TED Ankara College Foundation Private High School

INVESTIGATING THE EFFECTS OF PLANT NUTRIENT ON PELARGONIUM

Extended Essay (Biology)

Supervisor: Amina BURSLEM

Candidates Name: Zeynep BORAN

Candidates Number: D1129020

Word Count: 3541

ABSTRACT

Plants need a variety of elements for their survival in addition to carbon, hydrogen and oxygen which are the main elements in carbohydrates, fats and proteins. These are in generally referred to as mineral elements. [1] Plant nutrients are contained in many agricultural products as they affect the plant growth in a positive way. As I wanted to observe the effect of the volume of the plant nutrients, I used the plant nutrient *Anadolu* which contains these essential mineral elements, I decided to investigate the effects of the volume of the plant nutrient on the plant growth and I formed a research question. My research question is “How does the volume of the plant nutrient affect the number of leaves and flowers and the length of stem in *Pelargonium* as an indication of the rate of plant growth?” I conducted an experiment to observe its effects. I formed five groups which contain three plants and gave water to them which have different concentrations of the plant nutrient.

In the experiment, the volumes of the plant nutrient which were added to the water given to the plants were measured by the measuring cylinder. 0, 1.7, 3.4, 5.1 and 6.8 ml of the plant nutrient were added to the each of the flowerpots for groups 1, 2, 3, 4 and 5 respectively. They were given 94 ml of water once every three days. The number of leaves and flowers were counted once every three weeks and these measurements were recorded.

The results of the experiment supported my hypothesis. There is a statistically significant difference in the number of leaves and flowers when different concentrations of plant nutrient were added to the water which was given to the plants. There is no significant difference in the stem lengths.

Word count: 295

[1] : http://www.nios.ac.in/srsec314newE/PDFBIO.EL9.pdf

CONTENTS PAGE

Introduction……………………………………………………………………..….1-2

Hypothesis ………………………………………………………………………...…..3

Method Development and Planning……………………………………..……..….4-5

Method ……………………………………………………………………….……....6

Diagrams…………………………………………………………………………..….7

Results…………………………………………………………………………….….8-12

Data Analysis…………………………………………………………….….…....13-14

Conclusion and Evaluation……………………………………………..….….15-16

Appendices

- **Appendix 1……………………………………………………………………….. 17**
- **Appendix 2………………………………………………………………...………17**
- **Appendix 3………………………………………………………………………...18**
- **Appendix 4………………………………………………………………………..19-21**
- **Appendix 5………………………………………………………………………...22**
- **Appendix 6………………………………………………………………………...22**
- **Appendix 7………………………………………………………………………...23**
- **Appendix 8………………………………………………………………………...24**
- **Appendix 9………………………………………………………………………...24**
- **Appendix 10……………………………………………………………………….25**
- **Appendix 11……………………………………………………………………….26**
- **Appendix 12……………………………………………………………………….26**
- **Appendix 13……………………………………………………………………….27**

Bibliography……………………………………………………………………………28

INTRODUCTION

Extensive research has been conducted to investigate the nutritional requirements of different crops and ways to enhance soil fertility, which has greatly benefited agricultural production.

Even though people have known for more than two thousand years that adding mineral elements to the soil can improve plant growth, the systematic study of plant nutrition is a relatively young science, considering humanity's long history of cultivating crops. About 250 years ago, farmers and gardeners started to ask the question, "What makes plants grow?" [1]

As I wanted to find an answer to this question, I decided to conduct an experiment which can help me to observe the factors affecting the rate of plant growth. I decided to find out how the amount of the plant nutrient affects the rate of plant growth as it contains the essential minerals for plant growth.

Green plants use the sun's energy for only certain stages in the build-up of carbohydrates, and from these all the other compounds necessary for protoplasm and cell wall. [2] The mineral compounds are divided into two groups: Macronutrients and micronutrients. Macronutrients can be broken into two more compounds: primary and secondary nutrients. Primary nutrients are nitrogen (N), phosphorus (P) and potassium (K). The secondary nutrients are calcium (Ca), magnesium (Mg) and sulfur(S). [3] Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. It is also a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis. It helps plants with rapid growth. [4] Like nitrogen, phosphorus is an essential part of the process of photosynthesis and is involved in the formation of all oils, sugars, starches, etc. It also helps with the transformation of solar energy into chemical energy. Potassium helps in the building of protein, photosynthesis, fruit quality and reduction of diseases. Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as the strength of the plant. Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth. Sulfur is essential for production of protein, promotes activity and development of enzymes and vitamins and helps in chlorophyll formation. Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities. The micronutrients are boron (B), copper (Cu), iron (Fe), chlorine (Cl), manganese (Mn), molybdenum (Mo) and zinc (Zn). Copper is important for reproductive growth and aids in root metabolism. Chlorine aids in plant metabolism. Iron is essential for formation of chlorophyll. Manganese functions with enzyme systems involved in breakdown of carbohydrates and nitrogen metabolism. Molybdenum helps in the use of nitrogen. Zinc is essential for the transformation of carbohydrates. [5]

Choosing the plant is important in the experiment because it is important to observe the effects of the plant nutrients in a short period of time. I decided that the plant *Pelargonium* is suitable for this experiment. The plant *Pelargonium* is a popular plant and is cultivated all over the world. [6]

As I make an investigation to show how the minerals affect the plant growth, I should also research the liquid plant nutrition system. The liquid earth plant nutrition system provides all major, minor, and micro elements essential to promote vigorous growth. Properly nourished plants easily reach their full genetic potential to produce lush foliage, big colorful flowers, fragrant essential oils, and fruits and vegetables ripe with flavor and vitamins." [7]

I decided to use the plant nutrient *Anadolu* as it is used in order to provide the plants fastly. In the plant nutrient *Anadolu* there is nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, boron, copper, iron, chloride, manganese, molybdenum and zinc. As it contains the minerals which are essential for plant growth, the plant nutrient can affect the rate of growth of the plant *Pelargonium.*

This essay focuses on the research question: "How does the volume of the plant nutrient affect the number of leaves and flowers in *Pelargonium* as an indication of the rate of plant growth?"

[1] : http://lifeofplant.blogspot.com/2011/03/nutrition-in-agriculture.html

[2] : Introduction To Biology, 5th Edition, D.G.Mackean, page:54.

[3] : http://www.ncagr.gov/cyber/kidswrld/plant/nutrient.htm

[4] : http://www.ncagr.gov/cyber/kidswrld/plant/nutrient.htm

[5] : http://www.ncagr.gov/cyber/kidswrld/plant/nutrient.htm

[6] : http://cicekderyasi.blogspot.com/2007/05/pelargonium-sardunya.html

[7] : http://www.liquidearthplantnutrients.com/

HYPOTHESIS

In addition to carbon, hydrogen and oxygen, which are obtained from carbon dioxide and water, green plants need at least 13 essential elements in order to produce new tissues and maintain their correct functioning. [8] The essential minerals for plant growth are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, boron, copper, iron, chloride, manganese, molybdenum and zinc.

As the plant nutrient that I'm going to use to observe the effects of its volume on the rate of growth of Pelargonium contains all of these minerals, the rate of growth can increase. It can be hypothesized that: As the volume of the plant nutrient increases, the rate of growth increases. It can be predicted that: If the rate of growth of Pelargonium increases as the volume of the plant nutrient increases, the number of leaves and the number of flowers.

[8] :Genetics, Evolution and Biodiversity, revised edition, Nelson Advanced Science, John Adds, Erica Larkcom, Ruth Miller, page:13

METHOD DEVELOPMENT AND PLANNING

Planning a method for the experiment is necessary to be able to conduct the experiment successfully and to reach accurate results. The species of the plant which is appropriate for this experiment and the factors affecting the rate of growth of the plant must be determined before starting doing the experiment.

I decided to use the plant 'Pelargonium' in the experiment. *Geraniums*, also known as *Pelargoniums* grow very quickly. [9] As they grow quickly, it is easy to observe the effects of the plant nutrient in a short period of time. Moreover, when the plants can't grow or one of the controlled variables inhibits the rate of growth of the plants, it is easier to start the experiment again.

To achieve accurate results, I'm going to make five groups which consist of three plants. Plants in different groups are going to be given water which have different concentrations of the plant nutrient. As I'm going to observe only the effect of the volume of the plant nutrient on the growth rate of the plant, I must keep other variables constant which are temperature, the volume of water which is given to the plant, light intensity, the concentration of oxygen and carbon dioxide in the air, the pH of water which is given to the plant, the determined time that the reaction occurs and the type and the mass of the soil.

Temperature is important for the plant growth. At low temperatures the enzymes responsibility for photosynthesis have very little energy so the rate of photosynthesis is very slow. As the temperature increases, the enzymes get more energy so the rate of photosynthesis increases. If it gets too hot the enzymes begin to lose their shape (denature). This means they are unable to function properly and the rate of photosynthesis decreases again. [10] To keep the temperature constant, I'm going to use a thermometer and the plants are going to be in the same room.

Volume of the water which is given to the plant also affects the plant growth due to its effect on the rate of photosynthesis. If water is in short supply, it may indirectly become a limiting factor in photosynthesis.[11] I'm going to use a measuring cylinder to keep constant the volume of the water and of the water which is given to the plant.

The light intensity is also a factor affecting the plant growth is related with the photosynthesis. It can be kept constant by placing all of the plants in the same room as they are going to get sunlight. The concentration of oxygen and carbon dioxide also affect the plant growth as they affect the rate of photosynthesis. Carbon dioxide is needed in the dark reaction as a raw material used in the synthesis of glucose if there is no other factors limiting photosynthesis and increase in the concentration of carbon dioxide results in an increase in the rate of photosynthesis. [12] Placing the plants to the same room also provides to keep constant the concentration of oxygen and carbon dioxide.

Also pH affects plant growth and nutrient availability. It can affect the absorption of nutrients by plant roots. pH values above 7.5 cause iron, manganese, copper, zinc and boron ions to be less available to plants. pH values below 6 cause the solubility of phosphoric acid, calcium and magnesium to drop. I'm going to use pH test paper to measure the value of pH and give same types of water to every plant. [13]

The determined time which the reaction must be kept constant to reach accurate results because when the duration of the experiment is constant for all of the plants, the affect of the amount of the plant nutrient can be observed.

Mass and type of the soil are also the factors affecting the plant growth. They must be kept constant as they affect the concentration of minerals in the soil. I'm going to use a weighing machine to keep constant the mass of soil.

By this method, I'm going to be able to reach a conclusion as I'm going to have data which is going to make me determine the effect of the volume of the plant nutrient on plant growth.

[9]: http://www.searle.com.au/Geraniums.html

[10]: http://wiki.answers.com/Q/How_does_temperature_affect_the_rate_of_photosynthesis

[11]: Introductory Plant Biology, 9th Edition, McGraw-Hill, page:174

[12]: http://www.scribd.com/doc/4801703/FACTORS-AFFECTING-PHOTOSYNTHESIS

[13]: http://www.weedfarmer.com/cannabis/phfacts_guide.php

MATERIALS AND METHOD

Materials:

15 x Pelargoniums
15 x Flowerpots
2x Packet of the plant nutrient *Anadolu* (1000ml)
42x15x94 ml Water
1x Graduated cylinder (100ml)
Stirring rod
1x Beaker (200ml)
1x Injector (5ml)
Thermometer
pH papers
Weighing machine
Pen
15 x Labeling stickers
15x115gr Soil

Method:

Five groups of plants were formed. Each group consisted of three plants. As the aim of the experiment was to observe the effect of the amount of the plant nutrient, the amount of the plant nutrient which was added to the water given to the plants must have been different.

Fifteen flowerpots were labeled with the labeling stickers.

The volumes of the plant nutrient which were added to the water given to the plants were measured by the measuring cylinder. 1.7, 3.4, 5.1 and 6.8 ml of the plant nutrient were measured by using the injector. 0, 1.7, 3.4, 5.1 and 6.8 ml of the plant nutrient were added to the each of the flowerpots for groups 1, 2, 3, 4 and 5 respectively.

Preparing these solutions were repeated in each trial of watering.

The plants were watered once for every three days. In each trial of watering, 94 ml water was used for each of the flowerpots as the volume of the water is a controlled variable.

I learned that a small glass of water is suitable for plant growth so I used 94 ml water instead of 95 or 100 ml which is equal to the volume of a small glass of water. In the same way, I used 1.7, 3.4, 5.1 and 6.8 ml of plant nutrient.

The number of leaves and flowers were counted once for every three weeks and these measurements were recorded.

Besides these measurements, the colour and the structure of the leaves and flowers were observed.

DIAGRAMS

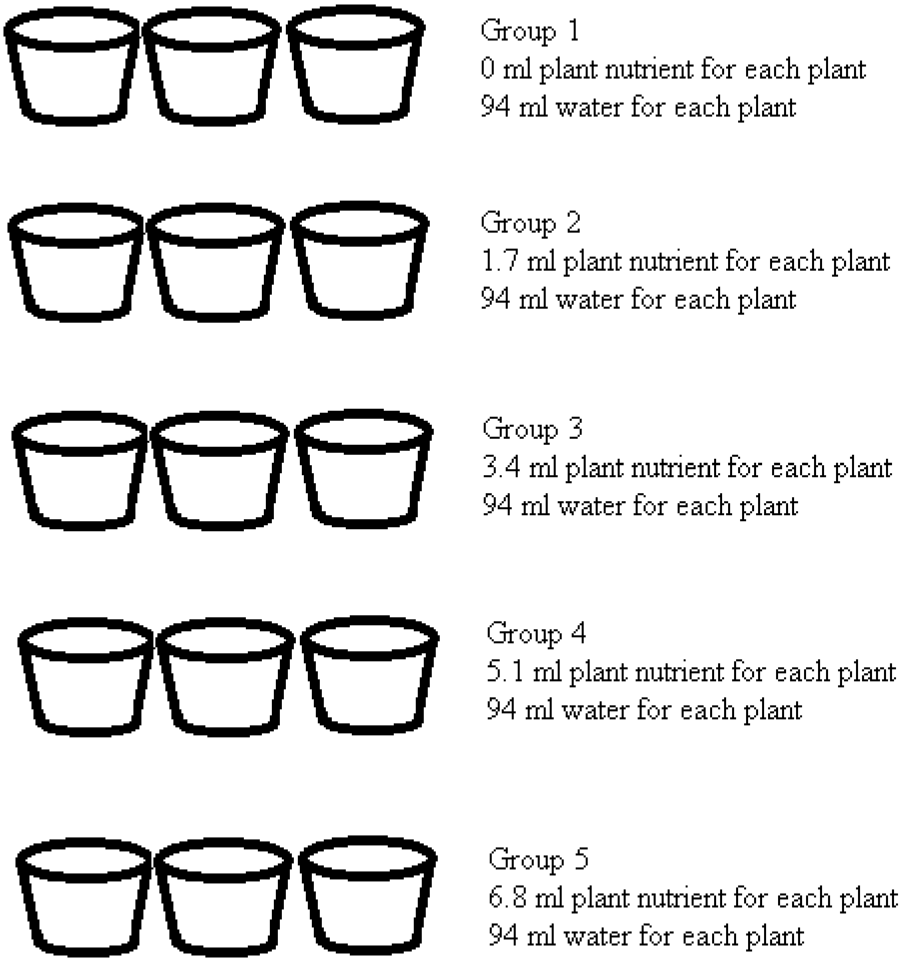


Diagram 1: Diagram showing how the groups were formed and the volume of the plant nutrient and water which is given to each plant.

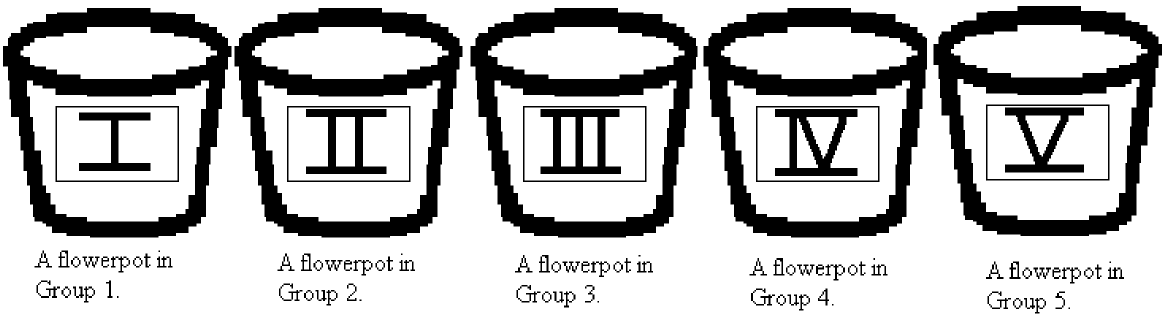


Diagram 2: Diagram showing how the flowerpots were labeled.

RESULTS

Volume of the plant nutrient (ml) (±0.1 ml)	Date when the measurements were taken	Number of leaves	Number of flowers	Volume of water (ml) (±0.1ml)
0.0	16th june	37	64	94.0
		39	65	94.0
		34	62	94.0
	10th july	43	66	94.0
		45	64	94.0
		44	65	94.0
	31 th july	47	71	94.0
		49	72	94.0
		48	69	94.0
	21st august	52	70	94.0
		51	71	94.0
		52	70	94.0
	11th september	54	72	94.0
		55	73	94.0
		53	71	94.0
	9th october	56	75	94.0
		55	74	94.0
		56	76	94.0

Table 1: Volume of the plant nutrient which was the independent variable, date when the measurements were taken, change in the number of leaves and flowers which were dependent variables, volume of water, ph of water, mass of soil and temperature which were controlled variables are shown.

Volume of the plant nutrient (ml) (±0.1 ml)	Date when the measurements were taken	Number of leaves	Number of flowers	Volume of water (ml) (±0.1ml)
1.7	16th june	36	63	94.0
		37	61	94.0
		35	62	94.0
	10th july	45	67	94.0
		46	65	94.0
		44	66	94.0
	31 th july	51	73	94.0
		51	72	94.0
		52	74	94.0
	21st august	57	76	94.0
		55	77	94.0
		58	75	94.0
	11th september	61	76	94.0
		63	77	94.0
		60	76	94.0
	9th october	63	78	94.0
		64	79	94.0
		62	77	94.0

Table 2: Volume of the plant nutrient which was the independent variable, date when the measurements were taken, change in the number of leaves and flowers which were dependent variables, volume of water, ph of water, mass of soil and temperature which were controlled variables are shown.

Volume of the plant nutrient (ml) (±0.1 ml)	Date when the measurements were taken	Number of leaves	Number of flowers	Volume of water (ml) (±0.1ml)
3.4	16th june	35	66	94.0
		34	65	94.0
		33	63	94.0
	10th july	50	66	94.0
		51	65	94.0
		50	67	94.0
	31 th july	60	80	94.0
		58	81	94.0
		58	82	94.0
	21st august	66	80	94.0
		68	81	94.0
		67	80	94.0
	11th september	71	82	94.0
		71	81	94.0
		70	83	94.0
	9th october	75	83	94.0
		75	84	94.0
		73	83	94.0

Table 3: Volume of the plant nutrient which was the independent variable, date when the measurements were taken, change in the number of leaves and flowers which were dependent variables, volume of water, ph of water, mass of soil and temperature which were controlled variables are shown.

Volume of the plant nutrient (ml) (±0.1 ml)	Date when the measurements were taken	Number of leaves	Number of flowers	Volume of water (ml) (±0.1ml)
5.1	16th june	36	90	94.0
		35	88	94.0
		37	89	94.0
	10th july	58	91	94.0
		58	92	94.0
		59	90	94.0
	31 th july	71	97	94.0
		72	96	94.0
		70	99	94.0
	21st august	70	100	94.0
		71	101	94.0
		72	99	94.0
	11th september	77	104	94.0
		78	102	94.0
		77	103	94.0
	9th october	80	111	94.0
		83	112	94.0
		82	110	94.0

Table 4: Volume of the plant nutrient which was the independent variable, date when the measurements were taken, change in the number of leaves and flowers which were dependent variables, volume of water, ph of water, mass of soil and temperature which were controlled variables are shown.

Volume of the plant nutrient (ml) (±0.1 ml)	Date when the measurements were taken	Number of leaves	Number of flowers	Volume of water (ml) (±0.1ml)
6.8	16th june	38	95	94.0
		36	96	94.0
		38	93	94.0
	10th july	66	98	94.0
		68	97	94.0
		67	99	94.0
	31 th july	76	112	94.0
		75	113	94.0
		75	114	94.0
	21st august	80	115	94.0
		78	114	94.0
		79	115	94.0
	11th september	86	113	94.0
		86	115	94.0
		85	116	94.0
	9th october	90	115	94.0
		88	117	94.0
		91	118	94.0

Table 5: Volume of the plant nutrient which was the independent variable, date when the measurements were taken, change in the number of leaves and flowers which were dependent variables, volume of water, ph of water, mass of soil and temperature which were controlled variables are shown.

DATA ANALYSIS

The volume of the plant nutrient (ml) (±0,1ml)	Average change in the number of leaves	SD	SE	CI
0,0±0,1	18,3	6,88	2,81	7,22
1,7±0,1	27,8	10,55	4,31	11,07
3,4±0,1	29,9	15,04	6,14	15,79
5,1±0,1	46,6	16,79	6,86	17,62
6,8±0,1	51,9	18,95	7,74	19,89

Table 6: The volume of the plant nutrient, average change in the number of leaves, the values of standard deviation, standard error and confidence interval are shown.

The volume of the plant nutrient	Average change in the number of flowers	SD	SE	CI
0,0±0,1	11,7	4,43	1,81	4,65
1,7±0,1	15,0	6,20	2,53	6,51
3,4±0,1	17,6	8,01	3,27	8,40
5,1±0,1	19,3	7,27	2,97	7,63
6,8±0,1	21,7	9,89	4,04	10,37

Table 7: The volume of the plant nutrient, average change in the number of flowers, the values of standard deviation, standard error and confidence interval are shown.

ANOVA

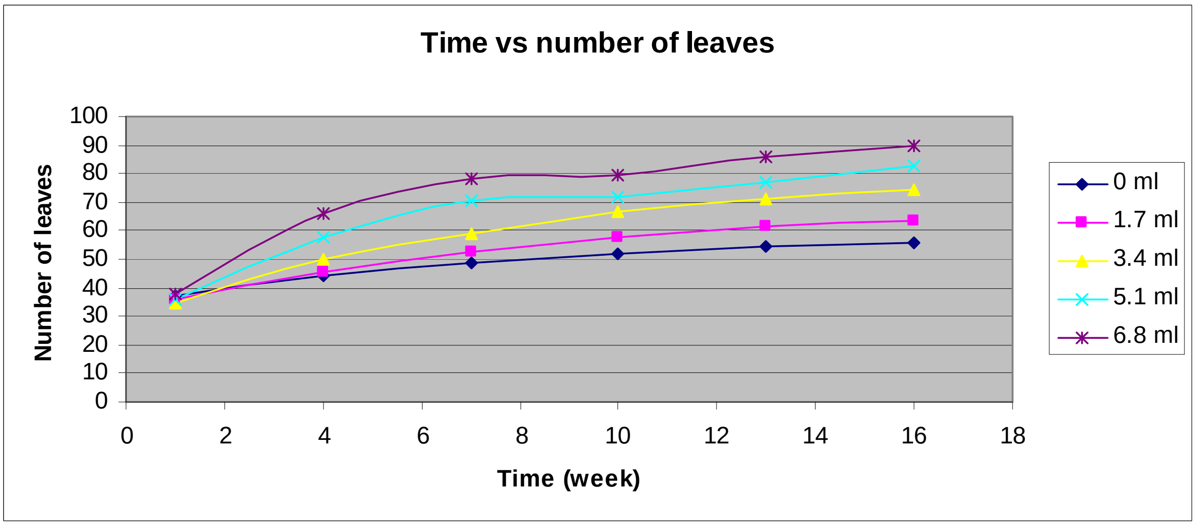
Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F ölçütü*
Between Groups	2336,698	4	584,1745	2,891737	0,042717	2,75871
Within Groups	5050,377	25	202,0151			
Total	7387,075	29				

Table 8: ANOVA test applied on results which are the number of leaves.

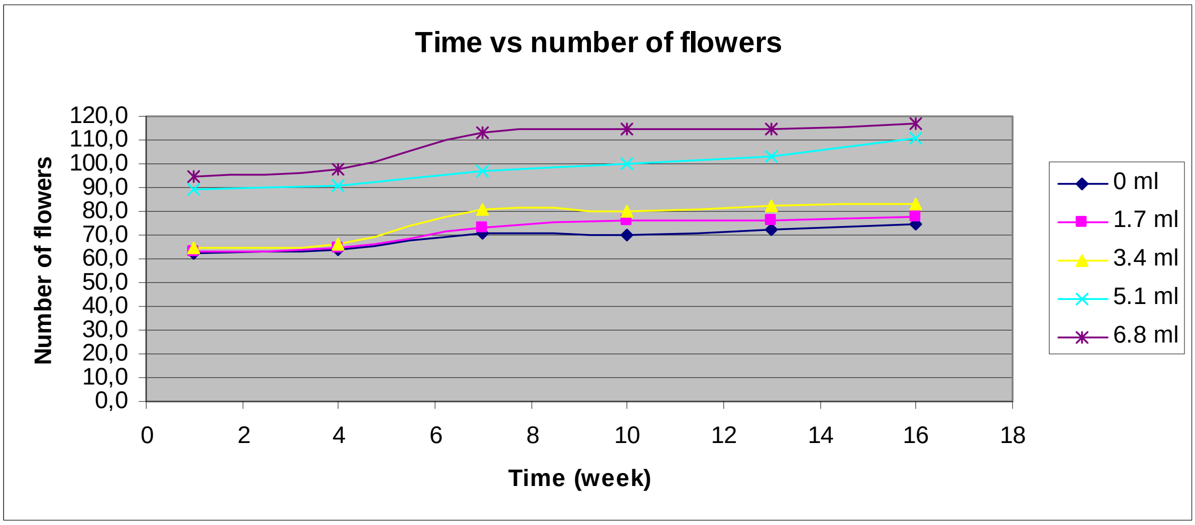
ANOVA

Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F ölçütü*
Between Groups	7483,369	4	1870,842	31,67043	1,87E-09	2,75871
Within Groups	1476,805	25	59,0722			
Total	8960,174	29				

Table 9: ANOVA test applied on results which are the number of flowers.



Graph 1: Graph which shows the number of leaves in five groups and the elapsed time to show the increase in the number of leaves.



Graph 2: Graph which shows the number of flowers in five groups and the elapsed time to show the increase in the number of flowers.

CONCLUSION AND EVALUATION

The aim was to observe the effect of the plant nutrient *Anadolu* on the rate of plant growth of *Pelargonium.* My research question was "How does the volume of the plant nutrient affect the number of leaves and flowers in *Pelargonium* as an indication of the rate of plant growth?"

Hypothesis was "As the volume of the plant nutrient increases, the rate of growth increases." I expected these results before the experiment because I knew that plants need minerals to produce new tissues and maintain their correct functioning. Many of the essential minerals are required for enzymes to function. Others form parts of essential plant substances. [14]

In the experiment, five groups were formed. Each group consisted of three plants which were given water having different volumes of plant nutrients. The volumes of the water and the plant nutrient were measured by the measuring cylinder and the injector. The plants were given 94 ml of water. 0, 1.7, 3.4, 5.1 and 6.8 ml of the plant nutrient were added to the water which were given to the plants in groups 1, 2, 3, 4 and 5 respectively. They were watered once for every three days. The number of leaves and flowers were counted and the stem lengths were measured once for every three weeks. These measurements were taken regularly over a period of eighteen weeks. They were recorded in order to determine the relation between the rate of growth of the plants and the volume of the plant nutrient.

I used 0, 1.7, 3.4, 5.1 and 6.8 ml of the plant nutrient as the optimum volume of plant nutrient for the Pelargonium is a 6.8 ml.

The measurements which show the effect of the plant nutrient on plant growth were number of leaves and flowers.

The initial number of leaves and flowers were different but it did not affect the accuracy of the experiment as I investigated the effect of the plant nutrient on the change of the number of leaves and flowers.

The change in the number of leaves were 18.3, 27.8, 29.9, 46.6 and 51.9 for groups 1, 2, 3, 4 and 5 respectively. As it is seen in the Graph 1, the change in the number of leaves is directly proportional to the volume of the plant nutrient. In ANOVA test which is in Table 5, P-value is 0.042 and smaller than α-value, 0.05. It verifies the hypothesis.

The change in the number of flowers were 11.7, 15.0, 17.6, 19.3 and 21.7 for groups 1, 2, 3, 4 and 5 respectively. As it is seen in the Graph 2, the change in the number of flowers is directly proportional to the volume of the plant nutrient. In ANOVA test which is in Table 6, P-value is 1.87×10^{-9} and smaller than α-value, 0.05. It verifies the hypothesis.

These results in ANOVA test shows that there is a statistically significant difference between the number of leaves and flowers of the plants when different volumes of plant nutrients added to the water which is given to them.

There are many observations about the rate of growth of Pelargonium in the experiment. Beside the quantitative measurements, qualitative measurements also show the effect of the volume of the plant nutrient on the rate of growth of Pelargonium. I observed that the darkness of the colour of the leaves and flowers increases when the volume of the plant nutrient increases.

The difference between the changes in the number of leaves and flowers in different groups shows that the volume of the plant nutrient *Anadolu* increases the rate of growth of *Pelargonium.*

[14] : Biology, The Study of Life, 8th Edition, William D. Schraer and Herbert J. Stoltze, page: 380.

APPENDICES

Appendix 1:

Now we will discuss how plant get the nutrients. You already know that carbohydrates are synthesised by the process of photosynthesis. What are the elements present in these carbohydrates?

Carbon, hydrogen and oxygen are the main elements in carbohydrates, fats and proteins. In addition to these three elements, plants need a variety of elements for their survival. These are generally absorbed by the root system of plants in the form of their salts.

The study of how plants get mineral elements and utilize them for their growth and development is called **mineral nutrition.**

If the minerals are not available to plants, specific symptoms appear due to the deficiency of a particular element. These are methods to determine the requirement of minerals by plants. [15]

Appendix 2:

Extensive research has been conducted to investigate the nutritional requirements of different crops and ways to enhance soil fertility, which has greatly benefited agricultural production.

Even though people have known for more than two thousand years that adding mineral elements, such as plant ash or lime, to the soils can improve plant growth, the systematic study of plant nutrition is a relatively young science, considering humanity's long history of cultivating crops. About 250 years ago, farmers and gardeners started to ask the question, "What makes plants grow?" [16]

[15]:http://www.nios.ac.in/srsec314newE/PDFBIO.EL9.pdf

[16] :http://lifeofplant.blogspot.com/2011/03/nutrition-in-agriculture.html

Appendix 3:

[17] :Introduction To Biology, 5th Edition, D.G.Mackean, page:54.

Appendix 4:

The 13 mineral nutrients, which come from the soil, are dissolved in water and absorbed through a plant's roots. There are not always enough of these nutrients in the soil for a plant to grow healthy. This is why many farmers and gardeners use fertilizers to add the nutrients to the soil.

The mineral nutrients are divided into two groups: macronutrients and micronutrients.

Macronutrients

Macronutrients can be broken into two more groups: primary and secondary nutrients.

The primary nutrients are nitrogen (N), phosphorus (P), and potassium (K). These major nutrients usually are lacking from the soil first because plants use large amounts for their growth and survival.

The secondary nutrients are calcium (Ca), magnesium (Mg), and sulfur (S). There are usually enough of these nutrients in the soil so fertilization is not always needed. Also, large amounts of Calcium and Magnesium are added when lime is applied to acidic soils. Sulfur is usually found in sufficient amounts from the slow decomposition of soil organic matter, an important reason for not throwing out grass clippings and leaves.

Micronutrients

Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities . These elements are sometimes called minor elements or trace elements, but use of the term micronutrient is encouraged by the American Society of Agronomy and the Soil Science Society of America. The micronutrients are boron (B), copper (Cu), iron (Fe), chloride (Cl), manganese (Mn), molybdenum (Mo) and zinc (Zn). Recycling organic matter such as grass clippings and tree leaves is an excellent way of providing micronutrients (as well as macronutrients) to growing plants.

Macronutrients

Nitrogen (N)
• Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. • Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis. • Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops. • Nitrogen often comes from fertilizer application and from the air (legumes get their N from the atmosphere, water or rainfall contributes very little nitrogen)

Phosphorus (P)

- Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis.
- Involved in the formation of all oils, sugars, starches, etc.
- Helps with the transformation of solar energy into chemical energy; proper plant maturation; withstanding stress.
- Effects rapid growth.
- Encourages blooming and root growth.
- Phosphorus often comes from fertilizer, bone meal, and superphosphate.

Potassium (K)

- Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.
- Helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.
- Potassium is supplied to plants by soil minerals, organic materials, and fertilizer.

Calcium (Ca)

- Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant.
- Sources of calcium are dolomitic lime, gypsum, and superphosphate.

Magnesium (Mg)

- Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth.
- Soil minerals, organic material, fertilizers, and dolomitic limestone are sources of magnesium for plants.

Sulfur (S)

- Essential plant food for production of protein.
- Promotes activity and development of enzymes and vitamins.
- Helps in chlorophyll formation.
- Improves root growth and seed production.
- Helps with vigorous plant growth and resistance to cold.
- Sulfur may be supplied to the soil from rainwater. It is also added in some fertilizers as an impurity, especially the lower grade fertilizers. The use of gypsum also increases soil sulfur levels.

Micronutrients

Boron (B)

- Helps in the use of nutrients and regulates other nutrients.
- Aids production of sugar and carbohydrates.
- Essential for seed and fruit development.
- Sources of boron are organic matter and borax

Copper (Cu)

- Important for reproductive growth.
- Aids in root metabolism and helps in the utilization of proteins.

Chloride (Cl)

- Aids plant metabolism.
- Chloride is found in the soil.

Iron (Fe)

- Essential for formation of chlorophyll.
- Sources of iron are the soil, iron sulfate, iron chelate.

Manganese (Mn)

- Functions with enzyme systems involved in breakdown of carbohydrates, and nitrogen metabolism.
- Soil is a source of manganese.

Molybdenum (Mo)

- Helps in the use of nitrogen
- Soil is a source of molybdenum.

Zinc (Zn)

- Essential for the transformation of carbohydrates.
- Regulates consumption of sugars.
- Part of the enzyme systems which regulate plant growth.
- Sources of zinc are soil, zinc oxide, zinc sulfate, zinc chelate.

[18] :http://www.ncagr.gov/cyber/kidswrld/plant/nutrient.htm

Appendix 5:

Sardunyalar dunyanin her tarafinda sevilen ve yetistirilen bir cicek. Cunku bakimi ve cogaltmasi cok kolay. Yil boyunca cicek acabiliyor. Ustelik cok goz alici renkleri ve buyuk cicekleri var. [19]

Appendix 6:

REAL WORLD RESULTS

The liquid earth plant nutrition system provides all major, minor, and micro elements essential to promote vigorous growth. Properly nourished plants easily reach their full genetic potential to produce lush foliage, big colorful flowers, fragrant essential oils, and fruits and vegetables ripe with flavor and vitamins. [20]

[19] :http://cicekderyasi.blogspot.com/2007/05/pelargonium-sardunya.html

[20] :http://www.liquidearthplantnutrients.com/

Appendix 7:

[21] :Genetics, Evolution and Biodiversity, revised edition, Nelson Advanced Science, John Adds, Erica Larkcom, Ruth Miller, page:13

Appendix 8:

Geraniums, also known as Pelargoniums, flourish in our warm tropical climate. These plants grow very quickly and produce masses of dazzling flowers all through the year. Some of the colours available include whites, pinks and oranges to brilliant reds. As well as this, Geraniums have many varied and delightful coloured markings on their leaves, which can add to the overall display in the garden. [22]

Appendix 9:

The rate of photosynthesis in relation to temperature forms a bell curve. At low temperatures the enzymes responsibility for photosynthesis have very little energy so the rate of photosynthesis is very slow. If it is cold enough for water to freeze it can be very harmful to a plant. As the temperature increases, the enzymes get more energy so the rate of photosynthesis increases.If it gets too hot the enzymes begin to lose their shape (denature). This means they are unable to function properly and the rate of photosynthesis decreases again. Also, at higher temperatures the stomata close to prevent water loss. This also stops gas exchange which slows photosynthesis even further. If it is hot enough for water to boil this can be very harmful. [23]

[22] :http://www.searle.com.au/Geraniums.html

[23] :http://wiki.answers.com/Q/How_does_temperature_affect_the_rate_of_photosynthesis

Appendix 10:

[24] :Introductory Plant Biology, 9th Edition, McGraw-Hill, page:174

Appendix 11:

Carbondioxide is needed in the dark reaction as a raw material used in the synthesis of glucose if there is no other factors limiting photosynthesis and increase in the concentration of carbondioxide results in an increase in the rate of photosynthesis. [25]

Appendix 12:

pH affects plant growth and nutrient availability. pH can affect the availability of nutrients. pH can affect the absorption of nutrients by plant roots pH values above 7.5 cause iron, manganese, copper, zinc and boron ions to be less available to plants. pH values below 6 cause the solubility of phosphoric acid, calcium and magnesium to drop. pH values between 3 and 5 and temperatures above 26 degrees Celsius encourage the development of fungal diseases. [26]

[25] :http://www.scribd.com/doc/4801703/FACTORS-AFFECTING-PHOTOSYNTHESIS

[26] :http://www.weedfarmer.com/cannabis/phfacts_guide.php

Appendix 13:

[27] : Biology, The Study of Life, 8th Edition, William D. Schraer and Herbert J. Stoltze, page: 380.

BIBLIOGRAPHY

[1] : http://lifeofplant.blogspot.com/2011/03/nutrition-in-agriculture.html

[2] : Introduction To Biology, 5th Edition, D.G.Mackean, page:54.

[3] : http://www.ncagr.gov/cyber/kidswrld/plant/nutrient.htm

[4] : http://cicekderyasi.blogspot.com/2007/05/pelargonium-sardunya.html

[5] : http://www.liquidearthplantnutrients.com/

[6] :Genetics, Evolution and Biodiversity, revised edition, Nelson Advanced Science, John Adds, Erica Larkcom, Ruth Miller, Martin Furness Smith, page:13

[7]: http://www.searle.com.au/Geraniums.html

[8]: http://wiki.answers.com/Q/How_does_temperature_affect_the_rate_of_photosynthesis

[9]: Introductory Plant Biology, 9th Edition, New York, McGraw-Hill, 2003, page:174

[10]: http://www.scribd.com/doc/4801703/FACTORS-AFFECTING-PHOTOSYNTHESIS

[11]: http://www.weedfarmer.com/cannabis/phfacts_guide.php

[12] : Biology, The Study of Life, 8th Edition, William D. Schraer and Herbert J. Stoltze, page: 380.