficial, not just for its antagonistic effect on *Fusarium* and other root pathogens, but because it is known to promote plant growth of a number of species of plants, but in this case, not tomato. In Dan’s situation with limited land and solid business plan based in part, on heirloom tomatoes, grafting seems to be essential, though we didn’t show a significant increase in yield. You can see that from pictures of Dan’s plants. Take a guess which plants were grafted... Obviously, the plant in the middle would not be able to produce the quantity of fruit that the ones on the outside could. In some years, the difference between grafted and un-grafted would be huge, but once the weather dried up last July, it was a tomato’s season. Differences didn’t show themselves. This is why studies like this need to be carried out over two or three seasons.

Next newsletter: Managing nutrient applications to high tunnel tomatoes