Growth Pattern of Celery by Using Different Amount of Bokashi

By

Nurul Huda Binti Hamdi

A report submitted in fulfilment of the requirements for the degree of

Bachelor of Applied Science (Agrotechnology) with Honours

Faculty of Agro Based Industry

UNIVERSITI MALAYSIA KELANTAN

2018

FYP FIAT

FYP FIAT

DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

____

Student

Name: Nurul Huda Binti Hamdi

Date:

I certify that the report of this final year project entitled "Growth Pattern of Celery by Using Different Amount of Bokashi" by Nurul Huda Binti Hamdi, matric number F14A0309 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Agriculture Technology) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

Approved by:

____

Supervisor

Name: Dr. Nurul Syaza Bt Abdul Latif

Date:

ACKNOWLEDGEMENT

Alhamdulillah, I have finished my Final Year Project (FYP) in this semester. I started this study in early July to end of October. First and foremost, my special thanks and appreciation goes to my supervisor, Dr. Nurul Syaza Abdul Latif for her unlimited encouragement, tolerance and patience. I am also grateful for all the guidance that have been taught throughout my studies in the field. I got a lot of knowledge and inputs from her. I would also like to thank my supervisor who showed me how to interpret the results and discuss my findings properly.

I would also like like to send my gratitude to my co-supervisor, Dr. Dwi Susanto , who was assisted me in the fieldwork. He always supported my studies and taught me on not to give up, even the study was difficult. I would also thanking my parents for always supporting me in whatever study that i work on.

I wish to acknowledge my research colledges, Farah Hanis Amanina, Nurul Syafarin, Nurul Nadihah and Nur Aqilah, who were with me through the experimental design and all the field work. I will be grateful forever for their motivation in accomplishing the studies whenever i want to give up.

Lastly, I would extend my deepest gratitude to University Malaysia Kelantan (UMK) for providing all the materials that made it possible for me to further my studies.

FYP FIAT

UNIVERSITI MALAYSIA KELANTAN

Growth Pattern of Celery by Using Different Amount of Bokashi

FYP FIAT

ABSTRACTS

Celery is a member of family *Apiacea* which is known as *Apium graveolens* in scientific name. Celery is essential crops and basic ingredient requirement in Malaysia. It can be grown in wide range of climate. Nowadays, a lot of leaching occur and give bad impact to fertility of soil. Nutrients from chemical fertilizer in soil run off to the streams, lakes and sea affecting the aquatic species. As soil fertility decrease, the production of celeries and other crops also decrease. Soil properties can be enriched through treatment with soil amendments like Bokashi and compost. The purpose of this research is to study the response of celery plants to different dosage of Bokashi. The results showed that Treatment 3 with 4000 kg/ha of Bokashi had the greatest outputs; height, number of leaves and yields. One of the more significant findings to emerge from this study is that Bokashi generates better growth performance of celery than compost. Other than that, the net profit comparison also indicate that Bokashi were more profitable than compost. In general, the best dosage of soil amendment was Treatment 3; 4000 kg/ha.

Keywords: celery, *Apium graveolens*, Bokashi, compost, net profit

UNIVERSITI
MALAYSIA
KELANTAN

Corak Pertumbuhan Saderi dengan Menggunakan Jumlah Bokashi yang Berbeza

ABSTRAKS

Saderi adalah merupakan keluarga *Apiacea* yang dikenali sebagai *Apium graveolens*. nama saintifik. Saderi merupakan tanaman penting dan makanan asas keperluan di Malaysia. Ia boleh ditanam di pelbagai jenis iklim. Pada masa kini, banyak larut lesap berlaku dan memberi kesan buruk kepada kesuburan tanah. Nutrien dari baja kimia tanah mengalir ke Sungai, tasik dan laut yang mempunyai spesies akuatik. Apabila kesuburan tanah menurun, pengeluaran saderi dan lain-lain tanaman juga menurun. Sifat-sifat tanah boleh dirawat dengan pindaan tanah seperti Bokashi dan Kompos. Tujuan kajian ini adalah untuk mengkaji maklum balas daripada tumbuhan saderi untuk dos Bokashi yang berbeza. Hasil kajian menunjukkan bahawa Rawatan 3 dengan 4000 kg/ha untuk Bokashi mempunyai output terbesar; ketinggian, bilangan daun dan hasil. Salah satu penemuan dalam kajian ini adalah bahawa Bokashi menjana prestasi pertumbuhan saderi yang lebih baik daripada Kompos. Selain daripada itu, perbandingan keuntungan juga menunjukkan bahawa Bokashi adalah lebih menguntungkan berbanding Kompos. Secara amnya, dos terbaik tanah pindaan adalah Rawatan 3; 4000 kg/ha.

Kata kunci: saderi, Apium graveolens, Bokashi, Kompos, perbandingan keuntungan

FYP FIAT

UNIVERSITI MALAYSIA KELANTAN

TABLE OF CONTENTS

FYP FIAT

UNIVERSITI MALAYSIA KELANTAN

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

LIST OF TABLES

FYP FIAT

UNIVERSITI MALAYSIA KELANTAN

LIST OF FIGURES

FYP FIAT

UNIVERSITI MALAYSIA KELANTAN

LIST OF ABBREVIATIONS AND SYMBOLS

NPK	Nitrogen-Phosphorus-Potassium
cm	Centimeter
g	Gram
Kg	Kilogram
Ha	Hectare
EM	Effective microorganism
Mm	Millimeter
SDN	Sendirian
BHD	Berhad
≤	Lesser than

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

FYP FIAT

CHAPTER 1

INTRODUCTION

1.1 Research Background

The native area of celery crops is at Mediterranean area. It is the family of *Apiaceae*. The oldest cultivated form of celery is leaf celery. Leaf celery, *Apium graveolens var. secalinum*, grows in marshlands. It is a cultivar from East Asia. Celery is a leafy crop which has pungent and bitter taste. Moreover, leaf celery has characteristically thin skin stalks. It also has a stronger taste and smell compared to other cultivars. It is used as a flavoring in soups and sometimes pickled as a side dish.

Celery has other benefits and usage from its leaves to the root. It was used for medicinal purpose ages year before. In 1600s, celery was firstly harvested as a food plant (Department Agriculture, Forestry and Fisheries Republic of South Africa, 2013). Some of nutrients in celery are vitamin K, molybdenum, folate, potassium and fiber. These healthy crops are very recommended to be eaten for people who practices a balanced diet as celeries also are low in calories.

UNIVERSITI MALAYSIA KELANTAN

However, it is not yet commercially grown in Malaysia even though the price is quite high nowadays (Tay Hong Yi, 2017). Celery is only planted at several states. They are not yet cultivated in Kelantan widely. Farmers afraid to cultivate celery because of the changeable weather and uncertain if the soil texture at their place is suitable for planting it. The pattern growth of celery will decrease when it is cultivated during raining seasons. Harsh rain will cause leaf injury. Other than that, crops are not able to uptake nutrients properly without the help from soil amendment.

Composts are one of widely used soil amendment in any crops cultivation including celery. Compost is produced through compost processing. The materials used in the processing are any plant material and other materials that are compostable. All those materials are mixed and then, let them decompose into black friable materials (Robert, 2015). Compost helps in restructuring the soil texture, therefore crops able to uptake the nutrients easily. Other than that, in a study conducted by Chen et. al (2001), it was shown that compost application onto the soil enhanced the Nitrogen and Phosphorus availabilities.

Another alternative soil amendment is Bokashi. Bokashi is proven in many studies that it brings a lot of benefits to the crops cultivation. The effect of compost on the soil properties are similar to Bokashi. However, compost is usually used with amount 10 kg/ha as the concentration of nutrient in compost is less than chemical fertilizer. Besides, the release rate of nutrient is slow (Emiru, 2004). It can only be improved by using a large amount of compost. In contrast to compost, there are Effective Microorganism (EM) in the Bokashi. The process of producing Bokashi is called fermentation. EM is the mixture of bacteria and yeasts (Robert, 2015). They produce plenty of antioxidants and also control the breakdown of organic matter.

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

Therefore, integration of the best and the right amount of soil amendment onto the soil is the best way to improve cultivation of celery and enhance the productivity of the soil. Research on the usage of Bokashi on mustard green and lettuce which is leafy crops like celery proven that the crops that were treated with Bokashi had better growth than treatment with NPK fertilizer (Yacobus, 2010). Thus, this study was conducted to determine an optimum Bokashi dosage for cultivation of celery.

1.2 Problem statement

The continuous usage of land for cultivation leads to degradation and loss of soil fertility. Therefore, farmers should practice on application of soil amendment to improve soil fertility. The focus of this study was to identify the right amount of Bokashi that may enhance the pattern growth of celery; height, number of leaf and weight of yield. When focusing on the exact quantity of Bokashi, it may reduce the cost that is wasted on fertilizer. Bokashi is another soil amendment besides compost. Excess or too little applications of soil amendments or fertilizers are not good to the soil fertility and crop growth.

Besides, application of chemical fertilizer is too much in agriculture. Chemical fertilizer may lead to bad impacts on the environment and when the soil leached, it will run off to the river, lake and sea affecting the aquatic species and pollute the water resource. Thus, it is better to add up Bokashi or compost with right amount to make it easier for the plant to uptake the nutrient in the soil. Bokashi as a good soil amendment is proven in many studies that it enhances the fertility of the soil. To determine

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

effectiveness and the favourable amount of Bokashi to the plant growth, the growth development of celery was recorded every week to identify the difference. Several outputs were analyzed to identify the effect of Bokashi.

1.3 Objectives

- To study the effect of different levels of Bokashi on the pattern of celery growth development.
- To fit the experimental data to logistic curve equation

1.4 Scope of study

The research was conducted in Agro park of University Malaysia Kelantan, Jeli Campus. The study utilized 6 different levels of Bokashi including the control treatment. The study was done to determine the growth pattern of celery and analyze the effective quantity of Bokashi needed for productivity of celery.

1.5 Limitation

There were some limitations during this study. Firstly, the growth development of celery was affected by the initial soil condition before the study was conducted. The planting area that was provided were not been used for a while and the previous cultivation may leave any crop residues or nutrients that were not uptake by the crops.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

Consequently, this effect the end result of the plant growth as each treatment were randomly choose on the plots. Each plot may contain different previous nutrient residue.

Moreover, the growth of celery was also influence by environmental factor. This limitation cannot be controlled as the weather was unpredictable. Few weeks before the harvesting time, the rains fall almost every day. Thus, the leaves of celeries were wounded.

1.6 Significance of study

This study is essential to identify which is the appropriate level of Bokashi treatment for celery plantation and to determine whether Bokashi shall increase the height, number of leaf and weight of celery yield. Along the study, the celery development rate and pattern of growth were observed. With the outcome of this study, it will increase the awareness of farmers and the government to start cultivating celery in Malaysia. It also shall assist human society in understanding the effect of Bokashi to crop growth and help other peoples in further development of the usage of Bokashi in agriculture.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Bokashi

Bokashi is a Japanese word which means fermented organic matter. Bokashi is very good for high decomposition of organic matter. Bokashi containing Effective Microorganism (EM) in the form of semi-solid which consists of rice brans, rice husks, coconut fibres and husks, and chicken manure. All the materials are fermented to produce Bokashi. Prof. Teruo Higa is the one that developed the technology of EM in 1980 at the University of Ryukyus, EM is utilized in agriculture, composting, bio-remediation, septic tanks and household use.

Among all of the ingredients, the important ingredient of Bokashi that is recommended is rice bran because it consists of high nutrients for microorganisms. Porous materials like rice husks and charcoal enhance the physical conditions of the soil and the ability of the soil to hold nutrients. Other than that, according to Alvarez-Solis. et al (2016) they stated that Bokashi contents high amount of Nitrogen (N) which is 0.95 % and a low Carbon/Nitrogen (9.6 %) which favours the nutrients availability.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

2.1.1 Response of Bokashi to various plants

Alvarez-Solis. et al (2016) found that Bokashi application increased the number of leaves and plant heights in onion (37 and 62%) significantly and also enhanced the diameter and weight of the onion bulbs (69% and 269%) respectively compared to the plants with control treatment without fertilizer application. Hence, they conclude that the usage of Bokashi produced better yields and quality of onions with an efficient use of the land. In another research study on application of EM Bokashi on other plant than onion; peanut, (Yan Pei-Sheng and Xu Hui-Lian, 2002) reported that their result from the studies showed an enhancement in the yields of pod to 9.4% compared to the chemical fertilizers. The photosynthetic rates and transpiration rates were high by using EM Bokashi.

Moreover, Suthamathy and Seran (2013), reported that the diameter for tuberous root of radish which grown in EM Bokashi showed larger tuber compared to the plant that grown in chemical fertilizer. Other than tuber, other parts of the plants also give a very positive response toward the usage of Bokashi. Thus, EM Bokashi should be supplied to other green vegetables to enhance the vegetative and reproduction growth of plant.

2.1.2 Effect of Bokashi on soil properties

Bokashi is an organic fertilizer which raised the soil fertility chemically, physically and biologically. A study in (Shao Xiaohou, Tan Min, Jiang Ping and Cao Weiling, 2008)

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

stated that the soil which is treated by EM Bokashi showed a higher level of microbial biomass, alkaline Nitrogen, available Phosphorus and cation exchange capacity (CEC) compared to treatment of chemical fertilizer or farmyard manure and chemical fertilizer. Thus, it is proven that the usage of Bokashi did give positive effect to the soil properties.

2.1.3 Bokashi Ismail Sulaiman

Bokashi that is produced by Mr. Ismail Sulaiman contained lactic acid bacteria, phototrophic bacteria, yeast, organic ferment extraction, goat manure, molasses and bran. All the materials used are 100% bio-organic. Therefore, it will not bring any harmful effect to the environment. A study conducted by (Higa and Kinjo, 2017) has indicated that the acceleration for decomposition of organic amendments in soil and their nutrients for the growth of plant uptakes are faster with treatment that contains 90% of lactobacillus bacteria.

In an analysis of the effectiveness of algae extract and yeast application, Elham Z. A. E. et al (2010) found that when the combination of algae at 2% and yeast at 0.2% bring positive impacts to the mango fruits production in term of quality and quantity and also increased total soluble solids (T.S.S.). The result on Hashem and Metwally, 2014 also has highlighted that Indole Acetic Acid (IAA) which is produced by yeast hormone was the cause of the enhancements recorded on the formation of root growth and lateral roots. It also led to greater nodulation and nutrient uptake and consequently generate high yield of common Bean (*Phaseolus vulgaris L.*). Therefore, it can be seen that yeast in Bokashi is a beneficial agents to improve the growth performance.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

In addition, goat manure in Bokashi also gives favourable conditions to soil fertility and crop development. However, manure contain high amount of Phosphorus. If too much amount is used, there will be a lot of Phosphorus accumulation and this subsequently leading to soil toxicity (Robert, 2016). Besides, mycorrhizal fungi which provide phosphorus and water, as well as other nutrients to the plant unable to live in a high level Phosphorus. Plants therefore have to use more energy in making larger root system to uptake their nutrients as there are no presences of mycorrhizal fungi and consequently produce low production of yield.

2.2 Apium graveolens

Apium graveolens belongs to family *Apiaceae*, genus Apium. The cultivation of celery is not yet commercial in Malaysia due to several problems which one of it is weather. Celeries are one of important ingredients in many dishes which has own aroma and flavour. Thus, they are very profitable to farmers to generate their income. *Apium graveolens* has different shape, length and weight depend on the varieties and other factors like fertilizer application. They can be harvested after it reached it maturation. They bring a lot of benefits to the human being.

2.2.1 Morphology of celery

Celery is a biennial, slow growing plant. It is cultivated as an annual, its leafy stalks or called as petioles are consumed as a vegetable. The Chinese celery (Asiatic type) is comparatively small and delicate, but has a very strong flavor. The leaves and

FYP FIAT

petioles are light green in color. The stems are thin and hollow. They are crisp, fragrant, aromatic, and delicious.

Celery leaves are pinnate to bipinnate with rhombic leaflets 3–6 cm (1.2–2.4 in) long and 2–4 cm broad. The seeds size is 1.5–2 mm long and wide. Modern cultivars have been selected for solid petioles, leaf stalks. A celery stalk readily separates into "strings" which are bundles of angular collenchyma cells exterior to the vascular bundles.

2.2.2 Importance and production status of celery in Jeli Area, Kelantan

In 2016, according to a report by Jabatan Pertanian Malaysia, it was stated that celery was cultivated widely only in Pahang, Johor, Perak and Sabah. Besides, in 2016, Hemananthani Sivanandam has reported about Malaysia that is too depending on the imported food from other countries. The government spent money close to RM 1.98 billion to import vegetables in 2015 from January to June. One of the imported vegetables is including celery. It is reported in The Weekly Time that the largest export of celery from Australia are Malaysia and Singapore, which holding a combined 84.87 per cent share of exports for 2014-15.

In 2015, there was cultivation of celery in Kelantan; however because of bad weather and flood, the farmers stopped planting celery. This situation not only effect Malaysian market, it also effect Singapore who import celery from Malaysia. According to Tay Hong Yi in 2017, the price of vegetables has risen as much as 20 per cent. increments. Celery

FYP FIAT

is nowadays sold with higher price which is RM10 per kilogram. This situation happened because of less celery cultivation in Malaysia. Celery cultivation in Malaysia can be developed by a lot of further research and new technology. There are not many researches have been done about celery in Malaysia.

The status of cultivation of celery in Malaysia is not yet reached satisfaction as the demand for celery are high. There is still no commercialized celery cultivation. However, plantation of celery in Jeli, Kelantan has potential to be done from March to October as there is less rainfall during those months. The soil in Kelantan is less acidic, so it is very suitable and favoured by celery. In addition, the consumption is high, as there are a lot of restaurants and markets in Jeli area. Other than that, many plantations in Kelantan using chemical fertilizer on their farm, this study will help the farmer to change their fertilization way by applying soil amendment (Bokashi) to enhance the fertility of soil and increase the pattern growth of their plants.

2.2.3 Response of Bokashi to Celery

(Hazairin and Bengkulu, 2016) has reported that the media treatment of celery that was treated with composition of 100% Bokashi show the best response to the growth of celery. The height of celery achieved in the research was 25 cm which was recorded in week 8. They also concluded in their study that Bokashi was a good media for cultivation of celery because of its availability of nutrients for plant uptake and causing the physical structure of soil become loose, thus, the plant’s root will grow healthier.

FYP FIAT

UNIVERSITI MALAYSIA KELANTAN

FYP FIAT

CHAPTER 3

METHODOLOGY

3.1 Description of the Study Area

Figure 3.1: Agropark Umk Jeli

KELANTAN

FYP FIAT

The experiment was conducted at University Malaysia Kelantan in Agropark which is located at 8.2 km away from Jeli District (Figure 3.1). The study site is located at Jeli, Kelantan. It is situated at the latitude of 5.7445^{o} N and longitude of 11.8642^{o} E. The climate in Malaysia is hot and humid throughout the year or it is also known as tropical rainforest climate. The areas in Kelantan have raining for every interval of month. The raining season in Kelantan is from October to March, which is at the northeast monsoon season. The mean minimum and maximum temperature ranges from 22^{o} C to 26^{o} C and 31^{o} C to 39^{o} C, respectively.

3.2 Planting Material

The planting material used in the research was the celery seeds. Celery seeds for planting were obtained from the market. The celery seeds have very tiny size. It took about 9 to 10 weeks for harvesting the yields. Other than that, hoe, balance, measuring tape, garden spade and fork are used for bed preparation and maintenance. Labeling was done to differentiate the plot with several treatments.

UNIVERSITI
MALAYSIA
KELANTAN

3.3 Fertilizer Material

The sources of fertilizers used were compost, Bokashi and NPK (chemical basal fertilizer) for soil amendment. 6 kg of Bokashi and 3 kg of compost were used in this study.

3.4 Treatment and Experimental Design

The treatment applied were the different amount of Bokashi at 6 levels; T1: 0 kg/ha as negative control, T2: Bokashi 2000 kg/ ha (0.2 kg/m^2), T3: Bokashi 4000 kg/ha (0.4 kg/m^2), T4: Bokashi 6000 kg/ha (0.6 kg/m^2), T5: Bokashi 8000 kg/ha (0.8 kg/m^2), T6: Compost 10000 kg/ha (1.0 kg/m^2) as positive control. The experiment was laid out as randomized complete block design (RBCD) with three replications. Hence, there were 18 experimental units. Each treatment was assigned to the plots randomly. The spacing between furrows is kept at 0.5 m and the spacing between the double rows in a furrow was 0.2 m.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

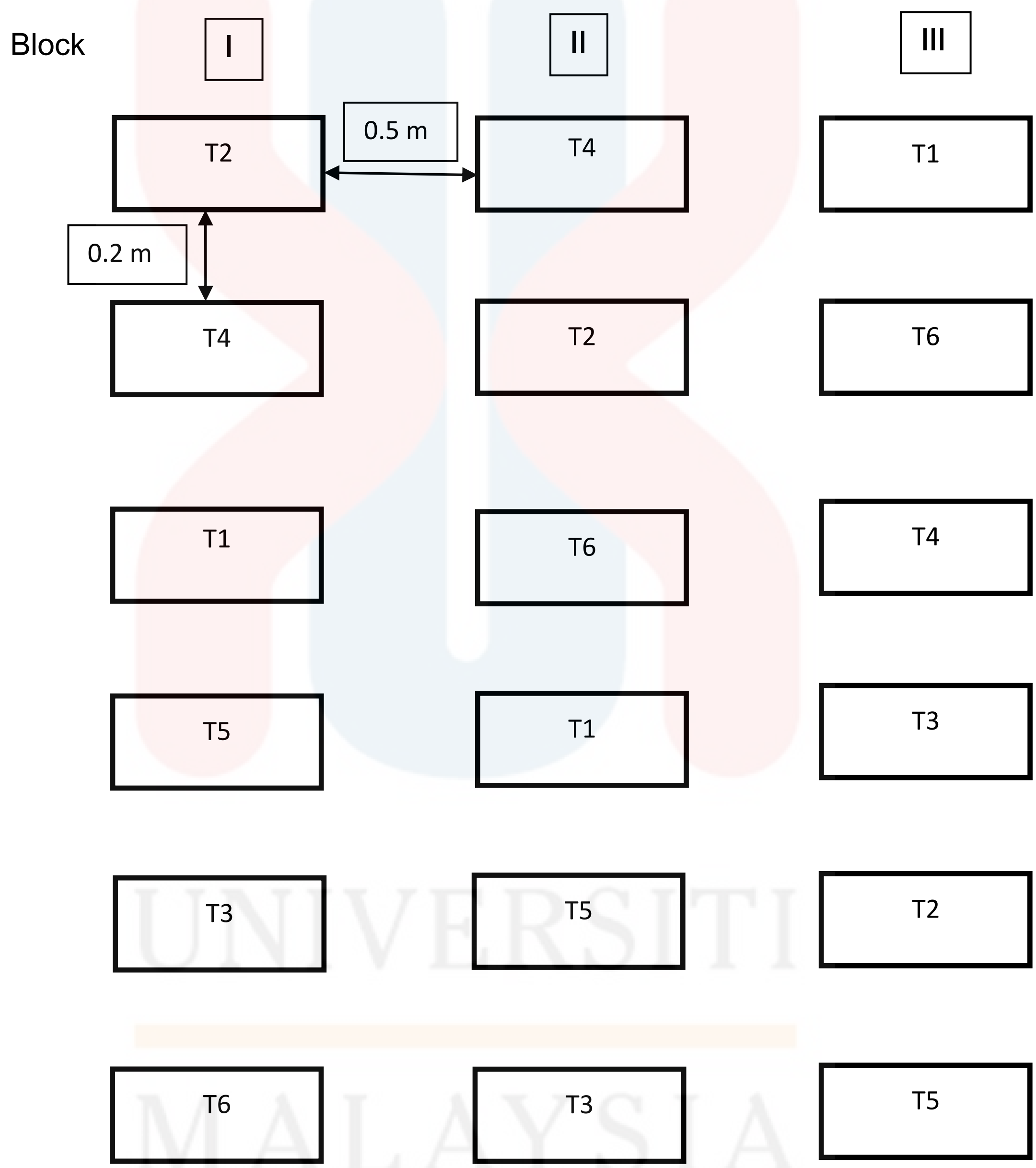

Figure 3.2: Experimental layout

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

3.5 Management of Experimental Field

Firstly, the plots were cleared and ploughed to make 18 planting beds with a measurement of 1 m x 1 m (1 m^2) for each plot. The blocks are separated by 0.5 m width whereas the space between each plot within a block was 0.2 m. The seedlings of celery were planted on the bed with planting distance of 25 cm x 25 cm resulting in 25 of celeries in each plot. Overall number of crops that will be cultivated are 450. The overall area was 40 m^2. The independent variable in this experiment was the different dosage of Bokashi. The Bokashi and compost were put before planting. The basal fertilizer, NPK were also be put before the planting process.

Plots are supplemented will well drainage and celeries are watered twice a day in the morning and evening. Weeding and hoeing are done manually by own hand and hoe. The crops were harvested after 9 to 10 weeks of planting.

3.6 Data collection

All the data on the growth of celery and yield were recorded from the plants which are selected randomly in each plot. The growth development difference of celeries was measured every week.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

The growth and development of celery was observed follow the dependents variables of celery:

- Plant height per week
- Number of leaves per week
- Yield per sample
- Yield per plot

3.7 Statistical Analysis

The data were subjected to analysis of variance (ANOVA) using Microsoft Excel 2010 and SPSS. Observation on the data were conducted to compare plant height per week, number of leaves per week, yield per sample and yield per plot on different range of Bokashi application and only single treatment of compost application.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

CHAPTER 4

RESULT AND DISCUSSION

4.1 Height of Plant

There were six different treatments have been assigned in this study. The treatments were T1; 0 kg/ha (negative control), T2; 2000 kg/ha of Bokashi, T3; 4000 kg/ha of Bokashi, T4; 6000 kg/ha of Bokashi, T5; 8000 kg/ha of Bokashi and T6; 10000 kg/ha of Compost. The H_o of this study is the different dosage of Bokashi application does not affect the pattern growth of celery. In contrast, the H_1 is the pattern growth of celery is influenced by different dosage of Bokashi application.

Figure 4.1.1 presents the growth pattern of celery height which is increasing continuously throughout 8 weeks. All treatments show positive feedback, however the highest height of plant that is recorded on week 8 were crops that were planted from Treatment 3 with 24.9 value. Treatment 4 and Treatment 5 follows closely with final height at 23.5 cm and 23.0 cm respectively. Meanwhile, it is followed by height of plant with 19.2 value; Treatment 2. At last, Treatment 6 has 0.5 cm increment from Treatment 1 which has the lowest final height which is 14.6 cm. From the result, it can be seen that, it is not certain that when the amount of Bokashi is added up, the plant height became higher.

FYP FIAT

FYP FIAT

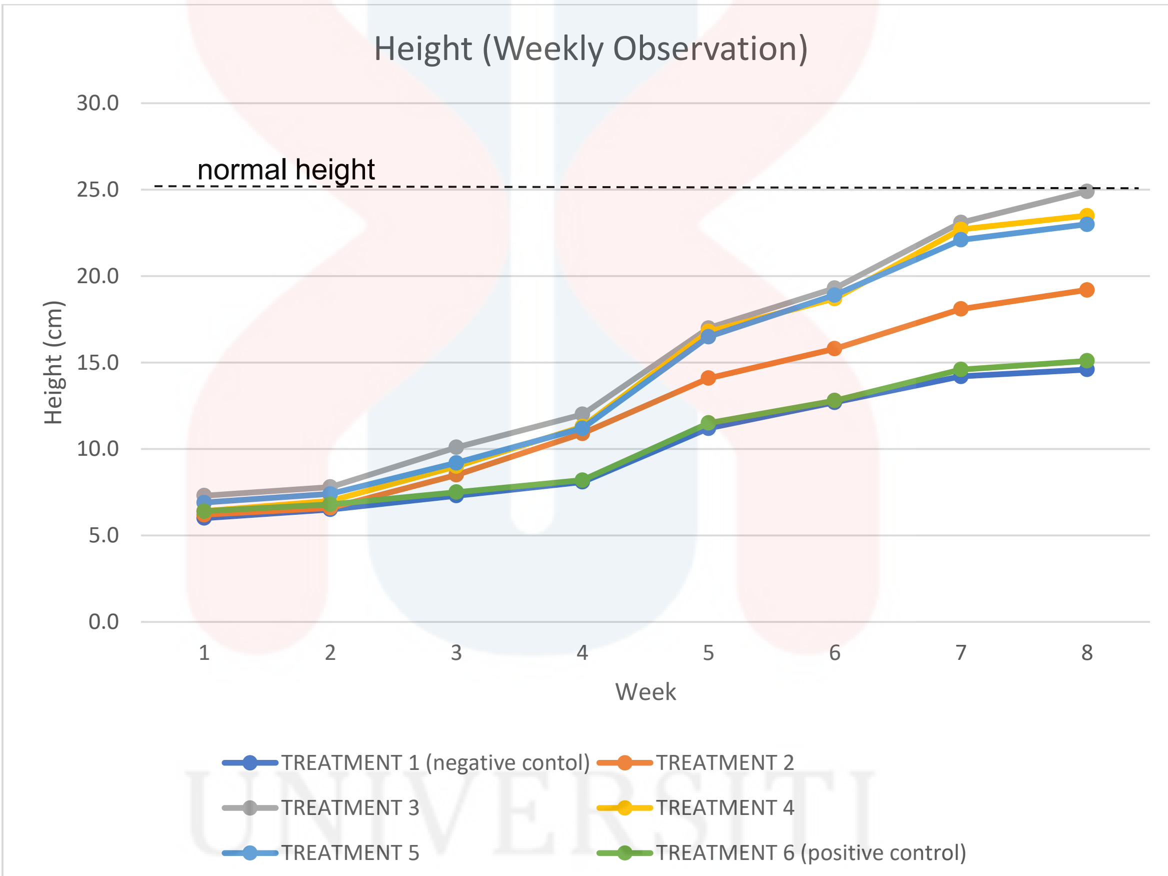

Figure 4.1.1: The graph of plant height across weeks

UNIVERSITI MALAYSIA KELANTAN

FYP FIAT

Based on Table A.1 (b), since the F value is greater than F critical= 2.353809, therefore H_0 should be rejected at significance level 0.05. Identification of the highest height was done by using Duncan's Multiple Range Test (DMRT) in SPSS. Valued followed by the same letter within the same column are not significantly different (P≤ 0.05) based on Duncan's Multiple Range Test (DMRT).

Post hoc result for plant height in Table 4.1.2 showed that T3= 4000 kg/ha Bokashi are in the last subsets in week 8 as this treatment has the highest mean height and T1= 0 kg/ha in the last week are shown first as they have the lowest mean height. The mean height for T3= 4000 kg/ha is only in one column by itself and not appear in other columns. This shows that the mean height in T3= 400 kg/ha is significantly different to the mean height of all the other treatment. T2, T4, T5 and T6 are not statistically significant because the mean of those treatments is shown in the same column. Treatment 3 with only 4000 kg/ha is more effective than the usage of Treatment 6 which use large amount of compost, thus it is better to use lower dosage of Bokashi which is T3 to planting celery.

UNIVERSITI

Table 4.1.1: Post hoc result of plant height for week 8

Treatment	Week 8
T1= 0 kg/ha	14.57^{d}
T2= 2000 kg/ha Bokashi	19.20^{bc}
T3= 4000 kg/ha Bokashi	24.90^{a}
T4= 6000 kg/ha Bokashi	23.53^{ab}
T5= 8000 kg/ha Bokashi	23.00^{ab}
T6= 10000 kg/ha Compost	15.13^{cd}

MALAYSIA
KELANTAN

In addition, referring to Table 4.1.2, it shows that the fastest growth rate is also achieved by Treatment 3.

Table 4.1.2: The height growth rate of celery

TREATMENT	RATE (cm)
TREATMENT 1 (negative control)	1.08
TREATMENT 2	1.63
TREATMENT 3	2.20
TREATMENT 4	2.14
TREATMENT 5	2.01
TREATMENT 6 (positive control)	1.09

4.2 Number of Leaves

The Figure 4.2.1 shows the number of leaf throughout the eight weeks observation. The greatest number of leaf achieved by week 8 was the plants from Treatment 3 with 17 leaves. This is followed closely by Treatment 5 with 16 leaves and Treatment 4 which has 15 leaves. Treatment 2 and Treatment 6 have the same value of leaves which are 10. Meanwhile, Treatment 1 has the lowest number of leaf which is 9. From the graph, there are only slightly different of number between the treatment.

Based on Table A.1 (d), since the F value= 6.114894 is greater than F critical, therefore H_0 should be rejected at significance level 0.05. Post hoc is used to identify which Treatment has greater end result.

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

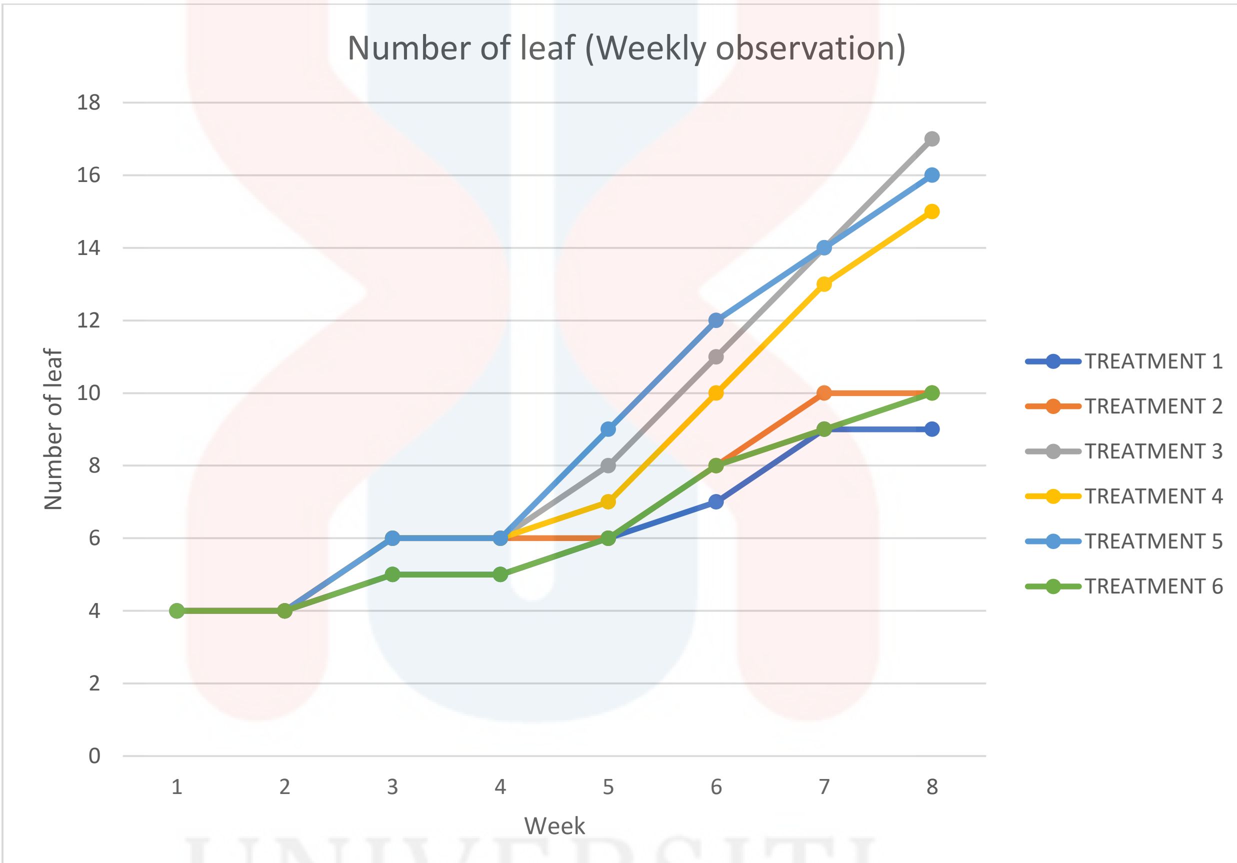

Figure 4.2.1: The graph number of leaf across weeks

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

Post hoc result for number of leaf in Table 4.2.2 showed that T1= 0 kg/ha, T2= 2000 kg/ha Bokashi and T6= 10000 kg/ha compost in the last week are shown first as they have the lowest mean number of leaf and they are not significantly different from each other. In contrast, T3= 4000 kg/ha Bokashi are in the last subsets in week 8 with T4 and T5 as these treatments have the high mean number of leaf. This shows that T3, T4 and T5 are not statistically significant because the mean of those treatment is shown in the same column. Therefore, the best treatment that should be used is T3 with only 4000 kg/ha Bokashi as it can produce slightly similar output rather than using fewer amount of Bokashi.

Table 4.2.1: Post hoc result of number of leaves for week 8

Treatment	Week 8
T1= 0 kg/ha	9.47^{b}
T2= 2000 kg/ha Bokashi	10.10^{b}
T3= 4000 kg/ha Bokashi	16.60^{a}
T4= 6000 kg/ha Bokashi	14.60^{a}
T5= 8000 kg/ha Bokashi	16.43^{a}
T6= 10000 kg/ha Compost	9.53^{b}

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

4.3 Yield

The Figure 4.3.1 represents the weight of celery per plant according to different treatment. It is showed that Treatment 3 has the greatest total weight of celery per plant, which is 63 g, followed closely by Treatment 5 which produced 62 g of celery per plant. Treatment 4 is the third high weight of celery per plant with 50 g in value. The value of celery per plant for Treatment 2 and Treatment 6 followed each other closely at 32 g and 30 g respectively. The production of celery per plant from Treatment 1 is the lowest weight, which is 27 g. The celeries are harvested on the same day; thus, it can be seen that there are greater different between the highest number of yield, which is T3= 4000 kg/ha with T6= 10,000 kg/ha. From the graph, it showed clearly that the celery production by compost is not effective as using Bokashi. The result almost obtains the same amount with celery production without any compost or Bokashi.

Based on Table A.1 (d), since the F value is greater than F critical= 3.105875, therefore H_0 should be rejected at significance level 0.05. Further analysis was done by using Post Hoc in SPSS to identify the highest mean value.

FYP FIAT

UNIVERSITI
MALAYSIA
KELANTAN

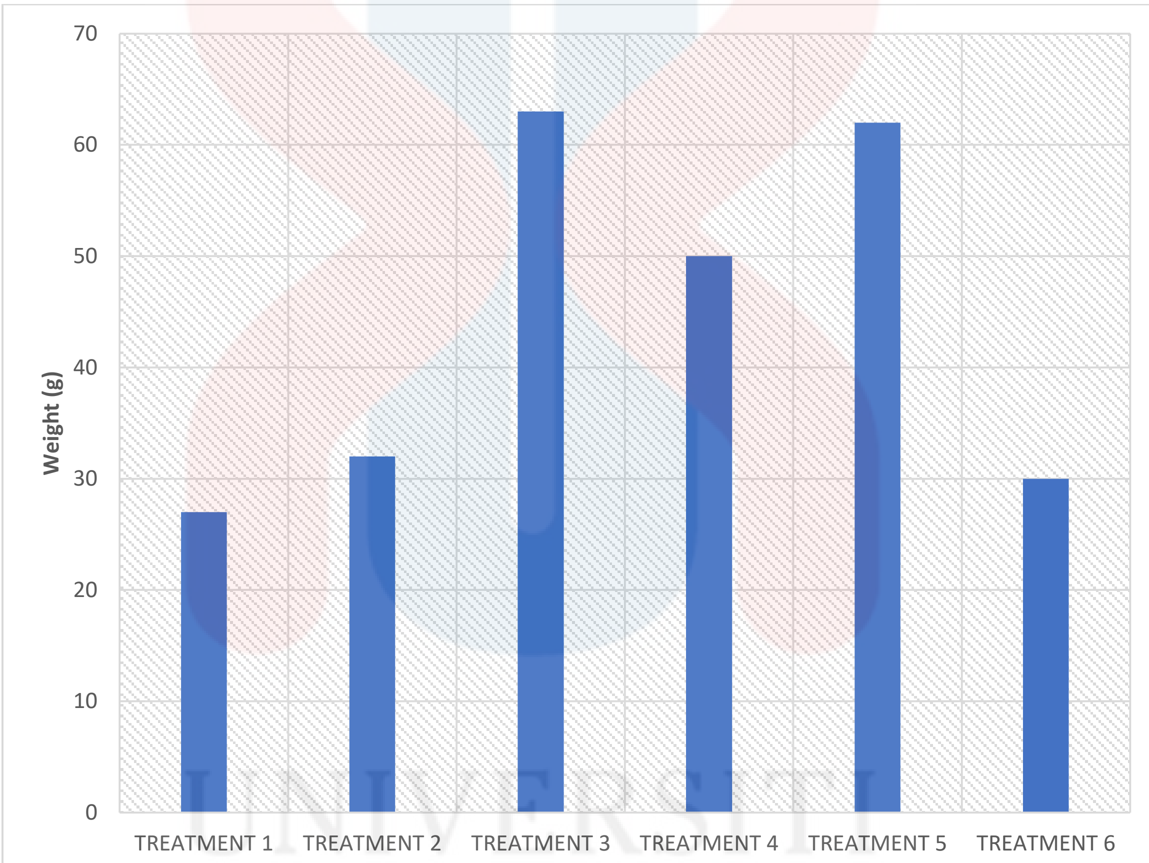

Figure 4.3.1: Yield per Plant

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

Post hoc result for yield per sample in Table 4.3.1 showed that T3= 4000 kg/ha Bokashi and T5= 8000 kg/ha are in the last subsets as this treatment has the highest mean yield per sample. This show that, they are not significantly different from each other. T1= 0 kg/ha is shown first as they have the lowest mean yield per sample. T2 and T4 are not statistically significant because the mean of those treatments are shown in the same column.

Table 4.3.1: Post hoc result of yield per sample

Treatment	Yield per Sample
T1= 0 kg/ha	26.93^{c}
T2= 2000 kg/ha Bokashi	31.77^{bc}
T3= 4000 kg/ha Bokashi	62.70^{a}
T4= 6000 kg/ha Bokashi	49.77^{ab}
T5= 8000 kg/ha Bokashi	62.27^{a}
T6= 10000 kg/ha Compost	29.53^{bc}

The Figure 4.3.2 projects the weight of celery for each treatment per plot. The greatest amount of celery weight is achieved by Treatment 3 which 3682 g. In contrast, Treatment 1 produced the lowest weight of celery per plot, which is 1774 g only. The production of celery from Treatment 6 also has lower weight of celery per plot which is 1898 g. it is followed by Treatment 2 with 2290 g of weight. Treatment 4 and Treatment 5 have about the same values of weight which are 3171 g and 3441 g respectively. Yield per plot in Treatment 3 and Treatment 5 clearly showed great difference with Treatment 1, Treatment 2 and 6.

Based on Table A.1 (h), since the F value= 6.440256 is greater than F critical, therefore H_0 should be rejected at significance level 0.05.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

FYP FIAT

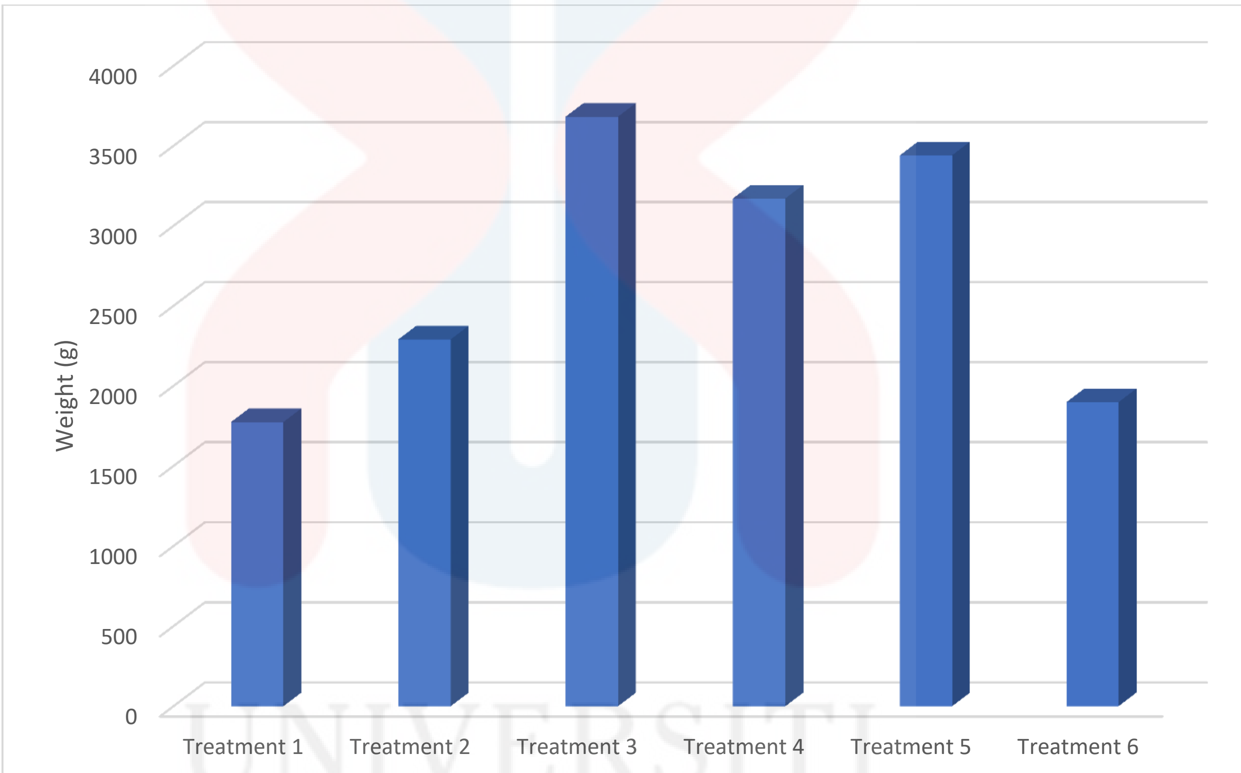

Figure 4.3.2: Yield per Plot

UNIVERSITI
MALAYSIA
KELANTAN

Post hoc result for yield per sample in Table 4.3.2 showed that T3= 4000 kg/ha Bokashi and T5= 8000 kg/ha are in the last subsets as this treatment has the highest mean yield per sample. This show that, they are not significantly different from each other but higher than the other treatment. T1= 0 kg/ha and T6= 10000 kg/ha are shown first as they have the lowest mean yield per sample. T2 and T4 are not statistically significant because the mean of those treatments are shown in the same column. Therefore, the best Treatment was T3 with highest mean; 1227.33.

T3 showed better performance than T4 and T5 with higher dosage of Bokashi can be caused by the high Phosphorus which moves very slow in the soil. Too much Phosphorus can be toxic to the soil.

Table 4.3.2: Post hoc result of yield per plot

Treatment	Yield per Plot
T1= 0 kg/ha	591.33[c]
T2= 2000 kg/ha Bokashi	763.33[bc]
T3= 4000 kg/ha Bokashi	1227.33[a]
T4= 6000 kg/ha Bokashi	1057.00[ab]
T5= 8000 kg/ha Bokashi	1147.00[a]
T6= 10000 kg/ha Compost	632.67[c]

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

4.4 Correlation between Parameters

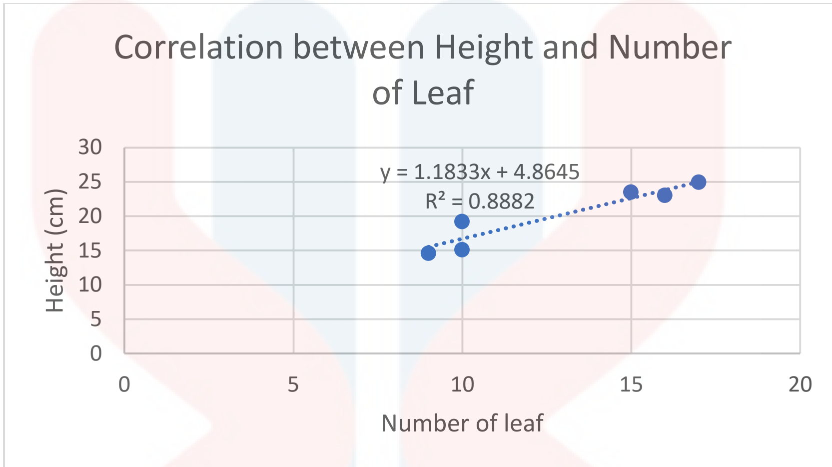

Figure 4.4.1: Correlation graph between plant height and number of leaf

Correlation between all the parameters of celery was constructed in order to identify whether one parameter growth will affect another parameter. The strength of correlation was determined by R^2 value. The value which is closer to 1, make a strong positive correlation. As example, from Figure 4.4.1, it can be seen that the parameters of plant height and number of leaf have a positive correlation. The value of R^2 is 0.8882, which is close to 1. This shows that there is significant correlation between the two parameters.

FYP FIAT

FYP FIAT

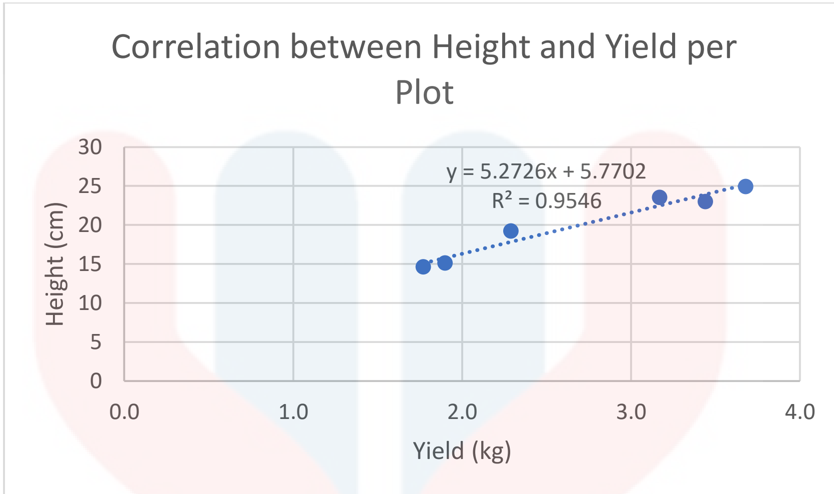

Figure 4.4.2: Correlation graph between plant height and yield per plot

From Figure 4.4.2, it can be observed that the parameters plant height and yield per plot do have a positive correlation. In addition, the R^2 value is 0.9546, which is very close to 1. This proves that the two parameters have a significant correlation.

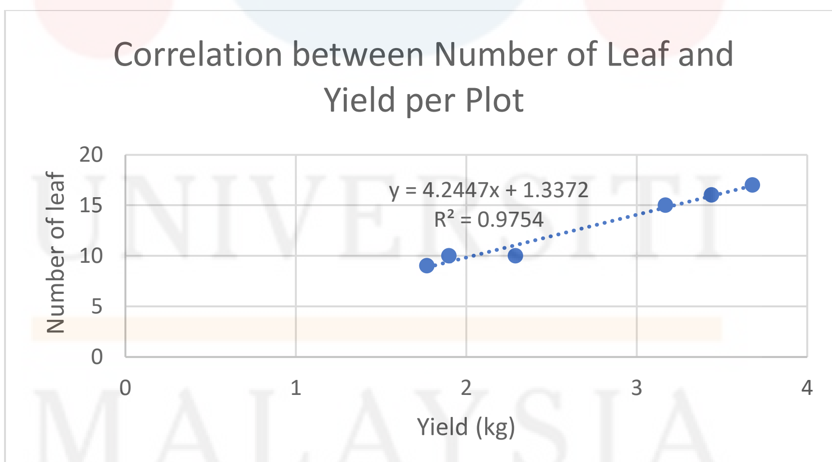

Figure 4.4.3: Correlation graph between number of leaf and yield per plot

UNIVERSITI
MALAYSIA
KELANTAN

From the Figure 4.4.3, it can be observed that the parameters number of leaf and yield per plot do have a positive correlation. the R^2 value is 0.9754, which is closer to 1. This proves that the two parameters have a significant correlation.

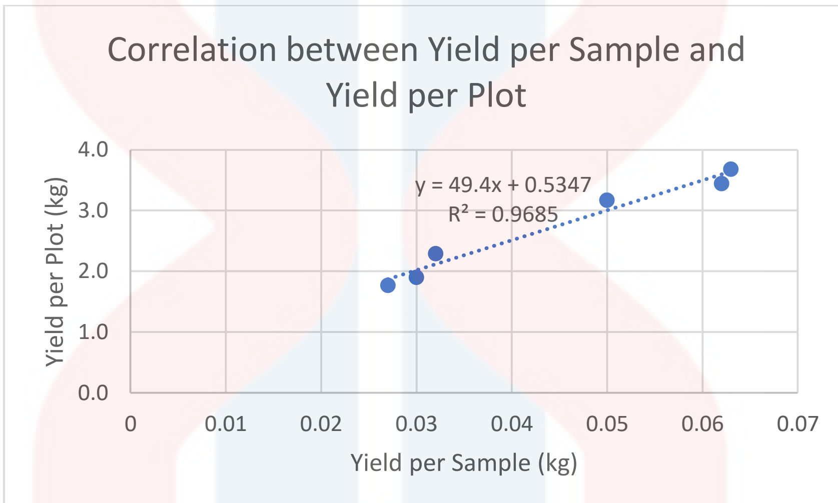

Figure 4.4.4: Correlation graph between yield per sample and yield per plot

Figure 4.4.4 indicate that the parameters of yield per sample and yield per plot have a positive correlation. The value of R^2 is 0.9685, which is very close to 1. This shows that there is significant correlation between the two parameters. From all four correlations, it is shown that all parameters do affect each other's.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

4.5 Fitting Data to Growth Curve Model

Figure 4.5.1 shows the fitted experimental data to the Growth Curve Model. It is a logistic function or logistic curve where it has a common “S” shape (sigmoid curve), with equation:

$$y = \frac{K}{1 + e^{-r(t-t_0)}}$$

Where *K* is the carrying capacity (maximum level), *r* is the steepness of the curve and t_0 is the *x*-value of the sigmoid’s midpoint. The function was named in 1844–1845 by Pierre François Verhulst, who studied it in relation to population growth. The growth of celery at initial stage is approximately exponential. Then, as saturation begins, the growth slows, and at the time of maturity, the growth stops. The logistic function finds applications in a range of fields, including agriculture.

For this fitting data process, only Treatment 3 (4000 kg/ha Bokashi) is chosen because from result in Section 4.1 shows it is the highest plant among the treatments From the parameter estimation procedure called ‘fminsearch’ in MATLAB, the best –fit parameters are:

$$K = 38.53$$

$$r = 0.33$$

$$t_0 = 5.99$$

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

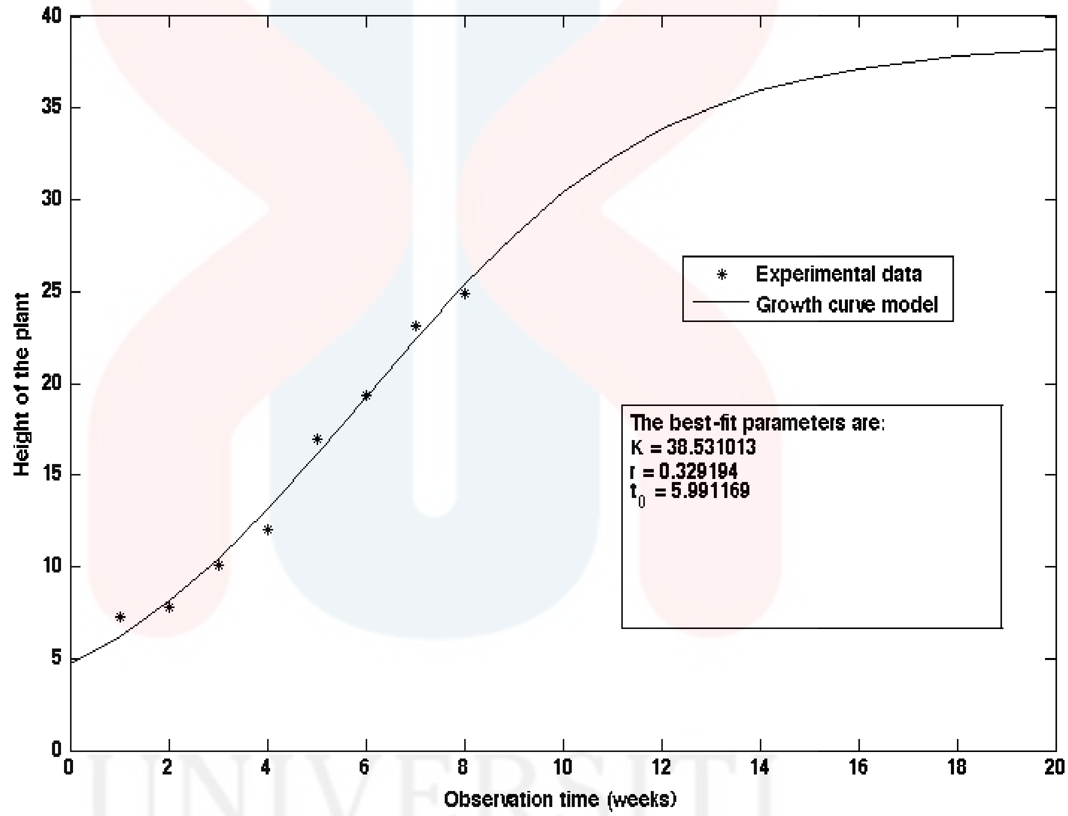

Figure 4.5.1: The logistic growth curve of celery height

FYP FIAT

From this model simulation, the calculated $R^2 = 0.9874$ using EXCEL function 'RSQ'. This shows that the model has a very good fit to the experimental data obtained. Although, we only have the data of the height from week 1 until week 8, the model is able to predict the height of the plant until 20 weeks. It shows that the plant is still growing its height until it reached a maintain height at 38.53 cm which is approximately at week 18.

What can we say about this simulation is that if we leave the plant and started to harvest at week 18 instead of week 8, it will yield the most crop of celery. This is supported by the results in Section 4.1 and 4.3 that Treatment 3 (4000 kg/ha Bokashi) gave the highest yield. Moreover, this is also supported by the correlation result of Height vs. Yield (see Section 4.4).

FYP FIAT

UNIVERSITI
MALAYSIA
KELANTAN

FYP FIAT

4.6 Net Profit Obtained From Different Rate of Soil Amendment

Table 4.6: The net profit comparison

TREATMENT	WEIGHT (kg)	COST (RM)	Weight (g)	GROSS PROFIT (RM)	NET PROFIT (RM)
1 (negative control)	0.0	0.00	1774	23.06	23.06
2	0.6	1.80	2290	29.77	27.97
3	1.2	3.60	3682	47.87	44.27
4	1.8	5.40	3171	41.22	35.82
5	2.4	7.20	3441	44.73	37.53
6 (positive control)	3.0	4.20	1898	24.67	20.47
		TOTAL	16256	211.32	189.12

In order to identify the net profit, a comparison was made by calculating the cost of Bokashi and compost and then, the values were substracted by gross profit. The calculation was made by excluding the labour cost and equipment used and only focused on the main materials. The price of celery was obtained from newest market price which is RM 13.00. The price of Compost was RM35 per 25kg equal to RM 1.40 per kg. In the other hand, the price of Bokashi was RM75 per 25kg and equal to RM 3 per kg.

UNIVERSITI MALAYSIA KELANTAN

Based on Table 4.5, it can be seen that the greatest profit obtained was Treatment 3 with RM 44.27. treatment 3 gaining more profit as the yield per plot also higher. In contrast, Treatment 6 gained only RM 20.47 which indicate it to be the lowest profit. Treatment 6 with 10000 kg/ha compost not able to generate more return as the yield per plot were low. Therefore, these show that the usage of compost does not bring greater values like Bokashi.

FYP FIAT

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This research provides a framework for the exploration of the use of Bokashi as soil amendment. Bokashi contained several benefits that help in plant growth and soil structure. In this research, the aim was to determine whether the pattern of growth for celery is affected by different dosage of Bokashi. This study has identified that Treatment 3 with 4000 kg/ha of Bokashi had the greatest outputs; height, number of leaves and yields. It was followed by Treatment 4 (6000 kg/ha) and Treatment 5 (8000 kg/ha) that was not significantly different in term of height and number of leaves, and slightly different at the amount of yield per sample and per plot.

For logistic growth curve, it has determined that celery which was treated with Treatment 3 still able to growth after week 8 and will produce higher yields. Moreover, one of the more significant findings to emerge from this study is that Bokashi generates better growth performance of celery than compost. The end result from compost as soil amendment clearly giving low values in every parameter of celery. Other than that, the cost effectiveness also indicate that Bokashi were more profitable than compost. In general, the best dosage of soil amendment was Treatment 3; 4000 kg/ha.

Further research and experimentation into soil properties is strongly recommended as the previous usage of land may use for different purpose. Thus, the nutrients availability will be different. Soil analysis make it easier to identify all the organic matter, nutrients and other soil properties that may affect the growth performance of celery. Moreover, the study should be conducted in netted house to avoid unpredictable weather like rainfall. Any pest or disease able to be controlled in netted house.

At last, it is much recommended for the farmer to use Bokashi as soil amendment at rate with only 4000 kg/ha in celery cultivation.

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

FYP FIAT

REFERENCE

Chen, Jen-Hshuan, Jeng-Tzung Wu and Wei-Tin Huang (2001), "Effects of Compost on the availability of nitrogen and phosphorus in strongly acidic soils".

Department Agriculture, Forestry and Fisheries Republic of South Africa . (2013). *Celery Apium graveolens L.* Department of Agriculture, Forestry and fisheries.

Department of Agriculture Peninsular Malaysia. (2015). *Vegetables and Cash Crops Statistic Malaysia 2015*.

Department of Agriculture Peninsular Malaysia. (2016). *Vegetables and Cash Crops Statistic Malaysia 2016.*

Elham Z. et al. (2010). Effect of algae extract and yeast application on growth, nutritional status, yield and fruit quality of Keitte mango trees. *Agriculture and Biology Journal of North America* , 421-429 .

Emiru S. (2004), "Organic farming in the context of food security in Ethiopia: Novelty or Necessity?", In Tesfahun Fenta and Osman Ali (eds.), Proceedings of the food security Conference 2003, Challenges and prospects of food security in Ethiopia UNCC, Addis Ababa, August 13-15,2003.

Hashem M. M. and Metwally A.K., 2014. Effect of Combined Inoculation of Rhizobium with Soil Yeasts on Nodulation, Growth and Yield of Common Bean (Phaseolus vulgaris L.) Under Field Condition. *American Journal of Plant Nutrition and Fertilization Technology*, 4: 1-10.DOI: 10.3923/ajpnft.2014.1.10

Higa, T & Kinjo, S. (2017). Effect of Lactic Acid Fermentation Bacteria on Plant Growth and Soil Humus Formation

Hui-Lian, Y. P.-S. (2002). Influence of EM Bokashi on Nodulation, Physiological Characters and Yield of Peanut in Nature Farming Field . *Journal of Sustainable Agriculture*, 19:4 pp 105-112, DOI: 10. 1300/J064v19n04_10.

Jose D. Alvarez-Solis, J. A.-N.-M.-A.-M. (2016). Effecy of Bokashi and Vermicompost Leachate on Yield and Quality of Pepper (Capsicum annum) and Onion (Allium cepa) under Monoculture and Intercropping Cultures. *Ciencia e Investigation Agraria*, 43(2) pp 243-252.

Robert P. (2016, May 1). *Too Much Compost – Is It Poisoning Your Garden?* Retrieved September 15, 2017, from Garden Myths: http://www.gardenmyths.com/compost-is-it-poisoning-your-garden/

Shao Xiaohou, T. M. (2008). Effect of EM Bokashi application on control of. *Water Science and Engineering*, Vol. 1, No. 4, 99-106.

Sivanandam, H. (2016, April 7). *Nation: Price for being a food paradise*. Retrieved March 25, 2017, from The Star Online: http://www.thestar.com.my/news/nation/2016/04/07/price-of-being-a-food-paradise-rm45bil-spent-on-items-sourced-from-120-countries/

Szalay, J. (2015, April 28). *Celery: Health Benefits & Nutrition Facts*. Retrieved from Live Science: https://www.livescience.com/50640-celery-nutrition.html

Tay H. Y. (2017, May 29). *Vegetable prices rise due to rainy*. Retrieved from The Straits Time: http://www.straitstimes.com/singapore/environment/vegetable-prices-rise-due-to-rainy-weather-in-malaysia

Teguh Wijayanto et al (2016). Agricultural Waste based-Organic Fertilizers (Bokashi) Improve the Growth and Yield of Soybean (Glycine max (L.) Merril). *International Journal of Agricultural Science*, pp 27-32.

T.H, S. N. (2013). Residual effect of Organic manure EM Bokashi applied to Proceeding Crop. *Research Journal of Agriculture and Forestry Sciences*, Vol. 1(1), 2-5.

The Weekly Times. (2016, March 24). *Celery exports increase according to new data*. Retrieved from Thre Weekly Times: http://www.weeklytimesnow.com.au/agribusiness/horticulture/celery-exports-increase-according-to-new-data/news-story/15b20333f63dc0373950fc79378f7ca3

U.S. Food and Drug Administration. (2016, June 1). *Nutrition Information for Raw Vegetables*. Retrieved from U.S. Department of Health and Human Services: https://www.fda.gov/Food/IngredientsPackagingLabeling/LabelingNutrition/ucm114222.htm

Yacobus S. (2010). Effect of Vermicompost and Bokashi on Nutrient Content of Mustard Geen and Lettuce. *International Seminar on Horticulture to support Food Security*, A136 – A140.

Yang Y. and Guixing R. (2011). Effect of thermal treatment on phenolic composition and antioxidant activities. *LWT - Food Science and Technology 44*, 181-185.

.

Yaso, I. A.-R. (2007). Effect of NPK Fertilization on Bulb Yield and Quality of Onion under Reclaimed Calcareeous Soil Condition. *Journal Agriculture and Environmental Science*, Vol. 6 (1) pp 225-240.

FYP FIAT

UNIVERSITI MALAYSIA KELANTAN

APPENDIX A

1. Results of ANOVA

PLANT HEIGHT

Table A.1 (a) and Table A.1 (b): ANOVA result for plant height

SUMMARY

Groups	*Count*	*Sum*	*Mean*	*Variance*
Treatment 1	12	174.7	14.55833	6.808106
Treatment 2	12	230.1	19.175	11.00205
Treatment 3	12	298.6	24.88333	28.10515
Treatment 4	12	282.2	23.51667	20.04879
Treatment 5	12	275.8	22.98333	23.41424
Treatment 6	12	181.7	15.14167	4.602652

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1187.986	5	237.5971	15.16884	6.64074E-10	2.353809
Within Groups	1033.791	66	15.6635			
Total	2221.777	71				

FYP FIAT
UNIVERSITI
MALAYSIA
KELANTAN

NUMBER OF LEAVES

Table A.1(c) and Table A.1 (d): ANOVA result for number of leaves

SUMMARY

Groups	Count	Sum	Mean	Variance
Treatment 1	12	113	9.416667	9.537879
Treatment 2	12	121	10.08333	4.265152
Treatment 3	12	199	16.58333	44.08333
Treatment 4	12	175	14.58333	23.35606
Treatment 5	12	197	16.41667	56.44697
Treatment 6	12	114	9.5	4.272727

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	723.4028	5	144.6806	6.114894	0.000103	2.353809
Within Groups	1561.583	66	23.66035			
Total	2284.986	71				

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

YIELD PER SAMPLE

Table A.1 (e) and Table A.1 (f): ANOVA result for yield per sample

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Treatment 1	3	80.8	26.93333	13.61333
Treatment 2	3	95.3	31.76667	51.56333
Treatment 3	3	188.1	62.7	194.23
Treatment 4	3	149.3	49.76667	99.26333
Treatment 5	3	186.8	62.26667	237.3633
Treatment 6	3	88.6	29.53333	216.4633

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4099.943	5	819.9886	6.055325	0.005052	3.105875
Within Groups	1624.993	12	135.4161			
Total	5724.936	17				

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

YIELD PER PLOT

Table A.1 (g) and Table A.1 (h): ANOVA result for yield per sample

SUMMARY

Groups	*Count*	*Sum*	*Mean*	*Variance*
Treatment 1	3	1774	591.3333	6181.333
Treatment 2	3	2290	763.3333	20001.33
Treatment 3	3	3682	1227.333	22390.33
Treatment 4	3	3171	1057	48243
Treatment 5	3	3441	1147	80404
Treatment 6	3	1898	632.6667	34169.33

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1134501	5	226900.2	6.440256	0.003949	3.105875
Within Groups	422778.7	12	35231.56			
Total	1557280	17				

FYP FIAT

UNIVERSITI
MALAYSIA
KELANTAN

2. RESEARCH ACTIVITIES AND PROGRESS

Figure A.2 (A): Land preparation after weeding and hoeing

Figure A.2 (B): Bokashi

Figure A.2 (C): Compost

Figure A.2 (D): Celery Seeds

FYP FIAT
UNIVERSITI MALAYSIA KELANTAN

FYP FIAT

Figure A.2 (E): Seed Germination

Figure A.2 (F): Celery at early stage

Figure A.2 (G): Celery at Week 3

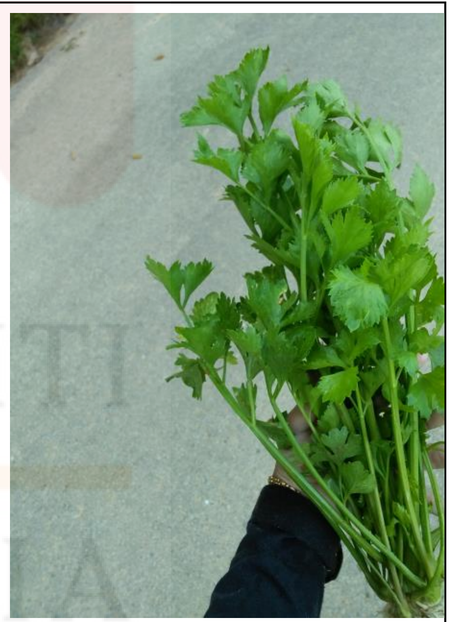

Figure A.2 (H): Harvested celery