# THE EFFECT OF GOAT MANURE FOLIAR ON CHILLI PLANT (*Capsicum annuum*) GROWTH PERFORMANCE

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**DECLARATION**

I hereby declare that the work embodies 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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I certify that the report of this final year project entitled “The Effect of Goat Manure Foliar on Chilli Plant (*Capsicum annuum*) Growth Performance” by Shahirah Basyirah binti Mokhtar, matric number F14A0346 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.

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**Effects of Goat Manure Foliar on Chilli Plant *(Capsicum annuum*) Growth Performance**


## ABSTRACT

Excessive usage of agrochemical in agricultural activities such as fertilizers and pesticides may cause pollution and damage the environment especially aquatic biodiversity. Many issues had been arising when farmers had been exposed to hazard health as well as the consumers that consumed the contaminated agricultural products posed by the excessive agrochemical used. This project was conducted to develop an alternative organic foliar from organic inputs such as goat manure, egg shell and molded bread which can sustain and enhance the natural environmental elements. The effectiveness of goat manure foliar was compared to commercial foliar based on chilli plant growth performance such as height, number and size of leaf. The chilli planting was conducted for two months and data collection was done twice a week. For comparative effects, 30 chilli plants were divided into two groups which represented as control that used commercial foliar (C), and as treatment that used goat manure foliar (F). Initially, nutrient content analysed by XRF analysis showed commercial foliar had 0.33% nitrogen (N) and 0.08% phosphorus (P) while goat manure foliar contained 0.26% N and 0.10% P. Besides, potassium (K) element only presented in goat manure foliar sample with very little amount 0.17%. Statistically, the growth performances of chilli plants (*C.annuum*) treated with commercial foliar were significantly higher ($p<0.05$) compared to goat manure foliar where at the end of planting period, control plants had reached average height 46.12 ± 1.67 cm while plants applied with goat manure foliar only reached average height of 10.41 ± 1.42 cm after the increment of foliar volume every particular week. The findings of this project summarized that chilli plants (*C.annuum*) required appropriate volume of nutrients depending on the growth stages as well as a suitable foliar condition such as pH value and its concentration for optimal growth performance.



Keywords: goat manure, organic, foliar, chilli plant, growth

**Kesan Baja Daun Tinja Kambing ke atas Prestasi Pertumbuhan Pokok Cili *(Capsicum annuum)***

## ABSTRAK

Penggunaan agrokimia yang berlebihan dalam aktiviti pertanian seperti baja dan racun perosak boleh mengakibatkan pencemaran dan merosakkan alam sekitar terutamanya biodiversiti akuatik. Pelbagai isu telah ditimbulkan apabila petani serta pengguna yang makan hasil produk pertanian yang tercemar disebabkan oleh bahan agrokimia telah terdedah kepada bahaya kesihatan. Projek ini dijalankan untuk menghasilkan baja daun organik daripada sumber organik seperti tinja kambing, kulit telur dan roti berkulat di mana ia mampu mengekal dan menggalakkan unsur-unsur alam semulajadi. Keberkesanan baja daun tinja kambing telah dibandingkan dengan baja daun komersial berdasarkan prestasi pertumbuhan pokok cili seperti tinggi pokok, bilangan dan saiz daun. Penanaman pokok cili dijalankan selama dua bulan dan pengumpulan data telah dibuat dua kali seminggu. Untuk menentukan kesan bentuk perbandingan, 30 pokok cili telah dibahagikan kepada dua kumpulan iaitu kawalan yang menggunakan baja daun komersial (C) dan rawatan menggunakan baja daun tinja kambing (F). Pada permulaannya, kandungan nutrien yang telah dianalisa oleh analisis XRF menunjukkan baja daun komersial mengandungi 0.33% nitrogen (N) dan 0.08% fosforus (P) sementara baja daun tinja kambing mengandungi 0.26% N dan 0.10% P. Selain itu, elemen kalium (K) hanya terdapat dalam baja daun tinja kambing dalam kuantiti yang sangat sedikit dengan jumlah 0.17%. Secara statistik, prestasi pertumbuhan pokok cili (*C.annuum*) yang dirawat dengan baja daun komersial adalah lebih beerti ($P<0.05$) berbanding baja daun tinja kambing dimana pada penghujung tempoh penanaman, pokok kawalan telah mencapai purata ketinggian 46.12 ± 1.67 cm sementara pokok yang dirawat menggunakan baja daun tinja kambing hanya mencapai purata ketinggian 10.41 ± 1.42 cm selepas pertambahan kuantiti baja pada setiap minggu tertentu. Hasil kajian merumuskan bahawa pokok cili *(C.annuum)* memerlukan kuantiti baja daun yang sesuai bergantung kepada tahap tumbesaran di samping kesesuaian keadaan baja daun seperti nilai pH and kepekatan untuk prestasi pertumbuhan yang optima.

Kata kunci: tinja kambing, organik, baja foliar, pokok cili, pertumbuhan

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| | |
|---|---|
| CETDEM | Center for Environment, Technology and Development |
| C/N | Carbon-to-nitrogen |
| FELDA | Federal Land Development Authority |
| XRF | X-ray Fluorescence |
| cm | Centimetre |
| $cm^2$ | Square centimetre |
| g | Gram |
| L | Litre |
| m | Metre |
| ml | Millilitre |
| $m^2$ | Square metre |
| % | Percentage |

# CHAPTER 1

# INTRODUCTION

## 1.0 Research Background

Foliar feeding is the application through spraying of nutrients on plant's leaves and stems where the effective absorption occurred at those sites (Kuepper, 2003a; Pettinelli, 1914). Generally, foliar fertilizer is available in the market as one of the alternative choices to chemical and solid substrate based fertilizers. Foliar fertilizer has commonly been used in modern agriculture soilless farming system such as fertigation and hydroponic. Basically, foliar fertilizer is made up through fermentation process which recommended to be used within three months. The advantage of foliar is it gives faster utilization of nutrients and improved nutrients deficiencies in lesser time compared to soil application (Fageria, Filho, Moreira, & Guimar, 2009). Foliar feeding is the best alternative option for short term solution of certain nutrient deficiencies especially during stress times of the plant (Pettinelli, 1914). Organic farming is a production system which do not use of chemical fertilizers, pesticides, growth stimulators and livestock animals feed additives. This system utilized crop residues, animal wastes and off-farm organic wastes as well as aspects of biological pest control to maintain environmental safety by protecting the natural resources including soil structure and fertility, water resources and biodiversity (Yunus, Pujiasmanto, & Rahayu, 2014).

## 1.1 Problem Statement

Farming industry in Malaysia is still utilizing agrochemicals such as chemical fertilizers and pesticides for their crops. These agrochemicals may cause environmental destruction such as aquatic biodiversity and food safety issues. A related issue arising when the farmers are exposed with health hazards due to agrochemical effects. Growing effort is taken on reviewing the use of chemical-based farm inputs while introducing an alternative approach using organic fertilizer (Othman & Jafari, 2014). Increasing of livestock farming in Malaysia is good for the growth of economic but without proper waste management may cause trouble to human being as well as the environment. Nitrogen leaching for example may pollute the water source as well as harming the aquatic lives. On the other hand, food waste has also becoming one of the greater portion of municipal solid wastes which may pollute the environment (Leung, Cheung, Zhang, Lam, & Lin, 2012). Bread turned into a food waste when it is not consumed, yet nearly all wasted bread will be thrown in landfill sites (Melikoglu, Sze, Lin, & Webb, 2013b). The wastes from bakery can be formed during the process of manufacturing, storage and supply of bread (Kawa-Rygielska, Joanna, Czubaszek, Anna & Pietrzak, 2013). In addition, a lot of egg shells are generated everyday as bio-waste around the world. Not only that, eggshell also can cause pollution to the environment and increasing disposal cost as odour of eggshell can attract flies and pests (Gaonkar & Chakraborty, 2016).

## 1.2 Hypothesis

Within one and a half month, the goat manure foliar was ready to be applied on the chilli plants (*Capsicum annuum*).

$H_o$: Goat manure foliar (F) does not enhanced the growth performance of chilli plants (*Capsicum annuum*) compared to commercial foliar as a control (C).

$H_1$: Goat manure foliar (F) enhanced the growth performance of chilli plants (*Capsicum annuum*) compared to commercial foliar as a control (C).

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

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

## 1.3 Objectives

1. To develop an organic foliar from goat manure, egg shell and molded white bread.
2. To determine the effect of goat manure foliar application on chilli plant (*Capsicum annuum*) growth performance.

## 1.4 Scope of study

The scope of this study was related to the waste management and by-product development using goat manure, egg shell and molded white bread as main ingredients in producing a foliar. The effectiveness of these alternative organic foliar was determined by the application on chilli plants (*Capsicum annuum*) and observation on the growth performance.

## 1.5 Significance of the study

The present study was focused on producing organic foliar as the best alternative to promote the usage of environment-friendly fertilizers in order to minimize pollution using goat manure as the main ingredient, eggshell and molded white bread. Waste are commonly considered as low value products that could be converted into potential products which will return many benefits for human being as well as nature. The usage of organic fertilizer have a great potential to increase crops production in Malaysia and guaranteed on food safety (Farahzety & Aishah, 2013). Not only that, the utilization of available organic wastes from the farm and kitchen waste into foliar will lower the dependence on commercialize fertilizers which are now quite expensive. Although farmers know that fertilizers help for increasing crop production, very little of available manure is utilized in the farming (Awodun, M. A, Omonijo, L. I, Ojeniyi, 2007) Therefore, this study attributed some scientific basis and knowledge for advising farmers on application of goat manure foliar for the crops for example chilli plant (*Capsicum annum*). Chilli had an economic value and benefits for human consumption such as it is useful as food or seasoning in the food industry as well as in the pharmaceutical sector (Maisin, Hassan, Hussein, & Sajap, 1997).

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 By-product

Malaysia is one of the developing countries that shows an improvement in livestock industry activities. Livestock industry known as the third contributor for the growth of Malaysia economy. According to Sakawi & Ismail (2015), the statistics data from the Department of Statistic Malaysia in 2011 stated that the output of the livestock from 2006 to 2010 has been steadily inclined. Even though livestock production activities has promote the growth of economic, large scale livestock farming without effective waste management could pollute the environment. The releasing of nitrogen, N, phosphorus, P, other nutrients and microorganisms from manure into water source can reduce water quality and affect human health, biodiversity loss, weather change, acidification of soil as well as degeneration of ecosystems (Nations, 2009).

Higher number of chicken eggs in an industrial production contributes to a considerable quantity of shell residue. The utilization and management of by-product is an opportunity for the industry because it may provide additional revenue as well as reduce the cost for disposal of these by-products (Zaynudheen, 2010). The discarded eggshell obtained from food industry processing, restaurants, houses, hotels and landfills were collected then purified for making powder using a mixer. The powder of eggshell was applied as fertilizer and being used in medical purposes such as

supplement for females as it is probably good natural source of calcium (Gaonkar & Chakraborty, 2016).

Not only that, food waste such as bread waste are known as a source of complex carbohydrates, proteins and lipids which suitable to be reuse in fermentation processes. These bread waste has been used in several bio processing approaches to make higher value products such as ethanol, methane, lactic acid, succinic acid, amylase and protease (Haroon, Vinthan, Negron, Das, & Berenjian, 2016). Common methods for elimination of bread waste are through burning returned pastries, composting or giving to farmers for animal feed (Kawa-Rygielska et al., 2013). Since 1986, government encouraged agricultural sector in Malaysia for practising sustainable agriculture and organic farming basically by applying organic fertilizer made of by-product. The Center for Environment, Technology and Development (CETDEM) at Sungai Buloh has been developed by the government to encourage small-scale farmer to invest in Organic Farming (OF) to generate income, maintain environment and promote exports. However, the adoption of organic farming among the farmers are relatively low regarding to many challenges such as limited land for plantation, certification processes, recruiting foreign workers, marketing, training, side services and support from government (Tiraieyari, Hamzah, & Samah, 2014).

### 2.1.1 Manure

Manure from livestock is traditionally converted into organic fertilizer and usually applied to crops in order to sustain the nutrients requirement (Kuepper, 2003b). Understanding nutrient requirement of crops are important for an efficient application of animal manure which later might support the plants growth (Maerere, Kimbi, & Nonga, 2001). Basically, manures have different nutrient composition and heavy metal content depending on the types of feed eaten by the animals (Hariadi, Nurhayati, & Hariyani, 2016a). Manure is categorized as the natural by-product including solid and slurry manure of cattle, goats, sheep, horse and other livestock animals.

Goats consumed green forages where the dung can be converted into organic compost to replace some chemical fertilizer (Coffey, Hale, & Wells, 2004). Goat manure was relatively high with nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and organic matter for chilli growth (Awodun et al., 2007). From Table 2.1, fresh goat manure contents were relatively high with K compare to P and N.

Table 2.1: Livestock fresh manure characteristics

| Manure Source | Average Animal Weight Lb | Feces and Urine Production | | Total Solids TS %w.b | Nitrogen | | Phosphorus $P_2O_5$ lb/ton | Potassium $K_2O$ lb/ton |
|---|---|---|---|---|---|---|---|---|
| | | lb/day | tons/yr | | Total lb/ton | $NH_4$-N lb/ton | | |
| **DAIRY** | 1,400 | 122.3 | 22.3 | 62.5 | 13.9 | 1.9 | 5.1 | 8.2 |
| **BEEF** | 800 | 48.5 | 8.3 | 61.4 | 14.7 | 3.9 | 7.3 | 8.9 |
| **VEAL** | 200 | 12.4 | 2.0 | 62.2 | 6.5 | 3.7 | 4.0 | 10.6 |
| **SWINE** | 135 | 11.1 | 1.9 | 61.5 | 10.3 | 7.5 | 9.3 | 8.8 |
| **SHEEP** | 60 | 2.4 | 0.4 | 62.3 | 28.1 | 5.8 | 9.4 | 19.0 |
| **GOAT** | 140 | 5.8 | 1.1 | 62.5 | 32.5 | 6.1 | 12.1 | 23.6 |
| **HORSE** | 1,000 | 50.3 | 9.2 | 61.1 | 29.6 | 2.4 | 6.3 | 12.0 |
| **RABBIT** | 10 | 0.31 | 0.056 | 28.0 | 51.6 | 0.4 | 25.2 | 11.1 |
| **LAYER** | 4 | 0.26 | 0.047 | 61.6 | 24.9 | 6.6 | 21.3 | 11.6 |
| **BROILER** | 2 | 0.16 | 0.024 | 63.7 | 25.6 | 6.7 | 16.3 | 11.7 |
| **TURKEY** | 15 | 0.68 | 0.112 | 63.5 | 25.3 | 8.1 | 24.4 | 12.1 |
| **DUCK** | 3 | 0.33 | 0.050 | 62.4 | 27.0 | 8.2 | 23.4 | 17.2 |

*Source* (Barker, Hodges, & Walls, 2002)

Recently, crops residues and animal manure has been used together to made biogas through anaerobic digestion. The co-digestion of crop residues and animal manures accelerates the production of biogas compared with the single digestion of feedstock because of the greater balance between carbon and nitrogen and increases anaerobic digestion efficiency. Goat manure is an excellent raw materials used for anaerobic digestion due to its high content of N and fermentation stability. High total N content is useful to co-digestion with crop residues because it reduces the carbon-to-nitrogen (C/N) ratios of single crop residues substrates. Not only that, goat manure is also insensitive to acidification during anaerobic fermentation but the mixing ratios of multi-component substrates between goat manure and various crop residues are unknown (Zhang et al., 2013).

### 2.1.2 Egg shell

Eggshell represents 11% of overall weight of an egg, made up of bio-mineralized composite of calcite crystals enclosed in an organic framework of protein fibres. Eggshell is an alkaline, rich with N and high of calcium carbonate ($CaCO_3$) which is about 95% but lack of organic matter. Generally, good quality of egg shell has approximately 2.2 g of calcium in a form of calcium carbonate. Phosphorus (P) and magnesium (Mg) content in the eggshell was 0.3% respectively. Other elements also present in the eggshell including sodium (Na), potassium (P), zinc (Zn), magnesium (Mg), iron (Fe) and copper (Cu) (Verma, Kumar, & Bansal, 2012).

Eggshell powder was used as fertilizer for tomato plant which help in reducing plant diseases such as blossom end root, besides, it is also being used as calcium supplement for female (Gaonkar & Chakraborty, 2016). The specialities of eggshell is that it contains high calcium level (39% w/w) and small amount of toxic elements such as lead (Pb), aluminium (Al), cadmium (Cd) and hydrargyrum (Hg), thus it can be used as supplement for human dietary (Quina, Soares, & Quinta-Ferreira, 2016). Calcium carbonate ($CaCO_3$) powder which obtained from eggshell become an agent to remove of heavy metals such as lead (Pb), cadmium (Cd) and copper (Cu) from aqueous solution, besides $CaCO_3$ is also being used as an alternative for the immobilization of heavy metals in soil (Oliveira, Benelli, & Amante, 2013).

In egg processing industry, eggshell can be also utilised as raw material for food additive, soil amendment, purified calcium carbonate and biomaterial composites. Calcium content in eggshell has chemical composition nearly similar to limestone. By utilizing waste such as eggshell waste instead of used cement in concrete production

helped to reduce the usage of cement thus it will conserve natural lime (Yerramala, 2014).

### 2.1.3 Molded white bread

Bread is commonly a staple food for many countries which made up from grains, mixing flour, water, yeast and certain secondary materials. After fermentation period, it will be shaping and baking to produce its final product. The loaves have to be cooled down after being taken out of the oven which later made them become drier and decrease their quality (Njezic, Zivkovic, & Cvetkovic, 2010). In general, 100 g of bread contains approximately 50 g carbohydrate (47 g starch), 9 g proteins, 5 g fat, 0.1 g phosphorus, 2.3 g ash and 28.7 g water. Typically, the shelf life of bread is short around four to seven days (Haroon et al., 2016). The bread can become spoiled during the manufacturing process such as by poor storage, transport condition or has exceeded it expired date which it would be eliminated them from trading (Kawa-Rygielska et al., 2013). For example, bread wrapped in a polyethylene plastic packaging is easily become contaminated because wrapping allows moisture condensation and temperature gradients might occur during transport and storage (Magan, Aldred, & Arroyo, 2012). Bread can be spoiled by many moulds but the most common spoilage is caused by *Penicillium* sp. (Milling, 1993). Spoiled bread is a major source of food waste yet nearly all wasted bread ends up in landfill sites, where it is degraded into methane by anaerobic digestion. Instead, these food waste can be utilized to solve the problem (Melikoglu et al., 2013).

The earliest work on utilization of bread waste was conducted by Nakano and Yoshida in 1977 which they mixed pieces of crushed waste bread with molasses,

cellulolytic, proteolytic and saccharifying enzymes. These mixture was incubated at 50ºC for 75 hours to produce glucose rich syrup which was used as a sugar substitutent (Haroon et al., 2016). Not only that, yeast has also been utilized as fertilizer as it contains many nutrients that can enhance some plant growth regulators such as auxin and gibberellins as well as it has the ability to produce enzymes that help in converting monosaccharids into carbon dioxide and alcohol which are essential in plants photosynthesis process (Kahlel, 2015). Besides that, considerable amount of bread waste is also used in the production of animal feed. It is palatable, high in carbohydrates but its proteins and vitamin content are low depends on the type of bread samples (Afzalzadeh, Boorboor, Fazaeli, & Kashan, 2007).

## 2.2 Chilli plant (*Capsicum annuum*)

### 2.2.1 History of cultivation of chilli plants in Asian continent

The chilli crops has been introduced to the Asian continent since the new sea routes Portuguese and Spanish explorers identified new sea routes in the late of 16$^{th}$ century. Planting of chilli crops become rapidly famous in the whole of Asia and native Asian due to favourable climate for planting this crops. Today the largest and valued varieties of chillies are only grown in Asia (Subbiah & Jeyakumar, 2012).

First originated from tropical America, chilli plant (*C. annuum*) is the most commonly species planted in Malaysia. About 14,560 hectare of land area required for chilli plantation in commercial scale where Johor, Perak and Kelantan would become the largest chilli producers (Anem, 2011).

### 2.2.2 Morphology of chilli plants

*Capsicum annuum* is spices, a fruit type vegetable under family of Solanaceae (Anem, 2009). Chilli is a valuable crops that growth upright, rooted with green branched stems and the foliage are light or dark green with oval width. The flora are white in colour with five petals while the fruits are elongated tapered shape (Suhaimi, Mohamad, & Hani, 2014). By referring to floral and leaves morphology, three species of distinguishable chilli plant including *Capsicum annuum*, *frutescens* and *chinensis* but only two species (*C.annuum* and *C.frutescens*) have an economic value, however *C.chinensis* known as ornamental chilli plant (Anem, 2009).

Not only that, the size of fruit also varies, for instance *C.annuum* has size 14 gram to as small as 1 gram (Melor, 2007). Chilli is also called as 'hot pepper' and known for their sharp acidic taste and colour. Some types of chillies are popular for red colour because of capsanthin pigment while others are famous for biting pungency due to capsaicin (Subbiah & Jeyakumar, 2012). Under Malaysia environment, *C. frutescens* is more pungent than *C. annuum* with capsaicin content 0.7%-1.2% and 0.16%-1.2% respectively. One interesting observation is the relation between size of chilli and pungency. The smaller the size, the hotter the chilli. This is true for both *C. annuum* and *C. frutescens* but differ for *C. chinensis* (Melor, 2007). The common temperature for chilli plant was 20 ºC to 30ºC with monthly amount of rainfall 1500 mm to 2000 mm while pH soil should be in the range from pH 5.5 to pH 6.8 (Anem, 2009).

### 2.2.3 Nutrient uptake and deficiencies

Chilli plants absorbed more nutrients compared to tomato or brinjal to produce a unit of dry matter or fruit production. Nitrogen, phosphorus and potassium (NPK) concentration in plant are highest in leaf followed by fruit and stem. Meanwhile, calcium (Ca) and magnesium (Mg) are highest in leaf, followed by stem and fruit. In general, nutrient uptakes and fruit production of the plant are correlated (Hedge, 1997).

Chilli plant needs consistent supply of N to maintain effective growth, increase in plant height, more branches and leaves, deep green colour, high quality and fruit yields. For instance, N is essential for chlorophyll development which gives plants the green colour and allows plants to convert solar energy to sugars used for growth. Therefore, plants were taller and promoted improvement in other growth parameters as a results of increase in cell division in the tissues (Ayodele, Alabi, & Aluko, 2015). Increasing the rate of N application on chilli plants accelerates N uptakes. At the same times, stimulated K and P uptake through the synergistic effect of N on them (Bhuvaneswari, Sivaranjani, Reeth, & Ramakrishnan, 2013).

Differ from nitrogen (N), phosphorus (P), calcium (Ca) and magnesium (Mg), potassium (K) does not enter into permanent organic combination in plants but it is present as soluble inorganic and organic salts (Bidari & Hebsur, 2011). Even though K is not a constituent of any organic molecule or plant structure, it is important for many biochemical and physiological processes in plants such as photosynthesis, activities of enzymes, and translocation of water and nutrients in the plant (Akram et al., 2017). For instance, adequate K helped in the regulation of stomata and maintain the turgidity and

osmotic equilibrium. Besides, it is also involved in the activation and regulation of enzyme activity in plant metabolism (Bhuvaneswari et al., 2013).

Nitrogen (N) is one of macronutrients which is very essential for plant growth. Lacking of N supply will cause problem for tips growing, it turned pale and weak. The older leaves are pale green to yellow and probably dry up. Sometimes, the leaves may become purplish, do not thrive, and have little flowers, poor fruit production as well as small in size (Fallis, 2013).

Poor germination and establishment of seedling are the effects of Phosphorus (P) deficiency. Besides that, the foliage are small in size with dark or grey-green colour. The underside leaves of the seedlings turned into purple colouration whereas the leaf margins showed reddening or yellowing. Brown patches also may develop between the veins on mature leaves. At the flowering stage, crops have fewer flowers as well as weak root system and be stunted (Fallis, 2013).

Next, insufficient of potassium (K) may cause leaf margins become yellow or scorched. The signs can be noticed spreading to the area between the veins, then the leaf centre. The leaves curled downwards and cup upwards due to the scorching of the leaf margins. Fruit from potassium-deficient also has unevenly colour (Fallis, 2013).

Commonly the signs of nutrients deficiency for chilli plants were similar to other plants such as tomato and eggplant. For example, insufficient supply of calcium (Ca) will cause distorted of leaves as it appear scorched and bent downwards. This is due to the condition where the leaf margin cannot fully expand. Sometimes the growing

point turned blackening or death. Not only that, the fruits may develop a sunken, black leathery patch that will be enlarged and cover the whole blossom end of the fruit. All these problems may happen due to lack of translocation of calcium to the growth point especially during the rapid growth of the chilli plant. The acidic soils with a pH less than 5.5 may contain too much nitrogen, high potassium or insufficient boron thus it will not suitable for chilli plant growth (Fallis, 2013).

On the other hand, deficiency of iron (Fe) may affect the youngest leaves where light-green chlorosis of all tissue between the veins are developed. Besides, a distinctive pattern will be formed by the midrib and veins, which initially remain green. If the condition turned worst and continuously, chlorosis changed yellowish or even bleached white and burnt patches within the chlorotic areas also will be formed. Insufficient of iron is also called as iron-induced or lime-induced chlorosis because it always affects the crops grown in the alkaline soil or high pH soil. Not only that, soils that have free lime or limestone layer also may affect the plant performances (Fallis, 2013).

### 2.2.4 Importance of chillies

Chillies has economic value and benefits for human consumption such as it is useful as food or seasoning in the food industry as well as in medicine in the pharmaceutical sector (Maisin et al., 1997). Chillies has high content of vitamin C about twice that of citrus fruits, great source of β-carotene, antibacterial qualities, bioflavonoids and anti-oxidant whereas dry chillies has rich of vitamin A (Pawar, Bharude, Deshmukh, Raut, & Umarkar, 2011). Chillies are also being used for making various type of chilli sauce (Senik, 2010).

## 2.3 Commercial organic foliar

Organic fertilizers can be prepared from plant and animal by-products. Interestingly, it is a nutrient-saving technology because all the sources could be obtained from the farm such as crop residues and animal manure.

In the past, farmers making as organic fertilizers to be applied in their farms, however, this kind of fertilizer commodity does not pass through the market exchange system. Recent development technology however had encouraged the production of organic fertilizer by organic fertilizer manufacturing enterprises in commercial quantity for farmers' use during plantation (Alimi et al,. 2006). Soil application is the common method which mostly effective for nutrients uptake but required in higher amounts to be absorbed by the roots. However, under certain circumstances, foliar fertilizer is more economic and practical due to its high mineral absorption when applied as foliar sprays onto plant leaves in appropriate concentration (Bi & Scagel, 2007; Fageria et al., 2009). Foliar feeding showed result 95% efficiency of nutrient use compare to soil fertilizer application which is only had 10% efficiency. In contrast, foliar feeding is not sufficient to supply large amount of nutrients which required by the plants such as nitrogen, phosphorus and potassium. It is only acts as supplement nutrients for the plants and provide small boost in growth and yield. Not only that, foliar fertilizer also helps to overcome nutritional deficiencies in plant especially due to lack of micronutrients. Ideally applying foliar fertilizer should be done in the cooler morning or late evening. It is not practical to spray foliar on leaves during hot day because the combination effects of fertilizer and sunlight could destroy the plant tissues (Pettinelli, 1914).

# CHAPTER 3

# MATERIAL AND METHODS

## 3.1 Materials

In this study, the materials used were chilli seedlings, coco peat, goat manure, egg shell, molded white bread and molasses.

### 3.1.1 Chemical and reagents

The reagent used was commercial foliar.

### 3.1.2 Equipment and apparatus

The apparatus used were polybags, water sprayer, trowel and watering pot.

## 3.2 Methods

### 3.2.1 Goat manure foliar with eggshell and molded white bread preparation

Approximately 500 gram of goat manure was taken at Agrotechno Park, UMK Jeli as the main ingredients for the foliar. Additional materials were added into the foliar including egg shell and molded white bread. The manure was dried for a week. During preparation process, the egg shell were crushed by using a blender while the molded bread were cut into smaller pieces. Next, a clean plastic container was used to prepare the foliar with the ratio of 4:4:1:1. After that, 500 gram of goat manure, 500 ml of molasses, 125 gram of egg shell and 125 gram of molded white bread were weighed and mixed well. After that, the solution was stirred evenly using a stick to mix well the solution. Lastly, black plastic was used to cover the container and tighten using rope. All these components were allowed to be aerated by stirring it once per day to remove the carbon dioxide ($CO_2$) throughout the fermentation process. The fertilizer was ready in one and a half month of fermentation period of time.

Figure 3.1: Goat manure after being sundried for one week before it was used as main ingredient in the preparation of foliar.

(a) (b)

Figure 3.2: Eggshell. (a) Before grinding. (b) After grinding.

(a) (b)

Figure 3.3: Molded white bread. (a) Before cut. (b) After cut into pieces.

### 3.2.2 Planting of chilli plants (*Capsicum annum*)

A tray of chilli seedlings with four weeks old was purchased from a farmer at Machang, Kelantan. The tray with chilli seedlings was put at Agrotechno Park for about one week for acclimatize period.

The planting plot was prepared at the rain shelter area at Agrotechno Park with an area of 12.54 $m^2$ (3.8 m x 3.3 m). The planting area was covered with silver shine to control weeds growth. Once the planting area was ready, cocopeat was filled into

the polybags with size of 20 cm x 16 cm. The polybags were transferred to the plot and arranged with distance 0.5 m from each other.

Each polybags were labelled according to treatment groups which represented treatment (C) as control while treatment (F) as goat manure foliar. Each treatment consists of three replicates where one replicate has five plants. Therefore, the total number of chilli plants (*Capsicum annuum*) for both treatments were 30 plants.

Approximately 30 healthy chilli seedlings in the tray were chosen to be transplanted into individual polybags in the depth of 2 cm. After all the plants were transferred to the planting plot, watering activity took place daily using watering pot.

(a)

(b)

(c)

Figure 3.4: Preparation of planting plot at Agrotechno Park, UMK Jeli. (a) Planting plot was covered with silver shine. (b) Cocopeat was filled into polybags. (c) Polybags were transferred to planting plot.

### 3.2.3 Dilution and application of foliar

After one and a half month of fermentation period, the goat manure foliar was strained using tea strainer in order to obtain concentrated stock foliar upon the application on plants. 5 L of diluted foliar was prepared using dilution factor 1:100 where, 50 ml of stock foliar was mixed with 4 950 ml of dechlorinated water. The standard application dilution used in this study was 1%.

These steps were done by measuring 50 ml stock foliar using measuring cylinder and poured it into 5 L plastic bottle. Next, 4 950 ml of dechlorinated water was measured and poured into the same container. Thus, this solution was called working foliar. The goat manure foliar was ready to be applied on plants twice a week. The goat foliar was sprayed on stomata of the leaves. Plant normally opens their stomata early

in the morning or late evening for water transportation and absorption thus the rate is faster and more efficient.


(a) (b)

Figure 3.5: Preparation and dilution of foliar. (a) Stock foliar. (b) Bottles contained working foliar were wrapped with black plastic to prevent it from direct sunlight.

The same procedures were done for commercial organic fertilizer. The gap between application days was three days of interval to ensure that there were no excessive nutrients and allowed the plants to fully utilize the fertilizer before supplying them with nutrients again.

The dilution of stock foliar was calculated as followed:

- 1% dilution for 5 L foliar

$$\frac{1}{100}\ x\ 5000mL = 50\ mL\ concentrated\ stock\ foliar$$

$$50\ mL\ concentrated\ stock\ foliar + 4950\ mL\ of\ dechlorinated\ water$$

$$= \mathbf{5\ L\ of\ 1\%\ working\ foliar}$$

### 3.2.4 Data collection and analysis

Data on plant height, the number and size of leaves were measured as shown in Figure 3.6 and recorded in using Microsoft EXCEL 2013. Statistical analysis of variance and means were analysed using ONE-WAY ANOVA in SPSS software version 23.

(a) (b)

Figure 3.6: Measurement of leaf size (cm). (a) Length of leaf. (b) Width of leaf.

# CHAPTER 4

# RESULTS

The results for each test were presented in graph and table form. Results displayed included the analysis of elements in the foliar samples and the growth performances of the chillies plants such as height of plant, the number and size of leaves, condition of leaves as well as fruit yields prior to the application of foliar which were commercial foliar as a control and goat manure foliar as treatment.

## 4.1 Analysis of elements in the foliar samples

The chapter explores the use of automated data analysis by X-ray Fluorescence (XRF) spectroscopy. Both foliar samples, commercial and goat manure foliar had undergo XRF analysis to identify the concentration of particular elements presence in 1% of foliar samples.

Table 4.1 below presented the concentration of elements in commercial foliar and goat manure foliar sample. It could be seen that commercial foliar sample contained lower percentage of potassium (K) (<0.001%) compared to goat manure foliar (0.165%). In contrast, the concentration of nitrogen, N (0.330%) in commercial foliar was relatively higher than goat manure foliar which were 0.333% and 0.260% respectively. Ordering in the three major macronutrients concentration needed by

plants was N>P>K for commercial foliar while for goat manure foliar the order was N>K>P. Commercial foliar was more diluted compared to goat manure foliar as it contained more water. Certain trace elements also could be found in the commercial foliar sample including Ba, Ca, Cl, Fe, Mn, S, Sb and Sn. On the other hand, the goat manure foliar sample also contained the same type of trace elements with varies concentration as commercial foliar but with the addition of few others elements such as Na and Si. Percentage of sodium in goat manure foliar was higher than commercial foliar which was 2.63% and <0.001% respectively.

Table 4.1: Concentration of elements presence in 1% of commercial foliar and goat manure foliar.

| **Formula** | **Concentration (%)** | |
|---|---|---|
| | Commercial foliar | Goat manure foliar |
| Nitrogen (N) | 0.330 | 0.260 |
| Phosphorus (P) | 0.083 | 0.099 |
| Potassium (K) | <0.001 | 0.165 |
| Barium (Ba) | 0.001 | 0.007 |
| Calcium (Ca) | 0.023 | 0.090 |
| Chloride (Cl) | 0.167 | 0.183 |
| Iron (Fe) | 0.001 | 0.002 |
| Water (H2O) | 99.6 | 96.6 |
| Manganese (Mn) | 0.001 | <0.001 |
| Sulphur (S) | 0.096 | 0.136 |
| Antimony (Sb) | 0.001 | 0.002 |
| Stannum (Sn) | 0.002 | 0.002 |
| Silicon (Si) | <0.001 | 0.045 |
| Sodium (Na) | <0.001 | 2.63 |

## 4.2 Plant growth performance analysis

### 4.2.1 Height of plant

The parameter included in this study was plant height where the measurement started from the soil surface to the plant apical top by using a ruler and a measuring tape. The measurement were recorded 15 times in order to observe the plant growth performance prior to foliar application.

Figure 4.1 showed the height of the plants after the applications of commercial foliar and goat manure foliar. The first foliar application for both control and treatment groups began on Day 6 after plant acclimatization periods in polybags with the volume used approximately 100 ml per plant. The results showed the height of plants for both groups were constant from Day 9 to Day 17 with average height of 11.02 cm. Second application of foliar was sprayed on Day 18 with the increased volume of 150 ml per plant. Starting from Day 21, the height of plants which treated with commercial foliar had rose drastically over the planting period. The highest of average plant height was 46.12 cm which represented by commercial foliar treatment.

Meanwhile, for goat manure foliar treatment showed contrast response compared to commercial foliar. The trend of the plant growth did not show any positive effect where the height of the plant had remained average value of approximately 11 cm at Day 29 until towards the end of planting period on Day 62 as shown in Figure 4.1. Although the volume of goat manure foliar had been increased, it was still did not support the plant growth performance (Figure 4.2).

Statistically, significant difference between group treatments can be observed based on height of plants as determined by one-way ANOVA ($p<0.05$). The final height for commercial foliar plant recorded was higher than goat manure foliar with 46.12 ± 1.67 cm and 10.41 ± 1.42 cm respectively (Table A.1).

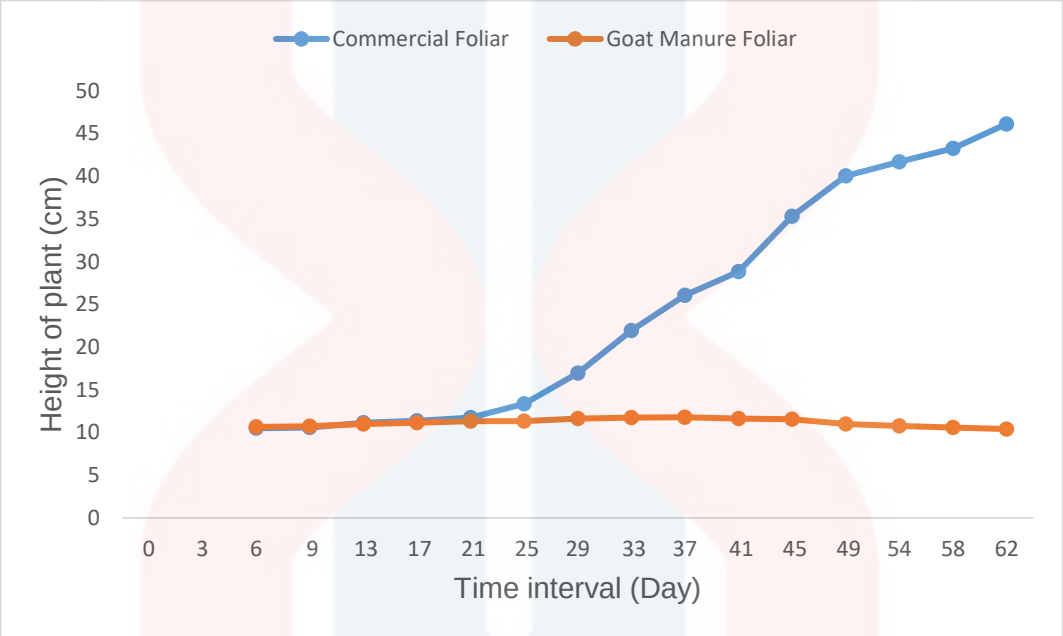


Figure 4.1: Height of chilli plants based on application of commercial foliar and goat manure foliar.

Figure 4.2: Comparison of plant height between commercial foliar (left) and goat manure foliar (right) application at Day 29 after second application of foliar.

### 4.2.2 Number of leaves

Throughout two months of planting period, the number of leaves showed a significant results between plants applied with commercial foliar treatment and goat manure foliar treatment. The number of leaves were recorded by counting the leaves and before the average number of leaves per plant was calculated.

From Figure 4.3, the highest number of leaves was obtained by matured plant that being applied with commercial foliar with the average number of leaves was 59 on Day 62. In contrast, the lowest value was found from plants treated with goat manure foliar with the average of only two leaves per plant on Day 62. In the early stage of planting, the number of leaves represent each group did not differ, however the graph pattern suddenly changed after Day 29 where the number of leaves in treatment group was decreased due to fallen leaves as the nutrients content in the goat manure foliar were too low to support the plants growth.

Table A.2 showed a statistically significant difference between commercial foliar and goat manure treatment on the average number of leaves ($p<0.05$). Commercial foliar plants has more average number of leaves than goat manure foliar plants which was 59.00 ± 2.23 and 1.53 ± 0.27 respectively.

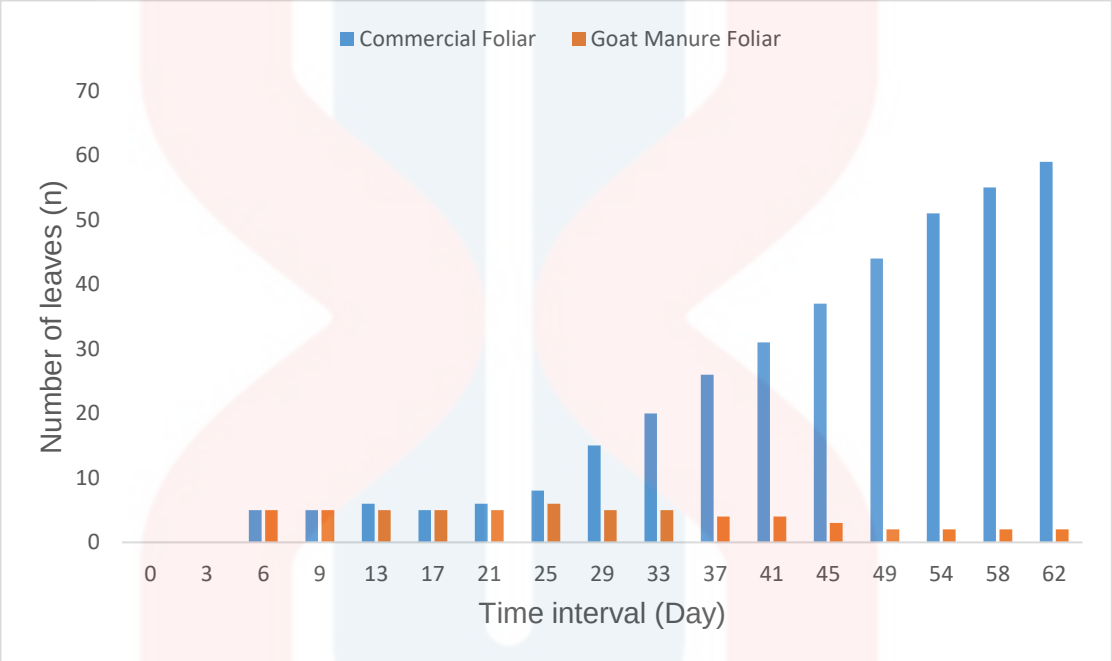


Figure 4.3: Number of leaves on chilli plant based on application of commercial foliar and goat manure foliar.

### 4.2.3 Size of leaves

Size of leaves were measured by considering the length and width of the leaves before multiplying both values and their averages were taken.

Figure 4.4 displayed the results of leaves size ($cm^2$) after the application of commercial foliar and goat manure foliar. Between Day 9 and Day 17, the leaves size treated with both commercial foliar and goat manure foliar were consistent and similar. However, after Day 17, the size of the plant leaves which treated with commercial foliar

began to dominate over those plants treated with goat manure foliar. The graph showed size of leaves for plant treated with commercial foliar were increased dramatically from Day 37 to Day 49 but then rising steadily until the end of planting period with the average of 55.70 $cm^2$.

Table A.3 represented a statistically significant difference between commercial foliar and goat manure foliar treatment on average size of leaves ($p<0.05$). Commercial foliar plants had wider average leaves size than goat manure foliar plants which was 55.70 ± 3.01 cm and 6.03 ± 1.08 cm respectively.

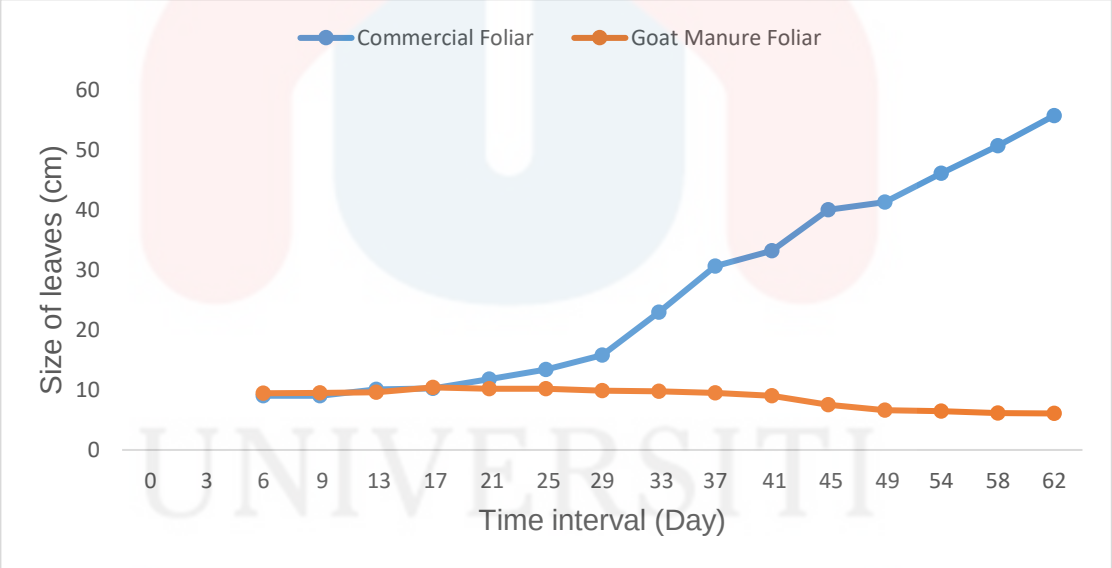


Figure 4.4: Size of leaves ($cm^2$) based on application of commercial foliar and goat manure foliar.

### 4.2.4 Leaves condition

Based on the results obtained, the comparison can be made based on leaves condition between plants treated with commercial foliar and goat manure foliar. Enough volume of commercial foliar given to the plants could produce higher number of leaves with wider leaves size as well as mature old green colour. However, there were also some typical plant stress symptoms were observed on plants treated with commercial foliar such as wrinkles on the leaves with few white spots and tiny holes on it (Figure 4.7).

Meanwhile, plants treated with goat manure foliar had survived with retarded growth, small yellowish leaves, excessive fall and leaves burning at the tips. However, no wrinkles were founded. Figure 4.6 showed comparison between the leaves colour at Day 29 after second application of foliar. Meanwhile figure 4.6 showed burning at the leaf tips of plant treated with goat manure foliar at Day 41.

Figure 4.5: Comparison of leaves colour at Day 29 after the second application of commercial foliar (left) and goat manure foliar (right).


Figure 4.6: Burning at the leaf tips of plant treated with goat manure foliar after being recorded at Day 41.

Figure 4.7: Wrinkles and white spots found on the leaves treated with commercial foliar at Day 41.

# CHAPTER 5

# DISCUSSION

## 5.1 Analysis of elements in the foliar sample

A standard volume of foliar application, 100 ml of 1% foliar commercial and 1% goat manure foliar were sprayed on chilli plants in order to determine the effectiveness of foliar towards plants performance. Analysis had been done for both commercial and goat manure foliars showed there were lack of some nutrients elements in the samples especially NPK. Only N and P elements could be detected by XRF analysis in the commercial foliar sample while K elements was too low to be detected assuming that the concentration was less than 0.001%. Meanwhile, NPK elements were detected and presented in goat manure foliar which might be contributed by different source of organic wastes such as goat manure, egg shell and molded white bread.

Goat manure was rich with N, P, K, Ca, Mg and organic matter for chilli growth, relatively high with K compared to P and N (Awodun et al., 2007). On the other hand, eggshell contained high N, P and calcium carbonate, $CaCO_3$ as well as other trace elements such as Zn, Mg, Fe and Cu (Verma et al., 2012). Yeast contained in the bread was an organisms (fungi) which could be used as a fertilizer because it has many nutrients such as N, P, K, Mn, Ca, Na, Mg and Zn, besides yeast also produced some plant growth regulators, for instance auxin and gibberellins. The ability of yeast to produce a group of enzymes helped the conversion of monosaccharids into alcohol

and carbon dioxide, $CO_2$ which was important for photosynthesis process in plants (Kahlel, 2015). All of these various elements contributed by different sources of materials had been caused the percentages of concentration elements in the foliar varies with each other.

## 5.2 Plant growth performance analysis

### 5.2.1 Height of plant

By referring to Table 4.1, although commercial foliar had lesser than 0.001% of potassium (K) compared to goat manure foliar, the plants could still survive but with slower growth. In most crop seeds, K commonly not excessively absorbed by plants because too much of K element may cause another elements deficiencies such as Mg, Mn, Zn or Fe. Only adequate amount will enhance the accumulation of carbohydrate and helped the plants to withstand low temperature and diseases. Although K is not a part of plant structures, it is important element in many regulation process in plants such as photosynthesis, translocation of photosynthesis, retention of water as well as to activate the enzyme activities (Khan et al., 2014).

Early season of growing, plants required high N application with addition of supplemental applications after the fruit initiation period. At least 50 to 90% of total N should be given to the plants (Haifa, 2014).

By comparing the results of elements in 1% of both samples, it can been seen that the goat manure foliar has much higher elements concentration than commercial

foliar but the results was still did not satisfying. An initiative was taken by increasing the volume of foliar with additional of 50 ml for every particular week during foliar application in order to reach the optimal growth of the chilli plants. It was observed that plant height after second application of foliar gradually with the increment of volumes especially for commercial foliar which can be seen at Figure 4.1. This must be due to higher availability of nutrient which might support the nutrients requirement of the plant itself. Plants response to foliar application might be positive, negative or no effect depending on the species of the crops, the nutrients supply, concentration, frequency foliar application as well as plant growth stages (Fageria et al., 2009; Kuepper, 2003). The study has been proved that, although the volume of both foliars given to the plants were similar throughout the planting period but still the growth performances of chilli plant (*C.annum*) varies with each other.

Foliar application might only supply nutrients to the higher plants with an appropriate concentrations which could give a results 95% efficiency of nutrient use than soil application which is about 10% efficiency (Fageria et al., 2009; Pettinelli, 1914). Nutrients can be passed into the leaves stomata where in some cases the results had shown within hours (Media, 2012). Although application of foliar may be relatively effective in term of absorption, however foliar feeding could not supply large amount of nutrients present in the plant growth medium such as soil.

Apart from lack of nutrient contents, several factors that might cause retardation of plant growth after the foliar applications including contamination during foliar preparation process, low pH and oxidation of foliar during storage. After been tested with pH indicator, the goat manure foliar showed pH of 4 while commercial foliar has pH of 6. Slightly acidic of foliar with a pH around 6 or remains in the near-neutral

range around 5.5 to 8.5 ensure the solution to be absorbed easily into the film on the leaf (Media, 2012). If pH adjustment was needed, vinegar can be an option to increase acidity while baking soda to reduce it (Kuepper, 2003).

### 5.2.2 Number and size of leaves

The results given had shown that application of commercial foliar gave optimal growth by producing greater number of leaves and wider leaves size. Higher leaf area index was required for effective absorption of nutrient solution from foliar application (Fageria et al., 2009). The increasing pattern of leaves size treated with commercial foliar indicated that it may be due to enough supply of nitrogen (N) to the plants. Nitrogen contributed to green colour of the leaves and important in enhancing plant development during all stages. It was also promoted on the photosynthesis process and at the same time stimulated K and P uptake through the synergistic effect of N on them (Bhuvaneswari et al., 2013; Hariadi, Nurhayati, & Hariyani, 2016b). Each elements mentioned above were importance to support the growth performances of chilli plant, for examples to produce greater number and size of leaves. Ensuring enough volume supply of foliar to the plant based on the nutrient requirement was important for positive responses.

On the other side, less number of leaves reduced the rate of photosynthesis because less uptakes of nutrients to support plant metabolism. The photosynthesis process was influenced by micronutrients through various modes of action. Boron (B) involved in carbohydrate metabolism which directly affecting plant development and indirectly influencing the efficiency of photosynthetic process. Iron (Fe) and manganese (Mn) are participated in the carbon fixation by activation and constitution

of enzymes. In turn, copper (Cu) involved in the electron transport flow, uniting the two photochemical systems whereas zinc (Zn) was responsible as an activator of various photosynthetic enzymes of the oxidase class. In fact, lacking of certain nutrient elements might cause different responses and symptoms to the plants (Figure 4.7).

### 5.2.3 Leaves condition

Comparison made between plants treated with both foliars showed that commercial foliar produced better results based on leaves condition in term colour, size as well as the number. For instance, the highest average of leaves number reached up to 54 leaves whereas average for leaves size was 55.70 $cm^2$ which was quite large. Although the growth performances of the plants applied with commercial foliar application were positive, some typical stress symptoms were detected on the plants. For example, one of the plants was having wrinkles leaves with few white spots while the old leaves turned into dark green. These symptoms might be due to lacking of calcium (Ca). Insufficient amount of Ca can cause the leaves appeared scorched, curled and bent downwards (Fallis, 2013). Besides that, dark green or grey-green colour of older leaves might due to poor phosphorus, P supply (Haifa, 2014).

Even though the nutrient supply was deficit to support the plant growth performances, but there was no water stress symptom showed by the plants treated with commercial foliar and goat manure foliar such as rolling of leaves or wilt indicated that water supply or irrigation schedule was enough for the plants (Figure 4.6). Closure of stomata, leaf rolling and shifts in assimilate partitioning induced by water stress can affect the growth of vegetative (Tadesse, 1997).

On the other hand, plants treated with goat manure foliar were having yellowish leaves with burning at the tips. These symptoms might be due to insufficient amount of nitrogen (N) as it might cause older leaves turned pale green to yellow and probably dry up. Leaves burning at the tips were probably due high salt concentration of the foliar. Table 4.1 showed that goat manure foliar has higher salinity as it contained 2.63% of sodium (Na) concentration compared to commercial foliar (<0.001%). The sensitivity of plants toward salt stress can be observed in many ways such as leaf chlorosis, necrosis, burning or firing of leaves tips or margin. Higher salt concentration in substrate give depression to the plants either by osmotic effects, ion imbalance as well as toxic effects (Tadesse, 1997).

### 5.2.4 Flowering and fruit yields

The first flowering had developed at Day 37 for commercial foliar plants but none for goat manure foliar plants. Number of flowering per plant is an important factor which contributed to the final fruit yield. Flowering was enhanced by the present of phosphorus (P) which was essential for the normal growth of roots and reproductive organs such as flowers, fruit and seeds. Phosphorus also promoted early fruit ripening. Lacking of phosphorus might cause retardation in development of too small and short branches, many undeveloped buds and less of fruit (Haifa, 2014). In chilli plant, the greatest demand for N, P and K was during the period from about 10 days after flowering to about 30 day to 33 days from flowering (Hedge, 1997). Figure B.1 showed the stage of fruit development of plant treated with commercial foliar at Day 41 and Day 49.

# CHAPTER 6

## CONCLUSION AND RECOMMENDATION

The result showed the effectiveness of commercial foliar was significant ($p<0.05$) compared to goat manure foliar on the chilli plant (*Capsicum annuum*) growth performance such as plant height, condition of leaves, number and size of leaves as well as fruit yields. Goat manure foliar (F) does not enhanced the growth performance of chilli plants (*C. annuum*) compared to commercial foliar as a control (C). Hence, the null hypothesis was accepted.

Application of both foliars began at Day 6 with volume used of 100 ml but no changes were shown by the plants until Day 17. The effectiveness of both foliars showed the responses on Day 21 after the volume of foliar had been increased to 150 ml. Goat manure foliar plants showed more signs of nutrient deficiencies compared to commercial foliar plants, however no signs of water stress occurred for both plants. The XRF analysis showed that the concentration of elements presented in commercial and goat manure foliar were varies from each other due to different sources of matter. The pH of both foliars also differ as commercial foliar has pH 6 while goat manure foliar has pH 4 which was acidic. With appropriate volume and concentration, organic foliar can be efficient as nutrient spray for the chilli plant (*C. annum*) as it gave positive results within a few days. However, it could not supply all the nutrients needed for plant growth thus organic foliar only practical to be used as nutrient supplements to plants to fulfil certain nutrient deficiencies.

As a recommendation, further study on the plant nutrient requirement for every stage of growth are needed to ensure that the plants received enough nutrients for the development. Next, better management is important to ensure no contamination during preparation of foliar such as wash clean all the apparatus and proper storage area for working foliar. Monitoring the condition of foliar to maintain it in optimum condition before being applied on plants to minimize risks of plant symptoms. For instance, adjustment of pH can be done using available source such as vinegar to increase acidity while baking soda to reduce it. Besides that, addition of some oil into the foliar might allow the foliar to stick on the leaves surface to increase efficiency of nutrient absorption through stomata. Lastly, further study can be conducted to determine the effectiveness of goat manure foliar on ornamental, flowering plants to observe whether the plants can perform better results than chilli plant (*C.annum*).

## APPENDIX

Table A.1: Descriptives table and One-way ANOVA for height of plant (cm).

**Descriptives table**

**Height of plant (cm)**

| Treatment | | N | Mean | Std. Deviation |
|---|---|---|---|---|
| 1 | (Commercial foliar) | 15 | 46.12 | 6.46 |
| 2 | (Goat manure foliar) | 15 | 10.41 | 5.52 |
| | Total | 30 | 28.27 | 19.09 |

**One-way ANOVA**

**Height of plant (cm)**

| Treatment | | Sum of Square | df | Mean Square | Sig. |
|---|---|---|---|---|---|
| 1 | (Commercial foliar) | 9562.25 | 1 | 9562.25 | .00 |
| 2 | (Goat manure foliar) | 1009.54 | 28 | 36.06 | |
| | Total | 10571.79 | 29 | | |

Table A.2: Descriptives table and One-way ANOVA for number of leaves (n).

**Descriptives table**

**Number of leaves (n)**

| Treatment | | N | Mean | Std. Deviation |
|---|---|---|---|---|
| 1 | (Commercial foliar) | 15 | 59.00 | 8.62 |
| 2 | (Goat manure foliar) | 15 | 1.53 | 1.06 |
| | Total | 30 | 30.27 | 29.84 |

**One-way ANOVA**

**Number of leaves (n)**

| Treatment | | Sum of Square | df | Mean Square | Sig. |
|---|---|---|---|---|---|
| 1 | (Commercial foliar) | 24768.13 | 1 | 24768.13 | .00 |
| 2 | (Goat manure foliar) | 1055.73 | 28 | 37.71 | |
| | Total | 25823.87 | 29 | | |

Table A.3: Descriptives table and One-way ANOVA for size of leaves (cm).

**Descriptives table**

**Size of leaves (cm)**

| Treatment | | N | Mean | Std. Deviation |
|---|---|---|---|---|
| 1 | (Commercial foliar) | 15 | 55.70 | 3.01 |
| 2 | (Goat manure foliar) | 15 | 6.08 | 1.08 |
| | Total | 30 | 30.89 | 4.87 |

**One-way ANOVA**

**Size of leaves (cm)**

| Treatment | | Sum of Square | df | Mean Square | Sig. |
|---|---|---|---|---|---|
| 1 | (Commercial foliar) | 18467.08 | 1 | 18467.08 | .00 |
| 2 | (Goat manure foliar) | 2151.88 | 28 | 76.85 | |
| | Total | 20618.95 | 29 | | |

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