SUCCESS WITH ORGANIC SUBSTRATES

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Some greenhouse operations have noticed an increasing consumer demand for organic edible transplants. The term edibles encompass not only vegetable and herb transplants but also edible flowers (ex: viola, nasturtium, calendula) and plants used for essential oils (ex: lemon verbena, pineapple sage, and scented geraniums). Operations can choose to produce "certified organic" edibles, in this case the crop can be marketed as organic but the operation must follow The National Organic Standards (NOS) and must use a USDA-accredited certifying agent. However, we are noticing an uptick in the number of operations following organic production practices for edible transplants but not as "certified organic". In this case the operation cannot use the term "organic" when marketing their crops; however, they can have an honest conversation with their consumers regarding their production practices.

Organic growers have identified that it is difficult, especially at first, to manage the root-zone using organic fertilizers and substrates. The January Greenhouse Management article addressed selecting organic fertilizers. In this article we will follow up with suggestions for using and selecting organic substrates.

Common pitfalls with organic substrates

Many of the ingredients used in common soil-less substrates are also suitable for use in organic substrates, examples include peat, bark, perlite, vermiculite, limestone, and compost prepared following NOS. However conventional fertilizers and wetting agents are not allowed. In our extension work with growers over the past couple years we have noticed some common problems with organic substrates:

- The substrate contains high salts or unfinished compost leading to poor seed germination (Picture 1). Older seedlings transplanted into such mixes may exhibit soluble salt burn, or leaf damage to ammonia or volatile organic compounds. High salts may come from unfinished compost or an excessive amount of organic fertilizer incorporated into the mix.
- Nutrient starved plants because the fertility in the substrate runs out over time. Organic substrates vary greatly in how much of a starter fertilizer charge is added. We have observed commercial substrates that provide only 2-3 weeks of fertility for vigorous growing plants while others have lasted up to 6 weeks. It is important to work with your supplier to determine how much fertility can be expected from their substrates and their recommend strategies for adding fertilizer.
- Problems with high pH. When pH of the substrate rises above 6.5 many micronutrients (such as iron, manganese, zinc, and boron) become insoluble making it difficult for plant roots to absorb them. Iron deficiency (yellowing between the veins of new leaves) is a common symptom of high substrate pH (Picture 2). Many common components of organic substrates contribute to a high pH (composts, manures, poultry litter, etc.). The rate that limestone is incorporated into the substrate should be adjusted downward to account for this. If your irrigation water contains moderate or high alkalinity (> 100 ppm $CaCO_3$) you may also be increasing your substrate pH every time plants are watered.

Conventional growers can use ammonium- or urea- based fertilizers to lower pH or add sulfuric, phosphoric, or nitric acids to the irrigation water. These tools are not available to organic growers; but they may use citric or acetic acids prepared following NOS.

Test early, test often

It is important to test your substrate for pH and EC (electrical conductivity, a measure of total salts) prior to growing plants in it. Begin by taking substrate samples from several different plants; be sure to take your sample for the area of active root growth in the container. Following the 1:2 dilution method you can mix 1 part (by volume) substrate sample with 2 parts distilled water. Mix the substrate and water thoroughly and test with handheld pH and EC meters. Check the EC to make sure it is appropriate for the crop to be grown. An EC of 0.75 dS/cm or less is desirable for germinating seedlings (Table 1). EC guidelines such as Table 1 were developed for conventionally grown crops and may need to be adapted somewhat for organic materials. However, these guidelines and in combination with periodic monitoring will help to indicate whether fertility/salts are too low, excessive, or on track.

Most crops prefer a substrate pH of 5.5 to 6.5, though some crops (such as pansies, basil, peppers, and petunias) are more sensitive to iron deficiency and prefer a pH less than 6.0. Periodic monitoring is important to indicate whether plants continue to have proper substrate EC and pH. More information and details on various methods of pH and EC testing is available at www.greenhouse.cornell.edu

Getting fertilizer right

Conventional transplant producers are accustomed to supplying water soluble fertilizers in their irrigation water (fertigation). However, the cost of liquid organic fertilizers is high enough that many seasoned organic growers prefer to load up their fertility into the substrate prior to transplanting. For crops grown for an extended time or for vigorous feeders (tomatoes) additional substrate incorporation above what is already in the substrate or top dressing granular organic fertilizers is common. Occasional applications of liquid organic fertilizers are used, as necessary, to green plants up.

At Cornell University we recently conducted an experiment to determine the best incorporation rates of Sustane 8-4-4 organic fertilizer in production of retail ready tomato and pepper transplants in four-inch containers. Sustane 8-4-4 is a 45-day slow release fertilizer derived from composted turkey litter, hydrolyzed feather meal, and sulfate of potash. We chose to grow tomato because it has a relatively high fertilization requirement. We chose pepper because it has a low/moderate fertility requirement and it is sensitive to high substrate pH. Plugs of tomato 'Celebrity' and pepper 'Declaration' were transplanted into a peat-perlite substrate with added dolomitic limestone (5 lbs. per cubic yard). Sustane was incorporated into the substrate at rates of 0, 5, 10, 15, or 20 lbs. per cubic yard and there was no additional starter nutrient charge in the substrate. Plants were watered as needed with tap water that had an alkalinity of 120 ppm $CaCO_3$ (moderate alkalinity). Periodic PourThru measurements were taken to determine root-zone pH and EC (electrical conductivity, a measure of total salts). After six weeks, shoot fresh weight of the plants was measured to determine effect of Sustane treatments on plant growth.

The Sustane 8-4-4 added to substrate pH (Fig. 1.), this was higher than optimal (i.e. greater than 6.5) when the incorporation rate was 15 lbs. per cubic yard or higher. We should have decreased our limestone addition for the higher Sustane rates to end up with a balanced pH. The initial EC of the substrate correlated closely with the Sustane incorporation rate (Fig. 2). Between week 3 and 4, EC declined dramatically suggesting much of the fertilizer was becoming consumed. By six weeks after transplanting the EC was very similar regardless of incorporation rate suggesting the fertilizer had been consumed. This makes sense in light of the fact that Sustane 8-4-4 is stated to have a release period of 45 days. If we had continued to grow on these plants we should have top-dressed with additional fertilizer.

For tomato, 10 pounds per cubic yard Sustane was about the right incorporation rate under our experimental conditions. Greater incorporation rates did not significantly enhance plant size/fresh weight (Pic. 3., Fig. 3.). For pepper 5 pounds per cubic yard Sustane gave the greatest growth, higher rates of incorporation led to a modest decline in plant fresh weight (Pic. 4., Fig. 4.). This finding may be primarily due to the fact that pepper is a lower feeder, but also due to the fact that pepper is sensitive to high root-zone pH. Visually, iron deficiency was noted when the incorporation rate was 15 pounds per cubic yard or greater.

Take aways

Production of organic edible transplants can be both challenging and rewarding. Organic growers have a more limited tool kit available to correct for high pH, low fertility, or for solving specific nutrient disorders as compared to conventional growers. Therefore organic transplant production requires extra diligence in testing substrates and fertilizer components prior to their use and periodic monitoring during production. Small-scale trials before using new materials can also save thousands of dollars in later losses.

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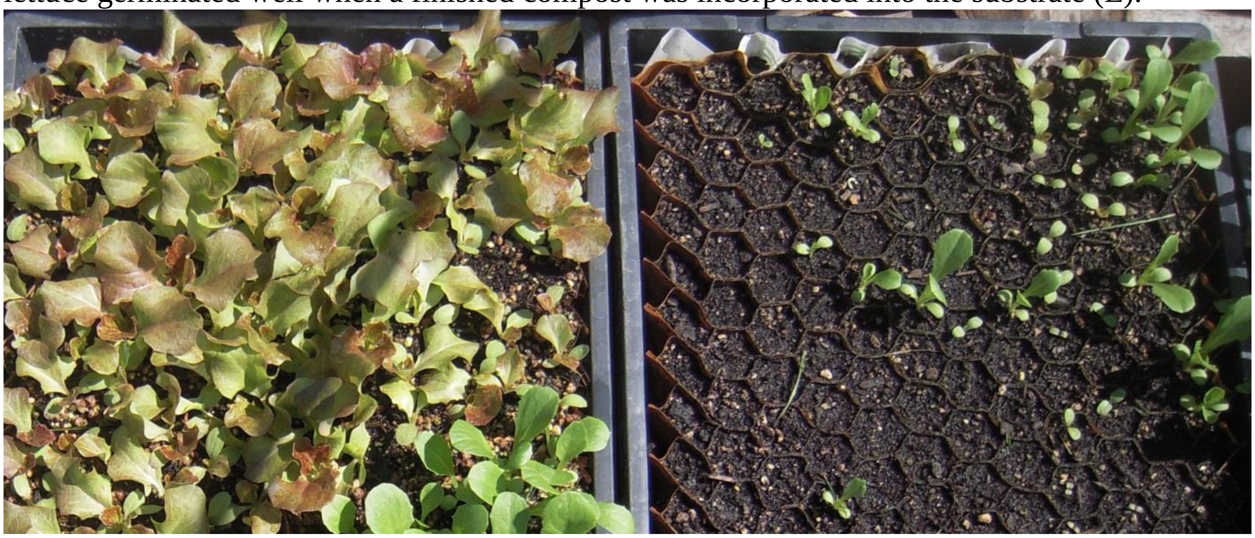
Table 1. EC interpretation values, units: mS/cm = dS/m = mhos/cm (these 3 units are equivalent to each other)

[1]**1:2 Dilution**	**PourThru**	**Interpretation**
0 to 0.25	0 to 1.0	**Very Low**. Nutrient levels may not be sufficient to sustain rapid growth.
0.26 to 0.75	1.0 to 2.6	**Low**. Good for germination. Suitable for light feeders and salt sensitive plants.
0.76 to 1.25	2.6 to 4.6	**Normal**. Standard range for most established crops actively growing. Upper range for salt sensitive species.
1.26 to 1.75	4.6 to 6.5	**High**. Reduced vigor and growth may result, particularly during hot weather.
1.76 to 2.25	6.6 to 7.8	**Very High**. Salt injury may occur, reduced growth rates likely.
> 2.25	> 7.8	**Extreme**. Most crops will suffer salt injury at these levels. Immediate leaching is required.

[1]Adapted from: Cavins, Whipker, Fonteno, Harden, McCall and Gibson. 2000. Monitoring and Managing pH Using the PourThru extraction Method.

Pic. 1. Poorly germinating lettuce (R) due to high substrate salts from use of fresh compost, lettuce germinated well when a finished compost was incorporated into the substrate (L).



Pic. 2. High substrate pH can lead to iron deficiency which appears as yellowing between the veins of newer leaves.

Pic. 3. Tomato response to Sustane 8-4-4 incorporated at rates of (L to R) 0, 5, 10, 15, and 20 pounds per cubic yard.

Pic. 4. Pepper response to Sustane 8-4-4 incorporated at rates of (L to R) 0, 5, 10, 15, and 20 pounds per cubic yard.

Fig. 1. Substrate pH in response to Sustane incorporation rate.

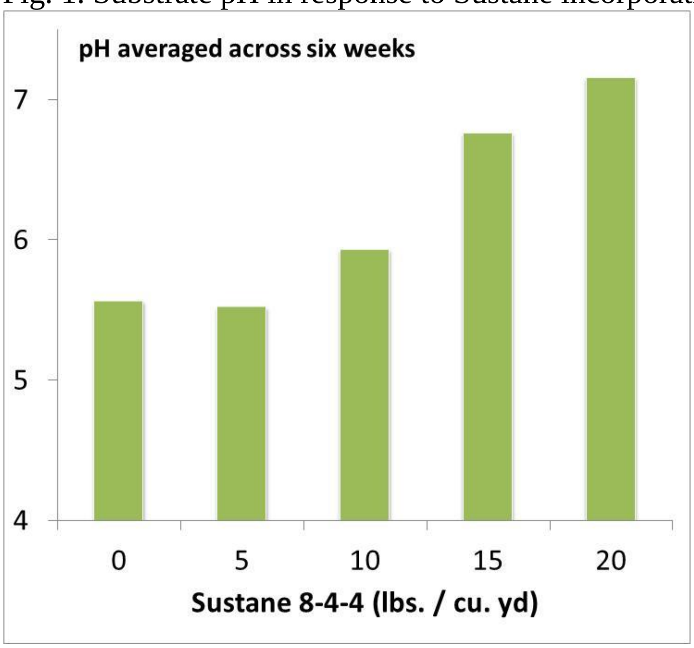


Fig. 2. PourThru EC trends in response to Sustane incorporation rate.

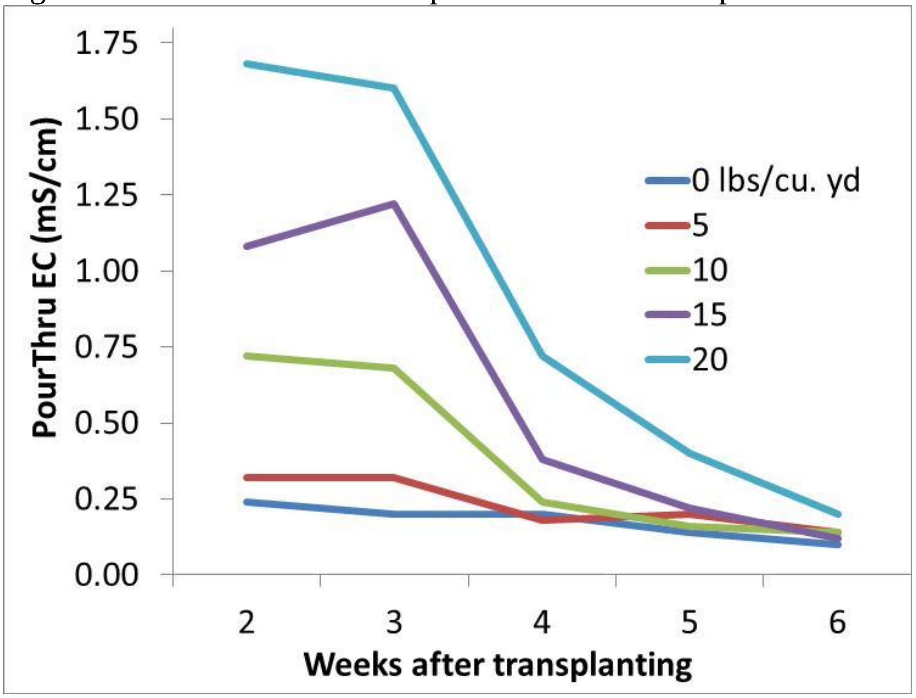


Fig. 3. Tomato growth in response to Sustane incorporation rate.

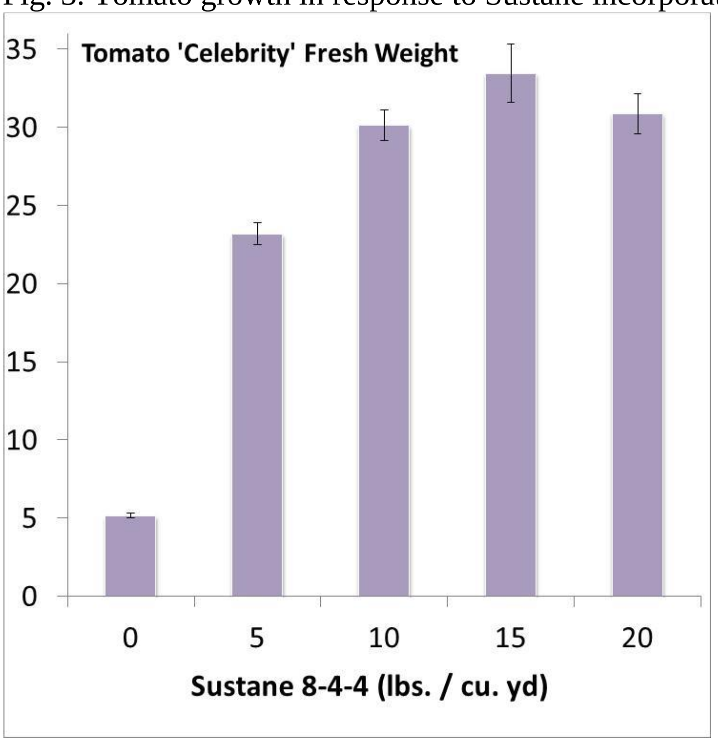


Fig. 4. Pepper growth in response to Sustane incorporation rate.