LESSONS LEARNED FROM ON-FARM TRIALS WITH ORGANIC MIXES – MIX FERTILITY

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In spring 2012, our team worked with 14 local growers on this project looking at substrates and fertilizers for organic transplant production. Thank you to the many willing growers who hosted a trial! This article is the first of two on lessons learned. This one is related to mix fertility.

The typical organic potting mix has some permutation of the following recipe: 70% peat, 30% compost, lime, and bagged nutrients (bloodmeal, kelp meal, greensand, rock phosphate, bonemeal, etc). Usually vermiculite (a natural mineral that expands with heat) or perlite (volcanic glass, popped like popcorn by fire) is added to lighten the mix and increase drainage. Sometimes coconut coir (fibrous coconut shells) is included or occasionally other materials (rice hulls, other organic fertilizers). Everyone has their proprietary proportions and tweaks on this recipe.

Making your own mix on farm is attractive because the components are simple, compost is usually available locally or on-farm, and shipping potting mix is ungodly expensive. However, we've seen several problems with farm-made mixes that have limited plant growth.

High salt levels is a common problem, especially when using manure-based composts. "Salts" in this case means any ion (molecule with a positive or negative charge), including nitrate (NO_3), ammonium (NH4), K, Ca, Mg, Na and Cl. Notice that most of those are plant nutrients—only sodium and chloride (table salt) are not. Plants need these nutrients to grow, but too much of them burns root tips, causing poor germination and slower plant growth.

We measure salts with an Electrical Conductivity meter (EC meter), and there are several methods and units of measurement. In our tests, we diluted 1 part potting mix with 2 parts distilled water and measured results in microseimens per centimeter (µS/cm). Another common unit that EC meters list is milliseimens per centimeter (mS/cm) which is equivalent to mhos/cm. To convert to µS/cm multiply mS/cm (or mhos/cm) by 1,000. Therefore, 0.5 mS/cm (0.5 mhos/cm) = 500 µS/cm. Phew! The tables below list guidelines for EC of vegetable seedlings and transplants. Notice that in the tables the acceptable range for germinating seeds is lower than for sizing transplants. Germinating seeds are particularly susceptible to salts damage. Remember, salt damage is often because of high nutrients like high nitrogen, rather than sodium chloride.

EC guidelines 1:2 extraction method (1 part soil, 2 parts distilled water)

1:2 extraction µS/cm	Indication
0-250	Very low
260-750	Good for germination
760-1250	Desirable for growth – reduced growth in onions, peppers and lettuce
1260-1750	Slightly high, too high for seedlings
1760-2250	Reduced growth, leaf edge burn
>2250	Extreme. Most crops will suffer salt injury at these levels. Immediate leaching required.

Source: Knott's Vegetable Handbook

EC guidelines – maximum salinity before plant damage 1:2 extraction method (1 part soil, 2 parts distilled water)

Vegetable	Max salinity before damage (µS/cm)
Turnip	900
Bean	1000
Carrot	1000
Onion	1200
Radish	1200
Lettuce	1300
Pepper	1500
Sweet potato	1500
Broad bean	1600
Corn	1700
Potato	1700
Cabbage	1800
Celery	1800
Spinach	2000
Cucumber	2500
Tomato	2500
Broccoli	2800
Summer Squash	3200
Beet	4000
Zucchini	4700

In our on-farm measurements, high salts really did lower germination and early plant growth. One farm tried three potting mixes for growing early transplants of lettuce, spinach and beets. There was a marketable difference between plant growth in the different mixes. The pH was acceptable in all mixes, so in this case the EC measurement explained the growth difference. The best plants had an EC of 850 us/cm, right in that "good for growth" range. The smallest plants had an EC of 1400 us/cm, too high for seedling germination and growth. The middle plants had an EC of 420 us/cm, fine for germination but nutrient-limited for growing on the seedlings. An additional mix they had made with poultry compost didn't germinate anything at all—EC was sky high at 2200 us/cm, and the compost used was still producing heat.

Compost maturity is another major factor that affects the finished potting soil. Immature composts produce ammonia, a gas which damages seedlings. Compost used for potting mixes can be tested for maturity with a Solvita test kit that measures carbon dioxide and ammonia given off over a 4 hour period. We have found that even when farms purchase "composted manure," it is often not finished with the whole composting process. That's fine for spreading on the field, but not for using in a potting mix.

Overall fertility of the mix is harder to measure and seems to be one of the tougher things for organic farms to optimize. Organic farmers generally expect the mix to provide the majority of the nutrients the plants will need until they are transplanted into field soil, but front-loading the mix with too many readily-available nutrients can result in high salts levels that decrease germination. The challenge is providing enough nutrients that will be released over time (using those unpredictable biological processes!) without burning seedlings.

Farms *could* use a different mix for germinating and potting up—at least one farm in our area does this. Still, there are plenty of instances where seeds germinate and grow to transplant size in the same cell, without a potting-up step. Vermont Compost Company, a supplier of some of the highest-performing organic potting mixes, suggests that their mixes contain enough nutrients for plant growth until the plants' roots fill the container. At that time, they should either be potted up or given over-the-top supplemental fertilizer. This recommendation seemed to hold true in our observations of many organic potting mixes.

In our trials on farms, several of the more experienced farmers routinely fertilize their organic transplants as they are growing. Liquid fish emulsion is one option, but my favorite low-labor simple method is sprinkling Fertrell (4-2-4) over top of the plants using a parmesan cheese container. Sweetland farm does this, and reports that plants green up in just a couple days.

Trialing several commercial organic potting mixes next to your own farm-made mix can be eye-opening. During our trials, several experienced farms that *had no complaints* about the transplant growth in their own mixes saw that plant growth was still better in some of the other mixes.

In one case, measuring media pH provided the clue as to what was going on. Their mildly alkaline water made the media pH creep up, and their mix ended up with a pH of 7.6 in tomatoes, 7.9 in onions—and plant growth suffered. McEnroe and Vermont Compost mixes start out at fairy low pH's (~5.5) to compensate for alkaline water, and these mixes consistently performed well in our trials. Next year this farm will use less lime in their mix recipe.

In another instance, plant growth was limited by low nutrients in the farm's mix. Most of the time manure-based composts can't provide enough fertility for a good potting mix by themselves--when used successfully, compost-based mixes include supplemental fertilizers. But this farm also processes poultry and includes the waste in their compost, essentially adding their own bloodmeal and bonemeal, resulting in an exceptionally high-nutrient mix. But last fall we had excessive rain, and we suspect that the nutrients they normally count on got washed out. The farm hopes to make a covered composting area to address this problem. Incidentally, this farm germinates seeds in a low-EC mix using channel

trays, then pricks out seedlings into their high-nutrient mix. Germination in their high-nutrient mix has been unreliable, probably because the mix has a high EC.

One of the inherent challenges with composts is that they are variable, so two of the trial farms are planning to test their compost for nutrients well before making up their mix for the year. By doing this year after year, they hope to establish a baseline level of nutrients that their compost normally contributes to their potting mixes. With a baseline established, they hope to be able to supplement their mix with extra nutrients only when the test indicates that they would need it.

Potting soils in trials: We included one national brand organic mix in our trials—Sungro makes organic versions of Sunshine mix, a commonly used mix among conventional bedding plant growers. These mixes were essentially peat/perlite based mixes with a rather small dose of organic starter charge, after just 3-4 weeks plants were beginning to look nutrient deficient (such as purpling of stems and the underside of lower leaves indicating not enough phosphorous; or lower leaves turning quite yellow indicating not enough nitrogen). McEnroe and Vermont Compost mixes consistently had much higher fertility levels, while not experiencing germination problems. The two Vermont Compost mixes (Fort Vee and Fort Lite) both seemed to have a little more fertility than McEnroe's mix, but all three mixes did very well. We threw in an organic mix made at Cornell that includes 5% vermicompost, plus bagged organic nutrients over a peat/perlite base. It usually did very well, but ran short on nutrients a little before Vermont Compost and McEnroe.

Tools for making your own mix: A pH and EC meter is a wonderful tool; I'd even say an essential tool for growers making their own mixes. For this project I bought an Oakton pH/EC tester for $130. The pH meter is able to be calibrated—this is important! With my new meter we learned that 5 weeks of watering with mildly alkaline water raised media pH's over 1 unit from the starting point, and that was limiting plant growth. We measured dairy manure compost EC level, and found that it was contributing to high salts level of potting mix, also limiting plant germination and growth. Coconut coir, though originally suspected of contributing to the salts level in this mix, was innocent. The meter allowed us to go from supposition and guess-work to facts, diagnosis, and improvement of the mixes, $130 well spent.