THE EFFECT OF POME (PALM OIL MILL EFFLUENT) ON GROWTH, FRUITING AND POST HARVEST QUALITY OF BRINJAL ON BRIS SOIL

NOR HIDAYAN BINTI SALIM

FACULTY OF AGROTECHNOLOGY AND FOOD SCIENCE
UNIVERSITI MALAYSIA TERENGGANU

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By
Nor Hidayani binti Salim

Research Report submitted in partial fulfillment of
the requirements for the degree of
Bachelor of Science in Agrotechnology (Post Harvest Technology)

DEPARTMENT OF AGROTECHNOLOGY
FACULTY OF AGROTECHNOLOGY AND FOOD SCIENCE
UNIVERSITI MALAYSIA TERENGGANU
2010

ENDORSEMENT

The project report entitled **The effect of POME (palm oil mill effluent) on growth, fruiting and post harvest quality of brinjal on bris soil** by **Nor Hidayani bt. Salim**, Matric No. **UK15383** has been reviewed and corrections have been made according to the recommendations by examiners. This report is submitted to the Department of Agrotechnology in partial fulfillment of the requirement of the degree of Science in Agrotechnology (Post Harvest Technology), Faculty of Agrotechnology and Food Science, Universiti Malaysia Terengganu.

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(ASSOC. PROF ABDULLAH MOHD. ZAIN)

Date:
25 APRIL 2010

PROF. MADYA ABDULLAH MD. ZAIN
Pensyarah
Jabatan Agroteknologi
Fakulti Agrotek dan Sains Makanan
Universiti Malaysia Terengganu.

DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

Signature : ....
Name : NOR HIDAYANI BINTI SALIM
Matric No. : UK15383
Date : 25 APRIL 2010

ACKNOWLEDGEMENT

Praises and thanks to God for giving me strength and patience to finish up my project and thesis writing. An appreciation to my supervisor Associate Professor Haji Abdullah Mohd Zain for the advice and guide from the beginning of my final year project until completing this thesis writing.

A very thankful also to my beloved parents for their blessing, praying and encouragement to finish up my final year project. Sincerely thanks to all my friends which helping me directly or indirectly to ensure my project run smoothly. Not forgotten also to all lecturers and Post Harvest Technology Laboratory Assistant which have been helped me much in completing my project thesis.

Besides, special thanks also to my beloved friend who has given me strength, encouragement and love during my process to complete this project successfully. And finally thank lecturer who are correcting and giving comments on this project. Thank you.

ABSTRACT

Bris soils are knowingly unstructured, have high moisture stress, and low in water holding capacity. Furthermore, it is also low in nutrient content and has high surface temperature since it has less water holding capacity. Thus, the way to solve this problem is to build up humus in the soil as well as facilitating nutrient cycling. It needs organic matter to improve water holding capacity to make it suitable to be used for crop planting. The use of inorganic fertilizer such as POME (palm oil mill effluent) will improve the soil, reduce the cost of production and provide nutrients for plants. The aim of this study is to see the effect of POME on growth, fruiting and post harvest quality of brinjal on bris soil. In this study, there were 5 treatments with different ratios of Bris soil and POME. The evaluation of effect of POME on brinjal plants was based on several parameters. On growth effects, Bris soil treated with the highest ratio of POME (3:4) gave even better plant growth and greater stem diameter after four weeks of planting. This showed that the plants growth were vigorous with the addition of POME. On fruiting effect, Bris soil treated with POME gave even greater yield and the weight of each produce was greater compared to plants without POME's treatment. For the post harvest quality of brinjal, plants treated with POME gave better fruit firmness, total soluble solid and pH. Generally, these traits are much preferred by the consumers.

ABSTRAK

Tanah Bris adalah tanah yang tidak berstruktur, mempunyai tekanan kelembapan yang tinggi dan keupayaan untuk memegang air yang rendah. Di samping itu, tanah Bris juga mengandungi kurang nutrient dan suhu permukaannya yang tingi disebabkan oleh keupayaan memegang air yang rendah. Oleh itu, untuk menyelesaikan masalah ini adalah dengan menambah humus ke dalam tanah Bris untuk memudahkan kitar nutrien. Bahan organic seperti POME (bahan buangan kisaran kelapa sawit) boleh digunakan bersama tanah Bris untuk tujuan penanaman kerana mempunyai keupayaan untuk memegang air, memperbaiki keadaan struktur tanah, menyediakan nutrient kepada tumbuhan dan boleh menjimatkan kos pengeluaran tanaman. Tujuan utama kajian ini adalah untuk mengetahui kesan menggunakan POME pada tanah bris untuk pertumbuhan, pembuahan dan kualiti lepas tuai terhadap penanaman terung. Dalam kajian ini, terdapat 5 rawatan dengan kadar tanah Bris dan POME yang berbeza dengan penggunaan baja bukan organik yang sama rata. Kesan penggunaan POME ke atas pokok dan hasilan berdasarkan beberapa parameter. Untuk kesan pertumbuhan, tanah Bris yang dirawat menggunakan kadar POME yang paling tinngi (3:4) menunjukkan pertumbuhan pokok dan diameter batang yang paling tinggi. Ini menunjukkan bahawa dengan penggunaan POME, pertumbuhan adalah pesat. Untuk kesan pembuahan, tanah Bris yang dirawat menggunakan POME memberikan hasil dan berat buah yang tinggi berbanding pokok yang tidak dirawat dengan POME. Untuk kesan kualiti lepas tuai hasilan, pokok yang dirawat dengan POME menunjukkan nilai keteguhan isi yang baik, kandungan pepejal terlarut yang tinggi dan pH yang boleh diterima di peringkat pengguna.

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LIST OF ABBREVIATIONS

cm	centimeter
in.	inch
ft	feet
^{o}C	Degree Celsius
%	Percentage
POME	Palm Oil Mill Effluent
BOD	Biological Oxygen Demand
kg	kilogram
ha	hectare
t	tonne
π	pi
r	radius
TSS	Total Soluble Solid
SPSS	Statistical Package for Social Sciences
mm	millimeter
W	Week
g	gram

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CHAPTER 1

INTRODUCTION

1.1 Background of study

1.1.1 Brinjal (*Solanum melongena* L.)

Solanum melongena L. is one of the few cultivated solanaceous species originating from the Old World. It is known as brinjal in its home country, India, where it was domesticated long ago and where the greatest diversity is found. Widely grown in temperate and tropical Asian countries, eggplant has been also a common crop in the Middle-East and around the Mediterranean basin and is now cultivated worldwide (Fernando *et al*., 2008).

The fruit is a pendant berry, which contains numerous small, soft seeds, which are edible, but are bitter because they contain (an insignificant amount of) nicotinoids alkaloids, unsurprising as it is a close relative of tobacco. This fruit is classified as non-climacteric fruit.

It is a delicate perennial often cultivated as an annual. It grows 40 to 150 cm (16 to 57 in) tall, with large coarsely lobed leaves that are 10 to 20 cm (4-8 in) long and 5 to 10 cm (2-4 in) broad. Semi-wild types can grow much larger, to 225 cm (7 ft) with large leaves over 30 cm (12 in) long and 15 cm (6 in) broad. The stem is often spiny. The flowers are white to purple, with a five-lobed corolla and yellow stamens. The fruit is fleshy, less than 3 cm in diameter on wild plants, but much larger in cultivated forms.

There have four types of flowers in brinjal; having long, medium, pseudo-short and short styles. It is a warm season crop and is very susceptible to frost. It requires a long and warm growing season. The best mean temperature for its better growth and development is between 18.3°C to 21. 1°C. Brinjal can do well on a variety of soils ranging from sandy loam to heavy clay but for better yield and quality heavy loam soils have been found to be the best. The best pH is 5.5 to 6.0. The crop remains in the field for a number of months. Therefore, the soils should be well prepared by repeated ploughings and harrowing.

Spacing should be 45 cm (18 in.) to 60 cm (24 in.) between plants, depending on cultivar, and 60 cm to 90 cm (24 to 36 in.) between rows, depending on the type of cultivation equipment being used. Mulching will help conserve moisture and prevent weeds and fungal diseases. The flowers are relatively unattractive to bees and the first blossoms often do not set fruit.

For transplanting process, four to six weeks old seedlings are supposed to be the best for transplanting. The distance, however, depends upon the variety. For the long ones, there are transplanted at 60 x 45cm or 45 x 45cm distance. A light irrigation should be given immediately after transplanting process. Only healthy, disease-free seedlings should be transplanted.

It is essential to keep the crop weed free by repeated hoeing and weeding especially during the early stage of plant growth. Normally, two to three weeding will be sufficient during spring season while three to four will be sufficient during rainy season.

The fruit are harvested when they reach a size that the market requires, but if this is delayed too long, they can become seedy, dull and fibrous. The diseases that already found in brinjal plant are little leaf, leaf spots and root knot. For little leaf problem, it is a very serious disease and affects directly the yield of the crop. The leaves become smaller and petioles get shorter considerably. In the later stage, the plants acquire bushy appearance. Due to this malady very poor fruit set takes place and ultimately there is heavy reduction in the yield. To control these problems, the diseased plant should be removed in the early stage of development or it can be sprayed with Ekalux or Folidol at the rate of 0.2 % at fortnightly interval till fruit set. This will check the spread of the disease which is transmitted by insects *Euletix phycitis* and *Empoasca devastans*.

For the leaf spots problems, it is caused by *Alternaria melongenae* fungus especially during rainy season. Irregular spots are formed on the leaves and later on the leaves drop down. Sometimes, the spots are also observed on the fruits and they become yellow and drop down. Thus, to control the problem, the crop should be sprayed with Dithane M-45 at the rate of 0.2 % solution at fortnightly interval.

For the root knot problem, it is likely have small nodules-like structures encircling the roots are formed on the roots. The plants become stunted and leaves show chlorotic symptoms. To prevent this problem, the resistant varieties should be grown. Soil fumigation with some nematicides like Nemagon should be done.

This plant also have the insect pests same with the other plants. One of it is the Jassids or *Empoasca* sp. They can suck the sap from the leaves and causing the leaves curling. In the later stage leaves become yellowness. Thus, the way to prevent this type of pest is with sprayed the crop with Metasystox at the rate of 0.15 % solution at fortnightly intervals. The other one of pest type is the Epilachna beetle or *Epilachna* sp. which it eats the green portion of the leaves and leaving a skeleton of the veins. This is very serious during the early stage of plant growth.

1.2 Problem Statement

Bris soil is poor soil with the properties that easily make everything added to the soil such as fertilizer to leach without give benefit to the plant. Bris soil has low water holding capacity without composed any permanent nutrient within it. It needs organic matter to provide the property of water holding capacity to make it benefits to be used for crop planting. Besides, the lack of nutrient also makes it unsuitable for any planting especially agricultural produces and gives disadvantage for the farmer to plant crops with higher cost due to the using of inorganic fertilizer. The use of organic fertilizer such as POME (palm oil mill effluent) will improve the soil and reduce the cost of production.

1.3 Significance of study

Normally in growing brinjal and for vegetable production a complete fertilizer grade such as NPK fertilizer has been used. Besides using fertilizer grade, organic fertilizer such as POME also used as additional nutrient in growing brinjal. The result of this study will be useful for the farmer to increase their crop production with the using of POME in addition of using the fertilizer grade. Furthermore, this material is environmentally friendly and pollution free. Therefore, the information of the potential effect of POME on fruit quality is very important to meet the consumer demand.

1.3 Objective

The objective of this study is to determine the effects of POME on growth, fruiting, and post harvest quality of brinjal on bris soil.

CHAPTER 2

LITERATURE REVIEW

2.1 Nutrient Requirement

The nutrients required in the greatest quantity by plants are carbon, oxygen and hydrogen and fortunately for us gardeners these are available from the air and water so we don't have to worry about them. Next come the major soil or fertiliser supplied nutrients and they are nitrogen (N), phosphorus (P) and potassium (K), each of which plays a significant role in the growth functions of the plant. In very simple terms, nitrogen stimulates growth, particularly that of the leaves and stems, as well as the production of protein; phosphorus stimulates the formation of roots, flowers and fruit; while potassium enhances the colour and quality of fruit and flowers, strengthens stems, as well providing a good measure of disease resistance to plants. The secondary nutrients are calcium, sulphur and magnesium and, although needed in reasonably large quantities, are generally supplied as by-product additives of fertilizers or liming materials. Last, but not least, are the trace elements, which are so named because plants need only a trace of them. (Colin Campbell, 2009).

Initially, organic resources were merely seen as sources of nutrients, mainly nitrogen (N). A substantial amount of research was done on quantifying the availability of N from organic resources as influenced by their resource quality and the physical environment (Palm et al., 2001, for example). More recently, other contributions of organics extending beyond fertilizer substitution have been emphasized in research, such as the provision of other macro and micro-nutrients, reduction of phosphorus sorption capacity, increase in carbon/organic matter, reduction of soil borne pest and disease spectra in rotations, and improvement of soil moisture status (Vanlauwe et al., 2002a).There are some key differences in the way that the organic systems contribute to soil fertility. Those systems using nitrogen-fixing species add large amounts of nitrogen without withdrawing it from soils.

Organic sources will differ in terms of nutrient content, mineralization processes (in which the nutrients in the organic compounds can become available to the crop), and the provision of other soil fertility benefits (e.g. weed reduction). Management aspects also influence the effectiveness of organics. The growing of legumes in situ (rather than transferring biomass from outside) can provide other benefits to crops through rotation effects (e.g. reducing weeds) and through water infiltration effects (from the root systems). (Frank Place et al., 2003)

2.2 POME (Palm Oil Mill Effluent)

Palm oil processing is carried out using large quantities of water in mills where oil is extracted from the palm fruits. During the extraction of crude palm oil from the fresh fruits, about 50% of the water results in palm oil mill effluent (POME). It is estimated that for 1 tonne of crude palm oil produced, 5 - 7.5 tonnes of water ends up as POME (Ahmad et al., 2003). Palm oil mill effluent (POME) contains organic matter and plant nutrients which are excellent substitutes for inorganic fertilizer. In view of its proven value, majority of POME produced by palm oil mills is fully recycled as manure. Since POME is originally from the water waste treated anaerobically in a series of ponds which over half of the land has to be spared for the waste water treatment ponds, therefore it is becoming useful for the plant nutrient taken. Although, there is a concern that this water might pollute underground water because the nitrogen will be lost if the POME is stored for long periods in the effluent ponds. Thus, the sludge from the effluent ponds should be applied to fields that are low in organic matter.

Raw POME is high in BOD and acidic with pH of around 4.0. After treatment, the pH is raised to around 8 and BOD is lowered. In terms of nutrient value, anaerobic sludge of treated POME contains high plant nutrients. Application of anaerobic sludge in the oil palm fields is carried out using the tractor-tanker system at the rate of 360 and 500 liters/palm/year for coastal and inland soils respectively. In terms of fertilizer value, this application is equivalent to 1.96 kg urea, 1.83 kg Christmas Island Rock Phosphate (CIRP), 1.45 kg Muriate of Potash (MOP), 2.3 kg kieserite for coastal and 2.99 kg urea, 2.80 kg CIRP, 2.22 kg MOP, 3.5 kieserite for inland soils.

According to Lim and P'ng (1983), with the application of POME to the soil it will increase the pH, potassium, calcium, magnesium and organic matter content in the soil.

This POME is applied to plant with mixing it well with the soils provided.

Palm oil processing is carried out in mills where oil is extracted from the palm fruits. Large quantities of water are used during the extraction of crude palm oil from the fresh fruits and about 50% of the water results in palm oil mill effluent (POME). It is estimated that for 1 tonne of crude palm oil produced, 5 - 7.5 tonnes of water will end up as POME (Ahmad et al., 2003). It has been observed that most of the POME produced by the small-scale traditional operators in Anyigba, Kogi State undergo little or no treatment and is usually discharged into the surrounding environment.

The application of raw or digested POME as fertilizer on land was initially thought to be impractical because of the effluent killing vegetation and leading to the blocking of percolation and water logging, thus resulting in anaerobic conditions. However, Wood et al.(1979) found that although raw POME would readily cause clogging and water logging of the soil, these problems could be overcome by the controlled application of small quantities of POME at a time. The testing of ground waters after 6 to 12 months of trial applications of raw POME as fertilizer showed no substantial percolation of oxygen demanding or other polluting elements without excessive run-off over the surface during wet weather (Wood et al., 1979). It was thus established that the water quality in the applied areas was unaffected (Dolmat et al., 1987). Oviasogie and Aghimien (2003) later reconfirmed that a proper use and safe disposal of POME in the land environment would lead to improved soil fertility and contribute to environmental sustainability. Their results showed an enrichment of the soils with regard to phosphorus, nitrogen, calcium, magnesium, sodium and potassium following the application of the POME. Copper, iron and lead were predominant in their organic forms, while zinc was particularly present in its exchangeable form.

The potential for using POME as a cheap organic fertilizer may offer an alternative to the excessive application of chemical fertilizers, especially phosphorus, for which cost is a severe economic constraint. For example, biologically treated POME has been widely used in the oil palm plantations for irrigation purposes and can be employed as a liquid fertilizer. It is estimated that each 15 million tonnes of POME would have a fertilizer value of RM 95.41 million. According toWood et al. (1979), an application of POME at 4.5×106 l per applied hectare was estimated to represent a fertilizer application of about 30 kg ammonium sulfate, 7 kg rock phosphate, 52 kg potash and 18 kg kieserite per palm per year. An incorporation of POME may help to increase the organic matter in the soil, which may turn into humus after decomposition and become an active soil component. Thus, POME application would result in changes in the chemical properties of the soil. According to Ferreira and Araujo (2002), average contents of calcium, magnesium, potassium and phosphorus were found to increase in the soil with an increase in POME dosage, especially at a depth of 0–20 cm but an application of 120 m3/ha of POME to the soil reduced the aluminum content to zero at a depth of 20 cm after 12 months. Such a reduction of aluminum in the soil would eventually help prevent toxicity and growth hindrance for plants in acid soils (Matsumoto, 2000; Guo et al.,2007). Nevertheless, variations in POME quality among the mills and the rate of application as well as other details need to be determined in relation to local situations (Agamuthu et al., 1992).

Moreover, the use of POME as fertilizer must be carried out with caution because of imbalances in the nutrient composition. A prolonged improper utilization may cause an accumulation of magnesium and thereby inhibit the availability of potassium (Onyia et al., 2001). According to Chan et al. (1980), the use of POME has been shown to improve soil productivity and increase the yield of crops as well as contribute to better root health by improving the soil structure. An increase in crop yield on the order of 10 to 24% has been reported (Tam et al., 1982; Lim et al., 1984). Teoh and Chew (1983) have further shown that mixtures of soil and POME in a ratio of 1:5 resulted in more vigorous growth of cocoa seedlings and decreased nursery rotation without the addition of supplementary fertilizers. With the help of organic matter consisting of peat and the sludge from POME, Shamshuddin et al. (2004) confirmed that aluminum toxicity towards the growth of cocoa seedlings on acid sulfate soil could be reduced to a certain extent. Agamuthu (1994) stated that the application of POME alone as fertilizer provided the highest yield of Napier grass (Pennisetum purpureum), up to 3276 kg/ha, as a result of POME containing almost all the major and minor elements required for its growth (Agamuthu et al., 1992).

Although the application of fresh dung also gave rise to high yields of Napier grass, up to 2574 kg/ha, POME was preferred since fresh dung releases an unwanted odor that might attract flies (Agamuthu, 1994). Shamshuddin et al. (1998) indicated that the application of POME together with ground magnesian limestone, which might last for 3 years, was a sound agronomic option to alleviate the soil acidity and improve the fertility in Ultisol for maize production. They also revealed that a POME application up to 40 t/ha did not significantly change the topsoil pH and exchangeable calcium, magnesium and aluminum, in which case the calcium and magnesium from the POME were held by the negative charge present on the exchange complex.

Salètes et al. (2004) conducted a trial on a composting platform in windrows comprised of shredded empty fruit bunches that were watered weekly with POME. They found that the resulting compost had a good agronomic value but that the mineral balance was considerably affected due to the nutrients provided by POME being poorly retained by the substrate and partially lost in percolation following the weekly watering operations. According to Salètes et al. (2004), a better distribution of POME applications together with a system for recovering the leaching might substantially reduce the nutrient losses while maintaining a suitable humidity for microbial degradation. In a similar case to that of Salètes et al. (2004), Aisueni and Omoti (2002) also used shredded empty fruit bunches together with POME in the composting process but with the addition of poultry droppings as nutrient supplements. They noted that the use of POME in the composting process was particularly beneficial in significantly reducing the amount of poultry droppings, which were required to produce the same amount of final compost.

The slow release of the total N and P after the first 12 weeks could also become a limiting factor if these nutrients were to be made available for plant growth (Palaniappan et al., 1983). Therefore, Azizah Chulan (1991) suggested that if POME were to be reused as fertilizer, the soil should be inoculated with vesicular–arbuscular mycorrhizal (VAM) fungus Scutellospora calospora because the combination between POME and VAM will form mycorrhizae that may enhance the breakdown of certain soluble phosphates and insoluble organic phosphate such as phytate by roots (Gianinazzi-Pearson, 1985). Onyia et al. (2001) stated that the application of organic nitrogen from raw POME has been associated with lower yields due to ammonia being liberated during the mineralization of organic matter. Onyia et al. (2001) therefore suggested that nitrification of POME was necessary since a nitrified POME would be more easily absorbed by most plants than a raw POME with a high organics content, especially in the tropics where nitrate leaching does not present a major problem.

Numerous studies have identified ammonia volatilization as the major cause of low N efficiencies in urea (Mikkelsen et al.,1978; Fillery et al., 1984), in which case up to 80% of the applied urea-N may be lost within 2–3 weeks of application (Hargrove and Kissel, 1979; Torello et al., 1983). Siva et al. (2000) reported that POME is rich in organic matter and varying amounts of humic substances across their respective organic matrices. Seeing as humic substances have been reported to interact with ammonia compounds (Banerjee and Basak, 1978; Thorn and Mikita, 1992) and urea (Patti et al., 1992), Siva et al. (1999, 2000) investigated the effects of POME-derived humic substances on ammonia volatilization from urea. Initial studies by Aminuddin (1994) showed that POME could introduce a preferred environment within the urea–soil reaction zone (microsite) and successfully reduce ammonia volatilization to 8% of the applied N. Siva et al. (1999) displayed that this reduction in ammonia volatilization was accompanied by a corresponding increase in ammonium recovery and a decrease in pH, particularly at the microsite.

The performance of humic fractions from POME also indicated interplay of several mechanisms that could possibly include urease inhibition, urea absorption and ammonia fixation (Siva et al., 2000). These results have implications to the reduction of N loss by ammonia volatilization from urea applied to the soil during crop production. According to Muhrizal et al (2006), the incorporation of organic material into iron-poor acid sulfate soil might enhance the beneficial effects of reducible Fe(III) oxides or S in the soil and eventually promote an increase in pH under flooded conditions. However, not all organic materials are able to alleviate acid sulfate soil infertility with equal efficacy (Muhrizal et al., 2003). Although POME contains considerable amounts of organic materials, Muhrizal et al. (2006) revealed that POME did not significantly affect the pH and redox potential in the iron-poor acid sulfate soil during submergence. They also claimed that POME contains high concentrations of lignin that presumably decomposes slowly under anaerobic condition. Thus, these materials could not become active electron donors in the reduction process.

Under proper agronomic practice, palm oil mill effluent reacts as a unique nutrient source, which contributes directly to the decomposition of soluble phosphate (or insoluble organic phosphate) and improving of physical and microbial soil sanitation, leading to a tremendous elevation of crops yield. Dry matter yield increased quantitatively with the addition of palm oil mill effluent, computing a competent phosphorus recovery of 24.8% (quadratic relationship). Exploration in symbiosis relationship offers a viable substitution to the excessive application of chemical fertilizers, thus alleviating the severe economic constraint of fertilizer input, quoted a cost saving of \$5.00 ha^{-1} of plantation. (K.Y. Foo, B.H. Hameed, 2010)

2.3 Bris soil

Bris soils are knowingly unstructured, have high moisture stress, and low in water holding capacity. Furthermore, it also low in nutrient and have high surface temperature since it is less water holding capacity. Since it is low in water holding capacity, the nutrients make their way down to the ground water causes fertilizer leach into waterways. Thus, the way to solve this problem is to build up humus in the soil as well as facilitating nutrient cycling. This is basically recycling nutrients in the same spot rather bringing them in from another source. (Josh Byrne, 2003).

The pros to sandy soil is that it is non-wetting or water repellent, well aerated, free draining and best of all, easy to dig. Since it is water repellent, it also has the characteristic of hydrophobic soils. This hydrophobia is partly caused when organic matter breaks down and coats sand particles with a waxy substance. To treat dry hydrophobic soils it's best to initially apply a quality, surfactant-based wetting agent. This helps breaks down waxy coatings and helps water to penetrate. After applying the wetting agent it's important to add organic matter to help retain water and nutrients by applying organic matter. (Josh Byrne, 2009).

Furthermore, sandy bris soil also low in soil fertility. So, a small amount of organic fertilizer can help to get them off and also mulching as well. This will help to convert to plant food with the help of local soil microbes and fungi. When they are small, start it by build up the soil around the tree's roots but keep it away from the stem. With the application of organic fertilizer regularly and rock minerals are the best to improve the sandy bris soil fertility.

Most soils around Brisbane are low in boron and magnesium and most Australian soils are low in potash and zinc. The easiest and safest way to supplement all these nutrients and to stimulate healthy, living soil at the same time is to use seaweed fertilizers. Fish & Kelp is useful because the calcium in the fish helps plants to absorb phosphorous in seaweed more effectively. (Jerry Coleby, 2006).

CHAPTER 3

METHODOLOGY

3.1 Materials

3.1.1 Plant materials

Brinjal seeds of variety F1 Hybrid 302 were obtained from the greenhouse of Universiti Malaysia Terengganu.

Processed POME (Palm Oil Mill Effluent) is obtained from greenhouse of Universiti Malaysia Terengganu. The processed POME is exposed to the sunlight for a day before mixing with Bris soil as required treatment (ratio).

3.2 Method

3.2.1 Seedling preparation

The seed was sowed in the peat moss medium in the tray and germinated after 5 days of seeding. The seed tray was watered daily to prevent the soil dry.

3.2.2 Pot preparation

3.2.2.1 Preparing of pot

45 pots with the diameter 23.5cm were used. Each treatment was conducted with 3 replication. Each replication has 3 pots.

Table 3.1: The treatment arrangements

Treatment	Stage of growth	
	Stage I (Growth)	Stage II (Fruiting)
1	Bris soils (control) + NPK green	NPK Blue
2	Bris soils + POME (3:1) + NPK green	NPK Blue
3	Bris soils + POME (3:2) + NPK green	NPK Blue
4	Bris soils + POME (3:3) + NPK green	NPK Blue
5	Bris soils + POME (3:4) + NPK green	NPK Blue

3.2.2.2 NPK fertilizer requirement

Fertilizer grade (NPK green) that has been used followed the calculations (300kg/ha) below:

Diameter of pot : 23.5cm

By using the formula of pot width: πr^2

$= \pi\ (11.752\text{cm})^2$

$= 433.736\text{cm}^2$

1ha = 300kg

$1\text{x}10^8\text{cm}^2 = 300\text{kg}$

$\frac{300\text{kg}}{1\text{x}10^8\text{cm}^2} \text{ x } 433.736\text{cm}^2 = 1.30\text{x}10^{-3}\text{ kg} = 1.3\text{g per pot}$

Fertilizer grade (NPK blue) that has been used followed the calculations below (600kg/ha) :

Diameter of pot : 23.5cm

By using the formula of pot width: πr^2

$= \pi\ (11.752\text{cm})^2$

$= 433.736\text{cm}^2$

1ha = 600kg

$1\text{x}10^8\text{cm}^2 = 600\text{kg}$

$\frac{600\text{kg}}{1\text{x}10^8\text{cm}^2} \text{ x } 433.736\text{cm}^2 = 2.60\text{x}10^{-3}\text{ kg} = 2.6\text{g per pot}$

3.2.3 Transplanting of seedlings

The seedlings were transplanted to the pot at 4 to 5 leaves stage.

3.2.4 Crop care

The plants were watered twice daily in the morning and evening. The pesticide was applied when necessary. Weeding was done weekly by hand.

3.2.5 Harvesting

All produces were harvested three weeks after anthesis (flowering time), labeled, measured their weight and done the laboratory analysis of fruit.

3.2.6 Data collection

The data collections were on the field observation and laboratory data evaluation. The field observation was on growth which based on the quantitative parameters of plant height and stem diameter while the observation of fruiting was based on the quantitative parameters of number of fruit per plant and fruit weight.

The laboratory data evaluations were on the post harvest quality which included total soluble solid (TSS) measurement, pH and firmness measurements.

3.2.6.1 Total Soluble Solid (TSS) measurement

The TTS of the brinjal was determined by using Refractometer (Atago Hand Refractometer, Model 11, 50% Brixs). Results were expressed as degrees of Brix. Flesh sample of brinjal was cut into small pieces and put in a muslin cloth. Then, it was squeezed to get the juice. The platform of refractometer was cleaned with distilled water first and dried. 1 to 2 drops of brinjal juice is placed on the prism of the refractometer. Then, the refractometer was pointed towards the light source and the percentage of total soluble solid concentration was read. The refractometer surface was cleaned before replacing with the other sample of brinjal. Three readings were taken and these values were averaged to represent the sugar content for the brinjal samples.

3.2.6.2 pH measurement

The pH of each harvested brinjal was measured using the pH meter. 5g of flesh sample of brinjal was cut into small pieces and was mashed and 5ml of distilled water was added. Then, the pH was determined.

3.2.6.3 Firmness measurement

After harvested, each of brinjal in each replication was immediately measured its firmness using the texture analyzer. An indication of firmness was obtained by the force necessary to cause penetration of a standard probe within a specified distance into the product.

3.3 Data analysis

3.3.1 Anova

The analysis was carried out using Statistical Package for Social Sciences (SPSS) version 16. All data were subjected to a one-way analysis of variance (ANOVA) and the significance of differences for each stage was analyzed using Tukey's Test. The level of significant used were P=0.5.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results and Dicussion

4.1.1 Plant height

Figure 4.1 showed the average effect of different treatment of Bris soil and POME ratio on the height of brinjal plants with time. Weekly, the growth in height was normal in all treatments. At the first four weeks of growth, all plants had a little significant difference ($P<0.05$) in height as shown in Appendix (H) because POME which was acted as the nutrients and improved Bris soil properties, were slowed in nutrients released to be up taken by plants. This has been proved by Onyia et al. (2001), that a nitrified POME would be more easily absorbed by most plants than a raw POME with high organics content. But after the first week of growth the plants height was increased rapidly except for the control, the graph showed slightly flattened. Treatments with the ratio of Bris:POME (3:2) and (3:3) showed a very little significant difference ($P<0.05$) as in the Appendix (H) On average, the addition of POME gave better plant growth even after two weeks of planting. However, the application of POME at the highest ratio gave even better plant growth after four weeks of planting. This showed the vigorous growth similar with Teoh and Chew (1983) which have further shown that mixtures of soil and POME resulted in more vigorous growth of cocoa seedlings. While for the control noted by the Bris:POME (3:0), there had the lowest plant height since no POME was applied.

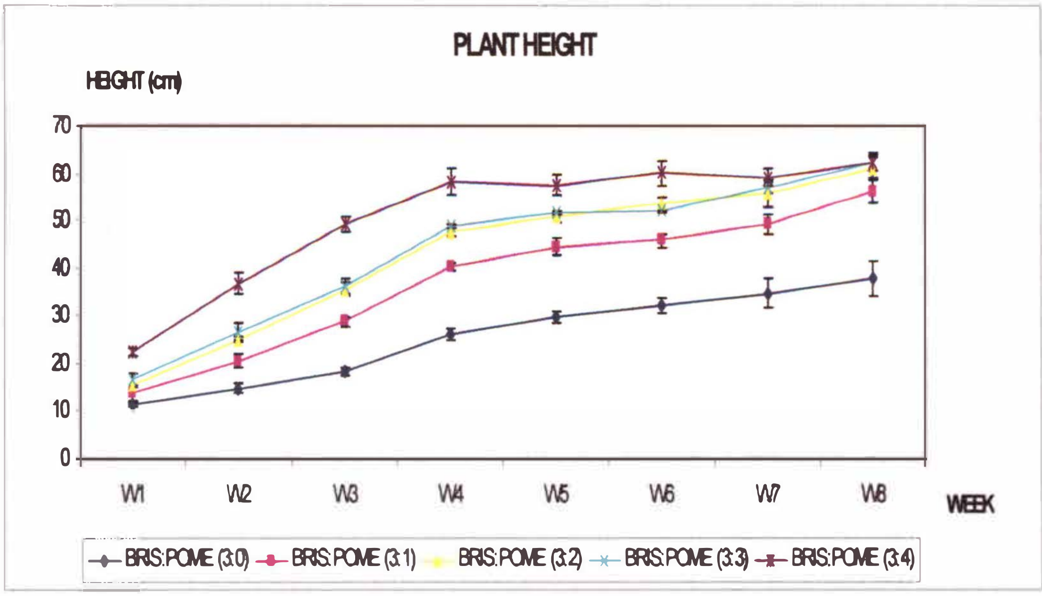

Figure 4.1: Graph for plant height

4.1.2 Stem diameter

According to the results of Appendix (B) that was interpreted into graph form, figure 4.2 showed the average effect of different treatment of Bris soil and POME ratio on the stem diameter of brinjal plants with time. The stem diameter of plants was increased with time and showed normal in all treatments. Along the week of planting, there have significant difference ($P<0.05$) between the control and the treatment applied with POME as in the Appendix (I). On average, the addition of POME gave greater stem diameter even after two weeks of planting. However, the application of POME at the highest ratio gave even greater stem diameter after four weeks of planting. This showed the vigorous growth similar with Teoh and Chew (1983) which have further shown that mixtures of soil and POME resulted in more vigorous growth of cocoa seedlings. While for the control noted by the Bris:POME (3:0), there had the lowest stem diameter averagely since no POME was applied.

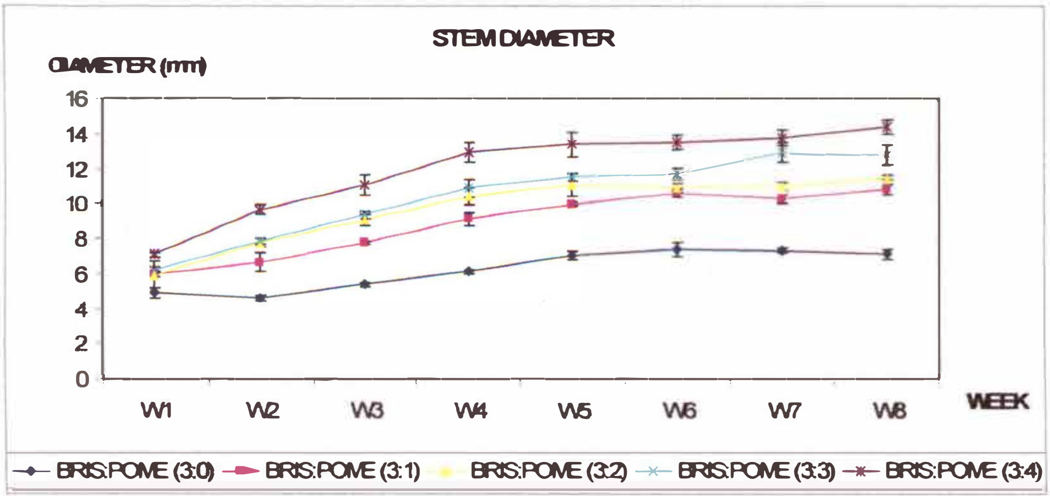

Figure 4.2: Graph of stem diameter

4.1.3 Fruit weight

The average effect of different treatment of Bris soil and POME ratio on the fruit weight showed in the figure 4.3. The fruit produced from the control showed very low in weight compare with all treatment with POME applied according to Appendix (C). Through the treatment, there have significant difference (P<0.05) between the control and the treatment applied with POME as in the Appendix (J). On the other hand, there have no significant difference (P>0.05) of fruit weight for treatment 3 and 4 according to Appendix (J). On average, the addition of POME gave greater fruit weight compared to control. However, the application of POME at the highest ratio gave even greater fruit weight.

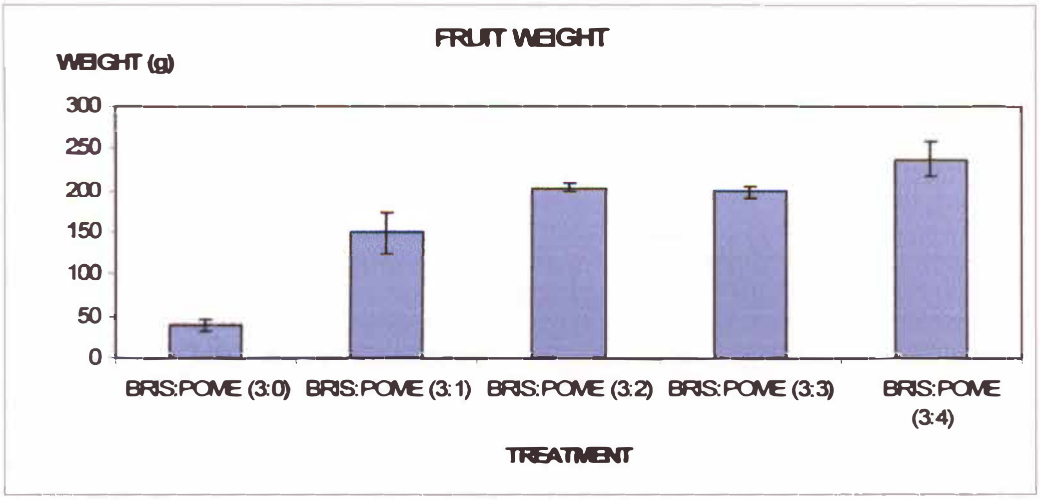

Figure 4.3: Bar graph for fruit weight

4.1.4 Number of fruit

Another evaluation is based on the fruit number. The average effect of different treatment of Bris soil and POME ratio on the number of fruit showed in the figure 4.4. All fruits in each of treatment were harvested three weeks after flowering time. It showed that the fruit number is increasing with treatment. From the Appendix (K), it showed no significant ($P>0.05$) difference among the treatment 1, 2, 3 and 4 except for treatment 5. Treatment 5 with the highest ratio of POME produced highest number of fruit per plant. On average, the addition of POME gave greater fruit number. However, the application of POME at the highest ratio gave even greater fruit number. Oviasogie and Aghimien (2003) later reconfirmed that a proper use and safe disposal of POME in the land environment would lead to improved soil fertility. According to Chan et al. (1980), the use of POME has been shown to improve soil productivity and increase the yield of crops as well as contribute to better root health by improving the soil structure. An increase in crop yield on the order of 10 to 24% has been reported (Tam et al., 1982; Lim et al., 1984).

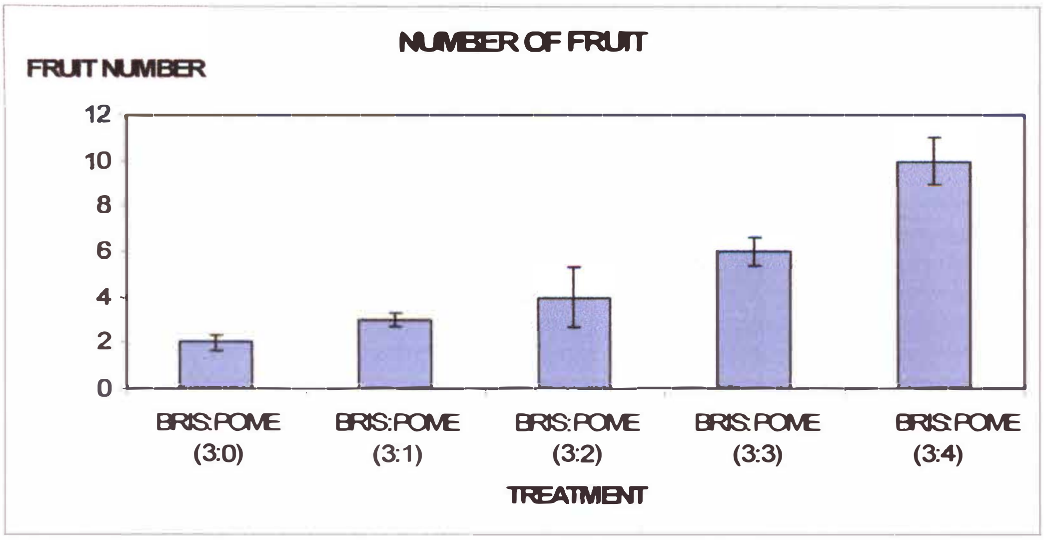

Figure 4.4: Bar graph for number of fruit

4.1.5 Fruit firmness

Figure 4.5 showed the average effect of different treatment of Bris soil and POME ratio on the fruit firmness. It showed that control has the lowest average of fruit firmness while the treatments with POME have greater fruit firmness. From the Appendix (L) it showed no significant difference ($P>0.05$) between control and the treatment with POME. On average, the addition of POME gives greater fruit firmness. However, the application of POME at the highest ratio gives lower fruit firmness compare to lower using of POME. It indicates that in term of fruit firmness, a little use of POME (3:2) is enough to produce greater firmness of fruit.

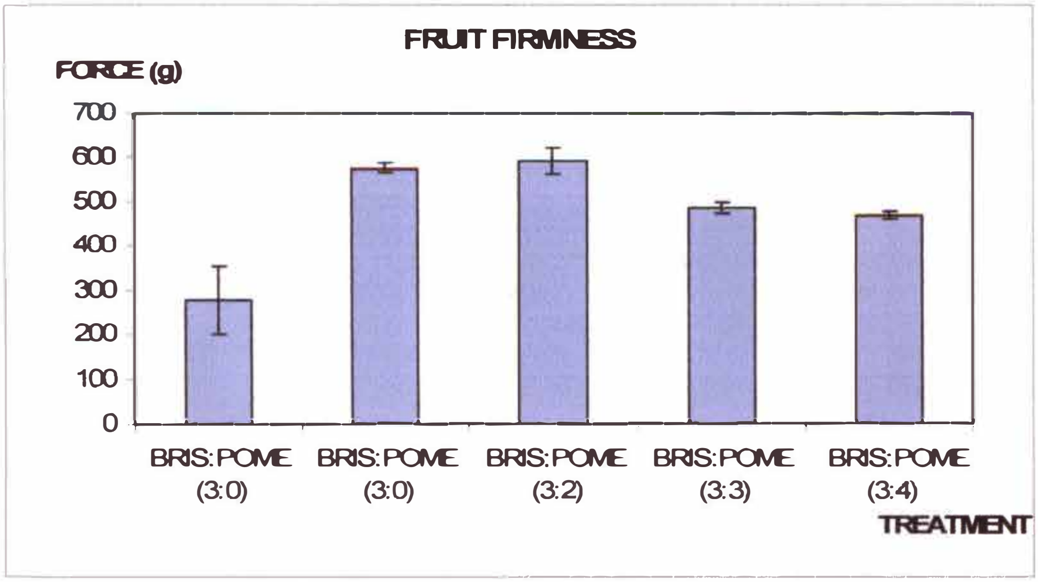

Figure 4.5: Bar graph for fruit firmness

4.1.6 Total soluble solid of fruit

The average effect of different treatment of Bris soil and POME ratio on total soluble solid of fruit is determined by figure 4.6. It showed the significant difference ($P<0.05$) on treatment 1, 4 and 5 while no significant difference between treatment 2 and 3 as shown in Appendix (M). On average, the addition of POME gives greater total soluble solid. However, the application of POME at the highest ratio gives even greater total soluble solid which indicates the sweetness of the fruit.

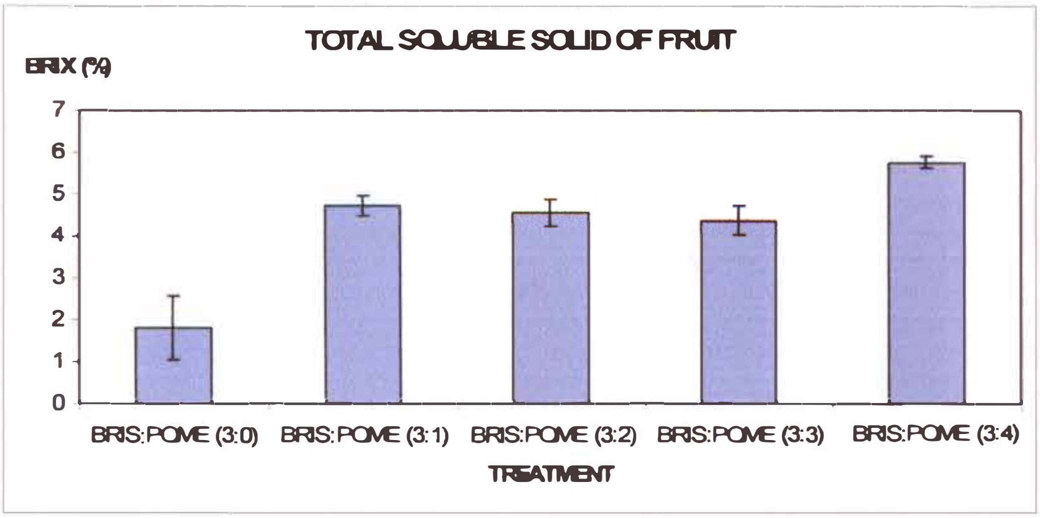

Figure 4.6: Bar graph for total soluble solid of fruit

4.1.7 pH of fruit

The average effect of different treatment of Bris soil and POME ratio on the pH value of fruit showed in the figure 4.7. From the Appendix (N) apparently it showed no significant difference ($P>0.05$) among treatment with POME. However, the treatment with POME as compared with the control showed significant difference ($P<0.05$). Control showed the lowest pH value since it was not treated with POME and it indicates the fruit sourness of fruit. This implies from the previously study that by application of POME into the soil will increase the soil pH (Lim and P'ng, 1983). On average, the addition of POME gave greater pH value which indicates less sourness of brinjal.

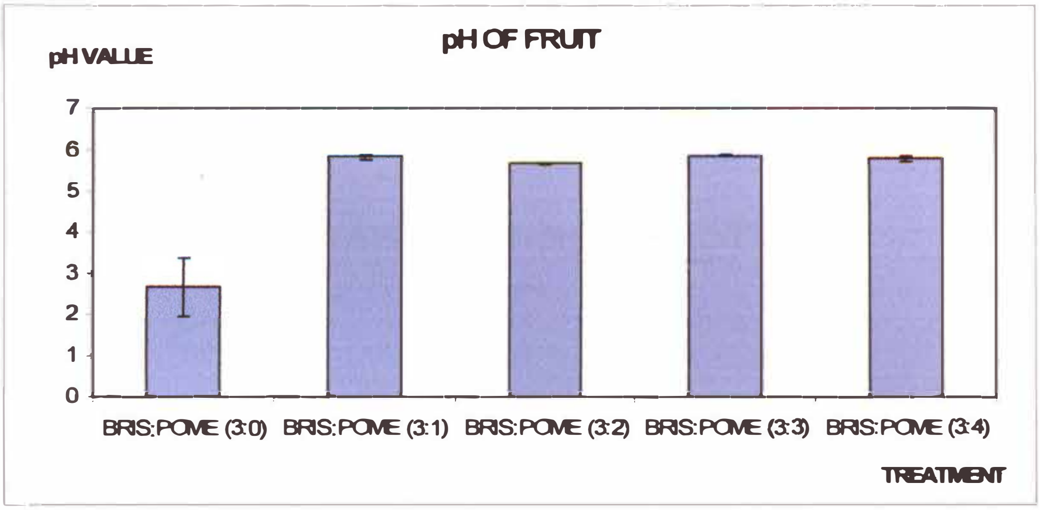

Figure 4.7: Bar graph for pH of fruit

CHAPTER 5

CONCLUSION AND SUGGESTIONS

5.1 Conclusion and Suggestions

Since planting using Bris soil are well-known to be a major problem because of the properties which has a low water holding capacity and losses in nutrients through the ground water causes fertilizer leaching into waterways. Addition of POME improved soil productivity and increase the yield of crops. POME contributed to better root health by improved the Bris soil structure.

As from this study, the application of POME at the highest ratio of Bris soil and POME (3:4) gave better and vigorous plant growth and greater stem diameter after four weeks of planting. While in term of fruiting, the application of POME with the highest ratio of Bris soil and POME (3:4) showed even greater fruit weight and greater fruit number per plant. It also indicates that the application of POME gave better effects to the post harvest quality of fruit. A lower ratio of Bris soil and POME (3:2) was enough to produce greater firmness of fruit while the application of POME at the highest ratio (3:4) gave even greater total soluble solid which indicates the sweetness of the fruit. On average, the addition of POME gave greater pH value which indicated less sourness of fruit.

This findings corroborates the post harvest quality gave all those criteria that can be achieved by consumer at acceptable level. Whereas the pre harvests quality of plants which specify to the growth performance and fruiting gave better achievement which can be accepted among growers that gave better expression to the quality of fruits yet after harvest.

For future study, it is appropriate to analyze the composition of POME to determine the macro and micro elements which can affect the growth and post harvest quality of fruits.

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APPENDICES

Appendix (A) : Raw average data of plant height with weeks

	BRIS:POME (3:0)	BRIS:POME (3:1)	BRIS:POME (3:2)	BRIS:POME (3:3)	BRIS:POME (3:4)
W1	11.50	13.72	15.39	16.67	22.33
W2	14.72	20.44	25.00	26.56	36.78
W3	18.22	28.78	35.61	36.22	49.17
W4	25.94	40.22	47.72	48.89	58.28
W5	29.72	44.44	50.72	51.67	57.44
W6	32.11	45.83	53.56	52.00	60.17
W7	34.78	49.17	55.72	56.83	59.17
W8	37.83	56.33	61.17	62.11	62.33

Appendix (B) : Raw average data of stem diameter with weeks

	BRIS:POME (3:0)	BRIS:POME (3:1)	BRIS:POME (3:2)	BRIS:POME (3:3)	BRIS:POME (3:4)
W1	4.90	5.94	5.92	6.26	7.10
W2	4.60	6.66	7.77	7.85	9.65
W3	5.38	7.75	9.02	9.34	11.06
W4	6.12	9.11	10.43	10.89	12.93
W5	7.01	9.97	11.08	11.54	13.40
W6	7.36	10.59	10.92	11.72	13.52
W7	7.28	10.26	10.97	12.91	13.75
W8	7.09	10.80	11.50	12.76	14.38

Appendix (C) : Raw average data of fruit weight by treatment

TREATMENT	AVERAGE VALUE
BRIS:POME (3:0)	38.90
BRIS:POME (3:1)	149.25
BRIS:POME (3:2)	204.15
BRIS:POME (3:3)	198.81
BRIS:POME (3:4)	237.57

Appendix (D) : Raw average data of number of fruit by treatment

TREATMENT	AVERAGE FRUIT NO.
BRIS:POME (3:1)	2
BRIS:POME (3:2)	3
BRIS:POME (3:3)	4
BRIS:POME (3:4)	6
BRIS:POME (3:5)	10

Appendix (E) : Raw average data of fruit firmness by treatment

TREATMENT	AVERAGE VALUE
BRIS:POME (3:0)	276.51
BRIS:POME (3:0)	577.6
BRIS:POME (3:2)	593.02
BRIS:POME (3:3)	486.65
BRIS:POME (3:4)	469.58

Appendix (F) : Raw average data of total soluble solid by treatment

TREATMENT	AVERAGE VALUE
BRIS:POME (3:0)	1.80
BRIS:POME (3:1)	4.73
BRIS:POME (3:2)	4.56
BRIS:POME (3:3)	4.38
BRIS:POME (3:4)	5.78

Appendix (G) : Raw average data of pH of the fruit by treatment

TREATMENT	AVERAGE VALUE
BRIS:POME (3:0)	2.67
BRIS:POME (3:1)	5.83
BRIS:POME (3:2)	5.67
BRIS:POME (3:3)	5.85
BRIS:POME (3:4)	5.79

Appendix (H) : ANOVA table for plant height with weeks

	PLANT HEIGHT VALUE							
TREATMENT	WEEK 1	WEEK 2	WEEK3	WEEK4	WEEK5	WEEK6	WEEK7	WEEK8
1	11.5 ± 0.5^{a}	14.723 ± 1.003^{a}	18.223 ± 0.816^{a}	25.943 ± 1.281^{a}	29.723 ± 1.392^{a}	32.11 ± 1.495^{a}	34.777 ± 3.027^{a}	37.833 ± 3.838^{a}
2	13.723 ± 1.401^{ab}	20.447 ± 1.392^{ab}	28.78 ± 1.073^{b}	40.223 ± 0.863^{b}	44.443 ± 1.788^{b}	45.833 ± 1.495^{b}	49.163 ± 1.922^{b}	56.5 ± 2.696^{b}
3	15.387 ± 0.241^{ab}	25 ± 0.479^{b}	35.613 ± 1.281^{c}	47.723 ± 0.722^{c}	50.723 ± 0.974^{bc}	53.553 ± 1.440^{cd}	55.723 ± 2.784^{b}	61.163 ± 2.587^{b}
4	16.667 ± 1.070^{b}	26.553 ± 1.892^{b}	36.223 ± 1.733^{c}	48.89 ± 0.39^{c}	51.663 ± 0.333^{c}	52 ± 0.191^{bc}	56.83 ± 1.258^{b}	62.11 ± 1.307^{b}
5	22.333 ± 0.726^{c}	36.777 ± 2.257^{c}	49.163 ± 1.590^{d}	58.277 ± 2.872^{d}	57.447 ± 2.216^{c}	60.167 ± 2.635^{d}	59.167 ± 1.830^{b}	62.333 ± 1.781^{b}

a-d -significant $P<0.05$ within the same week

Appendix (I) : ANOVA table for stem diameter with weeks

TREATMENT	PLANT STEM DIAMETER VALUE							
	WEEK 1	WEEK 2	WEEK3	WEEK4	WEEK5	WEEK6	WEEK7	WEEK8
1	4.898 ± 0.308^{a}	4.6 ± 0.147^{a}	$5.382 \pm 0.129_{a}$	6.117 ± 0.107^{a}	7.011 ± 0.238^{a}	7.361 ± 0.407^{a}	7.285 ± 0.113^{a}	7.086 ± 0.294^{a}
2	5.941 ± 0.791^{ab}	6.661 ± 0.496^{b}	7.753 ± 0.067^{b}	9.112 ± 0.357^{b}	9.967 ± 0.133^{b}	10.592 ± 0.258^{b}	10.257 ± 0.230^{b}	10.796 ± 0.287^{b}
3	5.916 ± 0.111^{ab}	7.775 ± 0.244^{b}	9.019 ± 0.320^{bc}	10.426 ± 0.484^{b}	11.077 ± 0.656^{b}	10.921 ± 0.259^{b}	10.973 ± 0.226^{b}	11.5 ± 0.119^{bc}
4	6.256 ± 0.102^{ab}	7.852 ± 0.137^{b}	9.341 ± 0.200^{c}	10.888 ± 0.543^{bc}	11.54 ± 0.191^{bc}	11.72 ± 0.307^{b}	12.907 ± 0.559^{c}	12.756 ± 0.553^{cd}
5	7.098 ± 0.113^{b}	9.652 ± 0.262^{c}	11.058 ± 0.586^{d}	12.933 ± 0.552^{d}	13.398 ± 0.696^{d}	13.518 ± 0.411^{c}	13.751 ± 0.447^{c}	14.379 ± 0.374^{d}

a-d -significant $P<0.05$ within the same week

Appendix (J) : ANOVA table for fruit weight

FRUIT WEIGHT VALUE				
Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
$38.9±6.882^{a}$	$147.247±24.382^{b}$	$204.147±4.197^{bc}$	$198.813±6.834^{bc}$	$237.573±21.294^{c}$

a-c -significant P<0.05 within the treatment

Appendix (K) : ANOVA table for number of fruit with weeks

FRUIT NUMBER VALUE				
Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
$2.667±0.333^{a}$	$3.333±0.333^{a}$	$4.333±1.333^{a}$	$6.00±0.577^{a}$	$10.00±1.00^{b}$

a-b -significant P<0.05 within the treatment

Appendix (L) : ANOVA table for fruit firmness with weeks

FRUIT FIRMNESS VALUE				
Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
$276.513±76.083^{a}$	$577.6±10.558^{b}$	$593.023±29.348^{b}$	$486.65±11.153^{b}$	$469.577±10.389^{b}$

a-b -significant P<0.05 within the treatment

Appendix (M) : ANOVA table for total soluble solid with weeks

FRUIT TOTAL SOLUBLE SOLID VALUE				
Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
1.797 ± 0.769^{a}	4.733 ± 0.234^{bc}	4.557 ± 0.324^{bc}	4.38 ± 0.346^{b}	5.777 ± 0.147^{c}

a-c -significant $P<0.05$ within the treatment

Appendix (N) : ANOVA table for pH of fruit with weeks

FRUIT pH VALUE				
Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
2.673 ± 0.700^{a}	5.83 ± 0.060^{b}	5.67 ± 0.029^{b}	5.85 ± 0.025^{b}	5.787 ± 0.058^{b}

a-b -significant $P<0.05$ within the treatment

CURRICULUM VITAE

Name	: Nor Hidayani Binti Salim
Permanent Address	: Rumah K/T Ladang Felda Selancar 6, W/P Perwira Jaya, 85070 Segamat, Johor
Telephone number	: 019-8968830
E-mail	: alifahida_88@yahoo.com
Date of Birth	: 8th of June 1988
Place of birth	: Johor
Nationality	: Malaysian
Race	: Malay
Gender	: Female
Religion	: Islam

Educational Background:

1995-1998	: Sekolah Kebangsaan Mambang, Pekan, Pahang
1998-2000	: Sekolah Kebangsaan (LKTP) Mayam, Triang, Pahang
2001-2003	: Sekolah Menengah Kebangsaan Desa Kencana, Bandar Sahabat, Lahad Datu, Sabah
2004-2005	: Sekolah Menengah Sains Lahad Datu (SMSLD), Lahad Datu, Sabah
2006-2007	: Kolej Matrikulasi Labuan (KML), Wilayah Persekutuan Labuan
2007-2008	: Bc. Sc. of Agrotechnology (Post Harvest Technology) Universiti Malaysia Terengganu, Terengganu

THE EFFECTOF POME (PALM OIL MILL EFFLUENT) ON GROWTH, FRUITING AND POST HARVEST QUALITY OF BRINJAL ON BRIS SOIL- NOR HIDAYANI BINTI SALIM