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Growth Performance of Oil Palm Seedlings on Different Types of Organic Fertilizer

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ABSTRACT

Fertilizer and soil nutrient management is important to sustain the productivity of nursery systems for oil palm seedling. Inorganic fertilizer usually applies to the oil palm seedling in nursery. The problem of the inorganic fertilizer nowadays is the price is quite expensive and can cause pollution if not manage well. So, by changes the inorganic to organic fertilizer, farmers can reduce their cost, and can gets many benefits through the usage of organic fertilizer. This study investigated the effects of organic fertilizer on growth performance and development of oil palm seedling. 3-month-old Tenera oil palm seedling was treated with an organic fertilizer (10 g of goat manure, 10 gram of fish waste and 10 gram of coffee waste). Control treatments were left untreated. Growth of seedling, plant morphology, plant physiology and soil pH were measured to compare among the treatments. Application of organic fertilizer significantly increased number of fronds about 28% to 46% compare from the control treatment, 28% to 41% increment in plant girth for treatment that treat with organic fertilizer, and significantly increase chlorophyll content of oil palm seedling leaves more than 11% for organic fertilizer application but not significantly increase the plant height and relative growth control (RGR). Several treatments on different organic fertilizer, like soil pH and relative water content (RWC), not significantly different from control but application of organic fertilizer help to increase the soil pH and help to increase the percentage of RWC in plant. These finding indicates that application of different organic fertilizer help to improve several morphology characteristics like number of fronds, and plant girth. It also can help to increase the chlorophyll content in leaves and help to improved soil pH. In future, application of organic fertilizer can be fully utilized for growth and development of oil palm seedling in nursery where it can help to reduce the usage inorganic fertilizer and help to reduce the cost of the nursery.

Keywords: Oil palm seedling, organic fertilizer, plant morphology, plant growth, chlorophyll content

INTRODUCTION

Oil palm (*Elaeis guineensis*) is a main industrial crop in Malaysia for production of vegetable cooking oil. Malaysia produces around 19.14 million tons of crude palm oil in 2020 (MPIC, 2021). Malaysia is the world's second largest producer of oil palm, where the average yield of oil palm was 15.47 metric tons per hectare (Hirschmann, 2022). Oil palm originated from West Africa and introduced to be planted in Malaysia by the government in large scale in 1960. The purpose of introduce the oil palm in Malaysia is to eradicate poverty and raise the standard of living among the rural population (MPOC, 2021). Palm oil is a multipurpose and useful plant where it can be used to make cosmetics products, food products, pharmaceuticals product, agriculture products and can be used as a renewable energy. Oil palm characteristic is woody and can be categorized as largely herbaceous monocotyledon (Britannica, 2021). Oil palm can live more than 150 years and the production of high yield can continue from 20 to 30 years after planting. Oil palm is monoecious plant, has an adventitious root system, feather palm with its stem topped by 35 to 60 pinnate fronds borne on a columnar stem and its height can reach about 30 – 40 meters (Jalani et al., 2003). Oil palms produce two to three fonds per month and both inflorescences (male and female) are borne on the same palm. Genetic and environmental factors play a vital role for the duration of each floral cycle.

Fertilizer is one of the important sources that needs by crops where it can help to improve growth of the crops and enhance the soil fertility in crops area. Fertilizer is essential because it provides balanced mineral supply that required on development of crops. Fertilizer content supporting element and complementary substance that required in development of crops. Fertilizers are created or supplies to the crop in a readily available form and can help to increase the food production to feed the human (Jaswal et al., 2021). Sufficient amount of fertilizer is needed to cover deficiency of mineral in the soil and optimum utilization of fertilizer in soil can be symbolized by good appearance of crops (Noor et al., 2022). Good fertilizer management leads to great yield production and optimum growth performance of crops. Others than good fertilizer management, plants also required suitable soil condition to fulfil their optimum performance in term of yield and growth (Chowdhury et al., 2008). To achieve the best performance of crops, study on soil characteristics of plant growth also important to develop good management practices to produce higher yield with better quality (Oshiro et al., 2016).

There is various method to apply fertilizer in crops and it depend on the species of the crop. Farmers can use fertilizer in granule or liquid form to nutrify the crops. There are two main categories for fertilizer, that is organic and inorganic fertilizer where both are widely used in agriculture sector. Organic fertilizer can be produced from agriculture waste like animals' dung, coffee waste, fish waste, and any parts of plants and animal. Currently, Malaysia has many agricultures activity that will provide the waste from the activity. Every year, due to the rapid development of agriculture sectors in Malaysia, the waste will continuously increase from time to time. Malaysia produces at least 168 million tonnes of biomass, including timber and oil palm waste, rice husks, coconut trunk fibres, municipal waste, and sugarcane waste annually (Siddiqui & Naidui, 2019). Our country is one of the largest producers of Palm Oil Fuel Ash (POFA) in the world where we produce one thousand tons of POFA annually from palm oil mills operation (Tambichik et al., 2018). These POFA will be dumped into ponds as agriculture waste and not fully utilised even it gave benefits back in agriculture sectors (Awal & Shehu, 2013). Agriculture waste from rice plantation also showed that approximately around 110 million tons of rice husk and 16-22 million tons of rice husk ash are generated worldwide (Shafigh et al., 2014). There is abundant agriculture waste that produce prior to agriculture activity; therefore, innovation and research is needed to treat this waste so that it can fully utilized in agriculture sector (Tziolas et al., 2019).

Application and utilization of organic fertilizer can help to improve land quality in sustainable manner, increase agricultural production for quality and quantity of yield and can help to reduce environmental pollution by recycle the waste as a new source. Organic fertilizer can give a lot of benefits in agriculture. Continuous use of organic fertilizer in the long term can help to increase land productivity and prevent land degradation. Application of organic fertilizer can help to improves soil fertility, soil biological activity, soil physio-chemical properties and can help to reduce phytotoxicity issue related to acidic soil (Kashem & Singh, 2001). Previous research suggested that application of organic fertilizer gives promising physical characteristics to crops and

provide a lot of potassium that can be utilized by crops (Lim & Matu, 2015). Consistent application of organic fertilizer able to increase crop production and soil fertility and produces comparable production with inorganic fertilizer and showed no significant difference in soil chemical properties (Muda et al., 2021). Application of organic fertilizer gave greats benefit to oil palm seedling for their growth and development. Utilization of foliar organic fertilizer and compost to oil palm seedling can help to increase the girth of the oil palm stem, increase the chlorophyll content in leaves, and increase the total N uptake of oil palm leaves (Hastuti, 2021). Implementation of bio-organic fertilizer with the combination of inorganic fertilizer also can help to increase plant height, increase yield production especially fresh fruit bunches, and help to increase bunches number of oil palm tree (Ashari et al., 2017). The purpose of this research is to see the potential of different organic fertilizer as a replacement of inorganic fertilizer that can be applied for oil palm seedling and to see whether organic fertilizer can help to improve the growth and development of oil palm seedling. Even application of organic fertilizer gives a promising advantage in agriculture sector, the utilization of organic fertilizer is still low among farmers. Farmers prefer to using chemical fertilizer for their crop production even the price of inorganic fertilizer is keep increasing. Application of inorganic fertilizer in long term can damage the fertility of the soil itself and overuse of this fertilizer can cause pollution to environment (Ichwana et al., 2020). Lack of organic fertilizer on the market cause farmers more intend to use inorganic chemical for their crops.

MATERIALS AND METHODS

Study site

Field experiment was conducted at 100 acres share farm (3°44'59.3"N, 102°33'40.5"E) of Universiti Teknologi Mara Kampus Jengka, Pahang (Fig. 1) for five months from January to May 2021. The weather at study location was classified as tropical. The average temperature at research location is ranges in between 28 °C-38 °C.

Seed material and cultivation selection

Tenera oil palm seedling from FGV Tekam nursery was used for this research. The size of polybag that been used is 50 x 38 cm and soil was filled up compatly inside the polybag until the soil content reach up to more than ¾ of the polybag height. 100% of mineral soil without any mixture was used as a growing medium for the seedling.

Fig. 1. Oil palm seedling at 100 acres share farm UiTM Jengka, Pahang

Experimental design

Three months seedling of Tenera variety were used for this experiment. There were four different treatments including control are presented in Table 1. Fertilizer was applied according to the treatments after one month. The polybags are arranged in Randomized Complete Block Design (RCBD) with five replicates for each

treatment. Plants were watered twice a day (two litres per day) using drip irrigation system. The drip irrigation system was calibrated three times without a sample to equalize the water discharge from each emitter. Weeding was done around and inside polybag manually to avoid the weeds from interfere with nutrients, lights and avoid it to become a host for pest and diseases. Pest and disease control also were done manually using pesticide like rat bait – EBOR 401 (Sime Darby Plantation Agri-Bio Sdn Bhd, Malaysia), insecticide (HALEX Cypermethrin 5.5 Malaysia and VITA Dimethoate 38 Malaysia), and fungicide (BAYER Antracol 70 WP and IMAS-Thiram 80).

Table 1. Treatment of different types of fertilizer

Treatments	Different types of fertilizer
T0	0 gram of fertilizer (Control)
T1	10 gram of goat manure
T2	10 gram of fish waste
T3	10 gram of coffee waste

Data collections

Data on morphological growth and physiology which included seedling height (cm), number of fronds, size of the girth (cm), length of fronds (cm), growth rate (%), chlorophyll content, soil pH, and relative water content (%) were recorded. For every parameter data was collected once for two weeks and the average was calculated.

Seedling height

The height of the seedling was measured from initial of the experiment. The height of the seedling was measured from ground up to the top shoot every two weeks. The unit of the measurement was used as centimetres (cm) and the seedling height was measured using measuring tape from the ground level to the end of the shoots of oil palm seedling. Data were taken from five different shoots of different polybags and made the average. The average height was taken every two weeks until the final experiment. The height of the seedling was taken to see the growth performance of each seedling by the application of different types of organic fertilizer.

Numbers and length of fronds

Only number of new fronds were counted and recorded until the end of the experiment. Numbers of fronds were counted every two weeks until the end experiment. Length of fronds also was measured using measuring tape for every two weeks. The unit of the measurement was in centimetres (cm).

Size of the girth

Size of the seedling girth also was measured using measuring tape for every two weeks. The unit of the measurement was in centimetres (cm).

Growth rate

The relative growth rate (RGR) of oil palm seedling was calculated by subtracting the second measurement of plant height from the first measurement of plant height and dividing the value by the number of days between the two measures and expressed in percentage (Alam et al., 2022). RGR was calculated using this formula: RGR = [(In H2 – In H1)/(T2-T1)] x 100

Chlorophyll content in leaves

The SPAD-502 chlorophyll meter was used to measure the leaf chlorophyll content. The measurement was taken on the leaf of seedling and five measurements were taken per leaf in each polybag. The reading was measured from 10 a.m. to 12 p.m. to avoid moisture on leaves (Che Lah et al., 2011).

Soil pH

The pH of the soil was measured using a portable Spectrum® USA IQ 150 pH meter (Che Lah et al., 2011). The pH was calibrated with appropriate buffer solution before using each time.

Relative water content

A fresh and healthy leaf was collected from each polybag. After taking the fresh weight (FW), the samples were placed in container containing distilled water and keep for 24 hours to obtain full turgidity. After 24 hours, the samples were removed from water and turgid weight (TW) was recorded. Then, the sample was kept in oven at 60 °C overnight then weight for dry weight (DW). The relative water content (RWC) was calculated using the following formula: RWC (%) = [(FW-DW)/(TW-DW)] x 100.

Statistical analysis

Data were analysed by one-way ANOVA using Minitab version 17.1 software. The differences at $P<0.05$ were considered significant.

RESULTS AND DISCUSSION

Table 2. Effect of different types of organic fertilizer on oil palm seedlings

Treatments	Plant height (cm)	No. of fronds	Plant girth (cm)	Frond lengths (cm)	RGR (%)
T0 (control)	23.96^{a}	5.0^{c}	3.52^{b}	4.66^{b}	21.0^{a}
T1	24.24^{a}	6.4^{b}	4.82^{a}	6.88^{ab}	36.0^{a}
T2	25.88^{a}	6.6^{b}	4.68^{a}	8.16^{ab}	31.0^{a}
T3	25.22^{a}	8.0^{a}	5.34^{a}	8.58^{a}	61.0^{a}

Note: means values with the same letter had no significant difference at $p \leq 0.05$; T0 (0 gram of fertilizer, control), T1 (10 gram of goat waste), T2 (10 gram of fish waste), T3 (10 gram of coffee waste); RGR – Relative Growth Control

Plant height (cm)

Plant height was found to show not significantly difference ($p \leq 0.05$) over control treatment after application of different organic fertilizer (Table 2). The highest plant height (25.88 cm) was measured under T2, which was statistically similar with T3 (25.22 cm), followed by T1 (24.24 cm) and the lowest was found under the control treatment T0 (23.96 cm). From the results it was observed that 8.01% increase of plant height under T2; 5.25% increase under T3 and 1.16% increase under T1 over the control treatment T0, respectively (Table 2). Oil palm seedling need a high rate of fertilizer in their first year for good performance of growth and development of the seedling (Sukmawan et al., 2015) and due to the characteristic of organic fertilizer that is slow release of organic content to soil compare from inorganic fertilizer (Hao et al., 2022), application of organic fertilizer did not affect the plant height of the seedling at the early stage of development. According to Hastuti (2021), application of liquid organic fertilizer and compost at the early stage of the oil palm seedling did not affect the plant height and accordance with the finding of this studies.

Numbers of fronds

For the numbers of fronds there were no significant variations among three treatments of organic fertilizer application (Table 2). The highest numbers of fronds (8.0) were produced by those plants grown under T3 and followed by T2(6.6) and T1 (6.4) and significantly ($p \leq 0.05$) the lowest numbers of branches (5.0) were counted in the plants grown under control treatment T0, respectively (Table 2, Fig. 1). From the findings it was clearly observed that highest proportion of organic fertilizer help to induce the oil palm seedlings to grow more fronds over the control treatment. Application of organic fertilizer help to improve during the vegetative stage of any crops like number of fronds, number of leaves, number of tiller and others vegetative parts. Previous study by Abu Bakar et al. (2015) showed that application of organic fertilizer helps to increase maximum number of tiller production where the number of tillers is important in yield production.

Size of Girth

Based on the results of the study presented in Table 2, organic fertilizer application exhibited a significantly difference on oil palm seedlings over control treatment. Significantly the highest size of oil palm seedlings girth (5.34 cm) was measured under treatment T3. T1 and T2 was recoded 4.82 cm and 4.68 cm respectively and have a significantly difference with the control treatment (3.52 cm). This finding is accordance with Hastuti (2021), that state the usage of organic fertilizer indirectly can increase the girth of seedlings since it has a nutrient that can help for early-stage development for oil palm.

Frond length

Oil palm seedling frond length was significantly affected by the application of organic fertilizer. Seedling that was treated with coffee waste (T3) was measured at 8.38 cm and have more than 80% frond length than control treatment. T2 and T1 was observed and recorded 75.1% and 47.6% respectively over the control treatment. Its show that the organic fertilizer basically can increasing the seedlings frond length over 14 weeks of plant development. Samsuri et al. (2016) described that organic fertilizer can increase the frond length and have no significant difference from the seedlings that treated inorganic fertilizer. It shows that although the seedling treated with organic fertilizer, it still can have a same result with inorganic fertilizer.

Growth rate (%)

From the experiment conducted, no significant differences are recorded among the treatment on oil palm seedlings. Since the growth rate percentage was measured by using the changes of oil palm seedlings plant height that collected for every two weeks, it's did not show significantly difference result since it correlated with the plant height. The highest growth rate was counted under T3 (61.0%) and followed by T1 (36.0%), T2 (31.0%) and the lowest recorded on T0 (21.0%). The use of organic fertilizer basically can boost the plant growth rate although the seedlings do not show any significant differences since the plant still is still in development process. Similar findings have been described by Alam et al. (2022), that state the usage of organic fertilizer can enhance the plant height and can increase the growth rate indirectly. The positive correlation was shown for plant height and growth rate of plants.

Chlorophyll content in leaves

Chlorophyll content in oil palm seedling leaves were measured to see whether different organic fertilizer influence its. Treatment 0 for oil palm seedling significantly decreased chlorophyll content in oil palm leaves compared to that of leaves grown with application of organic fertilizer (Fig. 2). In addition, application of organic fertilizer on oil palm seedling help to increase the chlorophyll content. This result was consistent with previous result where application of organic fertilization can significantly increase the chlorophyll content in plant compared to control and at the same time, chlorophyll content between organic fertilizer treatment showed no significance different among them (Shenglan Ye et al., 2020). Organic fertilizer significantly increases the

physiology of plant likes chlorophyll content and net photosynthetic rate (Wang, 2010; Liu et al., 2008) and can accelerated the synthesis and accumulation of photosynthesis products (Wang, et al., 2012).

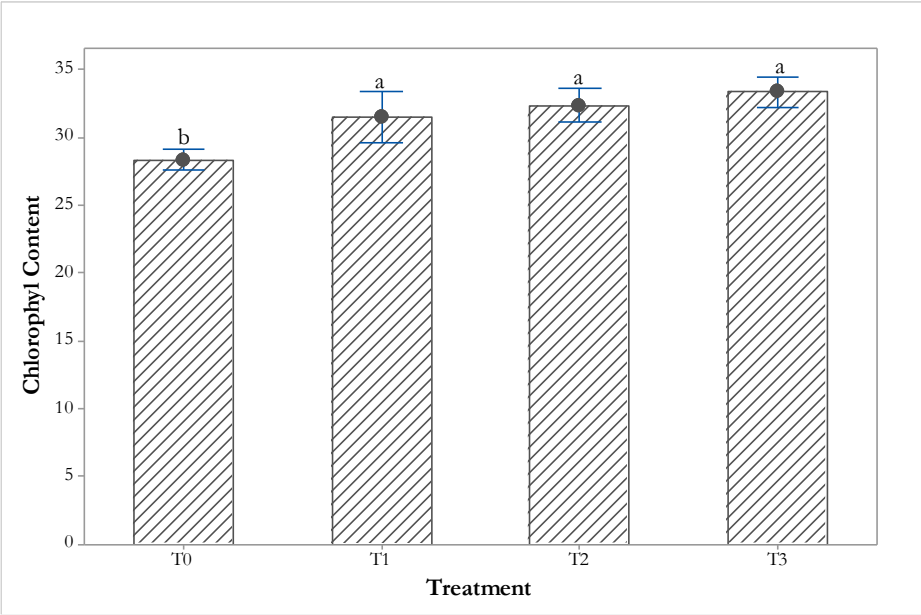

Fig. 2. Chlorophyll contents in leaves of oil palm seedling on different types of organic fertilizer.

Relative water content (RWC) in leaves

Data of RWC (Fig. 3) showed that T0 were not significantly different with T2 but showed significant different with other treatments. Even T2 is not significant with control, the percentage of RWC showed higher compare from the control. Consistent with previous study, application of organic fertilizer showed a significant different of RWC in leaves where continuous application of organic fertilizer can help to increase RWC in leaves where it can supply the water needed by keep the moisture in soil (Shenglan Ye et al., 2020), but soil condition did not affect RWC under similar moisture condition (Che Lah et al., 2011).

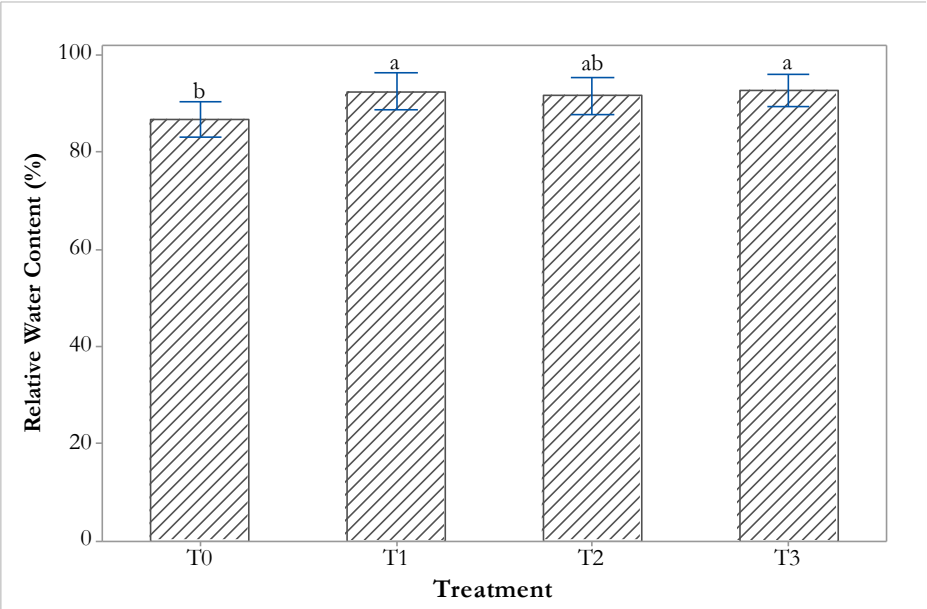

Fig. 3. Relative water content in leaves of oil palm seedling on different types of organic fertilizer.

Soil pH

Soil healthy and nutrients conditions can be indicating through soil pH where most of the agronomic crops growing well at pH 5.5 – 7.0. Fig. 4 shows that the soil pH of different application of organic fertilizer shows no significant different with control but only T3 is significant different with the control. Based on the previous study, amendment of organic fertilizer can increase the soil pH (Han et al., 2016) and can help to repair the physical and chemical properties of soil. Several studies shows that application of inorganic fertilizer like urea or NPK treatment cause a drop of soil pH to more acidic condition due to the H^+ was release back to soil after crops taken the nitrogen (Han et al., 2016; Ge et al., 2018). Meanwhile, amendment of organic fertilizer to acid soil can help to reduce or eliminates aluminium or manganese toxicity and can help to increases soil pH by 0.5 – 1.0 pH units in acidic soil and help to increase CEC of the soil (Che Lah et al., 2011). This result suggest that application of organic fertilizer gives a benefit to crops by help to improve soil chemical properties and sustain the crops yield.

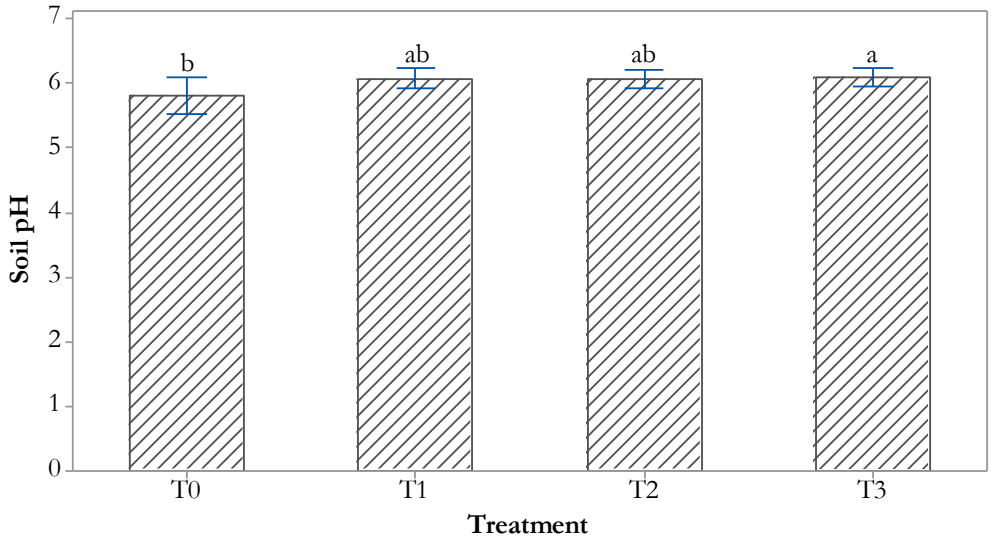

Fig. 4. Soil pH of oil palm seedling on different types of organic fertilizer

CONCLUSION

According to the overall results, it is concluded that oil palm seedlings can rely on organic manure as an alternative to mineral fertilization during their growth performance stage since it can increase the seedling development. So, from the overall findings, T3 was the best treatment for the growth development of oil palm seedlings. T3 was recommended and might be used as most available and economic substitute than animal waste (goat and fish) without affecting nutritional quality as well as reducing environmental pollution. On top of that it's also can lead to improved soil fertility and environmental sustainability indirectly.

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