THE UNIVERSITY OF RHODE ISLAND COOPERATIVE EXTENSION

VEGETABLE PRODUCTION

THE WEEK IN VEGETABLES

January 30, 2021

Where do unused nutrients go in a high tunnel?

The high tunnel, or "plastic shelter" as it was referred to in a 1958 CT Agriculture Experiment Station bulletin, is nearly ubiquitous on small and medium-sized vegetable farms in northern climates in North America. This is in large part thanks to the NRCS-EQIP High Tunnel program which has made it possible for so many growers to have them.

Because of the delightful "finite-ness" of the tunnel footprint, growers have been able to enrich these limited patches of soil to boost productivity, which makes perfect sense. Because every grower achieves this in their own unique fashion and has their own irrigation scheme, it's hard to gauge not only nutrient availability but also where excess nutrients go that aren't being taken up by the crops. This is what a group of us from URI, UConn, and UVM have set out to study.

The idea for this came up because our colleagues at UMaine and UVM requested some information gathering in 2019 from those of us working with high tunnel tomato growers from all around New England. Soil management information and crop production data was collected- not with great precision- but enough to get a sense of the scale of nutrient applications on many farms. The practices and soil management of two growers here in RI were fairly distinct. Some quantities of applied nutrients were eyebrow-raising enough to look deeper, literally, into the soil. We applied for and were awarded funding from an NRCS program called Conservation Innovation

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Pest Spotlight

Splotchy greens in your tunnel?

This is the feeding damage of Red-legged Winter Mites. This is really a very new pest (2017-18) of winter high tunnel greens in the Northeast, and they seem to feed on anything that you might grow over the winter. Photos on the right are from a hight tunnel in Rhode Island. The following are observations and recommendations from Jerry Brust, IPM specialist at the University of Maryland:

Red legged winter mites have dark purple/black bodies and bright red legs (See above). They thrive in what we would normally consider conditions too cold for an arthropod to cause problems. This mite is cold adjusted and cannot stand hot dry soil conditions and will die as summer heat approaches. Eggs are laid in late spring and over-summer in the soil. These are stress resistant eggs (i.e., they withstand drying and heat as well as synthetic chemical applications). In the fall they will begin to hatch and mites will be active throughout the fall and winter inside a high tunnel with crops. Damage appears as 'silvering' or 'whitening' of the attacked foliage (See upper and lower right photos). Mites are most damaging to newly emerging crops, greatly reducing seedling survival and development.

Red legged winter mites are difficult to control even when using synthetic chemicals. Foliar sprays of Pyrethroids (check label for the particular crops that are labeled as this will vary greatly) or Pyrethrum +Neem or Entrust (spinosad) will reduce feeding, but if mite populations are high it will be difficult to eliminate the damage. Applications should start as soon as damage is noticed before mites have a chance to build their population. Foliage should be thoroughly covered with spray material as should soil around the base of plants.

Cultural controls involve using high levels of heat such as clear plastic mulch that is used to heat the soil and kill mites and, if used in the summer, even their eggs. Steam heat used to control nematodes and soil pathogens can be used to greatly reduce mite numbers before next fall planting. Many cultivations during the summer can significantly decrease the number of over-summering eggs that survive.

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Grants. Funding from these grants is used to study particular resource concerns and develop practices which can be employed by farmers to mitigate them. We will be engaged in this project through 2022.

Big (sort of) data collection

We are working with three farms in RI and two in CT, where we have installed sensors into the soil that monitor and log temperature and moisture conditions round the clock. From April until October, we drive in 6- three inch soil cores every four weeks

(see figure.) These are left in the ground for four weeks, at which time they get replaced by another 6 cores. These are used to study rates of mineralization of nitrogen and phosphorus over the course of the season as soil temperature and moisture vary. [Mineralization is the microbial breakdown of organic materials to the point that the N, P, and S turn into forms that are water soluble and can be taken up by plant roots.] Along with soil temperature and moisture, mineralization is affected by organic matter content, soil texture, soil structure, and even fertilizer applications. This last factor can really change mineralization rate if nitrogen fertilizer is added because this lowers the C/N ratio, potentially favoring more rapid release of nutrients. By understanding the rate at which mineralization proceeds, we are better able to predict when nutrients become available to crops. A potential issue is that because high tunnel soils warm up so much earlier than outside, nutrients may become available in much greater quantity than the crop can use. Perhaps you've noticed how in mid-June, you can pretty much watch your high tunnel tomatoes grow, and plants may become "bullish" (very thick-stemmed, with huge, very green leaves). Their roots are feasting on a massive buffet that's actually been waiting around to get "eaten". High tunnel soil conditions in early May can promote microbial activity that's more like activity that takes place in field soil in June. Small tomato plants have no use for such a big nutrient supply. If too much irrigation water is applied in these early weeks, those nutrients could be leaching away.

Where do those nutrients go?

Positively charged ionic forms of nutrients- which we call cations- stick to soil particles in a way similar to what we think of as "static electricity." That's because soil particles generally have a negative charge. This is especially true for organic matter particles, and since so many growers heavily enrich their high tunnel soils with compost, these soils tend to have high cation exchange capacities. This means such soils have the ability to "store" lots of nutrient cations, like calcium, magnesium, potassium, iron, zinc, copper, and manganese. [Don't forget, though, that for these last four elements especially, high pH (>7) will render them "bound up" into insoluble compounds.] BUT (and it's a big but, as one of my high school math teachers used to say): Negatively charged ("anionic") nutrient forms like nitrate, sulfate, borate, and even phosphate can be more easily lost to leaching because they don't "stick" as easily to soil particles. Will these nutrients leach straight down into the soil profile? And **will they somehow reach the ground water or surface bodies of water?**

Hardpans are common

In the information collecting from high tunnels in 2019, we used penetrometers to find out if there are hard pans or other impermeable layers down in the soil where water may perch. In fact, *this is a very common occurrence.* Annual or even bi-annual rototilling is often carried out in tunnels, which encourages the

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A sensor inserted sideways at 8" deep.

formation of hardpans. Also, our topsoils are not very deep, and often, less than two feet down, there is a subsoil of a very different texture- usually mucjh coarser- which also causes water to perch. If there is a saturated layer at a particular depth, it will probably flow in some direction, and that flow may be nutrient -laden. We are trying to track that movement by inserting resin capsules into the soil, both inside and outside of the tunnels. They really look like a little jelly balls wrapped in mesh teabags. We push a soil probe down to the hardpan and push the resin capsules, which we've tied strings to, down to the bottoms of the holes, and then cover them back over with soil. Twelve weeks later, we pull these back out and extract the nutrients which have been captured in them (nitrate, ammonium, and phosphate only). These resin capsules get installed in two straight lines across each of the tunnels (see figure), 22 per tunnel. The capsules installed outside of the tunnels will help us determine the direction of nutrient movements, if and when they are moving.

Soil climate

Each tunnel also gets six temperature/moisture/conductivity sensors (see figure), sunk at two depths, in pathways and within tomato rows. [Electrical conductivity (EC) is a measure of dissolved ions in solution, and is sometimes referred to as Soluble Salts.] These are connected to data logging units which collect readings every hour. We are also collecting irri-

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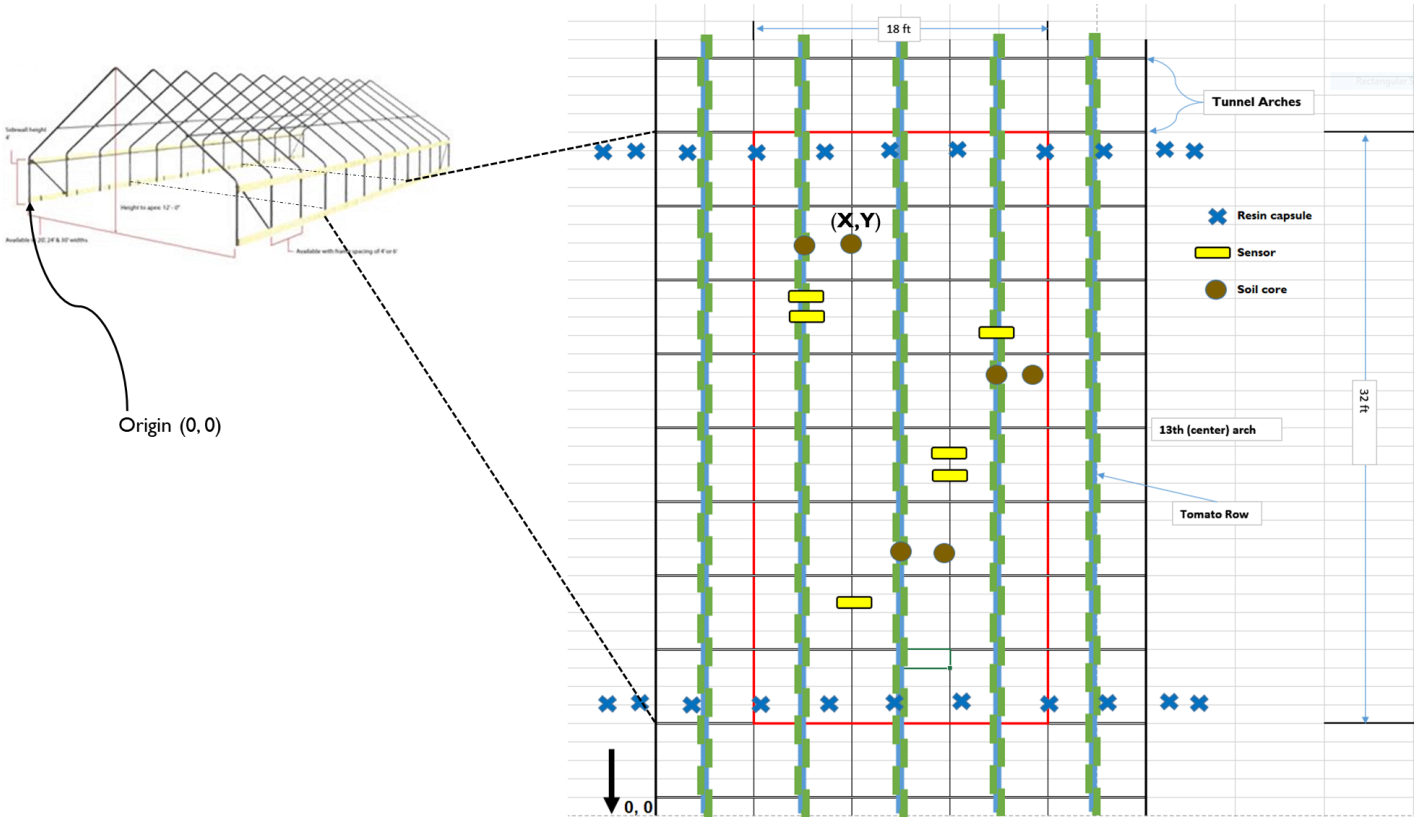

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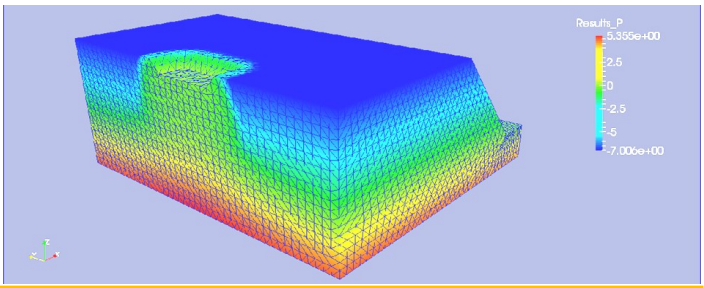
gation water usage data and calculating how much water is being applied. Irrigation events will also be captured in the soil moisture sensors. Together, these will help us to understand soil water movement in space and time.

Tying the information together

Luckily we have contracted with a soil hydrologist at the University of Vermont who will be bringing all of this information together into a modelling application called Hydrus 3D. Using accumulated data, we will be able to have a three dimensional understanding of nutrient and water movement in these soils. Such a model is used to run simulations. The model can be custom set up with a hypothetical set of physical properties (soil texture, organic matter content, and other parameters) and then varying amounts of applied nutrients and water can be plugged in to see what happens- are the nutrients remaining in the vicinity, or are some flowing away in the wrong direction? This model will become the algorithm that drives an "App" which a grower could use to help them decide on appropriate applications of nutrients and irrigation water. This is, of course, a few years down the road.



High Tunnel Tomato Fertilizer Decision Making: Do you have a plan?

The high tunnel survey of 2018 begat a great fact sheet that any high tunnel tomato growers should be familiar with. You can view it and download it. There are many suggestions worth considering, if not comparing with your own practices. One place to start is to test your high tunnel soil at UMaine. This is a package deal which uses two methods for soil analysis, and both sets of results should be weighed using Table 1 in the fact sheet. [Take samples ASAP: their lab will get backlogged if you wait for too long.] This is not a perfect set of guidelines but it's a good start. The project that we are doing at URI is meant to help growers customize their own fertilizer rates for their set of conditions. One thing we have learned so far is that every tunnel's soil is managed differently, and yields vary widely from tunnel to tunnel. **URI Cooperative Extension is available** to look at your soil tests with you, discuss your current practices, and help you decide if there are any changes that would be beneficial. Schedule an appointment when you get your test results by emailing andy_radin@uri.edu.

Your Input is Welcome

Everyone wants to hear from YOU

A paragraph or two in an email is all it takes. Also, please submit suggestions for articles, meeting topics, and research needs from us at URI.

Be sure to look at 2020 URI Research Reports

Reports from 2020 include

Fall Broccoli and Muskmelon

See them all here: https://digitalcommons.uri.edu/riaes_bulletin/

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Five Acres and Independence, the Contemporary Version

Michelle and Jim Garman, Garman Farm, Middletown

If you're one of those fortunate people whose farm has been handed down for three centuries, or even if you're a grower established on your own property, you may not find what we have to say here of much interest. But if you're a (relatively) new grower on the hunt for land, we have a few tips for you as you go forward with your search. Our first concentrated effort at acquiring property on Aquidneck Island ended in a bust, but we learned a few things along the way that may be of value for those of you considering buying land for the first time.

We are entering our ninth year of operating on land leased from the Aquidneck Land Trust, who are about as terrific a landlord as you can have. But of course, at some point, you want your own land. Our farm is only 3.5 miles from our house in Newport, but the number of times we have made the back-and-forth because someone forgot the seed or a tool is dazzling.

Our farm serves wholesale and retail customers on Aquidneck Island. We considered moving the operation to a place where land might be more affordable, but we've worked for eight years to build a 150-member CSA, and we know that most of these folks aren't going to make the drive "over the bridges" to pick up their produce. So we need to be on Aquidneck Island, where parcels are worth much more as house lots than farmland.

We were considering a parcel that was only vaguely on the open market. Wide open as late as the 1980s, it was reverting into secondary scrub and small-diameter trees. So there were land-clearing costs to be considered. Still, soil maps looked promising, so we plunged ahead in the process.

First question: could we even afford the purchase? We had no idea. But when we filed our CFAP-2 paperwork with the USDA/Farm Service Agency (FSA), we saw a brochure about mortgages through them and thought, why not? FSA has extremely attractive rates, and they are a "lender of opportunity" when the mega-bank won't even look at your application.

Working with Sheryl Michener and Pat Sullivan is a great experience. They will gently prod you to clean up any aspects of your operation that need attention – bookkeeping, credit issues, and record-keeping (even if you're not in the market for a mortgage, they'll point you to other excellent programs they have!)

If you are growing produce, you want to know everything that ever happened on the parcel you're considering. We scrutinized ninety years of aerial photographs (available through the state Department of Planning) and the parcel – now in secondary scrub and small trees – seemed to have never been in anything but hay or pasture.

You may assume you are allowed to build a house and operate a farm anywhere, which would be an ill-advised assumption. Different towns have different zoning regulations concerning farms, house lot size, and the siting and size of farm stands. In this case, the town officials were extraordinarily helpful in pointing out different regulations as well as potential tax breaks.

Soil Tests. After consulting with the FSA, the Town Planner, and the Tax Assessor, we were within a whisker of making an offer on the piece of property. All that was left was the soil tests, which weren't going to be a problem, right? The parcel was mapped as prime agricultural soil, so we were sure everything would look great.

During a run of frost-free weather, we waded out into the thicket and took samples across the property. The first batch got sidetracked somewhere in the USPS system, so we had to repeat the process and drive them to UConn. After about a week of pacing back and forth, we finally saw the soil test results come into our Inbox. And they were so unpromising that we felt like we had been run over. How could a field that had a nominally prime farmland soil and no history of over-cultivation be devoid of soil nutrients?

Here, our Extension Agent was extremely helpful in interpreting the soil test results. In this case, the nutrients had either leached out of the soil or were locked up in the secondary scrub and woody plants. So if we had, say three years to clear the parcel, chip the brush and let the chips decay into the soil, we might have something there. But he also looked at the Web Soil Survey [https://websoilsurvey.nrcs.usda.gov/] and discovered- and we could confirm it- that the soil there is very stony, which can foul up a market garden operation. This lowered our enthusiasm yet another notch. Not having those three years to carry a mortgage on a house in Newport and a separate farm mortgage, we had to pass.

Moral of the Story: Although we weren't successful in our effort, the process of getting ready to make the biggest purchase of our lives was helpful. If your credit is clear and your financial house is in order, you'll be poised to make that move when the opportunity comes up. Most important: avail yourself of the advice of every expert you can. We are ever optimistic that we'll get there in the end.