The Effects of Compost and Compost Tea on Radish Plant Growth

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Photo taken by Cindy Isidoro

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Abstract:

According to the Environmental Protection Agency, in 2013 recycling and composting prevented 87.2 million tons of materials from being thrown away. Composting can decrease the amount of organic waste from ending up in landfills. Compost is organic decayed matter used to fertilize soil . Compost tea is a brewed liquid made from compost and additives are usually added to increase microbial growth. Previous studies have shown compost does contain beneficial nutrients and minerals which plants need. In addition, compost tea may suppress soil-borne pathogens. What effect does compost and compost tea have on radish plant growth was the scientific problem. The results of this project can give more information about compost and compost tea since most if comes from books. If compost is added to pots with weekly compost tea applications then the radish plants will grow healthier since there are nutrients and minerals provided from these natural fertilizers. The project took approximately two months. The data and statistical test suggested compost did have an effect. Meanwhile, more research needs to be done on the effects of compost tea on plant growth.

Introduction:

Aerobic compost tea is a natural liquid fertilizer which can have positive effects on plants. Knowing the effects compost tea has on plant growth is important to get more organic waste out of landfills to create compost. Compost is made from decayed organic matter which can have many benefits to soil and plants. In addition, compost tea could be added to the plants all around the city creating healthier soil and less “waste” going to landfills. Aerobic compost tea has microbes which could be beneficial if applied to the soil and also to the plants

leaves as foliar applications (Ingham, 2004). The information on compost and compost tea is limited and the results of this project can add on to what is known about these natural fertilizers. If compost is added on radish plants then they will grow healthier than the control group because of the nutrients and microbes found in the compost (NYC Compost Project Tip Sheet,2009). Soil that has more microbes enhances the soil structure which brings better moisture retention and nutrients into the soil(NYC Compost Project Tip Sheet,2009).ant (Nadiu, 2010: NYC Compost Project Tip Sheet, 2009).

Background Information:

Compost tea is a water extract of compost with additives added to enhance the microbial populations in the extract (Ingham, 2004). There are mainly two types of compost tea, one of them is anaerobic compost tea which isn't aerated. Aerobic tea is aerated in order to create aerobic microbes. Usually, anaerobic compost tea takes longer to brew. Meanwhile, aerobic compost tea has many beneficial microbes which can improve the health of the plants.Compost tea can suppress plant diseases (Dunne, 2013). Soil typically consist of a mixture of organic remains, clay, and rock particles. Healthy soil is approximately fifty percent of this solid matter while the other fifty percent is open space. More microbial activity in the soil means less pathogen are able to harm plants (Lewis, 2006). Some beneficial microbes are bacteria, fungi, protozoa and nematodes (Dunne, 2013).

Compost is a dark porous soil-like material made from decomposed organic matter (NYC Compost Project Tip Sheet,2009). To create compost an equal amount of ”greens” and “browns” mixed with oxygen and moisture is needed (Dunne, 2013). "Greens" are rich in

nitrogen, examples are fresh leaves and food scraps. “Browns” are dry, rich in carbon with no life in them (NYC Compost Project Tip Sheet,2009).While examples of “browns” are wood chips and paper (Dunne, 2013). Microbes such as bacteria, actinomycetes, and fungi decompose these materials (NYC Compost Project Tip Sheet,2009). The temperature of the compost piles can get up to 130 degrees Fahrenheit, which is a high enough to kill most weeds and pathogens (Dunne, 2013). Animal manure is added in some cases. The manure provides a high amount of nitrogen (Dunne, 2013). Although animal manure may contain harmful pathogens (Dunne, 2013). Compost goes through three main stages; the first stage is the Mesophilic Phase. This is the stage where the microbes start to thrive and start to break down sugars and release heat. Next, is the Thermophilic Phase is where different organisms break down proteins and complex carbohydrates (Dunne, 2013). At this point the compost temperature is more than 113 degrees Fahrenheit and eventually decomposition decreases. As decomposition of tough compounds happens, the Curing Phase sets in and the temperatures go back down to below 113 degrees. This stage will take about two weeks to six months (Dunne,2013).

Additives were used in compost tea in order to enhance the population of preferable microbes. The amount of additives affects the amount and the kind of beneficial microbes in the tea(Dunne,2013). Fungi-rich teas are applied usually to trees and shrubs (Dunne,2013). Kelp is one of the additives that can be applied to increase fungi populations (Ingham, 2004). Humic acid can be applied to increase the number of fungi in the tea. Fish Hydrolysate is another additive, it provides the microbes with proteins (Ingham, 2004). Bacterial-rich teas are usually used to water herbaceous plants (Cohen,2013;Ingham,2004). Blackstrap molasses is a by-product of the third stage of the boiling refining sugar process which contains minerals and

nutrients removed from the process. Blackstrap molasses is usually recommended to use since it contains both simple and complex sugar (Ingham, 2004). Simple sugars feed bacteria and complex sugars feed both bacteria and fungi. (Ingham, 2004). Different additives and even liquids can be used, such as whey as a replacement for dichloride water (Catello Pane, 2012). Compost tea may minimize the possibility of a soil-borne pathogens (Catello Pane, 2012). Urban waste compost has been tested on calcareous soil which showed improvement on physical properties, even though it can cause an accumulation of heavy metals in the soil (P.L Giusquiani, 1994). Compost tea can also be applied on the leafs of the plant which is called foliar applications (Nadiu, 2010).

Radishes belong to the *Brassicacae* family and its scientific name is *Raphanus sativus* (Explore Cornell,2016). Radishes grow best in light soil with partial shade (MacMorland, 2008)(Explore Cornell,2016). Compost is suggested to be used by gardeners when growing radishes because radishes grow better in moist, fertile soil (Day, 2010). A pH of 5.8-6.8 is idea for radishes. The average height is 0.5 to 1.5 inches (Explore Cornell,2016). It takes three to four days for the seeds to germinate (Explore Cornell,2016). The season to best harvest radishes depends on the kind of radish plant being grown, but usually it's during midsummer to midwinter for the hardy radishes (MacMorland, 2008). Many radishes won't grow well during the summer because of the temperature and dryness, radishes prefer cool temperatures a moist soil (Day, 2010).

Locality:

This experiment was done at the UA New York Harbor School greenhouse located in Governors Island, New York. The coordinates are 40.6895° N, 74.0168° W.

Methods and Materials:

The purpose of this project was to determine the effect of compost and compost tea on radish plant growth. If plants grown with a compost and soil mixture have compost tea applied weekly, then radishes will grow faster and healthier because compost tea has beneficial microbes which can have a positive effect on the plant growth (Ingham, 2004;Lewis, 2006;NYC Compost Project Tip Sheet,2009; Dunne, 2013). If compost is added on radish plants then they will grow healthier than the control group because of the nutrients and microbes found in compost(NYC Compost Project Tip Sheet, 2009).

Compost tea was made and applied weekly. The water applied came from the recirculating aquaculture water system found in the UA New York Harbor School Marine Biology lab. The

amount of water applied was 100 mL of water, same for the compost tea applications. The plants were watered weekly and received an approximant amount of 10 hours of light. There were 4 replicates per treatment, in total there was 32 pots. The pots were randomized. The sample unit were each pots. Table 1 and 2 show the 8 treatments.

Table 01. These 4 treatments received water applications weekly.

Treatments	
compositions	Water application
Soil	A
Soil and compost	C
Compost	F
Hydroponic Sponge	H

Table 02. The treatments in this table received compost tea weekly.

Treatment	
composition	Compost tea application
soil	B
Soil and compost	D
compost	E
Hydroponic sponge	G

An air pump was used to brew the compost tea. Hybrids round radish seeds were brought from Johnny's Selected Seeds Company.

Preparing compost tea:

Compost was brought from Earth Matter NY, which is located in Governors Island. Prepared from an equal amount of organic waste like banana peels and other fruits, vegetables and browns such as brown leaves, wood chips in an earth tub for months. This mature compost was used for making the compost tea and the mixture of the pots with compost in them. The water used to prepare the compost tea comes from a RAS (Recirculating Aquaculture System) is used since the nutrients in this water can be advantageous to the aerobic growth in the compost tea during the brewing period. Recirculating aquaculture system water is collected in a bucket. A Hanna combo sensor is used to measure pH. The data was recorded into a data sheet. The air pump is then inserted into the bucket of water. Five cups of compost tea are added into a compost/mesh bag which is then clipped around the air pump. Additives are then applied, these additives are OrganicsRx Sea kelp 100, Blackstrap Molasses, Earth fort Liquid Fish Hydroslate, and Cento Pure olive oil. Additives are measured before they are added. The compost tea additive recipe is:

- 5 cups of mature compost

- 2-3 teaspoons of blackstrap molasses

- 2 Tablespoons of Fish Hydroslate

- 1 ½ teaspoons of Olive oil

- 2-3 Tablespoons of sea kelp

The mixture of additives, RAS water with the compost bag was mixed with a stick to make sure the additives are spread out equally. The Hanna Combo was used again to check the pH of the RAS water before the brewing process. The data is then recorded on a datasheet as shown below on figure 02. Finally, the air pump was plugged and the compost tea is left brewing for at least 24-48 hours. Throughout this time, it is recommended to stir with a stick to make sure all the nutrients are evenly spreading out throughout the bucket.

Applications:

A 100-mL beaker is used to apply compost tea to pots with treatments B, D, E, and G once a week. Pots with treatments A, C, F and H are also applied with 100 ml every week. The liquids were applied evenly through the pots.

Obtaining data:

Data was taken before the brewing process and after the 24-48-hour period. Before and after the process, the water pH was measured, how many hours the compost tea brewed, color of the compost tea, pH of the compost tea, the amount of compost tea and room temperature. As the radish plants started to grow, the amount of sprouts, leaves, the plant height, and root lengths data was taken. By the end the radish bulb circumference was taken. Data was collected every week. Pictures were taken throughout the experiment.

To know if there was any significant difference between the treatments an ANOVA (analyses of variance) and t-tests was performed for the leaf averages and stem height.

Analysis of results:

Table 3. Shows the parameters of the before brewing the compost tea data.

Date	time	temp (F)	Volume (L)	brewing hours	tea color	Electric Conductivity (µS)	tea pH
3/1/2016	1:50	45	14	48	brown	936	7.3
3/8/2016	2:40	46	14	48	brown	n/a	n/a
3/17/2016	1:43	52	14	48	dark brown	1738	7.84
3/24/2016	1:46	n/a	13	48	dark brown	636	n/a
3/29/2016	2:45	44	13	48	n/a	387	n/a
4/5/2016	2:13	49	13	48	very light	580	6.6

Project set up began late February while seeds were sowed on 03/03/16. Bulbs to grow a month and seven days after the seeds were sowed. Although data was still taken until early May. Table 3 shows the data received before the compost tea was brewed. The data was similar throughout the weeks.

The first week after the seeds were sowed treatment C had the highest count and percentage (figure 01 and table 02). E and F were alike in the number of sprouts (shown in Table 02). These three treatments had some amount of compost. By the second week, treatments B, C, D, E and F had a full percentage of sprouts compared to the rest. One of the replicate of treatment A did not have any seeds sprout. Treatments G and H didn't have any growth because of the composition in the pot.

Fig.01. The bar graph shows the different average sprout counts collected throughout two weeks after the seeds were planted. White bars represent the sum of sprouts counted on week 1, which is a week after the seeds were planted (03/08/16). The black bars represent the sum of the second week (03/18/16).

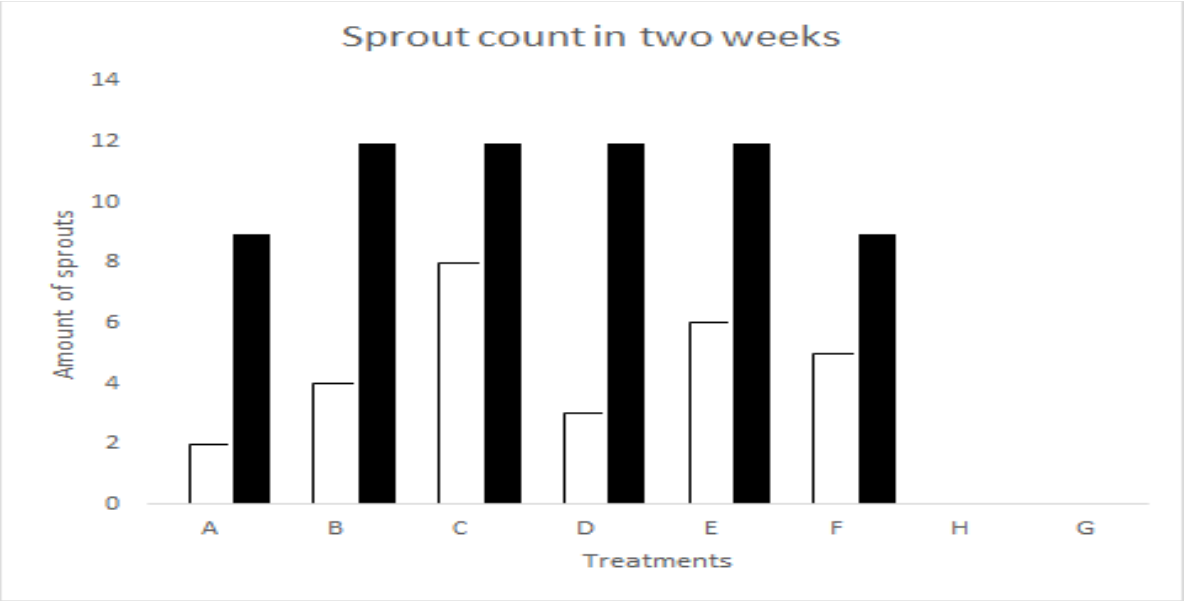

Table 02. This table shows the percentages of the two weeks after the seeds were planted. The sprout rates were calculated. As shown above treatments B, C and E which had compost tea applications. Event 1 was on 03/03/16. Event 2 was 03/08/16. Event 3 was on 03/18/16.

Percentages of sprouts								
	Treatments							
Event	A	B	C	D	E	F	G	H
1	0	0	0	0	0	0	0	0
2	17	33	67	25	50	42	0	0
3	75	100	100	100	100	83	0	0

Treatment A had the lowest amount of leaf count averages compared to treatments B-F. Treatment E had a higher average by the event 3, although throughout the weeks treatment C had a higher count average. Overall the ANOVA test indicated there was no significant difference in between the treatments (p=0.7). Although the T-test between treatments A and F was performed which indicated there was a significant difference (T=0.04). The derived T-test equals 0.03 for treatments C and D, indicating a significant difference.

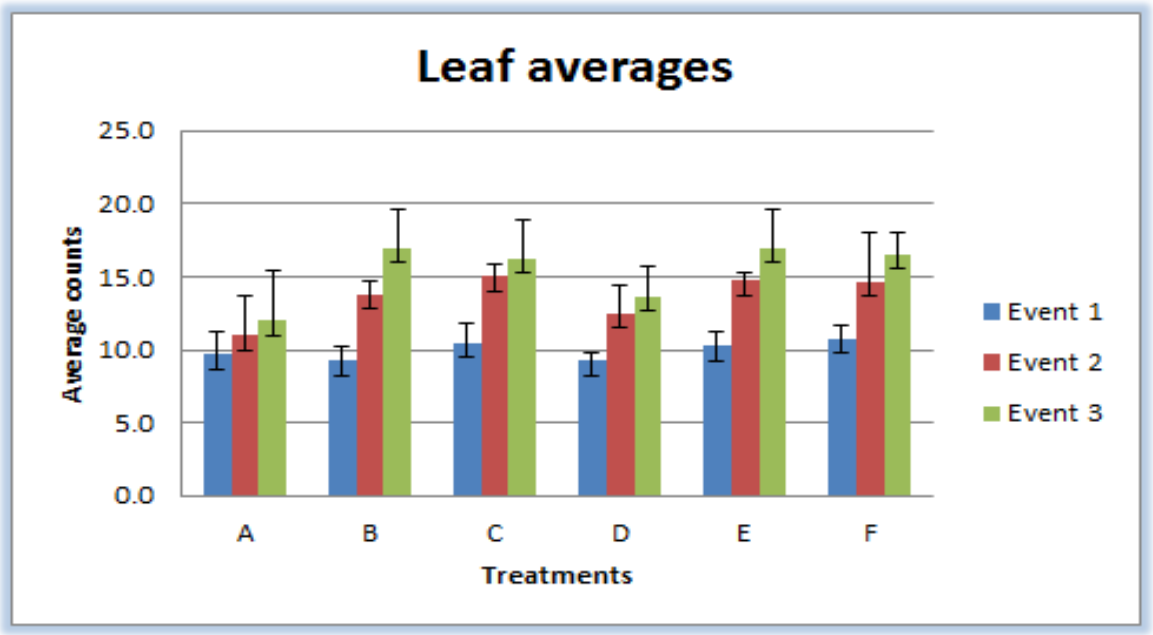

Figure 02. Leaf averages are shown in this bar graph. Event 1 was on March 22. Event 2 was on March 31. Event 3 was on April 17.

By the event 4 treatment C had the highest stem height average followed by treatment E. Treatment A had the lowest in comparison to treatments B through H. A two-way ANOVA test was performed and indicated there was a significant difference (p=0.002). T-tests were

performed with a T<0.05 for all the differences in between of treatment A and the other treatments.

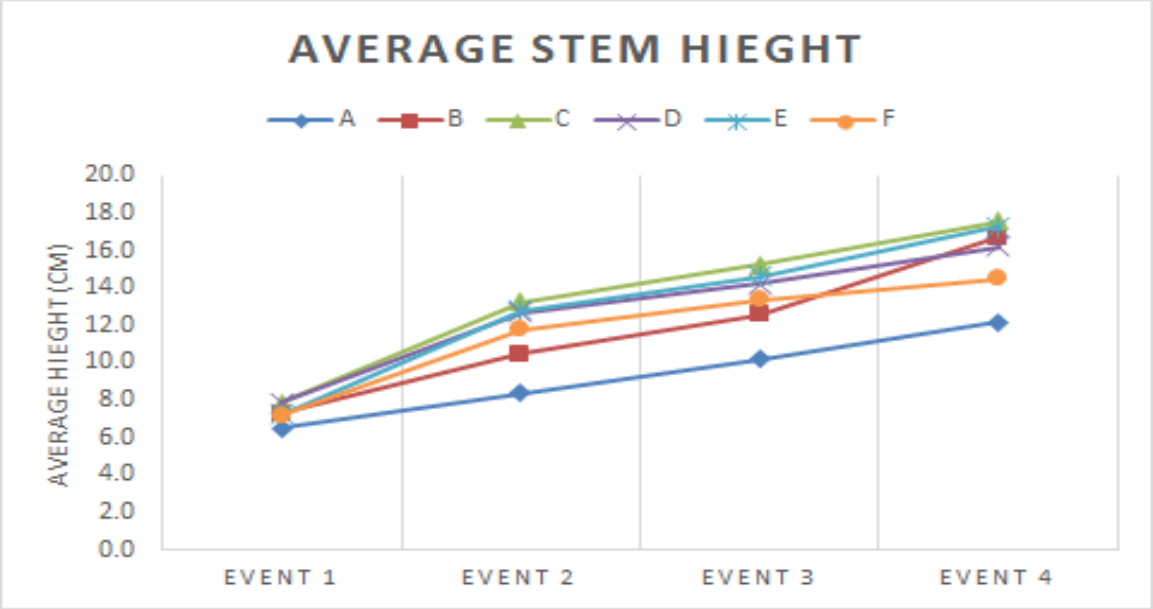

Figure 03. Shows the average stem height.

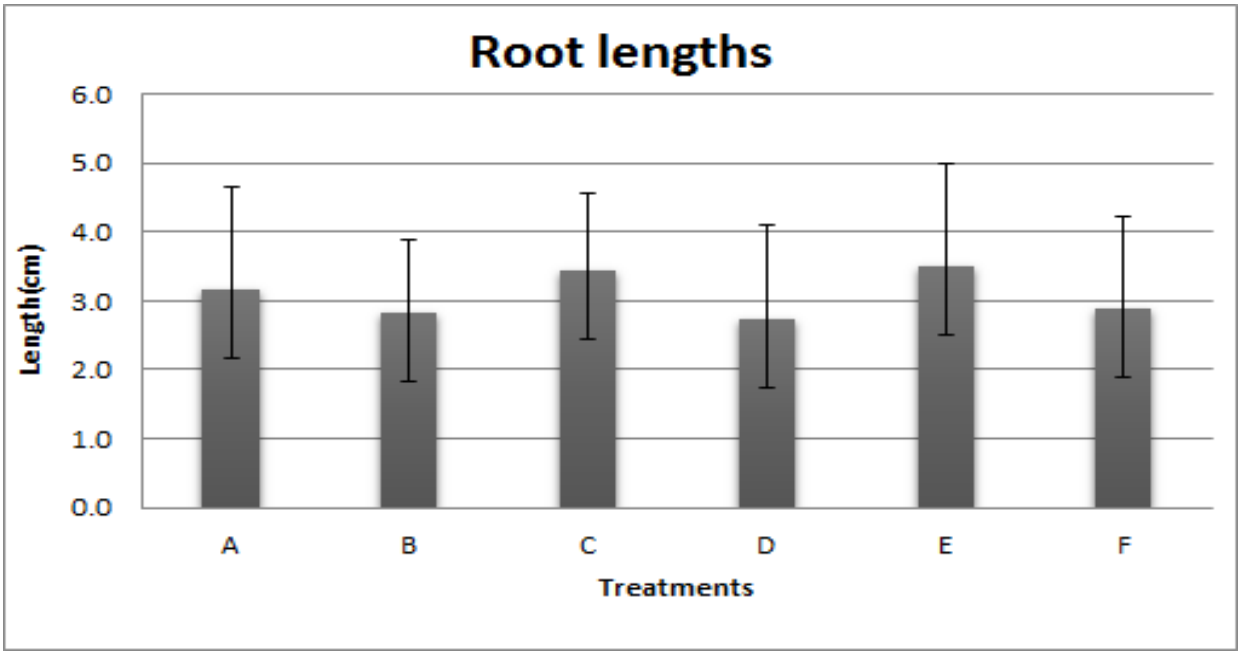

Figure 04. Shows the different root lengths collected on May 5. There was no significant difference.

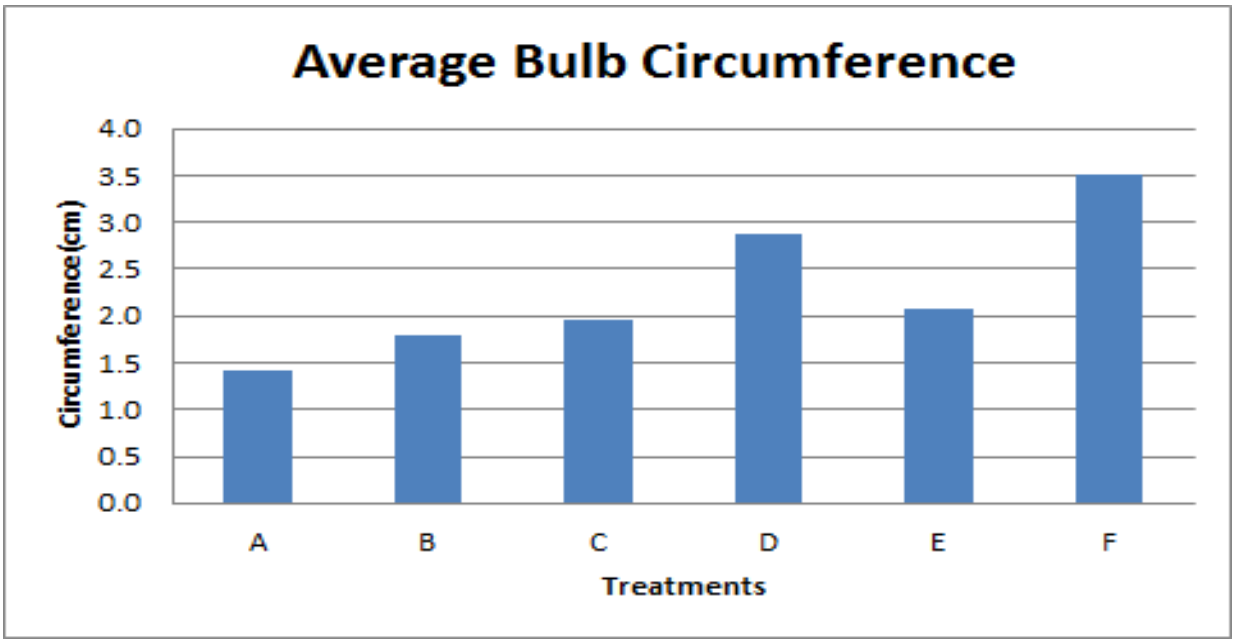

Figure 05. Shows the average bulb Circumferences in Centimeters.

Root lengths show no difference (figure 03). The averages were around 3 centimeters with treatment F having an average of 3.5 centimeters which was the longest. Bulb circumference averages showed treatment F having the largest circumference with 3.5 centimeters, while the control having a circumference of 1.4 centimeters (figure 04).

Discussion:

Treatment C had the most sprouts on event 2, although usually it takes 3 to 4 days to sprout (Explore Cornell,2016). Treatment E only had 50% of the sprouts during that week. Both treatments contained an amount of compost and RAS water. When plants were added compost applications to potato plants had the highest percentages of sprouts compared to the control (Al-Mughrabi, 2006).

Treatment F did not have the highest amount of leaves but it had a significant difference to the control. C and D both had a mixture of compost and soil, yet had a significant difference. Treatment C had higher leaf counts than D. Treatment B had applications of compost tea. Out of the 4 dependents measured treatments C and E had the highest amounts of measurements compared to the other treatments. Treatment B only had the highest stem average.

Conclusion:

The overall objective was to determine if compost and compost tea influenced radish plant growth in comparison to the control. Determining which of the 8 treatments had the best plant growth was another objective. Treatments C through E had a better plant growth than the control (A) in all the data collected. My first hypothesis was right since all the treatments containing compost had a higher plant growth in comparison to the other treatments. The temperature where the experiment was taken place at could have been a limitation since it might have been too cold for the plants to grow. Which then could have caused a delay in the radish plant growth. Sprouts should've emerged the first week after seeds were sowed. There was 33% difference between the average percentage and the one obtained (Explore Cornell,2006). The seeds which didn't sprout in one of treatment A replicate may have affected the outcomes of the averages.

It can be concluded that compost does influence radish plant growth. Since both treatments, C and E had contained compost. Although the treatments had different liquid applications. Compost tea didn't have a significant difference. More research needs to be done on compost tea recipes to figure out which additives can provide the most beneficial microbes

and nutrients. Pots with half or more compost will do better than having pots with only soil. For future projects, figuring out what composition or set up can tell if there's a difference between dichloride, water that contains nutrients and compost tea would have the best plant growth.

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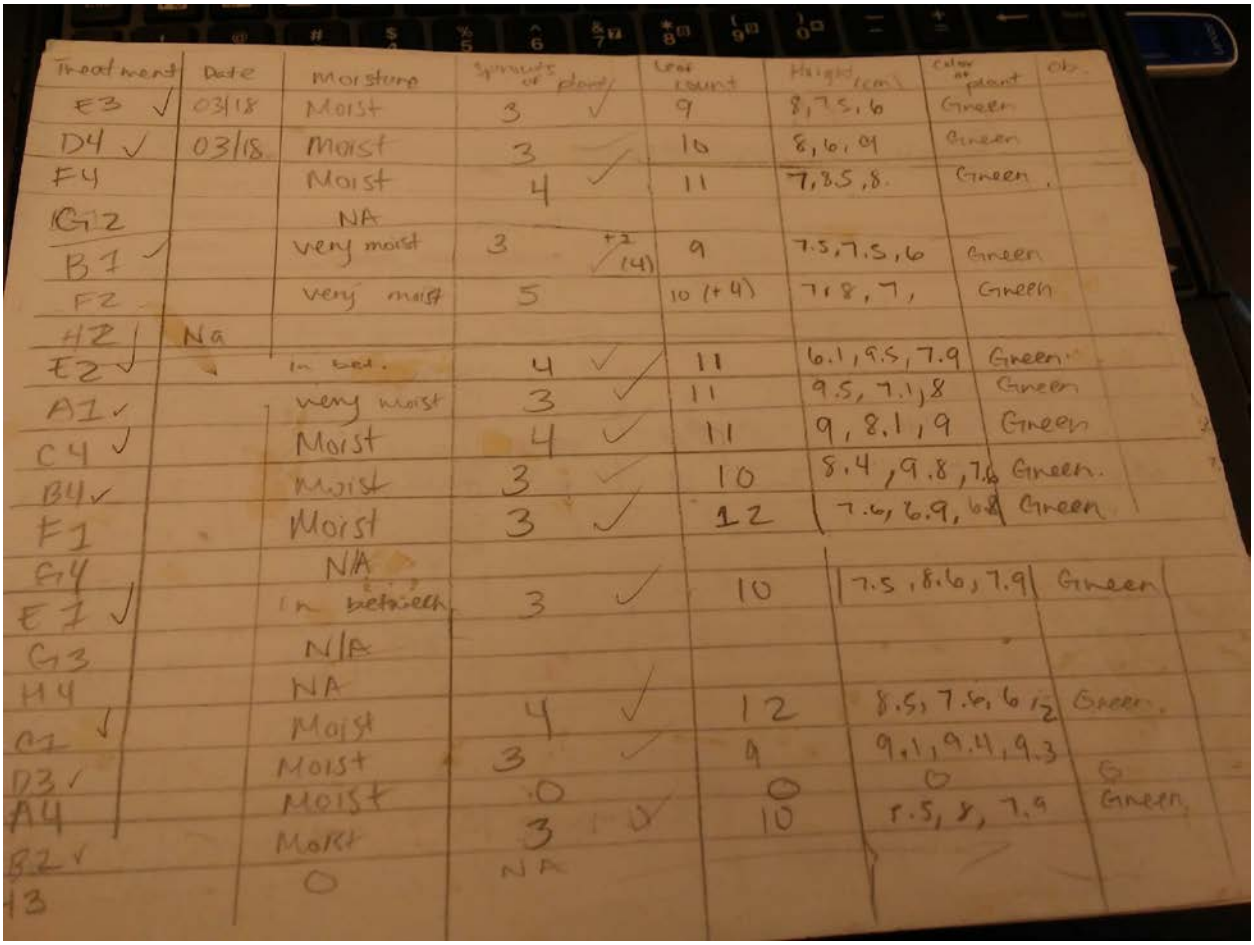


Treatment	Date	Moisture	Sprouts or plant	Leaf count	Height (cm)	Color of plant	Ob.
E3 ✓	03/18	Moist	3 ✓	9	8, 7.5, 6	Green	
D4 ✓	03/18	Moist	3 ✓	10	8, 6, 9	Green	
F4		Moist	4 ✓	11	7, 8.5, 8.	Green.	
G2		NA					
B1 ✓		very moist	3 ✓ (+2 14)	9	7.5, 7.5, 6	Green	
F2		very moist	5	10 (+4)	7, 8, 7,	Green	
H2 ✓	NA						
E2 ✓		in bet.	4 ✓ ✓	11	6.1, 9.5, 7.9	Green.	
A1 ✓		very moist	3 ✓	11	9.5, 7.1, 8	Green	
C4 ✓		Moist	4 ✓	11	9, 8.1, 9	Green	
B4 ✓		Moist	3 ✓	10	8.4, 9.8, 7.6	Green.	
F1		Moist	3 ✓	12	7.6, 6.9, 6.8	Green	
G4		NA					
E1 ✓		in between	3 ✓	10	7.5, 8.6, 7.9	Green	
G3		N/A					
H4		NA					
C1 ✓		Moist	4 ✓	12	8.5, 7.8, 6 1/2	Green.	
D3 ✓		Moist	3 ✓	9	9.1, 9.4, 9.3		
A4		Moist	0	0	0		
B2 ✓		Moist	3 ✓	10	7.5, 8, 7.9	Green	
13		0	NA				

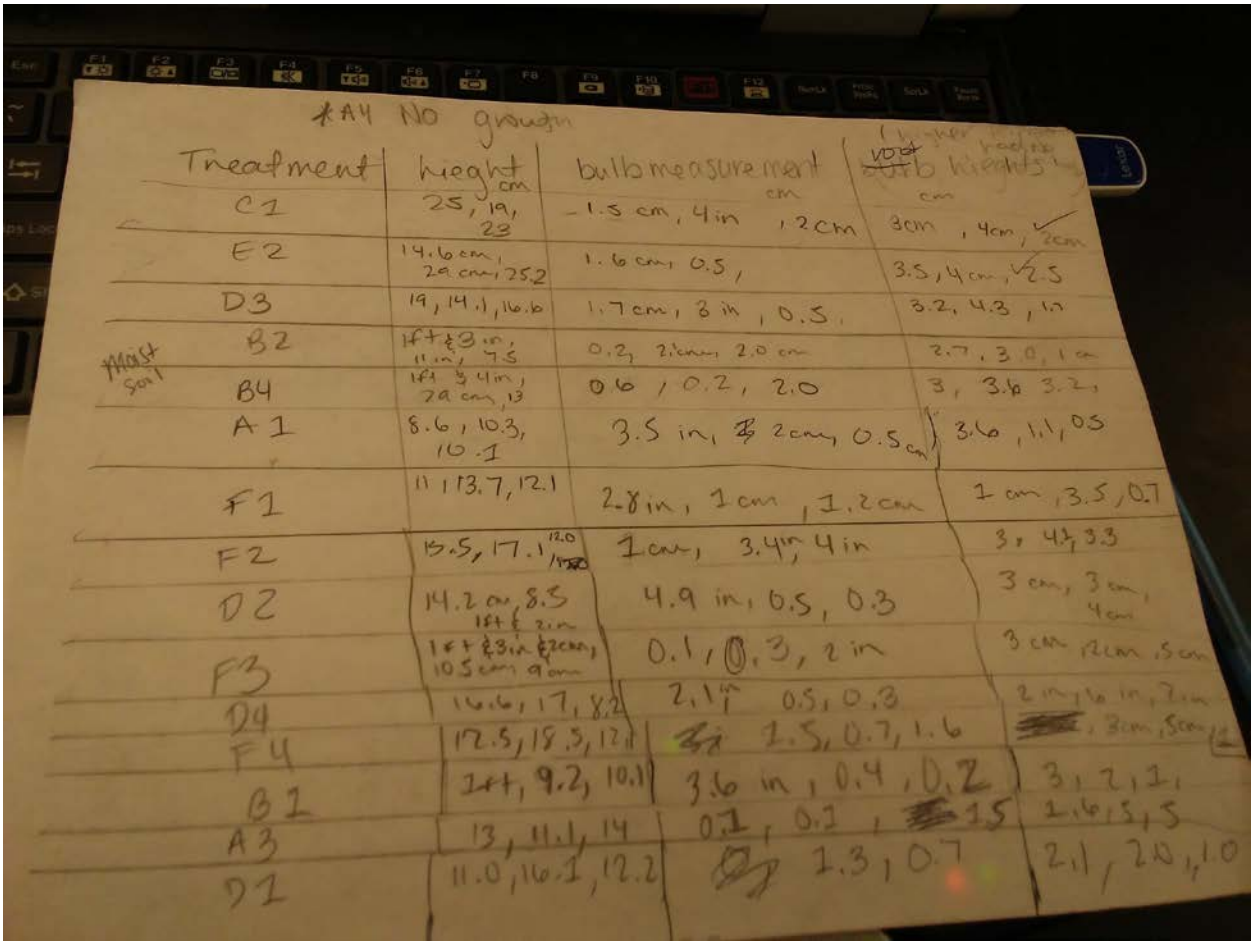
Compost Tea After Brewing Process Data Sheet

*Always use pencil

Project Name:_____ Grade: 11th

Location:_____ Start of project date: 03/07/16

Date	Time	Ambient temp. (C)	Volume	Brewing time	Tea color	Tea ph	Observatiions
03/07/16		46° C	14 L	48 hrs	Brown	7.30ph	936 ~~µ~~S (MICRO SIEMENS)
03/08/16		N/A	NA	48 hrs	Brown	N/A	Bubbly.
03/17/16	1:43	52° C		48hrs	Dark Brown	7.84	Bubbly. water 45 417 45 1738
03/ 16	1:46		13L	48 hrs	Dark Brown	7.45	Good earth smell
03/30	1:45	56° C	13L	48hrs	Brown	7.73	Less bubbly. water 45 867 45. pH 7.60



*A4 NO growth

Treatment	Height cm	bulb measurement cm	bulb heights cm
C1	25, 19, 23	1.5 cm, 4in, 2cm	3cm, 4cm, 2cm
E2	14.6 cm, 29 cm, 25.2	1.6 cm, 0.5,	3.5, 4cm, 2.5
D3	19, 14.1, 16.6	1.7 cm, 8 in, 0.5,	3.2, 4.3, 1.1
B2	1ft & 3 in, 11 in, 7.5	0.2, 2.1cm, 2.0 cm	2.7, 3.0, 1 cm
B4	1ft 3.4in, 29 cm, 13	0.6, 0.2, 2.0	3, 3.6 3.2,
A1	8.6, 10.3, 10.1	3.5 in, 2cm, 0.5cm	3.6, 1.1, 0.5
F1	11, 13.7, 12.1	2.8 in, 1 cm, 1.2 cm	1 cm, 3.5, 0.7
F2	15.5, 17.1, 12.0	1 cm, 3.4in, 4 in	3, 4.1, 3.3
D2	14.2 cm, 8.5 1ft & 2in	4.9 in, 0.5, 0.3	3 cm, 3 cm, 4 cm
F3	1ft & 3 in & 2 cm, 10.5 cm, 9 cm	0.1, 0.3, 2 in	3 cm, 2 cm, 5 cm
D4	16.6, 17, 8.2	2.1in, 0.5, 0.3	2 in, 1.6 in, 2 cm
F4	12.5, 18.3, 12.1	1.5, 0.7, 1.6	[illegible], 3cm, 5cm
B1	1ft, 9.2, 10.1	3.6 in, 0.4, 0.2	3, 2, 1,
A3	13, 11.1, 14	0.1, 0.1, [illegible]5	1.6, 5, 5
D1	11.0, 16.1, 12.2	[illegible] 1.3, 0.7	2.1, 2.0, 1.0

Before Brewing Compost Tea Data Sheet

*Always use pencil

Project Name:_____ Grade:_____

Location:_____ Start of project date:_____

Date	Time	Ambient temp.	Volume	Color of tea	Compost pH	Tea pH	Observations:

Project name: _____

Initial date: _____ Final date: _____

Date	Treatment	Height	Bulb circumference (cm)	Root length (cm)	Observations

*cm is centimeters

Project name: _____

Initial date: _____ Final date: _____

Date	Treatment	Sprouts	Leaf count	Height (cm)	Color of plant	observation

- Cm is centirmeters