ECHO® Research Notes

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Eggplant Fruit Production Response to NPK and Organic Fertilizer Rates

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Abstract

This study, conducted at ECHO during the Summer of 2011, was carried out to compare eggplant fruiting response to varying rates of a standard mineral fertilizer versus 6 month old compost with 25% cow manure and 75% plant matter (evenly split between woody and green, leafy material). The high rates were standard rates used on the ECHO Global Farm. Treatments included NPK (8%-2%-8%) fertilizer at 0%, 33%, 66% and 100% of the rate recommended by the University of Florida (200 lb N/acre), and compost at 33%, 66% and 100% of the ECHO-recommended high rate (1 liter/plant). The NPK fertilizer was applied in three equal amounts on 2 June (preplant), 13 July and 5 August, whereas all of the compost was applied on 2 June. Seedlings (resulting from seeds sown in the greenhouse on 5 May 2011) of *Solanum melongena* 'Florida Market' were transplanted into raised beds on 2 June 2011. Fruit weights, averaged over all the rates, were twice as high with NPK fertilizer as compared with compost. The effect of fertilizer rate on yields was similar with NPK and compost. With both fertilizers, eggplant production increased with increased fertilizer rate. Results indicate that: (1) NPK achieved more production than compost; and (2) the full yield potential of eggplant was not reached with the highest rates of either fertilizer. If conventional NPK fertilizer is to be replaced with compost, while still achieving the same level of production (especially on very sandy soils during an initial growing season), compost will likely need to be applied at higher rates and/or combined with other practices (e.g. split applications and mulching). It is also recognized that soil biology takes time to develop, and the performance of compost may improve over subsequent growing seasons.

Figure 1. Images of experimental plots, August 2011.

Introduction

Organic matter adds nutrients and hosts soil life that more effectively cycle nutrients. As ECHO implements management practices that build organic matter in the farm soil, less chemical fertilizer may be required to attain yields equivalent to those achieved in the past with rates based on University of Florida recommendations (200 lb N/acre).

Composted manure is a high-nitrogen fertilizer that can be readily produced and harvested in small-scale scenarios. Evaluation against a standard chemical fertilizer may show the relative effectiveness of composted manure as a fertilizer, thereby providing a guide for use as a chemical alternative at ECHO.

The purpose of this experiment is two-fold: a) to determine if ECHO's amended soils call for chemical fertilizer requirements lower than the IFAS recommendations in order to produce significant fruit yields.

Materials and Methods

Materials:

- Finished composted cow manure NPK fertilizer (8%N-2%P-8%K)
- *Solanum melongena* 'Florida Market' (ECHO seed bank accession: 02078-091e) seed
- 32 Bamboo stakes
- 28 Treatment application indicator signs
- Measuring units: Tablespoon, 1/8 cup, ¼ cup, volume cylinder Permanent marker
- Harvest collection buckets

Methods:

Field History

The experimental field (Photos 1 and 2) was held at the ECHO Global Farm in southwest Florida (17391 Durrance Road, Fort Myers, FL 33917). More specifically, the field was located on the east side of the Global Farm campus, behind the Forage Bank in an area known as "Growout." The field was composed of four raised box beds. For the past two years, this area has consistently been planted with a variety of annual crops for Market Garden production. During the fall-winter season 2010-2011, strawberries and onions were planted specifically in the beds where this experimental was conducted. Preliminary weeding was necessary in order to prepare the field for experimental treatment.

Experiment design

Each of four replications consisted of a raised box bed, 86 ft in length. Respective replications were divided into seven sections, each 12 ft in length. A randomized complete block design was used to determine the randomly assigned order of treatments within each replication (see Table 1 below).

Table 1. Randomized complete block design for assigning treatments to experimental plots. Numbers correspond to fertilizer treatments; letters correspond to replications, which are grouped into "blocks" of space.

	Treatment						
Replication	5A	2A	6A	3A	7A	4A	1A
	6B	5B	3B	1B	2B	7B	4B
	5C	6C	4C	7C	1C	3C	2C
	1D	6D	4D	2D	3D	7D	5D

Buffer rows were considered for the experimental design. After a discussion of the nature of each bed being protected (each a boxed bed), it was determined that additional buffer rows would not be a necessary addition. Easy access to each treatment within a bed facilitated accurate application of treatments and a protected environment as plants developed.

Treatments

1. NPK (8%-2%-8%) was applied to the experimental plot at four different rates (Table 2).

Table 2: NPK fertilizer rates applied to each of eight plants per plot and the equivalent rates in kg/ha. These rates were applied preplant (2 June), 13 July and 5 August. On 13 July and 5 August, the fertilizer was applied in a circle around each plant, underneath the area spanned by the leaves of each plant.

% of ECHO rate	Volume per plant (Tbsp)	Volume per plant (tsp)	Weight per plant (g)	Total seasonal rate (kg/ha)*
100%	6.21	18 5/8	62.6	160
66%	4.10	12 2/7	41.3	105
33%	2.05	6 1/7	20.9	54
0%	0	0	0	0

2. 6 month old compost - Compost [25% cow manure; 75% plant-based material split equally between browns (woody material) and greens (fresh, leafy material)] was applied at three different rates (Table 3). As per ECHO's experience with small scale farmers, 1 L can be considered a high rate with ½ L a more affordable and realistic rate for farmers to apply.

Table 3: Compost (25% cow manure) rates applied to each plant in a plot.

% of ECHO rate	Volume per plant (Tbsp)
100%	1
66%	2/3
33%	1/3

Trial Establishment:

The experimental study was conducted during the summer season of 2011. To prepare the field for planting, each bed was weeded, raked, and mulched with hay. This occurred during the month of May 2011.

Eggplant accession, *Solanum melongena* 'Florida Market' was chosen for this experimental study for its ability to tolerate the difficult weather conditions of southwest Florida in the summer months, proving itself as a good indicator crop. Additional benefits of this variety of eggplant include resistance to diseases such as *Phomopsis* blight and fruit rot.

Eggplant seeds were sown in 50-deep cells and placed in the greenhouse on 5 May 2011. They remained in greenhouse for protected development until June. Extra plants were seeded up for use as replacements for initial transplants that did not take.

Fertilizer (8%N – 2%P – 8%K) was applied as a pre-plant at each planting station on 2 June 2011. Transplants were inserted at the same time as the preplant fertilizer application (2 June). Plants were inserted with 18 inch spacing between plants in a row; one row per bed.

Trial Management

Fertility: Following 2 June fertilizer application, each treatment plot was fertilized an additional two times (13 July and 5 August, 2011). Both additional applications were distributed per plant and in a circle following leaf span.

Treatment application: Chemical and organic fertilizer treatments were applied to each experimental plot by experiment implementers and selected volunteers in one afternoon, between the hours of 2:30 and 4:30pm. Organic cow manure compost was acquired a head of time and ready for use during the initial implementation of the experiment. (Processing of the cow manure into compostable form took place on the ECHO Global Farm by interns conducting a different experimental trial.)

Watering: The plants were watered 2-3 times on a weekly basis using drip irrigation. As summer rains intensified, manual watering was adjusted accordingly.

Weeding & Mulching: Summer weeds were hand pulled by experiment implementers and volunteers throughout the trial. Fresh Vetiver (*Chrysopogon zizanioides*) mulch was applied to each bed in August 2011.

Data collection

Yield data was recorded five times throughout the months of August and September; (5 Aug, 12 Aug, 19 Aug, 26 Aug, and 3 September). Fruits were harvested based on marketable quality. The criteria used to determine marketability included the following:

- Minimum size: 5 inch (length)
- Average shape: narrow at top, wider at base
- Color: deep purple with sheen
- Length = top of cap to bottom

Procedure for harvesting of fruit involved the use of pruners and an incision about ½ – ¾ distance between node and cap of each eggplant. Data were subjected to an analysis of variance using SPSS.

Results and Discussion

Overall, unmarketable fruit weight was greater than marketable fruit weight regardless of fertilizer rate (see Table 4 and Figs 2-4 for yield data). This could be due, at least in part, to the fact that no fungicides were applied. Significant rainfall events (Fig 5) could have contributed to fungal pathogens impacting fruit quality.

There was no interaction of rate with the type of fertilizer, so the yields with NPK and compost were averaged with trends shown in Figs 2-4. Once fertilizer rate increased beyond 80% of the conventional value, both marketable (Fig 2) and unmarketable (Fig 4) fruit weights increased significantly. Fertilizer rates lower than 80% showed a minimal increase in marketable/unmarketable fruit weight. The response of total fruit weight to fertilizer rate exhibited a direct positive correlation. Total fruit yield increased consistently as fertilizer rate increased (Fig 3).

For marketable, total and unmarketable, fruit weight doubled utilizing chemical fertilizer versus compost. It is very likely that more N was applied with the NPK than compost (see Table 4).

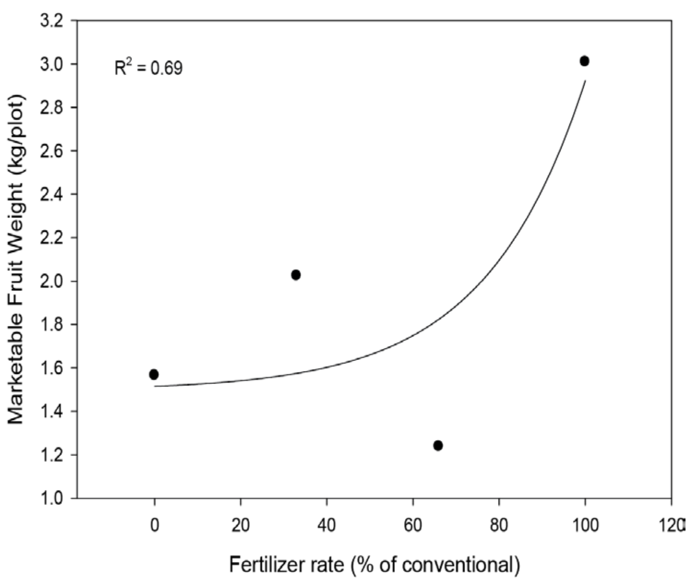

Figure 2. Response of marketable fruit weight to fertilizer rate (data for compost and chemical fertilizers averaged together)

Table 4. Main effects of fertilizer rate and type of fertilizer (chemical versus compost) on eggplant fruit weight.

	Fruit weight (kg/plot)		
Factor	Marketable	Total	Unmarketable
Fertilizer rate (% standard*)			
0	1.6	3.8	2.2
33	2.1	4.8	2.8
66	1.0	3.6	2.6
100	3.0	7.2	4.2
P value**	0.027	0.008	0.030
Fertilizer			
Compost	1.3	3.1	1.8
Chemical	2.6	6.6	4.0
P value	0.005	<0.001	<0.001
Rate X Fertilizer (P value)***	0.337	0.076	0.079

*The standard rate for NPK is based on the weight of fertilizer to apply 200 lb N/acre. The standard high rate for compost was 1 L of compost per plant---in this case, the resulting rate of N per acre is not known; assuming it contained 2% N, and a liter weighs 454 grams, the approximate amount of N put out by the highest rate of compost is l fertilizer rate used = 108 kg/ha

**Treatment effects were considered statistically significant if the P value was less than or equal to 0.05. See figures 1-3 for response curves for the effect of fertilizer rate (averaged of chemical and compost) on marketable, total and unmarketable fruit weight.

***Since the analysis of variance (ANOVA) showed that rate by fertilizer interaction (for all fruit grades) was insignificant (>0.05), the effect of rate was averaged over the two fertilizers (see Fig 1-3).

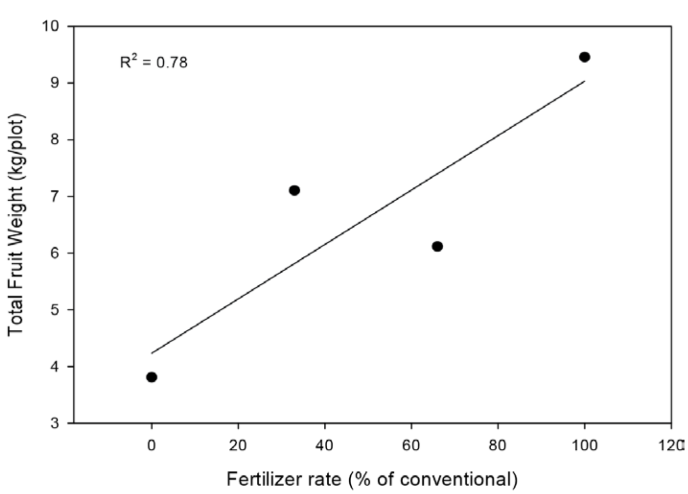

Figure 3. Response of total fruit weight to fertilizer rate (data for compost and chemical fertilizers averaged together)

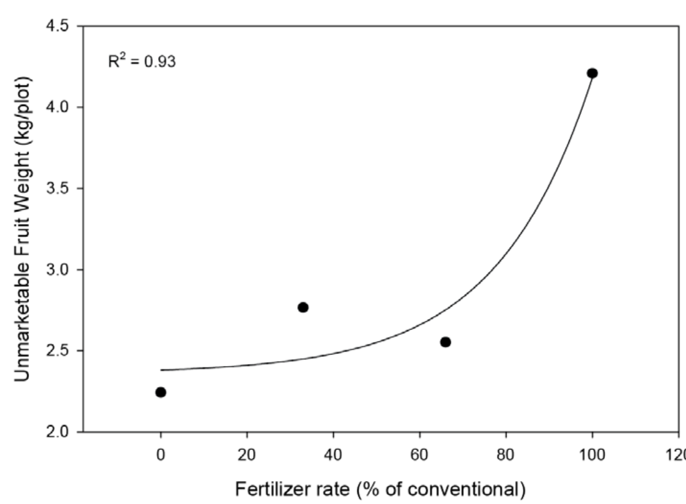

Figure 4. Response of unmarketable fruit weight to fertilizer rate (data for compost and chemical fertilizers averaged together)

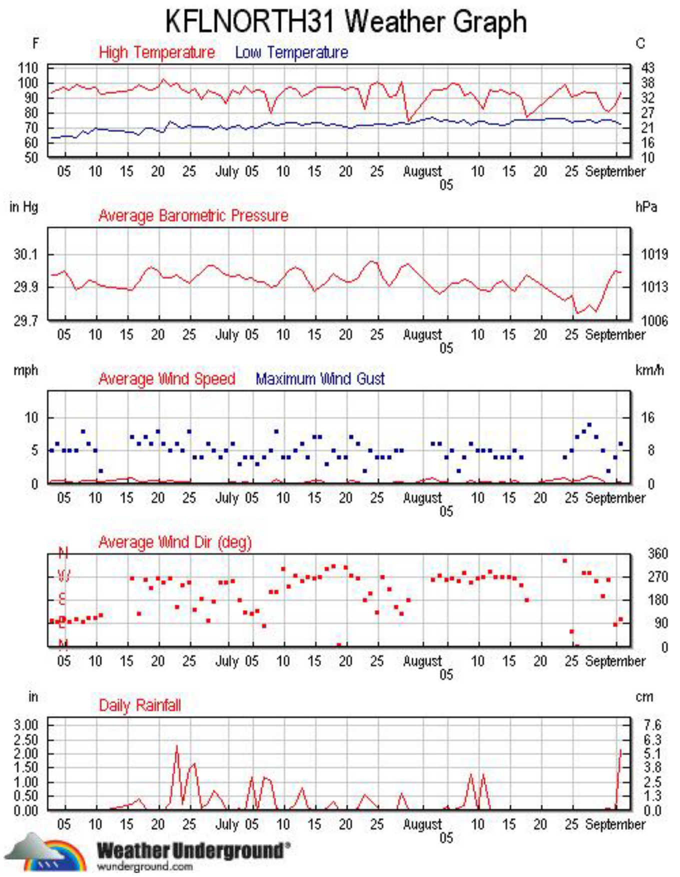

Figure 5. Weather data collected at the ECHO farm from 2 June to 2 Sept 2011.

Conclusions

Yields failed to plateau with the higher fertilizer rates; however, especially when dealing with organics, smallholder farmers cannot afford to apply unlimited quantities. Ways to maximize fertilizer efficiency include (1) band or target (e.g., in planting stations) vs broadcast applications and (2) mulching. To get a more complete understanding of the efficacy of compost vs. fertilizer, future studies should be conducted over a longer period of time. Perhaps the consistent use of compost would boost soil health, improving disease resistance, thereby increasing fruit quality. Total fruit weight of composted plants might not be as high as with NPK fertilizer, but a higher percentage of marketable fruit weight may contribute to a greater portion of saleable fruit weight in such an instance.