The Week in Vegetables

Managing plant nutrients for high tunnel tomatoes

Planning and documenting nutrient applications can help you to increase fruit quality and widen your profit margin

High Tunnel Nutrient Applications- We Have Lots to Learn

The high tunnel growing environment is still relatively new to growers and agricultural scientists. We know, through a lot of good documentation, that increasing soil organic matter has a positive effect on crop growth and health, and the high tunnel is a super-charged environment for tremendous productivity per square foot.

Most everyone does increase soil organic matter on their valuable little pieces of high tunnel real estate by applying copious amounts of compost. But we often see quirky and inconsistent crop growth in many tunnels, particularly with that grand-champion crop, Tomatoes. We are also seeing more foliar diseases on low growing, shallow-rooted, cold-weather crops like spinach and baby bok choi, two very popular and profitable items.

I’ve been invited to join in with 4 other states’ extension programs to study High Tunnel Tomato nutrient requirements. Why are we studying this? Because it may help us to provide growers with some fixes for some of the problems we see with fruit quality, productivity, and plant health. We will be testing high tunnel soils monthly during the season, and also taking leaf tissue samples of tomatoes. We’ll interview growers on what they are adding to their soils, and ask for yield records. The idea is to look for relationships between soil applied nutrients, soil test levels, and fruit productivity. In fact, three growers in the study will be from RI. I have two signed on already. Still looking for a third. But your tunnel has to have been in production for at least three years.

Nutrient stratification

Because tunnel soils don’t receive natural rainfall and irrigation wetting patterns tend to be narrow, much of the available applied nutrients remain in the surface few inches. While tillage can help redistribute those nutrients downwards, evaporation of irrigation water actually draws those nutrients back up to the surface. Shallow-rooted fall and winter crops like lettuce, spinach, and bok choi may encounter excessive salts while tomatoes, which can easily grow roots below two feet, may instead confine more of their roots to shallower depths.

--->Thinking about putting up a building on your farm? Inquiring Minds Wanted
You can ask all of your questions at a lunch meeting on Thursday, April 5, 2018, featuring Jack Leyden of Leyden Farm Vineyards and Winery, who also happens to be the Building Code Commissioner for the State of RI. Also, Josh Daly of the RI Small Business Development Center will provide a brief outline of what he and his colleagues can do for YOUR FARM BUSINESS!
LOCATION: USDA Building, Quaker Lane, WARWICK-- 11:00 to 1:30. LUNCH Included! RSVP andy_radin@uri.edu

---> The Census of Agriculture and YOU
Did you sell over $1,000 worth of farm product last year? If so, than you operate a farm. If you have received a census form, go dig it out of the old mail heap and fill it out. It’s really important for all of us. If you didn’t get a form in the mail but you are claiming more a $1,000 in farm product sales, get in touch with Gary Keough of the USDA-NASS: gary.keough@nass.usda.gov. (603) 224-9639. This only comes around once every FIVE years. There’s still time let the world know you exist!
High Tunnel watering practices

Short periods of watering (less than a ½ hour) may keep nutrients from moving downward in the soil profile, and may hasten evaporation. Watering for sustained periods (a few hours at a time) leaches nutrients downward. Excessive watering, however, may leach nutrients below the root zone. One discovery in recent Northeast SARE-funded work in VT-NH-ME is that undissolved nuggets of sulfate of potash were found in archived soil samples. This can be attributed to the narrow wetting patterns of irrigation tape, especially in well-drained soils. If you only use one drip tape, consider using two, but give some thought to using four tapes per bed. Making that switch would require some experimentation but could be worth the bit of extra setup and tape it requires.

Sampling tunnel soil for testing

Because of the stratification issue, it’s important when taking soil samples to take a uniform slice or core down to the sampling depth, which is the same as your tilling depth, usually 6 to 8 inches. If the whole tunnel’s soil is managed in the same way, a dozen samples should be enough, but if some beds are managed differently, then these should be used to create a separate sample. Put all cores in a bucket and mix thoroughly, and then take a subsample of two cups out for each management area for shipping to the lab. Samples can be spread out to air dry, or they can be sent immediately.

What can soil tests tell us about your high tunnel beds?

Besides very useful measures such as pH, bulk density, and organic matter content, soil tests are supposed to tell us approximately how much of essential plant nutrients will be available in the coming growing season. It’s an estimate, not a promise. Testing is done by mixing field soil with a weak acid, shaking it thoroughly, and analyzing the leachate. The acid helps to break free some of the nutrient cations and anions that wouldn’t immediately become soluble in soil water. It simulates cumulative rainfall and soil biological activity during the course of a growing season. The results can vary depending on the type of acid extractant used. The type of extractant used varies regionally around North America. Soil scientists have made these decisions as to what is standard in a region based on regional soil types. In New England, the Modified Morgan extractant is used (has nothing to do with cheap, flavored rum...). What’s good about soil testing is that it can, from year to year, give you an estimate of how demanding your crops are of your soil’s nutrients, and this can be used to fine-tune your annual nutrient applications if you keep a record over time. It’s a good practice to use the same lab every time you test.

Tunnel soil testing from another angle

After several years of enriching with compost, high tunnel soils actually have a tremendous Cation Exchange Capacity (CEC). But ongoing slow release of nutrients from that compost, combined with additional amendments applied for crop production means that the plentiful “exchange sites” are fully occupied with nutrients. Additional nutrients, as they become available from fertilizers, have no place to be except to remain dissolved in the soil water. This creates conditions for high electrical conductivity (EC), which can cause “fertilizer burn” because there are too many available nutrient cations. It also insures that testing soil from a tunnel that has been in production for several years will have nutrient test levels that will be “off the charts.”
The Saturated Media Extract (SME) is typically used to analyze soilless greenhouse media, which has a very low CEC. All added nutrients, therefore, are always available in the soil water, or else they’ve been leached out. SME uses plain water (very plain, in fact, deionized water). The media is wetted to make a paste, and then the water is sucked out of it using a vacuum funnel. This liquid is then analyzed for the dissolved nutrients, little of which came from exchange sites. It provides a “snapshot” of what is available in the media water at that time, which is sometimes referred to as “intensity” of nutrient supply.

SME is useful in high tunnel soil because tunnel soils have very high CECs and high nutrient loads. With all those sites filled up with nutrient cations, it makes sense to monitor what’s in the soil water. In high tunnels, tomato plants grow very rapidly and demand a readily available nutrient supply. Low numbers in the SME test could mean that even though you’re sitting on a sea of nutrients, they are not entering into the soil water.

Watering may be the key

Roots need water and they explore the soil to intercept it, which is also where the dissolved nutrients are. If water isn’t thoroughly moistening the volume of soil where you incorporated nutrient sources, those nutrients may not be available, even if they are present. Remember that rain isn’t falling on high tunnel soil to uniformly moisten and solvate those nutrients. Also remember that dry soil will have reduced microbial activity, and that’s where most of the nitrogen and phosphorus comes from (through microbial mineralization). Again, give some thought to using four drip tapes per bed. I will be trying it this year myself at URI.

What to do with the test results

If you send out your tunnel samples to UMaine or UMass, you will choose the “Basic” test for less than 3 years in production, or the “Long Term” test if it’s been in production longer than three years. The recommendations you receive will be based on the Modified Morgan extraction for the Basic, and the SME as well if you have been enriching your soil for several seasons. Remember that the SME result will always be lower because it represents what’s dissolved in the water, but if you have appreciable organic matter, much more is stored on exchange sites.

The tables here are adapted by Vern Grubinger at UVM and Bruce Hoskins at UMaine from work originally developed by Wittwer and Honma for greenhouse tomatoes. Table 1 lists the “optimum” ranges (in ppm) for SME nutrients. There’s a new round of research to modify and refine recommendations for K and N. Table 2 lists application rates for some organic amendments required to raise the ppm of some nutrients incrementally. These are by no means exact, but using these is probably better than guessing.

Fertilizer Application

Should you apply all up front, or does it make sense to apply a fraction at planting (50%), and then fertigate or topdress over the season? More and more growers are splitting the application, and with good reason. If all of your soil’s exchange sites are saturated, watering may cause leaching, especially of nitrate and K⁺. I don’t know about you but I am guilty of forgetting to turn the water off occasionally. (The $12, 2-hour mechanical timer though, has ended that problem.) If you are using fertilizers that can be carried in water, fertigation is the way to go. You can apply small amounts of N and K weekly,
and Mg and S if your soil test was less than optimum. Boron application is also possible, but it takes very little to supply an adequate amount, and it’s mainly a concern on sandy soils. If you apply compost, you will be applying micronutrients.

Table 3 shows leaf tissue test ranges. Combined with your direct observations, leaf tissue numbers may tell a better story during the season than anything. If you consider what you can potentially make in a tunnel full of tomatoes, profit-wise, it is money well spent. Consider doing it monthly during the season. If you need help with this, please contact me – I’d be glad to come out and show you how to do it and how to handle the leaves.

**What fertilizer products to use?**

Some of these nutrients, like Ca, Mg, P, and S can all be applied pre-plant. Nitrogen and potassium might better be applied with some up front and the rest fertigated or top dressed (remember that if you top dress, it must be worked in and needs to have irrigation water reach it, factors which make running them through the drip more attractive.)

**Calcium:** If your pH is on the low side (below 6), it’s OK to consider calcitic lime as part of your calcium application, but if you are on the higher side, use Gypsum, which is calcium sulfate (18% Ca, 15% S). This will not affect your pH.

**Magnesium:** Similarly, if your pH is low, you can use dolomitic limestone (~23% Ca, 9% Mg) for pH correction and addition of Mg and Ca. However, if your Mg is above optimum and you need pH correction, use calcitic limestone (~40% Ca), which has little to no Mg. If your pH is on the high side but you need Mg, use Epsom salt, which is magnesium sulfate (9% Mg, 14% S). Another magnesium amendment, known variously as Sul-Po-Mag, K-Mag, Sulfate of Potash-Magnesia, or in unrefined form, Langbeinite, has an analysis of approx. 0-0-22-25-11Mg. That K number is as K₂O.

**Potassium:** There is, as mentioned above, the sul-po-mag products, and at 22% K (as K₂O), that’s substantial. Sulfate of Potash (potassium sulfate) is 0-0-52-185. You can also use wood ash but it can be low in K content (0-1-3) and remember that it has a rapid liming effect. If your soil pH is already on the higher side, don’t use it.

**Phosphorus:** The best source (from organic production perspective) is bone char (13% P as P₂O₃), which has much more rapidly available P than bone meal, but it is expensive- but you shouldn’t need much, and if you have applied lots of compost over time, check your soil test: you may be all set for P. Bone meal has more slowly available P (also 13%), while rock phosphate is very slow release.

**Nitrogen:** Most organic N sources have little immediately available N, but in the warm, humid conditions of the high tunnel, mineralization proceeds rapidly, as long as irrigation water makes contact with applied amendments.

Seed meals (peanut, cottonseed, soy) don’t have instantly available N, but do mineralize rapidly. They tend to have around 6% to 9% N and nearly all (85% to 90%) of their organic N is mineralized within 60 days of application (Fine, Cole and Penn, 2013. HortScience 48(7):891-896.)

Animal wastes (Blood meal, feather meal): Both blood and feather (both total of ~12% N) have only about 0.03% immediately available N, but mineralization proceeds rapidly, with between 12% and 25% of the N in these products available within 2 weeks. An interesting study looked at these rates, and you can see the powerpoint on-line: [http://aesl.ces.uga.edu/seras6/PRES/MineralizationoforganicNfertilizers-SERA62012.pptx](http://aesl.ces.uga.edu/seras6/PRES/MineralizationoforganicNfertilizers-SERA62012.pptx).

A useful but expensive product is Chilean Nitrate (15-0-2), which chemically speaking, is Sodium Nitrate. If you are certified organic, you are allowed to use this for up to 20% of your total nitrogen usage. This product is largely water soluble, save for the impurities. It can be directly fertigated once it’s been dissolved. You may want to keep it on reserve for later season application.

Fish emulsion or hydrolysate: These products are often in the 5% range BY WEIGHT, so remember that if you are trying to calculate your application rate, you need to know the density of the product you are using, and that’s usually on the label. Otherwise, you will have to weigh a known volume yourself. These also usually contain a little P and K along with, but not enough to provide much of a supplement.

<table>
<thead>
<tr>
<th>Macronutrients (%)</th>
<th>Micronutrients (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Fe</td>
</tr>
<tr>
<td>4.0 - 5.0</td>
<td>50 - 200</td>
</tr>
<tr>
<td>P</td>
<td>Zn</td>
</tr>
<tr>
<td>0.5 - 0.8</td>
<td>25 - 60</td>
</tr>
<tr>
<td>K</td>
<td>Mn</td>
</tr>
<tr>
<td>3.5 - 4.5</td>
<td>50 - 125</td>
</tr>
<tr>
<td>Ca</td>
<td>Cu</td>
</tr>
<tr>
<td>0.9 - 1.8</td>
<td>8 - 20</td>
</tr>
<tr>
<td>Mg</td>
<td>B</td>
</tr>
<tr>
<td>0.5 - 0.8</td>
<td>35 - 60</td>
</tr>
<tr>
<td>S</td>
<td>Mo</td>
</tr>
<tr>
<td>0.4 - 0.8</td>
<td>1 - 5</td>
</tr>
</tbody>
</table>

Table 3: Optimal nutrient ranges in greenhouse tomato leaves (dry wt.)

From Oregon State University Greenhouse Tomato Production Guide

Similar ranges are recommended by North Carolina Dept of Agriculture

http://aesl.ces.uga.edu/seras6/PRES/MineralizationoforganicNfertilizers-SERA62012.pptx