Final Project Report to the NYS IPM Program, Agricultural IPM 2003 – 2004

Title:

Evaluation of Composts for Managing *Phytophthora capsici*

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Cooperator(s):

Type of grant:

Cultural methods; sanitation; physical controls

Project location(s):

throughout the Northeast

Abstract:

The primary goal of this long-term project is evaluating yearly soil amendment of commercially-available composts plus 3-year rotation for managing Phytophthora blight. This disease is a major concern for many growers because an effective management program (including fungicides) has not been identified and severe losses have resulted in cucurbit crops, especially pumpkin, and pepper. Research is being done where blight occurred in 1999 through 2001. Additionally, compost is being examined as a soil-building amendment and fertilizer for rotation crops. Yearly amendments of compost were demonstrated to be having a long-term impact on nutrient availability and organic matter content of soil. Soil samples collected in mid June before applying compost or chemical fertilizer in 2003 revealed that plots receiving compost in 2001 and 2002 had significantly higher organic matter content and more available phosphorus, potassium, magnesium, manganese, and zinc than non-compost-amended plots. A one-year-old compost made of leaves and fruit waste was used. Its nitrogen content was 0.77%, thus applying it at 40 ton/acre was expected to provide 30 lb/acre nitrogen assuming 10% availability of the nitrogen in the compost. More available nitrogen was detected 22 days after applying fertilizer and compost in soil of non-compost plots that received 50 lb/A nitrogen from a conventional chemical fertilizer (15-15-15) than in plots receiving a combination of compost and chemical fertilizer to achieve this same nitrogen rate. The compost may not have provided the expected quantity of nitrogen or it provided nitrogen more slowly than chemical fertilizer. However, nitrogen content of leaves did not differ significantly. Compared to non-compost plots, compost plots had a smaller plant canopy, numerically more weeds (but not a significant difference), and yielded slightly less based on data from the first harvest done 15-22

Sep (24.4 vs 20.7 marketable-sized pods/plant, respectively). In conclusion, amending soil with compost yearly is having a long-term impact. Compost appears to be a suitable source of nitrogen to at least partly replace chemical fertilizer. Results may be improved by applying compost more than a few days before planting or by using a lower estimate for the percent available nitrogen in this compost. Availability of nitrogen is known to vary substantially among composts.

Background and justification:

Phytophthora fruit rot of cucurbits (*Phytophthora capsici*) is a major concern for many growers because an effective management program (including fungicides) has not been identified and severe losses have resulted. This disease has been increasing in importance in New York and elsewhere in the U.S. After the disease occurs on a farm it tends to reoccur every year. Identifying effective management practices would benefit most vegetable growers because this pathogen affects all cucurbits (cucumber, melon, squash, pumpkin) and it also affects peppers, tomatoes and eggplants. Research on managing *Phytophthora* has been conducted in Riverhead since 1992. Management practices that have been evaluated include fungicides, a 2-year rotation, yard-waste compost applied immediately before pumpkins, organic and plastic mulches, solarization (solar heating of soil) and sorghum sudan grass. Most of these practices were ineffective or only moderately effective.

Other researchers have demonstrated compost-based suppression of several vegetable diseases, including club root on cabbage, lettuce drop, and Rhizoctonia root rots of pea, bean and radish, Fusarium wilt of cucumbers, and Phytophthora crown rot of peppers, through greenhouse and some field studies (2,3,4,5,6). Compost suppressiveness has been correlated to total microbial activity, which may be estimated by the rate of enzymatic hydrolysis of fluorescein diacetate (FDA) (1,2,7) as well as growth chamber bioassays (1). The yard-waste compost tested previously for *Phytophthora* management on Long Island may have been insufficiently effective because it had low microbial activity, based on FDA measurements. In addition, it was incorporated into a sandy loam soil, which inherently has low microbial activity.

We are taking a long-term approach to examine the efficacy of composts against *Phytophthora capsici*. Our hypothesis is that regular additions of compost, when integrated with other management strategies, will reduce Phytophthora blight incidence in susceptible crops. We are assessing the effects of multiple years of compost additions on soil microbial activity and fertility. In 2001, we applied a highly disease suppressive compost to two locations that had a history of *Phytophthora*- one location on Long Island and the other in the Capital District. On Long Island, compost additions did not reduce the incidence of this disease on pumpkins. In the Capital District, there was no disease pressure, and compost enhanced pumpkin growth and yield. In 2002, we applied compost again to the Long Island plots, and planted the field to sweet corn, a rotation crop. Although compost did not supply significant amounts of nitrogen to the crop, it did stimulate soil microbial activity and improve soil health. Sweet corn yields were higher in composted plots than non-treated plots due to the improved soil conditions. Tissue tests revealed no difference in nitrogen content of leaves. Amending the soil with compost is making it suppressive to soil-borne pathogens related to *Phytophthora capsici*, based on a growth chamber bioassay conducted with *Pythium ultimum*, which causes damping-off.

In 2003 compost was applied again and the field was planted to snap bean. In 2004 we plan to apply compost and replant this site with a susceptible crop (pumpkin) to determine if multiple years of compost addition combined with growing non-susceptible crops can reduce incidence of this disease.

Objectives:

1. Evaluate residual effect of compost applied in 2002 on soil fertility and health.
2. Evaluate effect of compost added in 2003 to soil fertility and health.
3. Assess growth and productivity of snap bean.
4. Project evaluation will integrate soil fertility and crop yield, to assess compost contributions to crop productivity, plus suppression of Phytophthora blight in 2004.

Procedures:

This project was funded at a reduced budget, thus necessitating modification of procedures.

1. Evaluate residual effect of compost applied in 2002 on soil fertility and health. Plots were continued as laid out in 2001 and 2002, at the Long Island Horticultural Research and Extension Center (LIHREC). Sixteen plots were established (8 control, 8 composted) based upon previous history of Phytophthora blight incidence in pumpkin. Soil samples were collected on 11-17 Jun after the field had been disked a few times during spring for weed control and before compost was amended. Samples were analyzed by Cornell's ICP Analytical Laboratory in the Department of Horticulture. This data was needed to have a baseline characterization of soil fertility, to set fertilizer rates and to determine if there was residual soil nitrate, ammonium, mineralizable N, pH and soluble salts, total carbon and nitrogen, and particulate organic matter from previous compost amendment.

2. Evaluate effect of added compost to soil fertility and health. One-year-old compost made from leaves and fruit waste was donated to the project and delivered by a local supplier, Briermere Farms. A sample of the compost was dried at LIHREC to determine percent moisture. Moisture content was 50%, therefore to obtain the desired rate of 20 dry tons/acre, the compost needed to be spread at 40 tons/acre. Another compost sample was sent to the University of MA Soil and Plant Tissue Testing Laboratory to determine nitrogen content. Based on these results, this compost was expected to provide 30 lb/A nitrogen when applied at 40 t/acre (fresh weight) assuming 10% availability. Fertilizer (15-15-15) was applied on 14 Jul at 50 lb/A N to non-compost plots and at 20 lb/A N to compost plots to obtain a similar level of nitrogen in both. Then compost was spread and disked to incorporate.

Due to the reduced budget, we did not assess health of soil in compost-amended and non-amended plots as planned. This was to have been done in the spring and fall. Also only one soil sample was taken.

3. Assess growth and productivity of snap bean. Herbicides Eptam and Treflan were applied on 17 Jul. 'Strike' snap beans were coated with inoculant on 15 Jul and seeded on 17 Jul a couple hours after herbicide treatment. The field was overhead irrigated and machine-cultivated when needed. No hand-weeding was done due to the reduced budget except for removing Jimson weed. Soil samples were collected on 5 Aug and sent to Cornell's ICP Analytical Laboratory to conduct a pre-sidedress nitrogen test (PSNT) to determine if nitrogen content varied between compost and non-compost plots. Due to the reduced budget it was not possible to test samples from each plot, therefore composite samples for the two treatments were analyzed to get an indication of differences between the treatments. To determine if plants differed in nitrogen content, petiole samples were collected and sent for analysis to Cornell's ICP Analytical Laboratory. These samples were taken on 22 Aug when most plants had 5 trifoliates and a few plants had started to produce flower buds. Samples from two replications were combined to form two-plot composite samples. Petioles were also taken from all the plots of each treatment

and combined to create two composite samples for full nutrient analysis to get an indication of any other differences between the treatments.

Plants were examined routinely for symptoms of disease and for insect pests during the growing season and more intensively at harvest. Weed coverage was rated on 10 Sep. Thickness of the bean plant canopy was assessed by determining light penetration, which was measured using a Licor light meter to measure light level at the top of the canopy and on the ground between rows for 3 locations per plot on 10 Sep.

Yield was assessed by removing two 5-ft sections of plants from each plot on 15-22 Sep. Harvest was done by replication. Marketable-sized pods were removed, counted and weighed. Roots were removed, then remaining plant tissue was weighed. The pods and 5 plants were put in a drying oven, then re-weighed when completely dry. The time needed to process each sample resulted in the harvest taking 7 days to complete, during which the pods continued to enlarge. Therefore, a second yield assessment was made by removing only 4 plants per plot on 2 Oct.

Due to the reduced budget,an economic analysis was not conducted.

4. <u>Project evaluation will integrate soil fertility and yield, to assess compost contributions to crop productivity, plus suppression of Phytophthora blight in 2004</u>**.** Both yield and compost fertility data from the first three years of study will be integrated to determine feasibility of compost use, when integrated over seasons and crops. The long-term goal of this project is to assess compost ability to suppress *Phytophthora capsici* in vegetable rotations. A susceptible crop (pumpkin) will be grown in 2004 following 4 years of compost amendment and 2 years of growing non-susceptible crops.

Results and Discussion:

Soil samples collected on 11-17 Jun before the 2003 compost amendment revealed significant differences between the compost and non-compost plots due to compost amendments during the previous two years. Compost plots had significantly higher organic matter (4% vs 3.2%) and more available phosphorus (P), potassium (K), magnesium (Mg), manganese (Mn), and zinc (Zn)(Table 1). Soil pH was 6.2 for both treatments. No available N was found for the samples collected on 11 and 12 Jun. A low level of nitrogen was detected in the samples collected on 17 Jun (average of 6.3 mg/Kg).

Nitrogen content of the one-year-old leaf and fruit waste compost used in this study was determined to be 0.77% (equivalent to 6.7 lb/cu yd). Applied at 40 t/A fresh weight (20 t/A dry weight), this compost was expected to provide 30 lb/A nitrogen assuming 10% availability of nitrogen in the compost.

Conventional chemical fertilizer (15-15-15) provided more available nitrogen than a combination of compost and chemical fertilizer based on PSNT conducted on soil samples collected on 5 Aug, which was 22 days after applying fertilizer and compost (48 vs 23 mg/kg available NO_3. for non-compost and compost plots, respectively). Fertilizer was added at a rate of 50 lb/A nitrogen to non-compost plots and at 20 lb/A nitrogen to compost plots to augment the 30 lb/A nitrogen expected from the compost. However, while there was more availble nitrogen in soil in non-compost plots, there was not significantly more nitrogen in the bean plants growing in these plots based on analysis of petiole samples collected on 22 Aug (2.1 and 2.6 %NH for non-compost and compost plots, respectively).

There was more available nitrogen in non-compost than compost plots based on pre-sidedress nitrogen test (PSNT) conducted on composite soil samples collected on 5 Aug (). Petiole samples were collected on 22 Aug when most plants had 5 trifoliates and a few plants had started to produce flower buds. Two-plot composite samples were analyzed by Cornell's ICP Analytical Lab. Nitrogen content did not differ significantly

Table 1. Quantity of available nutrients (mg/Kg), pH, organic matter content, and moisture content of non-compost-amended and compost-amended plots before fertilizer and compost were added in 2003. Differences are due to residual effects of applying compost in 2001 and 2002. Numbers in each column with a letter in common are not significantly different according to Fisher's Protected LSD (P = 0.05).

Treatment	**Phosphorus**	**Potassium**	**Magnesium**	**Calcium**	**Iron**	**Manganese**
No Compost	22.9 b	119.3 b	119.7 b	462.4 b	2.65 a	2.33 b
Compost	25.0 a	134.8 a	142.1 a	543.1 a	2.85 a	3.15 a
P-value	0.0291	0.0443	0.0213	0.0518	0.5231	0.0096
Rep *P-value*	0.0559	0.0134	0.0271	0.0137	0.0128	0.024

Treatment	**Zinc**	**Aluminum**	**Copper**	**pH**	**Organic Matter (%)**	**Moisture content**
No Compost	0.54 b	47.7 a	0.91 a	6.17 a	3.20 b	0.55 b
Compost	1.03 a	42.0 b	0.89 a	6.20 a	4.00 a	1.02 a
P-value	0.0065	0.0288	0.8436	0.6617	0.004	0.0332
Rep *P-value*	0.4708	0.0021	0.1595	0.0066	0.0042	0.325

Although weed coverage of compost plots was almost twice that of non-compost plots (20 and 11%, respectively, on 10 Sep), this difference was not significant (P-value = 0.18). Jimson weed seed evidently was in the compost since this weed was found in 4 of 8 compost plots (13 plants), while there were only 5 plants in 2 of 8 non-compost plots, and it does not occur in other research fields at this facility. Jimson weed density averaged 56 plants/A for compost plots.

Non-compost plots had larger differences in light levels between the top and bottom of the bean plant canopy, indicating lower light penetration and thus a thicker canopy than compost plots when assessed on 10 Sep (603 and 279; P-value = 0.031).

Diseases and insect pests did not reach levels of concern. A very few pods were found during harvest that were affected by Pythium, white mold, or Anthracnose. There were no symptoms of Phytophthora blight. Bean has been considered a non-host for this pathogen; however, in Michigan in 2003 symptoms were observed on snap bean for the first time, which suggests appearance of a new strain.

Plants in the non-compost plots yielded significantly more than those in the compost plots based on the first yield assessment (24.4 vs 20.7 marketable-sized pods/plant)(Table 2), but not the second (28.1 vs 29.8)(Table 3). Plant stand did not vary significantly among treatments (42,088 plants/A in compost plots and 44,776 in non-compost plots).

In conclusion, yearly amendments of compost are having a long-term impact on nutrient availability and organic matter content of soil. The compost may not have provided the expected quantity of N or it provided N more slowly than chemical fertilizer; consequently, plants receiving all 50 lb/A N as fertilizer formed a thicker canopy and out-yielded plants receiving a combination of compost and chemical fertilizer at the first harvest. Availability of nitrogen is known to vary substantially among composts.

Table 2. Yield and biomass of snap bean grown in non-compost-amended and compost-amended plots in 2003 based on two 5-ft sections of plants removed from each plot on 15-22 Sep. Numbers in each column with a letter in common are not significantly different according to Fisher's Protected LSD (P = 0.05).

Treatment	# Plants	# Pods/plant	Pod Wt/10-ft row (g)	Pod Wt (g)	Plant Dry Wt (g)
No Compost	14.6 a	24.4 a	887.2 a	2.58 a	22.6 a
Compost	13.7 a	20.7 b	741.6 b	2.64 a	19.6 a
P-value	0.4923	0.0353	0.0388	0.4505	0.0603
Rep *P-value*	0.4568	0.4256	0.0839	0.0108	0.1553

Table 3. Yield and biomass of snap bean grown in non-compost-amended and compost-amended plots in 2003 based on four plants removed from each plot on 2 Oct. Numbers in each column with a letter in common are not significantly different according to Fisher's Protected LSD (P = 0.05).

Treatment	# Pods /plant	Pod Wt (g)	Pod Wt /plant (g)	Pod Dry Wt /plant (g)	Plant Dry Wt (g)
No Compost	28.1 a	5.90 a	167.3 a	25.0 a	20.0 a
Compost	29.8 a	5.38 b	161.3 a	24.5 a	19.4 a
P-value	0.5566	0.0377	0.7787	0.8504	0.7113
Rep *P-value*	0.1053	0.695	0.164	0.1659	0.0705

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