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Producing local microorganisms (MOL) based plant booster and determining its efficiency on green mustard (*Brassica rapa* var. *parachinensis* L)

Nurul Aqilah Binti Zulkupli
F18B0183

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DECLARATION

I declare that this thesis entitled "Producing local microorganisms (MOL) based plant booster and determining its efficiency green mustard (*Brassica rapa* var. *parachinensis L*)" is the results of my own research except as cited in the references.

Signature : ____________________________

Student's Name : Nurul Aqilah Binti Zulkupli

Date : 9/3/2022

Verified by:

Signature : ____________________________

Supervisor's Name : Dr. Shamsul Bin Muhamad

Stamp :

Date :

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Producing local microorganisms (MOL) based plant booster and determining its efficiency on green mustard (*Brassica rapa* var. *parachinensis L*)

ABSTRACT

Local Microorganisms (MOL) is a fermented solution product that made from various organic resources. MOL acts as a living medium and the development of microorganisms useful for accelerating the destruction of organic matter. The objectives of this study are to produce MOL-based plant booster from fruits and determine its efficiency towards green mustard (*Brassica rapa* var. *parachinensis* L). This study was done by using three different local fruits. This study used a research design with six different formulations. It was tested on six treatments with four repetitions and six different formulations represented the concentration of MOL consists of 1%, 5%, 10%, 20%, positive and negative control. The parameters that were analyzed were the height of plants, number and size of leaves using different treatments and were measured weekly for six weeks. The data were analysed using analysis of variance (ANOVA) followed by a Duncan post hoc test to determine whether there are significant differences in the selected growth parameters of green mustard (*Brassica rapa* var. *parachinensis L*) due to treatments. This study showed parameters of the mean height of plants ranged from 21.45 to 25.73 for six weeks of observation. Meanwhile, the mean number of leaves ranged from 9.50 to 11.75 and the mean size of leaves ranged from 0.58 to 0.96 for six weeks. The parameter showed significant different from week 3 to week 6 and 20% of MOL solution are recommended to use. To conclude, MOL is suitable as an organic fertilizer because it effectively applied on the plants as a growth-promoting or growth booster for vegetables.

Keywords: Local microorganisms (MOL), plant booster, green mustard (*Brassica rapa* var. *parachinensis L*), plant growth

Menghasilkan penggalak tumbuhan berasaskan mikroorganisma lokal (MOL) dan menentukan keberkesanannya pada sawi hijau (*Brassica rapa* var. *parachinensis L*)

ABSTRAK

Mikroorganisma Lokal (MOL) ialah produk larutan yang difermentasi yang diperbuat daripada pelbagai sumber organik. MOL bertindak sebagai medium hidup dan perkembangan mikroorganisma yang berguna untuk mempercepatkan pereputan bahan organik. Objektif kajian ini adalah untuk menghasilkan penggalak tumbuhan berasaskan MOL daripada buah-buahan dan untuk menentukan keefektifan penggalak tumbuhan berasaskan MOL terhadap sawi hijau (*Brassica rapa* var. *parachinensis* L). Kajian ini dilakukan dengan menggunakan tiga buah tempatan yang berbeza. Kajian ini menggunakan reka bentuk kajian dengan enam formulasi yang berbeza. Ia telah diuji ke atas enam rawatan dengan empat ulangan dan enam formulasi berbeza mewakili kepekatan MOL terdiri daripada 1%, 5%, 10%, 20%, kawalan positif dan negatif. Parameter yang dianalisis ialah ketinggian tumbuhan, bilangan dan saiz daun menggunakan perlakuan yang berbeza dan diukur setiap minggu selama enam minggu. Data dianalisis menggunakan analisis varian (ANOVA) diikuti dengan ujian Duncan post hoc untuk menentukan sama ada terdapat perbezaan yang signifikan dalam parameter pertumbuhan terpilih sawi hijau (*Brassica rapa* var. *parachinensis* L) disebabkan oleh rawatan. Keputusan daripada kajian ini menunjukkan parameter purata ketinggian tumbuhan adalah antara 21.45 hingga 25.73 untuk enam minggu pemerhatian. Manakala purata bilangan daun adalah antara 9.50 hingga 11.75 dan purata saiz daun antara 0.58 hingga 0.96 selama enam minggu. Parameter menunjukkan perbezaan yang ketara dari minggu 3 hingga minggu 6 dan 20% larutan MOL disyorkan untuk digunakan. Kesimpulannya, MOL sesuai dijadikan baja organik kerana ia berkesan untuk digunakan pada tumbuhan sebagai penggalak tumbesaran bagi sayur-sayuran.

Kata kunci: Mikroorganisma lokal (MOL), penggalak tumbesaran, sawi hijau (*Brassica rapa* var. *parachinensis L*), tumbesaran tanaman

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LIST OF ABBREVIATIONS

MOL	Local microorganisms
N	Nitrogen
P	Phosporus
K	Potassium
Ca	Calcium
Mg	Magnesium
S	Sulphur
Zn	Zinc
Cu	Copper
Mo	Molybdenum
B	Boron
CO_2	Carbon dioxide
Mn	Manganase
Fe	Iron
C	Carbon
pH	Potential of hydrogen
EM	Effective microorganisms
w/v	Weight per volume
ANOVA	Analysis of varience

LIST OF SYMBOLS

%	Percentage
mg	Milligram
cm	Centimetre
kg	Kilogram
L	Litre

CHAPTER 1

INTRODUCTION

1.1 Research background

There are many decomposable microorganisms in the soil, including macronutrient and micronutrient ones. The formation of organic fertilizers is due to the decomposition of microorganisms and the combined effects of weather and human treatment. This decomposition is significant to form the organic fertilizers (Raras *et al.*, 2018), and local microorganisms (MOL) act as a medium for living and developing valuable microorganisms.

The MOL solution is a fermented product made from various available resources, such as rotten fruits and vegetables, rice, and banana peels. The MOL solution contains a large amount of (N, P, K, Ca, Mg and S) and trace amounts of nutrients (Zn, Cu, Mo, B, Mn, and Fe), and also contains bacteria that may decompose organic matter, stimulate growth and act as a pest and the plant disease control agent (Syaifudin *et al*., 2010).

Technological progress encourages large-scale industries to produce fertilizer products. Long-term use of chemical fertilizers at high doses can cause soil pollution and intensive agricultural use of many pesticides. Still, there is no doubt this has led to an overall increase in the productivity of agricultural products. Still, the adverse effects of these chemicals are visible in soil structure, soil microflora, water quality, food, feed, and food ingredients (Singh, 2021). Good soil biological plants can inhibit the growth of pests and plant diseases. They can improve physical, biological, and chemical properties by using inorganic fertilizers and garbage dumps to reduce soil pollution, thereby reducing environmental pollution. Also, Kusmanto *et al.* (2019) mentioned that the function of MOL is not only to increase plant growth, but it can fix the biological, chemical, and physical conditions of the soil. Therefore, an alternative method to reduce chemical fertilizers is to develop organic fertilizers, which are fertilizers derived from various natural fertilizers, such as animal manure, animal body parts, plants rich in minerals, and beneficial to soil fertility.

The green mustard plant, or its scientific name is *Brassica rapa var. parachinensis* L is a type of vegetable that contains nutrients. So, consuming green mustard leaves can improve human health. Fertilizing is an essential to increase crop yield, and fertilizers are the sources that are added to the soil to provide nitrogen, phosphorus, potassium, and other vital nutrients in plant growth. According to the materials used, fertilizers are divided into organic fertilizers and non-organic fertilizers (Suhastyo and Raditya, 2019).

1.2 Objectives

1. To produce MOL-based plant booster from fruits waste
2. To determine the efficiency of the MOL-based plant booster towards the growth of green mustard (*Brassica rapa* var. *parachinensis L*)

1.3 Hypothesis

$H_{0:}$ There is no significant different between MOL and positive control in order to enhance the growth of green mustard (*Brassica rapa* var. *parachinensis L*).

H_1: There is significant difference between MOL and positive control in order to enhance the growth of green mustard (*Brassica rapa* var. *parachinensis L*).

1.4 Problem Statement

The demand for organic food has dramatically increased, especially in developed countries. This trend has also shifted to developing countries, including Malaysia. Inorganic fertilizer remains on the surface of the soil, after a heavy rain causing leaching. It has a negative impact on our environment, and foods grown as a result of excessive inorganic fertilizer use might have an adverse effects on human health. So, this project aims to develop organic fertilizers from fruit waste to enhance the plant growth of of green mustard (*Brassica rapa* var. *parachinensis L*).

1.5 Significance study

This research will produce and determine the effectiveness of MOL-based plant boosters, which will be tested on the soft-stem vegetable (green mustard). Scientific information will encourage farmers and industries to make the MOL-based plant booster on plants so that the usage of chemical fertilizer will reduce and organic food demand will increase. Diverse from chemical fertilizers, organic fertilizers will reduce the soil's acidity and do not cause leaching, and they also will not kill the beneficial microorganisms in the soil. Increase in environmental awareness and the threat of pesticide use is also related to the growing interest in organic food production. As a result, consumers believe that organic products are safer because they think they are chemical-free compared to traditional agricultural products. Therefore, health can regard as an essential factor that positively influences consumer's purchasing of organic products. (Mohamad *et al*., 2014).

1.6 Scope of study

This study used local microorganisms from fruits, pre-filtered spring water, and local jaggery. Local microorganisms contain bacteria that can remodel organic matter and produce substances that are useful for plants, such as antibiotics, enzymes, and lactic acid, which suppress disease growth. Waste of fruits and vegetables contain microorganisms useful for accelerating the destruction of organic matter, while the washing waste of rice acts as microbial food. For this research, a plant booster from MOL was produced, and it tested on the soft stem vegetables, which is green mustard. Green mustards were tested because the planting period for this vegetable is short, which is for a month only. After this vegetable reached its maturity, the plant booster is applied to it, and the observation is recorded. The observation measured the height of the mustard plant includes the number of leaves, the size of the leaves and the height of the plant. This research was performed at Universiti Malaysia Kelantan Jeli Campus.

CHAPTER 2

LITERATURE REVIEW

2.1 Local Microorganisms (MOL)

Local Microorganisms (MOL) consist of a mixture of live cultures of microorganisms isolated from naturally fertile soils that are useful during crop production (Mohan and Srinivasan, 2008). Organic fertilizers are fertilizers that consist largely or entirely of organic materials obtained from plants or animals that have gone through the engineering process. Solids or liquids can provide organic materials to improve the physical, chemical and biological properties of the soil. This definition shows that more organic fertilizers consider the content of C-organic or organic matter than their content as the value of C-organic material differentiates it from inorganic fertilizers (Simanungkalit *et al*., 2016).

MOL is a microorganism used as a starter in the manufacture of solid organic fertilizers and liquid fertilizers (Sunarya, 2020). The main ingredients of MOL consist of several components, namely carbohydrates, glucose, and source microorganisms. Besides, MOL is a liquid fermented substrate or certain media (rice, fruits, eggs, milk, rice water, and vegetables) (Prawansa, 2014). The MOL solution contains micronutrients, macronutrients and bacteria that can transform organic matter, stimulate growth, and resist plant diseases and insect pests. Therefore, MOL can be used as a decomposition agent, biological fertilizer, and organic pesticides, especially as a fungicide. (Purwasasmita *et al*., 2009)

According to Purwasasmita (2009), MOL is a fermented solution with raw materials that available resources surrounding the environment, such as rice, waste of fruit, and vegetables. The MOL solution must have good quality so that it can increase soil fertility and plant growth. Quality is the level that indicates a set of inherent characteristics and meets a certain size. The factors that determine the quality of a solution of MOL include fermentation media, the concentration of raw materials or substrates, the shape and nature of the active microorganism in the fermentation process, pH, temperature, the length of fermentation, and the ratio of C and N in the material (Atmaja *et al*., 2013).

Fruit waste is processed into local microorganisms, containing several bacteria that can act as probiotic components (Munawaroh, 2019). According to Subagiyo and Djunaedi (2011), there are generally types of bacteria and fungi in the MOL solution of fruit. Bacteria involved in the degradation of vegetable and fruit waste decomposition include cellulolytic bacteria (Supriyatna *et al*., 2012). Examples of cellulolytic bacteria studied as cellulose producers include *Scopulariopsis brevicaulis*, *Ruminococcus albus*, *Clostridium*, *Cellulomonas*. These bacteria can have high cellulolytic and hemicellulolytic activity in the fermentation process to produce sugar. Cellulolytic bacteria in aerobic conditions break down cellulose and convert it to CO_2 and water, while in anaerobic conditions, it becomes CO_2, methane, and water (Supriyatna *et al*., 2012).

Effective microorganisms (EM) consist of a mixture of live cultures of microorganisms isolated from naturally fertile soils and useful during plant production (Mohan, 2008). The main activity of EM appears to be to increase the biodiversity of the soil microflora so that the real uses of EM are in agriculture (Sangakkara and Weerasekera, 2012). It was first used to improve the productivity of organic or natural farming systems, which reduced the time required to manufacture this biofertilizer. According to Ncube (2008), EM is effective and environmentally friendly during crop production, and various trademarks or formulations of EM use local microbial isolates made in approximately 40 countries around the world.

2.1.1 Pineapple

Pineapple is one type of fruit found which has an even distribution in Malaysia. Based on the nutrient content, it turns out that pineapple peels contain relatively high carbohydrates and sugar. According to Wijana *et al.* (1991), pineapple skin has 81.72% water, 20.87% crude fibre, 17.53% carbohydrates, 4.41% protein, and 13.65% reducing sugar. Due to the high carbohydrate and sugar content, the pineapple peel allows it to be used as raw material for plant nutrition and local microorganisms (MOL).

2.1.2 Papaya

Papaya fruit that has been accommodated in the garbage collection will undoubtedly provide nutrition for pre-existing microorganisms to cause a strong odour around the shelter (Syahputriani, 2017). The use of MOL from rotten papaya material is one of the uses of organic waste households that aim to produce decomposer or fertilizer liquid at low prices (Mirza, 2017).

Table 2.1: Nutrient content of papaya fruit

Content	Amount
C-organic	1.27%
Nitrogen N	0.14%
Phosphorus P_2O_5	0.02%
Potassium K_2O	0.023%
Magnesium MgO	0.319%

Source: Syahputriani (2017)

2.1.3 Banana

Banana peels are one example of organic waste that has not been managed well. According to Sinaga (2009), banana peels can be used as solid organic fertilizer or liquid organic fertilizer because they contain nutrients needed by plants, such as nitrogen, potassium, and phosphorus. Susetya (2019) explains that banana peels contain protein, potassium, phosphorus, magnesium, sodium, and sulfur, while the results of research conducted by Nasution et al. (2014) showed that banana peels contain 1.137% potassium and according to Dewanti (2008) elements of P contained in banana peels are 63 mg / 100 grams. The nutrients in banana peels show that banana peels can be used as liquid organic fertilizer.

2.2 Plant booster

Plant booster, which is one of the microbial inoculants on the market, is usually sold or supplied in liquid form and has a life span of 6 months. After a while, the amount of oxygen and water in the liquid plant booster will decrease, affecting the number of microorganisms in it (Noor *et al.*, 2015). Selected microbial-based bio-products can be compatible with chemical fertilizers to enhance fertilizer use–efficiency and crop yields (Huang *et al.*, 2020). Plant boosters, or in the generic name, is bio-enhancers are organic preparations obtained through active fermentation of animal and plant residues within a certain period of time. They are a rich source of microbial consortia, macro and trace elements and substances that promote plant growth (including immunity and enhancers) also utilized to treat seeds or seedlings, enhance the decomposition of organic materials, thereby enriching the soil and inducing better plant vigour (Pathak *et al*., 2013). An example of a plant booster is ACI N-Fixer, commercially known as N-Bio Booster RealStrong Fertilizer, which contains free-living nitrogenous bacteria Bacillus. It contains substances that can convert nitrogen (insoluble gas) in the atmosphere into ammonia which plants can freely ingest nitrate or nitrite to promote plant growth (Peng *et al*., 2020).

2.3 Fertilizers

Fertilizers, in the widest sense, are products that enhance the availability of plant nutrients or the chemical and physical qualities of soil, hence improving plant growth, production, and quality directly or indirectly.

2.3.1 Organic fertilizers

Several decades ago, organic fertilizers such as farmyard manure, chicken dung, and compost were employed then the use of waste before inorganic fertilizers, which is a relatively new development in comparison to organic fertilizers. In contrast to inorganic materials, they are more environmentally friendly (Akande *et al*., 2004). In comparison to other organic fertilizers, chicken manure provides greater nitrogen and phosphorus to plants (Garg *et al*., 2008).

Organic fertilizers improve soil fertility, soil structure, water retention capacity, physical and chemical characteristics, soil pH, microbial activity, and crop yield (Muhammad *et al*., 2009). It enhances nutrient release during soil decomposition. It also enhances the physical qualities of soil, such as bulk density, aeration, and porosity (Frankenberger *et al*., 1985). Organic fertilizer is vital for nutrient availability while also being environmentally friendly (Njoroge *et al*., 1999). Organic fertilizer increases the availability of essential nutrients including N, P, and K, which are crucial for plant growth and development (Palm *et al*., 2001). It is a surface soil nutrient source that gives the crop the most nutrients and prevents nutrient imbalances (Blay *et al*., 2002).

2.3.2 Inorganic fertilizers

Chemical fertilizer is becoming one of the most often used practises in developing intensive agriculture (da Costa *et al*., 2011). However, long-term usage of chemical fertilisers has resulted in a slew of unintended consequences. The cost of productivity, for example, does not increase linearly, leading to a huge waste of mineral resources. Furthermore, plants do not absorb millions of tonnes of synthetic fertilizers that are dumped into soil every year. Up to 50% of N and 90% of P have been observed to run off from agricultural fields and escape into the atmosphere or water sources, resulting in greenhouse gas emissions, eutrophication in aquatic systems, and soil salinization (Simpson *et al*., 2013).

Furthermore, the excess of chemical fertilisers causes food safety and quality issues, such as nitrate build up in vegetables products. For example, according to Caris-Veyrat *et al*. (2004) found that organic tomatoes had greater levels of carotenoids, polyphenols, and vitamin C than those grown in conventional agriculture.

2.4 Green mustard (*Brassica rapa* var. *parachinensis L)*

Mustard is a group of plants in the genus Brassica leaves or flowers used as food (vegetables), either fresh or processed. Mustard includes several species of Brassica, which sometimes resemble one another. Green mustard has the characteristics of a short stem and whitish-green leaves and a slightly bitter taste (Rukmana, 1994).

Mustard is a resistant plant against the weather. In the rainy season, it is resistant to rainwater exposure. In the dry season, it is also resistant to the stinging heat of the weather, provided that it is coupled with watering routine (Sunaryono,2003). According to Zulkarnain (2009), green mustard can be categorized into leafy vegetables based on the part consumed. Green mustard has a high economic value after crop cabbage, cauliflower, and broccoli. The contents of green mustard are proteins, fats, carbohydrates, Ca, P, Fe, vitamin B, and vitamin C.

2.4.1 Origin of green mustard

Green mustard (*Brassica rapa* var. *parachinensis* L.) is one of the horticultural crops of vegetable types that utilized the leaves are still young. Mustard leaves are used as a vegetable food and have various benefits and are used in people's daily lives. Besides being used as vegetable food, they also can be used for medicinal purposes. Besides, mustard greens are also favoured by consumers because they contain high pro-vitamin A and ascorbic acid. The area of origin of the mustard plant is from China and East Asia. This plant has been cultivated in China's area since 2500 years ago, then spread widely to the Philippines and Taiwan (Rukmana, 1994).

2.4.2 Taxonomy of mustard

According to the classification in the nomenclature (systematics) of plants, green mustard (Figure 2.1) included in

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Capparales

Family: Brassicaceae

Genus: *Brassica*

Spesies: *Brassica rapa* var. *parachinensis* L.

Figure 2.1: Green mustard (*Brassica rapa* var. *parachinensis* L) (Plantamor, 2021)

2.4.3 Plant Morphology

Mustard plants are still in the same family as cabbage-crop, cabbage-flower, broccoli, and lobal or rades, namely the Brassicaceae family. Therefore, the morphological and characteristics of plants are almost the same, especially in the root system, stem structure, flowers, fruit (pods), and seeds (Rukmana, 1994). The root system of the mustard plant has a taproot and elliptic (cylindrical) root branches spreading in all directions at a depth of 30-50 cm. These roots function, among other things, to absorb water and nutrients from the soil and strengthen the establishment of plant stems. The mustard plant has short and segmented stems, making it almost invisible. The mustard stalk can form and support the leaves, while the mustard leaves are long-stemmed and flat. Mustard flower structures will be arranged in flower stalks that are elongated to grow and have many branches. Each mustard flower consists of four petals, four petals bright yellow flowers, four stamens, and one white fruit with two hollows (Margiyanto, 2007).

CHAPTER 3

METHODOLOGY

List of the treatments and compositions used in this studies is given in Table 3.1 to assist the reader in understanding the results and discussion.

Table 3.1 Treatment and compositions

Treatment	**Composition**
T0	Positive control (1% foliar + 99% water)
T1	Negative control
T2	1% of MOL + 99% water
T3	5% of MOL + 95% water
T4	10% of MOL + 90% water
T5	20% of MOL + 80% water

3.1. Materials

The raw materials used in this study are soils, polybags, pre-filtered spring water, local jaggery and green mustard (*Brassica rapa* var. *parachinensis* L.), and ripe fruits. Planting materials were obtained around UMK Campus Jeli and authenticated by Dr Shamsul. 2 kg of local jaggery were purchased from a local vendor, and pre-filtered spring water will be used for fermentation. Meanwhile, the fruits were bought at Jeli market.

3.2 Equipments

The equipment used were plasticware, measuring cylinder and measuring tape. Plasticware and pump will be purchased at hardware in Jeli, and measuring tape to measure the plant's growth.

3.3 Method

The experiment was conducted in order to observe the effect of MOL on the plants content and to obtain the efficiency of MOL concentration for the growth of *Brassica rapa* var. *parachinensis* L.

3.3.1 Preparation of microorganism local (MOL) solution from ripe banana, papaya, and pineapple.

A solution of microorganism local (MOL) solution were prepared using three local fruits (banana, papaya, and pineapple) according to the method described by Kurniawan (2018) with some modification. Two kilograms (kg) of fully ripe banana, papaya, and pineapple were separately chopped into small pieces using a knife and exposed to the ambient for 2 hours to capture MOL. Chopped fruits were filled into a respective 10 L of plastic bottles and were added with 500 grams (or 5% (w/v)) of local jaggery and 7 L of pre-filtered spring water. The mixtures were mixed by continuously shaking for 3 minutes and fermented in the dark at room temperature for 14 days. After the fermentation process, a part of the MOL solution is carefully drawn from a bottle, then transferred into a fresh 5 L plastic bottle, and kept at room temperature until testing its growth-promoting activity on green mustard. These MOL solutions were considered 100% MOL solutions. The illustration of MOL were shown in Appendix C.

3.3.2 Growth-promoting activity of MOL solution on a green mustard

A growth-promoting activity of the MOL solution that was tested on green mustard by in-house technique. Twenty-four green mustard plants were planted in polybags using commercial media. After one weeks, plants were sprayed with different concentrations of MOL, which is 1%, 5%, 10% and 20%, respectively. These working concentrations of the MOL solution were diluted with the 100% MOL solution using pre-filtered spring water. The control plants were sprayed with pre-filtered spring water and chemical fertilizer. Throughout the study, the green mustard plants were watered manually one time daily (morning and evening). This practice ensured all plants received the same amount of water. The growth-promoting activity of MOL solution on green mustard is assessed on the number of leaves per plant, the size of leaves, and the height of the plant.

3.3.3 Concentration of MOL

The concentration was produced using 4 different concentration of MOL. The concentration 1 occurs of 1% of MOL and mixed of 99% of pre-filtered spring water. For second concentration consisted of 5% of MOL and mixed with 95% of pre-filtered spring water. For the next concentration is it consisted of 10% of MOL and 90% pre- filtered spring water and lastly is 20% of MOL solution mixed with 80% of pre-filtered water. All these solution then were put into sparaying bottles.

Table 3.2 : Concentration of MOL solution was mixed in the following:

Treatments	Composition of MOL and water
Treatment 1	1% of MOL + 99% water
Treatment 2	5% of MOL + 95% water
Treatment 3	10% of MOL + 90% water
Treatment 4	20% of MOL + 80% water

3.3.4 Seeds pre-treatment

The seeds of *Brassica rapa* var. *parachinensis* L undergo pre-treatment where the seeds that required to be sown were soaked in water at room temperature and left for overnight. This pre-treatment allowed water to penetrate to the strophiole of the seeds which considered as the weakest area of the seeds coat and thus allowing the germination of seeds to take place rapidly (Ibrahim et al., 2013).

3.3.5 Seeds sowing

Each polybags were filled with the mixture of top soil, sand and cocopeat with the ratio 1:1:2. Two seeds of *Brassica rapa* var. *parachinensis* L were sown in each polybag and the seeds were sown at 2-3 cm depth.

3.4 Plant Growth Observation

3.4.1 Height

Data on height of the plants were measured every week. Height was measured from soil level to the highest shoot tip (apex). A ruler was used to measure the height of the plants. All seedlings from each replicate were measured and the average height was taken to represent each replicate.

3.4.2 Number of leaves

Number of leaves of each plant were recorded every week throughout the project. The average number of leaves in each replication were taken for the data analysis.

3.4.3 Size of leaves

The data on the size of leaves were measured every week and the average of the size were recorded for the further analyzed.

3.5 Statistical analysis

The experimental data of height of plant, number of leaves and size of leaves were analyzed using one-way ANOVA and followed by Duncan post hoc test. The data were reported as means ± standard deviation. The differences between means of the samples were compared with probability value ($p<0.05$).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Plant growth

Plant growth may be defined as the increase in volume and mass of a plant, with or without the formation of new structures like organs, tissues, cells, or cell organelles. Development (cell and tissue specialisation) and reproduction are frequently linked to growth (production of new in dividuals). The parameters that were analyzed are the height of plants, number and size of leaves using different treatments. The first record for the parameters was taken a week after transplanting the plants into the polybags and the observation on plant growth is continued up to 6 weeks after transplanting. Different concentrations of the MOL and fertilizers have been found to affect the height, number and size of the *Brassica rapa* var. *parachinensis* L.

4.1.1 Height of plant

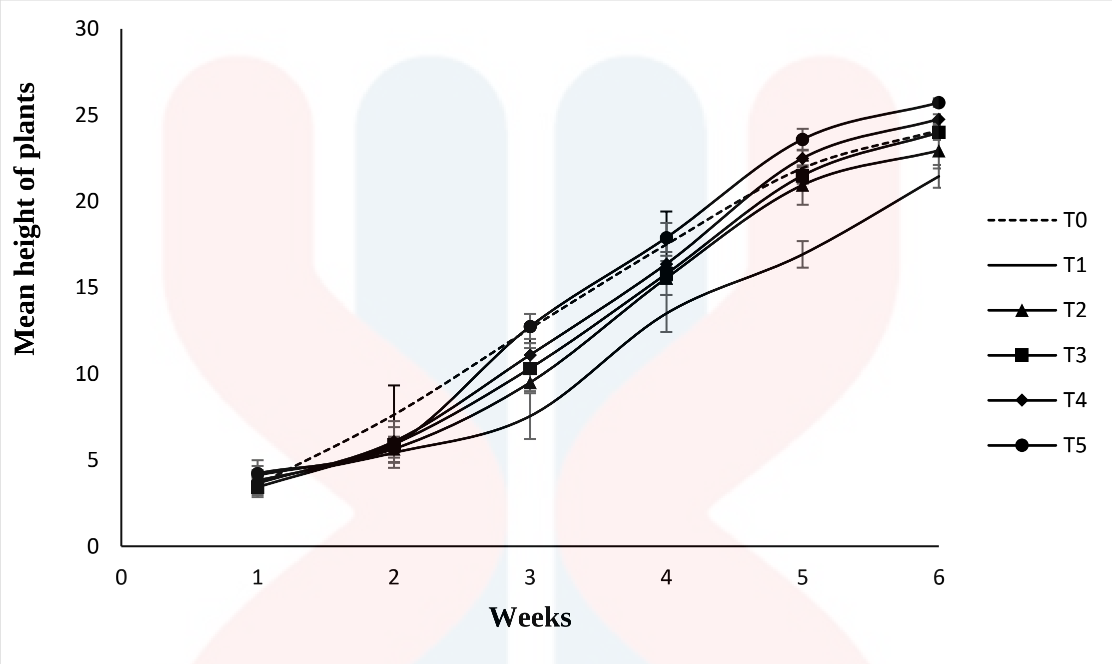

Figure 4.1: The mean height of the plants under different treatments

Based on the mean height of the plants recorded (Figure 4.1), it is shown that there was an increase in the plant height throughout observation in 6 weeks for all the treatments. Plants with the highest mean height are T5 and the lowest recorded in T1.

In this study, based on Figure 4.3, formulation of T0, T1, T2, T3, T4, and T5 were tested to identify the number of leaves after the given formulation application on plant. From the tests that have been conducted, the height of the plants is significant with ($p < 0.05$). It showed that the height of plants samples was significantly different from each other from week 3 to week 6. The height of plants value was affected by the concentration used in MOL formulation and application of positive also negative control. The effectiveness of fertilizer application on height of the plant can be arranged in order T5 > T4 > T0 > T3 > T2 > T1 after six weeks. The completed data on height of the plant were shown in Appendix A.

Organic fertilizer promotes vegetative and reproductive growth in plants by increasing plant height, shoot number, number of leaves, fresh biomass, and dry biomass. (Nandekar et al. 1990 & Said, 1997). Moreover, according to Ahmad (2013), MOL from fruits contain elements N and P which is quite balanced very good for vegetative growth of plants due contains available carbohydrates on rice washing water, granulated sugar and fruits as a source of microorganisms. Nitrogen is a composer of green matter leaves (chlorophyll), protein and fat.

4.1.2 Number of leaves

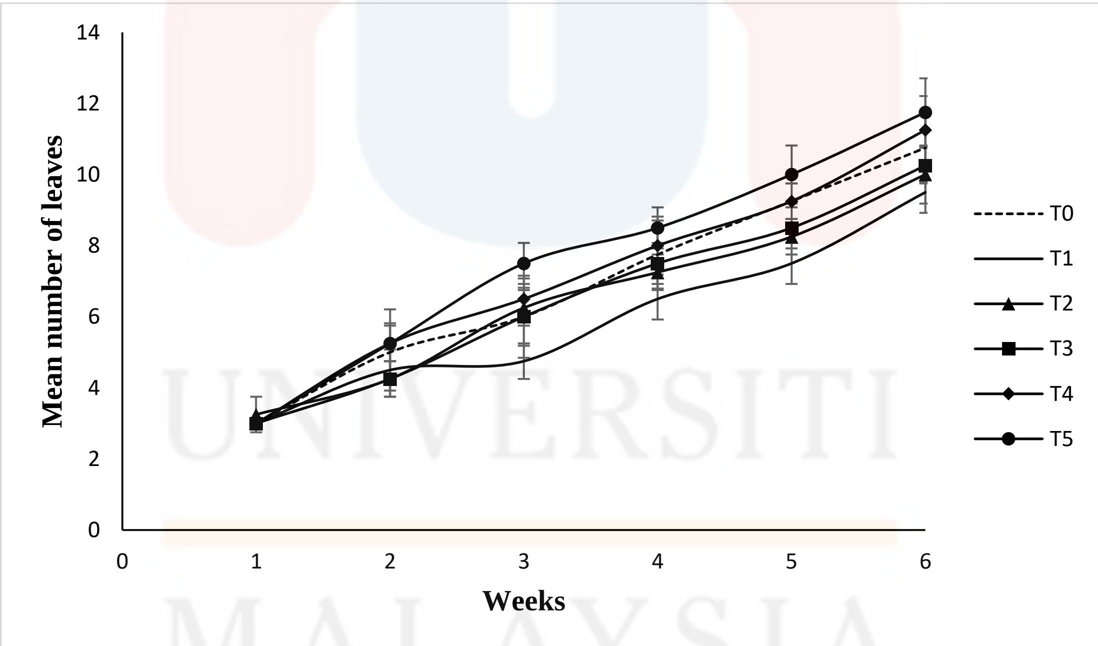

Figure 4.2: The mean number of leaves under different treatments

Figure 4.2 shows the result of the mean number of leaves for six weeks. It indicates that the highest number of leaves was obtained by T5. The number of leaves recorded per plant in each treatment shows some fluctuation due to the treatment effect. The lowest number of leaves on the six weeks was recorded by T1.

In this study, based on Figure 4.3, formulation of T0, T1, T2, T3, T4, and T5 were tested to identify the number of leaves after the given formulation application on plant. From the tests that have been conducted, number of leaves is significant with ($p < 0.05$), which indicates a significant difference for all treatments on the mean number of leaves recorded from week 3 to week 6. The effectiveness of fertilizer application on number of leaves can be arranged in order T5 > T4 > T0 > T3 > T2 > T1 after six weeks. The completed data on number of leaves were shown in Appendix A.

It can be concluded that the concentration of MOL and fertilizer influences the production of leaves of *Brassica rapa* var. *parachinensis* L during the six weeks of the experiment was carried on. According to Arifa (2013), the more leaves there are, the more effective photosynthesis is resulting in higher plant yields.

4.1.3 Size of leaves

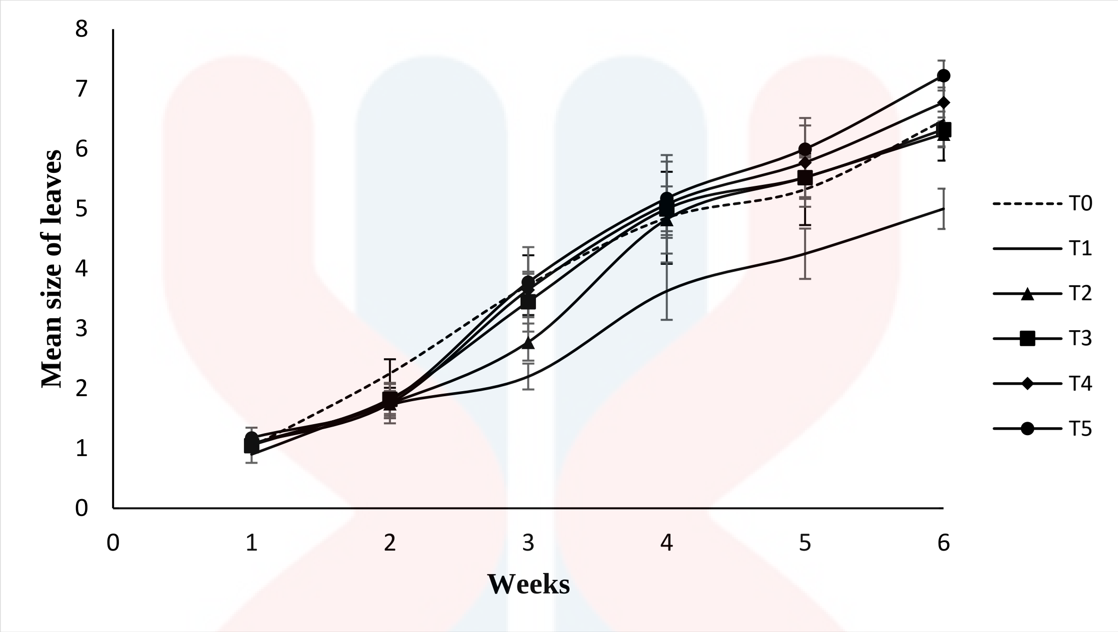

Figure 4.3: The mean sizes of leaves under different treatments

Figure 4.3 shows the mean size of leaves that ranged from 0.9-7.2 cm for all different treatments in six weeks. The sizes of leaves recorded per plant in each treatment show an increase due to the treatment effect. The largest sizes of leaves were obtained by T5 and T1 showed the lowest one.

From the tests that have been conducted, it showed the number of leaves is significant with ($p<0.05$), which indicates a significant difference for each of the treatments on mean size of leaves recorded. It showed that the height of plants samples was significantly different from each other from week 3 to week 6. The effectiveness of fertilizer application on size of leaves can be arranged in order T5 > T4 > T3 > T0 > T2 > T1 after six weeks. The completed data on size of the leaves were shown in Appendix A.

The area of the leaves and the high amount of chlorophyll help the photosynthesis process to run smoothly. The larger the leaf area of the plant, the greater the reception of sunlight. Light is a source of energy used to form photosynthesis and a high leaf area, and then the light will be more easily received by the leaves well. According to Hidayat (2013), N is essential for the production of proteins used to form cells and chlorophyll.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

Based on the studies, the results showed that all parameters collected from the plants showed significant differences from each other from week 3 to week 6 for plant growth through different concentrations applied on the green mustard. MOL with 20% concentration produces higher height of plants, number of leaves and size of leaves. This study proved that the MOL application on soft stem vegetables is suitable for use as an organic fertilizer in the future was successfully achieved for plant growth. Nevertheless, organic fertilizer is sustainable and much safer because it is one of the more environmentally friendly natural ways of treating waste.

For recommendation, the MOL can be tested on other types of soft stem vegetables plants to record further efficiency. Moreover, the community and farmers could utilize waste from fruit or vegetables as commercial organic fertilizer as this MOL is easily made, time efficient, and eco-friendly.

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APPENDIX A

One-Way ANOVA for height of plant

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
WEEK 1	Between Groups	2.002	5	.400	1.233	.335
	Within Groups	5.848	18	.325		
	Total	7.850	23			
WEEK 2	Between Groups	12.262	5	2.452	2.247	.094
	Within Groups	19.648	18	1.092		
	Total	31.910	23			
WEEK 3	Between Groups	78.203	5	15.641	18.504	.000
	Within Groups	15.215	18	.845		
	Total	93.418	23			
WEEK 4	Between Groups	49.712	5	9.942	8.647	.000
	Within Groups	20.697	18	1.150		
	Total	70.410	23			
WEEK 5	Between Groups	105.588	5	21.118	44.277	.000
	Within Groups	8.585	18	.477		
	Total	114.173	23			
WEEK 6	Between Groups	44.154	5	8.831	25.794	.000
	Within Groups	6.163	18	.342		
	Total	50.316	23			

Post Hoc Test for height of plant week 1

WEEK1		
Duncan[a]		
PLANT_HEIGHT	N	Subset for alpha = 0.05
		1
T3	4	3.4250
T0	4	3.5750
T4	4	3.6500
T1	4	3.8250
T2	4	4.1250
T5	4	4.2250
Sig.		.093

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for height of plant week 2

WEEK2			
Duncan[a]			
PLANT_HEIGHT	N	Subset for alpha = 0.05	
		1	2
T1	4	5.4250	
T2	4	5.6500	
T5	4	5.8750	
T3	4	5.9250	
T4	4	6.0750	6.0750
T0	4		7.6250
Sig.		.439	.050

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for height of plant week 3

WEEK3					
Duncan[a]					
PLANT_HEIGHT	N	Subset for alpha = 0.05			
		1	2	3	4
T1	4	7.5500			
T2	4		9.5000		
T3	4		10.3250	10.3250	
T4	4			11.1000	
T0	4				12.6250
T5	4				12.7500
Sig.		1.000	.221	.249	.850

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for height of plant week 4

WEEK4				
Duncan[a]				
PLANT_HEIGHT	N	Subset for alpha = 0.05		
		1	2	3
T1	4	13.5000		
T2	4		15.5500	
T3	4		15.8000	
T4	4		16.3750	16.3750
T0	4			17.5000
T5	4			17.9000
Sig.		1.000	.317	.072

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for height of plant week 5

WEEK5						
Duncan[a]						
PLANT_HEIGHT	N	Subset for alpha = 0.05			
		1	2	3	4
T1	4	16.9250			
T2	4		20.9500		
T3	4		21.5000	21.5000	
T0	4		21.9250	21.9250	
T4	4			22.5000	
T5	4				23.6000
Sig.		1.000	.074	.067	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for height of plant week 6

WEEK6					
Duncan[a]					
PLANT_HEIGHT	N	Subset for alpha = 0.05			
		1	2	3	4
T1	4	21.4500			
T2	4		22.9500		
T3	4			24.0000	
T0	4			24.1250	
T4	4			24.7750	
T5	4				25.7250
Sig.		1.000	1.000	.092	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

One-Way ANOVA for number of leaves

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
WEEK 1	Between Groups	.208	5	.042	1.000	.446
	Within Groups	.750	18	.042		
	Total	.958	23			
WEEK 2	Between Groups	4.500	5	.900	2.025	.124
	Within Groups	8.000	18	.444		
	Total	12.500	23			
WEEK 3	Between Groups	15.833	5	3.167	6.000	.002
	Within Groups	9.500	18	.528		
	Total	25.333	23			
WEEK 4	Between Groups	9.333	5	1.867	3.953	.014
	Within Groups	8.500	18	.472		
	Total	17.833	23			
WEEK 5	Between Groups	15.708	5	3.142	9.048	.000
	Within Groups	6.250	18	.347		
	Total	21.958	23			
WEEK 6	Between Groups	13.833	5	2.767	4.150	.011
	Within Groups	12.000	18	.667		
	Total	25.833	23			

Post Hoc Test for number of leaves week 1

WEEK1

Duncan[a]

NUMBER_OF_LEAVES	N	Subset for alpha = 0.05
		1
T0	4	3.0000
T1	4	3.0000
T3	4	3.0000
T4	4	3.0000
T5	4	3.0000
T2	4	3.2500
Sig.		.140

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for number of leaves week 1

WEEK2

Duncan[a]

NUMBER_OF_LEAVES	N	Subset for alpha = 0.05
		1
T2	4	4.2500
T3	4	4.2500
T1	4	4.5000
T0	4	5.0000
T4	4	5.2500
T5	4	5.2500
Sig.		.074

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for number of leaves week 3

WEEK3				
Duncan[a]				
NUMBER_OF_LEAVES	N	Subset for alpha = 0.05		
		1	2	3
T1	4	4.7500		
T0	4		6.0000	
T3	4		6.0000	
T2	4		6.2500	
T4	4		6.5000	6.5000
T5	4			7.5000
Sig.		1.000	.384	.067

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for number of leaves week 4

WEEK4				
Duncan[a]				
NUMBER_OF_LEAVES	N	Subset for alpha = 0.05		
		1	2	3
T1	4	6.5000		
T2	4	7.2500	7.2500	
T3	4	7.5000	7.5000	7.5000
T0	4		7.7500	7.7500
T4	4		8.0000	8.0000
T5	4			8.5000
Sig.		.066	.173	.073

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for number of leaves week 5

WEEK5					
Duncan[a]					
NUMBER_OF_LEAVES	N	Subset for alpha = 0.05			
		1	2	3	4
T1	4	7.5000			
T2	4	8.2500	8.2500		
T3	4		8.5000	8.5000	
T0	4			9.2500	9.2500
T4	4			9.2500	9.2500
T5	4				10.0000
Sig.		.089	.556	.104	.104

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for number of leaves week 6

WEEK6				
Duncan[a]				
NUMBER_OF_LEAVES	N	Subset for alpha = 0.05		
		1	2	3
T1	4	9.5000		
T2	4	10.0000	10.0000	
T3	4	10.2500	10.2500	
T0	4	10.7500	10.7500	10.7500
T4	4		11.2500	11.2500
T5	4			11.7500
Sig.		.061	.061	.117

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

One-Way ANOVA for size of leaves

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
WEEK 1	Between Groups	.149	5	.030	2.581	.063
	Within Groups	.207	18	.012		
	Total	.356	23			
WEEK 2	Between Groups	.795	5	.159	2.336	.084
	Within Groups	1.225	18	.068		
	Total	2.020	23			
WEEK 3	Between Groups	8.114	5	1.623	9.236	.000
	Within Groups	3.162	18	.176		
	Total	11.276	23			
WEEK 4	Between Groups	6.518	5	1.304	3.713	.017
	Within Groups	6.320	18	.351		
	Total	12.838	23			
WEEK 5	Between Groups	7.440	5	1.488	6.060	.002
	Within Groups	4.420	18	.246		
	Total	11.860	23			
WEEK 6	Between Groups	11.178	5	2.236	16.359	.000
	Within Groups	2.460	18	.137		
	Total	13.638	23			

Post Hoc Test for size of leaves week 1

WEEK1			
Duncan[a]			
SIZE_OF_LEAVES	N	Subset for alpha = 0.05	
		1	2
T1	4	.9250	
T0	4	1.0250	1.0250
T3	4	1.0500	1.0500
T4	4	1.0750	1.0750
T2	4		1.1250
T5	4		1.1750
Sig.		.085	.091

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for size of leaves week 2

WEEK2			
Duncan[a]			
SIZE_OF_LEAVES	N	Subset for alpha = 0.05	
		1	2
T1	4	1.7250	
T2	4	1.7500	
T4	4	1.7500	
T5	4	1.8000	
T3	4	1.8250	
T0	4		2.2500
Sig.		.631	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for size of leaves week 3

WEEK3			
Duncan[a]			
SIZE_OF_LEAVES	N	Subset for alpha = 0.05	
		1	2
T1	4	2.2000	
T2	4	2.7750	
T3	4		3.4500
T4	4		3.6500
T0	4		3.7250
T5	4		3.7750
Sig.		.068	.328

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for size of leaves week 4

WEEK4			
Duncan[a]			
SIZE_OF_LEAVES	N	Subset for alpha = 0.05	
		1	2
T1	4	3.6250	
T2	4		4.8250
T0	4		4.8500
T3	4		5.0000
T4	4		5.0750
T5	4		5.1750
Sig.		1.000	.462

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for size of leaves week 5

WEEK5			
Duncan[a]			
SIZE_OF_LEAVES	N	Subset for alpha = 0.05	
		1	2
T1	4	4.2500	
T0	4		5.3250
T2	4		5.5250
T3	4		5.5250
T4	4		5.7750
T5	4		6.0000
Sig.		1.000	.098

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Post Hoc Test for size of leaves week 6

WEEK6				
Duncan[a]				
SIZE_OF_LEAVES	N	Subset for alpha = 0.05		
		1	2	3
T1	4	5.0000		
T2	4		6.2500	
T3	4		6.3250	
T0	4		6.4750	
T4	4		6.7750	6.7750
T5	4			7.2250
Sig.		1.000	.080	.102

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

APPENDIX B

Growth of plants in positive control application

 Week 1	 Week 2
 Week 3	 Week 4
 Week 5	 Week 6

Growth of plants in negative control application

 Week 1	 Week 2
 Week 3	 Week 4
 Week 5	 Week 6

Growth of plants in 1% of MOL application

 Week 1	 Week 2
 Week 3	 Week 4
 Week 5	 Week 6

Growth of plants in 5% of MOL application

 Week 1	 Week 2
 Week 3	 Week 4
 Week 5	 Week 6

Growth of plants in 10% of MOL application

 Week 1	 Week 2
 Week 3	 Week 4
 Week 5	 Week 6

Growth of plants in 20% of MOL application

 Week 1	 Week 2
 Week 3	 Week 4
 Week 5	 Week 6

APPENDIX C

Fermented MOL for 2 weeks

100% of MOL solution