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Study on the Effects of Organic Liquid Fertilizer On The Growth of Vegetable Seedlings

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DECLARATION

I hereby declare that the work embodied here is the result of my own research except for the excerpt as cited in the references.

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Study on the Effects of Organic Liquid Fertilizer on the Growth Of Vegetable Seedlings

ABSTRACT

Organic liquid fertilizer is the fermentation of organic material in a solution containing several elements. Liquid organic fertilizer has various benefits with organic based and natural content composition that can supplement the plant with quick absorption. This study was conducted to cultivate vegetable seedlings using liquid organic fertilizer. The purpose was to enhance the vegetable seedlings growth. The objective of this study was to observe and measure the morphological development of seedlings. Next, to analyse the nitrogen contents in the seedling leaves. Furthermore, this study used four types of organic liquid fertilizers, which are microorganism ingredients (IMO) under T1: microbe under a bamboo tree, T2: Fermented Amino Acid (FAA), T3: microbe under a virgin forest tree, and T4: Fermented Fruit Juice (FFJ), on three varieties of vegetable seedlings (Caixin green stem, lettuce butterhead and lettuce looseleaf). The experiment used Complete Randomized Design (CRD) on the effect of organic liquid fertilizer on vegetable seedlings. The data analysed parameters of growth performances in the crop. The plant height, plant width, and leaf width were recorded throughout this study. Moreover, SPAD chlorophyll meter were used in this study to check the chlorophyll content in the leaves of vegetable seedlings. Lastly, Kjeldahl method were performed to study the nitrogen content in the leaves of vegetable seedlings. This study compared four different types of organic liquid fertilizer on vegetable seedlings. The result showed that the best treatment was the treatment for vegetable seedlings was Caixin green stem T1 (Microbes under Bamboo Trees) because T1 had the highest height (3.57cm) and leaf width (2.42cm) compared to other treatments. In conclusion, the study's result suggested that the treatment T1 is the best organic fertilizer to enhance the seedling planting because it had some nutrient sources with high quality of effective microorganisms (EM).

Keywords: Vegetable cultivation, tray germination, liquid organic fertilizer, vegetable seedlings, Kjeldahl method, SPAD chlory meter.

Kajian tentang Kesan Baja Cecair Organik terhadap Pertumbuhan Anak Benih Sayur

ABSTRAK

Baja cecair organik ialah penapaian bahan organik dalam larutan yang mengandungi beberapa unsur. Baja cecair organik mempunyai pelbagai kebaikan dengan komposisi kandungan berasaskan organik dan semulajadi yang dapat menambah tanaman dengan penyerapan yang cepat. Kajian ini dijalankan untuk mengusahakan anak benih sayuran menggunakan baja organik cecair. Tujuannya adalah untuk meningkatkan pertumbuhan anak benih sayuran. Objektif kajian ini adalah untuk memerhati dan mengukur perkembangan morfologi anak benih. Seterusnya, untuk menganalisis kandungan nitrogen dalam daun anak benih. Seterusnya, kajian ini menggunakan empat jenis baja cecair organik iaitu bahan mikroorganisma (IMO) di bawah T1: mikrob di bawah pokok buluh, T2: Fermented Amino Acid (FAA), T3: mikrob di bawah pokok hutan dara, dan T4: Fermented Jus Buah-buahan (FFJ), pada tiga jenis anak benih sayuran (batang hijau Caixin, kepala selada dan daun selada). Eksperimen menggunakan Reka Bentuk Rawak Lengkap (CRD) terhadap kesan baja cecair organik ke atas anak benih sayuran. Data menganalisis parameter prestasi pertumbuhan dalam tanaman. Ketinggian tumbuhan, lebar tumbuhan, dan lebar daun telah direkodkan sepanjang kajian ini. Selain itu, klorofil SPAD meter digunakan dalam kajian ini untuk memeriksa kandungan klorofil dalam daun anak benih sayuran. Akhir sekali, kaedah Kjeldahl digunakan untuk mengkaji kandungan nitrogen dalam daun anak benih sayuran. Kajian ini membandingkan empat jenis baja cecair organik yang berbeza pada anak benih sayuran. Hasil kajian menunjukkan bahawa rawatan terbaik adalah rawatan untuk anak benih sayuran adalah Caixin green stem T1 (Mikrob di bawah Pokok Buluh) kerana T1 mempunyai ketinggian tertinggi (3.57cm) dan lebar daun (2.42cm) berbanding rawatan lain. Kesimpulannya, hasil kajian mencadangkan bahawa rawatan T1 adalah baja organik terbaik untuk meningkatkan penanaman anak benih kerana ia mempunyai sumber nutrient dan effective mikroorganisma (EM) yang berkualiti tinggi.

Kata kunci: Penanaman sayur-sayuran, percambahan dulang, baja organik cair, anak benih sayuran, kaedah Kjeldahl, meter klori SPAD.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Organic farming is a method of farming food crops that are grown organically. Organic method uses natural providing inputs for the cultivation process, such as local microorganisms, livestock, plants, and environmental factors. It aims to have a positive impact on organic agricultural production. Organic farming believes that respect in the natural processes of agriculture is the best way to achieve high-quality yields. In addition, it aims to help reduce disease, poverty, and environmental degradation by providing alternative sources of income that can produce good food production. Organic farming ensures that beneficial and nutritious needs to people. Agricultural inputs using organic fertilizers can increase soil fertility to improve the plant growth process. As a result, organic fertilizer applicators can increase soil productivity in crop production and increase soil biodiversity. In addition, habitats are more resistant to stress; soil nematode abundance can be improved with organic fertilizers containing animal manure and crop residues (Keliikuli et al., 2019).

Furthermore, the current state problem caused by COVID19 infectious disease is associated with the agricultural sector. It affects all food markets, including demand for fruits and vegetables. The agro-food industry is highly integrated on a global scale. Due to COVID19, reduced activity due to COVID19 conditions has reduced shipments for food resources via commercial flights. Major global industries are experiencing disruption and the potential to restrict vital access to agricultural market supplies (Ivanov et al., 2020). This scenario had brought a negative impact on the current and future agricultural productivity.

There are various factors that can help vegetable seedling grow faster which can influence the establishment of stands in the production of vegetable crops. The physical characteristics of the soil, humidity, different cultural practices, temperature, and disease can be limiting factors in creating an optimal stand and achieving such high yields. Organic fertilizer is alternative fertilizers have organic fertilizers that can help to encourage fasten seedling growth. This becomes the positive of using organic fertilizers and increasing crop yields. Meanwhile, inorganic fertilizers will be negative effects, like environmental pollution caused by emitting chemical odours that can be detrimental to human health (Bakrie et al., 2010).

The study's objective was to study the effect of liquid organic fertilizer on the growth of vegetable seedlings to see how liquid organic fertilizer affects the growth and quality yield of vegetable seedlings. Besides, to study the content of nitrogen analysis in the leaf that can help to enhance and fasten the growth of the seedling's establishment.

1.2 Problem Statement

The problem associated with vegetable seedlings in the early stage is easily to die, and the leaves wither yellow. The main cause of the problem is due to hot compost and lack of nutrients in the media used. This can cause slow seedlings growth. After that, if unhealthy seeds are being planted in the field, the crop will not thrive and will not be able to survive. If taking other steps to replace them with new seedlings that are on time and high costs that cause delays in the planting period and affect the expected yields. The enhance seedling growth could prevent issues of stress plants during their first phase of establishment until the production of high-quality yield. Planted seedlings in the first stage are supposed to grow on time, but not all vegetable seedlings simultaneously grow in the first stages. Therefore, a proper solution is required to produce a uniform, faster and healthy growth of seedling to improve the vegetable yield and quality in the market.

1.3 Hypothesis

Null hypothesis (H0): Organic liquid fertilizer can enhance and fasten the growth rate of vegetable seedlings.

Alternative hypothesis (H1): Organic fertilizer is unable to enhance and fasten the growth rate of vegetable seedlings

1.4 Objective of The Research/Study

The main objective is to enhance and fasten the vegetable seedling establishments' growth. The below are the objectives:

i. To observe and measure the morphological growth of seedlings.

ii. To analyse the nitrogen contents in the seedling leaves.

1.5 Significance Of Study

The introduction of inorganic fertilizers on farms can be replaced with organic fertilizers that could reduce methane emissions, prevent groundwater pollution, soil acidity, and even global warming. In addition, organic fertilizers can supply clean, safe and unharmful nutrients to plants. Organic fertilizers can be collected from environmentally friendly and environmentally friendly materials. Therefore, organic fertilizers are encouraged to be used as alternative methods to accelerate seedling growth and increase vegetable production at lower cost while minimizing soil pollution.

1.6 Limitation of Study

Research has shown that the study limitation is this study do not cultivate seedling on the soil bed due to potential risks of many factors (Abiotic & Biotic) that could affect the growth of seedlings. Apart from that, it is much easier to plant seedlings in the planting tray for easy management and monitoring of the seedling growth in the nursery areas. Hence, pest & disease management will be easier and less occurrence which could impacting the seedling growth and could affect the overall data collection and data analysis process later on.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Organic fertilizers contain plant -based materials or process animals that occur naturally. Organic fertilizers are compounds that can be added to soil and plants that supply nutrients for good. Natural organic fertilizers include mineral supplies, all animal wastes including such as meat processing wastes, manure and plant-based fertilizers including such as compost, liquid manure and biosolid (Guertal et al., 2012). The advantage of organic fertilizers is that they can improve the biological processes of the soil. In addition, it increases the mobilization of nutrients from the decomposition of organic and toxic substances. It promotes mycorrhizal colonization, increases phosphorus supply, root growth due to better soil structure, increases soil organic matter (SOM) content, and increases nutrient exchange potential. Improves groundwater supply, analysed soil capacity, and enzymatic activity (Kala et al., 2011).

The embryonic process is triggered because of morphological and physiological changes in the formation of seed germination. Before germination, the seed absorbs water causing the seed embryo to expand and elongate. After transplanting, the consistency of the seedlings has an effect on their growth and yield. Features found in high-quality seedling morphology include dense stems, thick branches, dark green leaves, and long white roots. Changes in the organic fertilizer content due to exposure to the surrounding condition can damage seedlings with elongated stems, thin branches, slender limbs, light green leaves, and short, undeveloped roots can get reduced yields. Planting high quality seedlings is an important step to increase crop yields. Nutritious organic fertilizers can be used to facilitate this process (Rademacher et al., 2015). Important nutrients content in the organic fertilizer can help plant growth, disease resistance, quality fruit production, and green leaf production. Nutrients should not be used too much as it may causing harm to the seedlings. Plants require nitrogen, phosphorus, and potassium to help them thrive in healthy soil conditions. In addition, micronutrients need to be supplemented for plant growth as they contain calcium, magnesium, and iron. Abiotic and biotic factors also influence the seedling growth. Abiotic factors include water, temperature, sunlight, soil, and nutrients. While, biotic factors are living things, ecosystems including animals, bacteria and fungi (Lamichhane et al., 2018). The application of fertilizer treatment to the seedling 3 weeks after sowing could cause thin leaves or the leaves turn a yellow-green color, and particularly on the older leaf. Sometime, the seedlings may become tall and small. The seedlings growth in the nursery should be monitored as it may develop too quickly before transplanting which requires certain amount of fertilizer (Li-ju et al., 2015).

2.2 Type of Organic Fertilizer

The important nutrients are needed for the plant growth as they can improve crop quality and prevent damage. These nutrients needed are 16 different nutrients classified as macronutrients (N, P, K, S, Mg, and Ca), micronutrients (Fe, Cl, Mn, B, Zn, Cu, and Mo), and trace elements (Co, Si, Pa, and Ni). The nutrient requirements supplied by plants varies depending on the germination process. Plants need more nitrogen during the vegetative stage and more potassium in prolonging the flowering stage. Macronutrients are needed in large amounts during flowering, while micronutrients are needed in small amounts. The presence of nitrogen in the soil on the growth of the root system. Potassium is an important source for plant growth and production, and is widely used in plant tissues, which accounting for nearly 10% of plant dry weight (Suhaizan et al., 2009).

There are three type of alternative fertilizers used in the organic liquids fertilizer include fermented fruit juices (FFJ), indigenous microorganisms (IMO2), and fermented amino acid (FAA). Thus, fermented fruit juices increase the nutrient levels in the soil and benefit crops that grow with a supply of potassium. Fermented Fruit Juice (FFJ) is a nutrient-activating enzyme that aids in soil repair and function for growing crops. FFJ can be used to enhance crops through leaf formation. It also provides a natural flavour enhancer. Fermented fruit juice (FFJ) can be used to speed up the fruiting process and maximize yield in plants (Min et al., 2017).

Indigenous microorganism (IMO) is a form of soil microorganism that includes filamentous fungi, yeasts, and bacteria that have been collected from uncultivated soil. It has a higher concentration of these microbes in the soil due to the presence of earthworm castings, which are usually located under bamboo trees. Increased diversity and activity of those same beneficial microorganisms in the soil will speed up decomposition, ensuring a constant stream of nutrients from the soil's organic matter and improving plant nutrient uptake. Microbial inoculants are an essential component of agroecosystems because they help to reduce the use of chemical fertilizers while improving soil properties. The metabolites generate microbial inoculants in the decomposition of organic waste and improve humus quality (Anyanwu et al., 2015).

Fish amino acids (FAA) are products of fresh fish protein including bones, heads, meat, and other tank parts fermented with brown sugar. FAA is used as a soft leaf mist or wet soil along with other natural agriculture inputs to increase absorption and prevent runoff or leaching by providing sufficient nitrogen to plants for optimal absorption and chlorophyll production to preserve plant health. Later, the FAA promotes vegetable seedling growth, fruiting, and microbial activity in the soil (Weinert et al., 2014).

Chemical fertilizers are inputs from chemicals to increase crop production. However, chemical fertilizers having high doses have caused a decrease in soil properties during the crop yield period. Although inorganic matter can improve the chemical properties in the soil, such as continuous supply of macro and micro hazardous nutrients to meet the needs of crops and inorganic matter must improve the physical soil properties to ensure good soil conditions (Jaja et al., 2017).

Use of NPK fertilizers contained in inorganic fertilizers such as (nitrogen (N) for the formation of leaf enlargement, phosphorus (P) for root repair and potassium (K) for flower and fruit enlargement) in the form of Urea and other related products as well as KCl Plants. It is need to a constant supply of nutrients N, P, and K, which are sure to be present in the soil. Usually, the inorganic material has a high analytical fertilizer with little impurities. Increased levels of inorganic fertilizers are widely used for vegetable crops in order to obtain higher yields and optimum growth benefits (Stewart et al., 2019). However, inorganic fertilizers can have negative effects on human health and the environment. Nutrient sources from inorganic products have a role in agriculture for the importance of understanding their beneficial properties (Syafruddin et al., 2009).

2.3 Liquid Fertilizer

Liquid fertilizer is fermentation-derived organic material in the form of a solution containing several elements. Liquid organic fertilizers have the advantage including nutrients specific to the needs of the plant and able to supply nutrients quickly. In, addition, the application can be distributed more uniformly, and the concentration can be adjusted to meet the needs of the plant. After that, maintaining the equilibrium of nutrient components in soil, and reducing the effects of organic waste in the environment (Unnisa et al., 2015). Microorganisms may be applied to the fermentation process to speed up the fermentation process or increase the consistency of fermented goods while producing liquid fertilizer. Effective microorganisms are commonly used to speed up enzyme activity; they have a positive impact on the appearance of fermented products. Farmers are also promoting organic material as a way to encourage organic farming the number of microorganisms in the soil sample was used for soil damage inspection. In organic farming, artificial chemical agents, including pesticides, are not permitted for pest and disease control. Organic pesticides have been shown to be more effective and profitable, and biological pest control can prevent environmental damage caused by conventional pesticides while still being compliant with other pest control approaches (Subandi et al., 2017). There are five organic liquid fertilizers from several sources (shrimp extract, crop decomposition, vermic compost, seaweed extract, and fish extract). By preserving microbes at the rhizosphere level, the aims to investigate the impact of different fertilizer liquids on soil nutrient levels, soil quality, and bacterial diversity functioning (Ji et al., 2017). Liquid organic fertilizers have been widely used which is practiced to increase vegetable production from organic. However, it has been proven that effective liquid organic fertilizers on vegetables such as lettuce have been successful in increasing growth and yield a lot (Fahrurrozi et al., 2017).

The benefits of using liquid organic fertilizers to accelerate the synthesis of amino acids and proteins and accelerate plant growth. It is deep under the opinion that liquid organic fertilizers contain potassium which plays an essential role in every process of plant metabolism, namely in the synthesis of amino acids and proteins of ammonium ions. The element potassium also plays a role in maintaining good turgor pressure to allow metabolic processes to run smoothly and ensure continuous cell elongation. Liquid organic fertilizer is a fertilizer with a maximum low chemical content of maximum 5%. It can provide nutrients under the needs of plants in the soil due to its liquid form (Sudding, F. et al., 2021). Liquid organic fertilizers in fertilization are more even, and there will be none accumulation of fertilizer concentration in one place, this is because liquid organic fertilizer is 100% soluble. Liquid organic fertilizers have the advantage of being able to increase nutrient uptake and quickly overcome the lack of nutrients because the nutrients in it have been broken down for easier absorption and uptake with more efficient.

2.4 Morphological Characteristics Lettuce Butterhead Lettuce, Caixin Green Stem, and Lettuce Looseleaf

Lettuce (*Lactuca sativa L.*) belongs to the Asteraceae family, and it is a successful and varied plant family with a global distribution. Asteraceae is considering the biggest plant family, which consist between 23,000 and 30,000 species. Lactuca species have been classified in subfamily Cichorioideae, tribe Cichorieae (Lactuceae) based on morphometric characteristics, despite the phylogeny of the dandelion tribe Cichorieae (Lactuceae) being controversial (Funk et al., 2005). One of the most extensively adapted types of lettuce is leaf lettuce (*Lactuca sativa L.*), which produces crisp leaves and has a loosely organized stem. Lettuce may be eaten raw in vegetable salads and can also be used as a garnish or decoration in other dishes. More molecular genetic investigations have backed up this claim and helped clarify tribal relationships. Cultivation of cultivated lettuce from the wild species *Lactuca serriola L.* was thought to have occurred in the Mediterranean area. Long-leaved Costype lettuce was showed on the walls of Egyptian tombs, indicating that lettuce was farmed at least 4,500 years ago (R.I.S Mahlangu et al., 2016). Cultivated lettuce is classified into seven various types: Cos (also known as Romaine), Cutting (also known as Leaf), Stalk (also known as Asparagus), Butterhead, Crisphead (also known as Iceberg or Cabbage), Latin, and Oilseed. Except for the Oilseed group, which might be derived from either *L. serriola* or *L. Sativa* or maybe a hybrid between these two taxa, all of the groups are *Lactuca sativa L.* selections. The growth habits, leaf texture, shape, and colour of the various groupings vary significantly. Plants with rectangular upright inflexible leaves and a pronounced midrib with dark green leaves belong to the Cos group, which is named after the Greek island. A tiny head of almost spherical (orbicular) leaves surrounded by wrapper leaves constitutes the Butterhead group. The leaf texture is unique, and cultivars with anthocyanin have been created. Leaf colour ranges from green to yellowish-green. The Butterhead group is exported to Europe and was the second most important commercial group in the United States in the early twentieth century. Crispheads produce thick, compact heads made composed of spherical leaves folded on the base of each other (Mahlangu et al., 2016).

Mustard greens (*Brassica juncea L.),* often known as sawi Hijau (Indonesia); sawi bunga (Malaysia); phakkwangtung or phakkatkheokwangtung (Thailand); False pakchoi (English); Caixin (China), is a popular vegetable that may be eaten fresh or processed into pickles. Several varieties are cultivated in the area, each with its unique stem colour, leaf size, and flowering patterns. Mustard green from Cruciferae family vegetable trim with a notable commercial worth. Mustard could be a leaf vegetable that is higher in vitamins, minerals and vegetable proteins are required to upgrade food's nutrition of value (Kurniawati et al., 2016). Mustard green contains a wide run of environmental adaption, developing in both the highland and the lowlands, and often consumed by people, with a brief life expectancy of 20 to 45 days. When these veggies are allowed to ripen for 60-65 days after sowing, usually harvested seeds (Widnyana et al., 2018).

2.5 Seedlings of Growth

Development of seedling plant embryos from young sporophytes. Seed germination is a major phase in seedling growth. There are three main parts of the young embryonic root radicle, embryonic shoot hypocotile, and cotyledon. The number of seed leaves distinguishing flower groups in angiosperm monocotyledons provides one cotyledon of blade -like appearance, while dicotyledons provide two round cotyledons.

Plumulea is an embryonic component of a seed that grows into another shoot to produce the plant's first true leaves. Seedlings do not need a source of seed energy until it begins Photosynthesis. The apical meristem begins to develop and produce shoots and roots. The cotyledons gradually turn pale and fall off the plant as it grows and develops new leaves. Mechanical stimuli, such as wind or other means of physical contact, can also influence seedling development by a mechanism known as thigmomorphogenesis (Chehab et al., 2009). The related to seedling development, temperature and reflectivity interact for low light conditions is effective a daily temperature regime of 13–28°C. In the early stages, the seedlings are difficult to grow or stunted. The purpose of the rapid growth of seedlings before transplanting is not to interfere with growth propagation either leaf formation or fruit production.

2.6 Nitrogen on Fertilizer

Nitrogen is a necessary component for plant development to be effective. Organic fertilizers are used to keep various agricultural systems in good nutritional shape. Continuous application of fertilizers improves the nitrogen (N), phosphorus (P), potassium (K), calcium, and magnesium content the soil in an organic agricultural system (Watts et al., 2010). Inorganic nitrogen is released and absorbed by plants once organic fertilizers are added to soils and mineralization occurs. Agricultural management, microorganisms, soil characteristics, temperature, and water content, as well as the kind of organic fertilizer, all have an impact on the pace of mineralization (Lobell et al., 2007). Many other models have been developed to estimate nitrogen release from organic fertilizer been that have been applied (Dessureault-Rompré et al., 2011).

Nitrogen fertilizers are taken directly by crops or converted into various other forms through the process of oxidation after being applied to agricultural systems. Excess nitrogen will be lost and converted into gas or ions through washing, evaporation, and denitrification. If the roots of the plant do not take up nitrates, they are transported by runoff or washing into the soil with water (Tamme et al., 2009). When additional nitrogen is used, the phytol availability of the nitrogen group increases, increasing the potential for danger to the surrounding ecosystem. Excessive use of nitrogen fertilizers is associated with adverse problems including greenhouse effect eutrophication, and acid rain (Wang et al., 2002). Human health is disturbed when using contaminated groundwater or crops with high nitrate content (Ikemoto et al., 2002). In the garden maize production increased by 4%when the application rate of nitrogen fertilizer was increased by 30%, while the quantity of nitrate lost by leaching increased by 53%. Although its production decreased by 10%when the rate of nitrogen fertilizer application was reduced by 30%, the leaching loss was reduced by 37% (Sharifi et al., 2011). The application of manure (150kg-N-ha-1year-1) increases the production of *Phleum pratense L.* Champ; however, if twice the quantity of manure is applied, the excess nitrogen that accumulates in the soil may result in a loss in production (Sharifi et al., 2011). The development of nitrates in the nutrient content of crops is closely connected to the type of nitrogen fertilizer employed (Pavlou et al., 2007), as well as soil characteristics, according to previous research. The development of nitrate seen found to be affected by light intensity, fertilizer-N release time, and lettuce type (Escobar-Gutierrez et al., 2002).

For sustainable agriculture, rationalizing fertilizer use is critical since it can decrease the negative impacts of farming on the environment (Zebarth et al., 2009). During the management of an agricultural system, yield and environmental quality should be considered. Nitrate levels are highest in green leafy vegetables (Prasad et al., 2008), and lettuce is characterized as having a very high nitrate concentration (Santamaria, P et al., 2006). Consuming excessive amounts of nitrate can induce serious diseases in humans (Mensinga et al., 2003). Therefore, planting edible crops with low nitrate content is important. The Joint Expert Committee on Food and Agriculture (JECFA) of the United Nations/World Health Organization and the Scientific Committee on Food of the European Commission (EC) have similarly established a daily nitrate consumption of 0–3.7 mg kg1 body weight as appropriate (Santamaria et al., 2006). Organic fertilizers have no disturbing factors on the environment they are environmentally friendly and supply nutrients at macro and micro for the soil as compared to chemical fertilizers can cause risk to users or the environment due to the accumulation of toxic chemicals on vegetables with high concentrations (Adeyeye et al., 2016). The importance of seedlings in the production tray as it plays a role in strengthening and fixing plant roots to supply the roots with water. After that, the nutrients balance for the availability of water and air (Zhang et al., 2017).

2.7 Nitrogen and Chlorophyll Status of Vegetable Seeding Using SPAD Meter Readings

Nitrogen is an important nutrient for the development of plant growth. Chlorophyll (Chl), amino acids, protein, and nucleic acids, are found in nitrogen. Leaf chlorophyll could be a major marker of leaf greenness, and it regularly utilized to examine leaf nutrient insufficiencies and chlorophyll modifications (Ali et al., 2017). Noteworthy relationships between chlorophyll and leaf nitrogen substance detailed in agricultural crops (Wang et al., 2014; Kalacska et al., 2015). Dordas & Sioulas et al., (2008) detailed that after fertilization, low N supply reactivated to plant development, coming about in quickened leaf maturing and diminished chlorophyll content. Chlorophyll is used as a substitute for leaf nitrogen and is an important indicator of N deficiency in agriculture. (Cerovic et al., 2012). The nitrogen (N) concentration of the leaf is closely related to chlorophyll concentration in the plant (Zebarth et al., 2002). Therefore, could be used as a management strategy to enhance plant growth and yield. Therefore, it is important to in monitor the plant Chlorophyll and Nitrogen concentrations during production (Gitelson et al., 2003; Peng & Yuan et al., 2017). Using the SPAD 502 plus Chlorophyll Meter (Konica Minolta®, Japan) is commonly used for fast and non–destructive determination of relative leaf chlorophyll concentrations. SPAD readings had reported was related to the chlorophyll concentration of leaves (Basyouni et al., 2015; Basyouni & Dunn et al., 2017). The nitrogen and Chlorophyll concentrations have been reported determined in the laboratory found the high correlations with the SPAD readings for a variety of plant species, including cabbage (Westerveld et al., 2003), rice (Huang et al., 2016), mangrove (Dou et al., 2018), tomato (Ferreira et al., 2006), and corn (Hurtado et al., 2010).

2.8 Summary

This study made aimed is to fasten the growth and improve the establishment of seedlings without the use of chemicals fertilizer. There are three organic fertilizers being used which are (fermented fruit juices (FFJ), indigenous microorganisms (IMO), and fish amino acid fertilizer (FAA)) tested for three vegetable seedlings (caixin green stem, lettuce butterhead and lettuce looseleaf). There are various advantages of each of the three organic liquid fertilizers to improve the seed quality of vegetable seedlings.

CHAPTER 3

METHODOLOGY

3.1 Material and Apparatus

The preparation of material for the experiment is important to facilitate the procedures involves in the experiment. The materials used are three types of liquid organic fertilizers such as (fermented fruit juice (FFJ), indigenous microorganisms (IMO), and fish amino acid fertilizer (FAA)). After that, three varieties vegetables of seed (Caixin green stem, lettuce butterhead and lettuce looseleaf). While the tools used were germination trays, sprayer bottle, black plastic, garden gloves, hand shovel and peat moss. However, the liquid content of organic fertilizers used was evaluated by using the Kjeldahl method in the laboratory of the University Malaysia Kelantan. The apparatus involved include flasks, Kjeldahl, measuring cylinder, conical flask, burette, pipette, gloves, round bottom flask, dropper, stand and clamp, beaker, volumetric flask, media bottle, petri dish, pestle and mortar and centrifuge tube.

3.2 Fertilizer Preparation

3.2.1 Indigenous Microorganisms (IMO)

The preparation of one kilogram of ready-cooked rice in a rice cooker was required to make natural microorganisms (IMO). After that, the rice was cooled for 24 hours before being stored in a wooden container. The bottle was tightly closed with a cloth and fastened with a rubber band to prevent water and small insects from coming in. Next, the closed container was deposited on the forest floor. The container was left for three days in a protected location to protect it from moisture. If filaments of whitish mold have grown, the entire contents of the container were transferred to a larger glass jar placed together with 1 kg of brown sugar or molasses and mixed.

3.2.2 Fermented Fruit Juice (FFJ)

The process of making fermented fruit juice (FFJ) requires the main ingredient, which is banana. Banana were sliced into small pieces to speed up the fermentation phase. Next, brown sugar and molasses (100 ml) were added in a 1: 3 ratios. Jar was filled with all the mixture, labelled and cover with white paper before closing the bottle. The fermentation material was stirred from time to time, or at intervals of three to four days, to speed up the fermentation process and the extraction of gas from the fermentation process. The fertilizer was finished within two weeks, and the juice was filtered.

3.2.3 Fish Amino Acid Fertilizers (FAA)

Fish waste was cut into small of pieces using a knife to speed up the fermentation process. Brown sugar or molasses were mixed in a ratio (80ml). All ingredient is put in a jar and labelled accordingly. The ingredients used was covered with paper. Bottle cap was covered and at intervals every three days and required. The processing of the fermentation gas was accelerated by stirring and shaking of the bottle. The fertilizer was finished within four weeks, and the juice was filtered.

3.3 Preparation Planting Vegetable Seeds

Materials and apparatus were prepared for sowing the vegetable seeds. Before planting, the seeds should be was treated. The selection of germination tray based on seed size. Peat moss was inserted into each hole of the germination tray. Three to five mm small holes were made in the centre of each germination tray holes. Seeds were sown into the holes and trays were labelled accordingly following the three vegetable seeds (green stems of Caixin, lettuce butterhead and lettuce looseleaf). Water was sprayed using a bottle sprayer evenly. Trays were cover loosely with black plastic bag to keep the moist and placed under sheltered from light, rain and pests that could interfere the seed germination. Watering was done twice daily (in the morning and evening).

FERTILIZER MEASUREMENT FORMULA

Fertilizer 1ml = 50ml

50 ml × 1.92 ml = 96 ml (water)

20ml/ 104 hole ml = 0.192ml (1 hole)

0.192 ml × 10 hole = 1.92 ml (fertilizer)

3.3.1 Flow Chart Planting Vegetable Seed

The apparatus and materials were prepared.

↓

Seed treatment only.

↓

Tray germination were choose based size seeds.

↓

Peat moss was inserted into the germination tray.

↓

Sowing of three varieties vegetable seed (Caixin green stem, lettuce butterhead and lettuce looseleaf) in the germination tray.

↓

Germination tray was placed in the sheltered such as nursey area.

↓

The seedling was watered with using bottle sprayer

↓

Tray germination was covered with black plastic

Figure 3.1: Flow chart for planting vegetable seedlings

3.3.2 Distributor of organic liquid fertilizer

Table 3.2: Type of organic liquid fertilizer used and their supplies

Type of organic liquid fertilizer	**Company address**
 1) Fermented fruit juices (FFJ)	Qadhijah Natural Farm (Pg0496788-A) 14300 Nibong Tebal, Penang.
 2) Fish amino acid (FAA)	Qadhijah Natural Farm (Pg0496788-A) 14300 Nibong Tebal, Penang.
  3) Ingredient microorganisms (IMO)	Padeetech Sdn. Bhd., Blok P6, Upm-Mtdc Technology Centre, Universiti Putra Malaysia, 43400 Serdang, Selangor.

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3.4 Preparation Kjeldahl Method for Nitrogen Analysis Leaves

Kjeldahl method was carried out in the UMK laboratory. It consists of three steps which include the digestion, distillation and titration. About 1g of the sample weighed and placed into a Kjeldahl flask. 2 tablespoons of crystal powder (K_2SO_4: $CuSO_4$ = 9: 1) were added into the flask followed by adding of 12 ml of sulphuric acid (H_2SO_4) slowly. The digestive block turned on the 420 °C for heat. Inside the chamber, a Kjeldahl flask was mounted on a digestive tract. Initially, the mixture was heated slowly until the foaming stopped and during that time, the smoke began to emit. The heat was gradually amplified. After the digestion solution was complete, it was heated for an additional 30 minutes or 1 hour and the solution turned a translucent green. The solution was left to cool. A small amount of water was added to the solution, shaken, and rinsed into the flask. After allowing the solution to cool, 80 ml of water was added and cooled into the room.

In the second step distillation, distilled water 250ml (8 samples) were added to 10-gram boric acid. After that, boric acid was mixed with 2.5ml bromocresol green and 1.75ml methyl red and then put in the conical flask. The digestion flask was connecting to the distillation apparatus an 50ml 40% sodium hydroxide solution (NaOH) was added. Distillation was switch on for the start and continued until 100ml distillate in the titration flask was collected. The digestion flask was removed and titrating flask from the calculation unit. The acid was absorbed by ammonia and then nitrogen content was determined by titration. The colour for reddish-pink was changed to green.

In the last step, which is titration, the conical flask was taken out and the content was titrated with 0.1N 50 ml hydrochloric acid. The solution was changed colour green to pink for reading and calculation. The formula used for the calculation is shown below:

CALCULATION

$$\% \text{ Nitrogen} = \frac{(T-B) \times N \times 14.700 \times 100}{\text{Weight sample (mg)}}$$

T= Sample titration

B=Blank titration

N=Normality of titration

3.4.1 Flow Chart Kjeldahl Method

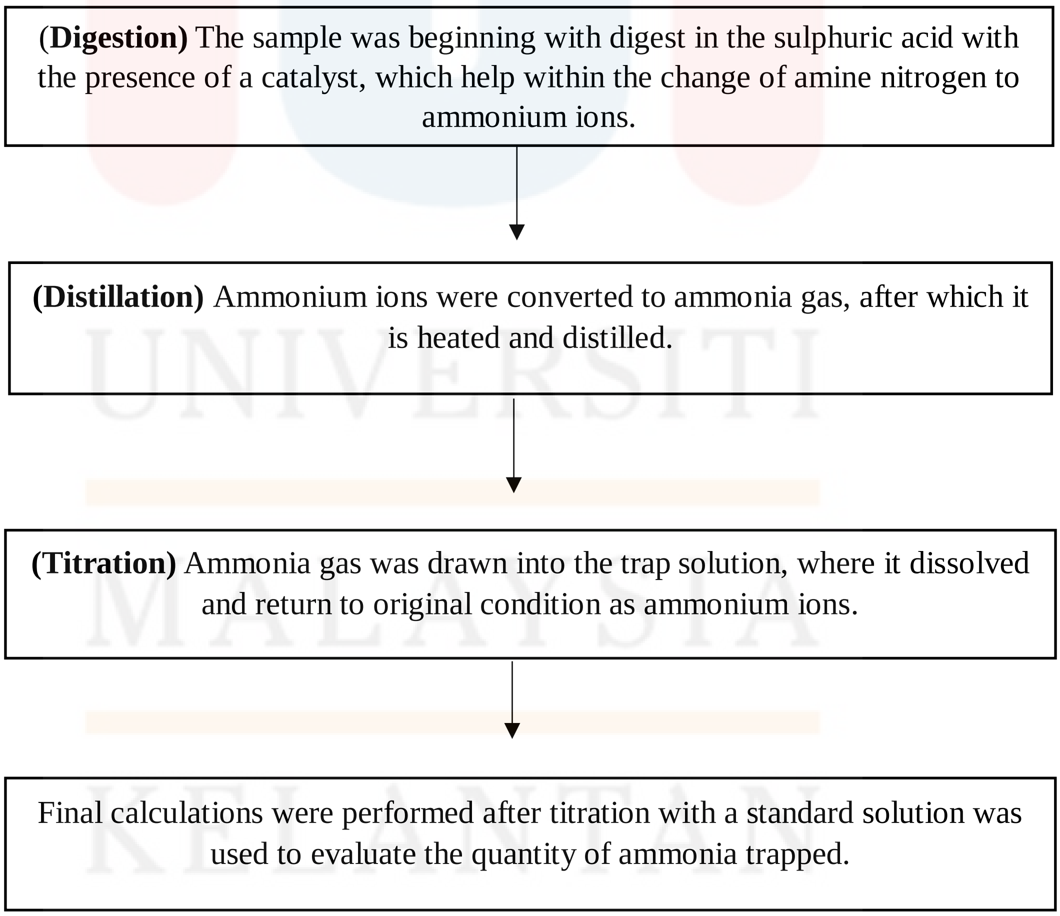


Figure 3.3: Flow chart of Kjeldahl method

3.5 Preparation of SPAD meter

Plant analysis uses a SPAD meter (502 plus Chlorophyll Meter Konica Minolta®, Japan) as a portable device that allows immediate measurement of chlorophyll contact. The leaf SPAD meter has a sensor that emits two frequencies of bright light. Green light absorbs chlorophyll, but the difference of red light cannot be the absorption of chlorophyll content on the leaves. The SPAD meter 'on' and press the handlebar without any leaf samples to determine until the meter sounds blank. Then, it was ready for the mission. First, select a physiologically active leaf, place it in the space, and press the handlebar to record the reading. Usually, took next three values were taken from each leaf, one middle to downstream of the other leaf, and clicks 'average' to obtain the average value. The final value for the sample now clicks on clear all data, and the instrument of SPAD meter was now ready for the next sample leaf. The value had taken for the next sample plant. Click on 'data recall' to view the data. Any discrepancies in values that occur there may be data. The SPAD meter instrument was taken from 7 am to 9 am taking data 2 times a week and day before of transplantation to minimize the potential effect of light intensity on Chloroplasts.

3.6 Experimental Design

The experiment to study the effect of organic liquid fertilizer on the vegetable seedlings was conducted using method completely randomized design (CRD). Table 3.4 show the treatments involved consisting of four liquid organic fertilizer (fermented fruit juice (FFJ), ingredient microorganisms (IMO) from Microbe under a bamboo tree, IMO from Microbe under a virgin forest tree, and fish amino acid fertilizer (FAA)) used to provide nutrients for three varieties of vegetable seedlings (Caixin green stem, lettuce butterhead and lettuce looseleaf). Each of the three vegetable varieties consists of ten seeds for each treatment. Therefore, the number of seedlings involved was 4 x 3 x 10, making the total number of seedlings involved are 120 seedlings. The amount of each four types of organic liquid fertilizer given was1.92 ml and added with 96 ml of water. After ten days, the amount of nitrogen in the leaves of the vegetable seedling was evaluated using the Kjeldahl method for nitrogen analysis.

Table 3.4: Experiment design for vegetable seedlings

Type of treatment	**Type of fertilizer**	**Number of pot/holes**	**Number of type replications**	**Total samples**
Treatment 1	Microbe under a bamboo tree	10	3	30
Treatment 2	Fish amino acid fertilizer (FAA)	10	3	30
Treatment 3	Microbe under a virgin forest tree	10	3	30
Treatment 4	Fermented fruit juice (FFJ)	10	3	30
			Total number of rows = 9	120

3.7 Data Collection and Statistical Analysis

The growth performance measurements, such as plant height, plant width, and leaf width, were taken from day one to day ten. Data was recorded and analysed through one-way ANOVA to compare the effect of four different type treatments on the growth the three types of different varieties vegetable seedlings. All measurements were performed by analysing the physical properties of plant height, plant width, and the leaf width of vegetable seedlings. Data analysed was recorded through the laboratory Data from the Kjeldahl method were compared between treatments. All data in the experiments were analysed with Tukey HSD post hoc through IBM SPSS Statistics at the significant level of $p = 0.05$.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Growth performance analysis

4.1.1 Caixin green stem

Symptoms of nutrient deficiency caused by nitrogen can be seen by completely yellow leaves (chlorosis), thin stems and stunted trees in the seedlings. Figure 4.1 shows the of Caixin green stem seedlings recorded from day 1 up to 10 days of germination in the germination tray using four types of organic liquid fertilizer. The results showed that the Microbe Virgin Forest Tress Treatment produced higher stem (4.13 cm) compared to Fermented Amino Acid Treatment (4.10 cm), Fermented Fruit Juices Treatment (3.57 cm) and Microbe Bamboo Tree Treatment (3.56 cm). Microbe Virgin Forest tree have tropical EM, which contribute for good crop growth compared to other treatment. This was due to Microbe Virgin Forest trees Treatment having a good source of plant nutrients to better the physical property of the soil (Tagotong, M. B et al., 2015).

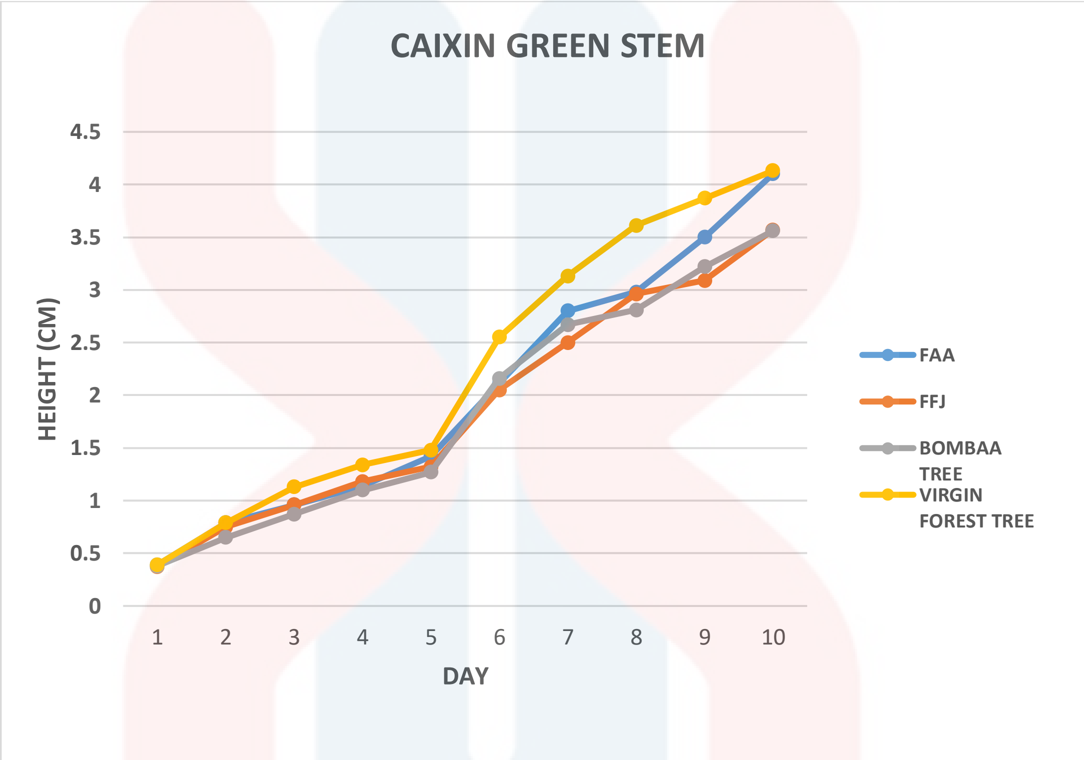


Figure 4.1: Height of C aixin green stem seedling observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

While Figure 4.2 showed organic liquid fertilizer on Microbe Bamboo Tree Treatment was higher (2.42 cm) plant width on Caixin green stem seedlings compared to Fermented Fruit Juice Treatment (2.23 cm), Fermented Amino Acid Treatment (2.03 cm) and Microbe Virgin Forest Tree Treatment (2.03 cm).

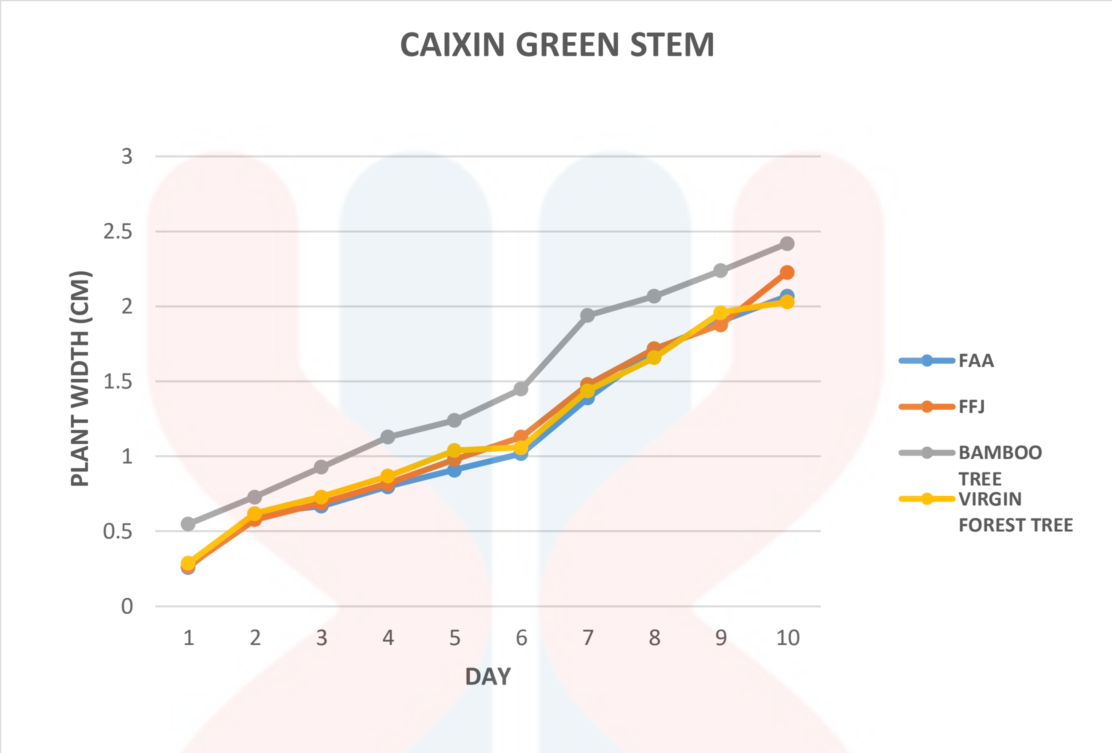


Figure 4.2: The width of Caixin green stem seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

Furthermore, the leaf width of the Caixin green stem in Figure 4.3 showed that the Microbes Bamboo Trees Treatment produced the highest leaf width (1.15 cm) compared to Fermented Fruit Juice Treatment (1.07 cm), Microbe Virgin Forest Tree Treatment (1.06 cm) and Fermented Amino Acid Treatment (0.96 cm). This result indicates that plant height in Fermented Bamboo Tree Treatment height was due to the increase in vegetable seedling parameters due to the accessibility of high-quality nutrients extracted from the decomposition of organic liquid by Effective Microorganisms. Further, the enhanced solubility of nutrients was due to the organic acids produced from the decomposition of organic liquid (Talaat et al., 2015).

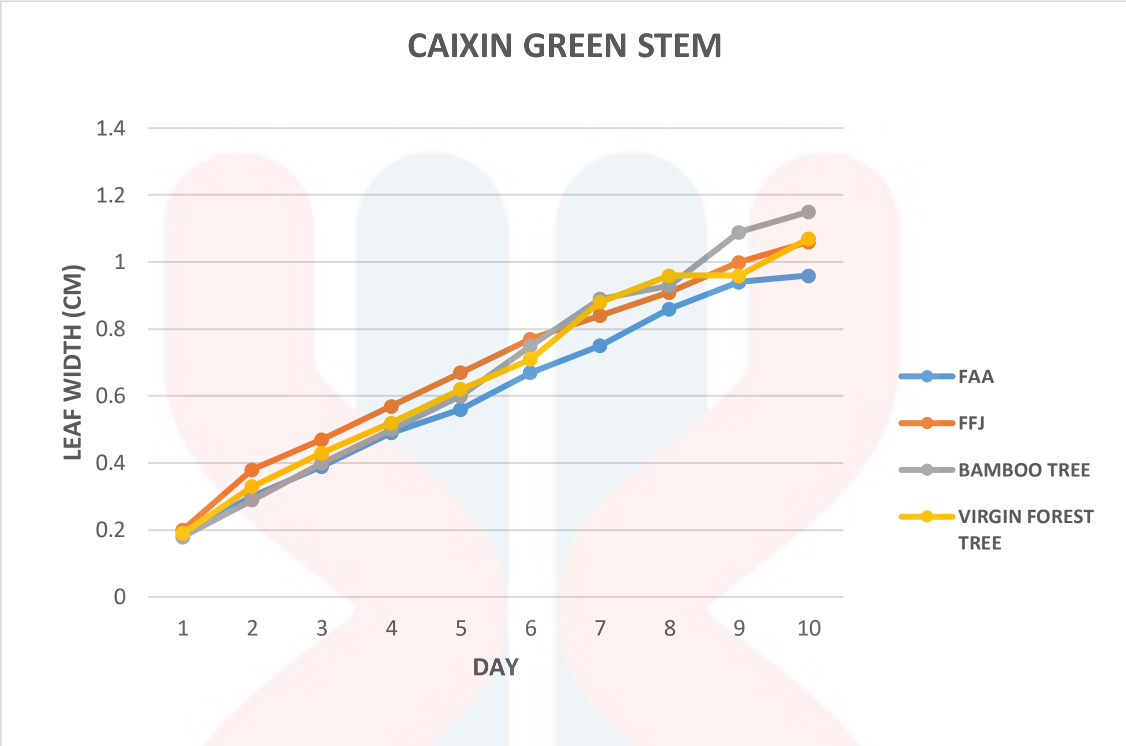
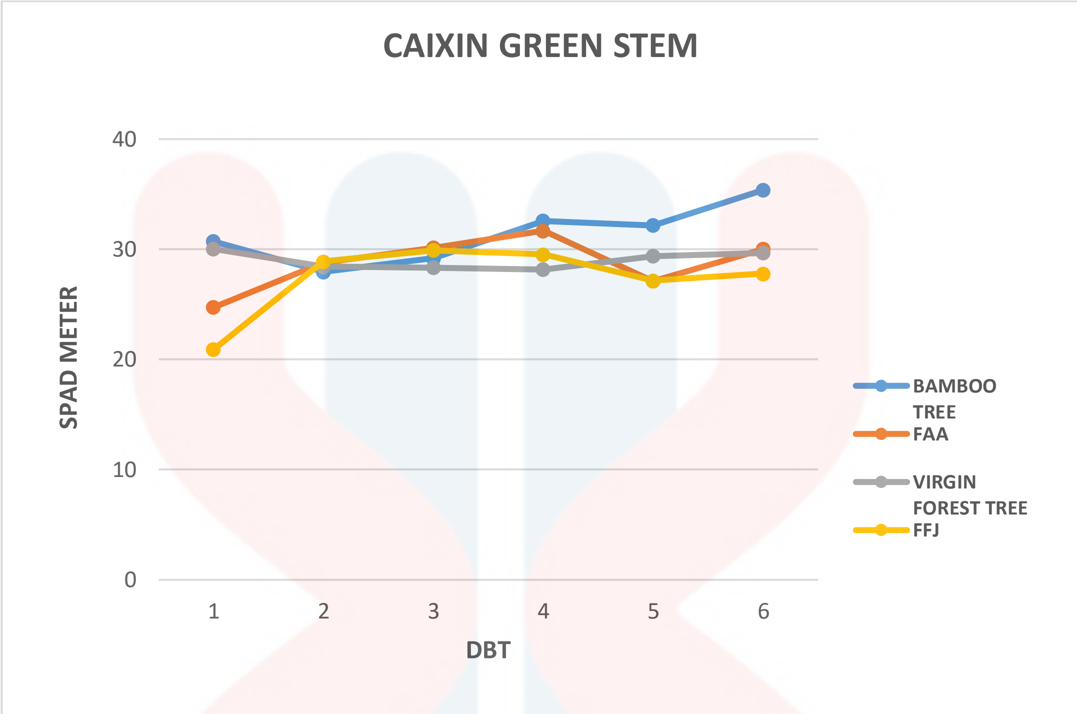


Figure 4.3: Leaf width of Caixin green stem seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

As shown in the Figure 4.4, treatment of Microbial Bamboo Trees (31.33) had the highest SPAD meter reading compared to other organic liquid fertilizers including Microbe Virgin Forest Tree Treatment (29.00), Fermented Amino Acid Treatment (28.75) and Treatment Fruit Juice (27.36). Result shown that the Microbes Bamboo Tree gave the best growth for Caixin green stem due to the effective microorganisms contained in it.



*DBT (DAY BEFORE TRANSPLANTING)

Figure 4.4: SPAD meter reading for Caixin green stem seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

4.1.2 Lettuce Looseleaf

Figure 4.5 shows the height of lettuce looseleaf seedlings recorded up to 10 days in the germination tray using four types of organic liquid fertilizer. The results showed that the Fermented Fruit Juices Treatment gave the highest looseleaf seedlings (1.98 cm) compared to Fermented Amino Acid Treatment (1.88 cm), Microbe Bamboo Tree Treatment (1.81 cm) and Microbe virgin Forest Tress Treatment (1.61 cm). This could due to Fermented Fruit Juices Treatment higher was due to containing 90% had high phosphate solubility the population. Phosphate-soluble microorganisms play an important role in P mineralization (Sureshkumar et al., 2013).

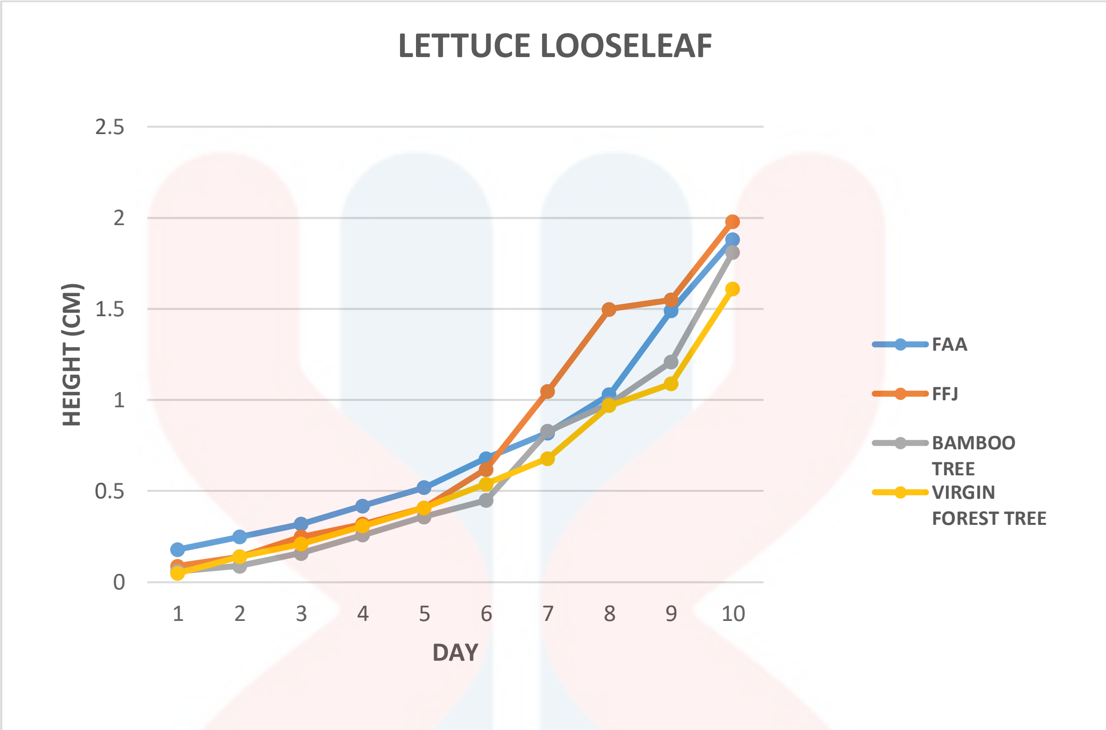


Figure 4.5: Height of lettuce looseleaf seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

Figure 4.6 shows plant width of lettuce looseleaf seedlings recorded up to 10 days in the tray germination using four types of organic liquid fertilizer. The results showed that the Microbe Bamboo Tree Treatment was higher (1.42 cm) compared to Fermented Fruit Juices Treatment (1.38 cm), Fermented Amino Acid Treatment (1.13 cm), and Microbe virgin Forest Tress Treatment (1.04 cm). Fish-based was used soluble materials have been developed as good organic fertilizers. Moreover, it was founded that lettuce seedlings grow well using microbial culture solutions (Shinohara et al., 2011).

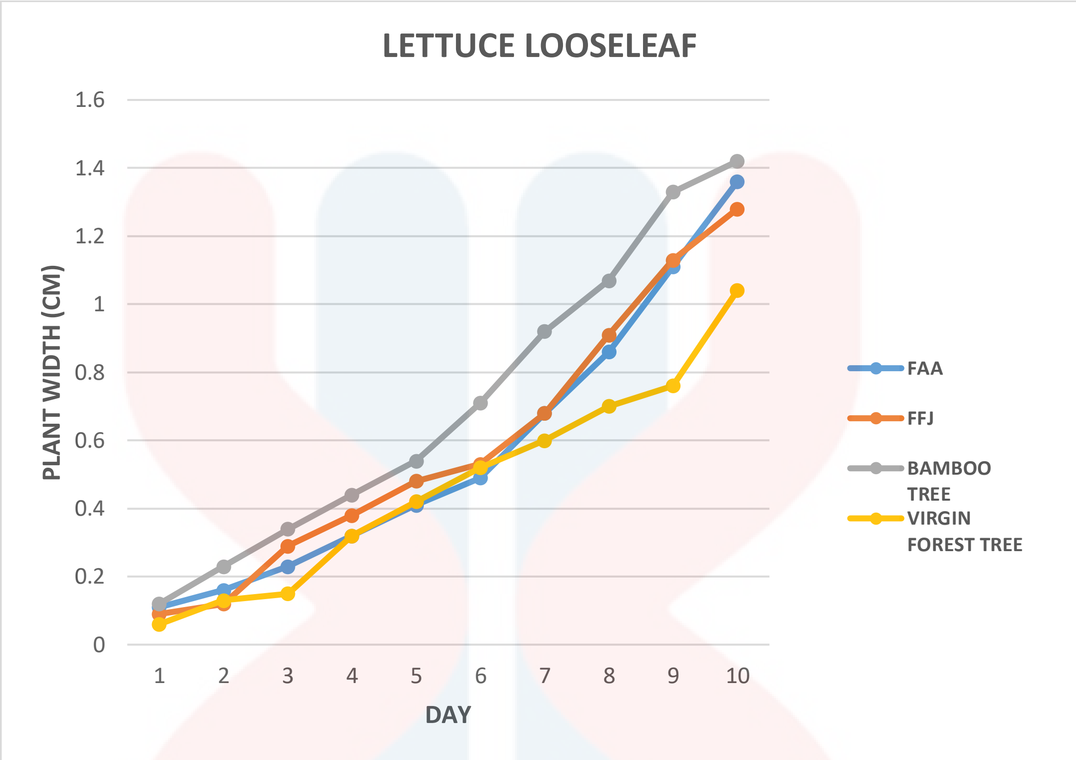


Figure 4.6: The width of lettuce looselaf seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

Figure 4.7 shows the leaf width of lettuce looseleaf seedlings recorded up to 10 days in the tray germination using four types of organic liquid fertilizer. The results showed that the Microbe Bamboo Tree Treatment gave highest leaf width (0.63 cm) compared to Fermented Fruit Juices Treatment (0.59 cm), Fermented Amino Acid Treatment (0.59 cm), and Microbe virgin Forest Trees Treatment (0.46 cm).

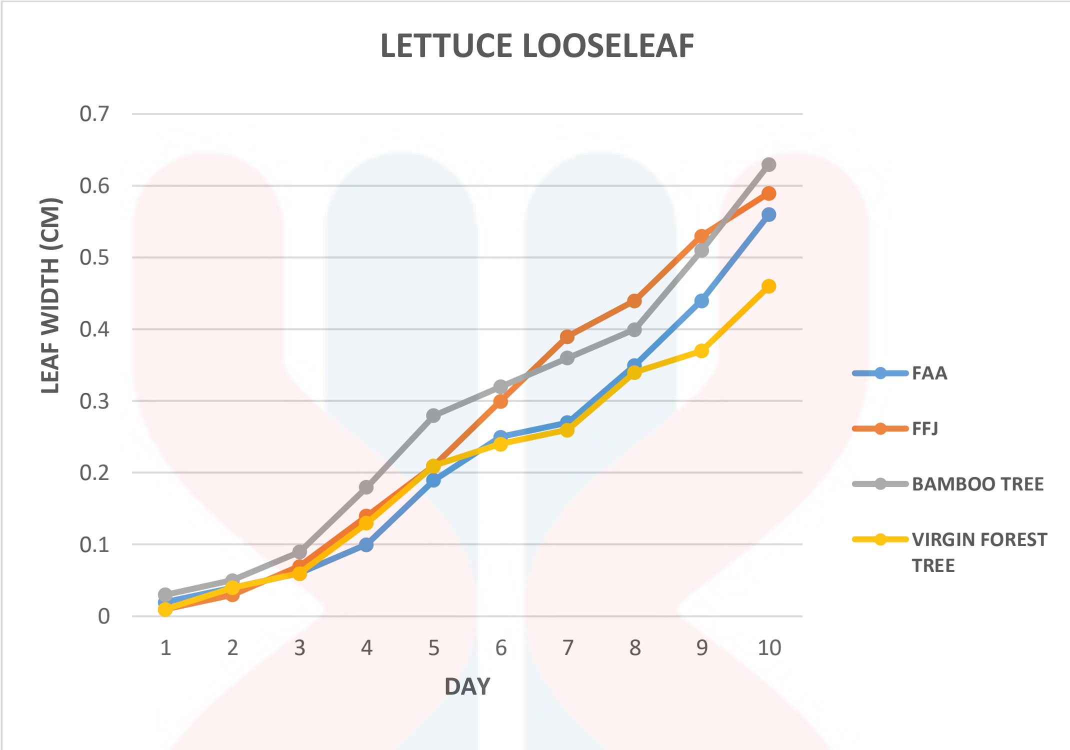
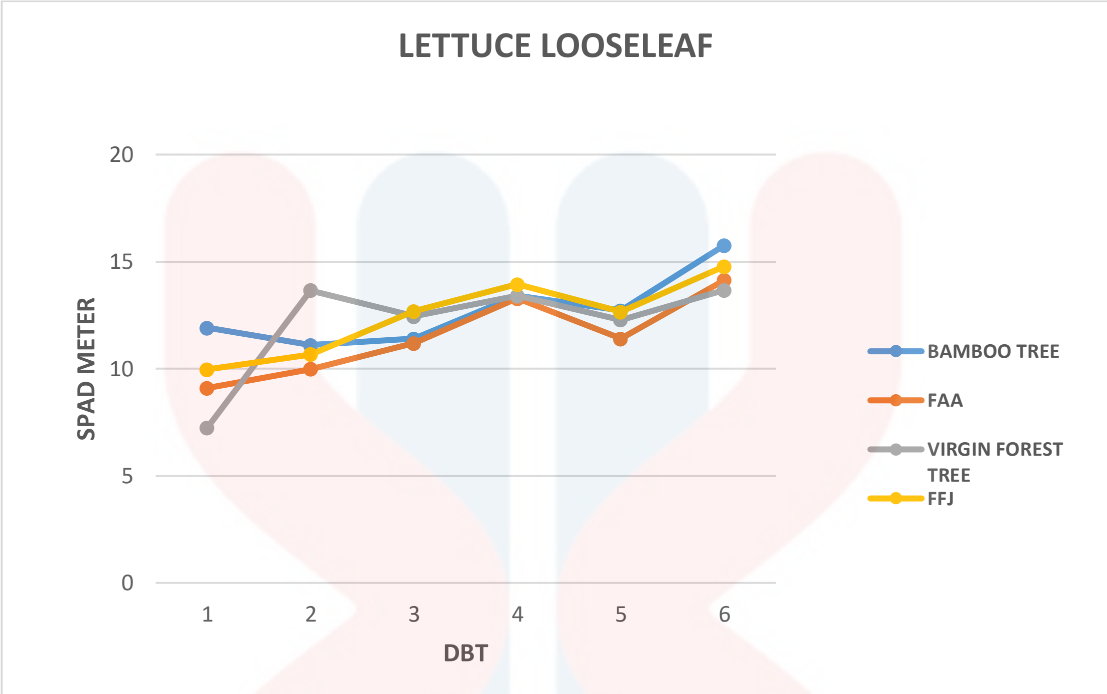


Figure 4.7: Leaf width lettuce of looseleaf seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

Vegetable seedlings need a certain amount of nutrients during the early stages of growth before being transplanted to the farm (Zhang et al., 2017). Based on Figure 4.8, treatment of Microbial Bamboo Trees (12.71) had highest reading of the SPAD values that obtained from SPAD meter reading compared other organic liquid fertilizers including Treatment Fruit Juice (10.73), Fermented Amino Acid Treatment (9.86), and Microbe Virgin Forest Tree Treatment (9.16). This showed that chlorophyll content in the leaves of lettuce looseleaf where highest when sprayed with organic fertilizer of Microbial Bamboo Trees compared to other organic liquid fertilizers as chlorophyll content directly related to the SPAD values.



*DBT (DAY BEFORE TRANSPLANTING)

Figure 4.8: SPAD meter reading of lettuce looseleaf seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

4.1.3 Lettuce Butterhead

Figure 4.9 shows the height of lettuce butterhead seedlings recorded up to 10 days on germination tray cultivation using four types of organic liquid fertilizer. The results showed that the Microbe virgin Forest Tress Treatment produce the highest height of seedlings (3.27 cm) as compared to Fermented Fruit Juices Treatment (2.84 cm) Microbe Bamboo Tree Treatment (2.55 cm) and Fermented Amino Acid Treatment (2.44 cm). The use of organic liquid has enhanced the microbial growth and nutrient content in the soil thus can reduce dependant on the synthetic nitrogen fertilizer as organic based can help seedling to absorb faster for growth purposes which proven through this study.

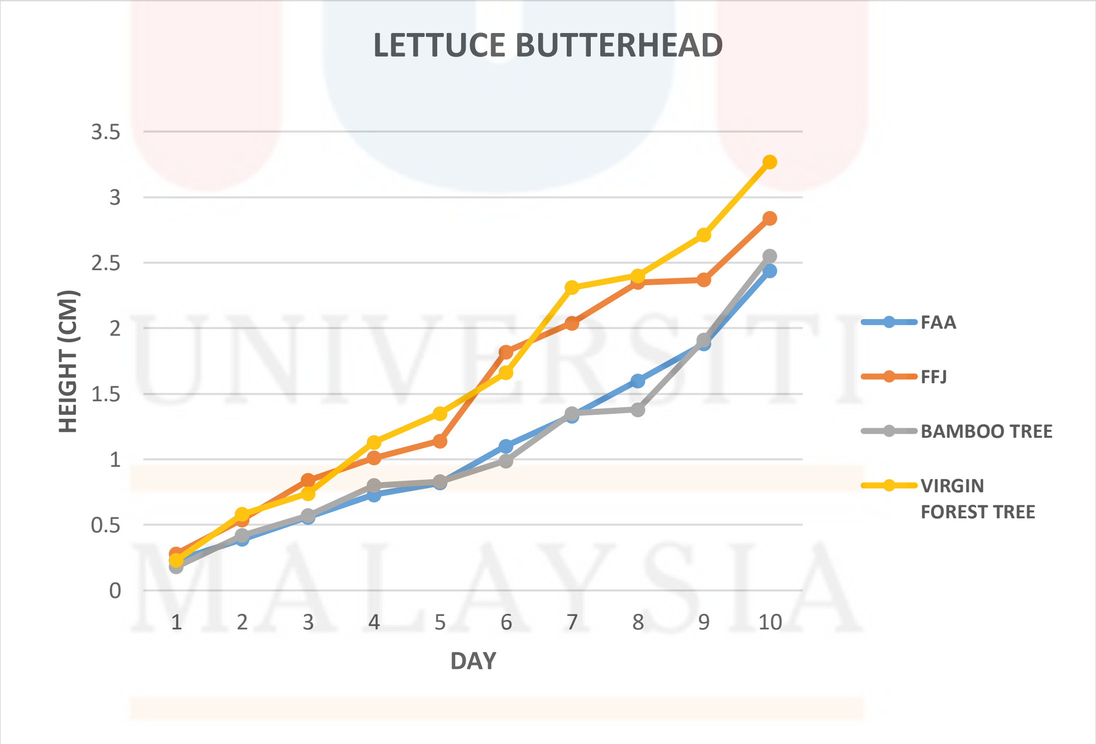


Figure 4.9: Height of lettuce butterhead seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

Next, Figure 4.10 shows the plant width of lettuce butterhead seedlings recorded up to 10 days on germination tray. The results showed that the Fermented Fruit Juices Treatment gave the height seedlings at (1.59 cm) as compared to Microbe virgin Forest Tress Treatment (1.52 cm), Microbe Bamboo Tree Treatment (1.47 cm) and Fermented Amino Acid Treatment (1.35 cm). This result showed that Fermented Fruit Juice (FFJ) provide better nutrient required to enhance lettuce butterhead seedling growth (Min et al., 2017).

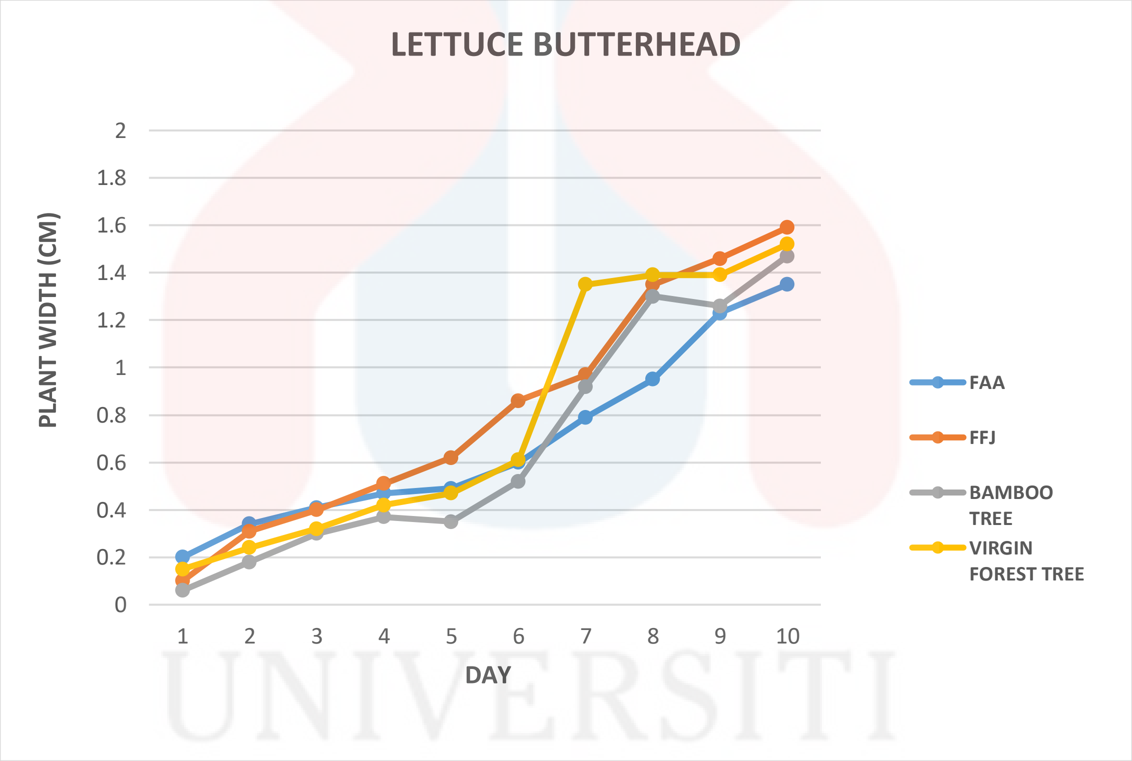


Figure 4.10: The width of lettuce butterhead seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

Figure 4.11 shows the leaf width of lettuce butterhead seedlings recorded up to 10 days on tray germination cultivation. The results showed that the Microbe Bamboo Tree Treatment was the highest (0.63 cm) compared to Fermented Fruit

Juices Treatment (0.60 cm), Microbe virgin Forest Tress Treatment was higher (0.60 cm), and Fermented Amino Acid Treatment (0.55 cm).

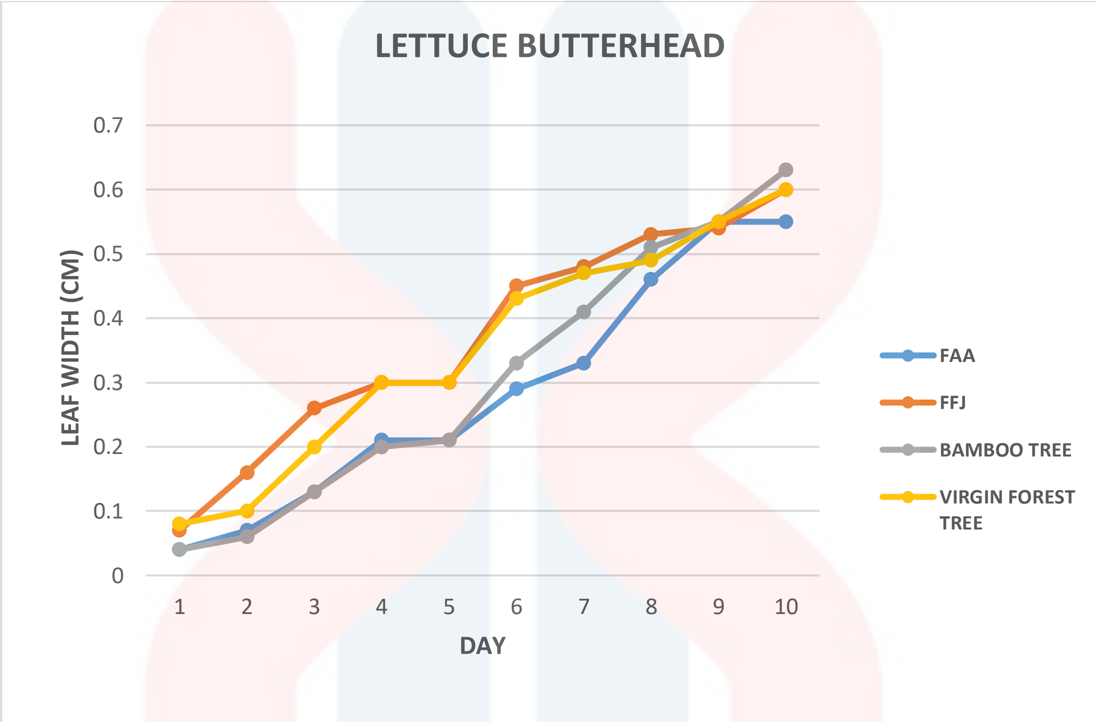
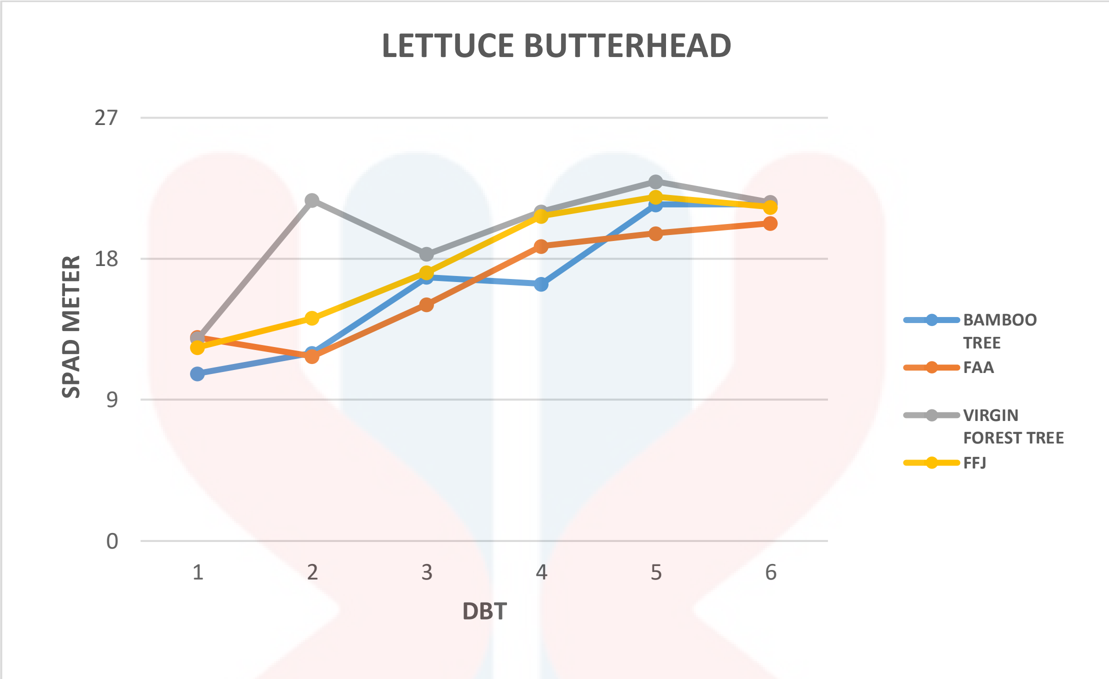


Figure 4.11: Leaf width of lettuce butterhead seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

Figure 4.8 show The SPAD meter reading for the lettuce butterhead seedlings from Day 10 showed the highest mean for Microbe Virgin Forest Tree Treatment (19.74) as compared to other organic liquid fertilizers, including Fermented Fruit Juice Treatment (17.95), Microbial Bamboo Trees Treatment (16.47) and Amino Acid Treatment (16.43).



*DBT (DAY BEFORE TRANSPLANTING)

Figure 4.12: SPAD meter reading of lettuce butterhead seedlings observed from Day 1 to Day 10 days in germination tray treated with four different organic fertilizer.

4.2 Yield performance analysis

4.2.1 Caixin green stem

Based on table 4.13, plant height comparison of Caixin green stem for different organic fertilizer treatment showed no significant difference level at p=0.05. Microbe under Virgin Forest Trees treatment had the highest plant height (4.13 cm) was due to the increased EM role in the soil to help increase nutrients availability in the soil for plant uptake (Verma et al., 2014). However, Fermented Amino Acid treatment (4.10 cm), Fermented Fruit Juice treatment (3.57 cm) and Microbe under Bamboo Trees treatment (3.56 cm) were among the lowest. Next, plant width also had a no significant difference level at p=0.05. Mean analysis for the highest plant width is the Microbe under Bamboo Trees treatment (2.42 cm) and the lowest mean was obtained on Fermented Fruit Juice treatment (2.23 cm), Microbe under Virgin Forest Trees treatment (2.08 cm), and Fermented Amino Acid treatment (2.07 cm). The width leaf for the Caixin green stem also had no significant difference level at p=0.05. Width leaf analysis showed that Microbe under Bamboo Trees treatment had the highest mean (1.15 cm), but Microbe under Virgin Forest Trees treatment (1.07 cm), Fermented Fruit Juice treatment (1.06 cm), and Fermented Amino Acid treatment (0.96 cm) were the lowest in mean analysis.

Table 4.13: Mean parameter Caixin Green Stem seedlings

	Plant height (cm)	Plant Width (cm)	Leaf Width (cm)
Microbe under a bamboo tree	3.56[a]	2.42[a]	1.15[a]
Fermented amino acid (FAA)	4.10[a]	2.07[a]	0.96[a]
Microbe under a virgin forest tree	4.13[a]	2.08[a]	1.07[a]
Fermented fruit juice (FFJ)	3.57[a]	2.23[a]	1.06[a]

* Means separation in each column followed by the same letter are not significantly different at p = 0.05

4.2.2 Lettuce looseleaf

Based on table 4.14, plant height comparison of lettuce looseleaf for different organic fertilizer treatment showed no significant difference level at p=0.05. Fermented Fruit Juice treatment had the highest plant height (1.98 cm). However, Fermented Amino Acid treatment (1.88 cm), Microbe under Bamboo Trees treatment (1.81 cm) and Microbe under Virgin Forest Trees treatment (1.61 cm) were among the lowest. Next, plant width also had a no significant difference level at p=0.05. Mean analysis for the highest plant width is showed by Microbe under Bamboo Trees treatment (1.42 cm) and the lowest mean was obtained on Fermented Amino Acid treatment (1.36 cm), Fermented Fruit Juice treatment (1.28 cm), and Microbe under Virgin Forest Trees treatment (1.04 cm). The width leaf for the lettuce looseleaf also had no significant difference level at p=0.05. While, width leaf analysis showed that Microbe under Bamboo Trees treatment had the highest mean (0.63 cm), but Fermented Fruit Juice treatment (0.59 cm), Fermented Amino Acid treatment (0.56 cm) and Microbe under Virgin Forest Trees treatment (0.46 cm) were among the lowest in mean analysis.

Table 4.14: Mean Parameter Lettuce Looseleaf seedlings

	Plant Height cm)	Plant Width (cm)	Leaf Width (cm)
Microbe under a bamboo tree	1.81[a]	1.42[a]	0.63[a]
Fermented amino acid (FAA)	1.88[a]	1.36[a]	0.56[ab]
Microbe under a virgin forest tree	1.61[a]	1.04[a]	0.46[ab]
Fermented fruit juice (FFJ)	1.98[a]	1.28[a]	0.59[b]

* Means separation in each column followed by the same letter are not significantly different at p = 0.05.

4.2.3 Lettuce butterhead

Based on table 4.15, plant height comparison of lettuce butterhead for different organic fertilizer treatment showed no significant difference level at p=0.05. Microbe under Virgin Forest Tree treatment had the highest plant height (3.27 cm). However, Fermented Fruit Juice treatment (2.84 cm), Microbe under Bamboo Trees treatment (2.55 cm) and Fermented Amino Acid treatment was the lowest (2.44 cm). Next, plant width also had a no significant difference level at p=0.05 where Fermented Fruit Juice treatment (1.59 cm) had the highest plant width, followed by Microbe under Virgin Forest Trees treatment (1.52 cm), Microbe under Bamboo Trees treatment (1.47cm), and Fermented Amino Acid treatment (1.35 cm) was the lowest. This shows that by using fish-based soluble materials has proven as good organic fertilizers to grow the lettuce butterhead (Shinohara et al., 2011). The width leaf for the lettuce butterhead also had no significant difference level at p=0.05. Width leaf analysis on Microbe under Bamboo Trees treatment had the highest mean (0.63 cm), but Fermented Fruit Juice treatment (0.60 cm), Microbe under Virgin Forest Trees treatment (0.60 cm), and Fermented Amino Acid treatment (0.52 cm) were among the lowest (0.52 cm) for mean analysis.

Table 4.15: Mean parameter Lettuce Butterhead seedlings

	Plant Height (cm)	Plant Width (cm)	Leaf Width (cm)
Microbe under a bamboo tree	2.55^a	1.47^a	0.63^a
Fermented amino acid (FAA)	2.44^a	1.35^a	0.52^a
Microbe under a virgin forest tree	3.27^a	1.52^a	0.60^a
Fermented fruit juice (FFJ)	2.84^a	1.59^a	0.60^a

* Means separation in each column followed by the same letter are not significantly different at p = 0.05.

4.3 SPAD meter performance analysis

4.3.1 Caixin green stem

Chlorophyll was important for plant leaves as having higher chlorophyll is important in producing sufficient food and energy content for plant growth (Phibunwatthanawong et al., 2019). Table 4.16 shows the SPAD values for Caixin green stem seedlings using four types of organic liquid fertilizers according to different planting week. SPAD meter was taken before transplanting vegetable seedlings. The 1st DBT until the 6th DBT also had no significant difference for the level at p=0.05. This shows that all organic liquid fertilizer treatments are not different significant in SPAD values. However, the SPAD values were different and fluctuated thus show inclining in trends as seedling grow older.

Table 4.16: SPAD values Caixin Green Stem seedlings

	Week 1		Week 2		Week 3	
	1st DBT	2nd DBT	3rdDBT	4th DBT	5th DBT	6th DBT
Microbe under a bamboo tree	30.73^{a}	27.96^{a}	29.20^{a}	32.59^{a}	32.17^{a}	35.38^{a}
Fermented amino acid (FAA)	24.73^{a}	28.80^{a}	30.15^{a}	31.70^{a}	27.13^{a}	30.01^{ab}
Microbe under a virgin forest tree	30.03^{a}	28.42^{a}	28.34^{a}	29.38^{a}	29.38^{a}	29.67^{ab}
Fermented fruit juice (FFJ)	20.91^{a}	28.88^{a}	29.90^{a}	29.38^{a}	27.14^{a}	27.79^{b}

* Means separation in each column followed by the same letter are not significantly different at p = 0.05. *DBT (day before transplanting)

4.3.2 Lettuce looseleaf

Table 4.17 shows the SPAD values for lettuce looseleaf seedlings that sprayed with four different types of organic liquid fertilizers according to different planting week. SPAD meter was taken before & after transplanting vegetable seedlings. The 1st DBT until the 6th DBT also had no significant difference for the level at p=0.05. This shows that all organic liquid fertilizer treatments are no different significant.

Table 4.17: SPAD meter Lettuce Looseleaf seedlings

	Week 1		Week 2		Week 3	
	1st DBT	2nd DBT	3rd DBT	4th DBT	5th DBT	6th DBT
Microbe under a bamboo tree	11.91[a]	11.11[a]	12.55[a]	13.40[a]	12.71[a]	15.76[a]
Fermented amino acid (FAA)	9.10[a]	9.98[a]	11.19[a]	13.28[a]	11.40[a]	14.13[a]
Microbe under a virgin forest tree	7.25[a]	13.65[a]	12.44[a]	13.41[a]	12.28[a]	13.67[a]
Fermented fruit juice (FFJ)	9.79[a]	11.59[a]	13.40[a]	13.94[a]	12.65[a]	14.78[a]

* Means separation in each column followed by the same letter are not significantly different at p = 0.05. *DBT (day before transplanting)

4.3.3 Lettuce butterhead

Table 4.18 shows the SPAD values for lettuce butterhead seedlings using four types of organic liquid fertilizers according to each of the planting week. SPAD meter was taken before transplanting vegetable seedlings. The 1st DBT until the 6th DBT also had no significant differences at P=0.05 for SPAD values of all the treatments. This shows that all organic liquid fertilizer treatments are not showing any significant differences even though there were fluctuated and were different in amounts. The chlorophyll content of leaves had a structural component of chlorophyll about the amount of nitrogen. The nitrogen content in the leaves was been found, which related to its colour. Much greener colour of the leaves showed that the leaves had higher chlorophyll content within the leaves cells that inflict that nitrogen amount within the leaves is higher and abundant. (Phibunwatthanawong et al., 2019).

Table 4.18: SPAD meter Lettuce Butterhead seedlings

	Week 1		Week 2		Week 3	
	1st DBT	2nd DBT	3rd DBT	4th DBT	5th DBT	6th DBT
Microbe under a bamboo tree	10.69ª	12.00ª	16.82ª	16.41ª	21.46ª	21.48ª
Fermented amino acid (FAA)	13.00ª	11.73ª	15.10ª	18.81ª	19.63ª	20.27ª
Microbe under a virgin forest tree	12.90ª	21.73ª	18.31ª	21.10ª	22.93ª	21.60ª
Fermented fruit juice (FFJ)	12.36ª	14.21ª	17.14ª	20.73ª	21.49ª	20.15ª

* Means separation in each column followed by the same letter are no significantly different at p = 0.05. *DBT (day before transplanting)

4.4 Kjeldahl method performance analysis

4.4.1 Caixin green stem

All vegetable seedlings were analysed through the laboratory using the Kjeldahl method to check nitrogen in the leaves. Based on table 4.19 showed that Caixin green stem vegetable seedlings showed no significant difference to each of the treatments at the level of $p=0.05$. Microbe under a Bamboo Tree (0.34%) had highest mean analysis of nitrogen content within the seedling compared to other treatment, followed by Fermented Amino Acid (FAA), Microbe under a Virgin Forest Tree and Fermented Fruit Juice (FFJ), which had similar nitrogen values at 0.23%.

Table 4.19: Kjeldahl method Caixin Green Stem seedlings

	Sample (%)
Microbe under a bamboo tree	0.34[a]
Fermented amino acid (FAA)	0.23[a]
Microbe under a virgin forest tree	0.23[a]
Fermented fruit juice (FFJ)	0.23[a]

* Means separation in each column followed by the same letter are not significantly different at p = 0.05.

4.4.2 Lettuce looseleaf

Figure 4.20 shows lettuce looseleaf for Microbe under a Bamboo Tree had a significant difference of ($p<0.05$) compared to other treatments no had a significant difference for the level at $p=0.05$. The higher mean analysis was Microbe under a Bamboo Tree (0.56%) compared to Fermented Fruit Juice (0.28%), Fermented Amino Acid (0.26%) and Microbe under a Virgin Forest Tree (0.23%) to the lowest. The interaction between SPAD meter values showed that Microbe under a Bamboo Tree was the highest compared to other treatment. In fact, plant growth performance also indicated that Microbe under a Bamboo Tree was much better compared to other treatment including the comparison of the nitrogen content analysis. The formation of humus from plant decomposition material is due to the ability of effective microorganisms (EM) to help improve the decomposition process well and help nutrient to be available in simple form for fast absorption by the seedlings (Sulok et al., 2016).

Table 4.20: Kjeldahl method Lettuce Looseleaf seedlings.

	Sample (%)
Microbe under a bamboo tree	0.56^{b}
Fermented amino acid (FAA)	0.26^{a}
Microbe under a virgin forest tree	0.23^{a}
Fermented fruit juice (FFJ)	0.28^{a}

* Means separation in each column followed by the same letter are not significantly different at $p = 0.05$.

4.4.3 Lettuce butterhead

Figure 4.21 shows the nitrogen content analysis for lettuce butterhead obtained through Kjeldahl method. Fermented Fruit Juice (0.30%) had the highest in term of nitrogen content analysis within the seedling leaves compared to Microbe under a Bamboo Tree (0.29%), Fermented Amino Acid and Microbe under a Virgin Forest tree were the lowest at the values of 0.28%. However, in term of mean comparison showed that there was no significant difference at p=0.05 for all the treatments. The interaction between SPAD meter values showed that Fermented Fruit Juice was the highest compared to other treatment. In fact, plant growth performance also indicated that Fermented Fruit Juice was much better compared to other treatment including the comparison of the nitrogen content analysis. In fact, nitrogen was critical for plant growth and development for the agriculture system (Wang et al., 2002).

Table 4.21: Kjeldahl method Lettuce Butterhead seedlings

	Sample (%)
Microbe under a bamboo tree	0.29[a]
Fermented amino acid (FAA)	0.28[a]
Microbe under a virgin forest tree	0.28[a]
Fermented fruit juice (FFJ)	0.30[a]

* Means separation in each column followed by the same letter are not significantly different at p = 0.05.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

In conclusion, using input materials from the fermentation products from plants, animals, and microorganisms to enhance the faster growth of seedling crops has been proven throughout this study. Seedling crop productivity was improved by using organic fertilizer management for vegetable seedlings. In this study, liquid organic fertilizer was used to plant Caixin green stems, lettuce looseleaf, and lettuce butterhead in tray germination by using four types of different treatment liquid organic fertilizer. Results show that the best treatment for Caixin green stem, lettuce looselaf and lettuce butterhead vegetable seedling was using Microbes under Bamboo Trees (T1) as it produces the highest height of seedling (3.57cm) and the highest leaf width (2.42cm) as compared to other treatments. Overall, organic liquid fertilizer could fasten and increase the seedling growth with higher leaf, wider leaf width, high plant of width, higher SPAD values, and higher nitrogen content in the leaf for all the types of vegetable seedlings tested. The results obtained from the study showed a positive performance in the in the seedling due to presence of high-quality EM (effective microorganisms) in the organic fertiliser used.

As for the recommendation, use of different concentration at different interval of crop growth could be explored in determining the use of organic fertilizer in improving vegetable growth for commercial production. Vegetable seedling crops need adequate amount of nitrogen to ensure good growth performance to maximize yield and reduce losses and damage of the crop.

REFERENCES

Ali MM, Al-Ani A, Eamus D, Tan DKY. 2017. Leaf nitrogen determination using non-destructive techniques—a review. Journal of Plant Nutrition 40(7):928–953

Anyanwu, C. F., Ngohayon, S. L., Ildefonso, R. L., & Ngohayon, J. L. (2015).Application of indigenous microorganisms (IMO) for bioconversion of agricultural waste. International Journal of Science and Research, 4(5), 778-784

Adeyeye, A. S., Akanbi, W. B., Sobola, O. O., Lamidi, W. A., & Olalekan, K. K.(2016). Comparative effect of organic and in-organic fertilizer treatment on the growth and tuberyeild of sweet potato (Ipomea batata L). International Journal of Sustainable Agricultural Research, 3(3), 54-57.

Bakri, M.M., Anas, I., Sugiyanta. dan Indris, K. 2010. Aplikasi pupuk anorganik dan organic strawsati pada budidaya padi SRI (System of Rice Intensification). Jurnal Tanah dan Lingkungan 12: 25-32.

Brix, H. (1972). Growth response of Sitka spruce and white spruce seedlings to temperature and light intensity. Can. Dep. Environ., Can. For. Serv., Pacific For. Res. Centre,Victoria BC, Inf. Rep. BC-X-74. 17 p

Basyouni R, Dunn B (2017). Use of reflectance sensors to monitor plant nitrogen status in horticultural plants. Retrieved 2019 March 2 from http://factsheets.okstate.edu/documents/hla-6719-use-of-optical sensors-to-monitor-plant-nitrogen-status-in-horticultural-plants/.

Basyouni R, Dunn BL, Goad C (2015). Use of non-destructive sensors to assess nitrogen status in potted poinsettia (*Euphorbia pulcherrima* L. (Wild. ex Klotzsch)) production. Scientia Horticulture 192:47-53.

Chehab, Elamir & Eich, Elizabeth & Braam, Janet. (2009). Thigmomorphogenesis: A complex plant response to mechano-stimulation. Journal of experimental botany. 60. 43-56.

Cerovic ZG, Masdoumier G, Ghozlen NB, Latouche G. (2012). A new optical leaf-clip meter for simultaneous non-destructive assessment of leaf chlorophyll and epidermal flavonoids. Physiologia Plantarum 146(3):251–260 DOI

D'Este, M., Alvarado-Morales, M., & Angelidaki, I. (2018). Amino acids production focusing on fermentation technologies–A review. *Biotechnology Advances*, *36*(1), 14-25.

Dordas CA, Sioulas C. (2008). Safflower yield, chlorophyll content, photosynthesis, and water use efficiency response to nitrogen fertilization under rain fed conditions. Industrial Crops and Products 27(1):75–85 DOI .1016/j.indcrop.2007.07.020

Demir, H., & Polat, E. (2014). Effects of different growing media on seedling quality and nutrient contents in cabbage (*Brassica oleraceae var. capitata L*.). Journal of food, Agriculture and environment, 12, 1378-1381.

Dessureault-Rompré, J.; Zebarth, B.J.; Chow, T.L.; Burton, D.L.; Sharifi, M; Georgallas, Porter, G.A.; Moreau, G.; Leclerc, Y.; Arsenault, W.J.; Grant, C.A. (2011) Predicate of soil nitrogen supply in potato fields in a cool humid climate. Soil Sci. Soc. Amer. J. 75, 626–637.

Dou Z, Cui L, Li J, Zhu Y, Gao C, Pan X,. Li W (2018). Hyperspectral estimation of the chlorophyll content in short-term and long-term restorations of mangrove in Quanzhou Bay Estuary, China. Sustainability 10(4):1127.

Escobar-Gutierrez, A.J.; Burns, I.G.; Lee, A.; Edmondson, R.N. (2002) Screening lettuce cultivars for low nitrate content during summer and winter production. J. Hortic. Sci. Biotechnol. 2002, 77, 232–237.

Fahrurrozi, F., Sariasih, Y., Muktamar, Z., Setyowati, N., Chozin, M., & Sudjatmiko, S. (2017). Identification of Nutrient Contents in Six Potential Green Biomasses for Developing Liquid Organic Fertilizer in Closed Agriculture Production System.

FunkVA, BayerRJ, KeeleyS,ChanR,WatsonL,GemeinholzerB,SchillingE,PaneroJL, BaldwinB G,Garcia-JacasN,Susanna A, Jansen RK (2005) Everywhere but Antaractica: using a superstreet to understand the diversity and distribution of the Compositae. Biol Skr 55:343–374

Gianquinto G, Goffart JP, Olivier M, Guarda G, Colauzzi M, Dalla Costa L,… Mackerron DKL (2004). The use of hand-held chlorophyll meters as a tool to assess the nitrogen status and to guide nitrogen fertilization of potato crop. Potato Research 47(1-2):35-80.

Gitelson AA, Gritz Y, Merzlyak MN (2003). Relationships between leaf chlorophyll content and spectral reflectance and algorithms for non-destructive chlorophyll assessment in higher plant leaves. Journal of Plant Physiology 160(3):271-282

Guertal, E. A.; Green, B. D. (2012). "Evaluation of organic fertilizer sources for south-eastern (USA) turfgrass maintenance". Acta Agriculture Scandinavica, Section B— Soil & Plant Science. 62 (sup1): 130–138

Huang L, Yang J, Cui X, Yang H, Wang S, ZhuangH (2016). Synergy and transition of recovery efficiency of nitrogen fertilizer in various rice genotypes under organic farming. Sustainability 8(9):854.

Ivanov D., (2020) predicting the impacts of epidemic outbreaks on global supply chains: a simulation- based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. Transp. Res. Part E. 2020; 136:101922.doi: 10.1016/j.tre.2020.101922

Ikemoto, Y.; Teraguchi, M.; Kaneene, Y. (2002) Plasma level of nitrate in congenital heart disease: Comparison with healthy children. Pediatr. Cardiol.23, 132–136.

Jaja, E. T., & Barber, L. I. (2017). Organic and inorganic fertilizers in food production system in Nigeria. Nature, 7(18).

Ji, R., Dong, G., Shi, W., & Min, J. (2017). Effects of liquid organic fertilizers on plant growth and rhizosphere soil characteristics of chrysanthemum. Sustainability, 9(5), 841.

Kala, D. R., Rosenani, A. B., Fauziah, C. I., Ahmad, S. H., Radziah, O., & Rosazlin, A. (2011). Commercial organic fertilizers and their labelling in Malaysia. Malaysian Journal of Soil Science, 15, 147-157.

Kalacska M, Lalonde M, Moore TR. (2015). Estimation of foliar chlorophyll and nitrogen content in an ombrotrophic bog from hyperspectral data: scaling from leaf to image. Remote Sensing of Environment 169:270–279 DOI 10.1016/j.rse.2015.08.012

Keliikuli, A., Smith, K., Li, Y., & Lee, C. N. (2019). Natural Farming: The Development of Indigenous Microorganisms Using Korean Natural Farming Methods. Sustainable Agriculture, 9.

Lobell, D.B. (2007). The cost of uncertainty for nitrogen fertilizer management: A sensitivity analysis. Field Crop. Res., 100, 210–217.

Lindqvist K., (1960) on the origin of cultivated lettuce. Hereditas 46:319–350

Lamichhane, Jay Ram & Debaeke, Ph & Steinberg, Christian & You, Mingpei & Barbetti,

Li-ju Lin, Gregory C. Luther, Peter Hanson. (2015). Raising healthy tomato seedlings. AVRDC publication No. 15-795.

Martin & Aubertot, Jean-Noël. (2018). Abiotic and biotic factors affecting crop Seed germination and seedling emergence: a conceptual framework. Plant and Soil. 432. 1-28.

Mensinga, T.T.; Speijers, G.J.; Meulenbelt, J. (2003) Health implications of exposure to environmental nitrogenous compounds. Toxicol. Rev., 22, 41–51.

Min, L. L., & Thwe, A. A. (2017) Effect of Different Fermented Fruit Juice as Foliar spra on the Growth and Yield of Maize (Zea mays L.).

Rademacher, W. (2015). Plant growth regulators: backgrounds and uses in plant production. *Journal of plant growth regulation*, *34*(4), 845-872.

Phibunwatthanawong, T., & Riddech, N. (2019). Liquid organic fertilizer production for growing vegetables under hydroponic condition. *International Journal of Recycling of Organic Waste in Agriculture*, *8*(4), 369-380.

Pavlou, G.C.; Ehaliotis, C.D.; Kavvadias, V.A. (2002) Effect of organic and inorganic fertilizers applied during successive crop seasons on growth and nitrate accumulation in lettuce. Sci. Hortic. 111, 319–325.

Prasad, S.; Chetty, A.A. (2008) Nitrate-N determination in leafy vegetables: Study of the effects of cooking and freezing. Food Chem. 106, 772–780.

R.I.S Mahlangu, M.M. Maboko, D. Sivakumar, P. Soundy & JohnJifon (2016): Lettuce (Lactuca sativa L.) Growth, Yield and Quality Response to Nitrogen Fertilization in a Non-Circulating Hydroponic System, Journal of Plant Nutrition, DOI:10.1080/01904167.2016.1187739

Sulok, K. M. T., Zainudin, S. R., Chen, Y. S., Zehnder, J. A. M., & Ambi, W.(2016) Impact of Natural Farming on Soil, Normalized Difference Vegetation Index and Chlorophyll of Black Pepper. *Advances in Plant Science and Technology*, 2.

Santamaria, P. (2006) Nitrate in vegetables: Toxicity, content, intake and EC regulation. J. Sci. Food Agr. 86, 10–17

Sureshkumar R, Mohideen ST, Nethaji N (2013) Heat transfer characteristics of nanofuids in heat pipes: a review. Renew Sustain Energy Rev 20:397–410

Syafruddin, M. Rauf, R.Y. Arvan and M. Akil. (2009). Requirements for N, P, and K Fertilizers on Inceptisol Haplustepts Soil, Indonesian Journal of Agriculture, 2(1),pp. 77-84.

Sharifi, M.; Zebarth, B.J.; Burton, D.L.; Rodd, V.; Grant, C.A. (2011) Long-term effects of semisolid beef manure application to forage grass on soil mineralizable nitrogen. Soil Sci. Soc. Amer. J., 75, 649–658.

Stewart, M.W., Dibb, W.D., Johnston, E.A. and Smyth, J.T. (2005). The Contribution of Commercial Fertilizer Nutrients to Food Production. 97: 1–6.

Subandi M, Setiati Y, Mutmainah N H (2017) Suitability of Corcyra cephalonica eggs parasitized with Trichogramma japonicum as intermediate host against sugarcane borer Chilo auricilius Bulgarian Journal of Agricultural Science 23(5): 779-786

Suhaizan binti lob. (2009). Kesan Interaksi Mikoriza Vesikular Arbuskular (MVA), Paras Berbeda Vermikas Dan Baja Kimia Terhadap Pertumbuhan 3 Varieti CILI (Capsicum annumL.)Tempatan, USM.

Sudding, F., Asri, M., & Rauf, A. W. (2021, February). Application of liquid organic and inorganic fertilizer on growth and production of hybrid maize. In IOP Conference Series: Earth and Environmental Science (Vol. 648, No. 1, p. 012140). IOP Publishing.

Tamme, T.; Reinik, M.; Roasto, M. (2009) Nitrates and Nitrites in Vegetables: Occurrence and Health Risks. In Bioactive Foods Promoting Health: Fruits and Vegetables; Watson, R.R., Preedy, V.R, Eds.; Academic Press: Salt Lake City, UT, USA, pp. 307–321.

Talaat, N. B., Ghoniem, A. E., Abdelhamid, M. T., & Shawky, B. T. (2015). Effective microorganisms improve growth performance, alter nutrient uptake and induce the accumulation of compatible solutes in common pea plants (Phaseolus vulgaris L.) subjected to salinity stress. Plant Growth Regulations, 75 (1), 281-295.

Tagotong, M. B., & Corpuz, O. (2015). Bioorganic fertilizer on pechay homegarden in Cotabato. *American Journal of Agriculture and Forestry*, *3*(6-1), 6-9.

Unnisa, S. A. (2015). Liquid Fertilizer from Food Waste-A Sustainable Approach. International Research Journal of Environment Sciences, 4(8), 22-25.

Verma, S.; Sharma, A.; Kumar, R.; Kaur, C.; Arora, A.; Shah, R.; Nain, L. (2014) Improvement of antioxidant and defense properties of Tomato (var. Pusa Rohini) by application of bioaugmented compost. Saudi J. Biol. Sci. 2015, 22, 256–264

Watts, D.B.; Torbert, H.A.; Prior, S.A.; Huluka, G. (2010) Long-term tillage and poultry litter impacts soil carbon and nitrogen mineralization and fertility. Soil Sci. Soc. Amer. J. 74, 1239–1247.

Wang, Z.H.; Zong, Z.Q.; Li, S.X.; Chen, B.M.(2002) Nitrate accumulation in vegetables and its residual in vegetable fields. Environ. Sci 23, 79–83.

Weinert, E. J., Miller, S. A., Ikeda, D. M., Chang, K. S., McGinn, J. M., & DuPonte, M. W. (2014). Natural farming: Fish amino acid. Sustainable Agriculture, SA-12. University of Hawai'i, College of Tropical Agriculture and Human Resources.

Widnyana, I. K., Kuspianta, I. W. S., & Sapanca, P. L. Y. (2018). AJAB. Asian J Agri & Biol, 6(2), 204-209.

Zebarth, B.J.; Drury, C.F.; Tremblay, N.; Cambouris, A.N. (2009) Opportunities for improved fertilizer nitrogen management in production of arable crops in eastern Canada: A review. Can. J. Soil Sci. 89, 113–132.

Zebarth BJ, Younie M, Paul JW, Bittman S (2002). Evaluation of leaf chlorophyll index for making fertilizer nitrogen recommendations for silage corn in a high fertility environment. Communications in Soil Science and Plant Analysis 33(5-6):665-684.

Zhang, J., Wang, Y., Wang, P., an Zhang, Q., Yan, C., Yu, F., ... & Fang, L. (2017). Effect of different levels of nitrogen, phosphorus, and potassium on root activity and chlorophyll content in leaves of Brassica oleracea seedlings grown in vegetable nursery substrate. *Horticulture, Environment, and Biotechnology*, *58*(1), 5-11.

APPENDIX A

Table A 1a: ANOVA Caixin Green Stem

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
PLANT_HEIGHT	Between Groups	3.030	3	1.010	1.940	.141
	Within Groups	18.746	36	.521		
	Total	21.776	39			
WIDTH_PLANT	Between Groups	.806	3	.269	1.424	.252
	Within Groups	6.794	36	.189		
	Total	7.600	39			
WIDTH_LEAVE	Between Groups	.182	3	.061	.986	.410
	Within Groups	2.214	36	.062		
	Total	2.396	39			

Table A 1b: Tukey Plant Height Caixin Green Stem

PLANT_HEIGHT

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05 1
TREATMENT 1	10	3.5600
TREATMENT 4	10	3.5700
TREATMENT 2	10	4.1000
TREATMENT 3	10	4.1300
Sig.		.306

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 1c: Tukey Plant Width Caixin Green Stem

WIDTH_PLANT

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05 1
TREATMENT 2	10	2.0700
TREATMENT 3	10	2.0800
TREATMENT 4	10	2.2300
TREATMENT 1	10	2.4200
Sig.		.289

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 1d: Tukey Width Leave Caixin Green Stem

WIDTH_LEAVE

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05 1
TREATMENT 2	10	.9600
TREATMENT 4	10	1.0600
TREATMENT 3	10	1.0700
TREATMENT 1	10	1.1500
Sig.		.332

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 2a: ANOVA Lettuce Looseleaf

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
HEIGHT_LOOSELEAF	Between Groups	.734	3	.245	.565	.642
	Within Groups	15.590	36	.433		
	Total	16.324	39			
WIDTHPLANT_2	Between Groups	.835	3	.278	1.693	.186
	Within Groups	5.920	36	.164		
	Total	6.755	39			
WIDTHLE AVE_2	Between Groups	.158	3	.053	2.716	.059
	Within Groups	.698	36	.019		
	Total	.856	39			

Table A 2b: Tukey Plant Height Lettuce Looseleaf

HEIGHT_LOOSELEAF

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05 1
TREATMENT 3	10	1.6100
TREATMENT 1	10	1.8100
TREATMENT 2	10	1.8800
TREATMENT 4	10	1.9800
Sig.		.595

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 2c: Tukey Plant Width Lettuce Looseleaf

WIDTHPLANT_2

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05
		1
TREATMENT 3	10	1.0400
TREATMENT 4	10	1.2800
TREATMENT 2	10	1.3600
TREATMENT 1	10	1.4200
Sig.		.174

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 2d: Tukey Width Leave Lettuce Looseleaf

WIDTHLEAVE_2

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05	
		1	2
TREATMENT 3	10	.4600	
TREATMENT 2	10	.5600	.5600
TREATMENT 4	10	.5900	.5900
TREATMENT 1	10		.6300
Sig.		.176	.677

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 3a: ANOVA Lettuce Butterhead

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
HEIGHT_BUTTERHEAD	Between Groups	4.121	3	1.374	1.529	.224
	Within Groups	32.334	36	.898		
	Total	36.455	39			
WIDTHPLANT_3	Between Groups	.307	3	.102	.528	.666
	Within Groups	6.971	36	.194		
	Total	7.278	39			
WIDTHLEAVE_3	Between Groups	.067	3	.022	1.117	.355
	Within Groups	.717	36	.020		
	Total	.784	39			

Table A 3b: Tukey Plant Height Lettuce Butterhead

HEIGHT_BUTTERHEAD

Tukey HSD[a]

		Subset for alpha = 0.05
TREATMENT	N	1
TREATMENT 2	10	2.4400
TREATMENT 1	10	2.5500
TREATMENT 4	10	2.8400
TREATMENT 3	10	3.2700
Sig.		.223

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 3c: Tukey Plant Width Lettuce Butterhead

WIDTHPLANT_3

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05
		1
TREATMENT 2	10	1.3500
TREATMENT 1	10	1.4700
TREATMENT 3	10	1.5200
TREATMENT 4	10	1.5900
Sig.		.619

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 3d: Tukey Width Leave Lettuce Butterhead

WIDTHLEAVE_3

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05
		1
TREATMENT 2	10	.5200
TREATMENT 3	10	.6000
TREATMENT 4	10	.6000
TREATMENT 1	10	.6300
Sig.		.317

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Table A 4: SPAD meter Caixin Green Stem

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
1st	Between Groups	646.948	3	215.649	2.094	.118
	Within Groups	3706.692	36	102.964		
	Total	4353.640	39			
2nd	Between Groups	5.259	3	1.753	.174	.913
	Within Groups	361.725	36	10.048		
	Total	366.984	39			
3rd	Between Groups	19.801	3	6.600	.665	.579
	Within Groups	357.258	36	9.924		
	Total	377.059	39			
4th	Between Groups	76.573	3	25.524	1.987	.133
	Within Groups	462.446	36	12.846		
	Total	539.019	39			
5th	Between Groups	171.417	3	57.139	1.838	.158
	Within Groups	1119.062	36	31.085		
	Total	1290.479	39			
6th	Between Groups	319.069	3	106.356	3.238	.033
	Within Groups	1182.475	36	32.847		
	Total	1501.544	39			

Table A 5: Meter SPAD Lettuce Looseleaf

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
1st	Between Groups	34.301	3	11.434	.142	.934
	Within Groups	2905.673	36	80.713		
	Total	2939.974	39			
2nd	Between Groups	652.658	3	217.553	3.114	.038
	Within Groups	2514.686	36	69.852		
	Total	3167.344	39			
3rd	Between Groups	52.789	3	17.596	.334	.801
	Within Groups	1894.669	36	52.630		
	Total	1947.458	39			
4th	Between Groups	135.468	3	45.156	1.298	.290
	Within Groups	1252.428	36	34.790		
	Total	1387.896	39			
5th	Between Groups	57.549	3	19.183	.486	.694
	Within Groups	1420.270	36	39.452		
	Total	1477.819	39			
6th	Between Groups	17.833	3	5.944	.204	.893
	Within Groups	1050.462	36	29.180		
	Total	1068.295	39			

Table A 6: SPAD meter Lettuce Butterhead

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
1st	Between Groups	34.301	3	11.434	.142	.934
	Within Groups	2905.673	36	80.713		
	Total	2939.974	39			
2nd	Between Groups	652.658	3	217.553	3.114	.038
	Within Groups	2514.686	36	69.852		
	Total	3167.344	39			
3rd	Between Groups	52.789	3	17.596	.334	.801
	Within Groups	1894.669	36	52.630		
	Total	1947.458	39			
4th	Between Groups	135.468	3	45.156	1.298	.290
	Within Groups	1252.428	36	34.790		
	Total	1387.896	39			
5th	Between Groups	57.549	3	19.183	.486	.694
	Within Groups	1420.270	36	39.452		
	Total	1477.819	39			
6th	Between Groups	17.833	3	5.944	.204	.893
	Within Groups	1050.462	36	29.180		
	Total	1068.295	39			

Table A 7a: ANOVA Caixin Green Stem

ANOVA

KJELDAHL_1

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.017	3	.006	4.370	.094
Within Groups	.005	4	.001		
Total	.023	7			

Table A 7b: Tukey Caixin Green Stem

KJELDAHL_1

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05 1
TREATMENT 4	2	.2311
TREATMENT 3	2	.2381
TREATMENT 2	2	.2381
TREATMENT 1	2	.3431
Sig.		.116

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 2.000.

Table A 8: ANOVA Lettuce Looseleaf

ANOVA

KJELDAHL_2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.134	3	.045	73.048	<.001
Within Groups	.002	4	.001		
Total	.137	7			

Table A 8b: Tukey Lettuce Looseleaf

KJELDAHL_2

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05 1	Subset for alpha = 0.05 2
TREATMENT 3	2	.2381	
TREATMENT 2	2	.2661	
TREATMENT 4	2	.2871	
TREATMENT 1	2		.5602
Sig.		.328	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 2.000.

Table A 9a: ANOVA Lettuce Butterhead

ANOVA

KJELDAHL_3

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.001	3	.000	.800	.555
Within Groups	.001	4	.000		
Total	.002	7			

Table A 9b: Tukey Lettuce Butterhead

KJELDAHL_3

Tukey HSD[a]

TREATMENT	N	Subset for alpha = 0.05 1
TREATMENT 2	2	.2871
TREATMENT 3	2	.2871
TREATMENT 1	2	.2941
TREATMENT 4	2	.3081
Sig.		.588

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 2.000.

APPENDIX B

Figure B1: Process sowing vegetable seedlings.

Figure B2: Fertilizer vegetable seedlings.

Figure B3: Check SPAD meter vegetable seedlings.

a) Height seedling b) Width seedling c) Width leave

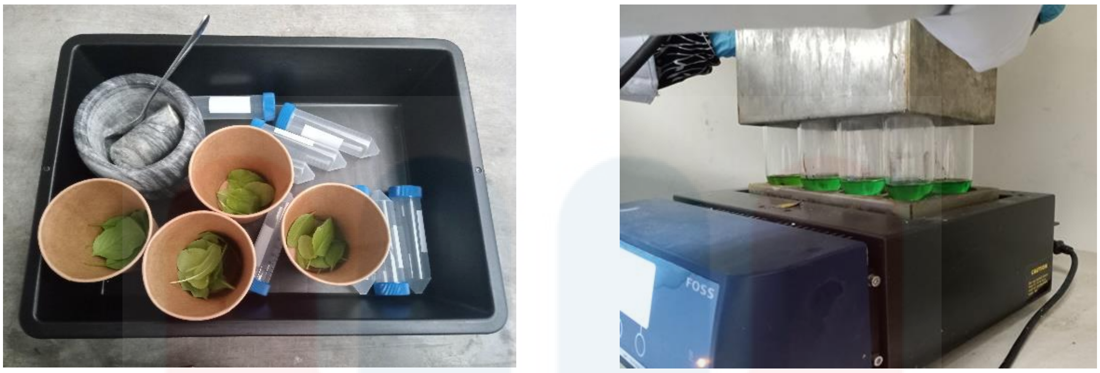
Figure B4: Measuring vegetable seedlings.

CAIXIN GREEN STEM

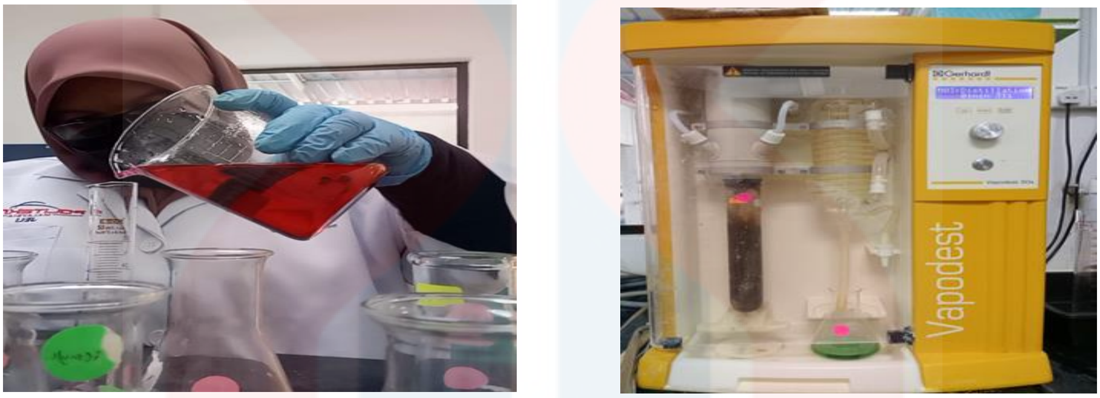
LETTUCE LOOSELEAF

LETTUCE BUTTERHEAD

Figure B5: Seedling enlargement



a) Digestion



b) Distillation

c) Titration

Figure B6: Kjeldahl method for check nitrogen

Treatment 1

Treatment 2

Treatment 3

Treatment 4

Figure B7: Different use treatment organic liquid fertilizer.