TED ANKARA COLLEGE FOUNDATION

PRIVATE HIGH SCHOOL

Comparison of wet weights and dry weights of the plant *Lactuca sativa* when different concentrations of homemade organic fertilizer that is made of organic kitchen wastes are given

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ESS EXTENDED ESSAY

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Word Count: 3982

ABSTRACT

The aim of this investigation was to observe the effects of homemade organic fertilizer on the lettuce plant. This extended essay includes the comparison of wet weight values and dry weight values of the lettuce plants if different concentrations of homemade organic fertilizer are mixed with their soil.

My research question was “What is the effect of different concentrations of home-made compost fertilizer on the growth rate of the vegetable Lactuca sativa?”

My hypothesis was “If the amount of organic fertilizer that is given to the plant lactuca sativa (lettuce) is increased, the wet weight and the dry weight of that plant (plant’s biomass) will also increase.”

In order to prove my hypothesis and receive an answer to my research question I collected the organic kitchen wastes and dry them in an oven. After putting them in blender I obtained my organic fertilizer. Then I mixed 0, 20, 40 and 80 grams of that fertilizer with 2 kilograms of soil and cultivated lettuce plants in those pots. At the end of 45 days I did the harvest and weighed them before and after I put them in the oven to obtain biomass. The results were in an increasing order. Moreover, I did an ANOVA test to find out if the average increase between the groups was significant. After the ANOVA test I proved that if the amount of organic fertilizer that is given to the lettuce plant is increased, the wet and dry weight of that plant will also increase. The subject that is processed in this investigation will not only provoke people to do reusing and recycling but also encourage them to do organic farming and healthy diet.

Word Count: 279

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INTRODUCTION

In daily life, pollution is one of the most common problems for the majority of living organisms because this situation affects the quality of life. That's why there are a lot of organizations whose real aim is to persuade people to recycle more.

I am an environmentally friendly person and I respect the nature. I believe that recycling should be supported in order to maintain the continuity of the natural resources. Since everyone is obsessed with the "healthy life style" nowadays, I thought that it would be a great idea to combine the concepts of healthy food and recycling. I did a couple of researches about how to plant a vegetable at home in a healthy way. Then, I thought of making fertilizers at home with the composts of organic trashes. By the help of these homemade fertilizers, planting a vegetable would not only be environmentally friendly but also healthy for us to eat our own products.

I also believe that pollution management is very important. It is something that every country has to show sensitivity, so that the continuity of our natural resources will be provided. It is a process which finds ways to deal with any kind of pollution. Every society has to develop a way to manage with it. In my opinion, people should try to prevent pollution as much as they can because human activities, increasing industrial output and spreading urbanization produce a variety of harmful substances. The aim in pollution management is to minimize the harmful substances as possible[1]. I think one of the things that have the biggest impact on pollution is waste. People around the world produce tons of waste materials in every second which can cause damages on Earth. An example in 2012, 251 million tons of trash is generated only in America.[2] There are also many ways to prevent this situation. Firstly, people should be informed about the importance of dealing with wastes.

[1] http://www.epa.gov/greenchemistry/basics-green-chemistry
[2] http://www.epa.gov/epawaste/nonhaz/municipal/

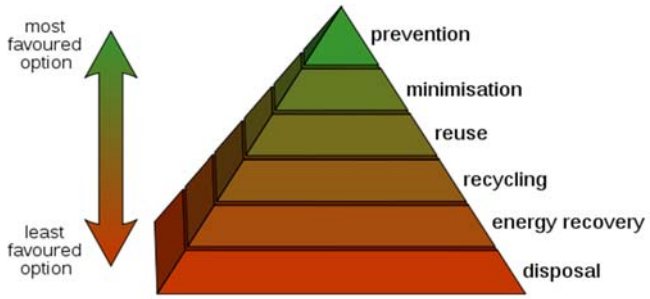

Figure 1: Waste hierarchy[3]

Waste management is the generation, prevention, characterization, monitoring, treatment, handling, reuse and residual disposition of solid wastes.[4] Recycling and reusing are two of the ways of waste management. Both of these processes help reducing waste of money, energy, time and resources. Non-hazardous industrial wastes become more by the developing industry and growing population. At this point disposition of waste become necessary. There are several methods of waste disposal such as landfill, combustion, recovery and recycling, plasma gasification and composting.[5]

Composting is taking organic wastes and turning them into nutrient rich food for plants. It is easy, natural and generally used for organic farming. Composting can turn unsafe organic products into safe compost. So, it is one of the best ways to deal with wastes. On the other hand, it is a process that takes a lot of time and effort.[6]

In this investigation my aim is to reflect the concept of composting. Firstly, I'm going to collect the organic household wastes. These substances will be parsley stalks, potato skins, residual tea, etc. After collecting, I'm going to turn them into compost. Through this process, organic homemade fertilizer is going to be revealed. Then, I'm going to plant 4 different groups of lettuce plant which includes different concentrations of that organic fertilizer. The reason of choosing the lettuce plant is that they are suitable for cultivation in winter and their growth can be easily observed. At the end of this investigation I will have a conclusion if this organic fertilizer can be an alternative fertilizer for growing plants.

So my research question will be "What is the effect of different concentrations of home-made compost fertilizer on the growth rate of the vegetable Lactuca sativa that will be measured by comparing dry and wet weights?"

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[3] http://commons.wikimedia.org/wiki/File:Waste_hierarchy.svg
[4] Waste Management (2013). [Retrieved from http://www.sciencedirect.com/science/article/pii/S0956053X14000269 "Editorial Board/Aims & Scopes"].
[5] http://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php
[6] http://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php

HYPOTHESIS

Our planet is getting polluted day by day. A lot of precautions are taken in order to prevent this pollution. One of the preferred of these methods is recycling. It helps to restore the daily waste in a useful way. I feel that for both healthy living, as well as to contribute to recycling, planting vegetables with organic fertilizers should be implemented.

To get organic waste materials evaluated, my idea is to produce my own organic fertilizer and grow a vegetable by the help of the fertilizer that I made.

The amount of food wasted should be reduced because it has significant economic, social and environmental benefits like reducing methane from landfills and making disposal costs lower.[7]By making food wastes drained, an organic fertilizer is produced.

Composting has important effects in gardening and agriculture. It can enhance the physical characteristics and productivity of soil as a soil amendment. Compost that does not contain any contaminants and has physical and chemical properties that are favorable should increase the growth level of plants.[8]

So, my hypothesis will be "If the amount of organic fertilizer that is given to the plant Lactuca sativa (lettuce) is increased, dry weight and wet weight of that plant will also increase."

[7] http://www.epa.gov/epawaste/conserve/foodwaste/
[8] http://cwmi.css.cornell.edu/chapter6.pdf

METHOD, DEVELOPMENT AND PLANNING

First, I started my project by deciding the subject I want to work on. After determining on the organic farming, I consulted Prof. Aydın Güneş who is a family friend and an expert on plant breeding and soil about how to develop my ideas and make the best investigation. Our joint decision was to collect the organic home waste, turning it into an organic fertilizer and grow a plant with it.

Figure1: Dried organic materials in a blender

We chose organic home waste for the growth of the plant because it would be the best choice if it is considered that one of my real aims is preventing the pollution and supporting reusing. This fertilizer was obtained by dehydrating the organic waste by spreading it out at first and then baking it in a special oven. After all the water in plant was eliminated, the remains were passed through the blender in order to maintain a matter with little particles. With this process, I obtained the most appropriate fertilizer for a plant since it reaches its anhydrous state and suitable to be mixed into the plant's soil with its sand-like structure.

I searched then decided that the best plant to observe the growth in this investigation would be lettuce (Lactuca sativa) because since this investigation was held in winter, the plant should be resistant to grow in winter, easy to observe the growth and easy to breed. Plant lettuce is suitable to grow in cool places and has an obvious change while it is developing.

In order to express my aim for the observation of the effects of organic fertilizer on the growth of the lettuce plant, I decided to give the organic fertilizer to lettuce in three different concentrations. First group was without any fertilizer to make a comparison. Second group was with 10 grams of fertilizer per 1 kilogram of soil. Third group was with 20 grams of fertilizer per 1 kilogram of soil. The last, forth group was with 40 grams of fertilizer

Figure2: Lettuce plants planted in pots

per 1 kilogram of soil. Since there were 2 kilograms of soil in each pot, the amount of fertilizer in each pot was doubled. I got the information that the best amount of soil to grow a lettuce plant is 2 kilograms from Mr. Aydın Güneş.

In order to have more accurate results, there were four pots for each group so that the observations would be distinguishable. While putting the soil in pots, I placed a plastic bag in each pot to prevent the material loss from the little wholes at the bottom of the pots. Those materials could be soil, fertilizer, vitamins and minerals.

When I had a conversation with Mr. Aydın Güneş, he told me that I can use the facilities like laboratory and greenhouse of the University of Ankara, Faculty of Agriculture, Soil Science and Plant Breeding Section where he is a professor at. In my investigation, I could also get help of the research assistant M. Burak Taşkın.

My experiment held in a greenhouse. So we could have the chance to set the temperature of the environment. According to the information given from M. Burak Taşkın, this temperature would be approximately between 15°C and 20°C because it is the best temperature for lettuce growth. I needed 16 lettuce plants for this investigation because there were 4 trials and 4 independent variables. Those lettuce plants are supplied from the faculty and planted in the middle of the pot as a seedling. The reason why I choose to use seedlings instead of seeds is that it would take so long to wait seeds to pullulate.

After setting the assembly, first of all I gave them lifeline. After this process I watered them regularly, about every day. I learned from University of Ankara that the amount of water should be in average not too much or a little and should be the same. This is the end of my experiment part. By the end of this stage, when the plants reached a certain point of growth (about 45 days later) I started the comparison between the pots. The comparison included the wet weight of the plant and dry weight (biomass) of the plant.

MATERIAL LIST

- 2 kilograms of organic kitchen waste
- Blender
- Precision weighing
- Drying oven
- Sieve
- 12 little boxes
- 16 pots with 160 cm^2 volume
- 16 lettuce plants
- 32 kilograms of soil
- Tap water
- Pure water
- Pruning shears
- Paper bags
- 16 little plastic bags
- Acetate pen

METHOD

A) PREPARATION OF ORGANIC FERTILISER

1. Collect and spread organic kitchen wastes such as mandarin peels or parsley longer on a sheet where they can dry up by the help of air until it reaches about 2 kilograms
2. Put the organic wastes in paper bags randomly
3. Put the paper bags in drying oven and set it to 200 degree
4. After 2 days of drying process when they all lose their water, take them out from the oven
5. By the help of a blender, turn the dried organic waste into a powder-like substance
6. In order to get rid of large particles, pass the substance through the sieve
7. Measure the organic fertilizer to be 4x20g, 4x40g and 4x80g and put those in separate little boxes

B) LETTUCE PLANTING PROCESS

1. Number 16 pots from 1 to 16
2. Put only 2 kilograms of soil to the first 4 pot
3. For the second 4 pots, mix 20 grams of fertilizer with 2 kilograms of soil for each pot
4. For the third 4 pots, mix 40 grams of fertilizer with 2 kilograms of soil for each pot
5. For the last 4 pots, mix 80 grams of fertilizer with 2 kilograms of soil for each pot
6. Plant 16 lettuce seedlings to the middle of the each pot to be 5 centimeters above the soil
7. Water them for the first time until all the soil got wet
8. After planting, give 100 mL of water every day

C) HARVEST AND WEIGHING

1. Number paper bags from 1 to 16
2. After 45 days when the growth can be distinguishable, Cut the lettuce plants from the bottom with a pruning shear and put those in paper bags which is the same number as their pots
3. Weigh each plant and write the data down
4. Wash the plants in tap water and then in pure water
5. After washing process, put them back in their numbered paper bags and put them in the drying oven
6. When all the water in the plants is lost, calculate their biomass with a precision weighing and write the data down

DATA COLLECTION AND PROCESSING

Concentration of fertilizer (g/kg) (±0.05)		Wet weight of lettuce plant (g)(±0.05)	Temperature of the environment (°C) (±0.5)	Weight of soil (kg) (±0.05)	Volume of the water given (mL) (±0.05)	Watering schedule	Volume of the pot (cm^2) (±0.01)
0.00 (Control Group)	**Trial1**	35.35	20.0	2.00	50.00	Every day	160.00
	Trial2	27.41	20.0	2.00	50.00	Every day	160.00
	Trial3	33.71	20.0	2.00	50.00	Every day	160.00
	Trial4	33.05	20.0	2.00	50.00	Every day	160.00
10.00	**Trial1**	56.17	20.0	2.00	50.00	Every day	160.00
	Trial2	52.50	20.0	2.00	50.00	Every day	160.00
	Trial3	38.27	20.0	2.00	50.00	Every day	160.00
	Trial4	57.32	20.0	2.00	50.00	Every day	160.00
20.00	**Trial1**	58.12	20.0	2.00	50.00	Every day	160.00
	Trial2	53.10	20.0	2.00	50.00	Every day	160.00
	Trial3	60.86	20.0	2.00	50.00	Every day	160.00
	Trial4	59.66	20.0	2.00	50.00	Every day	160.00
40.00	**Trial1**	80.35	20.0	2.00	50.00	Every day	160.00
	Trial2	71.29	20.0	2.00	50.00	Every day	160.00
	Trial3	74.18	20.0	2.00	50.00	Every day	160.00
	Trial4	45.05	20.0	2.00	50.00	Every day	160.00

Table 1: Wet weight of the plant Lactuca sativa after the harvest when different concentration of the organic fertilizer is given at a constant temperature

Concentration of fertilizer (g/kg) (±0.05)		Dry Weight of lettuce plant (g)(±0.05)	Temperature of the environment (°C) (±0.5)	Weight of soil (kg) (±0.05)	Volume of the water given (mL) (±0.05)	Watering schedule	Volume of the pot (cm^2) (±0.01)
0.00 (Control Group)	**Trial1**	1.94	20.0	2.00	50.00	Every day	160.00
	Trial2	1.59	20.0	2.00	50.00	Every day	160.00
	Trial3	1.94	20.0	2.00	50.00	Every day	160.00
	Trial4	1.87	20.0	2.00	50.00	Every day	160.00
10.00	**Trial1**	2.49	20.0	2.00	50.00	Every day	160.00
	Trial2	2.30	20.0	2.00	50.00	Every day	160.00
	Trial3	1.99	20.0	2.00	50.00	Every day	160.00
	Trial4	2.68	20.0	2.00	50.00	Every day	160.00
20.00	**Trial1**	2.72	20.0	2.00	50.00	Every day	160.00
	Trial2	2.68	20.0	2.00	50.00	Every day	160.00
	Trial3	3.13	20.0	2.00	50.00	Every day	160.00
	Trial4	2.53	20.0	2.00	50.00	Every day	160.00
40.00	**Trial1**	3.70	20.0	2.00	50.00	Every day	160.00
	Trial2	3.09	20.0	2.00	50.00	Every day	160.00
	Trial3	3.25	20.0	2.00	50.00	Every day	160.00
	Trial4	2.47	20.0	2.00	50.00	Every day	160.00

Table 2: Dry weigh of the plant Lactuca sativa after the harvest when different concentration of the organic fertilizer is given at a constant temperature

		Concentration of organic fertilizer (g/kg) (±0.05)			
		0.00	**10.00**	**20.00**	**40.00**
Wet Weight (g)(±0.05)	**Trial 1**	35.35	56.17	58.12	80.35
	Trial 2	27.41	52.50	53.10	71.29
	Trial 3	33.71	38.27	60.86	74.18
	Trial 4	33.05	57.32	59.66	45.05
Arithmetic Mean		32.38	51.07	57.94	67.72
Range		7.94	19.05	7.76	35.30
Variance		11.91	76.99	11.65	242.64
Standard Deviation		3.45	8.77	3.41	15.58
Standard Error		1.73	4.39	1.71	7.79
T value		3.18	3.18	3.18	3.18
95% Confidence Interval		5.49	13.96	5.43	24.79

Table 3: Mean, range, standard deviation and standard error values of the trials in each concentration calculated with the data given in table 1 for wet weight values

		Concentration of organic fertilizer (g/kg) (±0.05)			
		0.00	**10.00**	**20.00**	**40.00**
Dry Weight (g)(±0.05)	**Trial 1**	1.94	2.49	2.72	3.70
	Trial 2	1.59	2.30	2.68	3.09
	Trial 3	1.94	1.99	3.13	3.25
	Trial 4	1.87	2.68	2.53	2.47
Arithmetic Mean		1.84	2.37	2.77	3.13
Range		0.35	0.69	0.60	1.23
Variance		0.03	0.09	0.07	0.26
Standard Deviation		0.17	0.29	0.26	0.51
Standard Error		0.08	0.15	0.13	0.25
T value		3.18	3.18	3.18	3.18
95% Confidence Interval		0.27	0.47	0.41	0.81

Table 4: Mean, range, standard deviation and standard error values of the trials in each concentration calculated with the data given in table 2 for dry weight values

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
0	4	129.52	32.38	11.9132
10	4	204.26	51.065	76.98577
20	4	231.74	57.935	11.64757
40	4	270.87	67.7175	242.6408

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2671.126	3	890.3754	10.37772	0.001186	3.490295
Within Groups	1029.562	12	85.79682			
Total	3700.688	15				

Table 5: ANOVA single factor test that is done with the data given in Table1 for wet weight values

SUMMARY

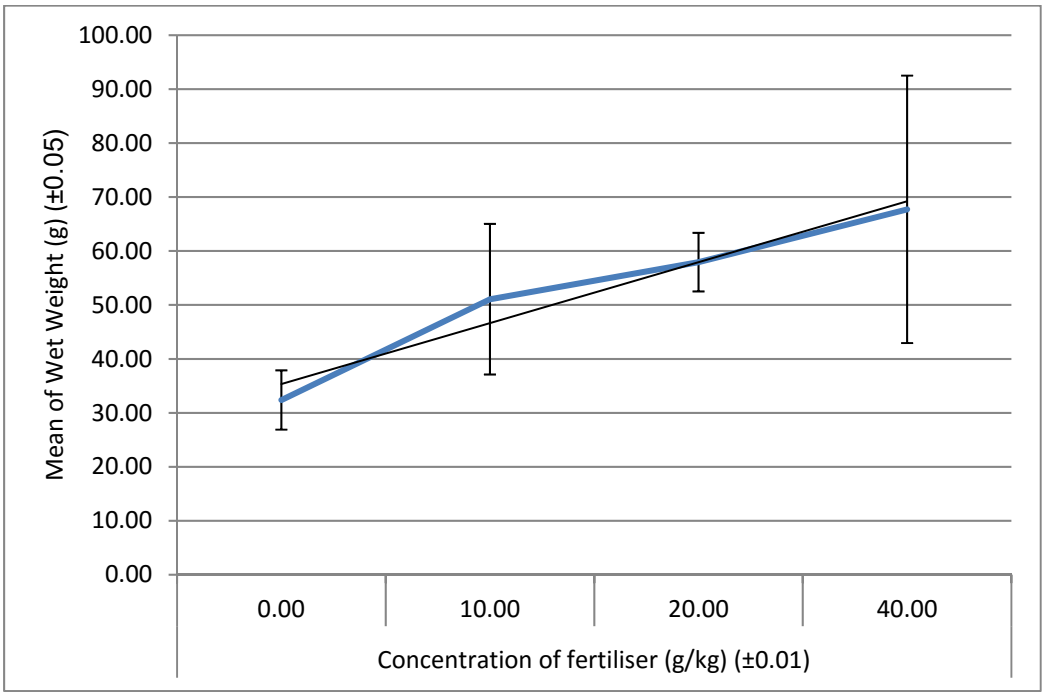
Groups	*Count*	*Sum*	*Average*	*Variance*
0.00	4	7.34	1.835	0.027767
10.00	4	9.46	2.365	0.086567
20.00	4	11.06	2.765	0.0659
40.00	4	12.51	3.1275	0.258825

ANOVA

Source of Variance	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.689169	3	1.229723	11.20328	0.000856	3.490295
Within Groups	1.317175	12	0.109765			
Total	5.006344	15				

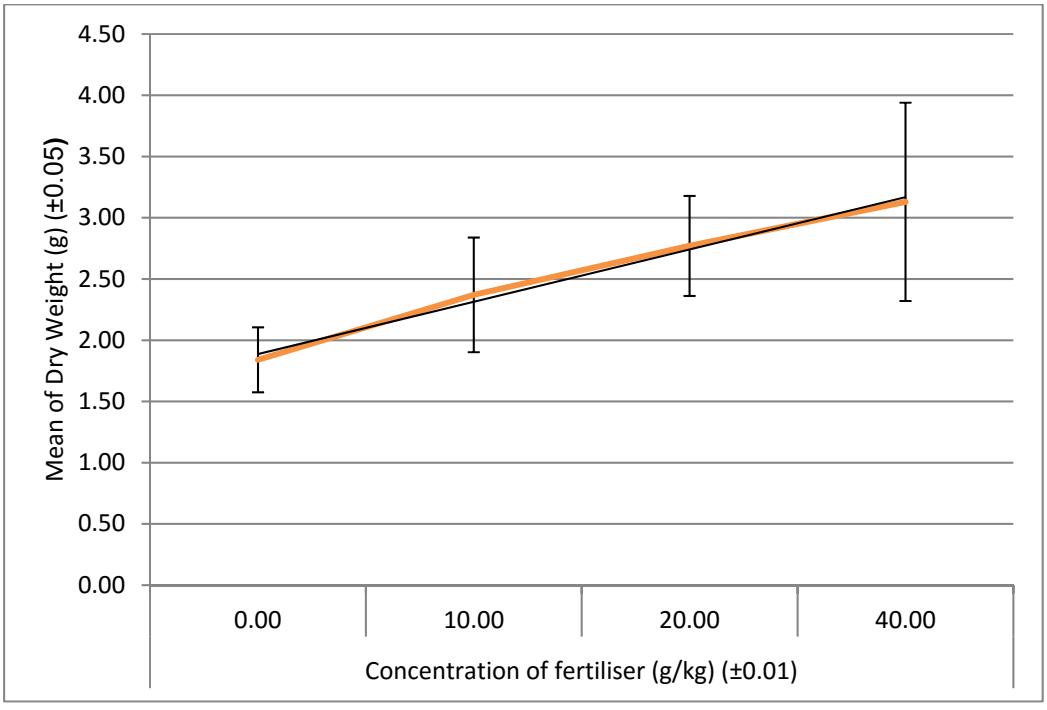
Table 6: ANOVA single factor test that is done with the data given in Table2 for dry weight values

Graph 1: Graph that is drawn by the data given in Table 3 which shows the average wet weights of Lactuca sativa if 0, 10, 20 and 40 grams of fertilizer is given per kilogram of soil



*Error bars are based on %95 confidence interval

Graph 2: Graph that is drawn by the data given in Table 4 which shows the average dry weights of Lactuca sativa if 0, 10, 20 and 40 grams of fertilizer is given per kilogram of soil



*Error bars are based on %95 confidence interval

CONCLUSION

In the World, recycling is one of the most important things, even for trashes. By the help of recycling, the amount of energy loss will be decreased and the sources of earth will not be wasted. In my experiment, I used the organic kitchen wastes to produce an organic fertilizer. If those wastes were put to a trash bin, they would be useless for the environment but I grow a lettuce plant with the compost of the trashes and they became valued. Besides I proved that a person can grow his own plant and make it more fertile by using the organic fertilizer that he produces.

Growing a plant in a natural way with no usage of chemicals is called organic farming.[9] Products of organic farming respect natural life cycles. The human impact on the environment decreases by the time organic farming occurs.[10]In my investigation the possibility of how both organic farming and recycling can be done at the same time is tested. My aim was to show that the homemade organic fertilizer has a great impact on the growth of Lactuca sativa.

At first, I collected the organic wastes that came from our kitchen. Those wastes were residues of vegetables and fruits. After it became around 2 kilograms, I put them into a specialized heating oven and leave there for two days. This process helps to get rid of excessive water and leave the nutrients inside the wastes. When they all became dry, I put them into the blender to make small particles. It provides the maintenance of a homogenous structure that can be easily mixed with the soil. At the end of these applications I obtain my organic fertilizer. Then, I put 0, 10, 20 and 40 grams of fertilizer per kilogram to each pot with 2 kilograms of soil. I use 4 trials in my experiment in order to prevent possible mishaps. In total, I planted 16 germinated lettuce plants. Approximately at the end of 45 days I reaped my lettuce plants. Before harvest, the volume difference between the pots in different groups was obvious enough to observe for a preview but dry and wet weights of the plants were compulsory for my investigation. I weighted before I took them into a heating oven in order to have the data of their wet weights.

[9] http://www.businessdictionary.com/definition/organic-farming.html
[10] http://ec.europa.eu/agriculture/organic/organic-farming/what-is-organic-farming/producing-organic/index_en.htm

If we accept the 0 gram/kilogram fertilizer as first group, 10 grams/kilogram as second group, 20 grams/kilogram as third group and 40 grams/kilogram as fourth group; it can be said that there was an increase in wet weight from first group to fourth when I took their average values. The values were 32.38, 51.07, 57.94, and 67.72 respectively. The graph of these values was drawn as an increasing graph. This also shows that when the concentration of organic fertilizer increases, the wet weight of the plants increases as well. In the first group, there were no obvious ups and downs in the data as in the third group. In the third trial of second group the value was 38.27. So, it can be said that there was big decrease in the value of wet weight. In the last group, the plant's wet weight in the trial four was 45.05. It is even smaller than the values in the second group. It caused a big standard deviation in their group like 15.58 when the other standard deviations were 3.45, 8.77 and 3.41 respectively. The second standard deviation can be explained by the fall in the value of wet weight of the third trial.

I did the same calculations for dry weight values as well. The values were increasing from group one to group four but I observed that dry weight values of the lettuce plants were smaller than their wet weight values. Their average values were 1.84, 2.37, 2.77 and 3.13 respectively. The graph of these values was an increasing graph as well but it was smoother than the graph of wet weights. The cause of this situation may be the distribution of excessive water in their structure. A plant may contain more water when the other contains less. In fourth group a shift could be easily observed compared to the other groups. In the other groups there were also deviations but not as obvious as the last group. Since the values got smaller and the water was vanished, the differences between the trials decreased as well. The standard deviations were 0.17, 0.29, 0.26, and 0.51 respectively. The shift in the fourth group explains the value of the standard deviation. As a result of all my calculations I observed that both wet weight and dry weight of the plant lettuce increased when the concentration of the homemade organic fertilizer that had been mixed with the soil of the plant was increased. But the values of the dry weight were less than the values of the wet weight due to the water loss.

In literature it is known that when nitrogen level increases in the environment where a plant is cultivated, plant growth is alerted.[11]. In the nutrients that are taken by humans, there is generally nitrogen. So I can predict that in the compost that I made, there is also nitrogen because I used daily nutrients of a human in my fertilizer. At the end of my experiment I observed that growth of lettuces were alerted by the time I increased fertilizer level. So, weights of lettuce plants were increased but that was just in appearance. In order to understand if this increase was significant statistically, I did analysis of variance test (anova). Anova test determines the impact of independent variables on dependent variables.[12] It is generally used to detect if there is a meaningful difference among at least one group where there are more than one samples.[13] At the end of the anova test If the p-value is under 0,05 (95% confidence interval) then there is a significant difference between your dependent variables. I did the anova test for both wet weight values and dry weight values. In the anova test that I did in Microsoft excel the p-value was found as 0,001186349 which is under 0,05. So it can be said that there is a significant difference in average values at least in one group. It proves that difference in organic fertilizer causes a significant change. The p-value of dry weight values that is calculated in Microsoft excel is found as 0,000855865 which is under 0,05 as well.

So, my hypothesis was "If the amount of organic fertilizer that is given to the plant Lactuca sativa (lettuce) is increased, plant's biomass and wet weight will also increase. At the end, a significant increase in wet and dry weight values is observed. So that I proved that my hypothesis is true.

[11] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4025000/
[12] http://www.investopedia.com/terms/a/anova.asp
[13] https://explorable.com/anova

EVALUATION

In four trials any of the data in each group were the same. In fact, there were two big deviations in two groups even if I took all the precautions I could because there were some limitations in this experiment.

One of the possible errors might be the distribution of organic fertilizer. The nutrients that are in the organic fertilizer are various. After the drying process and blender, I assumed that different kinds of nutrients are distributed equally in the powder-like mixture. But they may not. In order to prevent this situation, different kinds of nutrients can be separately dried, milled separately and given to the plant separately. After the organic fertilizer was mixed with the soil it may not distributed separately even If they are mixed very well. The roots may not be in the equal distance to the fertilizer but it is impossible to control what is going on under the soil. So, I assumed that the plants in every trial get the same amount of organic fertilizer as the rest of their group because of the chemotropism. Besides, the minerals that were already in the soil and may not be mixed well could cause an error and impossible to prevent but that situation can be explained with chemotropism as well.

The second error source might be that the seedlings can be different from each other. I used germinated lettuce plants, not the seeds because I could get the results faster but even if I choose the seedlings which are similar to each other, they cannot be the same except cloning them (it seems quite impossible in my conditions. But if there would be further investigation on this subject in a very developed university they might take this suggestion into their consideration.) Growing a plant from its seed would be easier. If they are germinated in the same conditions, the results might me more precise and accurate.

One of the causes of the standard deviations could be organic materials from outside such as dead insects, flies or bugs. These organic materials may cause excessive growth of a plant. Or if all of the plants are affected by these living organisms and one of the plants is not, it may become smaller than the other plants. It is impossible to prevent this situation because insecticides will affect the plant growth in a bad way. But it is possible to prevent these organisms to dissolve in the soil by checking the soil if there are any dead organisms or insect eggs frequently and taking them out so that there is only the organic fertilizer which affects the organic material level in the soil.

There are also limitations in this experiment which affect every plant and do not differ from trial to trial such as the tap water that was used for watering. For every plant, water was coming from the same tap. The water of that tap may contain less dissolved minerals while another tap may contain more dissolved minerals. It is hard to control. But in order to observe more growth of the plants in total, the water can be chosen which has more minerals in it at the end of the water analysis.

While preparing the compost, I used the wastes from our kitchen. But the nutrients may differ from one kitchen to another. An example if a family always eats mandarin then the level of vitamin c in the organic fertilizer will be the most or if they eat bananas very often, the potassium level will be the most in the organic fertilizer. It is uncontrollable and differs from kitchen. Most grown plants can be obtained by choosing the nutrients which are more efficient for a plant growth and composting them.

Producing an organic fertilizer from kitchen wastes and planting a lettuce plant with that fertilizer may be challenging and laborious but an incredibly good thing for our nature, our health and the economy.

Composting is good for an economy because if composting process occurs in a country, there will be no need to import inorganic fertilizer from another country and that country provides the sustainability of the economy. By composting they do not need to spend the country's money on the burning processes of wastes. In addition, organic farming and producing healthy food are preferred nowadays. So, people would want to make investigations on those subjects.

Producing organic fertilizer from kitchen wastes is also a way of waste management which supports reusing and recycling. Those processes provide sustainability of natural resources. By recycling and reusing the pollution can be reduced, energy can be saved, global warming can be prevented and wild life can be protected by not damaging the forests.[14]

Organic farming is beneficial for human's health because in the inorganic fertilizers there may be some ingredients (chemicals) which may be harmful for us but provides a plant

[14] http://www.socrra.org/recycling_top10.shtml

to grow more. In the market, people do anything to produce more and cheaper products (GMO's). But in organic farming, everything should be organic which is good for our health. Not only humans but also all the living organism are affected well by organic farming. It is even in the definition of organic farming. "It is a way of producing food which is respectful to natural life cycles."[15] It does not harm to the nature and decreases the human impacts on nature.

[15] http://ec.europa.eu/agriculture/organic/organic-farming/what-is-organic-farming/producing-organic/index_en.htm

APPENDIX 1

(STATISTICAL FORMULAS USED IN THE EXPERIMENT)

A) ARITHMETIC MEAN

The result that is found by taking the sum of the data and dividing it by the total number of values in the set is called arithmetic mean or average of a set of data.[16] It can be shown as:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i$$

Where μ is the Greek letter which represents the mean, N is the total number of values in a set and each data in the set denoted by x_i (where i =1, 2, 3…, N).

B) RANGE

It is found when the lowest value of a data set is subtracted from the highest value.[17]

C) STANDARD DEVIATION

It is a measure for determining how spread out the data of a set is. Standard deviation is shown by σ (sigma in Greek letters) and it is the square root of variance.[18]

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

Where μ is the Greek letter which represents the mean, N is the total number of values in a set and each data in the set denoted by x_i (where i =1, 2, 3…, N).

D) VARIANCE

Variance measures how far each number in the set from the arithmetic mean. It is calculated by subtracting each number in the set from the mean, making them positive by squaring the differences and dividing the sum of the squares by the number of values in the set.[19] It is shown as:

[16] http://www.mathgoodies.com/lessons/vol8/mean.html
[17] https://www.mathsisfun.com/definitions/range-statistics-.html
[18] http://www.mathsisfun.com/data/standard-deviation.html
[19] http://www.investopedia.com/terms/v/variance.asp

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2$$

Where σ is sigma in Greek letter which represents the standard deviation, μ is the Greek letter which represents the mean, N is the total number of values in a set and each data in the set denoted by x_i (where i =1, 2, 3…, N).

E) STANDARD ERROR

Standard deviation of a sampling distribution is called standard error.[20] It is found by dividing standard deviation by the square root of the number of values in the set.

$$SE = \frac{\sigma}{\sqrt{N}}$$

Where SE is the standard error, σ is the Greek letter that represents standard deviation and N is the number of values in a set.

F) CONFIDENCE INTERVAL

It shows how reliable a prediction is and is found by multiplying the standard error and the t-value of that data set.

[20] http://www.investopedia.com/terms/s/standard-error.asp

APPENDIX 2

(ANALYSIS OF VARIANCE TEST)

A) Usage of ANOVA

It is used to compare differences of means among more than 2 groups. ANOVA is the comparison of the amounts of variation between groups with the amount of variation within groups. It is expected that there should be some differences in means among different groups. ANOVA helps to understand if the difference between the groups is random or significant. While doing this, 95% confidence interval should be taken into consideration because it is determined with that value.[21]

B) P-VALUE AND HYPOTHESIS TESTING

It represents the probability of the occurrence of a given event.[22] If the p value is under (0.05) (when the error is under the 95% confidence interval) then the hypothesis is said to be true. It also suggests that at least one group of mean is significantly different from another.[23]

[21] http://www.edanzediting.com/blog/statistics_anova_explained#.VgKQpMvtmko
[22] http://www.investopedia.com/terms/p/p-value.asp
[23] http://www.edanzediting.com/blog/statistics_anova_explained#.VgKQpMvtmko

APPENDIX 3

(BIOMASS CALCULATION)

Living or recently living organisms' biological matter is called biomass.[24] In ecology it also means the mass of living biological organisms in a given area. Its definition can change according to where it is used. If the mass of one or more species is calculated then it is "*species biomass*". Or if the mass of all the species including plants, animals and microorganisms is calculated then it is called "*community biomass*". But in this experiment is regarded as the "*natural mass"* of an organism which means the mass if the water is taken out from that organism (dry weight).[25]

In order to calculate an organism's dry weight (in this experiment that would be the lettuce plants), it should be put in a drying oven which is set in 65-70˚C. After about two days, it should be weighted immediately when it is taken out from the oven. The result gives the biomass value.

[24] http://www.biomassenergycentre.org.uk/portal/page?_pageid=76,15049&_dad=portal
[25] https://en.wikipedia.org/wiki/Biomass_(ecology)

APPENDIX 4

(GREENHOUSE CONDITIONS)

Greenhouse is where a temperature is maintained in a desired range and is used for cultivating growing plants.[26] It also protects the plants from outside effects like wind, animals, insects…

I did my experiment in the greenhouse of the University of Ankara, Faculty of Agriculture, Soil Science and Plant Breeding Section. Throughout this experiment, the temperature was tried to be stabled at about 20°C which is the optimal temperature for a lettuce plant to grow. There was also air circulation in order to provide a healthy atmosphere for plants. Humidity in the air is maintained by spraying water to the floor to vaporize.

[26] http://dictionary.reference.com/browse/greenhouse

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