The Effect of Organic Fish Fertilizer with Tea Ground on Maize Plant (*Zea mays*) Growth Performance

By

Fatin Farhana Binti Ruslan

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

Bachelor of Applied Science (Animal Husbandry Science) with Honours

Faculty of Agro Based Industry

UNIVERSITI MALAYSIA KELANTAN

2018

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: Fatin Farhana bt Ruslan

Date:

I certify that the report of this final year project entitled "**The Effect of Organic Fish Fertilizer with Tea Ground on Maize Plant (*Zea mays*) Growth Performance**" by **Fatin Farhana bt Ruslan**, matric number **F14A0068** has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Animal Husbandry Science) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

Approved by:

_____

Supervisor

Name: Miss Hazreen Nita bt Mohd Khalid

Date:

ACKNOWLEDGEMENT

First and foremost, I would like to express my highest gratitude to the Almighty for His guidance and blessings, upon the completion of the dissertation. Also, I wish to express my sincere thanks to my supervisor, Miss Hazreen Nita Mohd Khalid for her time, guidance, patience, advices, suggestions and supervision throughout this study.

I would like to thank to all Agro-Techno park staff whose gave their cooperation, assisted and provided a facility during my study at Agro-Techno park. Especially, Mr Mohamad Saarani , Miss Lili Amira and Mr Kamarulzaman whose helped found out the planting plot and advised regarding maize plants.

Highest appreciation to my family who encourage and give full support in doing this study especially my parents Mr. Ruslan b Abdul Rahim and Mrs. Rozila bt Mat Isa who give a permission to do this research. Also, thanks to all my friends for their moral support, comments, opinion, and encouragement in completing this thesis.

The Effect of Organic Fish Fertilizer with Tea Ground on Maize Plant (*Zea mays*) Growth Performance

ABSTRACT

In agriculture sectors, fertilizer is a vital element that determined the sustainability of crop production. Recently, there are various type of chemical and organic fertilizers in global market. However, some of these fertilizers are very expensive and become a burden to small-scale farmers. Waste products such as fish trash and tea ground are known as valuable wastes that can be transformed into useful product such as fertilizer. Therefore, this study was conducted to determine the effect of organic fish fertilizer with tea ground towards maize plant growth performance. Organic fish fertilizer was produced by aerobic fermentation of fish wastes with tea ground within 45 days. Approximately 30 maize plants were divided into two groups, each with three replicates, which represented as control that used commercial fertilizer, and as treatment that used organic fish fertilizer. Fertilizers were applied using spraying method under the leaf in four days of interval throughout the 2 months of cultivation period. Parameters of plants growth performance were observed and recorded twice a week based on responses of plant towards respective fertilizers such as plant height, width and length of leaf and number of leaf. Undeniably, maize plant that applied with commercial fertilizer showed better results compared to organic fish fertilizers plants as it contained high nutrients level. However, statistically the height of maize plant treated with commercial fertilizer showed no significant different between both groups ($P>0.05$), where at the end of planting period, control plants had reached average height of 51.43 ± 4.76 cm while plants applied with organic fish fertilizer managed to reach average height of 41.55 ± 2.30 cm. As a conclusion, organic fish fertilizer was able to promote plant growth even though with slower growth. Further improvement could be done by adding other high nutrient value of by-products in order to increase the efficiency of organic fish fertilizer.

Keywords: organic fish fertilizer, tea ground, maize plant, waste product, plant growth performance

Kesan Baja Ikan Organik dengan Hampas Teh pada Pertumbuhan Pokok Jagung (*Zea mays*)

ABSTRAK

Dalam sektor pertanian, baja merupakan unsur penting yang menentukan kelestarian pengeluaran tanaman. Baru-baru ini, terdapat pelbagai jenis baja kimia dan organik di pasaran global. Walau bagaimanapun, harga baja-baja ini sangat mahal dan menjadi satu bebanan kepada petani berskala kecil. Sisa buangan seperti sisa ikan dan hampas teh dikenali sebagai sisa buangan berharga yang boleh ditukarkan menjadi produk yang bermanfaat seperti baja. Oleh itu, kajian ini dijalankan untuk menentukan kesan baja ikan organik bersama-sama hampas teh terhadap prestasi pertumbuhan pokok jagung. Baja ikan organik telah dihasilkan melalui penapaian aerobik menggunakan sisa ikan dan hampas teh selama 45 hari. Kira-kira 30 pokok jagung telah dibahagikan kepada dua kumpulan, masing-masing dengan tiga replikasi, yang mewakili pokok kawalan yang menggunakan baja komersil, dan pokok rawatan yang menggunakan baja ikan organik. Baja telah digunakan melalui kaedah semburan di bahagian bawah daun dalam selang masa empat hari sepanjang dua bulan tempoh penanaman. Parameter bagi prestasi pertumbuhan pokok jagung terhadap dua jenis baja ini telah dicerapkan dan direkodkan dua kali seminggu berdasarkan ketinggian pokok, lebar dan panjang daun, dan bilangan helaian daun. Tidak dinafikan, pokok jagung yang disembur dengan baja komersil menunjukkan hasil yang lebih baik berbanding pokok yang disembur dengan baja ikan organik kerana ia mengandungi tahap nutrien yang tinggi. Walau bagaimanapun, secara statistiknya ketinggian pokok jagung yang disembur dengan baja komersil menunjukkan tiada perbezaan yang ketara antara kedua-dua kumpulan ($P > 0.05$), di mana pada akhir tempoh penanaman, pokok kawalan telah mencapai ketinggian purata 51.43 ± 4.76 cm manakala pokok yang disembur dengan baja ikan organik berjaya mencapai ketinggian purata 41.55 ± 2.30 cm. Sebagai kesimpulan, baja ikan organik mampu menggalakkan pertumbuhan pokok walaupun dengan pertumbuhan yang lebih perlahan. Penambahbaikan dapat dilakukan dengan menambah bahan-bahan yang mengandungi nilai nutrien yang tinggi untuk meningkatkan keberkesanan baja ikan organik.

Kata kunci: baja ikan organik, hampas teh, pokok jagung, sisa buangan, prestasi pertumbuhan pokok

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

NPK fertilizer	Nitrogen-Phosphorus-Potassium fertilizer
N	Nitrogen
P	Phosphorus
K	Potassium
H_2O	Water
Na	Sodium
Ca	Calcium
S	Sulphur
Sb	Antimony
Sn	Tin
Ba	Barium
Fe	Iron
Mn	Manganese
Cl	Chlorine
XRF	X-ray Fluorescence spectrometry
^oC	degree Celsius
%	percentage
>	more than
<	less than
X	multiplication

CHAPTER 1

INTRODUCTION

1.1 Background of study

Fish is a source of protein that serves as integral components in pyramid diets. Fish industry has been expanded as the number of fish consumption in the worldwide increased. Fish waste such as head, bone and gut usually are discarded during fish processing which resulted in large quantities of waste or trash despite it contains high nutrient value. Usually, these wastes were not fully utilized and end up on landfill or dumped in the sea. Improper waste management will cause a destruction to the environmental and give an impact to public health such as pollution and outbreak of disease. According to Unnisa (2015), the major cost of waste management ranges from 75% to 80% of a municipal waste budget and 30% cost for landfilling has been recorded. Dumping the waste on the landfill will reduce land space, creating odour, leaching and increased green house effect. However, there are some possible potential that can be made up from this waste to form a new valuable product. In a previous study, stated that fish fertilizer products such as fish hydrolysates, fish emulsion, fish soluble nutrient and fish silage have widely been used in crop productions and produced similar yields as commercial fertilizer. Fish silage contains more valuable nutrients that is good for plant growth and soil microbes (Karim, Lee, & Arshad, 2015).

The previous study stated that, food waste has great potential to be converted into the organic fertilizer since it contains high nutrient contents and affordable. This organic fertilizer is considered as cost-effective fertilizer due to low expenditure was applied to produce this fertilizer. Besides, by producing an organic fertilizer from food waste will reduce environmental damage such as pollution that derived from chemical fertilizer in the farming system (Unnisa, 2015).

Generally, tea ground is by-products of beverages that derived from tea leaves that have been extracted and served as tea drinks. Tea leaf has a useful content of amino acids, proteins, vitamins, tannins and polyphenol that good for human consumption (Wang & Xu, 2013). A study that conducted by Karim et al., (2015) is to determine the effectiveness of fish silage as organic fertilizer on post-harvest quality of Pak Choy (*Brassica rapaL. subsp. chinensis*). As a result, they claimed that liquid fish silage has potential to be used as a fertilizer on crop production as it contained a valuable and nutrient and increased palatability of animal. Another research that conducted by Wang & Xu (2013) on utilization of tea grounds as feedstuff for ruminant stated that tea is one of the alternative that can be used for ruminant feed production as its serve as a protein source to the animal. However, there is no study has been conducted to determine the effect of organic fertilizer with tea ground on growth performance of maize plant.

1.2 Problem Statement

The increasing of food waste generation is the major problems that leads to poor waste management and environmental pollution. Poor waste management continues to be a major problem that affects the human-being and environment around the world (Unnisa, 2015). Thus, it is crucial to overcome this problem before it becomes worst. Next, the use of inorganic fertilizer has been observed to cause the destruction of soil texture and structure, which often leads to soil erosion and acidity as a result of the leaching effect of nutrients. All these give rise to reduced crop yields as a result of soil degradation and nutrient imbalance (Omidire, Bean, & Bean, 2015). Furthermore, there are no scientific study on the effect of organic fish fertilizer with tea ground towards maize plant growth performance.

1.3 Hypothesis

H_0: There is a significant between commercial and organic fish fertilizer towards maize plant growth performance.

H_a: There is no significant difference between commercial and organic fish fertilizer towards maize plant growth performance.

H_0: If $p < 0.05$, thus the null hypothesis is accepted.

H_a: If $p > 0.05$, thus the null hypothesis is rejected.

1.4 Objectives

1. To develop an organic fertilizer from fish waste and tea ground.
2. To determine the effect of organic fish fertilizer with tea ground on growth performance of maize plant.

1.5 Scope of Study

This study was conducted to minimize the usage of commercial or chemical fertilizer that can contribute to environment pollution and give a long-term effect for human if continuously consume inorganic plant. The development of organic fertilizer from by-product waste was conducted to reduce the waste disposal and turn it into useful product that can be applied to agriculture industry. Besides, increase the awareness of public regarding waste management and how to transform it into useful products.

1.6 Significance of study

Fertilizer was widely used in the crop production in order to enhance plant growth and increased crop production. However, misuse or overuse of organic fish fertilizer lead to soil damaged and reduce the organic matter in the soil. Besides, the cost of fertilizer also quite expensive even in a small amount. Thus, by producing an organic fertilizer from by-product would reduce the cost or fertilization and enhance plant growth performance. Studies have shown that organic fertilizer was able to promote the plant growth same as commercial fertilizer (Karim et al., 2015). Maize plant was used in this study as it provided a nutrient and served a main ingredient in animal feed (Ministry of Environment and Forests, 2010) . Furthermore, this study was conducted to determine the effectiveness of organic fish fertilizer on maize plant growth performance.

CHAPTER 2

LITERATURE REVIEW

2.1 Fertilizer

In the agriculture industry, fertilizer is considering as a feed or supplement for the plant. This is because fertilizers providing around 17 essential nutrients that required by the plant such as nitrogen (N), phosphorus (P), potassium (K) and sulphur (S). Fertilizer also replenishes the nutrient content in the soil to produce the good quality of the plant. Fertilizers can be categorized as chemical and organic fertilizer.

Chemical fertilizer also is known as commercial fertilizer since it has been commercially sold at global market. Usually, nitrogen (N) elements are derived from nitrogen gas (N2) through the Haber-Bosch process. Meanwhile, phosphate and potassium are generated from acid attack of natural rock and refined from soluble potassium salts respectively (Morari, Vellidis, & Gay, 2011).

2.2 Organic Fertilizer

According to Kim (2011), organic wastes have been found to contain compounds that capable of promoting plant growth. Nowadays, the organic fertilizer has high demand in the local and global market due to rapidly increase in organic agriculture activities in the world. However, the price of commercial organic fertilizer is quite expensive and quite limited (López-Mosquera et al., 2011).

Mostly, the organic fertilizers are introduced by small farmers that have limited resource to replenish the nutrient to the crop or soil and to cut the cost for fertilizer usage in their farming system. Commonly, the organic fertilizer is made from animal manure, household waste or aquaculture waste due to concern to environmental

sustainability. These wastes can be composted or fermented and to form a fertilizer. Organic fertilizer is able to improve the soil quality and structure by additional the organic matter contents in the soil such as beneficial fungal and bacteria in the soil (Omidire, Bean, & Bean, 2015).

The previous study stated that an organic fertilizer has been introduced and used by the farmer since a thousand of years ago in concerning to sustainability of agricultural productivity and maintaining soil quality (Morari et al., 2011). However, if this sources were not fully utilized or treated, it will cause a pollution in aquatic environments and lead to eutrophication (Delin & Engström, 2010) .

2.3 Organic Fish Fertilizer with Tea ground

Recently, fish consumption in worldwide has been rise steadily due to awareness to its proteins in diet and human health benefits. López-Mosquera et al., (2011) stated that fishing sector generates large quantities of fish wastes in wet markets and fish processing industries due to the booming fishing activity around the world. Usually, these wastes were disposed on the landfill or sea and give a big impact on the environment that may lead to pollution. Therefore, an action need to be taken to overcome this problem and find a way on how to utilize this waste properly (Kim, 2011).

One of the methods that can be used to recycle the fish waste is ensilation (make a silage) and composting of fish waste to produce high-protein meals for animal feeds. Undeniably, fish waste has been used as a low-cost nutrient for lactic acid production by providing a favourable medium for lactic acid bacteria growth through a fermentation of fish viscera (Kim, 2011).

There are many benefits of fish wastes and tea ground that could contribute to plant growth performance. Traditionally, fish have been used as fertilizer because of its wealth of nutritive elements such as nitrogen and phosphorus for rapid

decomposition and degradation (Kim,2011). According to Illera-Vives et al., (2015) fish waste is suitable for agricultural use because it rich in nutrients such as nitrogen, potassium and calcium.

Tea is serves as beverages in a coffee shop, Kopitiam, stall and restaurant in Malaysia. Most Malaysian prefer a strong and full flavoured black tea with milk or sugar. The famous menu that served of most stall and restaurant in Malaysia is *tea tarik.* Cameron Highland is one of the main tea producer in Malaysia due to its geographical location and a low temperature which suitable for tea plantation. After the tea has been extracted from the tea leaves, tea bags or grounds will be discarded as waste. Generally, tea ground has been used widely in farming and silage making for crop and livestock production due to its high nutrient contents and cost-effective materials.

In the previous study, tea ground served as food silage to the ruminants as it provides a source of protein to the animal feed. Tea grounds also contains a large number of aerobic bacteria, yeast, and mold that will help in the fermentation process, especially for the aerobic fermentation process during fertilizer preparation (Wang & Xu, 2013). In spite of that, tea grounds also have another valuable element that will enhance the plant growth performance such as amino acid, proteins, vitamins, tannins, and polyphenols. Tea grounds able to provide nutrients to the plant as much as the commercial fertilizer as it contained a high nitrogen level that required by the plant (Jayamangkala, Sutigoolabud, Inthasan, & Sakhonwasee, 2015).

2.4 Maize plant

Maize or corn (*Zea mays*) is a monoecious plant from grasses (*Poaceae*) family. It is an annual plant that produce by seed sowing. Typically, maize plant height range is (1-4 metre) with monocot roots which seasonal root system bearing a single erect stem. Maize is a C_4 plant that more efficient at utilizing carbon dioxide than C_3 plant. Generally, all maize varieties have the same pattern of development, despite specific time, interval between stages and number of leaves may vary between different hybrids, seasons, duration of planting and locations. There are two main stages of maize growth which are vegetative and reproductive stages. Vegetative stages started from seedling until development of tassel. Meanwhile reproductive stages begin when the female flower (ear) are invisible by producing the silk (Figure 2.1)("The Biology of Zea mays L . ssp mays (Maize or Corn)," 2008).

Maize plant produces a male inflorescence (tassel) and female inflorescence (an ear) during transition to reproductive stage and it known as protandrous plant as the male flower matures earlier than female flower. Development of tassel start on the top of stem after six to eight leaves emerged. The apical meristem of stem develops into tassel once its been indicated by leaf primordia. Silking stage involving the formation of female flower that occurs 2-3 after tasselling stage and begins once the silk appears outside of the husk. Pollination occurs when the silk catches the falling pollen grains that distributed by the wind. Then, the plant enters milky or soft-dough stage once the pollination and fertilizer are over. During this stage, the pollen grain started to develop inside the husk. This stage is observable when the silks on the top of the cob is retain green in colour similar as the covering of the cobs. Last stage is called maturity or hard-dough stages will noticeable once the colour of leaf and silk become dried and very brittle. Then, it is a perfect time to harvest the maize (Ministry of Environment and Forests, 2010).

Previous study stated that maize plant in temperate zones are shorter than tropical zones. Nodes gradually taper to the top of plant. Leaves of maize plant is abroad and develops at each node in opposite ranks with distichous of leaf arrangement. A matured maize plant able to produces almost 30 leaves. Present study showed, the tropical maize plant develops more leaves than the temperate maize plant. ("The Biology of Zea mays L . ssp mays (Maize or Corn)," 2008)

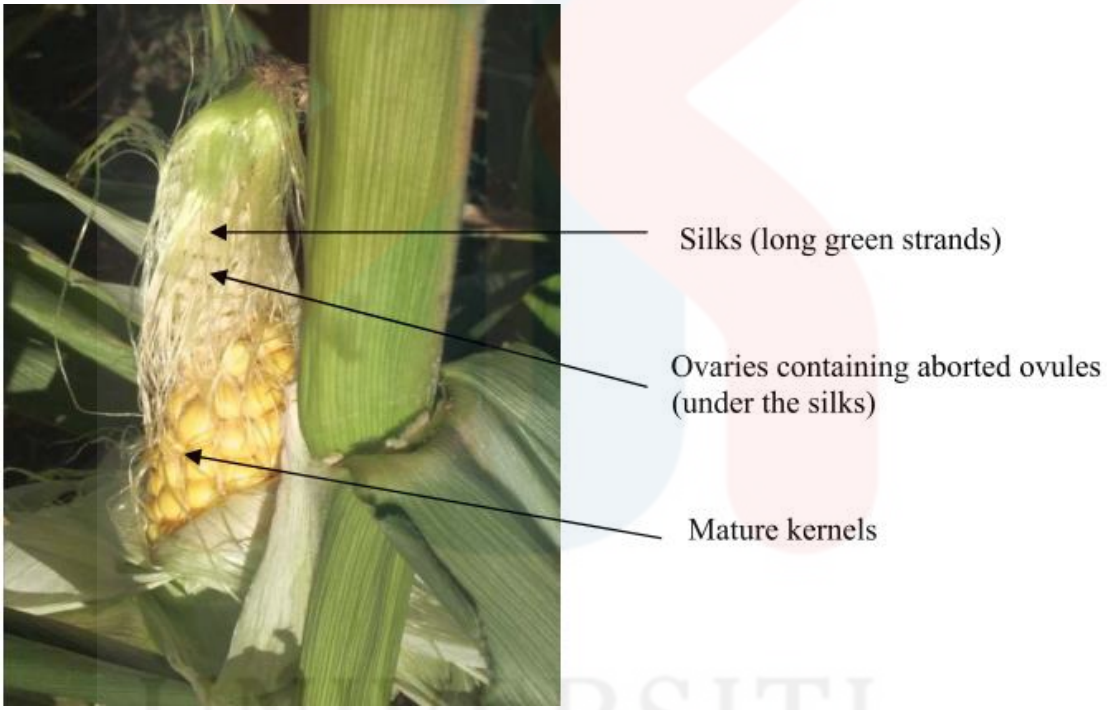

Figure 2.1 Reproductive part of maize plant. ("The Biology of Zea mays L . ssp mays (Maize or Corn)," 2008).

.

Maize plant has been planted globally and become one of the vital cereal crop that provided a nutrient to the human and contributed for animal feed. Maize is an adaptable plant that easy to plant and able to adapt to a various climate zones. Usually, the cultivation period of the maize plant is between three to 13 months depend on the breed (Ministry of Environment and Forests, 2010). Maize plant is a major crop

production that regularly used in the experiment trials due to it cultivation period and adaptability to a new environment. Maize plant needs more than 50% of water requirement on 30 to 35 days after tassel formation and adequate soil moisture at grain filling stage to ensure the production of fruits during reproductive stages. Maize plant required an optimum temperature at 35^{o}C and bright sunny days to accelerate the photosynthesis process and elongated plant growth (Ministry of Environment and Forests, 2010).

Soil structure is a vital element for maize plant because it is control moisture and nutrient utilization of the plant. Basically, maize plant required a loam or silt surface oil, and brown silt clay with pH range between 7.5 -8.5 to promote crop growth. (Ministry of Environment and Forests, 2010).

2.5 Effect of fertilizer on plant growth performance

The essential nutrients are mainly applied to soil and plant to achieve maximum economic yields. There are two methods for fertilizer application which are soil and foliar application. Commonly, soil application is the most effective methods to provide the plant with adequate nutrients. The second method is foliar fertilization which is more economic and effective. Soil fertilization usually were applied into the soil which required in a high amount of fertilizer while for foliar fertilization required higher leaf area index for absorbing the nutrients. Nitrogen was reported as the major elements that responsible for plant growth development. Phosphorus and potassium (NPK) fertilisers have different concentrations of the elements that needed by the plants for their growth and development (Oktem, Oktem, & Emeklier, 2010)

Nitrogen (N) promotes leaf growth and forms a protein as well as chlorophyll that produce green colour in plant. Phosphorus (P) contributes to strong root system, flower and fruit development and disease resistance. Potassium (K) on the other hand

contributes to the stem and root growth and the synthesis of proteins by forming the sugars, starches, carbohydrates (Ginindza, Masarirambi, Wahome, & Tajudeen, 2015). It also helps fortify plants' immune systems, strengthen stems, protect against the cold, preserve water, and encourages fruit ripening. NPK in a plant must stable and fulfil the plant requirement. This is because deficiency of one element of NPK will affect the grower performance of plant and may causes them to dead.

2.6 Factors that influence the growth performance of maize plant

Plants are affected by a few factors during the development and growing process. According to Haferkamp (1988), the factor that could affecting on plant emphasis on water, temperature, light, atmosphere, nutrients, fire and grazers. Water is necessary for all living organism in order to survive. All plant can be stressed if lack of moisture and water excess. Lack of water or moisture will cause the limiting growth performance and decrease the survival rate of plant.

Climate change also is one of the factors that can affect the performance of plant. In Asian, maize is known as rain fed crop which is planted just before monsoon rain. The maize plant can survive under temperature 21°C to 30°C and can be tolerate high temperature as 35°C. Usually, maize plant difficult to grown in rainy season because it can be affected by frost.

Leaf is the main medium that use to capture the source of light and whereas the photosynthesis occurs. The amount of captured light will affect the growth rate of plant. However, nutrient concentration and daily temperature may affect the structure of leaf when the fertilizer was applied such as leaf burning (Fageria, Filho, Moreira & Guimaraes, 2017)

Nutrient is the most important factor that contributes to plant performance. NPK fertilizer is important to fortify the nutrient and responsible for plant growing stages. The

deficiency of micronutrients reduces performance and profitability in the plant. The Manganese deficiency reduced dry matter production and yield but induced susceptibility to drought and heat stress that produces pale green or yellow patches on younger leaves of maize. Manganese is the major key in plant metabolic process such as respiration, photosynthesis, amino acid synthesis and hormone activation (Nozulaidi, 2016).

Nitrogen and phosphorus are the vital element for plant as they are contributing to plant growth and productivity. Deficiency of these two elements will affect the parameter plant such as plant height, root morphology, root diameter and chlorophyll content. Other than that, the maize plant also may be affected by the insect such as grasshopper, hairy caterpillar, root worm, leaf worm and others that might give a serious damaged to the plant and lead to mortality. Besides, maize also suffers from about various disease that carried by the bacteria, fungi, viruses that required a proper management to overcome the disease outbreak (Ministry of Environment and Forests, 2010).

CHAPTER 3

MATERIALS AND METHODS

3.1 Materials and Equipment

The materials used in this study were maize seed, molasses (sugar by-product), organic commercial fertilizer and waste product such as fish waste and tea ground. The equipment used in this study were included hoe, silver shine, watering can, measuring cylinder (1L), measuring tape, hand spade, plastic bag, 1.5L water container and small container.

3.2 Methods

3.2.1 Preparation and Fermentation Period of Organic Fish Fertilizer

Fish waste and tea grounds were obtained from the wet market. The fish waste was cut into smaller pieces while tea ground was cleaned several times with distilled water to remove any dirt and let it dry under direct sunlight. The ratio of fish fertilizer: molasses: tea ground was 2:1:1. The ingredients were mixed together in a container and stirred well to ensure all the ingredient are completely blended. Next, the container was covered with a plastic bag for anaerobic fermentation. The container was kept in store to avoid direct sunlight. The fertilizer was stirred once a day and fermented for 45 days. During this process, aerobic fermentation has involved that help in degradation of waste material fertilizer production.

(a) (b) (c)

Figure 3.1 Ingredients preparation. (a) Minced trash fish and dried tea grounds. (b) Molasses. (c) Organic fish fertilizer on Day 1.

3.2.2 Seed Germination

Maize seed was brought from a shop at Tanah Merah, Kelantan. The breed used was Super Sweet Corn with code 105. The seed was soaked in water for two hours. Then, the seeds were drained and covered with wet towel to maintain the moisture content. The seeds were continued rinsing for two days until it germinates and disbud appeared. Hand spade was used to make a hole on the beds where the hole's depth was 2 to 3 cm. The seed were directly planted on the bed and watered the beds every day. On Day 2, disbud started to appear on the top of soil.

(a) (b) (c)

Figure 3.2 Seed germination and planting. (a) Soaked maize seed. (b) Seed was planted on the beds. (c) Day 3 of maize plant.

3.2.3 Preparation of plot and planting beds

The plot for maize planting was located at Agro Techno Park, University Malaysia Kelantan (UMK). The plot area was measured for 6 m (length) x 4 m (width) and tagged using a rope and wood. The plants beds were prepared by ploughing the soil with the dimension of beds 0.8 m (width) x 5 m (length) with 0.1 m (height). The length of beds was estimated to have length 4.5-5 meters as the structure of soil a slightly bumpy. The beds were covered with silver shine to prevent the weeds grow. The silver side of silver shine were placed facing the sunlight to reduce the high temperature that might affect the humidity of soil. Each bed contained 15 plants with zigzag planting pattern to allow the pollination to occur. The space between the zigzag pattern is between 18-20 inches. The beds were divided into two parts and labelled as C (commercial organic fertilizer) and T (Organic fish fertilizer) which is represent control and treatment plant respectively.

Figure 3.3 Plot tagging and beds preparation.

Figure 3.4 Beds covered with silver shine.

3.2.4 Dilution factor and Application of Organic Fish Fertilizer

The fermented organic fish fertilizer was strained using cloth filter to get the stocking foliar after 45 day of fermentation period. After strained, the solid residue was being thrown away and the stock was poured into the bottles. Dilution of fish fertilizer was done prior to fertilizer application in the morning. Usually, dilution of fertilizer was prepared a day before the foliar application. Dechlorinated water was used for dilution of fertilizer. For producing 1.5 L of foliar with 1% dilution, the dilution factor was calculated as 1:100, where 15 ml concentrated fertilizer was mixed with 1485 ml of dechlorinated.

(a) (b) (c)

Figure 3.5 Stock for organic fish fertilizer. (a) Fermented organic fish fertilizer(b) Strained the fermented foliar. (c) Concentrated organic fish fertilizer.

The steps were done by measuring 15 ml of concentrated fertilizer using a measuring cylinder and pouring it into the bottle. Next, 1485 ml of dechlorinated water was measured and poured into the bottle that contained 15 ml of concentrated fertilizer. The bottle was being tilted to the right and left to ensure the mixture was well mixed together. This mixture was known as foliar. The similar steps were done for commercial fertilizer before it was sprayed on the leaves.

Foliar was sprayed below the leaves in morning twice a week with four days intervals. A plant takes the nutrients through the leaf more efficient rather through root or stem. Thus, the best way to apply the foliar is below the leaf as the absorption rate is faster and more efficient.

The dilution rate was calculated as followed

- 1% of dilution for 1.5L foliar

  $\frac{1}{100} \times 1500ml = 15$ ml (concentrated fertilizer)

  1500ml – 15 ml = 1485 ml (dechlorinated water)

Figure 3.6 Diluted foliar for both commercial and organic fish fertilizer.

3.3 Nutrient analysis

Nitrogen (N), phosphorus (P) and potassium (K) contents in organic fish fertilizer and commercial fertilizer were analysed to identify their concentration in both fertilizer. Nitrogen contents in both fertilizer was analysed at Malaysia Agricultural Research and Development Institute (MARDI) located at Serdang, Selangor, meanwhile for phosphorus and potassium contents were analysed at Universiti Malaysia Kelantan (UMK) using X-ray Fluorescence (XRF) spectrometry.

3.4 Data Collection and Analysis

The data was measured using the measuring tape and recorded based on analysis of several parameters such as height of plant, width and length of leaf and number of leaves. The data was analysed using One-way ANOVA by using SSPS Software Version 23 and graph was tabulated using Microsoft EXCEL 2016 to determine the significant difference between two group of fertilizer based on growth performance of maize plant.

CHAPTER 4

RESULTS

4.1 Analysis of Elements in Commercial fertilizer and Organic Fish Fertilizer

Analysis of element in fertilizer was conducted to determine the element available in the fertilizers. In this study, two fertilizers were used to identify the effectiveness of different fertilizers on maize plant growth performance which were commercial fertilizer and organic fish fertilizer respectively. This analysis was conducted using X-ray Fluorescence (XRF) spectrometry. Concentration of elements in these two fertilizers were listed in Table 4.1.

Table 4.1 The concentration of element in commercial fertilizer and organic fish fertilizer.

Formula	Concentration (%)	
	Commercial Fertilizer	Organic Fish Fertilizer
Nitrogen, N	0.3300	0.2200
Phosphorus, P	0.0828	0.1120
Potassium, K	< 0.0001	<0.0001
Water, H_2O	99.6000	98.2000
Sodium, Na	< 0.0001	1.3700
Calcium, Ca	0.0232	0.0350
Sulfur, S	0.0958	0.1290
Antimony, Sb	0.0013	0.0018
Tin, Sn	0.0015	0.0018
Barium, Ba	0.0014	0.0025
Iron,Fe	0.0011	< 0.0001
Manganese,Mn	0.0011	< 0.0001
Chlorine, Cl	0.1670	0.1740

The main elements that required by plant are nitrogen, phosphorus, and potassium that also known as NPK elements. Among these elements, water (H_2O) showed the highest concentration which are 99.6% and 98.2% for commercial fertilizer and organic fish fertilizer respectively. Meanwhile, potassium (K) element presented the lowest concentration in these two fertilizers with concentration less than 0.0001%.

Focusing on NPK elements, the concentration of NPK elements in these two fertilizers showed similar descending order of N > P > K. Concentration of nitrogen in commercial fertilizer was higher than organic fish fertilizer with 11% of difference while for the phosphorus element, its concentration in organic fish fertilizer was higher than commercial fertilizer. However, concentration of potassium, K is almost similar for both fertilizer as the value of K is less than 0.0001%.

Another element that were presence in these fertilizers are known as trace elements. These trace elements are also important and contributes to plant growth performance. Roughly, concentration of trace elements in organic fish fertilizer was higher compared to commercial fertilizer contents except for iron (Fe) and manganese (Mn) (Table 4.1).

4.2 Plant Growth Performance Analysis

Plant growth performance was determined by few parameters such as plant height, number of leaves, width and length of leaf. These parameters were obtained to determine the effect of commercial fertilizer and organic fish fertilizer on the maize plant growth performance. Maize seed has been germinated using direct planting technique on the planting beds.

Data was recorded on Day 12, as initial data prior to the first application of fertilizers. First application of fertilizer was performed on Day 13 of planting period. The fertilizers were applied by spraying diluted fertilizer directly on the leaves of plant. The volume of fertilizer was gradually increased every week followed the increment size of plant in order to provide an adequate nutrient to the plant for survive.

4.2.1 Height of Maize Plant

The height of plant was recorded throughout the maize cultivation period to identify the effectiveness of different fertilizers on plant growth performance. The maize plants that applied with commercial fertilizer were known as control group while plant applied with organic fish fertilizer were known as treatment group.

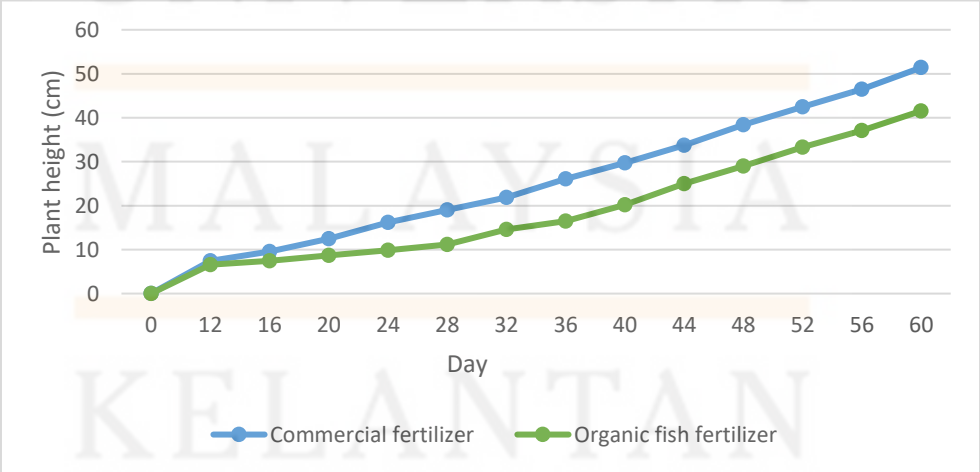

Figure 4.1 Height of maize plant between commercial fertilizer and organic fish fertilizer group.

Figure 4.1 represented the height of maize plant after the application of commercial fertilizer and organic fish fertilizer. Initially, the height of plant was similar at 7 cm. Obviously, plant height for both fertilizers were rose gradually throughout the cultivation period dominated by commercial fertilizer group. Plant height started to be boosted on Day 16 after the first application of fertilizer as the nutrients were provided to plant. Plant height was continuously elevated until Day 60 as the fertilizers were applied in a four day interval. However, plant height for the control group (commercial fertilizer) showed better performance up to 51 cm compared to the treatment group (organic fish fertilizer) which only reached up to 41 cm.

4.2.2 Width and Length of Leaf

The width and length of leaf are important parameters that can be used to determine the effectiveness of the fertilizer on plant growth performance. The width and length of leaf are influenced by the nutrient uptake of plant from the soil and fertilizer.

4.2.2.1 Width of leaf

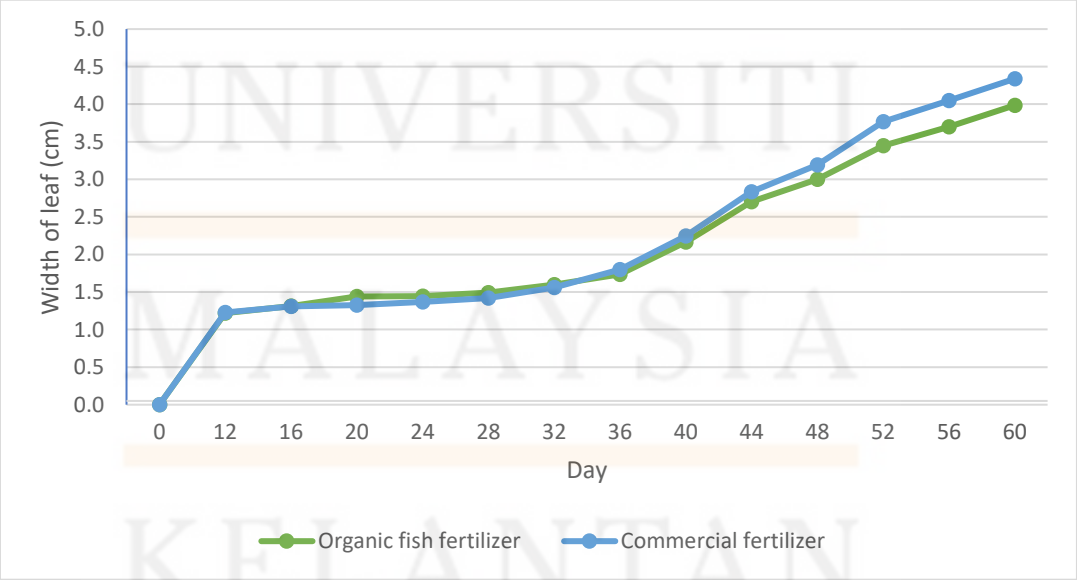

Figure 4.2 Width of leaf between commercial fertilizer and organic fish fertilizer.

Figure 4.2 showed the width of maize leaf for both fertilizer groups. Initially, the width of the leaves was similar for control and treatment groups with the average of leaf width is 1.4 cm. After the second application of organic fish fertilizer on Day 17, maize leaf slightly widen up to 2 cm on Day 36. The size of leaf was continued enlarged from Day 40 until Day 60 as the volume of fertilizer was increased every week. Generally, the width of leaves was monopolized by the plant that being applied with commercial fertilizer measurement of 4.5 cm. Meanwhile, the plant that being sprayed with organic fish fertilizer only have an average of 4 cm wide of leaf.

(a) (b)

Figure 4.3 The width of leaf between (a) commercial fertilizer and (b) organic fish fertilizer.

4.2.2.2 Length of leaf

Length of leaf was recorded throughout the cultivation period to determine the effectiveness of two fertilizers on maize plant growth performance. The comparison between both fertilizers were presented in the figure below.

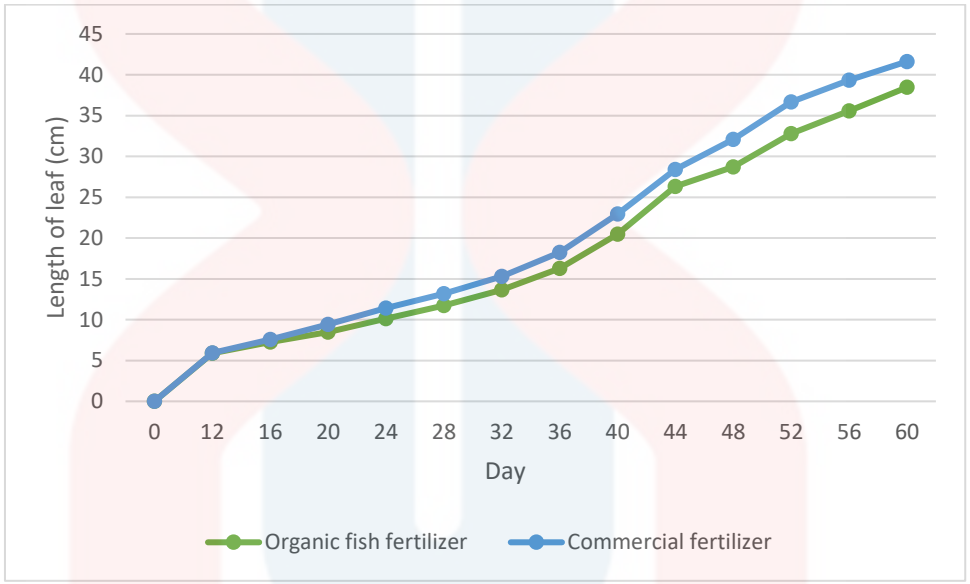

Figure 4.4 Length of maize leaf between commercial fertilizer and organic fish fertilizer.

Length of leaf for both treatment groups was rose steadily during the cultivation period. At the early stages of cultivation, length of leaf for commercial and organic fish fertilizer ‘s plants were similar at 6 cm of length. Maize leaf started to be elongated after the first application of fertilizer on Day 13 and steadily extended until Day 60 of cultivation period. Obviously, length of leaf for commercial fertilizer was greater than organic fish fertilizer with 3.2 cm differences in length.

4.2.3 The Number of Leaves

The number of leaves for both plant group were counted and recorded to compare the effectiveness of these two fertilizers on maize plant. The comparison between both fertilizers were presented in the graph below.

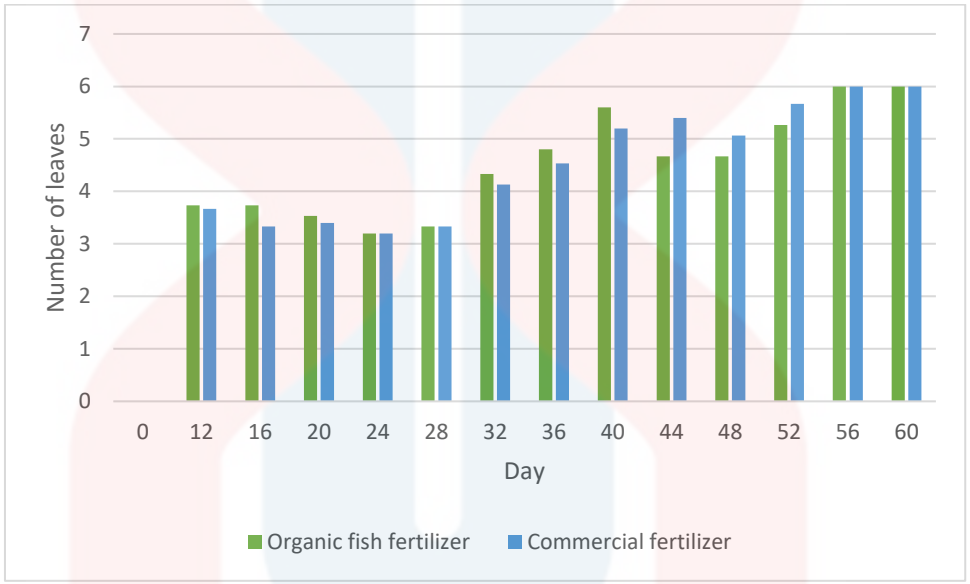

Figure 4.5 Number of leaves between fish fertilizer and commercial fertilizer group.

The pattern of this graph was fluctuated where for commercial fertilizer group, the number of leaves started to drop from 4 leaves to 3 leaves on Day 16 due to dry weather. However, on Day 32, the number of leaves in treatment group was rise from 4 leaves to 6 leaves due to new development of leaf during the cultivation period. The number of leaves was fallen out on Day 44 was due to leaf has been eaten by the insect and lead to dead of leaf. Corresponding to both fertilizer, the development of leaves was increased and remain unchanged on Day 56 until Day 60 as the leaves were provided with adequate amount of fertilizer.

4.3 Tassel Formation

Tassel is the male flower that formed at the apex of plant and also known as staminate. The formation of tassel gave a hint that the maize plant was changed over into floral transition. Before the development of tassel at apical meristem, the plant will produce 15- 26 leaves in leaf production phases (Figure 4.6). Generally, tassel begun to develop when plant produces about 50% the number of leaves during the vegetative stage (Bechoux, Bernier, & Lejeune, 2000).

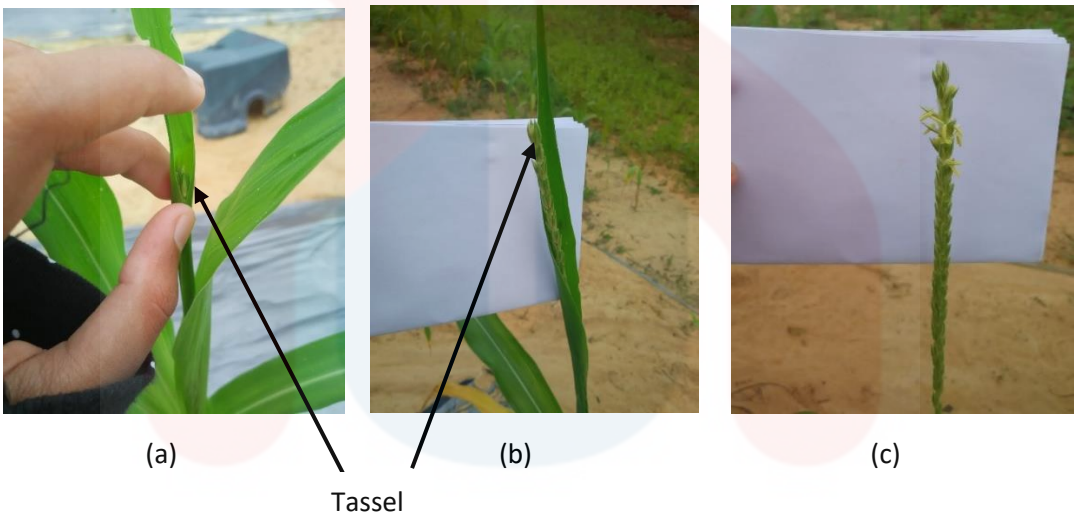

Figure 4.6 Tassel formation of maize plant applied with commercial fertilizer group. (a) Tassel started to develop. (b) Completed tassel development. (c) Matured tassel.

On Day 47, tassel begun to visible on maize plant that had been applied with commercial fertilizer (Figure 4.6 (a)). Meanwhile for treatment group, the tassel only developed on Day 60 of cultivation period. After 3-4 days, the tassel started to extend by adding the side branches (Figure 4.6(c)). A mature tassel growth pollen-bearing anther on the stem and branches. When the anthers matured, it released the pollen to the female flower known as pistillate. The pollen shed take time for a week.

The pollen grain falling from a tassel resembles a thin cloud of white or yellow dust. The pollen grain was carried over the beds by the wind as it is very small, light and invisible to naked eyes. However, pollination also may be occurred via self-pollination of the plant. Then, female flower started to develop and produce a silk. Silk was covered with sticky hairs that used to catch the pollen grain and continuously elongated until fertilization occurred. Fertilization begun when the silk caught the pollen grain by developing the pollen tube in the silk channel once it touched the silks (Ministry of Environment and Forests, 2010).

4.4 Presence of Insect-Pest During Cultivation Period

Based on observation, there are a few insects approached the maize plant during the cultivation period and affect the maize plant.

(a) (b)

Figure 4.7 Insect approached the leaf on organic fish fertilizer plant. (a) Bugs approached the leaf. (b) A caterpillar approached the leaf.

The leaves were infested by insect such as caterpillar, grasshopper, bugs and spider during the cultivation period. Most of these insects may caused damaged to the leaf. Figure 4.7 (b) showed the caterpillar found on the leaf. This situation caused the destruction of the leaves, stem and plant mortality as a long-term effect. These insects may attracted to this plant due to the smell and sweetness of fertilizer ingredients such as molasses.

CHAPTER 5

DISCUSSION

5.1 Analysis of Elements in Commercial Fertilizer and Organic Fish Fertilizer

Fertilizer is the main factor in agriculture industry that will enhance the crop productivity by improving the performance of the plant and helps to increase the organic matter in the soil (Diallo, Qing-jun, Zhen-ming, Jin-hu, & Dafaalla, 2016). In this study, organic fish fertilizer was prepared using three ingredients which were fish waste, tea grounds and molasses that undergo aerobic fermentation for 45 days. Fish waste was used as the main ingredient in organic fish fertilizer because it rich with nutrient and contain valuable compound that adequate in stimulating the plant growth performance (Kim, 2011). Tea ground was selected due to its high concentration of nitrogen (N) as had been mention in the previous study (Ebid, Ueno, Asagi, & Ghoneim, 2008). Besides, molasses was used to enhance the microorganism growth and fasten the fermentation process.

It is important to know the nutrient contents in the fertilizer before proceed the application of fertilizer to the plant. The most vital element that contributes to the plant growth are nitrogen, phosphorus, potassium which also known as NPK elements. Based on the elements analysis in Table 4.1, fertilizers contain high concentration of water (H_2O) but low in of potassium (K) element. Macronutrient of NPK, was presence in these fertilizers, however, their concentration was too low. Low concentration of NPK in the fertilizers may contribute to nutrient deficiency and disturbed the growth performance of plant.

Nitrogen (N) is the major plant nutrient that involves in plant growth and affects the quality and mineral contents of the maize. Basically, plant absorbed less than 50% of nitrogen to survive (Oktem et al., 2010). However, in these fertilizers, nitrogen (N)

contents only 0.33% and 0.22% for commercial fertilizer and organic fish fertilizer respectively. The appropriate amount of nitrogen should be applied to the different stages of plant in order to prevent the leaching and denitrification of nitrogen. (Oktem et al., 2010).

During vegetative stages, plant required high volume of nitrogen to undergo the photosynthesis and this element is responsible for the leaves expansion, growth of stem and roots. In contrast, concentration of phosphorus in organic fish fertilizer was greater than commercial fertilizer with 0.0292% of difference. Even though the concentration of phosphorus in organic fish fertilizer was high, its volume was still inadequate for plant growth. Generally, phosphorus (P) is responsible for root development and plant maturity. The concentration of potassium (K) was the lowest in both fertilizers which are < 0.0001%. Potassium (K) is responsible for internal reaction in the plant such as to activate the enzyme activity and transformation of sugar (Oktem et al., 2010).

Plant required high amount of NPK to survive and growth. Deficiency of these three elements will caused stress to the plant and lead to various problem such as stunted of plant height, delayed in tassel formation, leaves turn to yellow in colour and dead. The element analysis revealed that the amount of NPK in organic fish fertilizer were lower than the requirement of the plants need.

5.2 Plant Growth Performance Analysis

Plant height of organic fish fertilizer group was relatively uniformed but shorter than commercial fertilizer group with 9.9 cm of difference on Day 60. From the observation, growth rate of these plant was stunted as the height of the plant was abnormal than the general height maize plant during the cultivation period. Statistically as the height of plant were increased progressively for both groups, there is no significant differences between fertilizer ($p > 0.05$) as the value of $p = 0.72$ (Table A.1). According to Oktem et al. (2010), deficiency of N also resulting the low plant height due to low protein synthesis in the plant.

On Day 60, both maize plant groups only produced six leaves throughout the cultivation period (Figure 4.5). This situation happened due to inadequate of nutrient uptake from the soil and fertilizer. Furthermore, based on observation, the colour of leaves was easily turn into yellow when it reaches a bigger size. Indirectly, the nutrient in fertilizer influenced the chlorophyll contents in leaf as its keep on the green colour of leaf (Ling & Silberbush, 2002). This was happened due to lack of nitrogen supplied to the plant. Besides, concentration of nutrient and temperature should be optimal to avoid leaf burning and dead (Fageria et al., 2017). Statistically as the number of leaves for both group was fluctuated throughout of cultivation period, thus, there is no significant difference between two fertilizers on maize plant ($p > 0.05$) as the value of $p = 0.601$ in one-way ANOVA (Table A.1).

Leaf expansion was recorded up to 41.6 cm and 38.4 cm for commercial fertilizer group and organic fish fertilizer respectively while the size of leaf was less than 5 cm for both treatment groups. The width, length and number of leaves was intertwined together to undergo photosynthesis (Oktem et al., 2010). However, there was also no significant different between width and length of leaf, as the ($p > 0.05$) as the value of p in one-way ANOVA were $p = 0.208$ for leaf width and $p = 0.172$ for length of leaf (Table A.1). Photosynthesis activity depends on the number and width of plant

leaves in the plant (Oktem et al., 2010). Poor photosynthesis activity lead to low production of crop. Nitrogen is a major element for leaves development, thus by increasing the volume of N, the number of leaves will be increased and resulted a good yield (Oktem et al., 2010). Consequently, fertilizer affected the plant growth performance via an effect of photosynthesis process. The deficiency of nitrogen (N), and phosphorus (P) in fertilizer give a big impact to the plant growth as its affected the production of chlorophyll and photosynthesis process on leaf (Ling & Silberbush, 2002).

Not only nutrients deficiency, there are a few factors that influenced the plant growth performance such as intrinsic and extrinsic factors. Intrinsic factor including the plant hybrid, genetic, and cultivation period while extrinsic factor are the climate change, water supply, soil characteristic and the nutrient supplied. There a many maize hybrid in the global market such as Taiwan super sweet, Mas Madu and others. These varieties of sweetcorn have a difference cultivation period and genetic that control the formation and development of maize plant (Leong, 2004).

Climate change give a huge impact to the crop quality and performance. Extreme temperature such as drought will cause evapotranspiration to the plant (Oktem et al., 2010). Plant growth performance was directly reacted to the season and surrounding temperature. Climate changes also caused the nitrogen (N)losses from the soil and give an impact to the environment. Drought season cause nitrogen leaking from the soil as a ammonium while the raining season cause leaching and runoff of nitrogen (Oktem et al., 2010 ; Morari et al., 2011). The cultivation period may be shorten or lengthen due to the environment stress and affect the time between vegetative and reproductive stages of maize plant (Darby & Lauer, 2013).

5.3 Tassel Formation and Pollination

Tassel formation is important for the fruit plant such as maize to make sure the development of fruit is occurred. Tassel produces a pollen grain that pollinated the female flower and enhance the fertilization once the silk caught the pollen grain. If the tassel unable to develop, the plant will not able to produce the fruit. Generally, the tassel formed when eight number of leaves were produced within 3 to 4 weeks. (Hayashi, Makino, Sato, & Deguchi, 2015).

In this study, tassel only developed on Day 47 and Day 60 for plant applied with commercial fertilizer and organic fish fertilizer respectively which were delayed than normal maize plant which tassel formation was occur on Week 3 to Week 4. In addition, the plant also unable to produce the silks as the development of tassel was disturbed by heavy rains continued for a week. According to Ministry of Environment and Forests (2010), under any stress situation, the interval between tasselling and silking stages will be increased.

However, there a few barriers that stunted the pollination stages such as weather, nutrient uptake, insect, genetic and moisture contents. When the tassel formed, the silk started to develop and elongated as a preparation to catch the pollen grain. In this time, the development of kernel also begun and totally influenced by the genetic of the maize plant. Environmental stress such as weather, temperature or soil condition were influenced the development of kernel and ear size (Darby & Lauer, 2013).

During this stage, high amount of NPK were required by the plant to undergo the fertilization. Moisture deficiency at this stage will caused delay between distribution of pollen shed and formation of silk. Climate changes such as drought resulted in poor pollination process and seed development and lengthen the production of fruit (Darby & Lauer, 2013).

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In this study, maize plant that applied with commercial fertilizer showed better performance in plant growth parameters compared to organic fish fertilizer in term of plant height, width and length of leaf and number of leaves. This might be due to the high concentration of nutrient elements in commercial fertilizer compared to organic fish fertilizer. Thus, it is important to know the nutrient content in the fertilizer to assure the plant will absorbed an adequate amount of nutrient and able to survive.

The highest plant height was recorded on commercial fertilizer group up to 51.4 cm compared to organic fish fertilizer which only 41.5 cm. However, there is no significant difference between these two fertilizers on plant height ($p > 0.05$). Similar situation to the other parameters, there are no significant differences between commercial and organic fish fertilizer ($p > 0.05$). As a conclusion, organic fish fertilizer was assumed to have a similar effect as commercial fertilizer to enhance plant growth performance. Besides, the usage of organic fish fertilizer in agriculture farming system will reduce the cost of fertilization and produce healthy products. This is because, commonly, organic fertilizer was produced by using a valuable waste from the farm or household such as food waste or manure from livestock.

6.2 Recommendation

It is recommended to prolong the fermentation period of organic fish fertilizer to assure all the ingredients were degraded properly and produce the best organic fertilizer. Prevalently, some of ingredients could be added to this fertilizer to improve the nutrient contents in this organic fish fertilizer such as banana peel, papaya peel, egg shells or other food waste that contains high value of nutrients. The usage of molasses in this fertilizer could be replaced with another material such as effective microorganisms (EM) solutions to prevent the presence of pest-insect that may attracted to plant since it is sweet and smell goods. Other than that, the concentration of foliar could be increased to appropriate amount that will supplied an adequate nutrient to the plant. The planting plot should be chosen wisely to avoid weather effect that may influenced the plant growth performance. Another method of planting that also can be applied in future study is using a polybag to growth the maize plant. The advantages of this method is it able to maximize the usage of land and prevent run off of nutrient.

REFERENCES

Bechoux, N., Bernier, G., & Lejeune, P. (2000). Environmental effects on the early stages of tassel morphogenesis in maize (Zea mays L.). *Plant, Cell and Environment*, *23*(1), 91–98. https://doi.org/10.1046/j.1365-3040.2000.00515.x

Darby, H., & Lauer, J. G. (2013). Critical Stages in the Life of a Corn Plant. *Plant Physiology*, 15–20. https://doi.org/10.2489/jswc.69.3.67A

Delin, S., & Engström, L. (2010). Timing of organic fertiliser application to synchronise nitrogen supply with crop demand. *Acta Agriculturae Scandinavica Section B: Soil and Plant Science*, *60*(1), 78–88. https://doi.org/10.1080/09064710802631943

Diallo, L., Qing-jun, C., Zhen-ming, Y., Jin-hu, C., & Dafaalla, T. I. M. (2016). Effects of Various Doses of Mineral Fertilizers (NPKS and Urea) on Yield and Economic Profitability of New Varieties of Zea mays L. in Faranah, Guinea. *Journal of Northeast Agricultural University (English Edition)*. https://doi.org/10.1016/S1006-8104(16)30025-3

Ebid, A., Ueno, H., Asagi, N., & Ghoneim, A. (2008). Nitrogen Uptake by Radish, Spinach and "Chingensai" from Composted Tea Leaves, Coffee Waste and Kitchen Garbage. *Compost Science and Utilization*, *16*(3), 152–158. https://doi.org/10.1080/1065657X.2008.10702373

Fageria, N. K., Filho, M. P. B., Moreira, A., Guimarães, C. M., Filho, M. P. B., Moreira, A., & Guimarães, C. M. (2017). Foliar Fertilization of Crop Plants Foliar Fertilization of Crop Plants, *4167*(December). https://doi.org/10.1080/01904160902872826

Ginindza, T. K., Masarirambi, M. T., Wahome, P. K., & Tajudeen, O. (2015). Effects of different concentrations of NPK fertilisers on growth and development of wild okra (*Corchorus olitorius*), 74–80. https://doi.org/10.5251/abjna.2015.6.3.74.80

Haferkamp, M. R. (1988). Environmental factors affecting plant productivity. Achieving Efficient Use of Rangeland Resources. Retrieved from http://oregonstate.edu/dept/EOARC/sites/default/files/researchhome/documents/328.pdf

Hayashi, T., Makino, T., Sato, N., & Deguchi, K. (2015). Barrenness and Changes in Tassel Development and Flowering Habit of Hybrid Maize Associated with Low Air Temperatures. *Plant Production Science*, *18*(1), 93–98. https://doi.org/10.1626/pps.18.93

Illera-Vives, M., Seoane Labandeira, S., Brito, L. M., López-Fabal, A., & López-Mosquera, M. E. (2015). Evaluation of compost from seaweed and fish waste as a fertilizer for horticultural use. *Scientia Horticulturae*, *186*, 101–107. https://doi.org/10.1016/j.scienta.2015.02.008

Jayamangkala, N., Sutigoolabud, P., Inthasan, J., & Sakhonwasee, S. (2015). The effect of organic fertilizers on growth and yield of broccoli (*Brassica oleracea L . var . italica Plenck cv* . Top. *Journal of Organic Systems*, *10*(1), 9–14.

Karim, N. U., Lee, M. F. M. A., & Arshad, A. M. (2015). The effectiveness of fish silage as organic fertilizer on post-harvest quality of pak choy (*Brassica rapaL. subsp. chinensis)*. *European International Journal of Science and Technology*, *4*(5), 2304–9693. Retrieved from www.eijst.org.uk

Kim, J.-K. (2011). Cost-Effectiveness of Converting Fish Waste into Liquid Fertilizer. *Fisheries and Aquatic Sciences*, *14*(3), 230–233. https://doi.org/10.5657/FAS.2011.0230

Leong. (2004). Comparative performance of two sweetcorn varieties – Mas Madu and Taiwan Supersweet. *Journal of Tropical Agricultural and Food Science*, *32*(2), 141–146.

Ling, F., & Silberbush, M. (2002). Response of Maize To Foliar Vs. Soil Application of Nitrogen–Phosphorus–Potassium Fertilizers. *Journal of Plant Nutrition*, *25*(11), 2333–2342. https://doi.org/10.1081/PLN-120014698

López-Mosquera, M. E., Fernández-Lema, E., Villares, R., Corral, R., Alonso, B., & Blanco, C. (2011). Composting fish waste and seaweed to produce a fertilizer for use in organic agriculture. *Procedia Environmental Sciences*, *9*, 113–117. https://doi.org/10.1016/j.proenv.2011.11.018

Ministry of Environment and Forests. (2010). *Biology of Maize*. *Series of Crop Specific Biology Documents*.

Morari, F., Vellidis, G., & Gay, P. (2011). Fertilizers. *Encyclopedia of Environmental Health*, 727–737.

Nozulaidi, M. (2016). Effects of Manganese Application on Plant Parameters. Open Access Journal of Agricultural Research Production of Corn, 1(2), 1–7.

Oktem, A., Oktem, A. G., & Emeklier, H. Y. (2010). Effect of nitrogen on yield and some quality parameters of sweet corn. *Communications in Soil Science and Plant Analysis*, *41*(7), 832–847. https://doi.org/10.1080/00103621003592358

Omidire, N. S., Bean, R., & Bean, J. (2015). Assessing the Impacts of Inorganic and Organic Fertilizer on Crop Performance Under a Microirrigation-Plastic Mulch Regime, *3*(1).

The Biology of Zea mays L . ssp mays (Maize or Corn). (2008). In *Office of the Gene Technology Regulator* (p. 81). Retrieved from http://www.ogtr.gov.au

Unnisa, S. A. (2015). Liquid Fertilizer from Food Waste - A Sustainable Approach, *4*(8), 22–25.

Wang, H., & Xu, C. (2013). Utilization of tea grounds as feedstuff for ruminant, 2–7. https://doi.org/10.1186/2049-1891-4-54

APPENDIX

Table A.1: One-way ANOVA for plant parameters.

		Sum of Squares	df	Mean Square	F	Sig.
Number of leaves	Between Groups	.133	1	.133	.280	.601
	Within Groups	13.333	28	.476		
	Total	13.467	29			
Plant height	Between Groups	732.108	1	732.108	3.498	.072
	Within Groups	5860.347	28	209.298		
	Total	6592.455	29			
Width of leaf	Between Groups	.933	1	.933	1.661	.208
	Within Groups	15.723	28	.562		
	Total	16.656	29			
Length of leaf	Between Groups	75.177	1	75.177	1.968	.172
	Within Groups	1069.607	28	38.200		
	Total	1144.784	29			

Figure A.1 : Maize seed used in this study.

Table A.2 : Descriptive table for plant parameters.

Descriptives

			N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
							Lower Bound	Upper Bound			
Number of leaves	Commercial Fertilizer		15	5.93	.458	.118	5.68	6.19	5	7	
	Organic Fish Fertilizer		15	5.80	.862	.223	5.32	6.28	4	7	
	Total		30	5.87	.681	.124	5.61	6.12	4	7	
	Model	Fixed Effects			.690	.126	5.61	6.12			
		Random Effects				.126[a]	4.27[a]	7.47[a]			-.023
Plant height	Commercial Fertilizer		15	51.4267	18.41895	4.75575	41.2266	61.6267	33.30	100.50	
	Organic Fish Fertilizer		15	41.5467	8.90721	2.29983	36.6140	46.4793	25.00	54.00	
	Total		30	46.4867	15.07733	2.75273	40.8567	52.1166	25.00	100.50	
	Model	Fixed Effects			14.46714	2.64133	41.0762	51.8972			
		Random Effects				4.94000	-16.2820	109.2553			34.85399
Width of leaf	Commercial Fertilizer		15	4.3380	.58047	.14988	4.0165	4.6595	3.35	5.20	
	Organic Fish Fertilizer		15	3.9853	.88665	.22893	3.4943	4.4763	2.35	5.20	
	Total		30	4.1617	.75786	.13836	3.8787	4.4447	2.35	5.20	
	Model	Fixed Effects			.74936	.13681	3.8814	4.4419			
		Random Effects				.17633	1.9211	6.4022			.02475
Length of leaf	Commercial Fertilizer		15	41.6213	3.71597	.95946	39.5635	43.6792	35.60	46.50	
	Organic Fish Fertilizer		15	38.4553	7.91151	2.04274	34.0741	42.8366	23.35	48.30	
	Total		30	40.0383	6.28294	1.14710	37.6922	42.3844	23.35	48.30	
	Model	Fixed Effects			6.18064	1.12842	37.7269	42.3498			
		Random Effects				1.58300	19.9244	60.1523			2.46509

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

Figure A.2 : Degradation of organic fish fertilizer.

Figure A.3 Planting plot and maize plant from top and side view.