Research on the effects of different masses of ammonium nitrate fertilizer on growth of *Phaseolus vulgaris*

Extended Essay (Biology)

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Word Count: 3.990

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ABSTRACT:

Global warming has recently become one of the biggest threats that the world faces. The importance of fertile lands and water sources are constantly increasing. Many researches are done to get more qualified crops and different solutions are found. Fertilizers are one of those solutions. Ammonium nitrate (AN) is a type of chemical fertilizers and it increases the rate of the growth of the plants. Different masses of AN cause different effects on plants. Therefore, it must be given in an optimum ratio. The objective of this study is to investigate whether different masses of AN fertilizer used is effective on the growth of the *Phaseolus vulgaris.* During the experiment, proportionally increasing masses of AN is mixed to the soil that common beans are planted in. Four groups are developed; control group containing no fertilizer, experimental group 1 containing 0.42 g AN, experimental group 2 containing 0.84 g AN and the last group, experimental group 3 containing 1.26 g AN. The plants are irrigated daily and observed for 1.5 months in order to see the effects of different masses of AN by taking measurements of the stem length, number of offsprings produced and observing the color of leaves.

The results showed that there comes a significant difference if the mass of fertilizer used is changed. As the mass of AN used increases, the growth rate increases; however the excess mass of AN causes deficiency in some essential elements for the plant and reduces root growth.

Word count:246

INTRODUCTION:

For my extended essay I've been told that I can choose any subject unless it contains an experiment with an animal. That led me to think about plant growth and how it is effected. I wanted to have a worthful and reasonable subject so I thought working on a research about fertilizers; which is an absolutely important material for agriculture, would be interesting.

Fertilizers have become a significant part of agriculture industry. In countries, in which an important part of the source of income is provided by agriculture, many researches are done to find different ways to get more qualified crops. Agriculture provides a big part of the economy in Turkey, too, so I decided to choose a subject related to agriculture and fertilizer industry. During the research I found many studies about the types of fertilizers but I was not able to find studies made on the effects of difference in mass of fertilizers used, especially on green vegetables. Depending on this, I chose this topic for my extended essay: by doing this research and experiment, it is my aim to make a distinction between the effects of ammonium nitrate fertilizer used with increasing mass on the growth of *Phaseolus vulgaris* plants.

Only one type of plant is used to limit the extend of this study, whereas it is possible that other plants may have different results at the end of the experiment. I thought that as this experiment wouldn't be able to be done in a field or a greenhouse, I should choose a plant which can live and grow during any season, so I chose beans. The ammonium nitrate fertilizer is commonly used in agriculture and shows the effects in a short period.[1] That is why it is chosen for this study. Also ammonium nitrate is a powerful fertilizer and it can be stated that comparing this chemical fertilizer with the organic fertilizers, 0.42g ammonium nitrate in 4 kg of soil has equal effect on a plant as 7 kg of organic fertilizer.[2] Also ammonium nitrate is in many ways one of the best and certainly one of the cheapest sources of crop-nourishing nitrogen available[3].

1. www.plantcare.com/encyclopedia/beans-2119.aspx
2. Ankara University/Faculty of Agriculture/Dr.Fusün Tatlıdil
3. By Brendan I. KoernerPosted Thursday, Jan. 6, 2005, at 6:26 PM ET www.slate.com/id/2111955/,

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The terms of agriculture and fertilizers are used throughout the essay. AN means ammonium nitrate fertilizer which consists %33 nitrate in it.[4] In agriculture, cultivation is the process of growing plants on arable land, arable land is an agricultural term, meaning the land that can be used for growing crops.[5]

Phaseolus vulgaris, or Common Bean, is known as a herbaceous annual plant.[6] "Over a period of 7000 to 8000 years, the common bean has evolved from a wild growing vine distributed in the highlands of Middle America and the Andes into a major leguminous food crop, grown worldwide in a broad range of environments and cropping systems."[7] It is considered to be a highly nutritious source. Common beans can be harvested green four to six weeks after sowing.[8] If the scientific classification of common bean is examined it is seen that the Kingdom is *Plantae,* the division is *Magnoliophyta*,the class is *Magnoliopsida*, the order is *Fabales*, the family is *Fabaceae*, the genus is *Phaseolus* and species is *Phaseolus vulgaris*.[9]

Providing nutrient avalibility to a plant is important.There are 18 essential elements for normal growth.(See appendix 1) Some of these elements are:

- boron,
- carbon,
- hydrogen,
- magnesium,
- nitrogen,
- oxygen,
- phosphorus,
- potassium.[10]

4. www.landscape-and-garden.com/garden-soil/fertilizer-types.aspx

5. ^ Sullivan, Arthur; Steven M. Sheffrin (2003). *Economics: Principles in Action*. Upper Saddle River, New Jersey 07458: Pearson Prentice Hall. p. 480. ISBN 0-13-063085-3. http://www.pearsonschool.com/index.cfm?locator=PSZ3R9&PMDbSiteId=2781&PMDbSolutionId=6724&PMDbCategoryId=&PMDbProgramId=12881&level=4.

6:www.plantcare.com/encyclopedia/beans-2119.aspx

7:Common Beans research for crop improvement Edited by A.van Schoonhoven& O. Voysest /page7

8: www.plantcare.com/encyclopedia/beans-2119.aspx

9: http://en.wikipedia.org/wiki/Common_bean

10: Agricultural Extension Service/The University of Tennessee PB 1637

In my experiment AN fertilizer will be used. As I searched the effects of nitrogen I found out that if a plant is suffering from deficiency of nitrogen that plant might become light green; chlorosis[11] in lower leaves can be observed and plants may have short stems; stalks of yellowish green leaves can be short and slim if nitrogen is deficient in later stages of growth.[12]

Three types of different fertilizers containing nitrogen exists; sodium nitrate which contains 16% nitrogen, ammonium sulfate containing 20 to 12% nitrogen and the ammonium nitrate which contains 33 to35% nitrogen. [13]

AN is used as the fertilizer in this experiment. Plants are available to get the nitrogen from the soil in nitrate or ammonium form and AN contains both forms.[14] That is an important reason for choosing the AN as the fertilizer for my experiment. In addition I needed a type which would show the effects quickly and be suitable for any kind of plant and not require a specific type of soil. AN is considered to be a quickacting fertilizer which also led me to the fact that AN is suitable for this experiment.[15]

To sum up, the topic of this research is comparing the effect of increase in mass of AN fertilizer on growth of *Phaselous vulgaris* and my research question is that **how does an increase in mass of AN fertilizer used, effect the growth of *Phaseolus vulgaris* (by means of length of stems of the plants and the number of offsprings), when the other factors (atmospheric conditions that the common beans are exposed to, the volume of water, type of soil and the size of the pot that they are planted in) are tried to be kept constant?**

11. chlorosis:In botany, chlorosis is a condition in which leaves produce insufficient chlorophyll.

12. http://www.ehow.com/how_2248568_identify-nitrogen-deficiency-plants.html

13. www.landscape-and-garden.com/garden-soil/fertilizer-types.aspx

14.www.landscape-and-garden.com/garden-soil/fertilizer-types.aspx

15. www.landscape-and-garden.com/garden-soil/fertilizer-types.aspx

HYPOTHESIS:

Agriculture has been a significant source of income for economy in many countries such as Turkey[16], India[17], Thailand[18]. As agriculture became an industry, the agricultural science and the products used for qualified crop turned into an industry too, such as fertilizers.

In order to enable the plant to take the nitrogen from the soil nitrogen should be in nitrate or ammonium form.[19] Nitrate helps the cations present in the soil to be taken, while ammonium makes the same thing for anions to be taken from the soil.[20]

Lack of nitrogen in mostly source of soil is present throughout the world. The plants that are planted in soil that has lack of nitrogen, suffers by this fact and are not able to grow normally, also plants in an environment similar to that nitrogen-lacking soil, is seen to remain stunted, the leaves are small, their color is yellow or yellowish green, lower and old leaves will get dry and die afterwards, the grain is not good and plump and the amount of protein in leaves decreases, flowering is reduced and efficiency is not normal.[21]

On the other hand it is suggested that the excess amount of nitrogen for plants may effect the plant negatively in various ways like reducing the growth of the plants roots and the most significant effect is that it strengthens the deficiency symptoms of magnesium, potassium, phosphorus, molybdenum and boron, all of which are represented as essential elements for plants in introduction.[22]

16.http://www.fita.org/countries/india.html

17.http://www.haberpan.com/eker-tarimla-gecinen-nufus-azalmayacak-haberi/

18.http://www.fita.org/countries/thailand.html

19.. http://www.tarimziraat.com/faydali_bilgiler/gubreleme/287-azotun_topraktaki_islevi_nelerdir.html 17MARCH 2010

20. http://www.tarimziraat.com/faydali_bilgiler/gubreleme/287-azotun_topraktaki_islevi_nelerdir.html

21. http://www.tarimziraat.com/faydali_bilgiler/gubreleme/287-azotun_topraktaki_islevi_nelerdir.html

22: http://www.jstor.org/pss/4313090 *Ambio* © 1985 Royal Swedish Academy of Sciences.Abstract

Depending on the reasons above my hypothesis is that: **different masses of AN fertilizer effects the growth of *Phaselous vulgaris***. If the mass of AN fertilizer used is inreased, the plants will begin to have longer stems; wider, greener and more leaves; with more offsprings compared to the common beans that get less mass of AN and the common beans of control group of this experiment which will have no AN in their soil until the mass of AN used becomes an excess mass for the common beans.

It is predicted that the common beans getting the biggest mass of AN will show the greatest growth, the common beans getting the excess mass of AN will show the least growth.

METHOD DEVELOPMENT AND PLANNING:

For an experiment it is very important to design a suitable method that will have accurate results which will then be used to either support or disprove the hypothesis. That is why the factors that will effect the results of the experiment must be detected and should be tried to be kept under control.

In this experiment the independent variable will be the mass of fertilizer used. I did a lot of research about fertilizers and come up with a lot of different types. Organic fertilizers might be suitable for arable lands but they wouldn't be suitable to use in a pot so I had to make a decision between the chemical fertilizers. To make a clear decision about fertilizer type, I consulted to Dr. Füsun TATLIDİL who is teaching at Ankara University Agriculture Faculty. We agreed that the most suitable type to use for this experiment was AN as a chemical fertilizer because it is easier to find and more importantly show effects in short period of time. I wanted to use it in increasing mass and see what kind of effects it would have. At first, as I knew that fertilizers help the growth, my hypothesis was the best effect would be seen in the pot with the biggest mass of AN. More I searched about AN I realised that excess mass of AN would cause a worse condition instead of being beneficial as mentioned in hypothesis.

It was important to choose a plant that wouldn't grow to very big size since it will be planted in a pot. So I searched for a green vegetable to use in my experiment and chose common beans, because common beans don't need much space to grow, it may grow in a pot and it is easy to observe the difference of growth because it takes 4 to 6 weeks to grow.[23] Also it is a plant that is worldwide harvested. (See Appendix 2)

When buying the pots, I chose the one which will occupy less space as height but has big width for the big leaves of common bean. Then I bought 36 kg of soil and put 4 kg soil in each pot. I bought fertilizer free soil in order to prevent the interference of any other artificial chemicals other than the AN fertilizer that I would add in it.

23:www.plantcare.com/encyclopedia/beans-2119.aspx

I discussed ratios of AN that will be added into the pots with Dr. Tatlıdil. Then I got the AN from the faculty and weighed it on the weighing scale at biology lab of my school. I got three different masses 0.42 ±0.01 g; 0.84 ±0.01 g; 1.26 ±0.01 g. (0.01 is the uncertainity of the weighing scale) I weighed them like this because I had to have them increase proportionally to have healthy results. Finally I bought the seeds.

The purpose of this experiment is to investigate the effects of the increase in mass of fertilizer used, so everything else should be kept constant. The experiment will occur in two steps. First step will be germination of the *Phaseolus vulgaris* seeds. Before the experiment with the fertilizer, it must be considered that the germination process of seeds is also a variable, one of the seeds can grow much faster because of its genetics, not because of the fertilizer. It is impossible to control the genetics but it's error can be minimized. First 30 seeds will be placed in soil and they will get equal volume of water, same atmospheric conditions (light, atmospheric pressure, temperature), same type of soil will be used for every seed, they will have equal volume of space and sunlight from the same direction. To try to keep these variables constant, each seed will be watered with 10 ±0.5 ml water (brand name İnci) each day. (See Appendix 6) (0.5 is the uncertainity of the graduted cylinder) All of the cups that seeds are planted in, will be in the same room so they won't be exposed to a warmer or colder medium. They will all be planted in the center of the plastic cups with 4 ±0.05 cm diameter. (See diagram 1) After 10 days of germination process, the 16 seeds that have equal or approximately equal length will be chosen for the second step.

The second step is the growth process which will enable me to investigate the effects of increasing mass of AN on the growth of *Phaselous Vulgaris* in terms of length of stem and number of offsprings. In order to make a clear distinction on the effects of AN, there should be a control group which will show the usual growth rate of common beans when no fertilizer is added. Experimental group 1 will contain 0.42 ±0.01 g of AN, experimental group 2 will contain 0.84 ±0.01 g of AN and experimental group 3 will contain 1.26±0.01 g of AN (See appendix 4). Each of these groups will have 4 germinated common beans so if one of them dies data collection could continue. As mentioned the only variable in this experiment will be the mass of AN used so all the other factors that might interfere the results should be tried to be kept constant. 16 germinated common beans that will be selected at the end of the germination process will be divided into four groups, four germinated common beans will be planted in each of the four pots. (See diagram 2) They will be planted on the center of the rectangular shaped pots like a line with 5.00 ±0.05 cm (0.05 is the uncertainity of the ruler) distance between them so the errors that might be caused by shading or not getting equal sunlight will be tried to be minimized. (See diagram 3) In order eliminate the error that might be caused by temperature differences all of the four pots will be located in our balcony. By this way they will all be exposed to the same atmospheric conditions. I chose our balcony because it orients to the South and gets at least 6 ±0.5 hours a day which made me decide that this experiment can take place in our balcony and it will be easier than performing it in a garden somewhere else. Also the volume of water each group gets will be tried to be kept constant. Each group is watered 50.0 ±0.5 ml (0.5 is the uncertainity of graduated cylinder) water each day. The water will be measured with graduated cylinder and poured into the spray bottle and common beans will be watered with the spray bottle in order to prevent the accumulation of water under some of the common beans or at the corners of the pots. Since the soil type is important for plant growth all of the pots will be filled with 4 kg of fertilizer free soil which will be the enough mass to fullfill the pots.

As a result, the type and mass of soil used, the volume of the water each group gets, the type of fertilizer used, the atmospheric conditions that they are exposed to, the length of stems of the germinated common beans will be tried to be kept constant, only the mass of AN will be changed.

At the end of the experiment the criteria will be the length of stems of the common beans and the number of their offsprings and for the qualitative data the color and the width of leaves and the color of the offsprings. Since AN is important for the nourishment of plant, it will effect the growth of the germinated common bean seeds and provide more qualified (as in terms of longer stems, more offsprings and greener and wider leaves) crops. As the mass of fertilizer used increases too much, in this experiment 1.26 ±0.01 g, the nourishment it provides to common beans will be effected badly because of the negative effects of excessive nitrogen.

As mentioned in the hypothesis, excess nitrogen may cause reduced root growth and strengthed deficiency symptoms of magnesium, potassium, phosphorus, molybdenum and boron which will probably be seen as shorter stems and yellowish green leaves[24]. In addition, biochemically, excess use of nitrogen fertilizers decreases the amount of ascorbic acid, which inhibits the formation of carcinogenic N-nitroso compounds in plants.[25]

24:http://www.jstor.org/pss/4313090 *Ambio* © 1985 Royal Swedish Academy of Sciences.Abstract

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METHOD:

MATERIALS:

4 x square shaped pots (size: 30 x 18 x 18 cm)

Common bean seeds (30 seeds) (brand name migros)

Ammonium nitrate fertilizer (2.52 ±0.01 g in total)

16 kg soil (4 kg for each pot)

Graduated cylinder (50 ml) (uncertainity ±0.5ml)

Weighing scale (uncertainity ±0.01)

Ruler (100 cm) (uncertainity ±0.05 cm)

30 cups (4 ±0.05 cm diameter)

300 gr soil (Brand name torf) (See Appendix 5)

H_2O (Brand name inci)

Spray bottle

T.I. 84 PLUS

METHOD:

Procedure:

Germination step:

Each cup is filled with 10.00 ±0.01 g of soil (enough mass to fill the cup fully). Each seed of the thirty common bean seeds is planted in a separate cup. (See diagram 1) (See appendix 3 photo 1) All the cups are put in the same room. Each cup is watered with 10 ±0.5 ml water every day and the volume of the water will be measured by a graduated cylinder. The germination of the seeds are observed for 10 days. At the end of this process 16 seeds that has approximately grown to the same size (the length of stem) are selected for the growth step. (approximately 15.0 ±0.5 cm)

Growth step:

4 pots are bought. (30 x 18 x 18 cm) Each pot is labeled as control group (containing no AN), experimental group 1 (containig 0.42 ±0.01 g AN), experimental group 2 (containing 0.84 ±0.01 g AN), experimental group 3 (containing 1.26 ±0.01 g AN). (See diagram2) (See appendix 3 photo 6) 4kg fertilizer free soil is put into each pot .The fertilizers are added to the related group as mentioned above and mixed with soil. At the center of the pots 4 holes of 5.00 ±0.05 cm depth are digged along a line and one germinated common bean is planted in each hole, so there are 4 germinated common beans in the pot. (See diagram 3) This procedure is repeated for each pot. All of the pots are placed next to each other in order to minimize the possibility of unequal light intensity and temperature. 50.0 ±0.5 ml water is put into every pot everyday by spraying. The growth of germinated common beans (by measuring the length of stems with the ruler weekly) is observed for 1.5 months. At the end of observing period, the length of stems and the number of offsprings are measured as quantitative data; the color and the width of leaves and the color of offsprings are observed as qualitative data. Anova test is applied to datas and hypothesis is evaluated.

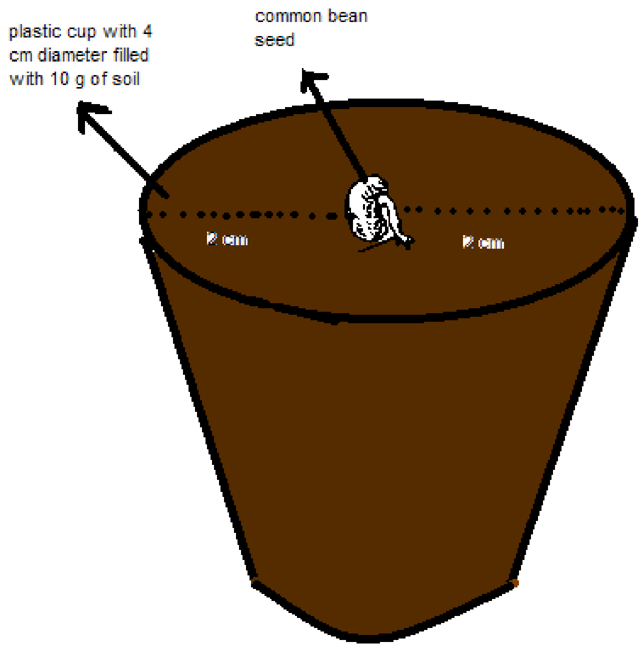


Diagram 1: the demonstration of planting the common bean seeds in germination step.

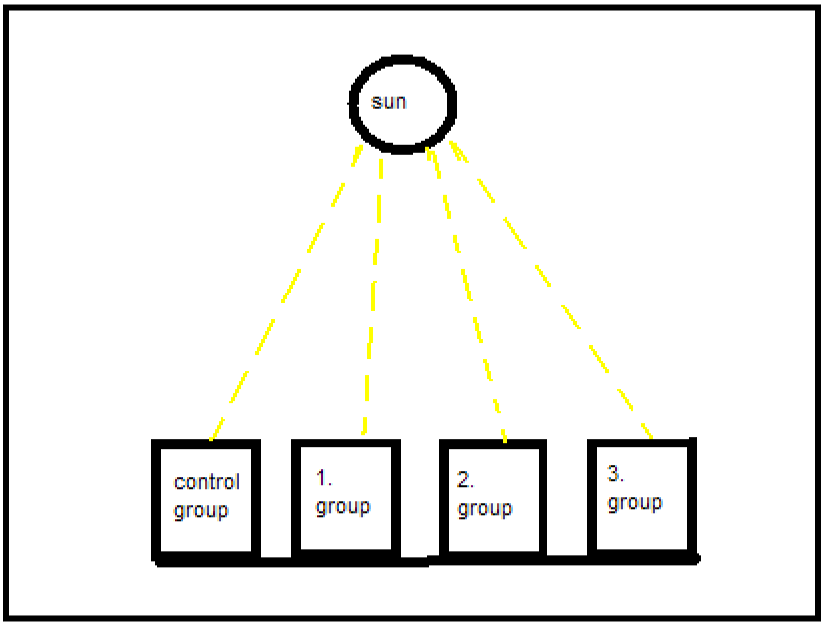


Diagram 2: Illustration of the setup of the experiment about the distances of the flowerpots from the sun in the balcony during the growth step.

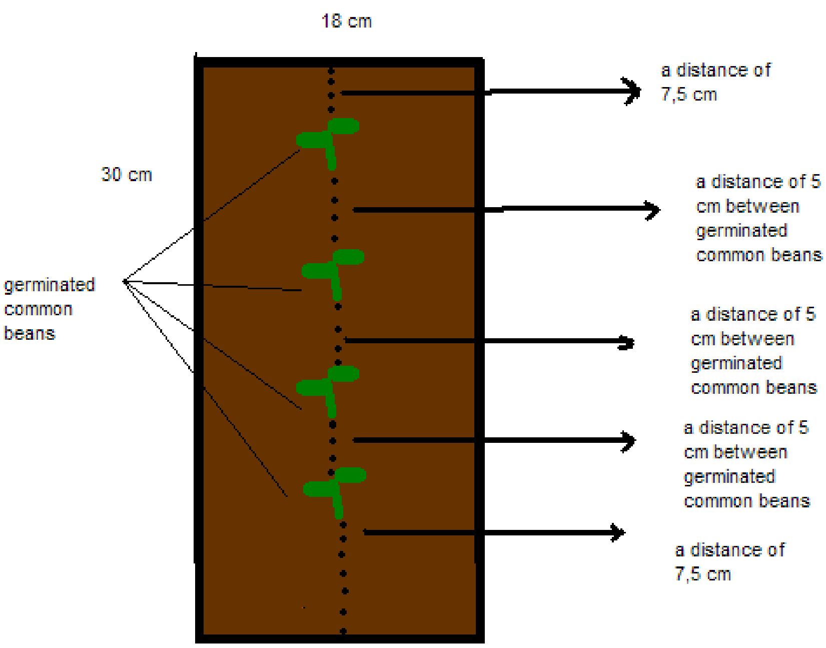


Diagram3 :the demonstration of the vision of one pot from the top in second step (growth process of *Phaselous Vulgaris*)

RESULTS:

DATA COLLECTION AND PROCESSING:

Plants	length of stems of germinated beans that are planted in the pot containing no fertilizer (cm) (±0.05)	length of stems of germinated beans that are planted in the pot containing 0.42 ±0.01g AN (cm) (±0.05)	length ofstems of germinated beans that are planted in the pot containing 0.84 ±0.01g AN (cm) (±0.05)	length of stems of germinated beans that are planted in the pot containing 1.26 ±0.01g AN (cm) (±0.05)
1	15.00	15.00	15.20	15.00
2	15.50	15.00	15.40	15.00
3	15.70	15.50	15.00	15.30
4	15.70	15.50	15.00	15.70

Table1: the length of stems of beans that are selected to be planted for the second step of the experiment (growth step). The uncertainities are taken as the half of the smallest unit of the measuring device.

RAW DATA

STEP 2 (Growth process of beans):

	Plants	Stem Length of Beans (cm) (±0.05) (Measured for 1.5 months by weekly)					
		27.09.2010	04.10.2010	11.10.2010	18.10.2010	25.10.2010	01.11.2010
control group(containing no AN)	1.plant	15.00	17.50	20.60	24.50	30.30	36.60
	2.plant	15.50	17.50	20.50	25.30	31.00	37.00
	3.plant	15.70	19.00	21.10	26.00	31.20	37.40
	4.plant	15.70	18.10	20.60	25.90	31.50	37.50
expriment group1(containing 0,42g AN)	1.plant	15.00	19.80	24.20	30.10	37.20	44.40
	2.plant	15.00	19.30	23.30	29.50	36.80	43.50
	3.plant	15.50	19.80	24.00	30.30	37.50	42.00
	4.plant	15.50	20.10	24.50	30.80	38.00	44.50
expriment group2(containing 0,84g AN)	1.plant	15.20	20.60	27.80	35.00	41.50	49.50
	2.plant	15.40	20.80	28.00	35.40	42.00	49.10
	3.plant	15.00	19.90	26.90	34.50	41.00	46.00
	4.plant	15.00	20.10	27.30	34.60	41.60	49.50
experiment group3(containing 1,26g)	1.plant	15.00	19.50	24.60	27.30	30.10	33.20
	2.plant	15.00	20.00	23.40	26.00	28.50	31.90
	3.plant	15.30	20.60	24.90	26.30	29.40	32.00
	4.plant	15.70	20.60	25.20	30.00	34.00	36.30

Table 2: the demonstration of the lengths of stems of beans of the four different groups. (The lengths are measured for 1.5 months by weekly)

CALCULATIONS:

SD= $\sum x - \frac{(\sum x)(\sum x)}{N}$

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

CI= $SE \times t$

Mean= $\frac{\sum x}{n}$

The difference of length of stem= final length- initial length

Example calculation:

Trials for control group:

The difference of length of stem of 1.plant=36.60 -15.00=21.60

The difference of length of stem of 2.plant=37.00 -15.50=21.50

The difference of length of stem of 3.plant=37.40 -15.70=21.70

The difference of length of stem of 4.plant=37.50 -15.70=21.80

Mean= $\frac{\sum x}{n} = \frac{21.60+21.70+21.80+21.50}{4}$ = 21.65

SD= $\frac{\sqrt{(21.60-21.65)^2+(21.50-21.65)^2+(21.70-21.65)^2+(21.80-21.65)^2}}{\sqrt{4-1}}$ = 0.13(2 decimal places)

SE= $\frac{0.129}{\sqrt{4}}$ = 0.07 (2 decimal places)

CI= $SE \times t$= $(0.07 \times 3) = 0.21$ (2 decimal places)

(All the calculations are done by T.I. 84 plus)

PROCESSED DATA:

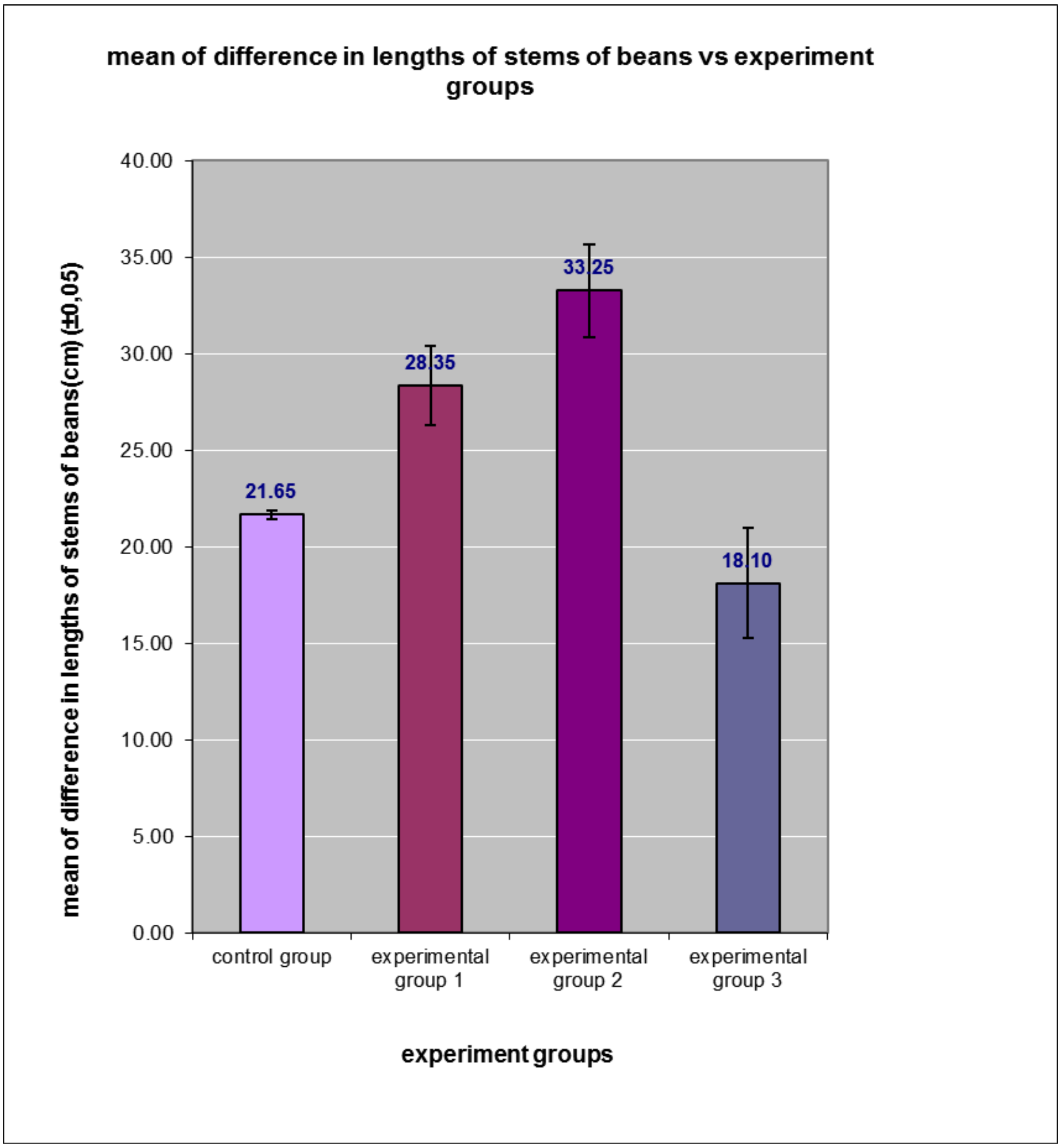
Trials	difference between initial and final length of beans of control group(cm)(±0.05)	difference between initial and final length of beans of experimental group1(cm)(±0.05)	difference between initial and final length of beans of experimental group2(cm)(±0.05)	difference between initial and final length of beans of experimental group3(cm)(±0.05)
1.plant	21.60	29.40	34.30	18.20
2.plant	21.50	28.50	33.70	16.90
3.plant	21.70	26.50	31.00	16.70
4.plant	21.80	29.00	34.00	20.60
Mean	21.65	28.35	33.25	18.10
Median	21.65	28.75	33.85	17.55
Range	0.30	2.90	3.30	3.90
Standart deviation	0.13	1.29	1.52	1.79
Standart Error	0.07	0.64	0.76	0.90
Confidence interval	0.21	2.05	2.42	2.86

Table 3: the demostration of the difference between the initial and final lengths of stems of beans at the end of 1.5 months and the statistical analysis of data collected . Each value is taken with 2 decimal places.

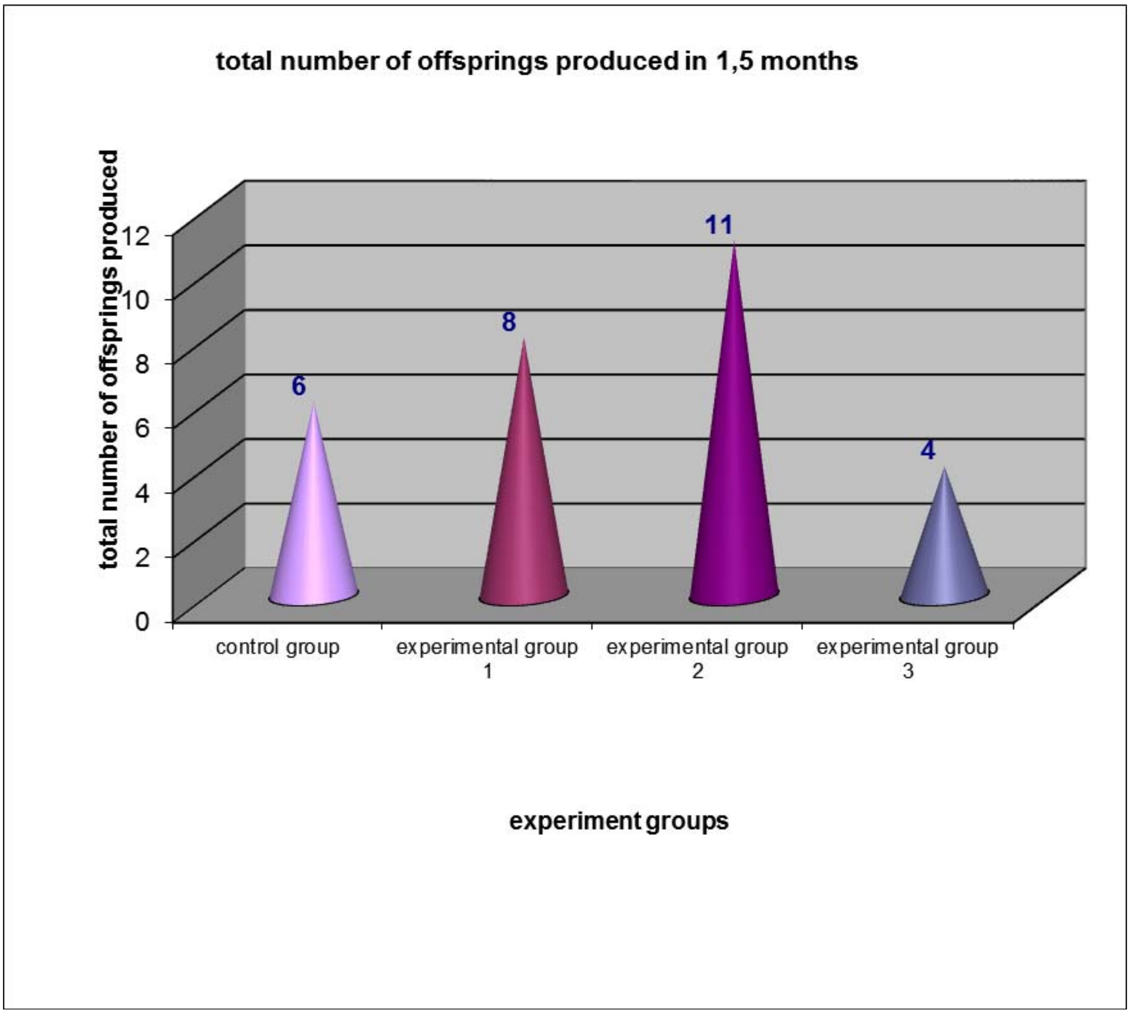
	trials	total number of offsprings produced after 1.5 months	total number of offsprings produced in groups after 1.5 months
control group containing no AN	1.plant	1	
	2.plant	2	
	3.plant	2	
	4.plant	1	6
experiment group 1 containing 0.42±0.01g AN	1.plant	2	
	2.plant	2	
	3.plant	3	
	4.plant	1	8
experiment group2 containing 0.84 ±0.01g AN	1.plant	4	
	2.plant	3	
	3.plant	3	
	4.plant	1	11
experiment group 3 containing 1.26 ±0.01g AN	1.plant	2	
	2.plant	1	
	3.plant	1	
	4.plant	0	4

Table 4:the demonstration of the total number offsprings produced

GRAPHS:



Graph1:the demonstration of the means of the difference in lengths of stems of *Phaselous vulgaris* vs. the experimental groups.



Graph 2:the demonstration of the total number of offsprings produced vs. the experiment groups.

QUALITATIVE OBSERVATIONS:

The color and the width of the leaves of common beans are also taken in consideration during the experiment. It is seen that the leaves of the plants in pots that contained 0.42 ±0.01 g and 0.84 ±0.01 g AN fertilizer is greener and wider compared to the other groups. (See appendix 3 photo 8) Also in control group some rotten parts on two leaves were detected while there were no deteriorations in the experimental group 1 and experimental group 2 (See appendix 3 photo 10). The leaves of the experimental group 3 containing 1.26 ±0.01 g of AN were narrower compared to the other groups that contains fertilizer and also some of them had yellowish color. (See appendix 3 photo 11) Finally the offsprings of the experimental group 1 and experimental group 2 are greener compared to control group and experimental group 3. (See photo 7-9)

DATA ANALYSIS:

ANOVA RESULTS:

ANOVA

Source of Variance	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	550.6475	3	183.5492	101.9246	8.37E-09	3.490295
Within Groups	21.61	12	1.800833			
Total	572.2575	15				

Table 5:the demonstration of anova results and the p-value.

H_0 (null hypothesis): Null hypothesis states that the difference between the means of difference of length of bean stems and difference between the number of offsprings produced according to increasing mass of AN used, is not significant; it might be caused by chance.

H_A (alternative hypothesis): Alternative hypothesis states that the difference between the means of difference of length of bean stems and difference between the number of offsprings produced according to increasing mass of AN used, is significant.

p =8.37E-09

$p < 0.05$

Depending on the fact that p value of this experiment is smaller than 0.05, null hypothesis is rejected, the alternative hypothesis is accepted.

CONCLUSION AND EVALUATION:

In this experiment my aim was to investigate the effects of increasing mass of AN type fertilizer on the growth of *Phaseolus vulgaris.* I decided to use the length of stems and the number of the offsprings produced as the indicator of growth. In order to see only the effects of fertilizer, I tried to keep all the other variables constant. First, in order to minimize the genetic factors of the bean seeds, I germinated them and selected sixteen germinated beans that were grown to approximately same size (same length). (See appendix 3 photos 2-3-4-5) After planting them, the volume of water that pots were watered each day, the size of the pots, the type and mass of soil that beans were planted in, were tried to be kept constant. All the pots were located in the same place so none of them would be exposed to a colder or warmer medium, the germinated beans were planted in the center of the pot, in order to minimize the error that might be caused by unabling plant to get the same amount of sunlight that the other plants get. (See appendix 3 photo 6) There was a control group to be reference and three groups containing different masses of AN fertilizer. The length of stems were measured weekly for 1.5 months to get more accurate results. My hypothesis was that different masses of AN fertilizer would effect the growth of *Phaselous vulgaris.* Increasing mass of AN fertlizer used would have a positive effect on *Phaseolus vulgaris'* s growth , so the *Phaseolus vulgaris* of experimental group 2 would have longest stems, experimental group1 would have less longer stems and control group would have the shorter stems compared to them. Experimental group 3 was expected to be shortest because the excess mass of AN fertilizer would damage the plant and cause the least growth. (See table 2) The results supported the hypothesis. When the mean of difference in length of stem of beans are calculated, they are found to be 21.65 ±0.05 cm in control group; 28.35 ±0.05 cm in group1; 33.85 ±0.05 cm in group 2; 18.1 ±0.05 cm in group 3. (See table 3) As the result of the anova ,the p value was found to be 8.37E-09 which is a smaller number than 0.05 and it showed that the difference between the means of difference in length of stems according to increasing mass of AN fertilizer used, is significant. (See table 5) The second criteria of this experiment was productivity which is measured by number of offsprings formed in this experiment. The graph of the total number of offsprings produced confirms that the productivity of experimental group 2 is greater than others while experimental group 1's productivity is greater than control group and experimental group 3, finally the number of offsprings the control group produced is greater than experimental group 3. (See graph 2) Though, by looking at graph 1 it is seen that especially the error bar of the mean of difference in length of stems in experimental group 3 is greater compared to the others, this error might be caused by genetic factors. However it was tried to be minimized, there were small differences in the length of germinated common beans that were planted in pot containing 1.26 ±0.01 g of AN. Also though the beans were planted in the center of the pot to get equal sunlight, when they started to grow higher and leaves getting wider, they might have prevented each other from getting equal light. I realised that the distance must have been increased as the common beans grow and develop. Finally the weighing scale and the ruler might have caused errors, more sensitive devices should have been used.

At the beginning I chose to investigate this topic because nowadays the global warming is the biggest threat to our world. As the global warming's damage gets greater and fertile lands exhaust, new ways to empower the agriculture are investigated and alternative solutions are found. In this experiment, the effects of AN fertilizer is investigated and results can be seen as valid and it is proven that different masses of AN fertilizer effects the growth of *Phaseolus vulgaris* as in longer stems and more offsprings, but to some extend. When excess mass of AN was used, it decreased the growth rate, provided shorter stems and less number of offsprings. This experiment also shows the importance of using optimum amount of fertilizer for agriculture and this made me ask the question what might be the optimum mass of fertilizer to use?

Since, the global warming increases its negative effects ,the fields that are present should be well culvitated, the optimum conditions for the crop should be provided. Especially the countries who provides a big part of their economic income from agriculture, should attend to the importance of using fertilizers consciously.

APPENDICES:

Appendix 1:

Table 1. Essential plant nutrients and their elemental (chemical) symbol			
Nutrients Supplied by Air and Water	Nutrients Supplied by the Soil System		
Non-Mineral	Primary or Macronutrients	Secondary	Micronutrients
Carbon - C	Nitrogen - N	Calcium - Ca	Zinc - Zn
Hydrogen - H	Phosphorus - P	Magnesium - Mg	Chlorine - Cl
Oxygen - O	Potassium - K	Sulfur - S	Boron - B
			Molybdenum - Mo
			Copper - Cu
			Iron - Fe
			Manganese - Mn
			Cobalt - Co
			Nickel - Ni

The essential elements for plant growth.

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Appendix 2:

Top ten green bean producers — 11 June 2008	
Country	Production (tonnes)
People's Republic of China	2,485,000
Indonesia	830,000
Turkey	499,298
India	420,000
Spain	225,000
Egypt	215,000
Italy	187,190
Belgium	105,000
Morocco	100,000
United States	100,000

The countries who harvest common bean.

Appendix 3:

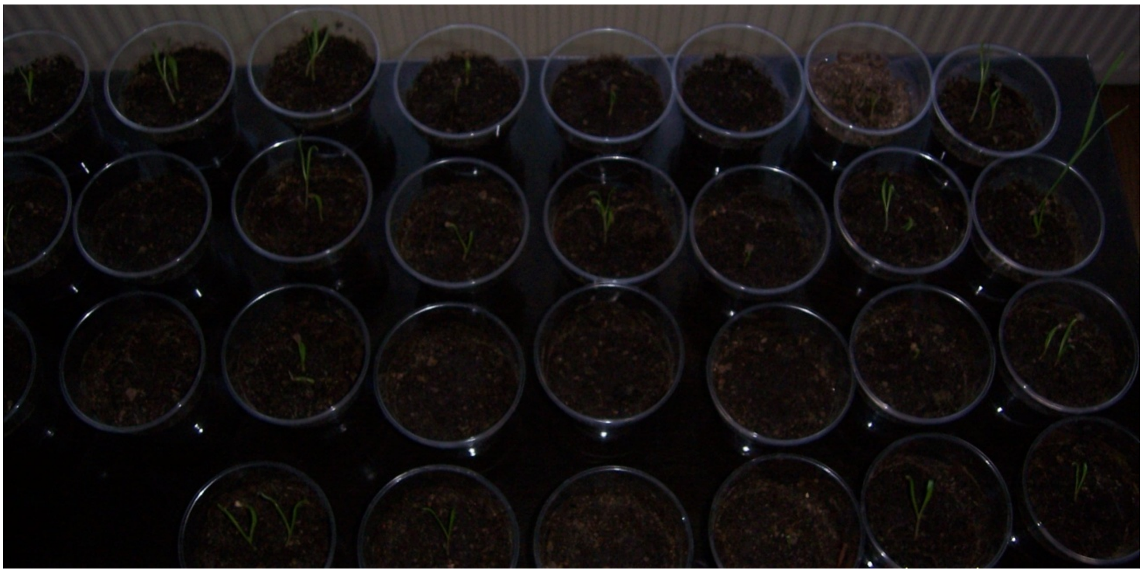

Photo1: the setup of germination step.

Photo 2: two examples of the germinated common beans

Photo 3:germinated common beans

Photo 4: an example the common bean that has grown to approximately 15 ±0,5cm

Photo5: an example the common bean that has grown to approximately 15 ±0,5cm

Photo 6:the demonstration of the setup of growth step of *Phaselous Vulgaris*

Photo 7:the first offspring of experimental group 2

Photo 8:experimental group1 and experimental group 2

Photo9: the first offspring of experimental group 1

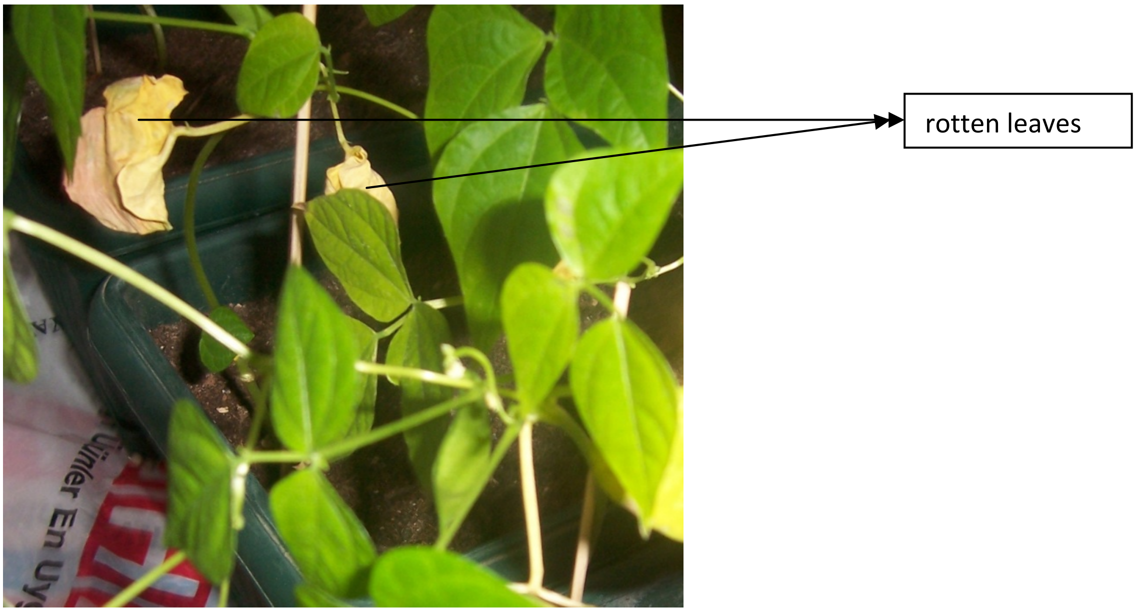

Photo10: the two deteriorated leaves with rotten parts of the *Phaselous vulgaris* in control group.

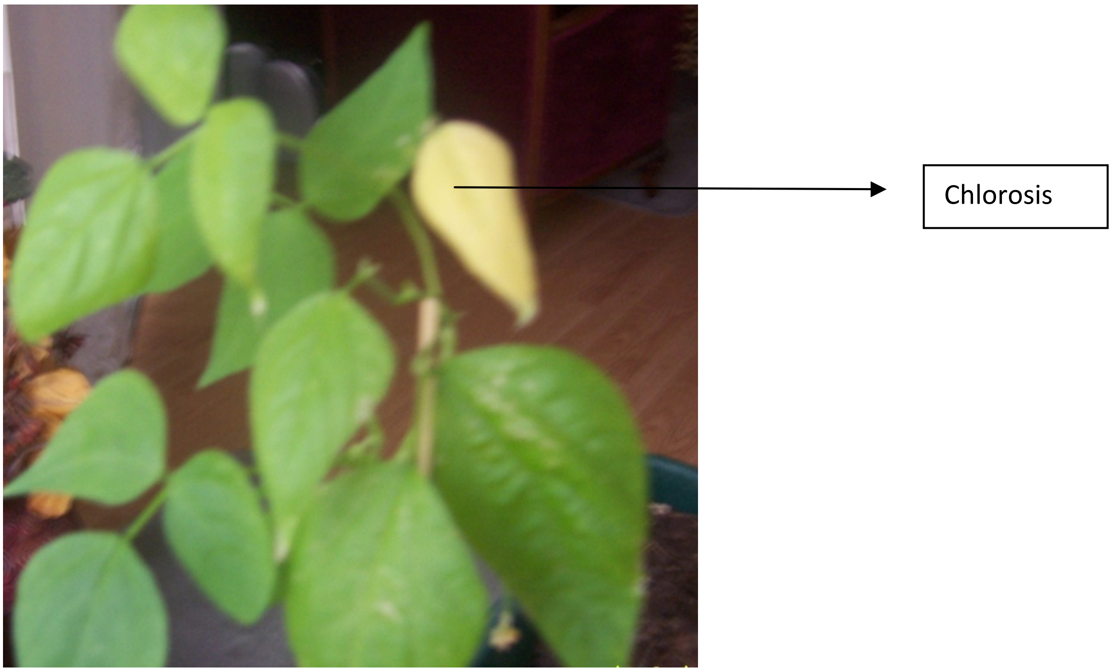

Photo 11 :the chlorosis on the leaves of the experimental group 3

Appendix 4:

The Ammonium nitrate fertilizer used in this experiment which contains 33% nitrate, brand name Gübretaş.

Appendix 5:

Soil: Anadolu Torf (anatoh@anatoh.com)

pH: 6-7
EC: 1-2 mS/cm
Purity: min. 95%

Appendix 6:

Ingredients of İnci su:

Chloride(Cl):3,9 mg/L

Iron(Fe) :0,01 mg/L

Sulphate(SO_4):36,3mg/L

Sodium(Na):84,1 mg/L

Nitrite(NO_2): NONE

Nitrate(NO_3):NONE

http://www.incisu.com/incisu.pdf

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[11]:chlorosis:In botany, chlorosis is a condition in which leaves produce insufficient chlorophyll.

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