Faculty of Resource Science and Technology

**Growth Performance of *Brassica Rapa Chinensis* Applied With Homemade Liquid Fertilizer**

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Bachelor of Science with Honors

Plant Resource Science and Management

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Growth Performance of *Brassica Rapa Chinensis* Applied With Homemade Liquid Fertilizer

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A project submitted in partial fulfilment of the requirement for the degree of Bachelor of

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(Plant Resource Science and Management)

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Plant Resource Science and Management

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## Growth Performance of *Brassica sp.* Applied With Homemade Liquid Fertilizer

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## ABSTRACT

Utilizing organic fertilizer is essential for supplying nutrient diversity to various plant species, improving the physical and chemical properties of the soil, increasing the soil's water-holding capacity, and boosting microbial activity. Liquid organic fertiliser has all of the components necessary for optimal plant growth, including macro and micro nutrients, microbial biology, and growth regulators. The aim of this study was to produce organic fertilizer from breads and banana peels, to evaluate the effectiveness of the organic fertilizer on growth of Pak Choy (*Brassica Rapa Chinensis*). The banana peels were collected from Aiman Mall and breads were bought from Taka Cake House. The 100g and 200g of banana peels and breads were fermented in bottles contain 1.5 ml of water for 2 weeks. A Completely Randomized Design (CRD) was used with four replicates as follow: T1: 100g bread/1.5 mL; T2: 200g bread/1.5 mL; T3: 100g banana peel/1.5 mL; T4: 200g banana peel/1.5 ml. The evaluation on the growth and development performance of Pak Choy in relation to plant height, number of leaves, chlorophyll contents and above ground biomass were determined. Pak Choy grown on 100 g bread fertilizer showed higher number of leaves, plant height, chlorophyll contents and above ground biomass than other treatments.

**Keywords: Homemade liquid fertilizer, banana peel, bread, growth, development**

Penggunaa baja organik adalah penting untuk membekalkan kepelbagaian nutrien kepada pelbagai spesies tumbuhan, meningkatkan sifat fizikal dan kimia tanah, meningkatkan kapasiti pegangan air tanah, dan meningkatkan aktiviti mikrob. Baja organik cecair mempunyai semua komponen yang diperlukan untuk pertumbuhan tumbuhan yang optimum, termasuk nutrien makro dan mikro, biologi mikrob, dan pengawal selia pertumbuhan. Tujuan kajian ini adalah untuk menghasilkan baja organik daripada roti dan kulit pisang, untuk menilai keberkesanan baja organik ke atas pertumbuhan sayur-sayuran terpilih iaitu Pak Choy (*Brassica Rapa Chinensis*). Kulit pisang dikumpulkan dari Aiman Mall dan roti dibeli dari Taka Cake House. 100g dan 200g kulit pisang dan roti ditapai dalam botol mengandungi 1.5 ml air selama 2 minggu. Reka bentuk rawak (CRD) digunakan dengan empat replika seperti berikut: T1: 100g roti / 1.5 mL; T2: 200g roti/ 1.5 mL; T3: 100g kulit pisang / 1.5 mL; T4: 200g kulit pisang/ 1.5 ml. Penilaian ke atas prestasi pertumbuhan dan pembangunan Pak Choy berhubung dengan ketinggian tumbuhan, bilangan daun, kandungan klorofil dan biojisim di atas tanah telah ditentukan. Pak Choy yang ditanam dengan baja roti 100 g menunjukkan bilangan daun yang lebih tinggi, ketinggian tumbuhan, kandungan klorofil dan biojisim di atas tanah berbanding rawatan lain.

**Kata kunci: Baja cecair buatan, kulit pisang, roti, pertumbuhan, perekembangan**

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# CHAPTER 1: INTRODUCTION

## 1.0 Background

At the turn of the twentieth century, about 40% of the world's population was dependent on fertilizers as their primary means of producing food, as stated by Erisman (2008). Fertilizers are organic, inorganic, natural, or synthetic chemicals used to offer crop nourishment not provided by soil (Mofunanya et al., 2015). Due to the presence of essential plant-growth compounds in soil, plants rely on soil nutrients for metabolic processes (Turing et al., 2006). However, there is a finite amount of essential chemicals available to plants in the soil. Once plants are harvested, its nutrient content decreases, leading to a decrease in both quantity and quality. Fertilizers are used to replenish the chemical substances in soil that plants use during growth and development (Miller, 2014). Plant growth removes chemical components from the soil, which are replaced by fertilizer. They are also designed to boost the soil's ability to thrive, and fertilizer can provide a more favourable environment for plant growth than natural soil can (Turing et al., 2006). Fertilizers supply significant quantities of macronutrients like nitrogen, phosphorus, and potassium, which natural soil might not possess in sufficient quantities (Turing et al., 2006). Additionally, fertilisers offer essential trace minerals to plants, such as magnesium, calcium, and copper, which are essential for plant development (Miller, 2014). Typically, amount of yield and quality are influenced by numerous factors, including agricultural service operations, especially fertilisation. In recent years, safe agriculture has been one of the world's primary issues (El-Kouny, 2002). The excessive use of inorganic fertilizer has numerous detrimental effects on the environment, in addition to the possibly harmful effects of chemical residues in plant tissues on the human and animal consumers' health.

Recent increases in chemical fertilizer production costs have resulted in an increase in the price of chemical fertilizer. The market anticipates a drop in the availability of chemical fertilizers. Rising chemical fertiliser prices may have a negative impact on farmers worldwide, exacerbate food supply safety problems, and increase international food prices (Brunelle et al., 2015). The increasing costs of fertilizer on the market have people looking for ways to coerce others into providing for the requirements of the crops they have planted. It is anticipated that the utilisation of organic food waste as a liquid fertiliser will alleviate these issues, and it can also assist increase the economy through the efforts of farmers and housewives in the community (Tiraieyari et al., 2014). This is in contrast to the organic liquid fertilizer that is good for the environment and very safe. Organic fertilisers are becoming increasingly vital for crop production and quality. An organic fertiliser is a soil supplement derived from natural sources that contains minimal amounts of nitrogen, phosphate, and potassium, such as plant and animal by-products, rock powders, seaweed, inoculants, and conditioners (Allison, 1973). Plants can benefit from the use of organic fertilizer since it can boost the availability of macro and micronutrients through naturally occurring processes (Vessey, 2003). Organic fertilizer has been the subject of extensive research and development in order to maximise agricultural yield and enhance soil fertility. Utilizing organic fertilizer is essential for supplying nutrient diversity to various plant species, improving the physical and chemical properties of the soil, increasing the soil's water-holding capacity, and boosting microbial activity (Myint et al., 2010). Organic agricultural practises and products gained favour with consumers as a result of the belief that organic foods are safer and more nutritious (Murmu et al., 2013).

### 1.2 Problem statement

Inorganic fertilizers are broadly utilized around the world to treat nutritional deficiencies and significantly improve agricultural yields. However, because they are not affordable or accessible, inorganic fertilizers are used infrequently by underprivileged farmers for sustaining crop production and maintaining soil fertility (Boraiah, 2017). As low-income farmers cannot purchase inorganic fertilizers due to high costs and low profit margins, it is crucial to implement more cost-effective and less harmful nutrient management approaches that contain essential elements that perform well. The goal of this study is to promote the household on making homemade liquid fertilizer. Homemade liquid fertilizer is as effective as chemical fertilizer and is completely free, as it is generated from food waste. Furthermore, compared to longer- acting dry organic fertilizers, liquid fertilizers are easier to control. Based on the nutrients they deliver, liquid fertilizers are better at regulating the pH of the soil compared to inorganic fertilizers. On this experiment, *Brassica Rapa Chinensis* is chosen to study the effectiveness of homemade liquid fertilizer from banana peel and bread for growth and development of *Brassica Rapa Chinensis* plants.

**1.3 Objectives**

1. To study the effect of liquid fertilizer on the growth and development performance of Pak Choy in relation to plant height, number of leaves, time to flowering, number of fruits and chlorophyll contents.

2. To determine the above ground biomass of Pak Choy applied with two types of homemade liquid fertilizer.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Pak Choy Production in Malaysia

Pak Choy originated in China, and there is evidence of the plant being cultivated there as early as the 5th century AD. This plant is widely grown in the Philippines, Malaysia, Indonesia, and Thailand. Over the course of the last several years, there has been a rise in demand for it throughout Europe, North America, and Australia (Welbaum, 2015; Dixon, 2007). *Brassica chinensis* L., more often known as Pak Choy, is a leafy green vegetable that grows best during the cooler months and is a member of the mustard family, the Brassicaceae. Pak Choy, also known as Chinese Chard, Chinese White Cabbage, and Chinese Mustard, is a popular non-heading Asian vegetable cabbage (Nair & Havlovic, 2005). It is a kind of Chinese cabbage that redundant, non-heading Asian vegetable cabbage and has multiple thick petioles that range in colour from ivory to light green. Additionally, its dark green leaves are smooth, glossy, and rounded (Fahey, 2016). Pak Choy is a versatile vegetable that may be consumed both fresh and cooked. The entire plant is edible and may be used in salads, side dishes, stir-fries, soups, and stews due to its propensity to absorb various flavours, which making it a highly adaptable vegetable. Temperatures in the range of 15 to 20 degrees Celsius are ideal for growing Pak Choy; the only exception to this rule is the Canton kinds, which thrive in higher temperatures. It thrives in soils that are rich in organic matter, have good drainage, and range in pH from 5.5 to 7.0. Raised beds, which promote both drainage and air circulation, are frequently used to cultivate the plant since they provide for optimal conditions (Fahey, 2016). The short crop period of Pak Choy (harvesting occurs 40–45 days after seeding) makes it a favourite vegetable among farmers. Numerous farmers markets, community supported agriculture vendors, and local supermarkets include Pak Choy in their produce sections (Nair & Havlovic, 2005). This vegetable is typically grown under the practise of conventional farming, which makes use of inorganic fertiliser to increase crop production. The current growth in demand for organic vegetables is a result of the public's desire for healthy, chemical-free food (Priadi & Nuro, 2017). Malaysia is among the top six or eight importers of brasiccas in the world, with USD67.71M and specifically RM87.0M (USD20.19M) worth of Pak Choy imported to meet demand for this variety (FAMA, 2017). In Sabah, imports of vegetables, especially Pak Choy, totalled RM149.0 million (DOA, 2016). The production of Pak Choy in Malaysia is poor since the import value is 77% higher than the export value (FAMA, 2017). In order to find a workable solution to this issue, it makes sense to boost the quantity of Pak Choy grown domestically in Malaysia. Farmers with lower incomes are negatively impacted by rising prices for chemical fertilisers; as a result, many farmers are unable to purchase inorganic fertilisers due to their expensive prices and low profit margins. In light of the fact that food waste is known to maintain soil health and boost crop yields, expanding production of Pak Choy in order to meet demand appears to have a good chance of being accomplished if it is accomplished by switching from the use of chemical fertilizers to the use of homemade liquid fertilisers.

### 2.2 Organic fertilizers

Utilizing organic fertilizer enhances the chemical, biological, and physical properties of the soil, thereby enhancing its capacity for long-term productivity. At the present time, organic fertilizers have developed into a component that is necessary in the nutritional system of plants (Ahmad et al., 2016). Mineral fertilizers are often used with different kinds of organic fertilizers. This is because using too much mineral fertilisers is expensive for production (Victor et al., 2013). Tennakoon et al. (1995) reported that the use of organic fertilizers boosts the soil's nitrogen availability and biological activity. Due to their high cost, farmers with limited resources have restricted access to synthetic inorganic fertilisers. Consequently, nutrient availability during optimal growth stages may be limited (Jude & Vidah, 2008). However, organic fertilisers can be obtained, and their prices, when compared to those of synthetic fertilisers, are more reasonable (Wang et al., 2020). The production of organic liquid fertiliser from biodegradable trash has the potential to be both one of the most cost-effective and environmentally friendly solutions to the problem of garbage disposal around the world (Le et al., 2018). Most soil organisms use organic materials as a loose grain adhesive, a source of plant nutrients, and an energy source (Hartatik et al., 2015). Organic fertiliser can increase the solubility of phosphorus, potassium, calcium, and magnesium, as well as increase C-organic, cation exchange capacity, water absorption, and decrease the saturation of aluminium and bulk soil density (Kuntyastuti et al., 2018). Organic fertilisers generally have two forms. Organic fertiliser has a solid cultivation method and a liquid fertiliser. The beginning of the twenty-first century experienced remarkable development on multiple levels, including the rules and determinants of organic agriculture, and a number of nations throughout the world conducted extensive research in which significant attempts were made to improve organic agriculture systems.

### 2.2.1 Organic Liquid fertilizers

Liquid organic fertilisers are more effective than other forms of fertilisers at treating nutrient deficiency symptoms (Fageria et al., 2009). The components that make up a particular brand of liquid organic fertiliser can vary from one another. There is a form of liquid organic fertiliser that has all of the components necessary for optimal plant growth, including macro and micro nutrients, microbial biology, and growth regulators (Jasmi et al,. 2015). They make rapid progress into the soil while simultaneously facilitating access for the root systems of plants to mineral and nutrient sources (Wang et al., 2020). Several studies have demonstrated that the application of liquid organic fertilisers increases the uptake of macro- and micronutrients and increases the soil organic matter content in comparison to other types of fertilisers (Browaldh, 1992).

### 2.3 Banana peels

The banana peel apparently contains many chemical elements or compounds that are beneficial to plants. Tuapttinaya et al. (2014) found that the application of 200 ml/litre of liquid fertilizer made from banana peel waste had a substantial impact on plant growth and development. This component of the banana has many advantages, as liquid fertilizer made from banana peels contains more potassium than other components. The peels of bananas contain 15% potassium and 2 % more phosphorus than the flesh. Similar to a slow-release fertilizer, banana peels give potassium as well as trace amounts of nitrogen, phosphate, and magnesium to the soil as they degrade (Hamilton, 2019). The transportation of water and nutrients between cells is facilitated by potassium. Furthermore, it reinforces stems and protects plants against disease. It is possible that the plant will produce more flowers now that it is healthy. Potassium can boost the quality and size of any fruit after the plant blooms (Tuapttinaya et al., 2014). Phosphorus is another of the most abundant nutrients in banana peels. Banana peels contain 3.25 % phosphorus, one of the other essential elements for plant growth. Phosphorus promotes root development, enhances winter hardiness, and accelerates flowering and fruiting. The banana peel does not contain nitrogen, the essential nutrient for plant growth. However, the peels contain quite high concentrations of several micronutrients. Calcium, which is concentrated at 19.2 milligrams per gram in fresh peels, enhances the decomposition of organic matter in the soil, makes other minerals in the soil, especially nitrogen, more accessible to plants, and controls the movement of nutrients and water into and out of cells. The 76.2 mg/g concentration of manganese in banana peels facilitates photosynthesis and the development of certain enzymes and plant pigments. The passage of water and ions between cells requires sodium, which is concentrated at 24.3 mg/g. The peels also contain magnesium and sulphur, which are required for the production of chlorophyll (Hamilton, 2019).

### 2.4 Bread

Bread is one of these fertilizers, and numerous studies have shown that bread is one of the most abundant sources of protein. Bread provides vital amino acids like lysine and tryptophan, amongst other essential amino acids. According to Khudair and Hajam (2021), bread is rich in a wide variety of mineral components, including calcium, cobalt, iron, and others. Additionally, bread is rich in vitamin B groups, including B1, B2, B6, and B12. Bread contains yeast, which is a useful source of critical components, particularly cytokinins, which work as a quickly available growth supplement for plants and ultimately boost plant production (Amer, 2004). It is also a source of cytokinin and protein that encourage cell division and expansion, and bread yeast has responsibilities during the vegetative and reproductive growth stages as a result of its high amount of auxins and cytokinins, which serve to increase the production of flowers in plants (Barnett et al., 1990). Bread also contains a vast store of vital nutrients (calcium, magnesium, iron, nitrogen, phosphorus, potassium, sulphur, sodium, zinc, and silicon), amino acids, proteins, and plant hormones such as gibberellins, cytokines, and oxins. Additionally, bread has the potential to manufacture a spectrum of enzymes that convert monosaccharides into alcohols and carbon dioxide which are needed by plants in the process of photosynthesis (Muslet et al., 2012). Bread is a type of bio fertiliser utilised in soil fertilisation or soil/foliar application to enhance the productivity of crops grown (Khedr & Farid, 2000). It is a natural bio-substance that has stimulatory, nutritive, and protective effects for fruit trees due to its hormones, carbohydrates, amino and nucleic acids, vitamins, and minerals. Bread yeast is an essential component in many biological processes, including the stimulation of vegetative and fruit growth; the acceleration of the accumulation of carbohydrates; the promotion of cell division and elongation; protein synthesis; nucleic acid production; and the production of chlorophyll (Khedr & Farid, 2000; Heikal, 2005; El-Desouky et al. 2007).

### 2.5 Process in production of liquid fertilizer

The general procedure for manufacturing homemade liquid fertilizer is to collect plants, fruits, or food waste and place them in a jar. The container will be filled with water and the top will be covered with a cloth. During fermentation, sugar derived from plants, fruits, or food waste will undergo an anaerobic conversion into acids, alcohol, and gases. Food waste is digested by microorganisms, which release carbon dioxide, methane, and acids into the atmosphere (Bhargav et al., 2008). Temperatures ranging from 25°C to 37°C are ideal for fermentation, with a pH of 4.0 to 5.5 considered optimal (Zulkeple et al., 2011). High temperatures can destroy the microorganisms employed in fermentation, as the majority of microorganisms are mesophilic, growing at temperatures between 20°C and 45°C. Extremely acidic or alkaline conditions are incompatible, as food waste is pasteurised and nutrients are kept for an extended period of time when the pH falls below 4.2 (Zulkeple et al., 2011).

## CHAPTER 3: METHODOLOGY

### 3.1 Experimental Location

This experiment was conducted at the laboratory of Faculty Resource Science and Technology (FRST) at the University of Malaysia Sarawak (UNIMAS) from April 2022 until May 2022.

### 3.2 Experimental design

The experiment was laid out in a Complete Randomized Design(CRD) as in Figure 1 in four replicates with four treatments as follow: T1: 100g bread/1.5 mL; T2: 200g bread/1.5 mL; T3: 100g banana peel/1.5 mL; T4: 200g banana peel/1.5 ml. In total, there were 16 pots. The experimental layout is on Figure 1.

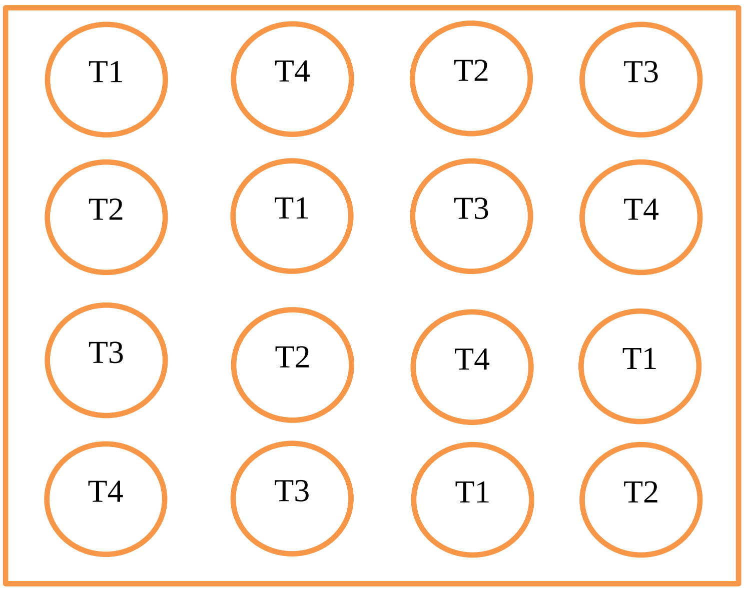

Figure 1: Experimental being in CRD design.

### 3.3 Collection and preparation of liquid fertilizers

The banana peels of Lady Finger banana were collected from the Food Court at Aiman Mall, while the bread was purchased from Taka Cake House. The type of bread used was white bread. Four bottles of 1.5 ml plastic bottles were used to produce homemade liquid fertiliser from bread and banana peel. Two different concentrations were prepared for each treatment. Both 100 g and 200 g of bread were soaked in 1.5 millilitres of water. 100 g and 200 g of banana peel were soaked in 1.5 mL of water in plastic bottles. The liquid fertilisers were kept at room temperature for a minimum of two weeks to allow the mineralization process to take place.

### 3.4 Planting

The seeds were germinated in a container. Seedlings that already produce 3 to 4 leaves and nearly have same size were transplanted into pots. Each pot was planted with 3 seedlings and irrigated immediately. The plants were kept in a shaded place for one week before being moved to an open area to receive full sunlight.

### 3.5 Crop management

#### 3.5.1 Irrigation

The plants were watered every morning with 500ml tap water a day.

#### 3.5.2 Fertilizer application

The fertilizers were applied 1 week after the plants acclimatized. 200 ml of each fertilizer were diluted into 1000 ml of tap water. The fertilizers were applied early in the morning to the soil with 250 ml per pot every seven days.

### 3.6 Pak Choy growth assessment

Before the plants entered their flowering stage, the number of leaves on each individual plant was counted including leaves that were just beginning to unfold. The plant height was measured from the ground to the plant's shoot with a ruler. A spectrophotometer was used to determine the chlorophyll content of the plants. The plants were harvested by severing its stem just above the soil surface, excluding the roots. The stalks and leaves were dried in an oven at 70°C for two days, and their weights were measured using an electronic balance scale.

### 3.7 Statistical Analysis

Comparisons were done for parameters observed on two types of homemade liquid fertilizers at different concentration using two-way ANOVA. The analyses used online statistical programme, i.e. VassarStats: Website for Statistical Computation (http://vassarstats.net).

# CHAPTER 4: RESULT

## 4.1 Number of leaves per plant

There were no significant differences (P>0.05) between the type of liquid fertilizers and concentration of liquid fertilizers on the number of leaves for Pak Choy. There was also no interaction between the type of liquid fertilizers and concentration of liquid fertilizers. Pak Choi produced the same number of leaves, i.e. ~7 leaves per plant (Table 1).

Table 1: Number of leaves per plant of Pak Choy grown at different treatments of homemade liquid fertilizers.

| | Number of leaves/plant (n) | | |
|---|---|---|---|
| Fertilizer | 100g/1.5L | 200g/1.5L | Mean |
| Bread | 7.2 | 6.8 | 7.0 |
| Banana peel | 6.8 | 6.5 | 6.6 |
| Mean | 7.0 | 6.7 | |
| | Fertilizer | Concentration | Fertilizer*Concentration |
| P-value | 0.1927 | 0.3111 | 0.8882 |
| Tukey HSD (5%) | 0.57 | 0.57 | 1.08 |

### 4.2 Plant height per plant

The final plant height of Pak Choy was quantified 3 weeks after application of fertilizers (Table 2). There was significant different ($P<0.05$) of the plant height per plant based on type of fertilizer used and there was no significant different ($P>0.05$) of the plant height per plant based on concentration of fertilizers. The mean plant height of Pak Choy plants using bread fertilizers is much higher 15.7 cm compared with banana fertilizer which was 12.5 cm.

Table 2: Plant height per plant of Pak Choy grown at different treatments of homemade liquid fertilizers

| | Plant height/plant (n) | | |
|---|---|---|---|
| Fertilizer | 100g/1.5L | 200g/1.5L | Mean |
| Bread | 16.8 | 14.6 | 15.7 |
| Banana peel | 12.5 | 12.5 | 12.5 |
| Mean | 14.6 | 13.5 | |
| | Fertilizer | Concentration | Fertilizer*Concentration |
| P-value | 0.0002 | 0.1796 | 0.1796 |
| Tukey HSD (5%) | 2.14 | 2.14 | 3.71 |

### 4.3 Chlorophyll content (SPAD value) per plant

There was significant different (P<0.05) of chlorophyll content (SPAD value) per plant based on type of fertilizer used and there was no significant different (P>0.05) of chlorophyll content (SPAD value) per plant based on concentration of fertilizers (Table 3). The mean chlorophyll content of Pak Choy using bread fertilizers much greater 38.5 compared with banana fertilizer which was 36.6.

Table 3: Chlorophyll content (SPAD value) per plant of Pak Choy grown at different treatments of homemade liquid fertilizers.

| | Chlorophyll content/plant (n) | | |
|---|---|---|---|
| Fertilizer | 100g/1.5L | 200g/1.5L | Mean |
| Bread | 39.0 | 38.1 | 38.5 |
| Banana peel | 36.7 | 36.6 | 36.6 |
| Mean | 37.9 | 37.3 | |
| | Fertilizer | Concentration | Fertilizer*Concentration |
| P-value | 0.0065 | 0.3667 | 0.544 |
| Tukey HSD (5%) | 1.25 | 1.25 | 2.42 |