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Horticulture Research

Effect of Compost Extract on Qualitative Soil Health and Carrot Yield

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In a Nutshell

- Compost extract (compost steeped in water, then sieved) is a popular soil amendment to increase beneficial biota and increase yields. Two treatment levels of compost extract were applied to carrots on two farms to determine impact on yield and soil microbes.

Key findings:

- Compost extract did not impact carrot yield at either farm.
- Compost extract did not impact soil biota (as measured by a Qualitative Soil Analysis).
- Carrots from the High compost extract treatment at Jason Jones farm were significantly longer than untreated plots.
- Carrots from the plots treated with compost extract at Siobhan Danreis' farm showed significantly higher degrees Brix.

Project Timeline

July – October 2014

Jason Jones shovelling compost at TableTop Farm.

Background

Fruit and vegetable farmers are exploring on-farm compost methods to lower their input costs, increase soil microbial diversity, and improve yields. These compost methods include different types of compost (manure, vermicompost, food scraps, aerobic vs. anaerobic) and different application methods (potting mixes, soil amendments, sidedress, extract and brewed tea). For this study, two farmers, Siobhan Danreis (Humboldt County) and Jason Jones (Polk County) were interested in researching the effect of compost extract applied in the field. Said Danreis, "This year is the beginning of compost extract application on our farm, and I am interested in compiling data on the impact on vegetable quality and health." Jones added that he was interested in "a greater understanding of how compost tea affects the biology of the soil and subsequent plant productivity."

Both farmer-cooperators were interested in having the study include a Qualitative Soil Analysis, which is the soil foodweb microbial analysis popularized by Elaine Ingham of Soil Foodweb Inc. (Soil Foodweb Inc., 2014). The concept of functional diversity for soil ecosystem resiliency is well-studied (Chapin et al., 1997; Nannipieri et al., 2003; Hooper et al., 2005), but the interactions and functioning of microbial organisms within the soil are still not fully understood. Ingham includes many citations on her website to support her work with compost teas and extracts (Soil Foodweb Inc., 2014b).

The objective of this project is to determine the effect of compost extract on carrot yield and soil health as measured by a Qualitative Soil Analysis.

Method

Project Design

Each farm planted nine plots for a randomized complete block design, three plots for each compost extract treatment (**Figure 1**). Treatments were compost extract applied once (Low) and twice (High) during the growing season. Study plots were 15 feet in length, with five foot

buffers between each study plot and on the row ends to prevent edge effects. Compost extract was prepared on each farm using compost purchased from the Living Soils Lab.

At Jason Jones' farm, he applied compost extract to both the Low and High treatments during carrot planting on July 20, at a rate of 4 gal/treatment plot. He applied compost extract on August 3 to the High treatments only at the same rate of 4 gal/treatment plot. During the growing period, the Low treatments received a compost extract drench one time, the High treatment was drenched twice. Control plots received no compost extract. Soil samples presented here were taken on August 25 and analyzed on August 27 by Zach Wright at the Living Soils Lab.

Siobhan Danreis followed a similar schedule, drenching the soil in the Low and High plots with compost extract at 4 gal/treatment plot and planting carrots on July 21. She applied the second round of compost extract to the High treatment plots on August 5. Soil sample data presented here was collected on August 26 and analyzed on August 29 by Zach Wright at the Living Soils Lab.

Soil samples were taken twice during the study. The first samples, however, were too dry by the time they were analyzed and results were not usable. For the second soil sampling, six 1-in. soil cores were taken in each plot to a depth of 2.5 in. (Fierer et al., 2003). Replicate samples were combined in a soil sample bag (polyethylene-lined paper bag), providing nine soil samples per farm. Soil was sent to the Maharishi University of Management Living Soils Laboratory in Fairfield, IA.

Soil Analysis Protocol at Living Soils Lab

Soil health for this project was measured using a Qualitative Soil Analysis, which uses a microscope to categorize and count soil biota and assess the functioning of the soil food web (Living Soil Lab, 2014). Samples for the living soil analysis were prepared as follows: Each sample was mixed to break up large aggregates, then ¼ Tbs. soil was mixed with 4 mL water to achieve a 1:5 dilution. Sample was lightly agitated to break up macro- and micro-aggregates and distribute throughout the solution. If mineral content was high, distilled water was added until the sample is appropriated diluted, then agitated again (the Danreis sample was diluted 1:20).

When the sample was prepared, the slide was scanned at the lowest magnification for nematodes and other large soil organisms. Magnification was increased to 400 total magnification and 19 fields (random "objective" snapshots) were scanned. This completed 20 scan soil assessments giving a Qualitative analysis of the soil's bacteria, fungi, oomycetes, flagellates, amoeba, ciliates, nematodes, and micro-arthropods.

The sample was further diluted to count bacteria (1:100 or greater). The slide was scanned for the bacteria count at 40x, counting the small "glowing" and often "moving" objects (Wright, 2014).

Carrot Harvest

Carrots were harvested on October 7 at Jason Jones' and October 9 and Siobhan Danreis'. Ten carrots were sampled from each plot. End-to-end length, width, and weight were reported. Brix measurements were taken by Danreis at harvest; no Brix measurements were taken by Jones.

Data were analyzed using JMP Pro 11 (SAS Institute Inc., Cary, NC) and comparisons among measured variables employ least squares means for accuracy. Statistical significance is determined at $P \leq 0.1$ level and means separations are reported using Tukey's Least Significant Difference (LSD).

Figure 1

	X	1	X	2	X	3	X
X	mowed path						
A	Buffer	High		Low		Control	Buffer
B	Buffer	High		Control		Low	Buffer
C	Buffer	Control		Low		High	Buffer
X	mowed path						

Figure 1: Plot layout for both farms. Each plot is 15 ft long with a 5 ft buffer between plots. All buffers were planted to carrots. Between row spacing is 18 in.

Results and Discussion

Treatment Effect on Carrots

There was no significant difference in carrot yield (lb) among treatments at either farm (**Figure 2**). It should be noted that Danreis harvested carrots before full maturity due to a miscommunication in protocol. For this trial, compost extract applications did not improve yields compared to the control (**Figure 2**). Mean carrot sample weight (10 carrots) at Jason Jones' was 2.4 lb, mean carrot sample weight at Siobhan Danreis' was 0.67 lb.

Looking at length, there was a significant

Figure 2

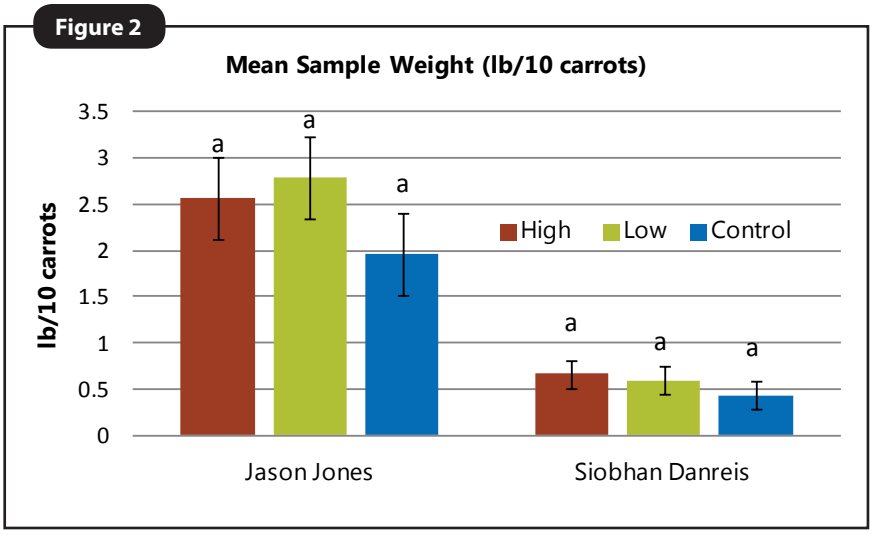


Figure 2. Mean carrot sample weight (lb/10 carrots) of the two treatments and control plots observed at the farms in 2014. By farm, columns with different letters above them are significantly different. Black bars about the means represent the least significant difference between treatments at each farm (Jones LSD = 0.887 lb/10carrots; Danreis LSD = .300 lb/10carrots).

difference between treatments and the control at Jason Jones' farm (**Figure 3**). The Low and High treatments were not different from each other, but both means were significantly different from the control mean length. No significant difference in carrot length was seen at Danreis' farm among the treatments.

Brix readings were significantly different based on treatment for Siobhan Danreis' carrots (**Figure 4**). The High treatment resulted in greater Brix readings than the control treatment. Many growers are interested in Brix readings, as they are indicators of nutritional quality (Kleinhenz and Bumgarner, 2012). In future years, Siobhan will likely monitor her carrot harvest to verify this result.

Treatment Effect on Qualitative Soil Health Measures

Means from four Qualitative Soil Analysis measurements were analyzed by treatment (bacteria µg/mL, fungi µg/mL, oomycetes µg/mL and fungi:bacteria (F:B) ratio). None of the means from treated plots from either farm were significantly different from the control, indicating that the addition of compost extract did not affect soil health as measured by the qualitative soil analysis. Means and standard deviations for bacteria, fungi, oomycetes, and F:B ratio for both farms are presented in **Table 1**.

As part of the Qualitative Soil Analysis, photos of different soil organisms from the two farms were provided (**Figure 5**). The Living Soil Lab also provided notes for most samples, including descriptions of good vs. bad fungi ("beneficial fungi with 2 strands >7 micrometers in diameter (red)") and general impressions of the scan ("3 ciliates, 1 testate amoeba observed," "active diatom," "a few long bacilli rods," etc). The Living Soils Lab also provided a phone consultation to go over the results.

Figure 3

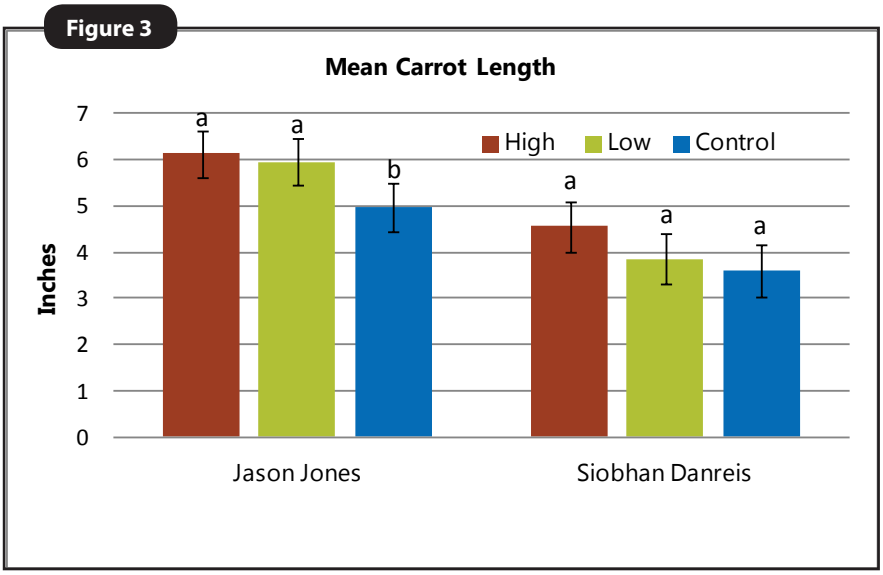


Figure 3. Mean carrot length (in.) of the two treatments and control plots observed at the farms in 2014. By farm, columns with different letters above them are significantly different. Black bars about the means represent the least significant difference between treatments at each farm (Jones LSD = 1.03 in., p = 0.068; Danreis LSD = 1.09 in.).

Figure 4

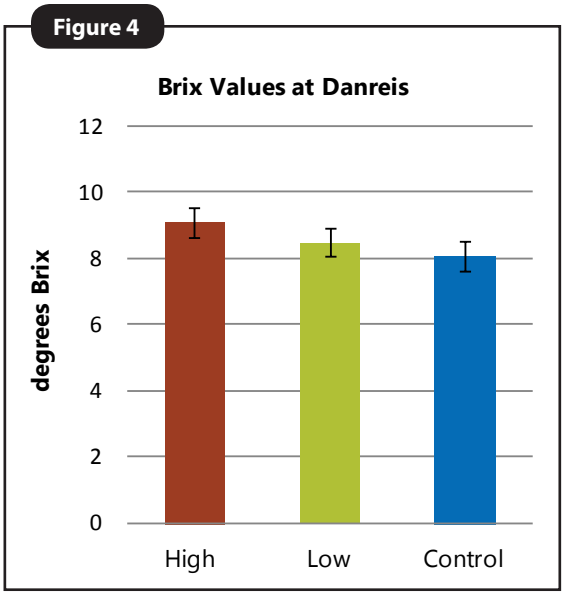


Figure 4. Brix readings of the two treatments and control plots observed at Danreis' farm in 2014. Columns with different letters above them are significantly different. Black bars about the means represent the least significant difference between treatments at each farm (Danreis LSD = 0.0833 degrees Bx., p = 0.067).

Table 1

Living Soil Analysis Results

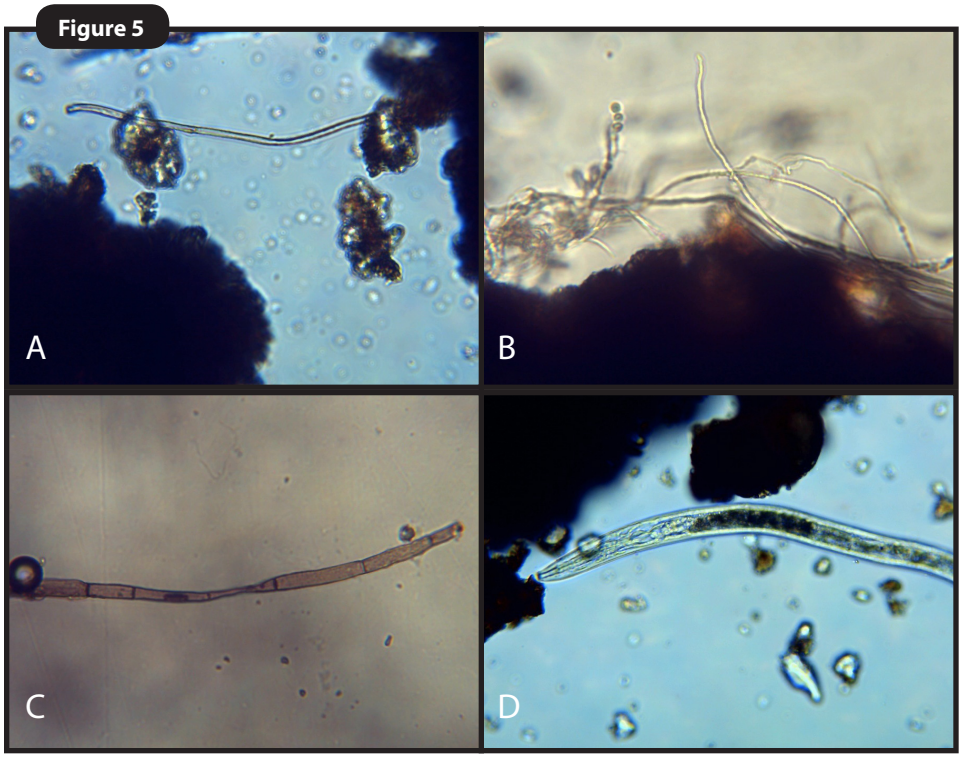
Farm	Treatment	Mean Bacteria ug/mL	Bacteria ug/mL std. dev.	Mean Fungi ug/mL	Fungi ug/mL std. dev.	Mean Oomycetes ug/mL	Oomycetes ug/mL std. dev.	Mean Fungi:Bacteria	Fungi:Bacteria std. dev.
Jones	High	11,212	3,885	230	385	12	21	0.020	0.032
Jones	Low	6,231	2,049	214	297	7	12	0.031	0.036
Jones	Control	7,384	4,524	23	28	42	39	0.008	0.014
Danreis	High	20,291	9,113	293	245	33	21	0.021	0.024
Danreis	Low	16,310	5,551	155	44	41	68	0.010	0.003
Danreis	Control	12,894	7,991	180	138	53	46	0.020	0.022

Conclusion and Next Steps

Though the application of compost extract did not have any statistically discernible impact on carrot yield or soil health (as measure by the Qualitative Soil Analysis), there were statistically significant differences in the length of carrots at Jason Jones' farm and in □ Brix at Siobhan Danreis' farm. The Qualitative Soil Analysis done for this project gave very large ranges for soil health indicators and thus large standard deviations about the means (**Table 1**). Given that, a Qualitative Soil Analysis provides a small window to the diversity of organisms in the soil, but may not be a useful tool for determining necessary soil amendments for production.

Both Jason and Siobhan own microscopes and are interested in performing Qualitative Analyses on their own soil and compost, and are interested in increasing their understanding of how different composts and compost qualities will affect soils and plants. Said Danreis, "There needs to be thought given to the composition of the compost and the method of making the compost before using it in an extract. In our case, we relied on consultation and recommendations from The Living Soil Lab. I would like to have a better understanding of what makes some composts increase bacteria in the soil and what makes others increase fungi."

Figure 5



A: A "beneficial" fungal hypha surrounded by two large humus aggregates. Observed in the Jones test plots, 400x.

B: Attached to a large humus aggregate is a dense web of potentially "non-beneficial" fungi known as oomycetes. Not all oomycetes are pathogens but most fungal plant-pathogens that we see in the soil are oomycetes. Observed in the Jones test plot, 400x.

C: A large "beneficial" fungal hypha. We estimate the identity of this particular specie to be a basidiomycetes due to its size, color and fairly equal segments throughout. Observed in the Danreis test plot, 400x.

D: Bacterial-feeding nematode from the Danreis plots, 200x.

References

Chapin, F.S., B.H. Walker, R.J. Hobbs, D.U. Hooper, J.H. Lawton, O.E. Sala, and D. Tilman. 1997. Biotic control over the functioning of ecosystems. Science 277(5325): 500–504.

Fierer, N., J.P. Schimel, and P.A. Holden. 2003. Variations in microbial community composition through two soil depth profiles. Soil Biology and Biochemistry 35: 167–176.

Hooper, D.U., F.S. Chapin, J.J. Ewel, A. Hector, P. Inchausti, S. Lavorel, J.H. Lawton, D.M. Lodge, M. Loreau, S. Naeem, B. Schmid, H. Setala, A.J. Symstad, J. Vandermeer, and D.A. Wardle. 2005. Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. Ecological Monographs 75(1): 3–35.

Kleinhenz, M.D., and N.R. Bumgarner. 2012. Using Brix as an Indicator of Vegetable Quality. The Ohio State University Extension, Wooster, OH.

Living Soil Lab. 2014. What do we do? LivingSoil.netAvailable at http://www.livingsoil.net/#!about/c1wfv (verified 6 December 2014).

Nannipieri, P., J. Ascher, M.T. Ceccherini, L. Landi, G. Pietramellara, and G. Renella. 2003. Microbial diversity and soil functions. European Journal of Soil Science 54(4): 655–670.

Soil Foodweb Inc. 2014a. SoilFoodWeb.com. Available at http://www.soilfoodweb.com/ (verified 6 December 2014).

Soil Foodweb Inc. 2014b. Current Bibliographic References on Compost Teas. SoilFoodWeb.comAvailable at http://www.soilfoodweb.com/References.html (verified 6 December 2014).

Wright, Z. 2014. Microscope Methods.

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