The effect of Different Frequency of Fertilizer Applications on Growth Performance and Yield of *Capsicum annuum*

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DECLARATION

I hereby declare that the work embodied in this report is the result of the original research except citations and summaries of each of which I have already described the source and has not been submitted for a higher degree to any universities or institutions.

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Signature

Student name :

Matric number :

Date :

Approved by:

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Signature

Supervisor name :

Date :

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LIST OF ABBREVIATIONS AND SYMBOLS

ANOVA	Analysis of Variance
CRD	Completely Randomized Design
DI	Days Interval
FAO	Food and Agriculture Organisations
SPSS	Statistical Package for the Social Sciences
TE	Trace Element
WAT	Week after Transplant
cm	Centimeter
g	Gram
g/l	Gram per litre

Kesan pengaplikasian baja dengan kekerapan yang berbeza terhadap prestasi tumbesaran dan tuaian daripada pokok *Capsicum annuum*

ABSTRAK

Kajian ini telah dijalankan untuk mengenalpasti kesan perbezaan kekerapan penggunaan baja terhadap prestasi tumbesaran dan pemerhatian tuaian Capsicum sementara mengekalkan kadar yang sama terhdapap penggunaan baja. Tiga rawatan kekerapan bagi setiap 4 hari, 7 hari dan 14 hari telah diaplikasikan menggunakan *Capsicum annuum* sebagai tanaman subjek eksperimen. Kajian ini telah dijalankan dengan tiga replikasi dan disusun mengikut reka bentuk rawak. *Capsicum annuum* tersebut telah ditanam didalam keadaan yang terkawal menggunakan beg polietilena dengan diameter berukuran 15". Parameter penilaian terhadap pokok adalah prestasi tumbesaran pokok dan penghasilan tuaian (bilangan buah, panjang buah dan berat buah). Keputusan daripada kajian menunjukkan bahawa kekerapan pengaplikasian baja yang pendek memberikan kelebihan terhadap tumbesaran pokok dan penghasilan buah yang baik terhadap *Capsicum annuum.* Apabila kekerapan pengaplikasian baja pada setiap 4 hari dilakukan, purata buah yang dapat dituai adalah sebanyak 16 biji setiap pokok manakala apabila kekerapan pengaplikasian dikurangkan kepada setiap 7 hari dan setiap 14 hari, penurunan terhadap hasil tuaian buah berkurang kepada 12 biji dan 9 biji setiap pokok. Begitu juga dengan berat buah dan saiz buah yang konsisten dengan hasil bilangan buah yang dituai iaitu semakin berkurang selang pengaplikasian kekerapan pembajaan, semakin meningkat berat dan saiz buah. Keputusan menunjukkan pengurusan kekerapan dalam pembajaan adalah sangat penting bagi memaksimumkan hasil tanaman.

Kata kunci : Kekerapan, Prestasi tumbesaran, Penghasilan tuaian

The effect of different frequency of fertilizer application on growth performance and yield of *Capsicum annuum*

ABSTRACT

This research was conducted to observe the effect of different frequency of fertilizer application on the growth performance and the yield production of Capsicum while keeping the rate constant. Three frequency treatments of every 4 days, 7 days and 14 days were used utilizing *Capsicum annum* as the subject crop for the experiment. The experiment was conducted in three replications and arranged in randomized design. The *Capsicum annum* was planted in a control environment utilizing polyethylene bags measuring 15" diameter. Parameters evaluated were growth performance, yield production (number of fruits, length of fruits and weight of fruits). Results of the experiment showed that the shorter the frequency of fertilizer application, the higher and better the growth development and the higher the yield of *Capsicum annum*. When the frequency was applied at every 4days interval, the fruits yield averaged at 16 fruits per plant, where as when the frequency of fertilization was reduced to 7 days interval and 14 days interval, there is a reduction of yield to 12 fruits and 9 fruits per plant respectively. Correspondingly, the fruit weight and size of fruits also are consistent with the results of the number of fruits in which the shorter the intervals of frequency between application the higher the weight and size of the fruits. The results show that frequency management in fertilization is important in maximizing crop yield.

Keyword : Frequency, Growth performance, Yield observation

CHAPTER 1

INTRODUCTION

1.1 Research Background

Fertilizers are materials used to provide plant nutrients which are deficient in soils and also to enhance the growth of plants. According to Byrnes and Bumb (1998), in the next 20 years fertilizer consumption has to increase by around 2-fold to achieve the needed increases in food production. Proper nutrients application timing and frequency are fundamental requirement in the production of crops. Appropriate nutrient supplement frequency and timing give a fundamental effect to the production of crops. Proper frequency and timing of the fertilizer application can increase yields, reduce losses of nutrients, increase nutrient uptake efficiency and prevent environmental damage (Guy, 2016). Excessive fertilizer application can have detrimental effect on plants growth which often results in fertilizer burn or even death of plants (Aliyu,2000). Wrong fertilization timing and frequency might lead to less production of crops, time and fertilizer wastage hence also may be resulted into crop disease and damage. Different nutrient rates and ratios is needed by plants at different growth stages, therefore, proper timing and frequency of fertilizer application are important (Russo,2008). The nutrients uptake patterns determine the optimum frequency and timing for fertilizer application of the crop. Different crop has different nutrient uptake pattern. The application rate of fertilizer depends on crops and soil fertility which was tested using soil test-kit prior to the experiment

Capsicum is one of the most important vegetables grown in Malaysia as well as other countries with similar tropical or subtropical conditions. Data from the Ministry of Agriculture (2015), showed that a sizeable area of land in the region of 3,104 ha are planted with capsicum yielding an average of 16.1 tonnes/ha with a total production of 47,015 tonnes per annum with a value of RM 281,307.28. It has varieties of names depending on its type and places. Capsicum consists of many species, five of which are domesticated such as *Capsicum annuum*, *Capsicum baccatum, Capsicum chinense, Capsicum frutescens*, and *Capsicum pubescens*. The most common capsicum species is the *Capsicum annuum*. However, species such as *Capsicum chinense* and *Capsicum frutescens* are also widely grown in various regions (Andrews 1995). Most capsicum species are diploid. The fruits of capsicum varies in color, shape or size between and among species which often lead to confusion over taxa relationship, many types of peppers have continually being bred especially for heat tolerant, size, and yield (Nasrudin, et al., 2012), specific pest, disease, and abiotic stress resistances are continually being selected.

1.2 Problem Statement

Proper timing and frequency of the fertilizer application increases crop yields, reduces nutrient losses, increases nutrient use efficiency and prevents damage to the environment. But when fertilizers are applied at the wrong timing can lead to nutrient losses, wastes of the fertilizers, damage to crop as well as increase cost of fertilizer. As indicated by FAO (2004), farmers in Malaysia has to deal with the increasing cost of fertilizers due both to the expansion of crop production as well as overuse of fertilizers which also lead to environmental concerns due to pollution of soil and water resources from the fertilizer residual and wastage that is not taken up by the crops. It was reported that the conventional practices of fertilizer application through broadcast, deep banding, top dressing or side dressings have been proven to be not effective in fertilizer use efficiency and can have detrimental effect to the environment. Water pollution, increase air pollution, eutrophication, nitrite contamination are some of the adverse effects of chemical fertilizer that are excessively applied to crop and not utilized by the plants.

The nutrients rates and ratios requirement of plants at different growth stage varies. Therefore it is important that nutrients are available to the plants when the plant needs them hence the importance of the correct timing and frequency of application to maximize their growth and yield. Production of agricultural crops can be increased by optimising the frequency or timing of fertilizers application with the advance of new technology (Omotoso and Shittu, 2007). Hence, the study between a different frequency or timing of fertilization application is conducted to observe the best practical regular interval of applications suits the crops in order to reduce wastage of fertilizer residue, pollution towards soil and water, and wastage of money to buy more fertilizers especially for smallholders' farmers.

1.3 Hypothesis

H0 : There is no effect between the frequency of fertilizer application and the yield of pepper.

H1 : There is an effect between the frequency of fertilizer application and the yield of pepper.

1.4 Research Objectives

i. To observe the effect of different frequency of fertilizer application on the growth performance and yield production of pepper.

ii. To determine the economics of different treatments.

1.5 Scope of Study

This study is confined to the evaluation of the effect of timing and frequency of fertilizer application on *Capsicum annum.* Three application frequencies will be utilized to see their effects on the growth and yield performance of the *Capsicum annum* while keeping the rate of fertilizer constant. The three frequencies were every 14 days, every 7 days and every 4 days. The rate of fertilizers were kept constant at 2g/liter of NPK + Trace Element. (20:20:20+TE). All fertilizers were applied through foliar application, applied at the evening for each of the application**.** Foliar application was chosen as methods of application because to avoid environmental conditions such as temperature stress, low soil pH, high or low soil moisture, root disease and nutrients imbalance in the soil that may limit the uptake of nutrients by roots. Foliar application has been found to be more efficient by 8-9 folds compared to nutrients applied in the soil.

1.6 Significance of Study

The findings of this study will give awareness on the importance of the correct timing and frequency of NPK fertilizer application towards the plant growth development and yield of crops. The application of correct frequency of NPK fertilizer to the plants is believed to enhance the growth and maturity of the plants thus it is apparent that deficiencies of NPK fertilizer according to false timing and frequency application are far more widespread than is generally experimented. The conventional fertilizer application has been reported to not only results in wastage which leads to high cost of production but also degrade the environment. When farmers are aware of the importance of the correct frequency of fertilizers application, not only that they can improve their production and reduce their production cost, they are also saving the environment from contamination of chemical fertilizers.

CHAPTER 2

LITERATURE REVIEW

This chapter discusses about the review of studies and empirical findings which are important in theoretical development and conceptual framework in order to achieve the objectives of this study.

2.1 Nutrient Requirements

Nutrients which are crucial for the plants are divided into three classes which is the primary nutrients, secondary nutrients and micronutrients or also known as trace elements.

2.1.1 NPK Fertilizers

Primary nutrients refer to the three most important elements which are nitrogen, phosphorus and potassium. The three of them are needed by the plants in a comparatively huge amount. In comparison to other nutrients, NPK are the most common and utilized in plant growth development. Fertilizers normally labelled with three prevalence which gives the whole proportion by weight of each nitrogen, phosphorus and potassium. However, phosphorus is indicated by the citrate soluble phosphorus (P_2O_5) and potassium represented by water soluble potassium (K_2O). The ratio of the fertilizer pointed the rate of nitrogen, P_2O_5 and K_2O comprised within the fertilizer. The soil nutrient intensity that has been tested influenced the ratio of fertilizer that is needed for the plants. These major nutrients play an important role in vegetative and reproductive phase of crop growth. Nitrogen acts as the component of protoplasm, protein, nucleic acid, chlorophyll. Phosphorus plays as a key role in energy transfer in the metabolic processes. This is due to its constituent of nucleoproteins and have a high energy transfer compounds such as ATP whilst potassium is involved in carbohydrate metabolism, protein synthesis, regulation of activities of various essential elements and activation of various enzymes (Kaushlendra,2015). Providing an adequate supply of potassium is important for plant production and is essential to maintain high quality and profitable yields (Alberto,2015). There are two reasons that have amassed a great significance in vegetable production which are the use of organic and inorganic fertilizers in recent years. According to Khan et al, 2010 the reasons why these fertilizers used, first is to increase the production of sustainable products therefore enhancement yield of vegetables per hectare that require increased amount of nutrients. Other than that, according to them, many researches that have been experimented on organic and chemical fertilizers resulted that the inorganic fertilizers itself cannot sustain productivity of soils for heavy cropping system. Omogoye, 2015 reported that NPK fertilizer gave longer plant height, higher fruit yield per plant (kg) and fruit yield (t/ha) of pepper as compared with cow manure. However, an observation from Adeola et al. (2007) stated that shortest number of days were recorded for the plants that were treated with NPK fertilizer to achieve 50% flowering in comparison with plants that were treated with poultry manure and control treatments. Besides, they also observe that NPK fertilizer treatment gave higher number of fruits per plant compared to poultry manure and control treatments on cassava and pepper intercropping plants. In the absence of resistant cultivars, chemical control also offers the only viable solution for disease management (Gopinath et al,2006).

2.1.2 Macronutrients

Micronutrients are referred to as the remaining essential elements that is also required by plants in comparatively small amounts. The micronutrients included Boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn). The quantity of nutrients that is needed for the plants then be referred as micronutrients. However, that does not mean that the quantity of micronutrients needed by the plants is in a tiny amount until people always forget about it. Any of plants that are lacking in micronutrients application or is not adequately applied balance with different nutrients might backward the plant growth and development. Different plants absorb differently the micronutrients according to the nutrients mobility and functions in the plants. generally, Boron is important in transporting sugar, division of cell and also production of acid in the plants. Otherwise, chlorine used in turgor regulation, resisting the diseases and reactions for the photosynthesis. Other than chlorine, copper also functioning in photosynthesis and iron also is a component of enzymes that also involved in photosynthesis.nitrogen metabolism of plants involved the molybdenum and the nutrient also essential in fixation of nitrogen in legumes. Next, manganese which is a chloropalast production, the cofactors of many plant reactions and the enzyme activation. Zinc is a component of many enzymes that is important for balancing the plant hormone and activity of the auxin. On the other hand, the chemical and physical properties of the soil might affect the micronutrients uptake and availability. Lower micronutrients can be found in soils with low organic matter hence more micronutrients can be found in the soils with higher organic matter. The important factors that need to be considered is mainly the soil temperature and moisture.

2.2 Effect of different fertilizer application

Proper fertilization management and practices are essential to enhance soil productivity and attribution. For developing countries, decreasing in global food production has been caused by the inadequate and imbalanced supply of chemical fertilizer that impaired soil fertility (Ismail,2005). Lately, the surrounding factors related to soil aggravation and production preservation, appealing on soil quality under other farming structure (Wenyi et. al, 2012). Soil nutrients are the good indicators of soil quality and soil productivity to prove the plants a good condition to produce their best when they are provided with adequate soil nutrients needed. It has been recognized that soil available nutrients including nitrogen (N), phosphorus (P) and potassium (K), coming from available components of fertilizers. They can be directly absorbed by plants and contributing greatly to the soil fertility. Other agronomic practices can serve straight discover changes in soil productivity and quality (Sajid et. al,2017). There are still a few argumentations on the consequences of different fertilization intervention among researchers. The most appropriate time and manner of applications of NPK and any other nutrients fertilization are determined according to plant requirement and element dynamics in soil. Some scientists presented that the use of fertilizers was required however other reviews have shown that the repeated fertilization may result in the decline of soil productivity. However, fertilizer plays a catalytic part in protein synthesis, chlorophyll formation, carbon assimilation and acceleration of enzymatic actions (Hedge, 2001). Generally, adequate N fertilisation increases fruit yield through more vegetative growth, more reproductive development and increased seed sites per unit area. Although inadequate rates of N application often restrict the fruit yields (Grant and Bailey 1993), excessive rates of N fertilisation can also reduce yields (Cheema et al. 2001; Laaniste et al. 2004) by promoting lodging (Ma and Herath, 2016). Excessive or poorly timed fertilization of residential landscapes can result in water quality degradation as nutrients, particularly nitrogen (N) and phosphorus (P), are lost in leachate or runoff (Amy et al,2017). As such, improving the fertilizer management practices (e.g., application rates, the timing of application, and method of application) of consumers and the commercial green industry is an important step in reducing nonpoint nutrient losses from urban landscapes. Previous research on fertilization of woody ornamentals in the landscape has focused on root growth (Struve, 2002), shoot growth (Gilman et al., 2000; Struve, 2002), and/or aesthetic plant response (Shober et al., 2013, 2014) to fertilizer applications. Yet, few studies have looked at the environmental impacts when applying fertilizers at rates recommended optimizing shoot growth and aesthetics (Rose, 1999; Shober et al., 2010). Among the studies that evaluate the potential for nutrient losses when fertilizing woody ornamentals, Qin et al. (2013) noted that nutrient losses from urban landscapes (containing turfgrass and ornamentals) were reduced when established woody ornamentals were included in fertilized Florida landscapes.

2.3 Fertilizer Responses on Pepper

In order to get high production of sweet pepper, there's the requirement to enhance the nutrient conditions of the soil to satisfy the crop requirement and maintain the fertility (Hussein, 2017). The response of pepper to fertilizer especially the macronutrients of N, P and K fertilizer study with and without the supplementary addition of other micronutrients can be observed under field condition (Osumah and Tijani, 2010). The primary nutrient is mentioned to be completed because they contain a total of nitrogen, phosphorus and potassium. Fundamentally, when there are one or more major elements lost from the fertilizer, it is said to be incomplete. For growing crops, the significant symptomatic implement to calculate the nutrient supply is by soil analysis and fertility throughout the growing up of the crops (Manbir, David and Amitava, 2015). To sustain the yield of the plants in terms of reaction toward fertilizers, soil fertility grade need to be preserved to meet with plants demand and in a proper frequency and timing. However, the application of these macronutrient chemicals when applied more in the field can affect the crop growth, build up in the soil causing day term imbalance in the soil pH and fertility (Anjali et al,2017). These conditions may affect the nutrients in the soil and the friendly microorganisms. The usage of chemical fertilizer capable to lessen the protein content of the crops other than reduces the crop's carbohydrate quality (Marzouk and Kassem, 2011). Chemically over fertilized vegetable and fruit are also prone to attacks by insects and disease (Karunji et al. 2006). The fact that manures generally contain low quantities of plant nutrients and because they are applied during land preparation, most of the soluble nutrients are used early in the season and the crop may likely suffer nutrient deficiency later in the season (Aliyu,2000). This might lead to the low yield from mixtures without supplementary mineral fertilizer such as NPK fertilizer and Brexil Combi that supply micronutrients to the crops. As the K fertilizer increase, the plant height are also increasing. Similar results could be observed for plant weight (Siti et al,1995).

2.4 Effect of chemical fertilizer and drought on growth and yield of pepper

In agricultural areas, nutrients area unit off from the soil by crop uptake, natural process and erosion (Ghosh et al., 2011). Effects of pepper crop residues as an amendment and their optimal application rates on an agricultural soil are important to be studied in order to produce the efficient amount of chillies. Chemical fertilizer and organic fertilizer has been broadly practised along with the advancement of agricultural production. Fertilization commonly put as a general practice to maintain soil productivity and crop production (Wenyi et al., 2012). Adequate supply nourishment of nutrients for pepper is crucial to obtain production reward in comparison to other implementation. Potassium plays a crucial role in water uptake and helps in maintenance of yields in an adverse atmospheric condition like drought. For peppers that is a world-known crop that is planted in arid and semi-arid condition, drought inflexion might be the biggest limiting element for crop production. These environmental stresses contribute considerably to reducing crop yields well below the potential most yields (Ismail,2005). Intense drought inflexion during vegetative development and flowering period encouraged to knock off the production rate of the crops. Therefore, fertilizers play a vital role in improving crop yields in this matter but the major challenge is to ensure an adequate balance between different nutrients to support optimal yield. As a result of soil degradation, chemical fertilizers have become an essential input for crop productivity in most areas of the world. Of the mineral nutrients, K plays a selected role in causative to the survival of crop plants below environmental stress conditions. In the Mediterranean region, irrigated vegetable crop production has undergone an enormous expansion over the last decades. In greenhouses, pepper is mainly grown as monocrop. Pepper crop residues (leaves, roots, stems and fruits) should be removed to facilitate the continuity of crop production (Jennifer et al, 2017).

2.5 Foliar Feeding

The development of foliar absorption has been delineated as foliar feeding. The foliar feeding is additionally called nutrient absorption by above-ground plant components, additional radical feeding and non-root feeding. Foliar fertilization has advantages of low application rates, uniform distribution of chemical materials and fast response to applied nutrients. The benefits of foliar fertilizers were obvious underneath growing conditions proscribing the absorption of nutrients from the soil, as reported by Hamdi (1979) and Verma et al, (2000). Moreover, foliar fertilization technique may be an best replacement to the traditional soil application to avoid the loss of fertilizers by natural process and thereby minimizing the ground water pollution (Paparazzi & Tukey, 1979). Foliar nutrition is suggested by many investigators as a possible fertilization methodology to enhance the growth development and flowering of anemone (Chaturvedi et al,1986), and carnation (Sharaf & El Nagar, 2003). Similar findings were additionally outlined by Mazrou (1991) on chrysanthemum, Eraki et al. (1993) on rose plants. Al-Humaid (2001) on Polianthes tuberosa, Pal & Biswas (2005) and Mahgoub et al. (2006) on iris plants. However, foliar applied chemical salts have the disadvantages of generating leaf burning and necrosis once applied in concentration higher than a given level (Marscner, 1995). It absolutely was labour intensive and also the success rate depends on many environmental factors. Thus, its advantages heavily outweigh the benefits under acknowledge conditions; foliar fertilization with K has been found to be way superior for cotton in arid or semi-arid conditions of Egypt (Eid et al., 1997) and the United States (Oosterhuis,1997). The result of K spray was considerably effective in monsoon season compared to within the winter season, because the higher temperature, wetness and higher growth condition throughout monsoon season favoured response to foliar K application (El-Fouly & El-Sayed, 1997). An analysis on the result of soil and foliar applied fertilizers on strawberry physiological condition, yield and berry quality has been done before. It was reported that the firmness of the beery was not boosted by foliar calcium fertilization. Whereas nitrate broadcasted to the soil had softened the berries by 0.9 N cm^{-2} as compared with the control (no fertilizer). However, foliar applied calcium nitrate and ecological chemical spray expand berry plant sucrose content. The further parameters like total sugars, soluble solids, nitrates, ascorbic acid and titratable acid content and natural berry weight loss had not been stricken by chemical treatment (Lanauskas et al., 2006).

CHAPTER 3

MATERIALS AND METHODS

3.1 Site experimental

This study site was carried out at the tunnel garden of the Faculty of Agro Based and Industry, University Malaysia Kelantan Jeli Campus, Jeli, Kelantan, Malaysia. The experiments were conducted in the area of 2 x 2 metre, in the polybags. In these experiments, there were several activities that had been done including the soil and crop establishment, planting activity, operation, treatment application and general maintenances which involved the irrigation application along with pest and diseases control.

The planting material of pepper used in this research was by sexual propagation which was seeds. The other materials and equipment are seedling tray, peat moss, fungicide, plastic polybags, chicken manure, NPK fertilizer and micronutrients (Brexil Combi) with the ratio of (20:20:20 + TE)

The experiment was conducted in University Malaysia of Kelantan, Jeli Campus at the faculty's tunnel garden during August to November 2018.

Figure 3.1 : Site experimental map

3.2 Soil and Crop Establishments

Capsicum (*Capsicum annuum*) seeds were seeded in a planting tray until the shoots emerged. The germinated seedlings were then transplanted into 6" diameter plastic pots. The media used for the establishment were a mixture of coco peat and topsoil with an addition of some organic fertilizer to help the establishment of the plants.

3.2.1 Medium used for the experiment.

The medium used in the experiment were prepared using a mixture of 50% topsoil obtained from 0-30 cm depth from the surface of the area behind IFSSA building, and 50% coco peat. The coco peat were added to the topsoil to avoid excessive compaction due to the clayey property of the soil. The medium mixture was thoroughly mixed and sieved using 2 mm mesh sieve to get a uniform mixture of coco peat and soil. The soil were then divided into 9 equal parts and filled into 9 polythene bags measuring 15” diameter each.

3.3 Treatments, Experimental Design and Plot Size

Prior to transplanting the capsicum from the plastic pots into the experimental plots, all soil in the experimental plots were tested for NPK content and pH level to determine the amount of nutrients present in the soil prior to the start of the experiment.

The established capsicum annum which were established in the plastic pots were then transplanted into the experimental plots in a random design. The treatment were replicated three times with treatment:

Table 3.1 : Types of treatment and its frequency

Treatments	Days Interval Application
Treatment Frequency 1	Every two weeks or 14 days
Treatment Frequency 2	Every One Week or 7 days
Treatment Frequency 3	Once every 4 days or twice a week

Fertilizers NPK+TE (20-20-20+TE) were then applied at the rate of 2g/l one week after transplanting to allow for the transplanted plants to stabilized before treatments were started.

Throughout the experiment, the plants were irrigated through surface irrigation on a daily basis.

3.4 Measurements and Data Collection

The treatment continued for three months in which observation of the growth performance and measurement of the plant height were carried out weekly.

The plant of Capsicum were measured throughout the experiment starting from the week of the plants being transplanted into the polybags. Matured fruits were harvested by hand picking, and nine plants were tagged per plot. The determination of plant height, number of fruits per plant, fruit length and the average of the fruit weight measured using the methods described in Table 3.2.

Table 3.2: Parameter from experiment of different frequency of fertilizer application on *Capsicum annuum* plants.

Parameters	**Methods**
Plant height (cm)	From the soil collar until the tip of plants using measuring tape.
Number of fruits	Determined the fruits harvested from the plants
Weight of fruits (g)	Weight the harvested fruits using electronic weighing balance.
Length of fruits (cm)	Measure end to end of the harvested fruits using measuring tape.

3.5 Statistical Analysis

Seedlings of each treatment will be carried out with three replications which will be arranged in a completely randomized design. All the data were analysed using the most suitable statistical analysis for this study which is from the IBM SPSS Statistics 21. A test known as Tukey Test was conducted from the descriptive and Two-way analysis of variance (ANOVA) as a multiple comparison for observed means for all the parameters to analyse the effects of two different factors (treatments and weeks) toward the growth performance and yield production of *Capsicum annuum*.

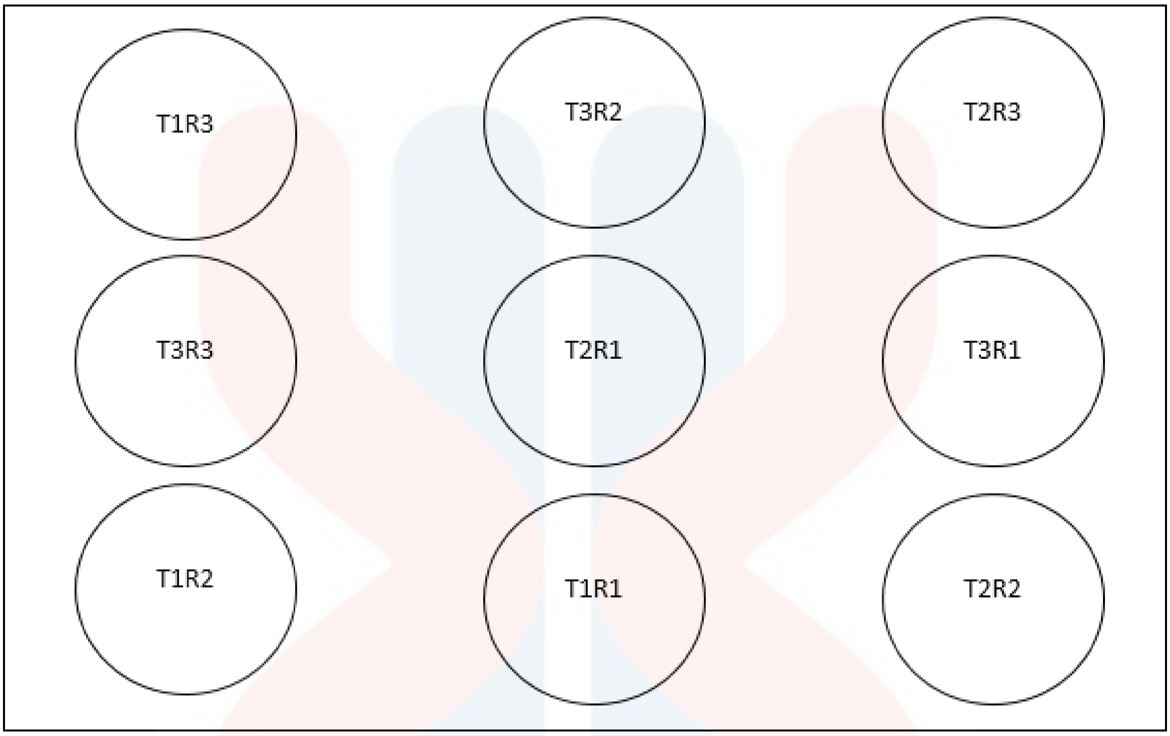


Figure 3.2: Experimental plot setup using completely randomized design (CRD)

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Growth Performance of *Capsicum annuum* Plants (Height).

The objective of this study is to determine the height performance of *Capsicum annuum* plants from three different treatments of frequency of fertilizer application and to compare their growth performance among the three different treatments. The indication for the parameter has been collected for 13 weeks started from the week zero of transplanting the *Capsicum annuum* plants into polybags.

Figure 4.1 showed the graph of plants height of three different treatment which is 4 DI application, 7 DI application and 14 DI application. from the graph, it can see that the height of plants increase over weeks.

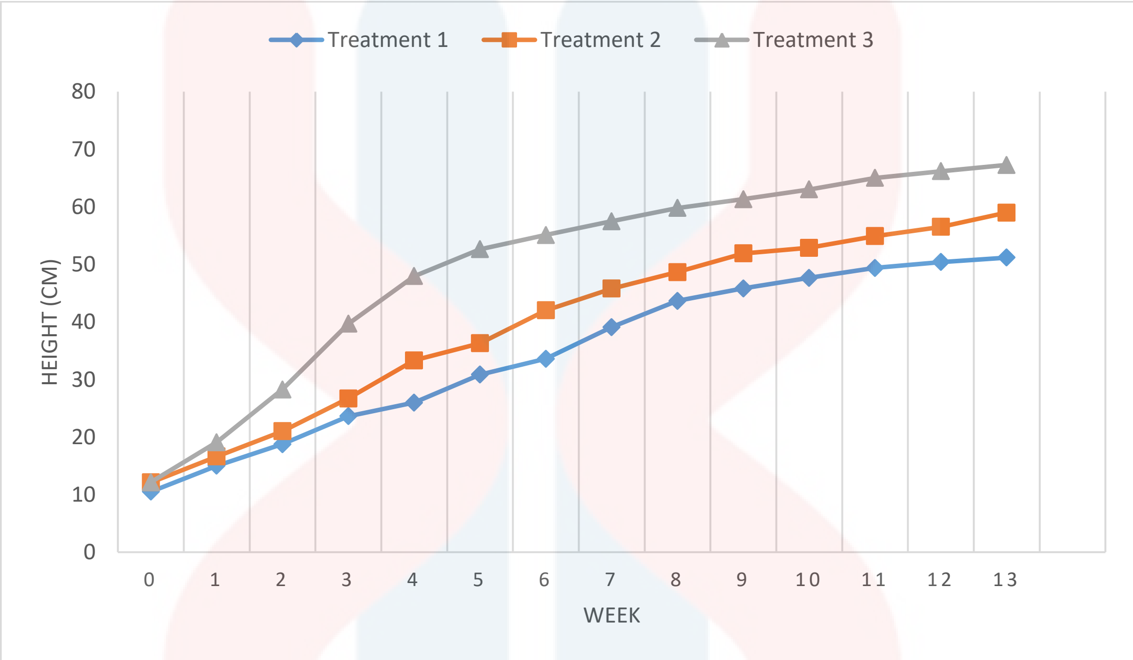


Figure 4.1.1: Average height of *Capsicum annuum* from different treatments throughout the weeks

Growth performance of plants is influenced by the amount of nutrients available for its growth. When nutrients are applied in adequate quantity at the right timing and frequency, there is little interruption in their uptake hence their growth performance are at the optimum if all other conditions are favourable.

Results of the plant heights measurement from the three frequency treatments are shown in Figure 4.1.1 as shown in the figure, capsicum annum fertilized with the 4 day intervals shows significantly higher growth rate than the 7days and 14 days interval respectively. Observation throughout the experiment showed that the increase in plant height corresponded with the frequency of application where the 4days intervals resulted in higher growth rate compared with the 7days and 14 days intervals. This is due to the uninterrupted supply of nutrients in the 4 days intervals whereas the 7 days and 14days intervals, there is a period in of diminished supply of nutrients resulting in the temporary stoppage or slow growth. In the case of diminished supply of nutrients especially nitrogen, a yellowing of the older leaves results as the plants relocated nitrogen from older tissue to younger tissue (Anonymous,2012) as it was observed in the 14days intervals treatment.

Observation of the flowering stages of the plants on all three frequency treatment during the 13 weeks period showed that the plant fertilized at shorter frequency of 4 days intervals started flowering at sixth week whereas the plant with 7 days intervals and 14 days intervals started flowering at seventh and ninth week respectively.

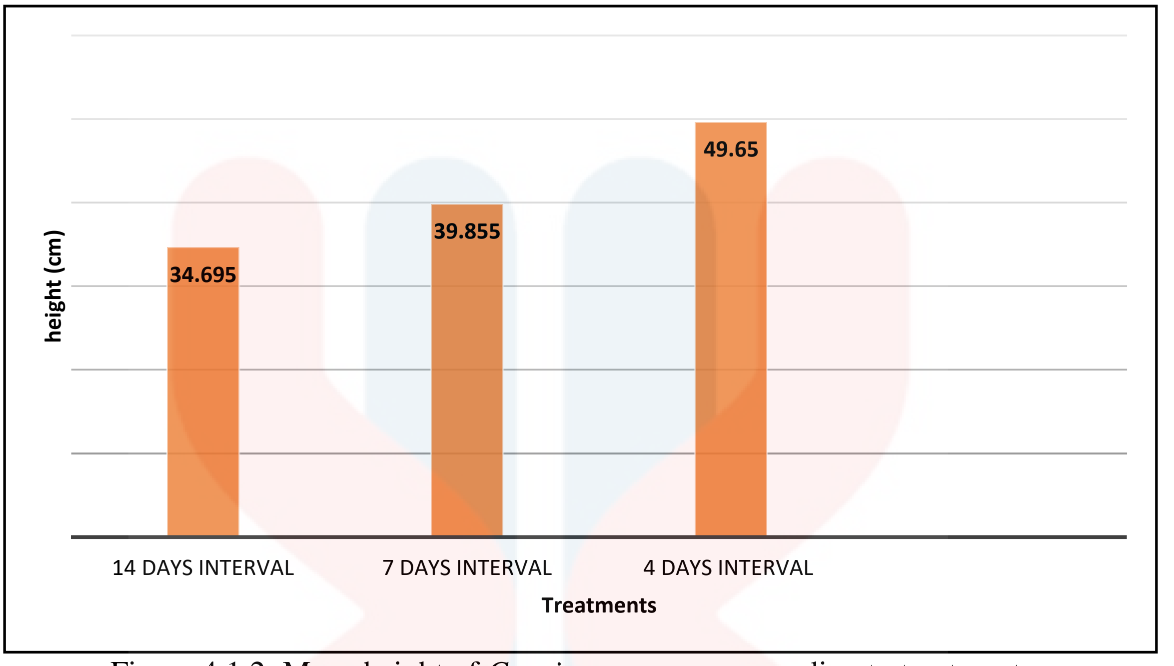


Figure 4.1.2: Mean height of *Capsicum annuum* according to treatments.

Different frequency interval of application of fertilizer towards crops influenced significantly the plant height of *Capsicum annuum*. According to the analysis that has been made, the mean average for height of the plants applied with frequency of 14 DI application is (34.695 cm) giving the plants the shortest compared to another two treatments. Second treatment of application with 7 DI give the plants a mean height of (39.855 cm) and treatment of application with 4 DI give the plants a mean height of (49.650 cm) which is the tallest among the three application. Treatment 1 has slower rate of growth development because the amount of fertilizer with the rate of 2 g/l has been given to the plants at the intervals of 14 days where the utilization of the fertilizer is interrupted and leaching of fertilizer from the soil also occurred. Overuse of fertilizers at inappropriate frequency causes a nutrient lock-out in the soil (Anonymous,2012). On the other hand, the Capsicum plants with treatment 3 has a significant growth development because the plants can utilize the 2 g/l rate of fertilizer within the application of frequency of 4 DI continuously without any interruption.

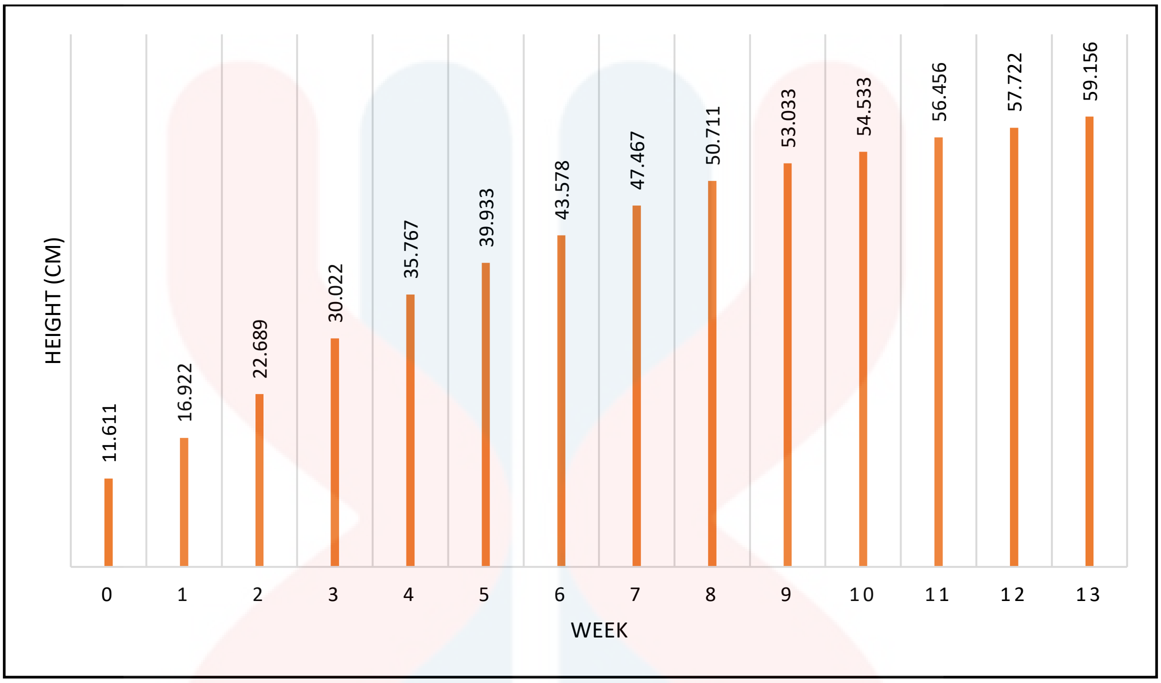


Figure 4.1.3 : Mean of height of *Capsicum annuum* according to weeks.

The plant's height of the Capsicum significantly increased throughout the weeks. There is a notable increased from the early weeks of the growth development stage, this is because the plants utilized adequate amount of nitrogen for growth development and photosynthesis. On the other hand, phosphorus helped the crops root system and sufficient of phosphorus applied to the plants avoid the plants from being stunted in their growth development. Plants with sufficient supply of phosphorus mature much quicker than plants with insufficient phosphorus. This is why plants with treatment of 4 DI matured early compared to plants with application of 7 DI and 14 DI.

Table 4.1 : Multiple comparisons between the height performance of different treatments

Dependent Variable: Height
Tukey HSD

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Treatment 1	Treatment 2	-5.160*	.7843	.000	-7.023	-3.296
	Treatment 3	-14.955*	.7843	.000	-16.818	-13.091
Treatment 2	Treatment 1	5.160*	.7843	.000	3.296	7.023
	Treatment 3	-9.795*	.7843	.000	-11.659	-7.932
Treatment 3	Treatment 1	14.955*	.7843	.000	13.091	16.818
	Treatment 2	9.795*	.7843	.000	7.932	11.659

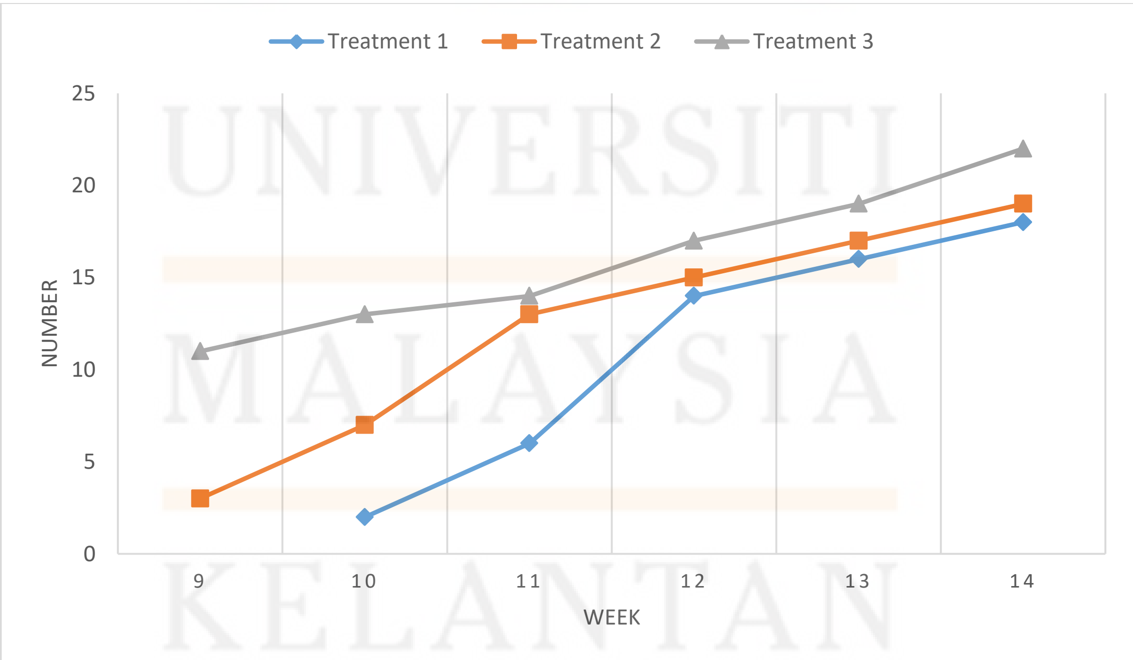
Based on observed means.
The error term is Mean Square(Error) = 12.918.

The result from the table above shows that the three treatments gave a significant growth development using Tukey Test for the Capsicum plants. It is said to be significant where the value ($P<0.05$). The mean difference between the first treatment and second treatment (-5.160) is not as great as the mean difference between second treatment and third treatment (-9.795) make it the total of (-14.955) mean difference between the third treatment and the first treatment. This proves that the nutrient uptake for the third treatment is helping their growth performance of the plants while there might be nutrient loss for the second and first treatment so that the growth performance of the Capsicum plants of these treatment is quite stunted compared to third treatment. According to Gizachew, 2018 all plant growth variables were lower in the control plots and increased with increasing rates of application of NPK and manure. This proves that the increase frequency of fertilizer application towards Capsicum plants help the plants to grow significantly.

4.2 Parameters from yielding fruits of *Capsicum annuum*.

4.2.1 Comparison of Yields Between Treatments.

Figure 4.2.1 shows the comparisons of yields of capsicum annuum between three fertilizer frequency treatments. As shown in the figure, the shorter frequency of 4day intervals of fertilizer application yielded much higher number of fruits with 16 fruits per plants compared to the 7days and 14days intervals with fruits numbering at 12 fruits and 9 fruits per plant respectively. The maturity of the fruits and readiness for harvest also showed that the shorter frequency yielded early maturity and ready for harvest at 8th weeks compared to the 7days intervals and 14th day intervals where the fruits matured and ready for harvest only at the 9th weeks.



As
Figure 4.2.1 : Number of fruits yield from Capsicum plants

Table 4.2.1: Tukey Test for number of fruits yielding according to treatment

Tukey HSD[a,b]

Treatments	N	Subset	
		1	2
Treatment 1: 14 day intervals	6	9.33	
Treatment 2: 7days intervals	6	12.33	
Treatment 3: 4 days intervals	6		16.00
Sig.		.089	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 4.756.

a. Uses Harmonic Mean Sample Size = 6.000.
b. Alpha = 0.05.

From the above table, there is a significant effect of frequency of fertilizer application treatment on the number of fruits produced from the first week of fruiting. This results could have been due to the interruption of nutrients supply especially on the longer frequency. As indicated by Bray et al., 2000, stress factor such as inadequate mineral nutrient supply or incorrect frequency of fertilizer application can lead to relatively decreasing in the potential maximum production of fruits or crop yields. Relative decreases in potential maximum crop yields is also associated with abiotic stress factors such as drought, salinity, high or low temperature, excess light, inadequate mineral nutrient supply and soil acidity.

Table 4.2.2: Tukey test for number of fruits yielding according to weeks

Tukey HSD[a,b]

Weeks	N	Subset			
		1	2	3	4
Week 9	3	4.67			
Week 10	3	7.33	7.33		
Week 11	3		11.00	11.00	
Week 12	3			15.33	15.33
Week 13	3				17.33
Week 14	3				19.67
Sig.		.673	.376	.231	.231

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 4.756.
a. Uses Harmonic Mean Sample Size = 3.000.
b. Alpha = 0.05.

From the experiment, the plants of Capsicum has started to fruiting on the ninth week after transplanting of the plants into polybags. Plants with treatment 2 and treatment 3 had started to fruits early compared to plants with treatment 1. In this cases, the plants with lowest yield had an inadequate supply of mineral fertilizer due to non-continuous fertilizer supplement. Table 4.2.2 shows that there is a significant effect for the number of fruits produced from the Capsicum plants started from the first week of fruiting.

4.2.2 Comparison of Length/Size and Weight of Fruits between Frequency Treatments

Table 4.2.3: Tukey test for length of fruits harvested according to treatment

Length

Tukey HSD[a,b,c]

Treatments	N	Subset		
		1	2	3
Treatment 1	56	9.576		
Treatment 2	74		10.530	
Treatment 3	96			11.612
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 1.262.

a. Uses Harmonic Mean Sample Size = 71.792.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = 0.05.

Table 4.2.3 shows the comparison of the length/size of fruits harvested from the three fertilizer frequency treatment. All fruits harvested from each replicates were averaged and compared between the three different frequency treatments. As shown in the table, there is a significance difference in the length and size of fruits between the three frequency treatments. Treatment 3, which is the 4 days intervals of fertilizer application yielded a longer or larger average fruits length measuring 11.612 cm, and treatment 2 with 7day intervals frequency yielded 10.530 cm fruit length whereas treatment 3 with 14 day interval frequency yielded and average measurement of only 9.576 cm. According to Mofijul et al, 2018. Nitrogen fertilizer, irrespective of rates and methods of application, significantly increased the length of panicles of yielding wheat compared to the control treatment.

Table 4.2.4: Multiple comparison using Tukey Test from ANOVA for length of fruits harvested.

Dependent Variable: Length
Tukey HSD

(I) Treatments	(J) Treatments	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Treatment 3	Treatment 2	1.082*	.1738	.000	.672	1.492
	Treatment 1	2.036*	.1889	.000	1.591	2.482
Treatment 2	Treatment 3	-1.082*	.1738	.000	-1.492	-.672
	Treatment 1	.954*	.1990	.000	.485	1.424
Treatment 1	Treatment 3	-2.036*	.1889	.000	-2.482	-1.591
	Treatment 2	-.954*	.1990	.000	-1.424	-.485

Based on observed means.
The error term is Mean Square(Error) = 1.262.
*. The mean difference is significant at the 0.05 level.

As with the fruit length, comparison of fruit weight between treatment also showed similar trend. Table 4.2.5 shows the results of the measurement and comparison of the weight of fruits between the three frequency treatments. The mean average of the fresh weight of the Capsicum fruits with shorter frequency of 4 days intervals yielded an average fruit weight of 11.1789g compared to the frequency of 7 days and 14 days intervals in which the average fruit weight weighed at 10.2746g and 9.7780g respectively. As indicated in the study by El-Tohamy, 2006, increase of fertilizer rate and frequency of application not only can significantly increase the number of fruits per plant but also can increase the fresh weight of pepper plants fruits.

Table 4.2.5: Tukey test for the weight of fruits according to different treatments.

Weight

Tukey HSD[a,b,c]

Treatments	N	Subset	
		1	2
Treatment 1	56	9.7780	
Treatment 2	74	10.2746	
Treatment 3	96		11.1789
Sig.		.060	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 1.690.

a. Uses Harmonic Mean Sample Size = 71.792.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = 0.05.

The ANOVA result shows that there is a significant difference between weight of fruits yielded from treatment with frequency of 4 DI with the treatment of frequency of 7 DI and 14 DI. Treatment 3 gave a relatively high weight of Capsicum fruits compared to other treatment. The mean average of the fresh weight of the Capsicum fruits produce from treatment 1 is 11.1789 g followed by the mean average of fruits for treatment 2 at 10.2746 g and treatment 1 with average weight of 9.7780 g. According to

Gomaa et al., 2017 experimented conducted showed that the foliar application of mineral fertilization increased the components of yielding maize such as weight.

Table 4.2.6: Multiple comparison using Tukey test from ANOVA for weight of fruits harvested.

Dependent Variable: Weight
Tukey HSD

(I) Treatments	(J) Treatments	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Treatment 3	Treatment 2	.9043*	.20110	.000	.4297	1.3788
	Treatment 1	1.4008*	.21859	.000	.8850	1.9166
Treatment 2	Treatment 3	-.9043*	.20110	.000	-1.3788	-.4297
	Treatment 1	.4966	.23025	.081	-.0468	1.0399
Treatment 1	Treatment 3	-1.4008*	.21859	.000	-1.9166	-.8850
	Treatment 2	-.4966	.23025	.081	-1.0399	.0468

Based on observed means.
The error term is Mean Square(Error) = 1.690.
*. The mean difference is significant at the 0.05 level.

4.3 External Factor

Although the results of the experiment confirmed that of the hypothesis, it cannot be taken at face value as there are numerous other factors that might have influence the results. These factors include the weather conditions during the experiment period. Firstly, weather in Jeli, Kelantan during the first week of after the start of the experiment until the sixth weeks of the experiment, the weather was hot and humid which could have influence the growth rate of the Capsicum plants. Towards the middle of the experiment at about the seventh week, the weather turned to rainy and humid which could have disrupted or washed away the fertilizer applied through foliar application. As the plants were planted in polyethylene bags, excessive rain also affected the root development of the plant. Ruth. (2005) indicated that extremely hot temperature and excessive rain or watering can affect the Capsicum plants, causing damping off, wilting and a poor harvest.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The findings of the study confirmed previous findings by numerous other studies that appropriate or right frequency of fertilizer application with complete essential nutrients is an important crop management in order to maximize yield of crop. The results showed the best growth performance of Capsicum plants were under treatment of 4 DI of fertilizer (NPK + TE) application with the rate of 2g/l. From this study, it can be concluded that the most frequent application of fertilizer (4 DI) gave the highest value for the height of plants and number of fruits yielding from the plants. In addition, correct frequencies of fertilizer application also enhance the quality of yield as well as prevent crops from stress due to nutrients deficits when frequency intervals are prolonged.

5.2 Recommendations

Although the result confirmed the findings of previous studies that frequency of fertilizer application is an important factor in crop management for maximum yield, however, the experiment was conducted only in a short period and limited by the number of parameters investigated. Also, the experiment was conducted in a control environment utilizing polyethylene bags. Therefore in order to have a thorough comparison of the parameters investigated, further study need to be conducted in a field environment with longer observation period under field growing condition and more replication of treatment with more parameters to be observed. Further, the measurement of parameter should also utilize proper equipment such as tensiometer, weather station and proper soil test.

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APPENDICES

Appendix A : The Tukey Test for the height of the Capsicum plants from different treatments

Height

Tukey HSD[a,b]

Treatment	N	Subset		
		1	2	3
Treatment 1	42	34.695		
Treatment 2	42		39.855	
Treatment 3	42			49.650
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 12.918.

a. Uses Harmonic Mean Sample Size = 42.000.
b. Alpha = 0.05.

Appendix B : The Tukey test for the height of the Capsicum plants according to weeks

Height

Tukey HSD[a,b]

Week	N	Subset									
		1	2	3	4	5	6	7	8	9	10
Week 0	9	11.611									
Week 1	9	16.922	16.922								
Week 2	9		22.689								
Week 3	9			30.022							
Week 4	9			35.767	35.767						
Week 5	9				39.933	39.933					
Week 6	9					43.578	43.578				
Week 7	9						47.467	47.467			
Week 8	9							50.711	50.711		
Week 9	9							53.033	53.033	53.033	
Week 10	9								54.533	54.533	54.533
Week 11	9								56.456	56.456	56.456
Week 12	9									57.722	57.722
Week 13	9										59.156
Sig.		.111	.054	.056	.446	.665	.562	.075	.056	.257	.278

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 12.918.
a. Uses Harmonic Mean Sample Size = 9.000.
b. Alpha = 0.05.

Appendix C: Multiple comparisons using Tukey test from ANOVA on the number of fruits yield towards different frequency treatment

Multiple Comparisons

Dependent Variable: Number_of_fruits
Tukey HSD

(I) Treatments	(J) Treatments	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Treatment 1	Treatment 2	3.67*	1.259	.038	.22	7.12
	Treatment 3	6.67*	1.259	.001	3.22	10.12
Treatment 2	Treatment 1	-3.67*	1.259	.038	-7.12	-.22
	Treatment 3	3.00	1.259	.089	-.45	6.45
Treatment 3	Treatment 1	-6.67*	1.259	.001	-10.12	-3.22
	Treatment 2	-3.00	1.259	.089	-6.45	.45

Based on observed means.
The error term is Mean Square(Error) = 4.756.
*. The mean difference is significant at the 0.05 level.

Appendix D: The Tests of between-subjects effects from the number of fruits for this experiment.

Tests of Between-Subjects Effects

Dependent Variable: Number_of_fruits

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	652.889[a]	7	93.270	19.613	.000
Intercept	2837.556	1	2837.556	596.682	.000
Treatments	133.778	2	66.889	14.065	.001
Weeks	519.111	5	103.822	21.832	.000
Error	47.556	10	4.756		
Total	3538.000	18			
Corrected Total	700.444	17			

a. R Squared = .932 (Adjusted R Squared = .885)

Appendix E: The tests of between-subjects effects from the length of fruits yielded throughout the experiment

Tests of Between-Subjects Effects

Dependent Variable: Length

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	167.613[a]	7	23.945	18.973	.000
Intercept	17928.111	1	17928.111	14205.990	.000
Weeks	15.455	5	3.091	2.449	.035
Treatments	133.194	2	66.597	52.770	.000
Error	275.118	218	1.262		
Total	26574.693	226			
Corrected Total	442.731	225			

a. R Squared = .379 (Adjusted R Squared = .359)

Appendix F: The tests of between-subjects effects from the weight of fruits harvested from the Capsicum plants

Tests of Between-Subjects Effects

Dependent Variable: Weight

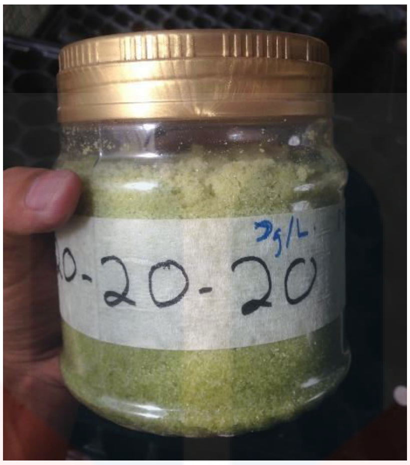
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	114.692[a]	7	16.385	9.696	.000
Intercept	16687.326	1	16687.326	9874.714	.000
Weeks	37.790	5	7.558	4.472	.001
Treatments	87.048	2	43.524	25.755	.000
Error	368.399	218	1.690		
Total	25569.139	226			
Corrected Total	483.091	225			

a. R Squared = .237 (Adjusted R Squared = .213)

Appendix G: The seeds of the Capsicum annuum L. sown in the planting tray.

Appendix H: The germinated plants established with the mixture of cocopeat and topsoil with an addition of some organic fertilizer before transplanted into polybags

Appendix I: The transplanted Capsicum plants in the polybags and was put into completely randomized design (CRD)



Appendix J: The NPK fertilizer that is being used in the experiment with the ratio of 20:20:20 and rate of 2 g/l according to the treatments.

Appendix K: The fruits of Capsicum that is yielded from the Capsicum plants before weighed using the electronic weighing balance.

Appendix L: One of the plants from treatment 1 that undergo yellow leaf curly virus disease with a yellow leaf symptoms and also stunted growth that is brought by the white flies.