Effect of Rabbit Manure as Bio-fertilizer on Chilli Pepper Plant

(*Capsicum annuum*) Growth Performance

By

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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.

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Student

Name:

Date:

I certify that the report of this final year project entitled "__________________________ ______________________________" by ______________, matric number _________ 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:

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Supervisor

Name:

Date:

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Effect of Rabbit Manure as Bio-fertilizer on Chilli Pepper Plant (*Capsicum annuum*) Growth Performance

ABSTRACT

Rabbit manure is known as one of better source by-products to make bio-fertilizer. However in previous years, rabbit manure bio-fertilizer is rarely being used by farmers due to low rabbit production in Malaysia. To date, rabbit farming has become one of the expand industry in Malaysia to fulfil demand of meat sources. Continuously, it will leads to increment of rabbit manure production. The aim of the study was to investigate the effects of rabbit manure bio-fertilizer on chilli pepper plant growth performance. The effectiveness of rabbit manure bio-fertilizer was compared to commercial bio-fertilizer based on chilli pepper plant height, number of leaf, average size of leaf and number of chilli pepper produced. The foliars were sprayed on chilli pepper plants twice a week respectively. The findings showed rabbit manure bio-fertilizer was less effective compared to commercial bio-fertilizer due to low availability of nutrient content such as nitrogen and phosphorus to boost the plant growth. Statistically, commercial bio-fertilizer showed significant effects ($p<0.05$) on plant height where at the end of planting period, control plants achieved 41.20 ± 9.56 cm height while plants applied with rabbit manure bio-fertilizer only reached 11.77 ± 0.63 cm height. Nevertheless, flowering and fruits only appeared on plants applied with commercial bio-fertilizer. The output of this study can be used to identify potential bio-fertilizer that may promote growth performance of chilli pepper plant as well as to reduce the use of chemical fertilizer in the nursery. Other than that, it also encourage better waste management in rabbit farming.

Keyword: bio-fertilizer, rabbit manure, commercial fertilizer, chilli pepper plant, growth performance

Kesan Penggunaan Tinja Arnab Sebagai Baja Biologi Terhadap Prestasi Pertumbuhan Pokok Cili (*Capsicum annuum*)

ABSTRAK

Tinja arnab dikenali sebagai salah satu sumber sampingan yang lebih baik untuk membuat baja biologi. Walau bagaimanapun, pada tahun sebelumnya, baja biologi yang diperbuat daripada tinja arnab jarang digunakan oleh petani kerana pengeluaran arnab yang rendah di Malaysia. Kini, ternakan arnab telah menjadi salah sebuah industri yang berkembang di Malaysia untuk memenuhi permintaan sumber daging. Secara tidak langsung, hal ini akan mengakibatkan peningkatan terhadap penghasilan tinja arnab. Kajian ini bertujuan untuk mengkaji kesan tinja arnab sebagai baja biologi pada prestasi pertumbuhan pokok cili. Keberkesanan baja biologi daripada tinja arnab telah dibandingkan dengan baja biologi komersial berdasarkan ketinggian pokok cili, jumlah helaian daun, purata saiz daun and jumlah cili yang dihasilkan. Foliar telah disembur pada pokok cili sebanyak dua kali seminggu. Hasil kajian menunjukkan baja biologi daripada tinja arnab kurang berkesan berbanding baja biologi komersial kerana ketersiadaan kandungan nutrien yang rendah seperti nitrogen dan fosforus untuk meningkatkan pertumbuhan pokok. Secara statistik, baja biologi komersial menunjukkan kesan bererti ($p < 0.05$) pada ketinggian pokok di mana di akhir tempoh penanaman, pokok kawalan telah mencapai ketinggian 41.20 ± 2.47 cm manakala pokok cili yang menggunakan baja biologi daripada tinja arnab hanya mencapai ketinggian 11.77 ± 0.63 cm. Walau bagaimanapun, pembungaan dan buah hanya terhasil pada pokok yang menggunakan baja biologi komersial. Hasil kajian ini dapat digunakan untuk mengenal pasti potensi baja biologi yang boleh menggalakkan prestasi pertumbuhan pokok cili serta mengurangkan penggunaan baja kimia di tapak semaian. Selain itu, kajian ini juga boleh menggalakkan pengurusan sisa yang lebih baik dalam ladang ternakan arnab.

Kata kunci: baja biologi, tinja arnab, baja komersial, pokok cili, prestasi pertumbuhan

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LIST OF ABBREVIATIONS AND SYMBOLS

cm	Centimetre
%	Percentage
L	Litre
ml	Millilitre
m	Metre
EC	Electric conductivity
pH	Potential of hydrogen
MARDI	Malaysian Agriculture Research and Development Institute
MOA	Ministry of Agriculture
DVSSEL	Department of Veterinary Service Selangor
XRF	X-ray fluorescence
RBT	Rabbit manure bio-fertilizer
CF	Commercial bio-fertilizer
CRPV	Cottontail rabbit papillomavirus
GMO	Genetically modified organisms
EU	Europe
H_0	H-null
H_1	H-alternative
EM	Effective microbe
CEC	Cation exchange capacity
SSP	Superphosphate
N	Nitrogen
P	Phosphorus
K	Potassium
Ca	Calcium

S	Sulphur
Sn	Stannum
Sb	Antimony
Ba	Barium
Cl	Chlorine
Fe	Iron
Mn	Manganese
CO_2	Carbon dioxide
CH_2O	Glucose
O_2	Oxygen
H_2O	Water

CHAPTER 1

INTRODUCTION

1.1 Research Background

Rabbit belongs to family of Leporidae and known as small type mammals which usually as pet animals. To date, rabbit farming has become one of the expanding industry in Malaysia to fulfil the demand of meat sources. Continuously, it will lead to increment of rabbit manure production. Rabbit farming in Malaysia may promote great production of rabbit manure to be managed. Rabbit manure is beneficial to the bio-fertilizer industry thus it can act as an activator to the plant growth. Previously, bio-fertilizer which made of rabbit manure is rarely used by farmers due to lower rabbit production in Malaysia. Other than that, rabbit is also used for research purpose because it is known as animal that genetically similar to human (Mapara, Thomas & Bhai, 2012). The first animal that become model for cancer caused by a virus is a cottontail rabbit papillomavirus (CRPV) (Understanding Animal Research, 2015). Louis Pasteur is a successor scientist developed a rabies vaccine by using a rabbits (Understanding Animal Research, 2015). The rabbit productivity is faster which could increase farmer profit in a shorter time rather than farming other animals. The average of foetus that can be delivered by a female rabbit was around seven to nine foetus per mother (Department of Veterinary Service Selangor (DVSSEL), 2017). The management of rabbit farming is not complicated compared to other animals farming such as goats, cows and poultry which required huge land to rear the animals. For example, a goat need 12-15 square feet for the pens, a cow need 30 square feet for the pens while rabbit just required 16 square feet barn which could fit in five parents.

The demand of chilli pepper in Malaysia was increasing from day by day. This is because most of Asian people like to consume spicy food. Based on the Ministry of Agriculture (MOA) Malaysia data, population in Malaysia need 33,000 tons chilli pepper per year but the production is only reached 23,000 tons per year (Ministry of Agriculture (MOA), 2017). Thus, chilli peppers are still need to be imported from other country such as India. In Malaysia, most farmers used fertigation method for chilli planting. One of the benefits of fertigation method is profitable because farmers able to plant high amount of chilli pepper plant in one time. The technology will control the volume of fertilizer, soil amendment and other water soluble products. Then, it will be inserted through irrigation system directly to the polybag. This innovation is useful for Malaysian chilli pepper farmers which able them to supply and fulfil demand of chilli pepper consumers in the country. In Malaysia, there are two types of fertigation either with or without rain shelter. The average production of chilli pepper using rain shelter is 27,720 kg/ ha while without rain shelter is 22,500 kg/ ha (Salleh, 2016). Thus, fertigation technology with rain shelter are more profitable and can achieve average net income until RM 105,654/ ha (Salleh, 2016). The chilli peppers also have variety of species and *Capsicum annuum* is commonly planted in Malaysia to supply for sauce making and chilli flakes. The levels of spiciness of chilli pepper are different and usually can be differentiated through their appearance and shape.

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1.2 Problem Statement

Waste management in animal farming is one of the main problems that need to be faced by farmers in operating the farms. In Malaysia, there are many small scale farmers that operating animal farms but does not aware of the proper waste management practice related to manure production. The main problem of the farmers is they do not have enough knowledge on managing the animal waste. Production of animal manure in high volume can lead to environment pollution if the manure is not being treated or managed properly. Thus, to overcome this problem, animal manure can be utilized and transformed into a potential product in order to minimize the environmental effect. An alternative approach of manure management is utilize manure as a source of bio-fertilizers.

1.3 Hypothesis

H_0: There is a significant between commercial and rabbit manure bio-fertilizer towards chilli pepper plant growth performance.

H_1: There is no significant difference between commercial and rabbit manure bio-fertilizer towards chilli pepper plant growth performance.

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

H_1: If $p > 0.05$, thus the null hypothesis is rejected.

1.4 Objectives

1. To determine the effect of rabbit manure as bio-fertilizer on chilli pepper plant growth performance.
2. To compare the efficiency of rabbit manure as bio-fertilizer with commercial fertilizer towards the growth performance of the chilli pepper plant.

1.5 Scope of Study

The utilized of by-product from rabbit farming in Agro Techno Park University Malaysia Kelantan such as manure to potential product which was organic bio-fertilizer.

1.6 Significance of Study

The aim of the study was to investigate the effect of rabbit manure as bio-fertilizer on chilli pepper plant growth performance. This study could promote the usage of organic fertilizer in order to reduce chemical fertilizer that may give harmful effect towards the environment. Contents of nutrients from rabbit manure are much more than other animals. Weight of 108.5 kg ammonium sulphate, 100.9 kg superphosphate (SSP) and 17.85 kg sulphuric acid potassium contains in one ton of rabbit manure (Li-li et al., 2013). Next, this study are able to educate small scale farmers to know more benefits of bio-fertilizer such as it can act as natural pesticides that excrete antibiotics from organic material degradation (Mahato, Visva-Bharati & Bhavana, 2017). The application of bio-fertilizer may increase nutrients availability and able to produce hormones and anti-metabolites that will promote root growth (Mahato et al, 2017). Other advantages organic fertilizer are may increase crop yield and able to cut the cost and dependency on chemical fertilizer. Besides, nutrients that contains in the bio-fertilizer are released slowly to the soils and it will be absorbed equally by plant to grow. Thus, it will prevent leaching and loss of nutrients. This study can promote better waste management to farmers, thus can reduce the volume of manure production as well as pollution towards environment. Poor management waste practice will create a bad impact to the environment as well as organisms.

CHAPTER 2

LITERATURE REVIEW

2.1 Bio-fertilizer

Bio-fertilizer can be defined as a substance that contains living microorganisms which colonizes the rhizosphere or the interior of the plant. It promotes plant growth when applied to soil, plant surfaces or seed of the plant by enhancing the supply of primary nutrient and growth stimulus to the target crop (Muraleedharan, Seshadri & Perumal, 2012). It can also be defined as a natural organic fertilizer which helps to provide necessary nutrients that required by the plants. Continuously, it will enhance the quality of soils with a natural microorganisms environment. Besides, bio-fertilizers also known as 'microbial inoculatants' which commonly defined as preparation that consists live or latent cells of efficient strains of nitrogen fixing, phosphate solubilising or cellulolytic microorganisms. These elements will apply to the seed, soil or composting areas with aim of increasing the numbers of microorganisms and induce certain microbial process to enlarge the extent of availability of nutrients present which can be used easily by plant (Panda & Hota, 2008).

There are many types of bio-fertilizer such as nitrogen fixing bio-fertilizers (*Rhizobium, Bradyrhizobium, Azospirillum and Azobacter*), phosphorus solubilizing bio-fertilizers (*Bacillus, Pseudomonas and Aspergillus*), phosphate mobilizing bio-fertilizer (*Mycorrhiza*) and plant growth promoting bio-fertilizers (*Pseudomonas sp.*) (Muraleedharan et al., 2012 ; Panda & Hota, 2008). The benefits of bio-fertilizer are enhancement of soil health, reduction of environmental pollution as well as decrease the usage of chemical fertilizer.

Furthermore, bio-fertilizer can be made from plant extract, composted urban wastes and mixture of various microbial. Bio-fertilizer commonly used for soil microorganisms such as bacteria, actinomycetes, fungi, algae and protozoa to increase the rate of nutrients uptake for the plants. The presence of bio-fertilizer in Malaysia has been recognized and Malaysian is aware about the benefit of consuming an organic product. The production of organic product is begin with the use of natural fertilizer such as manure or compost. Besides, an organic meat, eggs and dairy production is begin with the GMO-free feed and hormone with free access to the outdoors from barns or pens. Bio-fertilizer that is used widely in agriculture industry is *mycorrhiza inoculum* where have been started for research since 1980's (Rahim, 2002).

In the factory of fertilizer making, nitrogen is fixed industrially using Haber-Bosch process which requires H_2 gas with extremely high temperature and large energy (Panda & Hota, 2008). In previous study, application of some organic fertilizer which is combination of compost, rabbit manure and olive pomace with half amount of mineral fertilizers gave the highest value of growth rate towards eggplant (*Solanum melongena L.*) (Ahmed, Moula & Aly, 2017). Bio-fertilizer plays role as helper to enhance the nutrient supply to the soils naturally. It can improve level of nitrogen or increase availability of phosphorus in plant crops. There are some factors that affect crop response to bio-fertilizer such as nutrient interaction and microbial strains interaction.

2.2 Rabbit Manure

Rabbit manure is one of the potential by-product from rabbit farming industry. Rabbit droppings can be divided into two type which faecal pellets and caecotrophs. The difference of caecotrophs and faecal pellets is caecotrophs will be eaten back by rabbits as a source of protein and essential nutrients. High percentage of protein in feed caused rabbits not to consume the caecotrophs. The characteristic of faecal pellets is fibrous and brownish which contain undigested hay and grass. Usually, it will be rounded, firm with no liquid and odourless (Buseth & Saunders, 2015).

There are many researches that involved application of rabbit manure towards the crop, livestock and aquaculture industry. Commonly in crop industry, rabbit manure will be used as a bio-fertilizer which available in the formed of compost and foliar. In livestock, some of the farmers use rabbit manure as animals either directly or after some treatment by chemical (acidification) or physical (heating) process in feed formulation. However, this technique is prohibited in EU by Registration (EC) No 767/2009 (Annex III) (Bórquez et al., 2009). Another application of rabbit manure is as energy supply in formed of biogas from recycling process of biomass (Ward, Hobbs, Holliman & Jones, 2008). Researches showed that rabbit manure can produce 0.24 m^3 gas/ kg compared to cow dung which only able to produce 0.12 m^3 gas/ kg (Mahadevaswamy & Venkataraman, 1988)

Besides, rabbit manure was used in aquaculture industry to increase the growth and production of Nile Tilapia. The research on integrated farming, rearing rabbits and Nile Tilapia *Oreochromis niloticus* was done in Rwanda. This type of integration is commonly been done by livelihoods because it is easy to be practiced (Tabaro, Mutanga, Rugege & Jean-Claude, 2012a). It is more profitable and could fasten the rabbit production cycle compared to other livestock animals. The application of rabbit manure onto earth ponds to analyse water quality give better results for pond environment. It improve the growth of fish and reduce dejection for rabbit due to better waste management (Tabaro, Mutanga, Rugege & Micha, 2012b).

2.2.1 Rabbit Manure Bio-fertilizer

Rabbit manure is very effective to be used as bio-fertilizer. This is due to its nutrition content in the bio fertilizer that meets the requirements of N, P, and K of the plants (Islas-Valdez et al., 2015). Bio-fertilizer is highly recommended to farmers because the price of chemical fertilizer in the market is too expensive and it may affect the profit of the farmers. Besides, the production of bio-fertilizer are really good to be practiced as it can minimize the pollution that released to the surroundings especially to the ground that will affect the quality of ground water (He, Pagliari & Waldrip, 2016).

The rabbit manure are very effective to improve the soil properties, water holding capacity and cation exchange capacity (CEC) that will give benefits for plant mineral uptake as well as plant growth (Abdrabbo & Farag, 2008). The result was also supported by the research from Litterick, Harrier, Wallace, Watson, & Wood (2004) and Gül, Erŏul & Ongun (2005) which showed rabbit manure could help to increase the physical, chemical and biological properties of soil as well as the crop yield. Besides that, previous research had proven that the utilization of rabbit manure can enhanced the pepper and eggplant height, number of leaves and fresh and dry weight (Abdrabbo & Farag, 2008). This research also found that the mineral content presence in the rabbit manure boost the N, P, K percentage level. Other research also reported the usage of rabbit manure as an organic soil amendment with a specific dose of mineral fertilizer resulted in increase of vegetative growth aspects of bean plants when compared with fertilizer that made from chicken manure (Abo-Sedera, Shams & Mohamed, 2016).

Furthermore, the rabbit manure are dry and pelleted in shape. The N,P,K ratios that contains in the rabbit manure are 3.7% nitrogen, 1.3% phosphorus and 3.5% potassium with the combination of other trace elements for instance calcium, magnesium, boron, zinc, manganese, sulphur, copper and cobalt (Smith, 2001). The report also stated that rabbit manure did not contain excessive nitrogen that may give burn plants like other animal manures if applied directly to plants. Thus, the rabbit manure can be applied directly to the plants because it is considered as cold manure (Smith, 2001). Another fact of research reported that the rabbit manure can also act as feeder to earthworm and resulted in the elimination of unsightly manure piles, odour and flies trouble (Smith, 2001). Rabbit manure bio-fertilizer also gave positive results to basil crop plantation in season compared to the other ruminant manure bio-fertilizer. Other impact of rabbit manure usage as bio-fertilizer is its ability to produce better reading in area of leaves and chlorophyll contents in leaves (Cabanillas, Stobbia, & Ledesma, 2013).

2.3 *Capsicum annuum*

Chilli pepper plant *Capsicum spp.* originated from Mexico has varies species which are *Capsicum annuum*, *Capsicum frutescens, Capsicum chinense, Capsicum pubescens and Capsicum baccatum*. The growth of chilli pepper fruits is depending on plant size where fruits yield is depending on potassium (K) that available in the soils. The ratio of nitrogen (N), phosphorus (P) and calcium (Ca) contents in leaf tissues will not related with the proportion of K (Hassan, 1995). A research was done for the shoot induction in rooted hypocotyls on chilli pepper plants by cutting the elongated shoots and the other shoots will be further develop number of buds from the hypocotyls (Valera-Montero & Ochoa-Alejo, 1992). The interaction of chilli pepper plant on rabbit manure give a positive feedback where the presence of rabbit manure as a bio-fertilizer may increased pepper plant height, number of leaves and fresh and dry weight respectively (Abdrabbo & Farag, 2008).

A plant needs several important elements for growth which are nitrogen, potassium and phosphorus. Nitrogen is mainly for vegetative growth to have a better development of leaves and give a greenish colour to leaves. It also converting nitrogen to amino acid which act as building block for protein in the plant (Ball, 2007). Besides, it also acts as component for chlorophyll that necessary for enzyme activities (Ball, 2007). Chlorophylls is a pigments that contain in the plant leaves to absorb light and store it as chemical energy (Rabinowitch & Govindjee, 1965). This process is known as photosynthesis which the plant leaves able to utilize the minerals, carbon dioxide (CO_2) and water (H_2O). The equation of overall reaction that occur during photosynthesis:

$$CO_2 + H_2O + light \longrightarrow CH_2O + O_2$$

The element of CH_2O is representing a glucose contents which supply a carbohydrate to undergone development of plants.

In Asia countries, sowing of the chilli pepper usually take place on January to February, June to July and September to October. The application of manure as a bio-fertilizer on chilli pepper and respond of the plant is positive with application of fertilizer should be within four equal doses. Furthermore, the plantation of any type of vegetables should consider the climate such as Malaysia has monsoon and dry season. An optimum temperature of chilli pepper plants is 20 °C to 30 °C for growing (Usman, Rafii, Ismail, Malek, & Abdul Latif, 2014).

There are some conditions that become more favourable for the chilli pepper plantation. Chilli pepper plants will grow better in warm, well-drained soils of moderate fertility which approximately 6.0 to 6.8 pH range of soils acidity. The N,P,K ratio that commonly used is 1:2:2 ratio. For instance, 5:10:10 and 8:16:16 respectively. The chilli pepper plants are very sensitive to cold condition and the ideal temperature is about 21 °C to 27 °C during day and 16 °C to 21 °C at night. Thus, planting chilli peppers plants required a black colour plastic that can help to warm up the soils condition. However, an extremely hot, above 32 °C or cold below 16 °C temperature, during the flowering activities can drop the levels of blossoms. Other factors that can lead to lower production of fruits and stunning the plant are cold weather, lack of sufficient soils moisture and lack of sufficient fertilizer (Whitlock, 2010).

2.3.1 Hybrid Chilli Pepper

The character of chilli pepper plant is a woody plant which will consists of many branches. The maximum height of chilli pepper plants is 120 cm with a maximum canopy wide is 90 cm. Commonly, the leaves of plants will be dark green but depending on the type of variety. Besides, chilli pepper plant have tap root which can be spreading into the soil until 50 cm and 45 cm wide. Hybrid seed of chilli pepper is made from the combination of two parent gene with a desired trait such as high production of fruits and fast growth rate. The combination of these traits will produce a heterosis or hybrid characteristics which carry 50: 50 traits from different parents. This can also affect other factor of genetic traits such as height of plants, level of spicy, susceptibility to diseases, quality of fruits and other factor which can lead to affect its market price. Furthermore, hybrid type of seed usually will produce their own pollination because it consists of two sexes, male and female. Commonly, insects and wind will help in pollination process (Tarigan, Wiryanta & Sallehuddin, 2000).

Although the hybrid seed have various good impacts toward the production of fruits, it also has disadvantages when replanting it. The disadvantage of hybrid seed is require high technology to produce optimum production of chilli. Usually, chilli's farmers will use fertigation technology for chilli pepper planting. This is because it is more profitable and easy to manage the plant with a proper irrigation supply and enough nutrient supply to plant. The AB fertilizer is one of the chemicals fertilizer that commonly be used to supply a complete nutrient uptake using irrigation system directly connect to each polybag (Tarigan et al., 2000). Farmers are able to plant large quantity of chilli pepper in their nursery which only required low energy of labour in a farm. Even though this technology is costly at the beginning, it is more profitable than manually planting. Advantages of hybrid chilli pepper are it has faster growth rate and give high production of quality fruits, equal performance of growth between the plants, longer duration of chilli production and high susceptibility to diseases (Tarigan et al., 2000).

2.3.2 Chilli Pepper Diseases and Treatment

Disease in chilli pepper plant is one of the crucial issues that need to be avoided by farmers that planted the chilli pepper intensively. The causative agent of disease is commonly from pest in the surrounding. Chemical treatment was usually being used to treat the diseases and this should be done as soon as possible to prevent the spreading of diseases to other plants that will reduce the production and profitability. Factor that affects this pest to attack chilli pepper plant is planting the same species of plant throughout the year. Another factors that affect the health of the plants are presence of Mycoplasma, bacteria, fungi, nematode, insects and pest. For non-living factors are machine, electrical energy, hot weather, water and pH of soil. Besides, virus and viroid can also be the causes of diseases to the plants (Tarigan et al., 2000).

One of the diseases that caused by the pest *Myzus persicae Suiz is* green peach aphid. The symptom can be detected by observing the bottom part of the leaves. Generally, the ticks will be in greenish yellow in colour and live in a groups. The effect of this disease is the plant will not be dwarf and no production of fruit from the plant. Next, it also will make the leaves to be wrinkle, yellow in colour and rolled. Thus, photosynthesis process which related with the development of leaves also will be disturbed. Marshal 200 EC or Thiodan 35 EC insecticides can be used to recover the plant health. Electrical conductivity (EC) is a method that used by horticulturists to determine the level of soils health based on quality, nutrient content and pH. Other traditional method is planting the trap plant around the chilli nursery like maize plant (Tarigan et al., 2000). Trap plant or trap crop is useful for prevent pests such as insects away from nearby plants.

Second disease is Anthracnose. Anthracnose disease is caused by the bacteria named as *Colletotrichum spp.* The effect of this disease is plant stem become weak and the shoot of leaves was failed to growth. Thus, the treatment to avoid this disease is by selecting the best location for chilli pepper planting which free from these pathogen. In addition, the seed is soaking in warm water (55 °C) before germination process. The variety of chilli seed should be chosen properly to prevent from the disease. Lastly, frequent observation on removing plant that infected by the pathogen can be done to solve this problem (Hadi, 2012).

CHAPTER 3

MATERIALS AND METHODS

3.1 Materials

3.1.1 Chemicals and Equipment

In this study, no chemical was used. The apparatus had been used were 5 L container, 9 L bottle, filter funnel, strainer, 1 L beaker, 2 L measuring cylinder, sprayer bottle, planting tools, measuring tape, gloves, mask, weighing balance, watering can and 20 x 16 cm polybag.

3.1.2 Materials

The materials had been used were rabbit manure (Figure A.1), molasses (Figure A.2), commercial fertilizer, dechlorinated water, coco peat, and chilli pepper seedlings.

3.2 Methods

3.2.1 Collection of materials for bio-fertilizer preparation.

Approximately, one kilogram of rabbit manure was collected in the Agro Techno Park University Malaysia Kelantan. Then, 500 ml of molasses was added to be mixed with rabbit manure in a 5 L container. A chilli pepper seedlings were bought from the seller and used to test the efficiency of the rabbit manure bio-fertilizer. Lastly, a commercial fertilizer was purchased as control treatment to compare the efficiency of two types of fertilizer on the chilli pepper plants growth performance.

3.2.2 Rabbit manure as bio-fertilizer preparation.

The precaution step for preparing the rabbit manure bio-fertilizer was concerned by wearing a glove and mask to avoid direct contact of skin towards the manure (Figure A.5). The proportion for rabbit manure bio-fertilizer preparation were two part of manure, ten parts of water and one part of molasses (2: 10: 1). Dried rabbit manure was weighed for one kilogram using the weighing balance. Molasses was measured for 500 ml using measuring cylinder. Approximately, five litre of water was used in this study. All materials such as manure, molasses and water were mixed well in the 5 L container. The container was covered to prevent foreign object or insects entering the container. The rabbit manure bio-fertilizer was stirred once a day in duration of two months. After two months, the stock of rabbit manure bio-fertilizer was obtained by filtering the fermented fertilizer using a strainer (Figure A.6). The crude fertilizer was diluted to 1 % working solution before applying to the crops.

3.2.3 Foliar Dilution

The 1 % foliar was prepared for application purpose. Approximately, 90 ml of crude bio-fertilizer was added together with 8910 ml of de-chlorinated water in a container to prepare 9 L foliar solution. The similar step was followed to prepare 1 % of commercial bio-fertilizer dilution. These foliar was ready for application.

Dilution formula:

- 1 % dilution for 9 L foliar

$$\frac{1}{100} \times 9000 \text{ ml} = 90 \text{ ml concentrated stock foliar}$$

$$90 \text{ ml concentrated stock foliar } + 8910 \text{ of dechlorinated water}$$

$$= 9 \text{ L of } 1~\% \text{ working foliar}$$

3.2.4 Plot and Planting Preparation

The planting plot was placed at Agro Techno Park University Malaysia Kelantan and planted under rain shelter (Figure A.7). A measuring tape was used to measure the plot size for chilli pepper planting which was approximately 3.3 m X 3.8 m (Figure 3.1). The measurement was included two treatments group with three replicates. Each replicates consists of 15 chilli pepper seedlings which were transferred from the tray into the polybag. The age of the chilli pepper seedling was about one month which consists of 4 - 6 numbers of leaves (Figure A.9). Two third of cocopeat was poured into the polybag before placing the chilli seedlings. Next, one third of cocopeat was placed after chilli pepper seedlings were inserted into the polybag. A hole was made using a planting scoop to plant the chilli pepper seedlings.

Chilli pepper plants were watered in the morning and evening to ensure it get enough supply of water. The 1 % of rabbit manure bio-fertilizer and commercial bio-fertilizer were applied to the chilli pepper plants using a sprayer bottle respectively in three days of interval.

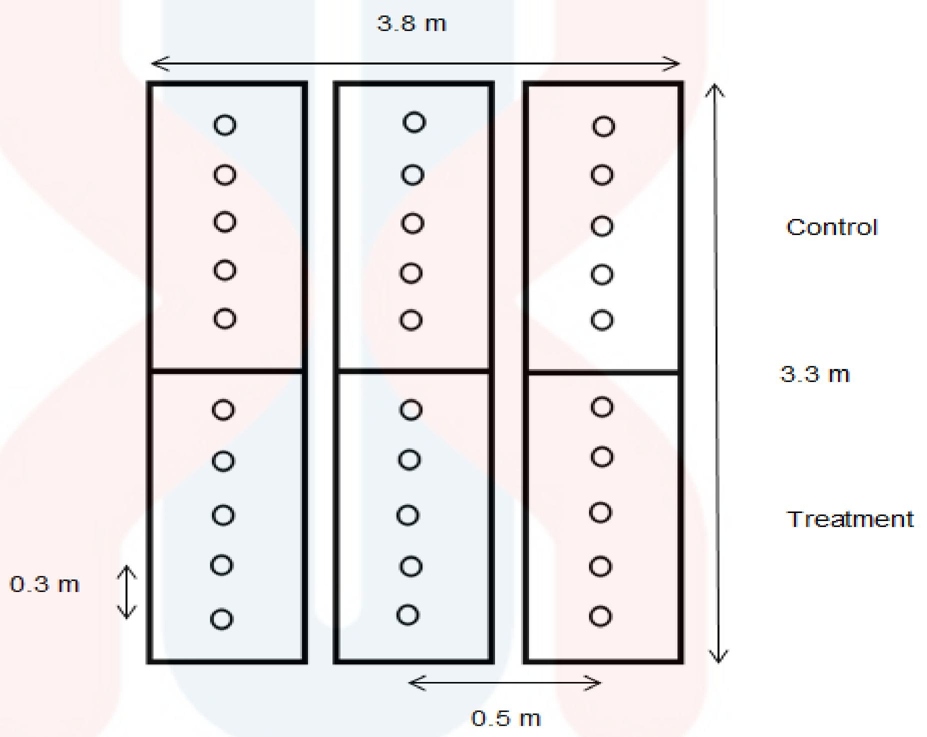

Figure 3.1: Experimental design of planting plot.

3.2.5 Data collection and analysis

The parameters that measured were the number of leaves, size of leaves, height of the plants and number of chilli pepper fruits that grow in each plant. The data was recorded in three days interval for duration of two months. The data analysis was done using an ANOVA test via Excel and SPSS version 23. Elements content in bio-fertilizer were analysed using XRF Technology in University Malaysia Kelantan and another sample of RBT bio-fertilizer and CF bio-fertilizer were send to

Malaysian Agricultural Research and Development Institute (MARDI) for nitrogen analysis purposed.

CHAPTER 4

RESULTS

4.1 Analysis of Elements in Rabbit Manure Bio-fertilizer (RBT) and Commercial Bio-fertilizer (CF)

Rabbit manure bio-fertilizer (RBT) contained elements such as water (H_2O), nitrogen (N), phosphorus (P), sulphur (S), stannum (Sn), antimony (Sb) and barium (Ba). The most important elements that required by plant are nitrogen (N), phosphorus (P) and potassium (K). Nutrient analysis results in Table 4.1 showed rabbit manure bio-fertilizer have lower percentage of potassium element which was less than 0.001 % of concentration. The percentages of N and P in the RBT bio-fertilizer were 0.23 % and 0.059 % respectively.

Commercial bio-fertilizer (CF) contained more element compared to the rabbit manure bio-fertilizer. The list of element were nitrogen (N), barium (Ba), calcium (Ca), chlorine (Cl), iron (Fe), water (H_2O), manganese (Mn), phosphorus (P), sulphur (S), stannum (Sn) and antimony (Sb). The percentages of N and K in the commercial bio-fertilizer were 0.33 % and 0.08 % respectively.

Table 4.1: Concentration of element in bio-fertilizer.

Element	Concentration (%)	
	Rabbit Manure Bio-fertilizer (RBT)	**Commercial Bio-fertilizer (CF)**
Nitrogen, N	0.230	0.330
Phosphorus, P	0.056	0.083
Potassium, K	<0.001	<0.001
Barium, Ba	0.012	0.001
Calcium, Ca	<0.001	0.023
Chlorine, Cl	<0.001	0.167
Iron, Fe	<0.001	0.001
Water, H_2O	99.800	99.600
Manganese, Mn	<0.001	0.001
Sulphur, S	0.136	0.096
Antimony, Sb	0.003	0.001
Tin, Sn	0.003	0.001

Based on the results analysis obtained from Malaysian Agricultural Research and Development Institute (MARDI), the percentage of nitrogen that contained in rabbit manure bio-fertilizer and commercial bio-fertilizer were 0.23 % and 0.33 % respectively. It proved that levels of N in the commercial bio-fertilizer are higher compare to the rabbit manure bio-fertilizer.

4.2 Plant Growth Performance Analysis

4.2.1 Height of Chilli Pepper Plant

Figure 4.1 showed the growth performance based on plant height of rabbit manure bio-fertilizer and commercial bio-fertilizer plant.

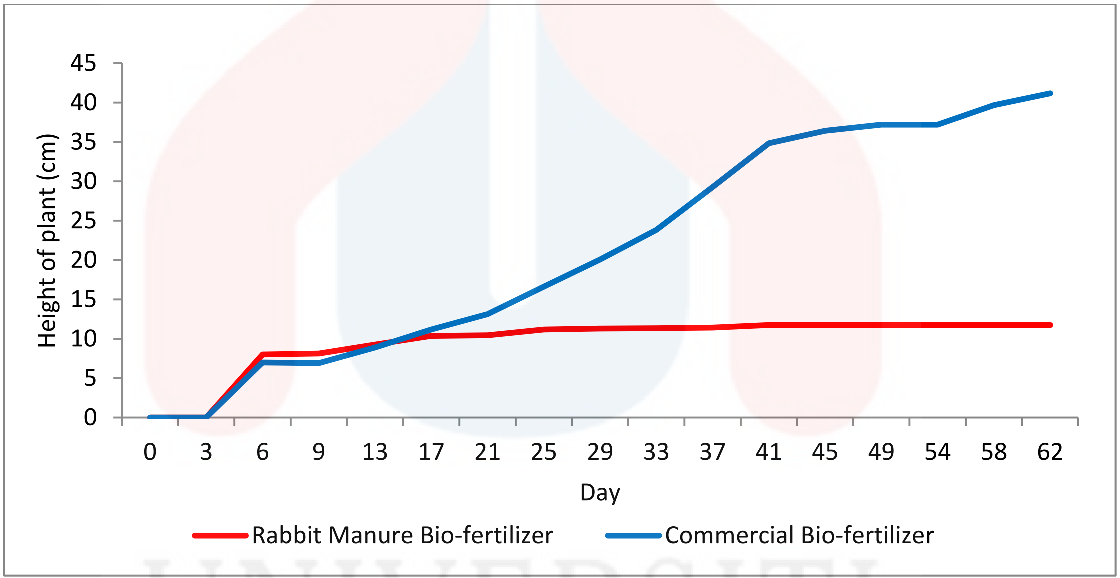

Figure 4.1: Plant growth performance based on height of chilli pepper plant between rabbit manure bio-fertilizer and commercial bio-fertilizer treatment.

The heights of chilli pepper plant throughout the study were increased for both of groups from Day 6 to Day 17. In the treatment application of rabbit manure bio-fertilizer, the height of the plant was increased slowly starting from Day 9 until Day 45 which is from 8 cm to 12 cm respectively. The static reading of height for chilli pepper plants were achieved on Day 45 until the end of period planting on Day 62 which measured at 12 cm of height. Maximum height of chilli pepper plant was 12 cm.

The application of commercial bio-fertilizer on plants showed better growth performance compared to rabbit manure bio-fertilizer. The height of chilli pepper plants was increased same as rabbit manure bio-fertilizer treatments during early stage of planting from Day 6 to Day 13 with a reading measured was 7 cm to 9 cm respectively. On Day 17, the height chilli pepper plants on commercial bio-fertilizer treatment were higher than rabbit manure bio-fertilizer treatment which was 11 cm and 10 cm respectively. On Day 21 until Day 41, the plant height was drastically increased from 13 cm to 35 cm then slightly raised until reached the height of 41 cm.

4.2.2 Leaves of Chilli Pepper Plant

Figure 4.2 showed the growth performance based on leaves number of rabbit manure bio-fertilizer and commercial bio-fertilizer plant.

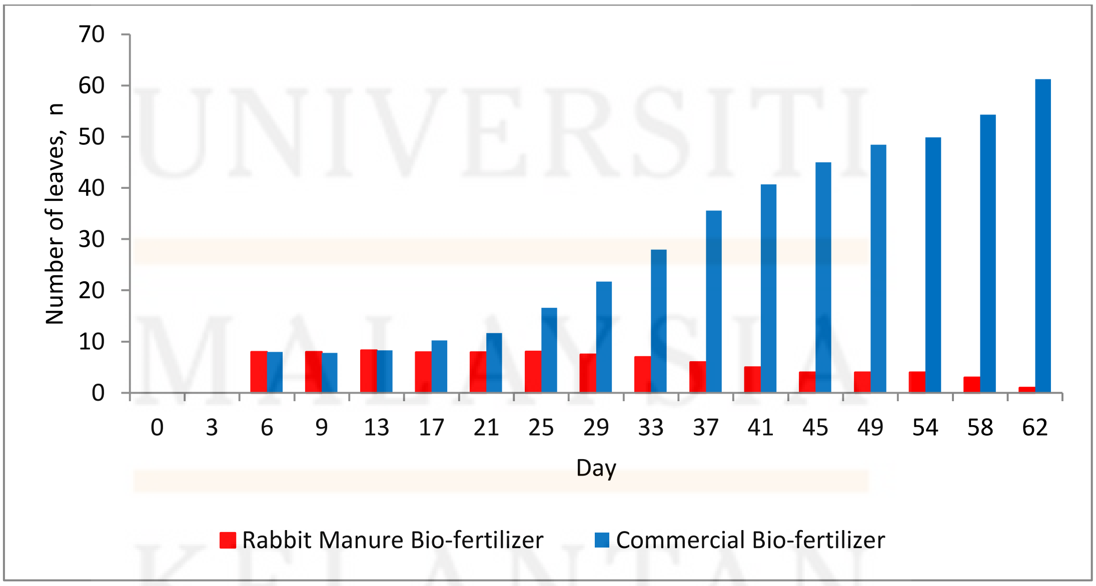

Figure 4.2: Plant growth performance based on number of leaves between rabbit manure bio-fertilizer and commercial bio-fertilizer treatment.

The plant applied by rabbit manure bio-fertilizer undergone declination number of leaves from Day 9 until Day 62. The maximum number of leaves counted on RBT treatment plant was eight leaves and the reading was constant from Day 9 to Day 25. The leaves started to fall on Day 29 until Day 62 from an average of seven to only one leaf. Besides, chilli pepper plant applied by commercial bio-fertilizer had better leaves development. The slight increment of leaves number on control plant was began on Day 17 with an average of 10 leaves until toward the end of planting period of 61 leaves.

Figure 4.3 and Figure 4.4 showed the size of leaves for rabbit manure bio-fertilizer treatment plants were decreased gradually throughout the planting period (Figure A.10). The length sizes of leaves were decreased from 5 cm to 3 cm whereas the width size of leaves were declined from 2 cm to 1 cm. As the declining of the number of leaves happened in the rabbit manure bio-fertilizer treatment, it was then affected the size of the leaves in term of length and width. The result was vice versa in the control treatment plant which used the commercial bio-fertilizer. The size of leaves that have been recorded was increased steadily from Day 9 to Day 62. Length of leaves was raised from 4 cm to 10 cm respectively while width of leaves were recorded to be inclined from 2 cm to 4 cm.

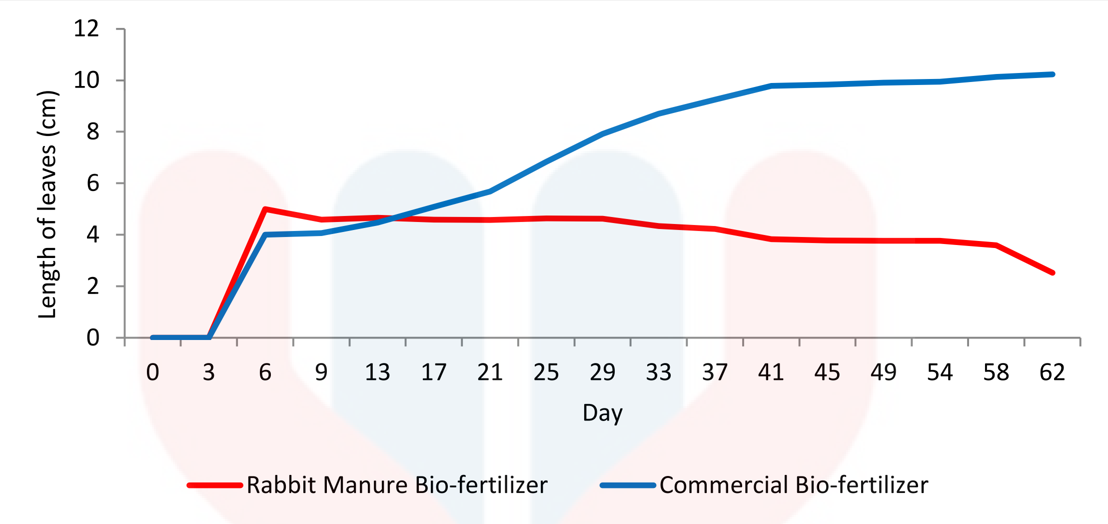

Figure 4.3: Plant growth performance analysis based on length of leaves between rabbit manure bio-fertilizer and commercial bio-fertilizer treatment.

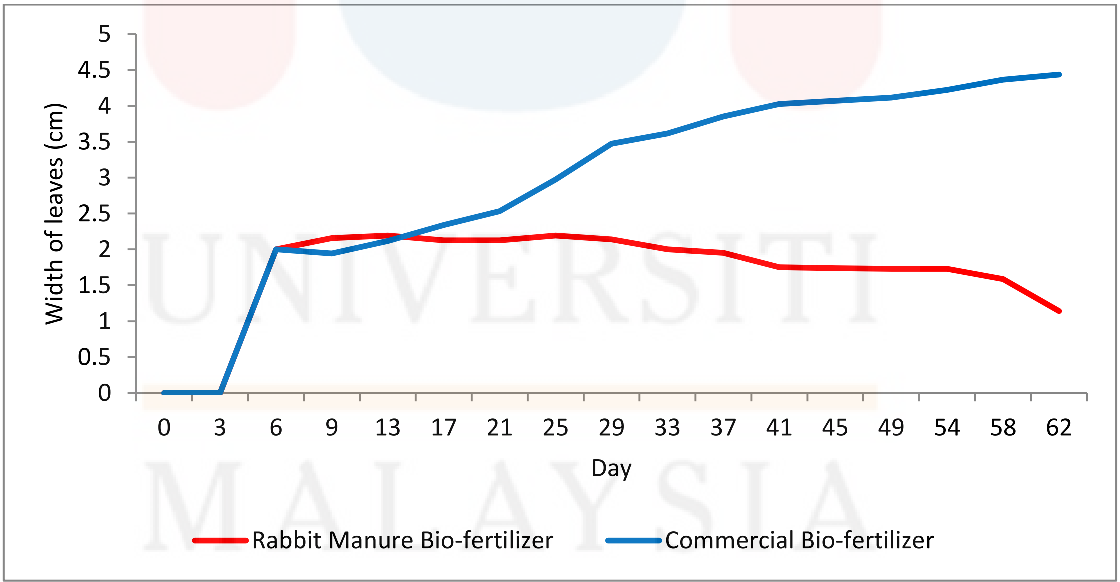

Figure 4.4: Plant growth performance based on width of leaves between rabbit manure bio-fertilizer and commercial bio-fertilizer treatment.

4.2.3 Fruiting Stage of Chilli Pepper Plant

Figure 4.5 showed the growth performance based on fruits produced of rabbit manure bio-fertilizer and commercial bio-fertilizer plant.

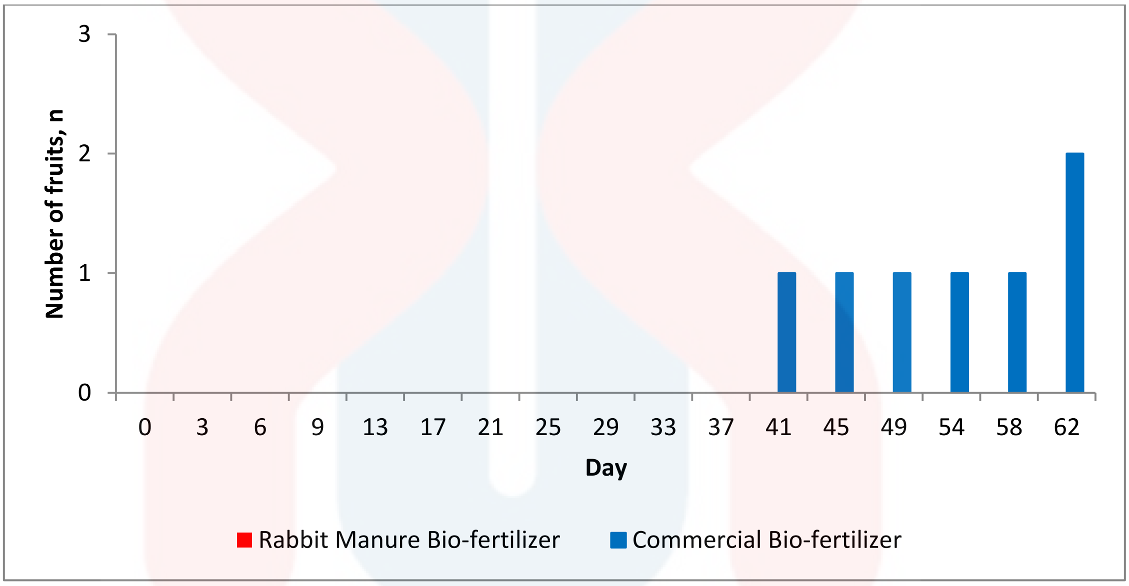

Figure 4.5: Plant growth performance based on fruiting stage of plant between rabbit manure bio-fertilizer and commercial bio-fertilizer treatment.

The fruiting stage was successfully developed on control treatment plant which using commercial bio-fertilizer (Figure A.11). Flowering stage was begin on Day 37 and fruiting of plant was begun on Day 41 of planting period which the age of plant was around three months old. The average number of fruits on plant was two chilli peppers while plants that used rabbit manure bio-fertilizer was not produced any fruits yet throughout the planting period up to Day 62.

CHAPTER 5

DISCUSSION

5.1 Analysis of Elements in Rabbit Manure Bio-fertilizer (RBT) and Commercial Bio-fertilizer (CF)

The analysis of rabbit manure bio-fertilizer and commercial bio-fertilizer was done using X-Ray Fluorescence (XRF) analysis. This technology involved the emission of characteristic fluorescent X-rays from a sample then has been excited by high energy X-rays or gamma rays. Element that can be detected from this machine is from sodium to uranium. Nitrogen element was not included and cannot be detected using this technology. Thus, the fertilizer samples were send to other institute for element analysis which was at Malaysian Agricultural Research and Development Institute (MARDI).

From the bio-fertilizer analysis, the result showed the percentage of nitrogen content in rabbit manure bio-fertilizer (RBT) was lower that commercial bio-fertilizer (CF) which is only 0.23 % and 0.33 % respectively. These results showed that commercial bio-fertilizer have an advantage to perform better rate of photosynthesis towards plants development especially on production of healthy leaves. Based on the previous study, the results showed nitrogen, phosphorus and potassium content in rabbit manure were 1.04 %, 0.99 % and 2.05 % (Adeniyan, Ojo, Akinbode & Adediran, 2011).

Analysis resulted for potassium element could not be detected by the XRF machine. This is because the amount of potassium that contained in the bio-fertilizer was less than 0.001 %. Potassium has an indirect role in plants which mean it is not involved in any part of plant. The function of potassium towards plants development is to activate an enzyme. Potassium role is to bind molecule with changing of physical shape to produce an appropriate active site for reaction to occur (Prajapati & Modi, 2012). The potassium also controls the stomata activity in terms of water absorption. The opening of stomata on the surface of plant leaves were depending on the potassium element because it will regulate the exchange of chemical process such as carbon dioxide (CO_2), water vapour and oxygen (O_2) between the atmosphere. The deficient level of potassium in the bio-fertilizer may cause stress effect to the plants due to shortage of water uptake for plants developments.

Potassium could triggered enzyme activity which mainly produced adenosine triphosphate (ATP) for regulating stomatal activity and source of energy for chemical reaction (Prajapati & Modi, 2012). The potassium is required to maintain the plants quality to withstand an extreme surrounding such as temperature and pests (Ball, 2007). Phosphorus also play important role in developing plant. One of the roles is it controls the energy transformation in physiological functions such as photosynthesis, respiration, cell division, energy transfer and storage also cell enlargement. An optimum level of phosphorus is required to have a good development of root in plants. Besides, phosphorus required in maturing the crop and seed formation during early stage of plantation (Mullins, 2017).

Overall results of plant growth performance showed less effectiveness of rabbit manure bio-fertilizer which may due to the inaccurate proportion of rabbit manure and molasses with addition of too much dechlorinated water into the mixture. The ratio of materials used (rabbit manure: dechlorinated water: molasses , 2:10:1) made the foliar stock too diluted. It caused lower availability of nutrients content in the bio-fertilizer. Water has ability to affect the performance of foliar because acid and alkaline water with little buffering or excess salts cause flourished of microbes (Merrill & McKeon, 1998). The preferred water to be used to made foliar were using spring water or filtered water.

Next, the fermentation period for degradation of materials used bio-fertilizer was too short and probably not fully completed. Thus, resulted an incomplete degradation of chemicals in the foliar stocks and mixture of aerobic and anaerobic process of fermentation. From the previous study, the duration of fermentation was 7 days to allow the nutrients from ingredients such as manure and molasses to dissolve (Mahmoud, 2011). Volume of molasses also affects the production of effective bio-fertilizer. Microbes that produced in the bio-fertilizer require food in the form of carbon source which contain in molasses to enhance the degradation of materials in the bio-fertilizer. Molasses also act as enhancement of microbial activity during fermentation period. Another role of molasses are as a natural deodorizer and mild natural fungicide (Osunkoya & Okwudinka, 2011). Furthermore, changes of oxygen, moisture, temperature and acidity can affect the bacteria to die or become inactive.

5.2 Plant Growth Performance Analysis

5.2.1 Height of Chilli Pepper Plant

The height of plant is crucial to the development of other part of plants such as development of leaves, flowering and fruiting stage of the plants (Omotoso & Shittu, 2007). There were significant different between height of chilli pepper plants between two treatments. The plants that applied with rabbit manure bio-fertilizer was not demonstrated better growth performance and only achieved a maximum height of 12 cm on Day 41 while the chilli pepper plants that were applied using commercial bio-fertilizer were increased in height throughout the planting period up until 41 cm (Figure 4.1). Based on the previous study, the results showed that an increment levels of nitrogen and phosphorus could affect the plant height (Naeem et al., 2002). Nitrogen rates also can determine other perimeter reading such as number of leaves, size of leaves, length of root, increased of branches number also plant height (Omotoso & Shittu, 2007 ; Amin, 2011). Besides, the height of plant is important to ensure the growth of other parts of plants such as fodder, grains and fruit yield (Gloria et al., 2017). The height of the plant is dependent on the amount of nitrogen supply to the plants. This is because it is related to the production of amino acids, proteins and nucleic acids (Vincentz et al., 1993). However, other study reported that potassium enhanced the plant height due to the production and translocation of carbohydrate (Ayemi, Singh & Fatmi, 2017). The potassium will synthesis the peptide bond, carbohydrate metabolism and protein to perform a rapid cell division and differentiation (Belorkar et al., 1992). The role of phosphorus is to give a supports in terms of cell walls to produce higher plants (Ayemi et al., 2017).

5.2.2 Leaves of Chilli Pepper Plant

Based on the results recorded in terms of leaves number, the chilli pepper from rabbit manure bio-fertilizer treatment had contrary results with chilli pepper plants from commercial bio-fertilizer treatment. It showed that after application of rabbit manure bio-fertilizer, the numbers of leaves were decreased throughout the planting period whereas the data showed an increment towards the other treatment. A study on chilli pepper plant development stated that the vegetative growth would be depending on the nitrogen element supply from the bio-fertilizer (Naeem et al., 2002).. Additionally, different scientist also reported that nitrogen supply will ensure the plant growth and increase yield achieve the optimum growth of plant (Mattson, Johansson, Lundborg, Larsson & Larsson, 1991 ; Khaskheli, 2011). Figure 4.3 and Figure 4.4 showed the comparison on size of leaves for rabbit manure bio-fertilizer and commercial bio-fertilizer chilli pepper plant. Lower level of nitrogen content in bio-fertilizer affects the growing tips to be pale and weak, plants will be small in size, do not thrive, few flower and poor fruits size and appearance (McDougall et al., 2013). The effect if low nitrogen content in soils are leaching due to overwatering. An uptake of nitrogen element will be depending on the root system of the plant and root diseases will cause ineffective nutrient uptake from the soils (McDougall et al., 2013)

Other impact of rabbit manure bio-fertilizer is the plant leaves was started to fall from Day 29 until day 62 (Figure 4.2). The fallen leaves may caused by the interference of nutrient absorption from bio-fertilizer based on pH or acidity of the foliar. The pH reading of rabbit manure bio-fertilizer was too high which was pH 4 same as measured on commercial bio-fertilizer. A suitable pH for maximum plant nutrient uptake should be around 6 to 7. This is because, at high acidity, iron is not available to plant roots. Some of the plants were very sensitive to high levels of pH. The effect of this condition will cause yellowing of young leaves because of iron chlorosis (Rosen & Bierman, 2011). The leaves will be wilt and fall out from the plant as it is related to the buffering capacity of the bio-fertilizer. This problem can be solved using bicarbonate to maintain pH values between 5.5 and 7.5 in water. Role of bicarbonate is to bind with acid which result in secretion of carbon dioxide to atmosphere.

5.2.3 Fruiting Stage of Chilli Pepper Plant

The flowering stage of chilli pepper was observed on treatments of commercial bio-fertilizer. Flowers started to develop on Day 37 which the ages of plants were reached three months old. The fruiting stage of chilli pepper plants began on the next of recording data session which was on Day 41 of planting. However, the other treatment plant which applied with rabbit manure bio-fertilizer was not giving any sign of neither flowering nor fruiting. From the observation, lower production of fruits from rabbit manure bio-fertilizer treatment compared to commercial bio-fertilizer may caused by many factors. The first limiting factor was nutrients deficiency of the plants to produce a fruits. There are various nutrients that required in fruiting stage such as nitrogen, phosphorus, potassium, calcium, manganese, zinc and others. As reported from the previous study, high intensity nitrogen elements could cause delays on flowering and fruiting of plants (Naeem et al., 2002). A balance nutrients that received by the plants were produced optimum yield of fruits. The deficiency of calcium during fruiting stage can caused a sunken, black or dark leathery patch appearance which covers the surface structure end of fruits (McDougall et al., 2013).

Next, fruiting stage is affected by the pH soil. This is because pH of soil will contribute to effective nutrient uptake that will be utilised by all parts of the plants.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The study was done to investigate the effect of rabbit manure as a bio-fertilizer on chilli pepper plant growth performance. This study was done to develop a potential by-product from waste produced in rabbit farming. The data analysis showed that there was no significant effect on plant growth performance after the application of rabbit manure bio-fertilizer on chilli pepper plants. However, the control group which used commercial bio-fertilizer have better performance of chilli pepper plants growth based on height, number of leaves, sizes of leaves in term of length and width and production of fruits. The used of commercial bio-fertilizer was able to boost the growth of chilli pepper plant and produced fruits. Overall growth performance of chilli pepper plants showed significant effect on plant height which maximum height of control plant was 41.20 ± 2.47 cm compared to treatment plant which only achieved maximum height of 11.77 ± 0.63 cm. From the statistical analysis, the p-value that calculated was less than 0.05. Thus, H_0 hypothesis was accepted and there was a significant difference between commercial and rabbit manure bio-fertilizer towards chilli pepper plants growth performance.

6.2 Recommendation

Based on the study, the rabbit manure bio-fertilizer were not performed well due to some of factor such as proportion of ingredient used and duration of foliar fermentation. Thus, to improvise this study on effectiveness of rabbit manure bio-fertilizer, several factor should be considered to ensure the study will be success and useful for future references. Firstly, to increase the effectiveness of rabbit manure bio-fertilizer, effective microbe (EM) can be used to replace the used of molasses in this bio-fertilizer. This is because effective microbe (EM) readily contained live microbe while molasses was only a medium to grow the microbe. The presence of microbe in the bio-fertilizer is important for materials degradation and conversion to elements such as nitrogen, phosphorus and potassium that useful for plants growth.

More than that, additional of waste material from farm yard such as rotten fruits and vegetables could increase the effectiveness of rabbit manure bio-fertilizer towards the chilli pepper plants. This is because it can provide more elements to the bio-fertilizer such as nitrogen and potassium which required for plant growth. Next, the proportion of ingredient to make a foliar should be enough to supply the plants important elements for growth. The solution should be prevented from addition of too much dechlorinated water because it could make the foliar to be too diluted and resulted in less elements content in the foliar. Furthermore, to produce more effective rabbit manure bio-fertilizer, the manure is preferably from rabbit that consumed high nutritional feed in their daily diets. This is because, the nutrients content in the manure will be related to the feed that consumed by the rabbit.

REFERENCES

Abdrabbo, M. A. A., Farag, A. A., (2008). Using different mixtures of organic and inorganic materials plus levels of rabbit manure to grow pepper and eggplant in pot culture. *The 1st Egyptian Conference on Rabbit Sciences*, (April). 42-52

Abo-Sedera, Shams, Mohamed, H. (2016). Effect of organic fertilizer and foliar spray with some safety compounds on growth and productivity of snap bean. *Annals of Agriculture Science, Moshtohor*, *54*(January), 105–118.

Adeniyan, O. N., Ojo, A. O., & Adediran, J. A. (2011). Comparative study of different organic manures and npk fertilizer for improvement of soil chemical properties and dry matter yield of maize in two different soils. *Journal of Soil Science and Environmental Management*, *2*(1), 9-13.

Ahmed M. S. M., Manal M. H. Gad-El Moula, A. A. Farag. and Mona. A. M. A. (2017). Response of eggplant (Solanum melongena L .) to application of some organic fertilizers under different colors of plastic mulch. *Journal, Middle East Awny, Ahmed Agricultural, Farag Protection, Climate Management, Natural Resources Improvement, Soil Energetic, Combined Utilization, Material Wastes, Lignocellulosic Agricultural View, Residues Investigations, Comprehensive Delta, Nil*, *5*(February), 636–646.

Amin, M. E. M. H. (2011). Effect of different nitrogen sources on growth, yield and quality of fodder maize (Zea mays L.). *Journal of the Saudi Society of Agricultural Sciences*, *10*(1), 17-23.

Ayemi, T. J., Singh, D. & Fatmi, U. (2017). Effect of npk on plant growth, flower quality and yield of gerbera (Gerbera jamesonii L.) cm. ruby red under naturally ventilated poluhouse condition. *Current Microbiology and Applied Sciences Journal,* 6(8), 1049-1056.

Ball, J. (2007). Back to basics: the roles of n, p, k and their sources. Retrieved 8 December, 2017 from Noble Research Institute: https://www.noble.org/news/publications/ag-news-and-views/2007/january/back-to-basics-the-roles-of-n-p-k-and-their-sources/

Belorkar, P. V., Patil, B. N., Golliwar, V. J., & Kothare, A. J. (1992). Effect of nitrogen levels and spacing on growth, flowering and yield of African marigold (Tagetes erecta L). *Journal Soil Crops*, *2*, 62-64.

Bórquez, J. L., Pinos-Rodríguez, J. M., González, S. S., Domínguez, I., Bárcena, R., Mendoza, G., & Cobos, M. (2009). Use of different kind of silage dairy cattle manure in lamb nutrition. *Italian Journal of Animal Science*, *9*(1), 129–133. https://doi.org/10.4081/ijas.2010.e25

Buseth, M. E., & Saunders, R. (2014). *Rabbit behaviour, health and care*. United Kingdom: Centre for Agriculture and Bioscience International. 1-242

Cabanillas, C., Stobbia, D., & Ledesma, A. (2013). Production and income of basil in and out of season with vermicomposts from rabbit manure and bovine ruminal contents alternatives to urea. *Journal of Cleaner Production*, *47*, 77–84. https://doi.org/10.1016/j.jclepro.2013.02.012

Department of Veterinary Service Selangor (DVSSEL). (2017). Rabbit meat. Retrieved March 29, 2017, from DVSSEL: http://www.dvssel.gov.my/Arnab-Pedaging.html#

Gloria, P.M., Ibrahim, Iro I., Zwalnan, D. N., Jameela, A., Henry, U. I. (2017). Effect of different levels of npk fertilizer on the growth and yield of okra (Abelmoschus Esculentus L .). *Science, Technology & Engineering*, *3*(1), 1–8.

Gül, A., Erŏul, D., & Ongun, A. R. (2005). Comparison of the use of zeolite and perlite as substrate for crisp-head lettuce. *Scientia Horticulturae*, *106*(4), 464–471. https://doi.org/10.1016/j.scienta.2005.03.015

Hadi, M. (2012). *Cili hibrid sebagai sumber bisnes.* Kuala Lumpur : Synergy Media. 1-192

Hassan, S. (1995). Growth and yield of chilli (Capsicum annuum L.) in response to mulching and potassium fertilization. *Pertanika Journal of Tropical Agricultural Sciences*, *18*(2), 113–117. Retrieved from http://psasir.upm.edu.my/

He, Z., Pagliari, P. H., & Waldrip, H. M. (2016). Applied and environmental chemistry of animal manure: A Review. *Chemistry and Animal Manure*, *26*(6), 779–816. https://doi.org/10.1016/S1002-0160(15)60087-X

Islas-Valdez, S., Lucho-Constantino, C. A., Beltrán-Hernández, R. I., Gómez-Mercado, R., Vázquez-Rodríguez, G. A., Herrera, J. M., & Jiménez-González, A. (2015). Effectiveness of rabbit manure biofertilizer in barley crop yield. *Environmental Science and Pollution Research*, (November). https://doi.org/10.1007/s11356-015-5665-2

Khaskheli, M.A., (2011). Sustainable agriculture and fertilizer practices in Pakistan. Retrieved on December 10, 2017 from Pakissan: http://www.pakissan.com/english/allabout/farminputs/fertilizers/sustainable.agriculture.an d.fertilizer.shtml.

Li-Li, B., Tie-Jun, Y., Bin, W., Lin, B., De-Gui, T., & Xiang-Chao, F. (2013). Evaluation and comparison of composting rabbit manure mixed with mushroom residue and rice straw. *Journal of Agricultural Science and Technology*, *15*(5), 1069-1081.

Litterick, A., Harrier, L., Wallace, P., Watson, C. a., & Wood, M. (2004). The role of uncomposted materials, composts, manures, and compost extracts in Reducing pest and disease incidence and severity in sustainable temperate agricultural and horticultural crop production - a review. *Critical Reviews in PLant Sciences*, *23*(May 2015), 453–479. https://doi.org/10.1080/07352680490886815

Mahadevaswamy, M., & Venkataraman, L. V. (1988). Integrated utilization of rabbit droppings for biogas and fish production. *Biological Wastes*, *25*(4), 249–256. https://doi.org/10.1016/0269-7483(88)90086-9

Mahato, M. A., & Bhavana, P. S. (2017). Bio-fertilizers in organic agriculture. Retrieved on December 10, 2017 from Acedemia: https://www.academia.edu/7273299/Bio-Fertilizers_in_Organic_Agriculture

Mahmoud & M.M. (2011). Manure tea and amino acids as potential economic and safe substitutes for mineral and organic fertilization and the effect on growth, yield and chemical composition of faba Bean Plants. *Soil and Agriculture Journal*, 2(10), 1059-1073.

Mapara, M., Thomas, B. S., & Bhat, K. M. (2012). Rabbit as an animal model for experimental research. *Dental Research Journal*, *9*(1), 111–118. http://doi.org/10.4103/1735-3327.92960

Mattsson, M., Johansson, E., Lundborg, T., Larsson, M., & Larsson, C. M. (1991). Nitrogen utilization in N-limited barley during vegetative and generative growth: I. Growth and nitrate uptake kinetics in vegetative cultures grown at different relative addition rates of nitrate-N. *Journal of Experimental Botany*, *42*(2), 197-205.

McDougall, S., Watson, A., Stodart, B., Kelly, G., Troldahl, D., & Tesoriero, L. (2013). *Tomato, capsicum, chilli and eggplant: a field guide for the identification of insect pests, beneficials, diseases and disorders in Australia and Cambodia*. Australian Centre for International Agricultural Research (ACIAR). 206-227

Merrill, R., & McKeon, J. (1998). Organic teas from composts and manures. *Organic farming research foundation project report*, 97-40.

Ministry of Agriculture (MOA) Malaysia. (2017). Vegetables. Retrieved March 29, 2017, from MOA: http://www.moa.gov.my/sayur-sayuran

Mullins, G., (2017). *Phosphorus, agriculture & the environment*. Virginia: Virginia State University. 1-12

Muraleedharan, H., Seshadri, S., & Perumal, K. (2012). *Booklet on Biofertilizer (Phosphobacteria)*. Chennai. 1-16

Naeem, N., Muhammad, I., Khan, J., Nabi, G., Muhammad, N. & Badshah, N. (2002) Influence of various levels of nitrogen and phosphorus on the growth and yield of chilli (*Capsicum annuum L.*). *Asian Journal of Plant Sciences*, 1(5), 599-601.

Omotoso, S. O. & Shittu, O. S. (2007). Effect of npk fertilizer rates and method of application on growth and yield of okra (Abelmochus esculents (L.) Meench) atdo-ekiti southwestern, nigeria. *International Journal of Agriculture Research*, 2 (7), 614-619.

Osunkoya, O. A., & Okwudinka, N. J. (2011). Utilization of sugar refinery waste (molasses) for ethanol production using Saccharomyces cervicae. *American Journal of Scientific and Industrial Research*, *2*(4), 694-706.

Panda, H.,& Hota, D. (2008). *Biofertilizers and Organic Farming*. Daya House Publishing, India. 1-608

Prajapati, K. & Modi, H.A. (2012). The importance of potassium in plant growth. *Plant Science Journal*, 1(02-03), 177-186.

Rahim, K. A. (2002). Biofertilizers in Malaysian agriculture: Perception, demand and promotion. *Country Report of Malaysia*, FNCA Joint Workshop on Mutation Breeding and Biofertilizer, (August), 20-23.

Rabinowitch, E. I., & Govindjee. (1965). The role of chlorophyll in photosynthesis. *Scientific American*, *213*(1), 74-83.

Rosen, C. J., & Bierman, P. M. (2011). Maintaing soil fertility in on organic fruit and vegetables crops system. *University Minnesota Extension Service*, *1192*. 1-10

Salleh, K. (2016). MyAgri.com.my. Analisa Ekonomi Tanaman Cili. Retrieved December 10, 2017, from MyAgri: myagri.com.my/2016/03/analsa-ekonomi-tanaman-cili/

Smith, K. K. (2001). Raising Worms With Rabbits. Retrieved March 23, 2017 from Happy Dranch: http://www.happydranch.com/printer_worms_rabbits.html

Tabaro, S. R., Mutanga, O., Rugege, D., & Micha, J. (2012a). Rabbit droppings as an organic fertilizer in earthen ponds , to improve growth and production of Nile tilapia , Oreochromis niloticus. *Rwanda Journal*, *28*, 11–38.

Tabaro, S. R., Mutanga, O., Rugege, D. & Micha, J. (2012b). Rearing rabbits over earthen ponds in rwanda: effects on water and sediment quality, growth and production of nile nilapia oreochromis niloticus, *Applied Aquaculture Journal,* 24(2), 170-181, https://doi.org/10.1080/10454438.2012.679155

Tarigan, S., Muhammad Sallehuddin, & Wahyu Wiryanta. *Penanaman cili secara intensif: Kaedah mengatasi masalah secara praktikal*. Kuala Lumpur: Synergy Media Books. 1-124

Understanding Animal Research. (2015). Rabbit. Retrieved December 10, 2017, from Understanding Animal research: http://www.understandinganimalresearch.org.uk/animals/10-facts/rabbit/

Usman, M. G., Rafii, M. Y., Ismail, M. R., Malek, M. A., & Abdul Latif, M. (2014). Heritability and genetic advance among chili pepper genotypes for heat tolerance and morphophysiological characteristics. *Scientific World Journal*, *2014*. https://doi.org/10.1155/2014/308042

Valera-Montero, L. L., & Ochoa-Alejo, N. (1992). A novel approach for chili pepper (Capsicum annum L.) plant regeneration: shoot induction in rooted hypocotyls. *Plant Science*, *84*(2), 215–219. https://doi.org/10.1016/0168-9452(92)90137-B

Vincentz, M., Moureaux, T., Leydecker, M. T., Vaucheret, H., & Caboche, M. (1993). Regulation of nitrate and nitrite reductase expression in Nicotiana plumbaginifolia leaves by nitrogen and carbon metabolites. *The Plant Journal*, *3*(2), 315-324.

Ward, A. J., Hobbs, P. J., Holliman, P. J., & Jones, D. L. (2008). Optimisation of the anaerobic digestion of agricultural resources. *Bioresource Technology*, *99*(17), 7928–7940. https://doi.org/10.1016/j.biortech.2008.02.044

Whitlock, L. (2010). How to grow peppers. *In The Economist* (Vol. 397, pp. 1–33).

APPENDIX

Table A. 1: One-way ANOVA.

		Sum of Squares	df	Mean Square	F	Sig.
Plant_height	Between Groups	6494.465	1	6494.465	133.620	.000
	Within Groups	1360.909	28	48.604		
	Total	7855.375	29			
Length_of_leaves	Between Groups	445.214	1	445.214	160.977	.000
	Within Groups	77.440	28	2.766		
	Total	522.654	29			
Width_of_leaves	Between Groups	78.732	1	78.732	138.841	.000
	Within Groups	15.878	28	.567		
	Total	94.610	29			
Number_of_leaves	Between Groups	25637.633	1	25637.633	189.674	.000
	Within Groups	3784.667	28	135.167		
	Total	29422.300	29			
Number_of_fruits	Between Groups	24.300	1	24.300	17.719	.000
	Within Groups	38.400	28	1.371		
	Total	62.700	29			

Table A.2: Descriptive table.

			N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between- Component Variance
							Lower Bound	Upper Bound			
Plant_height	Rabbit manure bio-fertilizer		15	11.77	2.428	.627	10.43	13.12	7	15	
	Commercial bio-fertilizer		15	41.20	9.556	2.467	35.91	46.49	20	53	
	Total		30	26.49	16.458	3.005	20.34	32.63	7	53	
	Model	Fixed Effects			6.972	1.273	23.88	29.09			
		Random Effects				14.713	-160.46	213.44			429.724
Length_of_leaves	Rabbit manure bio-fertilizer		15	2.53	1.994	.515	1.43	3.63	0	5	
	Commercial bio-fertilizer		15	10.23	1.248	.322	9.54	10.93	7	12	
	Total		30	6.38	4.245	.775	4.80	7.97	0	12	
	Model	Fixed Effects			1.663	.304	5.76	7.00			
		Random Effects				3.852	-42.57	55.33			29.497
Width_of_leaves	Rabbit manure bio-fertilizer		15	1.14	.889	.229	.65	1.63	0	2	
	Commercial bio-fertilizer		15	4.38	.587	.152	4.05	4.71	3	5	
	Total		30	2.76	1.806	.330	2.09	3.43	0	5	
	Model	Fixed Effects			.753	.137	2.48	3.04			
		Random Effects				1.620	-17.82	23.34			5.211
Number_of_leaves	Rabbit manure bio-fertilizer		15	1.47	1.302	.336	.75	2.19	0	4	
	Commercial bio-fertilizer		15	59.93	16.390	4.232	50.86	69.01	31	80	
	Total		30	30.70	31.852	5.815	18.81	42.59	0	80	
	Model	Fixed Effects			11.626	2.123	26.35	35.05			
		Random Effects				29.233	-340.74	402.14			1700.164
Number_of_fruits	Rabbit manure bio-fertilizer		15	.00	.000	.000	.00	.00	0	0	

	Commercial bio-fertilizer	15	1.80	1.656	.428	.88	2.72	0	6	
	Total	30	.90	1.470	.268	.35	1.45	0	6	
Model	Fixed Effects			1.171	.214	.46	1.34			
	Random Effects				.900	-10.54	12.34			1.529

Figure A.1: Drying process of rabbit manure.

Figure A.2: Molasses.

Figure A.3: Day 1 of fermentation process.

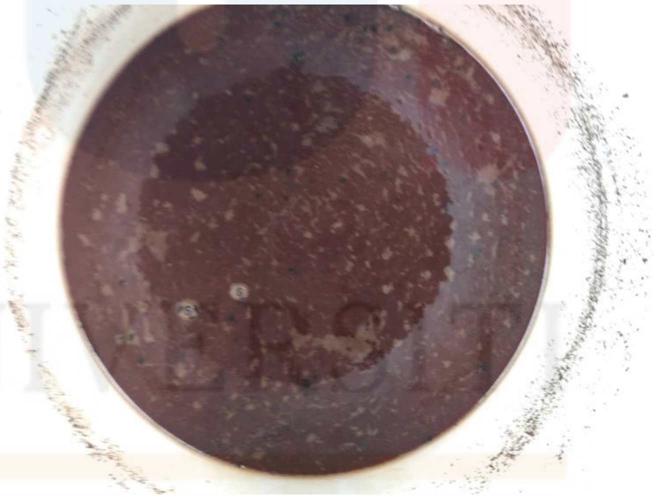

Figure A.4: Day 30 of fermentation process.

Figure A.5: Filtration of foliar stock for further dilution.

Figure A.6: Stock of foliar.

Figure A.7: Planting plot preparation.

Figure A.8: Arrangement of chilli pepper plants were based on the treatments.

Figure A.9: Chilli pepper plant seedlings at the age of 30 days.

Figure A.10: The differences between leaves size of chilli pepper plants. On the left was from rabbit manure bio-fertilizer treatment and on the right was from commercial bio-fertilizer treatment.

Figure A.11: Fruiting stage of chilli pepper plant on commercial bio-fertilizer treatment.