Organic Fruit Production in High Tunnels

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Raspberry Tunnels in September (L) and Buckwheat in uncovered tunnel in August (R), E. Lansing, 2010.

Background

Three season tunnels are low technology hoophouses that create a beneficial microclimate for crops. They are not designed to support snow so the plastic is removed before winter, but are less expensive (less than $1.00 per ft^2) than 4-season tunnels ($2.00 to $4.00 per ft^2). Brambles (raspberry and blackberry) and sweet cherries produce more and higher quality fruit under tunnels. Tunnels also reduce certain insect pests and diseases, so they have potential for organic production of high value fruit crops in Michigan. A 1-acre complex of Haygrove high tunnels was constructed in 2009 at the MSU Horticulture Teaching and Research Center in East Lansing. In 2010, three bays were planted in red raspberries and 6 bays received soil building treatments consisting of compost and cover crops in preparation for 2011 plantings of high density sweet cherries (3 bays), and apple nursery production and raspberry cherry inter-plantings (3 bays).

A primary goal is to learn how best to manage soil fertility and quality. Certain challenges are inherent to perennial crops under high tunnels, such as the absence of precipitation, inability to rotate crops, restriction of tillage around perennials and problems associated with injecting organically approved nutrients through trickle irrigation lines.

Objectives

- Understand nitrogen retention beneath high tunnels from amendments applied in spring
- Understand management effects on soil EC levels and distribution in the soil profile

Methods

The three raspberry tunnels were planted in late April, 2010 with three rows of raspberries per tunnel; one of each variety Himbo Top, Joan J or Polka. Each 200ft long tunnel was subdivided into eight 25ft long plots that received one of four treatments:

1. Dairy compost (Morgan's Compost) at 10,000 lbs/acre incorporated prior to planting
2. Dairy compost at 20,000 lbs/acre incorporated prior to planting
3. McGearies 8-1-1 organic fertilizer at 1,250 lbs/acre
4. McGearies fertilizer at 2500 lbs/ acre

Initial plans called for the low rates of compost and fertilizer to be repeated in early summer. Due to poor plant establishment and elevated soil EC's, second applications was omitted. Soils were sampled to a depth of 8 inches beneath the raspberry rows and soils were analyzed for pH, EC (salts), and nitrate-N and ammonium-N.

In October, a detailed set of soil samples was taken from the high compost treatments (Table 1). Samples were taken directly beneath the trickle irrigation line and 16" from the irrigation line and separated at three depths; 1", 4", and 10" from the soil surface.

Results

Nitrogen dynamics

- Ammonium-N was the dominant form of soil inorganic-N across treatments at the beginning of the season (Figure 1).
- Nitrate-N became the dominant form in all treatments by mid June (Figure 2).
- Total soil inorganic-N was similar across treatments at seasons end, around 5 mg/kg (Figure 3).

Soil Salts

- Levels were similar in low compost, low fertilizer and high fertilizer treatments and elevated in the high compost treatment (figure 4).
- The highest EC level was slightly higher than 1.0 mmhos/cm, which is not expected to affect mature raspberry growth.
- At the end of the season, salt levels were much higher near the surface and increased at a 16" distance away from the trickle line

Conclusions

Nitrogen dynamics

- End of season inorganic-N levels were high compared to typical field soils. This suggests that amendments applied in April maintained relatively high levels of available N though September.

Soil Salts

- Soil EC generally remained below levels that would effect mature raspberry plants but may have hampered plant establishment.
- Soil salts had a tendency to accumulate in the upper portions of the profile but to a lesser extent in the zone directly beneath the irrigation tube.

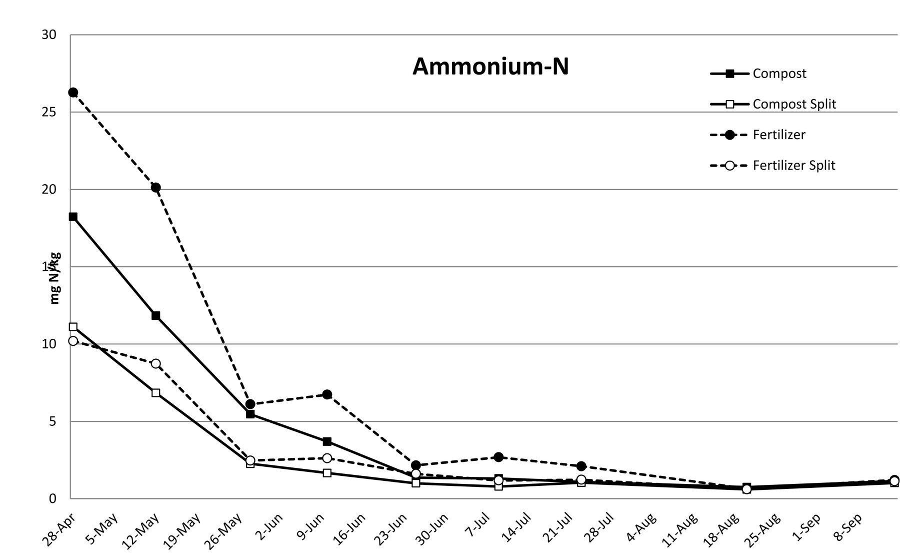

Figure 1. Effect of pre-plant additions on soil ammonium-N levels in high tunnels, E. Lansing, MI 2010

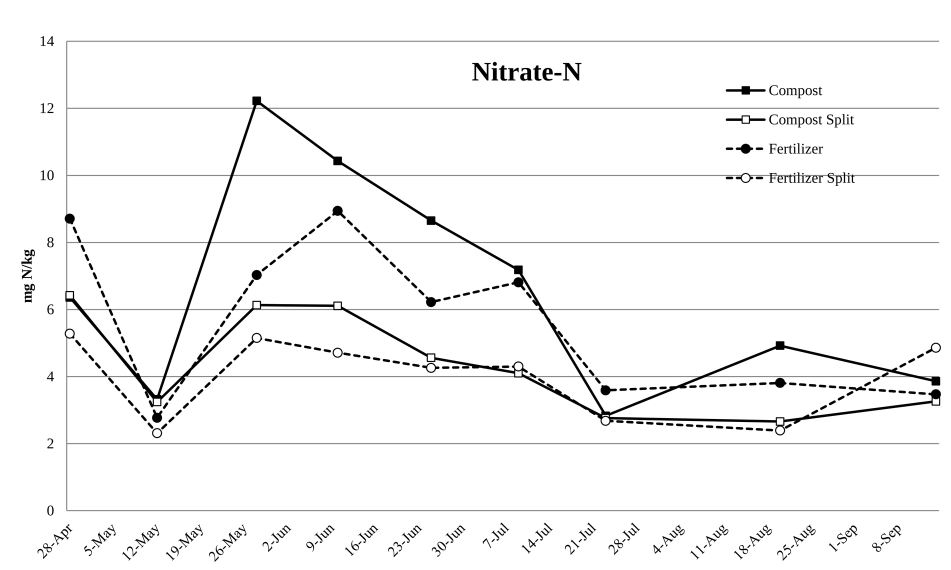

Figure 2. Effect of pre-plant additions on soil nitrate-N levels in high tunnels, E. Lansing, MI 2010.

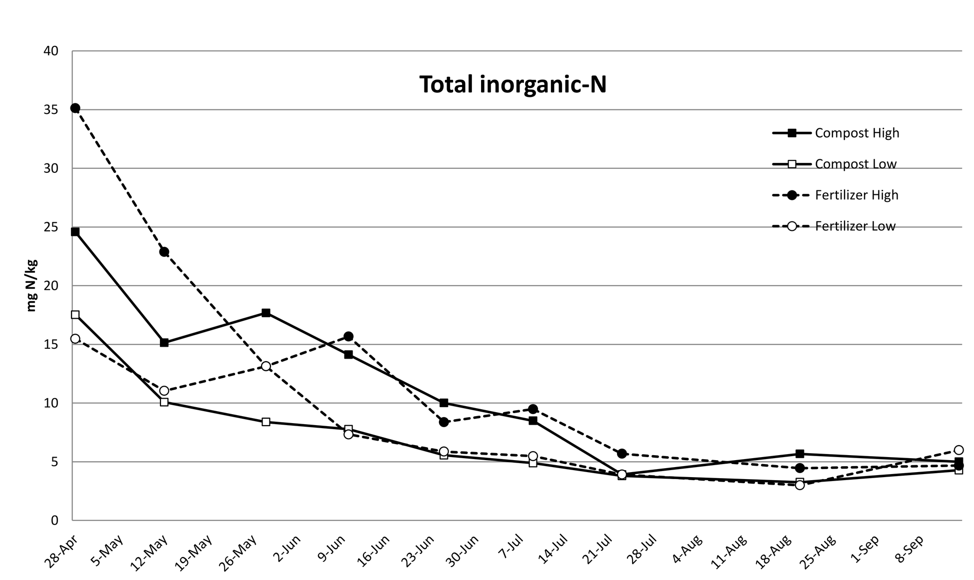

Figure 3. Effect of pre-plant additions on total soil inorganic-N (nitrate and ammonium) in high tunnels, E. Lansing, MI 2010

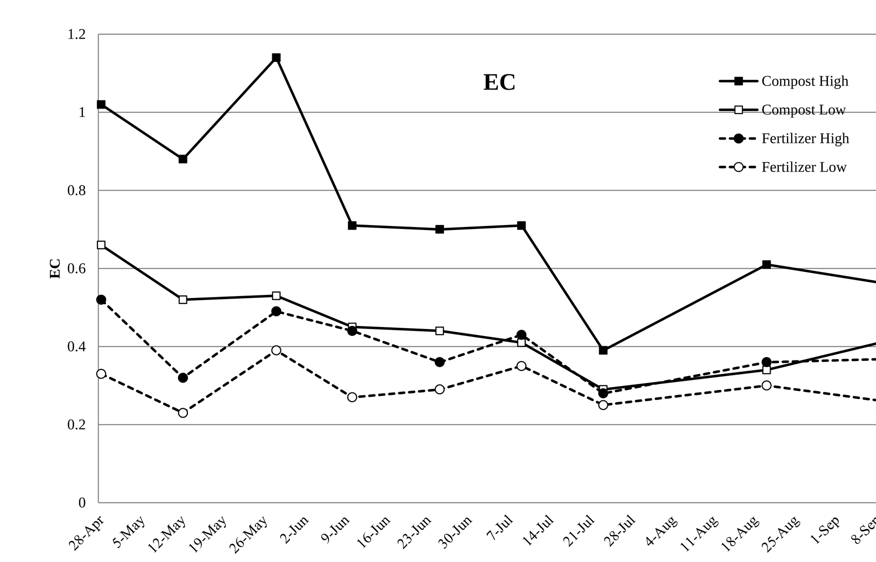

Figure 4. Effect of pre-plant additions on soil EC (mmhos/cm) in high tunnels, E. Lansing, MI 2010

Table 1. Variation in soil electrical conductivity (mmhos/cm) with depth and distance from trickle irrigation line, October, 2010.

Beneath trickle tube		16" from trickle tube	
Depth (in)	EC	Depth (in)	EC
1	2.27	1	3.36
4	0.91	4	1.13
10	0.50	10	0.67

High density sweet cherries under high tunnels at CHES, Clarksville, MI.

Raspberry plants were slow to establish in soils with elevated EC

Raspberries growing in early summer. The variety Himbo Top (center row) took longer to establish.

Fall Raspberries (L to R) from the varieties Himbo Top, Joan J and Polka

Funding Partners:
CERES Trust

USDA Organic Research and Extension Initiative

MSU AgBioResearch

MSU Undergraduate Research Program