The Growth of Oil Palm (*Elaeis guineensis* Jacq.) Seedlings at Various Media and Containers in Double Stage Nursery

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ABSTRACT---- ***The main issues arise in the present and in the future to develop oil palm plantations is the top soil removal. There are a few substances that can be used as an alternatives to be a growing media, such as compost, vermicompost, rice husk, and cow manure. maintenance activities in oil palm plantation produce wastes which are organic and inorganic waste. The organic and inorganic waste could become an alternative containers for growing media, replacing the small polybag and tray. The objectives of the research was found alternative growing media and containers that suitable for oil palm (Elaeis guineensis Jacq.) seedlings in double stage nursery (pre nursery and main nursery). The experiment was conducted at IPB Experimental Station, Cikabayan, Darmaga Bogor, from October 2013 to October 2014. The research was consist of two experimental. The first research held in pre nursery and then to continued on main nursery. The treatment in pre nursery was arranged in a factorial randomized complete design and consist of two factor with three replications. The first factor was the type of growing media consist of top soil, sub soil, vermicompost, rice husk, cow manure, and compost. The second factor was the type of containers consist of baby polybag, tray, bamboo strips, mineral glass and midrib. The treatment in main nursery was arranged in a factorial randomized block design. The treatment was growing media treatment consist of standar of growing media in nursery, top soil, sub soil, vermicompost, rice husk, cow manure, and compost. The results of first experiment in pre nursery showed that application of various growing media and containers significantly affected to morphological growth (plant height, leaf number, stem diameter) and physiological growth (chlorophyll content and stomata conductance). The interaction of these two factors significantly affect on plant height and number of leaves 1 month after planting (MAP), stem diameter 3 MAP, chlorophyll content and stomata conductance. Based on morphological growth, the best combination treatment was compost and bamboo strips however it is not significantly different with compost and minerall glass. The result of second experiment in main nursery showed that application of various growing media significantly affected to morphological growth (plant height, leaf number, stem diameter) and physiological growth (crown and root dry weight). Based on morfological treatment, the best treatment was compost however it is not significantly different with vermicompost treatment. Compost have a nutrient grade of N, P, K was 1.32%, 0.49%, 0.06%, while vermicompost have N 1.05%, P 0.58%, and K 0.03%. The growth media alternative for substitute top soil in oil palm seedlings that suggested was compost and vermicompost. Both of growing media have been showed best morphological and physiological growth and have high nutrient.***

Keywords--- growth media, morphological and physiological respon, NPK nutrient

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1. INTRODUCTION

The main issues arise in the present and in the future to develop oil palm plantations is the top soil removal. The utilization of top soil is based on the calculation of growing media needs. In the population of 136 oil palm/Ha, each seedling needs 0.001 m^3 top soil/polybag (the size of the small polybag after filled in with the growing media are 10 cm in length of diameter and 14 cm height) at the pre nursery stage. At this stage, the total top soil for the growing media obtained from the field equals to 214 m^3. This number equals to 1430 m^2 of field area or 0.143 Ha and 15 cm in depth of the topsoil. Whilst, at the main nursery stage, each seedling needs 0.016 m^3/polybag (the size of the large polybag after filled in with the growing media are 23 cm in length of diameter and 39 height). Then, the total of top soil media needed for the growing media are 2.400 m^3. This number is equal to 16.000 m^2 of field area or 1.6 Ha and 15 cm in depth of the top soil. Therefore, for two levels of the nursery stage, each oil palm plantation needs 2164 m^3 top soil from the field, which equals to 17430 m^2 or 1742 Ha.

There are a few substances that can be used as an alternatives to be a growing media, such as compost, vermicompost, rice husk, and cow manure. According to Irwan *et al*. (2005), vermicompost contains 0.5-2.0% N, 0.06-0.68% P_2O_5, and 0.10-0.68% K_2O. Nurbaity *et al*. (2011) mentioned that rice husk contains N, P, K with percentage 0.49, 0.07 dan 0.08 respectively in 7.4% water content. Rosmarkan and Yuwono (2002) showed that cow manure contains 0.45 % N, 0.09% P, and 0.36% K. According to Ariesandy (2014) leaves compost contains 0.50% N-total, 0.23% P, 0.13% K.

Besides that, maintenance activities in oil palm plantation produce wastes which are organic waste (frond waste which produced as by product of harvesting and pruning) and inorganic waste (e.g. plastic cup thrown away by resident and also the people in the field). Recently, small polybag or tray is used as containers for growing media at the pre nursery stage. Therefore, organic and inorganic waste mentioned above, could become an alternative containers for growing media, replacing the small polybag and tray.

For that reasons, the first experiment regarding to the oil palm growth seedlings at various organic growing media and several containers used in pre nursery stage were conducted, and continued in the second experiment to observe the oil palm growth in main nursery using various types of growing media.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted in IPB field experiment station at Cikabayan, Darmaga Bogor, from October 2013 until October 2014. Analysis of soil, fertilizer and plant tissue was performed at the Laboratory of Soil Fertility, Department of Soil Sciences and Land Resources IPB Bogor.

2.2 Experimental Design and treatment

The first experiment at the pre nursery stage were conducted for 3 months using Randomized Design Experiment with two factors and three replication. First factor were six types of growing media: top soil (control, M1), sub soil (M2), vermicompost (M3), rice husk (M4), cow manure (M5), and compost (M6). Second factor were five types of containers: baby polybag (size 15 cm x 20 cm, volume 0.001 m^3 (W3)), plastic cups (volume 0.0003 m^3 (W4)), oil palm frond waste (14 cm height and volume 0.001 m^3 (W5)). Each experiment consist of 3 germinated oil palm for one type of experiment. Therefore, 270 samples of germinated oil palm needed for this experiment.

The second experiment was at the main nursery stage using Randomized Block Design with one treatment and three replication. Treatments were seven types of growing media, which are standard media, top soil, sub soil, vermicompost, rice husk, cow manure, and compost. Standard media in this experiment was the growing media that is usually used in the plantation. The media consist of top soil and rock phosphate with the ratio 1 m^3 top soil : 50 kg Rock Phosphate. The volume of the media was 0.001 m^3. This experiment consist of 21 unit of experiment and each experiment consists of 4 oil palm seedling at age of 3 months. Then, all the seedlings used in this experiments are 84 samples.

2.3 Experimental Procedure

The six treatments of growth media in first experiment were given in beginning of research. After first experiment ended, the seedlings moved to second experiment and were given seven growth media. Fertilzer application was not given in this research.

2.4 Data collection

Morphological parameters observed every 1 months from November 2013 to January 2014 in first research, and from February 2014 to September 2014 in second research. Morphological parameters observed were plant height, number of leaf, trunk diameter and leaf area. Physiological parameters observed on October 2014. Physiological parameters observed were the density of stomata, leaf greenness, and nutrient tissues content). Leaf greenness was measured by SPAD-502.

2.5 Data analysis

The data was analyzed by analysis of variance. If the analysis variance test results was significant at 5%, then it continued to be analyzed by Duncan Multiple Range Test (DMRT).

3. RESULT AND DISSCUSSION

3.1 First Experiment : Oil palm (Elaeis guineensis Jacq.) seedling growth at various growing media and containers in pre nursery.

Morphological Response of the oil palm seedling

Application of various growing media highly significant affect plant height, stem diameter, and number of leaves at 1-3 months after planting (MAP). Various types of containers highly significant affect on plant height at 1-3 MAP, stem diameter at the age of 3 MAP and the number of leaves at 1 MAP. Compost, cow manure and vermicompost as growing media in this experiment produced significantly higher seeds, larger stem diameter and higher number of leaves compared to other seeds grown in others growing medium, but among to those three growing medium the growth of seedlings did not significantly different (Table 1).

Table 1. The influence of various growing medium and type of container to morphological growth of oil palm seedling at pre nursery stage.

Treatments	Months After Planting (MAP)		
	1	2	3
		---------- plant height (cm) ----------	
Top soil	-	10.4bc	14.7c
Sub soil	-	9.7c	14.3c
Vermicompost	-	11.8a	17.7a
Rice husk	-	10.1c	14.9bc
Cow manure	-	11.2a	16.1b
Composts	-	12.0a	18.4a
Small polybag	-	11.4ab	17.0a
Tray	-	9.7c	14.5b
Bamboo strips	-	11.2ab	16.7a
Mineral plastic cup	-	11.6a	16.7a
Modified frond		10.5bc	15.3b
		---------- stem diameter (mm) ----------	
Top soil	1.81b	3.86b	-
Sub soil	2.0b	3.9b	-
Vermicompost	2.4a	4.9a	-
Rice husk	1.9b	3.9b	-
Cow manure	2.4a	4.7a	-
Composts	2.4a	4.9a	-
Small polybag	2.1	4.3	-
Tray	2.0	4.1	-
Bamboo strips	2.1	4.5	-
Mineral plastic cup	2.2	4.2	-
Modified frond	2.2	4.2	-
		---------- number of leaves (strands) ----------	
Top soil	-	1.6cd	2.9c
Sub soil	-	1.6cd	2.6c
Vermicompost	-	2.0a	3.7a
Rice husk	-	1.4d	2.6c
Cow manure	-	1.6bc	3.3b
Composts	-	1.9ab	3.5a
Small polybag	-	1.7b	3.2a
Tray	-	1.6b	2.8c
Bamboo strips	-	1.9a	3.3a
Mineral plastic cup	-	1.7a	3.2ab
Modified frond	-	1.7b	3.0bc

Remarks: Value followed by the same letter in the same column not significantly different according to *Duncan Multiple Range Test at* 5%; MAP: Month After Planting.

Small polybag, piece of bamboo and used cups of mineral water as growing media container in this experiments produced significantly higher seeds, larger stem diameter and higher number of leaves compared to other seeds grown in others type of container, but among to those three types of container above showed the growth of seedlings were not significantly different (Table 1).

Interaction between types of media and types of container significantly affect plant height, number of leaves in 1 MAP and stem diameter at 3 MAP and leaf area at 3 MAP. The highest plant growth obtained by the seed grown in the compost using mineral glass container, but it was not significantly different from the other four types of containers with the same growth medium (Figure 1). Compost applied in the bamboo strips container produced the highest seed diameter (3 MAP) and the highest number of leaves (1 MAP), but not significantly different with seeds grown in the same medium using minerals plastic cup container and small polybag (Figures 2 and 3).

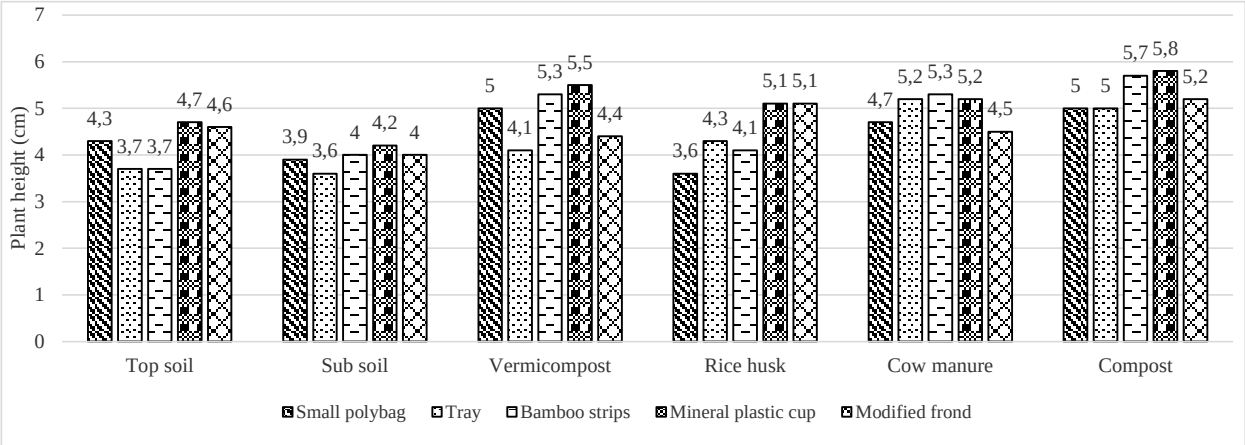

Figure 1. The influence of growing medium and type of container interaction to plant height at 1 MAP in pre nursery seedlings

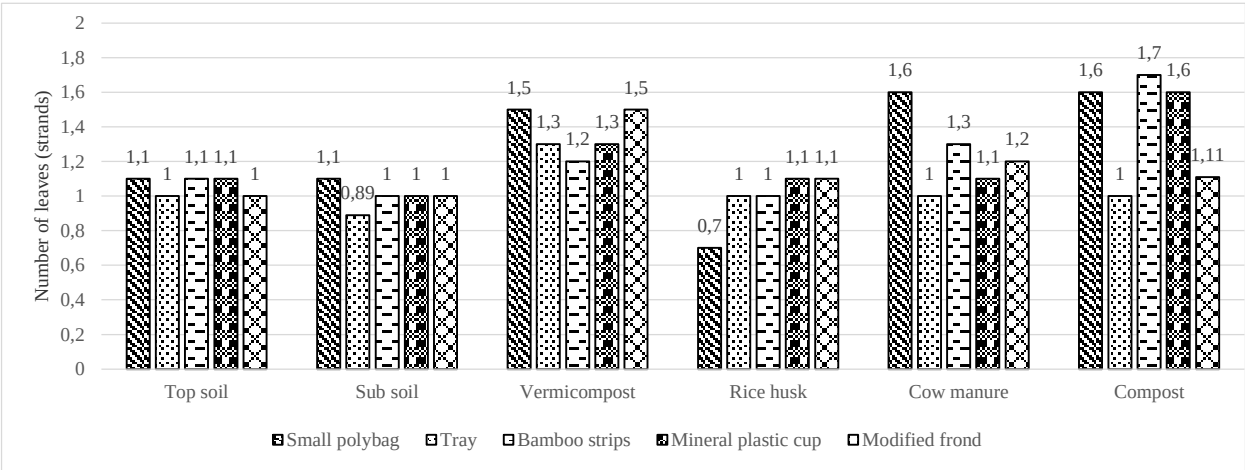

Figure 2. The influence of growing medium and type of container interaction to number of leaves at 1 MAP in pre nursery seedlings

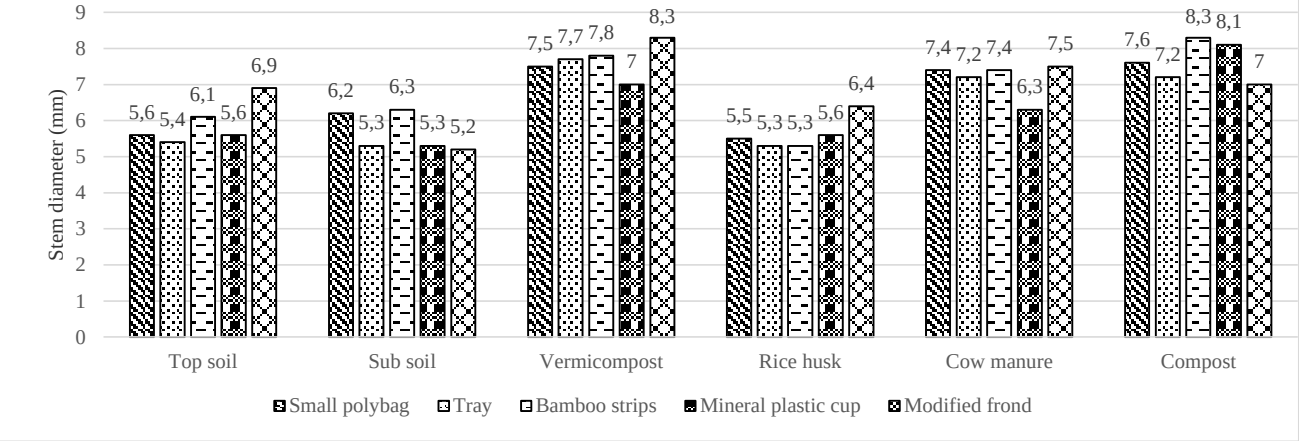

Figure 3. The influence of growing medium and type of container interaction to stem diameter at 3 MAP in pre nursery seedlings

Physiological Response of Oil Palm Seedlings

Application of various media and types of container significantly affected leaf area, leaf greenness and density of stomata. The largest leaves (56.7 cm^2) were obtained by the seedlings grown in vermicompost growing media using small polybag containers, but not significantly different with seedlings grown in the same growing medium in a piece of bamboo container and compost as growing media in small polybag containers (Figure 4).

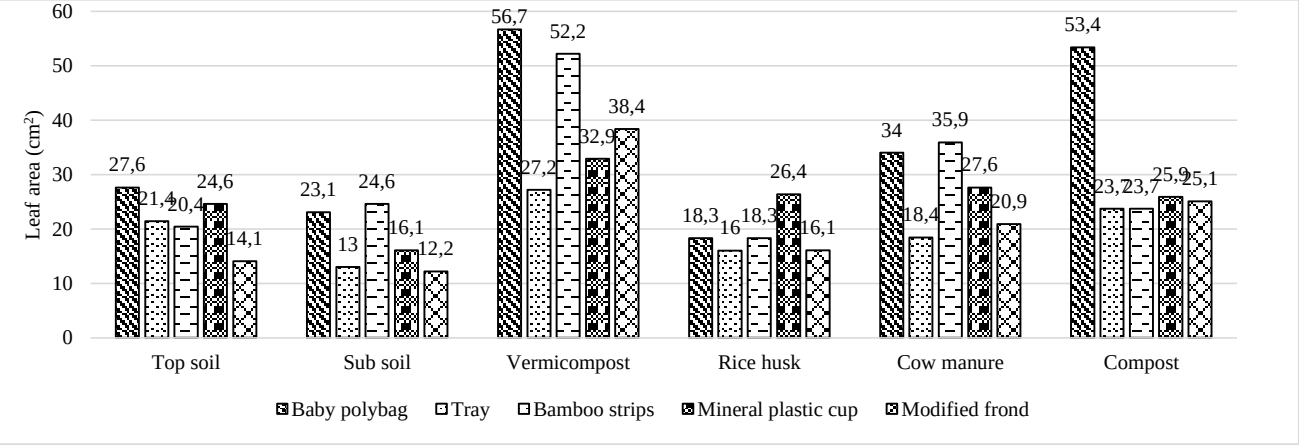

Figure 4. The influence of growing medium and type of container interaction to leaf area in pre nursery

The use of vermicompost media and bamboo strips container generates the highest leaf greenness 72.3, but not significantly different from the seeds grown in the compost growing media in small polybag container that has a value of 71.1 (Figure 5).

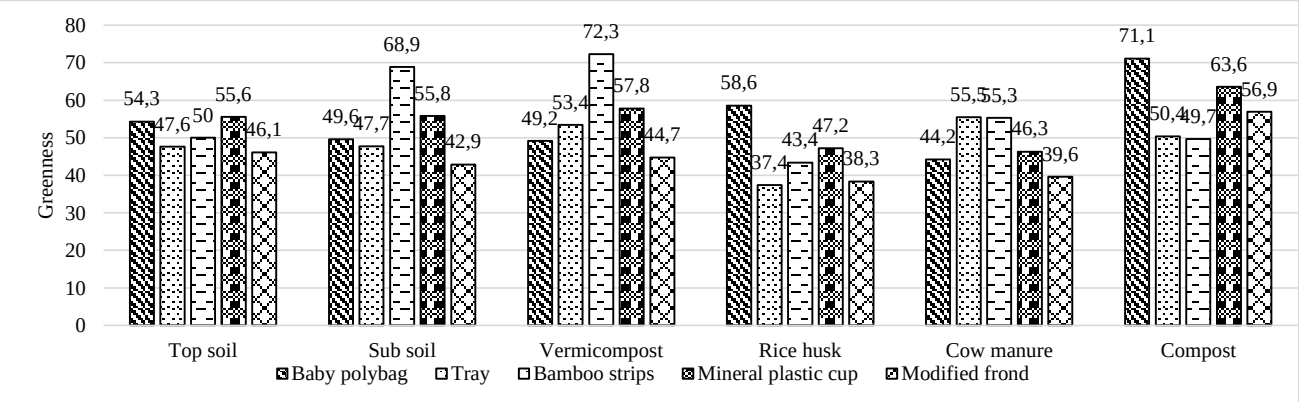

Figure 5. The influence of growing medium and type of container interaction to leaf greenness of oil palm pre nursery seedlings

Dark-green leaves are able to maintain the rate of photosynthesis during plant growth, thus assimilate (sugar) can be produced (Wahyuti *et al*. 2013). Seedling grown in tray with subsoil as a growing media produced plant with the highest density of stomata (5.4 stomata/mm^2), but this was not significantly different from the seed planted in the top soil in mineral plastic cup container, tray and small polybag, and also from the seed planted in vermicompost in tray and compost in small polybag (Figure 6.).

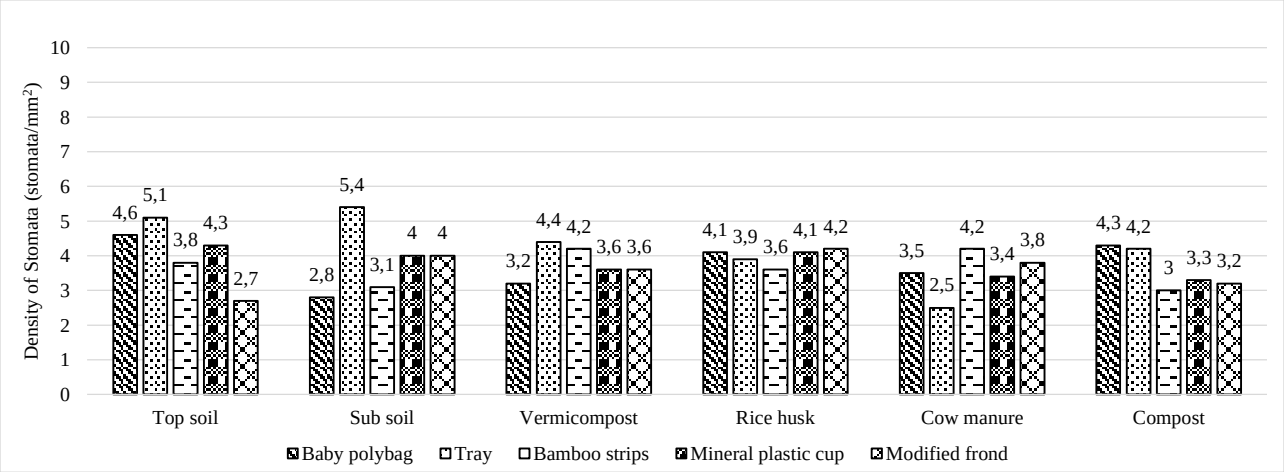

Figure 6. The influence of growing medium and type of container interaction to the density of stomata of oil palm pre nursery seedlings

Based on morphological and physiological variables oil palm seedlings in pre-nursery, bamboo strips were able to hold water better than other containers and also contains materials that can increase the nutrient content in the growing media. The result was also similar to the research of Fathurrohman (2011) that showed the utilization of various organic materials as a container for growing media in sengon (Paraserianthes falcataria (L) Nielsen) for 10 weeks. Sengon seedling growth that planted in growing media container from newspapers, compost and tannin showed the highest stem diameter value (0.8 cm) and the highest plant height (14.3 cm). These results significantly different with the treatment that combining newspapers and tapioca, which achieved stem diameter 0.6 cm and plant height 8.4 cm.

In this experiment, plastic cup waste generates the best seedling growth based on the morphological and physiological parameter observed. Plastic cup container has some advantages, that are light in weight, transparent, easy to find and has a low evaporation rate and it's tend to make growing media stable in temperature (having capability to adapt to various temperature). Ebookpangan (2007) stated that the plastic packaging has many advantages, which are strong, not able to get rust, thermoplastic, high temperature adaptability, as well as water vapor and gas permeability is low.

3.2 Second Experiment : Oil palm (Elaeis guineensis Jacq.) seedling growth at various growing media in main nursery

Morphological Response of the oil palm seedling

Oil palm seedlings that were planted in compost, vermicompost and cow manure produced plant height respectively 93.0 cm, 89.4 cm and 84.5 cm, and among the three media the plant height were not significantly different. Otherwise, the plant height grown in those three growing medium were significantly different from oil palm seedlings grown in top soil media, medium standard, sub soil and rice husk at age 10 MAP (Table 2).

Oil palm seedlings that were planted in compost and vermicompost, each produces the diameter of seedlings of 56.8 mm. This value was not significantly different from the diameter of seedlings grown in cow manure that produces a diameter of 52.0 mm, but plant grown in both media showed significantly different in stem diameter of oil palm seedlings planted in four others growth media, that are top soil, standard media, sub soil and rice husk (Table 2).

The highest value of plant height and stem diameter were obtained by the oil palm seedlings grown in compost media. The laboratory test of the content of Nitrogen is 1.32% and this value is able to influence the vegetative growth of the seedlings. According to the Walworth (2013) Nitrogen are the macronutrient needed by plants in high quantity because it is the main constituent of essential organic compounds such as amino acids, nucleic acids and proteins.

The highest number of leaves (13.2 strands) and leaf area (896.3 cm^2) obtained by plants that grown in vermicompost media. Number of leaves produced by plants grown in vermicompost media significantly different to the three media but

it was not significantly different to compost, cow manure and top soil. The widest leaf area produced by plants grown in vermicompost media and it was very significantly affect the four growing media, but it was not significantly different to the compost and cow manure.

Table 2. The influence of various growing medium to plant height, stem diameter and number of leaves.

Growing medium	Plant morphological growth			
	Plant height (cm)	Stem diamater (mm)	Number of leaves (strands)	Leaf Area (cm^2)
Standar	64.5b	44.0bc	11.5bc	475.1bc
Top soil	65.0b	36.0cd	12.0abc	325.3c
Sub soil	56.5b	37.1cd	11.0cd	278.6c
Vermicompost	89.4a	56.8a	13.2a	896.3a
Rice husk	55.4b	29.5d	10.1d	349.5c
Cow manure	84.5a	52.0ab	12.7ab	728.7ab
Compost	93.0a	56.8a	13.0a	706.4ab

Remarks: Value followed by the same letter in the same column not significantly different according to *Duncan Multiple Range Test at* 5%; MAP: Month After Planting.

Physiological Response of the oil palm seedling

The optimum amount of roots greatly influence plant growth and development as its function for point of water and nutrients intake to the plant. The highest dry weight of root and shoot which 187.0 g and 21.5 g respectively (Table 3) were obtained by plants grown in the compost media. These were in line with other morphological parameters which are plant height, number of leaves and stem diameter that also grown in compost and produced the highest value of each parameter. Kurniasih and Wulandhany (2009) stated that plant with high root dry weight had a great number of root and able to absorb water well.

The result of this experiment showed that the various media used were not significantly different to the density of stomata and the leaf greenness. According to Salisbury and Ross (1995), morphogenesis of the stomata was influenced by genetic and environmental factors. Photosynthesis activity depends on the opening and closing of the stomata (Lestari 2006; Palit 2008). The leaf greenness value was 58.8 in plants grown in compost and this was able to support chlorophyll dependent metabolisms happened in plant. A high value of leaf greenness gives a positive correlation with the high chlorophyll content in plants. The experiment result of Ramadhaini *et al*. (2013) stated that the application of NPK compound showed that increasing the dose of fertilizer can decline the leaf chlorophyll content, because the leaf chlorophyll content was close related to the availability of Nitrogen.

Table 3. The influence of various growing media to plant biomass of oil palm seedlings at 10 MAP

Growing medium	Shoot Wet Weight (g)	Root Wet weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)
Standard	201.0c	19.2	81.1c	10.1cd
Top soil	132.9cd	27.8	51.7c	13.3bc
Sub soil	99.4d	30.5	54.7c	9.5cd
Vermicompost	437.6a	40.1	133.9b	18.1ab
Rice husk	117.7d	34.3	57.2c	7.4d
Cow manure	340.8b	31.9	172.3a	16.1b
Compost	410.5ab	27.1	187.0a	21.6a

Remarks: Value followed by the same letter in the same column not significantly different according to *Duncan Multiple Range Test at* 5%; MAP: Month After Planting.

4. CONCLUTION

Compost and vermicompost can be used as an alternative growing medium replacing top soil and small polybags as a container of growing medium can be replaced by a bamboo strips or ineral plastic cup in pre nursery. Whilst, compost, vermicompost and cow manure can be used as an alternative growing medium replacing top soil on the main nursery.

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