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Growth Performance of Oil Palm Seedlings as Influenced by Fern Bio-Compost

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Dicranopteris linearis is a fern species commonly found in oil palm plantations throughout Malaysia. It easily spread with a wide covering root resulting in plant competition for nutrient, space, light and water. Generally, this species is managed through the application of herbicide that leads to environmental damage. Thus, composting of these ferns will act as a good source of organic fertiliser and growth bio-stimulant. This study aims to quantify the nutrient content of *D. linearis* bio-compost and to determine the most effective ratio of *D. linearis* bio-compost for optimal growth of oil palm seedlings. A Completely Randomised Design was adopted with four replications and six treatments where T0 (control), T1, T2, T3, T4, and T5 received 80 g, 160 g, 240 g, 320 g, and 400 g of fern bio-compost, respectively. The parameters observed were plant height, number of leaves, leaf width, root length, dry and fresh weight. Treatment T5 recorded the highest growth performance in all parameters measured. However, there were no significant differences among the treatments except for fresh weight at P value of 0.01. Conclusively, fern bio-compost has potential to be used as a planting media for the oil palm seedling, thus minimising the application of herbicides.

Keywords: bio-compost; fern; oil palm; seedling

I. INTRODUCTION

Malaysia continued as the leading competitor in oils and fats export market as it provides more than 30% of the world's oils and fats requirement (MPOB, 2016). Due to the high demand on vegetables oil, the plantation of oil palm has been expanded (Samedani *et al.*, 2013). Unfortunately, during the immature and mature stages, the oil palm plantation in Malaysia commonly faces the weeds problem (Kuntom *et al.*, 2007). The availability of weed in the plantation area may affect crop production resulting in yield reduction as the weeds compete for nutrient, moisture, light, soil water, space and carbon dioxide which are important for healthy growth (Dilipkumar, 2017).

Among the types of weeds that are commonly found in the oil palm plantation are ferns, broadleaves, grasses and sedges weeds (Umi Kalsom, 2010). The long economic life of oil palm causes adversity to assess the effect of weeds on oil palm but prolonged it can result in yield losses due to the lower growth rate of plants (Kuan *et al.*, 1990).

Dicranopteris linearis or locally known as Resam or tropical bracken is a common fern weed found in oil palm plantations in Malaysia (Kuntom *et al.*, 2007). Ferns are generally classified as seedless vascular plants that vary from seed plants as they reproduce via spores and most found in Malaysia rainforest. *D. linearis* forms a tangled thicket which is extremely difficult to cut through and smothers the soil completely and hardly anything can grow through it. However, it protects the soil from erosion and its roots do not

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penetrate deeply (Umi Kalsom, 2010).

In Malaysia, herbicides are widely used to control weeds amongst the plantation crops. It is considered as the rapid and the cost-effective ways in managing and controlling weeds spread in oil palm plantations (Dilipkumar *et al.*, 2017). Based on the FAOSTAT (2018) data, Malaysia has used about 39,407 and 49,199 tons of active pesticide ingredients in 2006 and 2014, respectively, and the highest herbicides used are about 83% in 2014. This phenomenon indicates that most of the farmers in Malaysia continuously rely on herbicides without concern of its implication on human and environmental health. Since the use of paraquat has caused poisoning to the workers (Shariff & Ab Rahman, 2008), the Malaysian government has developed many programs in order to increase public awareness on the extensive use of herbicide.

The prohibition of herbicides Class 1 such as paraquat is recommended. The chemicals should be reduced and replaced with other chemicals such as glufosinate-ammonium and glyphosate which are safer to human and environment. Pampulha and Oliveira (2006) noted that the use of paraquat in the field have possible residual impact on soil and lead to contact of microbes to herbicides. Therefore, the addition of the organic waste to the soil to enhance the microbial communities is significant as it contains accessible nutrients such as N, P, K, Ca, and micronutrients such as B, Zn and Mn (Aita *et al.*, 2007). The decomposition of plant matter resulting from weeding activities is called bio-compost. This bio-compost provides the main component of organic farming that supplies nutrients to the plants.

The bio-composting process usually begins by shredding the plant matter and adding enough water to maintain the moisture content. The mixture is turned on a regular basis to enhance aeration and left undisturbed for several months until it is turned into an amorphous dark brown to dark colloidal humus (Gandahi & Hanafi, 2014). Zheljazkov (2006) stated that the soil properties could be improved when different amount of compost is added to the agricultural soil. A study conducted by Nikpey and Nikpey (2016) on the characteristics of compost found that organic material leads to the enhancement of soil physical, chemical and biological properties.

The agricultural waste such as palm oil mill effluent (POME) produced by the palm oil mill residual has turned into a source of biofertiliser through technology innovation and research investigations. The raw or partially treated POME has high content of degradable organic matter due to the unrecovered oil presents in the effluent (Ahmad *et al.*, 2003). Thus, it is useful to apply compost from agricultural residual to the soil and acts as substitute for chemical fertiliser to promote the plant growth. Instead of POME, the use of weeds as compost to promote plant growth has been well documented. Jumadi *et al.* (2014) in their study on the effects of the Azolla (a small floating water fern) compost on the growth of upland water spinach in Indonesia showed that Azolla compost can be used as an alternative for urea fertiliser and reduce the production of N2O.

Considering the availability of *D. linearis* in most of the oil palm plantations in Malaysia, a study was conducted with the aim to determine the growth performance of the oil palm seedling towards different treatment of compost derived from *D. linearis* and to quantify the nutrient content of *D. linearis* compost. There is a lack of information on the nutrient property of this fern weed. The information gathered from this study could be used to determine the most effective ratio of fern bio-compost for the growth of oil palm seedlings in addition to reduce the weed problems in the oil palm plantation area.

II. MATERIALS AND METHOD

The field experiment was conducted from July to October 2014 at the greenhouse of Universiti Teknologi MARA, Cawangan Pahang, Malaysia.

A. Planting Material

Two weeks old of germinated oil palm seedlings were taken from Tun Razak Agricultural Research Centre, Pahang, Malaysia. The germinated oil palm seedlings were planted in polypropylene polybags with size 15 cm × 23 cm filled with 1.2 kg of soil mixture consisted of top soil, fern bio-compost and sand. Meanwhile, POME in liquid form was collected from Felda Jengka 8 Palm Oil Mill, Pahang, Malaysia.

B. Preparation of D. linearis Compost

D. linearis was collected in June 2014, from an oil palm plantation at Tun Razak Agricultural Research Centre (PPPTR) Jengka, Pahang, Malaysia. The fern samples were sent to the laboratory at Tun Razak Agricultural Research Centre, Felda Sungai Tekam, Jerantut, Pahang, Malaysia to carry out the nutrient analysis. The composting process started by shredding the fern into smaller pieces to increase its surface area and to facilitate the composting process. Then, the ferns were heaped in several layers to make a compost pile. The compost pile generated heat through the action of thermophilic microorganisms. The composting process continued for one week.

After one week, POME was added and mixed to the compost pile at the ratio 1:3 (1 kg of compost material mixed with 3 kg of POME). The moisture of the compost pile was maintained to support the composting process. The turning process of the compost pile was done regularly to allow the mix of air, moisture and heat to continue the decomposition process. The compost material was left in-situ for eight weeks to reach maturity phased. The composting process was finished after the pile has cooled off and its volume decreased to about one-third of its original volume. The final compost was dark in colour, crumbly and has an earthy smell.

C. Treatments

The experiment was arranged using Completely Randomised Design (CRD) with four replications and six treatments resulted with 24 numbers of experimental units. The treatments imposed six levels of the fern bio-composts as shown in Table 1.

Table 1. The treatments of *D. linearis* compost

Treatment	Top soil (g)	Sand (g)	Compost (g)	Ratio
T0 (control)	400	400	0	1:1:0
T1	400	400	80	1:1:0.2
T2	400	400	160	1:1:0.4
T3	400	400	240	1:1:0.6
T4	400	400	320	1:1:0.8
T5	400	400	400	1:1:1

Each experimental unit was arranged at the planting distance of 30 cm × 30 cm × 30 cm using the triangular system.

D. Statistical Analysis

The growth parameters of oil palm seedlings were taken at a weekly interval for 10 weeks. Data analyses were carried out through analysis of variance (ANOVA) using MINITAB software. Tukey Simultaneous Test at $P<0.05$ was used for mean comparison. Bar charts were developed to show the effects of different rates of fern bio-compost on the growth performance of oil palm seedlings.

III. RESULTS AND DISCUSSION

A. Nutrient Analysis of D. linearis

Table 2 shows the nutrient analysis of nitrogen (N), phosphorus (P) and potassium (K) contents in *D. linearis*. The chemical composition of the *D. linearis* showed that it was low in P and K, but rich in N which could be utilised by crops. Gandahi & Hanafi (2016) stated that N is important for the growth and the reproduction of more organisms in the composting process and therefore carbon (C) could be oxidised. The materials which seemed to be green and wet have higher N content.

Table 2. The nutrient analysis of *D. linearis*

Major elements	% of dry matter
Total – N	2.62%
P	0.15%
K	1.11%

B. Growth Performance of Oil Palm Seedling Parameters

Data were collected continuously on a weekly basis based on the observation and the measurement of variables of the oil palm seedlings growth in response to six different rates of treatment. Table 3 shows the summary of the F ratio and the P value of the parameters measured which included plant height, number of leaves, leaf width, root length, fresh weight and dry weight. It clearly shows that there were no significant difference at 95% confident level among the treatments except for the fresh weight of *D. linearis* bio-compost with P value of 0.01.

Tukey Simultaneous Test in Table 4 shows that there were no significant effects of *D. linearis* bio-compost on the means of roots length and dry weight except for the mean of fresh weight of oil palm seedlings at $P\leq0.05$. The means of root length and dry weight being not significantly different among the treatments could be explained by the coarse texture and the low concentration of P of this compost, all of which would retard the decomposition process. Duong (2013) reported that although the availability of P in their compost was moderate to high, P was immobilised in the compost and was not being transferred into the underlying soil.

Meanwhile, the mean fresh weight of the oil palm seedling showed a significant difference at 95% confident level, among the bio-compost treatments with P value of 0.01. Though treatment T0 (control) showed significant different to other treatments, T4 (320 g compost) and T5 (400 g compost) resulted in significantly higher in fresh weight than T0, T1, T2 and T3.

However, T4 and T5 were not significantly different from each other. The higher fresh weight in T1, T2, T3, T4 and T5 as compared to T0 (control) was due to the addition of fern bio-compost in the treatments. This can be explained by the ability of plant to absorb and retain water with the presence of compost in the soil. Vengadaramana and Jashothan (2012) reported that the addition of organic fertilisers increased the water holding capacity but vary with soil texture. The retained water used by the plants increased the water use efficiency, thus boosting the plant growth.

Table 3. Analysis of variance (ANOVA) for parameters collected on the growth of the oil palm seedling, F-values with degree of freedom and probabilities (P) for each parameter analysed with significant difference (P≤0.05) highlighted in bold

Parameters	F	P
Plant height	0.32	0.90
Number of leaves	0.06	0.99
Leaves width	1.22	0.31
Root length	0.83	0.55
Fresh weight	4.29	**0.01**
Dry weight	1.74	0.18

Table 4. Tukey Simultaneous Test of growth parameter

Parameters	Treatments					
	T0	T1	T2	T3	T4	T5
Plant height	9.33a	10.82a	11.58a	12.12a	12.98a	13.35a
Number of leaves	2.18a	2.30a	2.33a	2.35a	2.40a	2.50a
Leaves width	2.18a	2.30a	2.33a	2.35a	2.40a	2.50a
Root length	31.25a	33.17a	33.88a	35.27a	35.55a	38.73a
Fresh weight	**8.44b**	**11.98ab**	**12.85ab**	**15.33ab**	**16.87a**	**17.19a**
Dry weight	2.78a	3.33a	3.75a	3.78a	3.80a	4.25a

[a,b] Tukey grouping shows different letters indicates the mean elements of treatments are significance at 5% significant level

C. Effect of D. linearis Bio-compost to the Plant Height

The result of the effects of fern bio-compost on the plant height are shown on Figure 1. It was observed that the lowest growth of oil palm seedlings was at T0 (control) which was not treated with *D. linearis* bio-compost meanwhile T5 (400 g of bio-compost) showed the best effect for the height of oil palm seedlings. Hassan et al. (2012) reported that the higher rate of bio-compost applied to a plant will increase the plant's height and growth development. However, all treatments were not significantly affecting the mean height of oil palm seedlings as shown in Table 4.

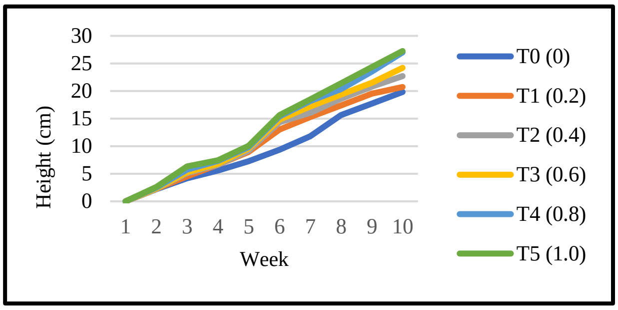

Figure 1. Mean of plant height on 10th week

D. Effect of D. linearis Bio-compost to the Number of Leaves

Figure 2 illustrates the effects of *D. linearis* bio-compost on the number of leaves of the oil palm seedlings. The number of leaves increased simultaneously over time. The results indicated that from 8th to 9th weeks after the application of fern bio-compost, T0, T1, T2, T3, and T4 showed similar number of leaves except for T5. It was observed that T5 containing 400 g of fern bio-compost recorded the highest mean of leaves after planting. The increase in the mean of leaves number might be attributed to the addition of POME in the compost as POME is considered to have a nontoxic nature and fertilising properties.

POME is therefore can be used as a fertiliser as it comprises of significant amounts of N, P, K, Mg and Ca that are essential components for plant growth (Muhrizal *et al.,* 2006). Muhrizal *et al.* (2006) also stated that POME has higher content of Aluminium (Al) compared to chicken manure and composted sawdust. Although T5 resulted in the highest number of leaves among the treatments, it was not significantly different with other treatments (Table 4).

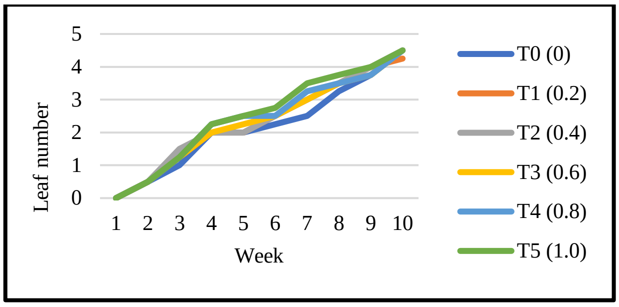

Figure 2. Mean of leaf number on 10th week

E. Effect of D. linearis bio-compost to the Leaf Width

The development of the leaf width for the oil palm seedling is shown in Figure 3. Although there were no significant effects of *D. linearis* bio-compost on the T0, T1, T2, T3, T4 and T5, the seedling treated with 400 g of fern bio-compost (T5) recorded the highest number of leaf width. In contrast, the plots treated with no fern bio-compost showed the lowest number of leaf width. As reported by Oliveira *et al.* (2002), the utilisation of bio-compost can improve the content of organic carbon in the soil. Higher concentration of soil organic carbon in turn will foster the plant growth.

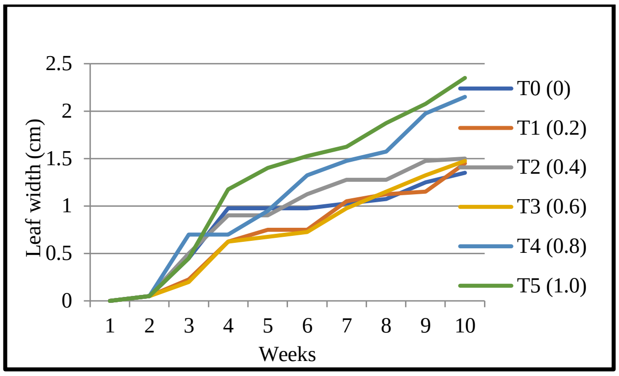

Figure 3. Mean of leaf width on 10th week

IV. CONCLUSION

The results of the study revealed that *D. linearis* composting combined with POME improved the performance of oil palm seedlings. The application of compost from agricultural residual is useful and as options against mineral fertilisers for enhancing crop productivity and the development of long-term soil fertility and quality. Bio-composting is therefore regarded as an economical approach for the decomposition of organic wastes that yield into beneficial fertiliser.

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VI. REFERENCES

Ahmad, AL, Ismail, S & Bhatia, S 2003, 'Water recycling from palm oil mill effluent (POME) using mem-brane technology', *Desalination*, vol. 157, pp. 87–95.

Aita, C, Giacomini, SJ & Hubner, AP 2007, 'Nitrification of ammoniacal nitrogen from pig slurry in soil under no-tillage', *Pesquisa Agropecuaria Brasileira*, vol. 42, pp. 95–102.

Dilipkumar, M, Chuah, TS, Goh, SS & Sahid, I 2017, 'Weed management issues, challenges, and opportunities in Malaysia', *Crop Protection* (2017) https://doi.org/10.1016/j.cropro.2017.08.027.

Duong, TTT 2013, 'Compost effects on soil properties and plant growth', PhD thesis, University of Adelaide, Australia.

FAOSTAT, 2018, 'Pesticide use', viewed 1 January 2019,<http://www.fao.org/faostat/en/#data/RP/visualize.

Gandahi, AW & Hanafi, MH 2014, 'Bio-composting oil palm waste for improvement of soil fertility, In: Maheshwari D. (eds) composting for sustainable agriculture', *Sustainable Development and Biodiversity*, vol. 3, pp. 209–243.

Hassan, KMM, Sarkar, G, Alamgir, M, Bari, QH & Heidrich, G 2012, 'Study on the quality and stability of compost through a demo compost plant', *Waste Management*, vol. 32, pp. 2046–2055.

Jumadi, O, Hiola, ST, Hala, Y, Norton, J & Inubushi, K 2014, 'Influence of Azolla (*Azolla microphylla* Kaulf.) compost on biogenic gas production, inorganic nitrogen and growth of upland kangkong (*Ipomoea aquatica* Forsk.) in a silt loam soil', *Soil Science and Plant Nutrition*, vol. 60, no. 5, pp. 722–730.

Kuan, CY, Ann, LS, Ismail, AA, Leng, T, Fee, CG & Hashim, K 1990, 'Crop loss by weeds in Malaysia': *Proceeding of Third Tropical Weed Science Conference*, Hilton Hotel, 4–6 December 1990, Kuala Lumpur, pp. 1-21.

Kuntom, A, Tan, YA, Kamaruddin, N & Yeoh, CB 2007, '*Pesticides application in the oil palm planta-tion*', Oil Palm Bulletin, vol. 54, pp. 52–67, Malaysian Palm Oil Board, Malaysia.

Malaysian Palm Oil Council, 2016, Annual Report 2016, viewed 28 December 2018, <http://www.mpoc.org.my/upload/AR%202016%20without%20FS.pdf.

Muhrizal, S, Shamshuddin, J, Fauziah, I & Husni, MAH 2006, 'Changes in iron-poor acid sulfate soil upon submergence', *Geoderma*, vol. 131, pp. 110–122.

Nikpey, MA & Nikpey, M 2016, 'Evaluating the impact of compost and bio compost enriched with chemical fertiliser on soil biological properties', *Advances in Agricultural Science*, vol. 4, no. 1, pp. 1–7.

Oliveira, F, Mattiazzo, M, Marciano, C & Rosseto, R 2002, 'Effects of successive applications of sewage sludge on a Yellow Latosol cultivated with sugar cane: Carbon organic, electrical conductivity, pH and CTC', *Revista Brasileira de Ciência do Solo*, vol. 26, no. 2, pp. 505–519.

Pampulha, ME & Oliveira, A 2006, 'Impact of an herbicide combination of bromoxynil and prosulfu-ron on soil microorganisms', *Current Microbiology*, vol. 53, pp. 238–243.

Samedani, B, Juraimi, AS, Anwar, MP, Rafii MY, Sheikh Awadz, SH & Anuar, AR 2013, 'Competitive in-teraction of Axonopus compressus and Asystasia gangetica under contrasting sunlight intensity', *The Scientific World Journal* (2013), pp. 1–8, http://dx.doi.org/10.1155/2013/308646.

Shariff, FM & Ab Rahman, AK 2008, 'Chemical weed control in the oil palm sector with reference to smallholders and nursery operators', *Oil Palm Industry Economic Journal*, vol. 8, no. 2, pp. 28–38.

Umi Kalsom, Y 2010, *Ferns of Malaysia rainforest*, pp. 3-8, Universiti Putra Malaysia Press, Serdang, Selangor, Malaysia.

Vengadaramana, A & Jashothan, PTJ 2012, 'Effect of organic fertilisers on the water holding capacity of soil in different terrains of Jaffna peninsula in Sri Lanka', J*ournal of Natural Product and Plant Resources*, vol. 2, no. 4, pp. 500–503.

Zheljazkov, VD, Craker, LE & Xing, B 2006, 'Effects of Cd, Pb, and Cu on growth and essential oil con-tents in dill, peppermint, and basil', *Environmental and Experimental Botany*, vol. 58, no. 1, pp. 9–16.