Evaluation of Compost for Plant Growth and Suppression of Soilborne Diseases

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Background

Pre-plant fumigation with methyl bromide (MeBr) has provided essentially pathogen-free soil for strawberry production over the last four decades. Increasingly, growers are required to grow without MeBr because of the 1993 Montreal Protocol requiring 100% MeBr phase-out by 2005. Alternative fumigants are facing tightening restrictions in California as seen with township caps on application of Telone, VOC regulations, barrier film requirements, and expanding buffer zones within which no fumigants can be applied. Already, trends from 2011 describe heightened incidence of soilborne diseases affecting strawberry production.

Microbially-mediated disease suppression

Disease suppressive soil is a well-known phenomenon in which soilborne diseases fail to develop in spite of high infestation levels. Qualitative and quantitative changes in the soil microbial community are generally regarded as the key suppressive mechanism. Some soils are naturally suppressive, however, suppressiveness can be induced by the addition of soil amendments such as compost. Previous work shows promise for managing Verticillium wilt with compost.

Characterization of composts

	1. Mushroom Compost	2. Vermicompost	3. Steer Manure	4. Yard Trimmings
				
	Composted horse manure + straw Amended with gypsum and peat post-decomposition	100% Composted dairy manure + rice hull bedding, fed to worms	20% steer manure 30-40% green waste fines 35-45% mix of: -Feed waste fr/ dairy cows -Straw bedding fr/ dairy stalls <5% vegetable waste	100% Yard Trimmings
Nitrate-N* (mg/kg)	120	502	234	6.6
pH*	7.3	7.0	8.1	7.6
EC* (dS/m)	4.8	7.1	28	4.5
C:N*	14:1	13:1	12:1	17:1
Microbial activity (ug FDA/gDw*min)	0.25		0.08	0.31
Fungal abundance (cfu/g soil)	4.6×10^6	1.8×10^5	2.3×10^5	4.6×10^5
Bacterial abundance (cfu/g soil)	1.9×10^9	1.2×10^7	7.6×10^7	4.4×10^8
Cost	$3-5/T	$500/YD	$5/T	$21/T
Application method	Broadcast	Apply to rootzone •In planting hole •In trench	Broadcast	Broadcast
OMRI approved	OMRI Listed	OMRI Listed	OMRI Listed	OMRI Listed

*Averages based on soil tests from a minimum of two batches

Vermicompost for suppression of *Verticillium dahliae* in tomatoes

METHODS

To evaluate the effect of vermicompost on growth of tomatoes exposed to *Verticillium dahliae*, ten-day old tomato seedlings (cv Bonny Best) were dipped in a *V. dahliae* conidial spore suspension (+V) or sterile water (-V) and transplanted into potting soil adjusted to four rates of vermicompost.

RESULTS

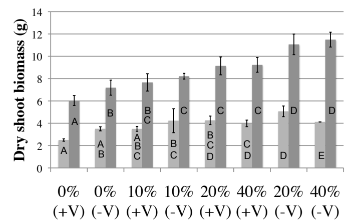

Figure 1. Mean dry shoot biomass of tomato plants grown for eight weeks in a mixture containing 0-40% vermicompost with (+V) and without (-V) exposure to *Verticillium dahliae*. Trial was replicated, Trial 1 , Trial 2 . Means followed by the same letter are not significantly different based on least significant difference (P < 0.05)

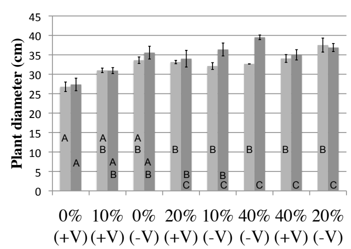

Figure 2. Mean canopy diameter of tomato plants grown for eight weeks in a mixture containing 0-40% vermicompost with (+V) and without (-V) exposure to *Verticillium dahliae*. Trial was replicated, Trial 1, Trial 2. Means followed by the same letter are not significantly different based on least significant difference (P < 0.05)

Figure 3 : Comparison of canopy diameter between tomatoes infected with *V. dahliae* (right) and, healthy tomatoes (left), in each image.

DISCUSSION

Incorporation of up to 20% vermicompost consistently improved plant growth and biomass production. At rates between 20 and 40% vermicompost, plant canopy and biomass formation were greater than in the zero or 10% vermicompost treatments, with and without the pathogen. This suggests that higher rates of vermicompost can significantly increase plant production in plants exposed to *V. dahliae*.

Field evaluation of compost in non-fumigated strawberry production

METHODS

Current trials are testing the effects of incorporating one of four commercially available composts, described in the characterization of composts, on soil nitrate levels, growth and yield of strawberry plants. Control treatment is the grower standard application rate of 10T/A.

RESULTS and DISCUSSION

Compost treatments significantly increased early fruit production. Differences between the control and compost treatments were much greater during the first 6-8 weeks of fruit production. Both steer manure and spent mushroom compost increased yield by approximately 100% over the control, and likewise mean yield of strawberries grown in vermicompost and yard trimming compost were about 50% greater than the control (Fig. 4).

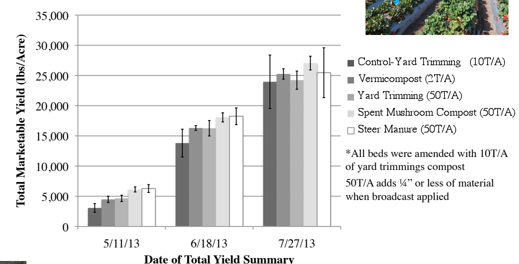

Figure 5. Ratio of 10T/A to soil based on incorporation to 12" depth

Figure 4. Mean yield-to-date at 5/11/13, 6/18/13, and 7/27/13 of strawberries* grown in non-fumigated soil amended with different types of compost. Each error bar is constructed using 1 standard error from the mean. *Proprietary variety # 273M171.

Strawberry yield differs significantly between compost type and rate. By 6/21/13, composted steer manure and spent mushroom compost provided the highest mean yield (>18,000lbs/A), an increase of roughly 30% increase over the standard control of 10T/A of yard trimming compost (13,807 lbs/A) (Fig. 4). Vermicompost at 2T/A and yard trimming compost at 50T/A yielded approximately 17% more than the control. Compost rate affects yield, as demonstrated by the yield difference between 10T/A yard trimmings (control) and 60T/A yard trimmings, and compost type affects yield as seen by the significant difference between plots with different composts applied at the same rate.

Nitrate. Strawberry fruit yield and quality are strong influenced by nitrogen availability. Sufficient nitrogen during early vegetative growth is important for crown development and ensuring yield. Despite uniform management practices, nitrate levels in compost treatments differ. Compost from steer manure and spent mushroom compost are at least 20x higher in nitrate (Fig. 6) than compost from yard trimmings. Pure vermicompost is highest in nitrate, but is added at a much lower rate. Once in the field, nitrate levels found in the control, yard trimming (50T/A) and vermicompost (2T/A), do not differ significantly, yet yield benefits are seen in the compost treatments.

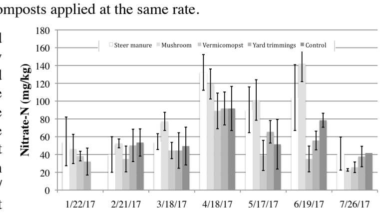

Figure 6. Nitrate-N levels from monthly soil samples taken from the root zone.

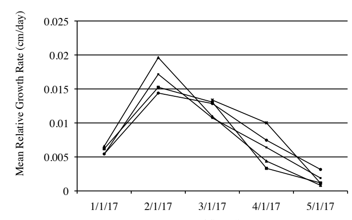

Figure 7. Mean relative growth rate of strawberry canopy. Plant diameter is recorded on a monthly basis to track plant growth rates. Initially, compost made from steer manure and yard trimmings (50T/A) had the highest growth rate. By March, vermicompost and the control treatment had the highest growth rates and by May, all treatments had similar rates of growth.

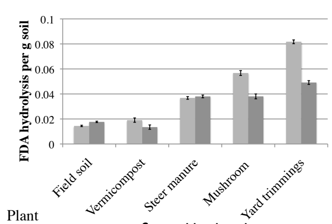

Figure 8. Microbial activity was measured at planting (11/13) and mid-harvest (7/25) using fluorescein diacetate (FDA) hydrolysis.