Vol. 11, No. 3 (2022) : 438 - 450
DOI : http://dx.doi.org/10.23960/jtep-l.v11i3.438-450

Agricultural Engineering
UNIVERSITY OF LAMPUNG

JURNAL TEKNIK PERTANIAN LAMPUNG

ISSN 2302-559X (print) / 2549-0818 (online)
Journal homepage : https://jurnal.fp.unila.ac.id/index.php/JTP

Effect of Market Waste Compost and Compound Fertilizer Application on The Vegetative Growth of Oil Palm Seedling (*Elaeis guineensis* Jacq) in Ultisol Growing Media

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Article History :

Received : 20 January 2022
Received in revised form : 5 February 2022
Accepted : 2 March 2022

Keywords :

Compound fertilizer,
Main nursery,
Market waste,
Oil palm,
Organic material

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ABSTRACT

Compost is very important for the soil and is useful in increasing soil productivity and agricultural production in a sustainable manner where quality and quantity are achieved, as well reducing enviromental pollution and improving the quality of land (soil) in a sustainable manner. This study aims to determine the effect of chemical fertilizers and market waste compost addition on the vegetative growth of oil palm seedlings in the main nursery. The research was carried out for 8 months, from December 2019 - July 2020 in the area of the Practical Farm of the Field Laboratory of Soil Management, STIP-AP Medan. This study used a Randomized Block Design (RBD) with 2 factors. Factor 1 was organic compost made of market waste with 3 levels (0, 100, and 200 g/bag). Factor 2 was compound fertilizer (NPK 16:16:16) at 3 levels (5, 10, and 15 polybag). All treatment combinations wer performed in 3 replication plots and 2 seedlings were planted per plot, and 54 polybags in total. Data were analyzed using ANOVA at a level α = 5% and 1% and followed by Duncan's Multiple Range Test (DMRT) at a level α = 5%. The results prove that market waste compost and compound fertilizers had a significant effect on the observed parameters including plant height, number of leaves, and has a very significant effect on the parameters of fresh shoot weight and root fresh weight as well as shoot dry weight and root dry weight (g), but did not significantly affect the stem circumference.

1. INTRODUCTION

Ultisol is a type of soil that is very poor in nutrients but is widely used in agriculture or plantations. The characteristics of this soil are the accumulation of clay in the lower horizon, low water absorption and high soil erosion rates, as well as low organic matter and alkaline properties. The texture of the ultisol soil is loamy, contains a lot of kaolinite minerals mixed with a little gibbsite and montmorillinite, and the soil pH is between 4.2-4.8 (Andalusia *et al.,* 2016).

Most of these ultisols or red-yellow podzolic soils are spread across the territory of Indonesia, and this causes problems in the agricultural sector, namely the difficulty of achieving high productivity. Ultisols are soils that have not been handled properly. Therefore, to increase productivity, it is important to provide organic matter. Application of organic matter can increase and increase soil nutrients and reduce specific gravity (BD) in the soil so that permeability, aeration and soil infiltration are better and soil nutrient input becomes more available to plants (Suhardjo, 1994).

Application of fertilizers with high nutrient content serves to get a good increase in yield due to increased soil carrying capacity and the availability of nutrients. To meet these objectives, it can be done through a combination of application of organic fertilizers as soil enhancers and inorganic fertilizers (Darlan *et al*., 2005). According to Stevenson (1994), the application of organic matter will be able to increase soil aggregates and improve soil structure to become more friable and easy to cultivate. According to Karama *et al*., (1996), organic fertilizer from market waste contains essential macro nutrients such as nitrogen 0.60% (N), phosphorus 0.30% (P), potassium 0.34% (K), calcium 0. 12% (Ca), 0.10% magnesium (Mg), and 0.09% sulfur (S). Agustina (2013) stated that waste is the end result of human activities and the final product has taken its main function. Market waste consists of two types, namely organic waste and non-organic waste. The increase in organic matter from waste has reached 80%, so that composting becomes an alternative for appropriate soil improvement.

According to Rohendi (2005), compost has great potential to be developed considering the increasing amount of vegetable waste that is not reused. This can cause free air pollution and lead to the presence of methane gas. By utilizing vegetable waste from the market to be applied as organic humus, it will help overcome the problem of waste that pollutes the environment (Murbandono, 2000). In addition, humus derived from vegetable waste from the market can be applied to reduce dependence on the use of chemical fertilizers which are increasingly being used.

In a previous study conducted by Tambunan *et al*. (2015) research conducted on oil palm (*Elaeis guineensis* Jacq) seedlings in early nurseries concluded that market waste compost treatment had a significant effect on seedling height, total leaf area and root dry weight, and soil pH. The treatment of NPK-Mg gave a significant effect on the parameters of stem diameter, total leaf area, crown fresh weight, and crown dry weight. In addition, the interaction of the two factors significantly affected the seedling height and the total leaf area of the seedlings.

In accordance with the description above, this study aims to determine the response of vegetative growth of oil palm seedlings in the main nursery due to the application of market organic waste compost and NPK fertilizer. Market waste compost is made by adding ingredients such as Effective Microorganism-4 (EM4) bioactivator and water. Organic vegetable waste compost as a soil improvement agent is expected to increase the carrying capacity of the soil in terms of the availability of organic matter and nutrients contained in NPK fertilizers.

2. MATERIALS AND METHODS

The research was carried out in the area of the Soil Management Field Laboratory, College of Agricultural Agribusiness Plantation (STIP-AP), Medan, from December 2019 to July 2020. The study was conducted using a Factorial Randomized Block Design (RAK -F) consisting of two factor. Factor 1 is the dose of market waste compost which consists of 3 application levels (Tambunan *et al*., 2015), namely: K0 = 0 g/polybag (control), K1 = 100 g/polybag, and K2 = 200 g/polybag. Factor 2 is NPK 16:16:16

compound fertilizer which consists of 3 application levels (Buku Pintar Mandor, 2017), namely: P1 = 5 g/polybag, P2 = 10 g/polybag, and P3 = 15 g/polybag.

2.1. Parameters and Measurement

Parameters observed in oil palm seedlings included plant height (cm), number of leaves, stem circumference (cm), crown fresh weight (g), root fresh weight (g), shoot dry weight (g), root dry weight (g).

2.2. Research Steps

The research begins with making organic compost from market vegetable waste. The vegetable waste used was taken from Pasar Raya MMTC-Pancing, Medan. Vegetable waste is selected that is still fresh until slightly wilted and not rotten. The vegetable waste used to make organic humus is 20 kg. After collecting, the material is chopped into small pieces so that it is easier to decompose and after that, Effective Microorganism-4 (EM4) bioactivator and 5 liters of water are given so that the ratio of waste:water:EM4 is 20:5:1. Composting is carried out using an anaerobic system, so that humus maturity is faster. The humus was closed for 35 days, but the humus was checked every 3 days. One of the characteristics of mature compost is that it has a crumb texture, does not smell, the material is not recognized again and does not have caterpillars. Mature compost also has a C/N of 10/20 and a pH of 6.5-7. After the compost is finished, the compost is started to be applied to the planting media according to the treatment given. The weight of the soil given in the polybag is 6 kg. Seedlings also began to be transferred to the planting medium. After 1 week after planting (WAP), compound fertilizer NPK 16:16:16 was applied according to the level of each treatment. Compound fertilizer application is done once a week. Every day maintenance is carried out in the form of: watering 2 times a day in the morning and afternoon as much as 1.5 L/plant, and observations of pests, weeds and diseases during the study. The end of the study was when the seedlings were 16 WAP.

3. RESULTS AND DISCUSSION

3.1. Plant Height (cm)

The results of measuring the height of oil palm seedlings showed that the application of organic vegetable waste compost had a very significant effect on plant height, while the application of compound fertilizers had no significant effect, and the interaction of treatment combinations had a significant effect. The interaction effect of the two factors is presented in Table 1. The graph of percent treatment of market waste organic compost and compound fertilizer at 16 WAP seedling height is in Figure 1 and the graph of the effect is in Figure 2 and Figure 3.

Table 1. Effect of treatment combination interaction on the plant height

Market waste compost	NPK fertilizer			Average
	P_1	P_2	P_3	
K_0	41.00 a	41.67 ab	45.00 abc	42.56 a
K_1	51.00 bc	46.00 abc	49.33 bc	48.78 b
K_2	46.00 abc	47.67 abc	53.33 d	49.00 b
Average	**46.00**	**45.11**	**49.22**	

Note: Numbers with the same notation in rows and columns show that they are not significantly different according to Duncan's Multiple Range Test (DMRT) at a percentage of 5%

Compost application significantly improve plant height by 15% as compared to that of without compost; meanwhile NPK addition of 15 g/polybag increase plant height by 7% as compared to that of 5 g/polybag. The effect of market waste organic compost and compound fertilizer on seedling height can be seen in Figure 2 and Figure 3. With the results of the DMRT test analysis at the 5% level that was significantly different, it can be said that the best treatment was the one with an average plant height of 53.33 cm. In other words, the treatment on seedling height with a dose of organic compost of market vegetable waste 200 g/polybag and treatment with a dose of 15 g/polybag of compound fertilizer showed significantly different results. This is due to the role of phosphorus, nitrogen and potassium nutrients where these macro nutrients can increase the growth of oil palm seedlings. Nutrients present in the soil will be able to improve soil conditions, both physical soil conditions, soil chemistry and soil biology, so that plant roots will easily absorb nutrients and distribute them throughout plant organs for vegetative growth of oil palm seedlings.

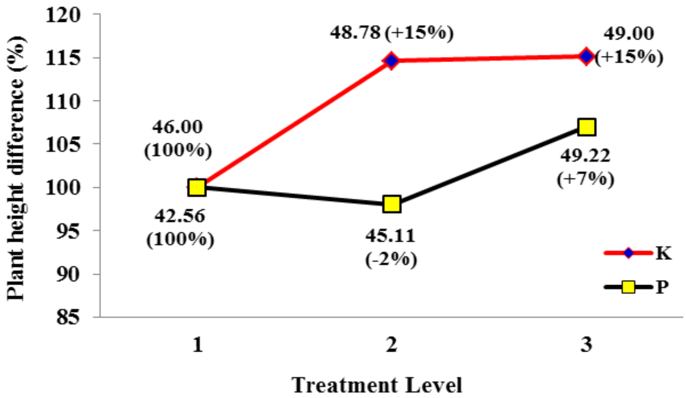

Figure 1. Effect of single factor compost (K) and NPK (P) on the plant height difference of oil palm seedlings at 16 WAP

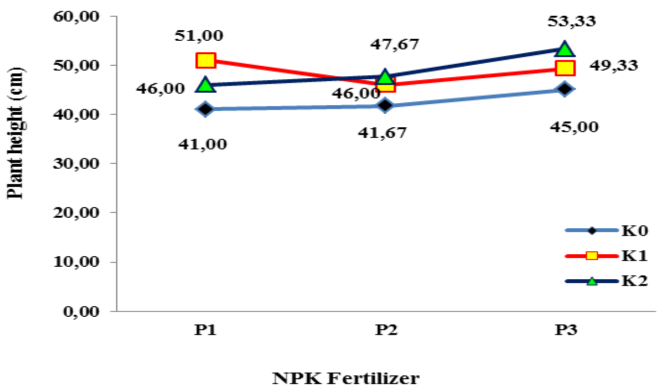

Figure 2. Effect of NPK on the height of oil palm seedling at 16 WAP for different compost application

In the opinion of Linga *et al*. (2006) the provision of N nutrients to plants will be able to stimulate vegetative growth in plants which is one of the important components in the preparation of amino acids, the formation of cell protoplasm and protein in plants. Meanwhile, Pitojo (1995) stated that besides having a role in the process of enzyme and protein components, it also has a role in respiration and metabolism and makes the vegetative and generative growth of plants better. Amino acids and proteins are useful in the formation of new cells and can increase the high vegetative growth of oil palm seedlings. While nutrient K functions as a process of photosynthesis and can stimulate vegetative and generative plants.

The same opinion was conveyed by Nyakpa et al. (1988) which stated that the process of growth of seedling height in oil palm was preceded by an increase in the number of leaf cells and vegetative enlargement of the plant if these nutrients were sufficient. In other words, that the nutrient balance has been fulfilled for the plants which proves that the plants are growing well and fresh and the plant processes can run well. Therefore, this study proved that the balanced dose treatment showed an effect on growth, development in plants as well as the height of oil palm seedlings. In the opinion of Christine (2013), that the application of organic fertilizer can increase plant height growth, and the application of market vegetable organic compost has met the adequacy of plants. The application of compound fertilizer and organic compost from market vegetable waste to oil palm seedlings aged 5-9 months in the main nursery showed that the seedling height was higher than the standard seedling height growth. In addition, the application of high N nutrients is expected to result in better plant growth.

3.2. Stem Circumference (cm)

The results of measurements of the stem circumference of oil palm seedlings showed that the single factor application of organic compost of vegetable waste and compound fertilizers and the interaction of the two factors had no significant effect as presented in Table 2. Figure 3 presents a graph of the effect of organic compost treatment of market vegetable waste and compound fertilizers on stem circumference at 16 WAP. It can be observed that compost application increase stem circumference by 2% to 6%, while addition NPK 10 g/polybag increase by only 1% and even decrease by 5% at a dose of 15 g/polybag. Results of DMRT at the 5% level, however, showed that the differences were not significant. The treatment of market waste organic compost at a dose of 100 g/polybag combined with compound fertilizer at a dose of 10 g/polybag showed an average stem circumference of 10.17 cm.

Table 2. The interaction effect of the application of market waste compost and NPK fertilizer on the average of stem circumference of oil palm seedlings (cm) at 16 WAP

Market waste compost	NPK fertilizer			Average
	P_1	P_2	P_3	
K_0	9.33 a	9.13 a	8.33 a	8.93 a
K_1	9.17 a	10.17 a	9.03 a	9.46 a
K_2	9.33 a	8.93 a	9.17 a	9.14 a
Average	**9.28 a**	**9.41 a**	**8.84 a**	

Note: Numbers with the same notation in rows and columns show no significant difference according to Duncan's Multiple Range Test (DMRT) at a = 5%

The effect of market waste organic compost and compound NPK fertilizer on the stem circumference can be seen in Figure 4. More potassium nutrients are needed in increasing the stem circumference of oil palm seedlings. Leiwakabessy (1998) stated that potassium plays a role in the development of plant stem circumference.

Potassium nutrients also play a role in connecting the network between roots and leaves in the process of nutrient transportation. Lack of potassium nutrients will have an impact on the development of poor stem circumference, while the provision of excessive nutrients will make plants slow to process nutrient metabolism through roots. Nitrogen plays a role in increasing plant development both vertically and horizontally. Phosphorus will increase plant development, as the number of leaves increases, the absorption of photosynthesis will increase and the diameter of the stem will develop better. According to Munawar (2011), the function of phosphate nutrients is very vital for plants in the process of photosynthesis and carbohydrate metabolism as well as the growth and development of stems and midribs. In relation to the growth and development of the stem circumference of oil palm seedlings, the function of the role of nitrogen and phosphate nutrients is very vital for plants. Phosphate deficiency will have a negative impact on leaves and stems that experience straight growth and even shrink the top of the growth. From these results, the application or application of market vegetable organic compost has no significant effect on stem circumference. It can be stated that in stem development, the availability of nutrients in accordance with what is needed so that plants grow and develop better.

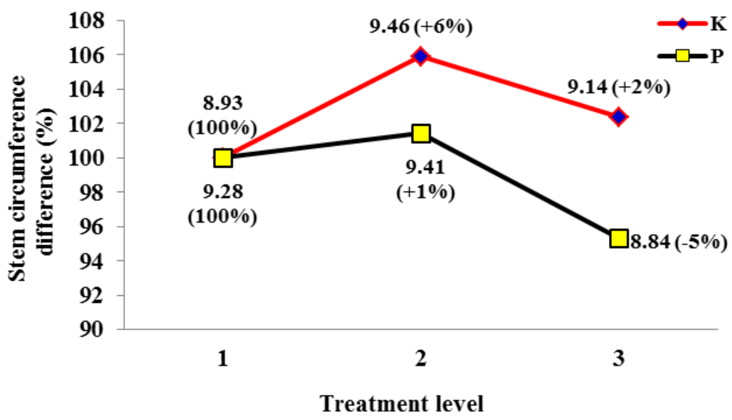

Figure 3. Effect of single factor compost (K) and NPK (P) on the stem circumference difference of oil palm seedlings at 16 WAP

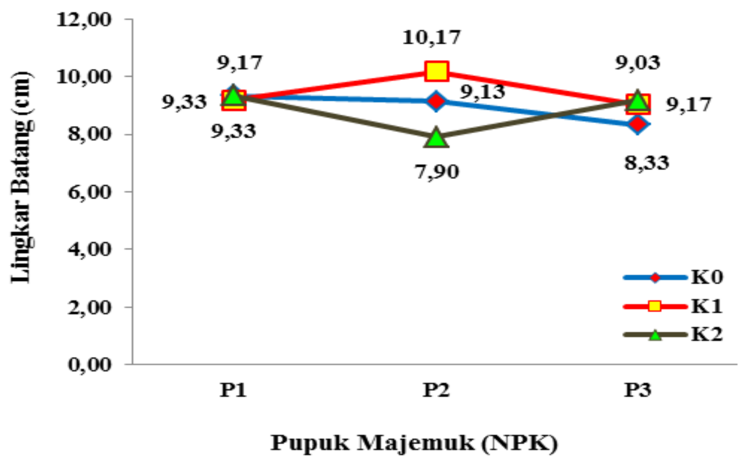

Figure 4. Effect of NPK on the stem circumference of oil palm seedling at 16 WAP for different compost application

3.3. Number of Leaves

The results of observations on the number of leaves of oil palm seedlings showed that the application of organic compost from market vegetable waste had a very significant effect, the application of compound fertilizers had a very significant effect, while the interaction of treatments had a very significant effect (Table 3).

Figure 5 presents a graph of the percent change in the number of leaves at 16 WAP due to the treatment of market waste organic compost and NPK compound fertilizer, while the effect of treatment on the number of leaves is given in Figures 6. The DMRT test results at the 5% level were significantly different. Compost application significantly increase number of leves up to 11%, while NPK addition increase leaves up to 6%. It was concluded that the best treatment was the application of market vegetable waste organic compost at a dose of 200 g/polybag and compound fertilizer at a dose of 15 g/polybag which produced plants with an average number of leaves of 14.33.

Table 3. The interaction effect of compost and NPK treatment on the average number of leaves of oil palm seedlings at 16 WAP

Market waste compost	NPK fertilizer			Average
	P_1	P_2	P_3	
K_0	12.00 a	12.67 ab	13.00 abc	12.56 a
K_1	12.67 ab	13.00 abc	13.67 bc	13.11 a
K_2	14.00 c	13.33 bc	14.33 d	13.89 b
Average	12.89	13.00	13.67	

Note: Numbers with the same notation in rows and columns show no significant difference according to DMRT at 5%.

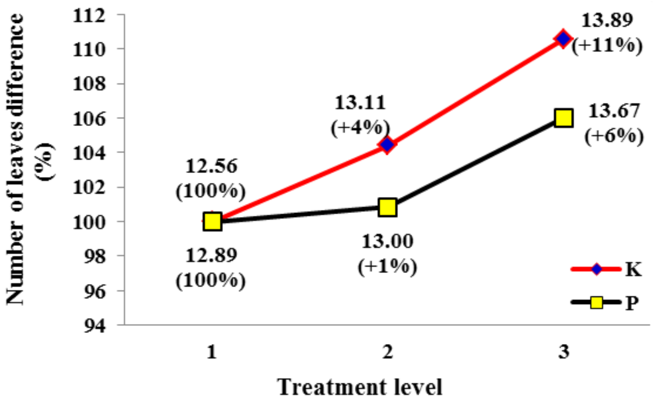

Figure 5. Effect of single factor compost (K) and NPK (P) on the number of leaves difference of oil palm seedlings at 16 WAP

The relationship between market waste organic compost and compound fertilizer at various levels of treatment on the number of leaves can be seen in Figure 6. Plants can grow well because the available plant nutrients are absorbed by these plants, and supported by an improvement in the properties of the soil due to the application of organic matter that directly stimulates the growth of oil palm plants. In addition to nutrients contained in the soil, solar radiation is also the main thing in the process of plant photosynthesis. According to Rosita *et al.* (2007), growth increases with increasing age of the plant which is supported by the addition of organic nutrients in the growing media. The growth includes the increase in plant height, stem circumference and the number of leaves of the oil palm seedlings.

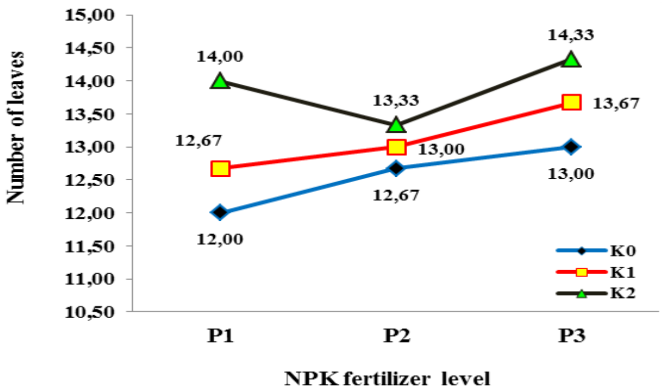

Figure 6. Effect of NPK on the number of leaves of oil palm seedling at 16 WAP for different compost application

Fauzi (2002) stated that the vegetative growth of plants depends on the age of the plant. The number of leaves is closely related to plant height, the taller the plant, the more midrib or the number of leaves formed (Harjadi, 1991). According to Hakim *et al.* (1998), nitrogen nutrients have an effect on leaf area and planting media containing nitrogen that is not optimal will reduce the potential for leaf area.

According to Sarief (1997), nutrient P plays a very important role in the development of the meristem network system. The development of meristem tissue will make the cells elongate and enlarge, so that plant parts that are active in cell division will affect the state of leaf area and support the growth of the number of leaves in plants. According to Rosita et al., (2007) the increase in plant growth will accompany the increase in plant age. Plant growth is due to the role of nutrients applied in the form of organic matter in the growing media that supports vegetative growth in plants.

3.4. Sooth Weight

The measurement of sooth fresh weight of oil palm seedling showed that the application of organic compost of vegetable waste, compound fertilizer, or the interaction of both factors had had a very significant effect, as it is presented in Table 4 for fresh shoot and Table 5 for dry shoot. Figure 7 presents the effect of market waste organic compost treatment on fresh and dry shoot weight at variations in levels of NPK compound fertilizers.

Table 4. The interaction effect of compost and NPK treatment on the sooth fresh weight of oil palm seedlings at 16 WAP

Market waste compost	NPK Fertilizer			Average
	P_1	P_2	P_3	
K_0	63.20	68.67	70.23	67.37 a
K_1	96.63	94.20	89.87	93.57 b
K_2	93.70	92.03	98.20	94.64 c
Average	84.51 a	84.97 ab	86.10 c	

Note: Numbers with the same notation in rows and columns show no significant difference according to DMRT at 5%.

Table 5. The interaction effect of compost and NPK treatment on the dry shoot weight of oil palm seedlings at 16 WAP

Market waste compost	Pupuk Majemuk (NPK)			Average
	P_1	P_2	P_3	
K_0	27.07	28.50	28.47	28.01 a
K_1	36.67	39.67	37.87	38.07 b
K_2	36.70	36.20	41.33	38.08 b
Average	33.48 a	34.79 b	35.89 c	

Note: Numbers with the same notation in rows and columns show no significant difference according to DMRT at 5%.

We can see that the treatment with the highest shoot fresh weight was organic compost from market waste as much as 200 g/polybag and compound fertilizer level as much as 15 g/polybag. When compared with the level of organic compost treatment of market waste as much as 0 g/polybag (control) and the level of compound fertilizer as much as 5 g/polybag, the canopy fresh weight was 63.20 g. This can be attributed to the availability of macro and micro nutrients that can be absorbed by plants. Macro and micro nutrients are very important needed by plants, if nutrient needs are not met then plant growth and development will be disrupted (Subagyo et al., 2004). This means that the plant will experience an increase in one of the vegetatives, namely the plant crown because the roots will be able to absorb these nutrients and will translocate the photosynthetic results to the plant canopy, this is functioned for the growth of the crown as one of the vegetative plants. According to Gardner *et al.* (1991), nitrogen nutrients that have been fulfilled and fulfilled by plants, the photosynthesis process that occurs from the roots will also be large so that the process will balance the shoot and root growth. According to Sarief (1997), the availability of nutrients absorbed by plants is one of the factors in influencing the ability to grow plants so that the weight of the plant crown increases.

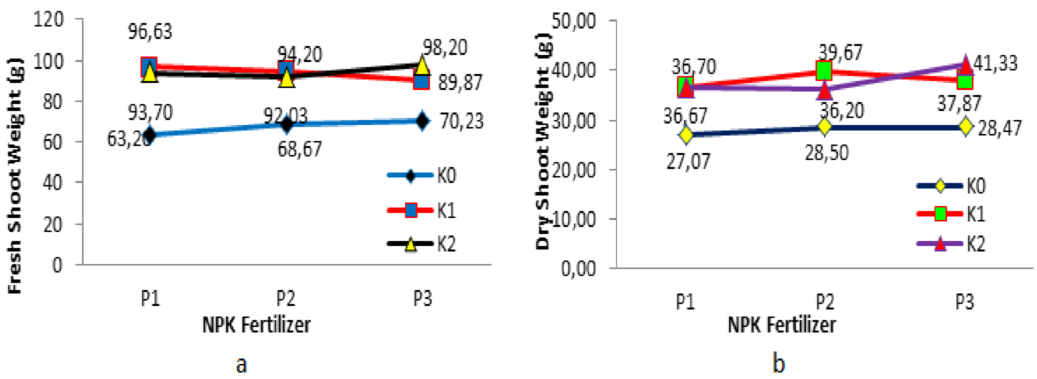

Figure 7. Effect of NPK on the shoot weight of oil palm seedling at 16 WAP for different compost application: (a) fresh; (b) dry

3.5. Root Weight (g)

The results of the measurement of the root weight of the oil palm seedlings showed that the application of organic vegetable waste compost and the application of NPK compound fertilizer, either alone or in interaction, had a very significant effect (Table 6 for fresh root and Table 7 for dry root). Figure 8 presents the interaction effect of the two factors on the fresh and dry weight of the roots of oil palm seedlings.

Table 6. The interaction effect of compost and NPK treatment on the root fresh weight of oil palm seedlings at 16 WAP

Market waste compost	NPK Fertilizer			Average
	P_1	P_2	P_3	
K_0	27.17	29.90	28.73	28.60 a
K_1	36.73	40.10	36.17	37.67 b
K_2	34.50	35.97	48.87	39.78 c
Average	32.80 a	35.32 b	37.92 c	

Note: Numbers with the same notation in rows and columns show no significant difference according to DMRT at 5%.

Table 7. The interaction effect of compost and NPK treatment on the dry root weight of oil palm seedlings at 16 WAP

Market waste compost	NPK Fertilizer			Average
	P1	P2	P3	
K0	8.80	7.57	9.57	8.65 a
K1	11.73	12.00	12.13	11.95 b
K2	12.23	13.40	14.90	13.51 c
Average	10.92 a	10.99 a	12.20 b	

Note: Numbers with the same notation in rows and columns show no significant difference according to DMRT at 5%.

The lowest NPK application (5 g/polybag) and without the addition of compost produced plant seeds with the lowest fresh root weight, which was 27.17 g. This is because plants still utilize nutrients in the soil even though Ultisol soil nutrients are low. Treatment with a dose of compost 200 g/polybag and NPK compound fertilizer 15 g/polybag increased the fresh weight of the roots to 48.87 g. This also explains that the application of organic humus to market vegetables can make heavy weight on the roots and compound fertilizers increase nutrient absorption to the roots by giving a balanced dose, and it is also suspected that the organic humus has met the nutrient needs of oil palm seedlings in the main nursery. Sarief (1997) stated that the support of vegetative growth in plants was due to the absorption of nitrogen nutrients, the formation of a good root system due to the absorption of phosphorus nutrients and the process of stimulation and root elongation due to the absorption of potassium nutrients. This supports Nyakpa *et al*. (1998) which states that nitrogen, phosphorus, and potassium nutrients in application to plants will increase plant generative development, the amount of chlorophyll, and increase photosynthetic activity so that it supports dry weight in plants. According to Ahira (2006), the provision of organic humus for market vegetables can make the soil more fertile which improves the physical, chemical and biological properties of the soil and can also meet the inductibility of nutrient needs in nutrient deficient soils. This is because the organic humus is a nutrient in available form and can be absorbed directly by plants.

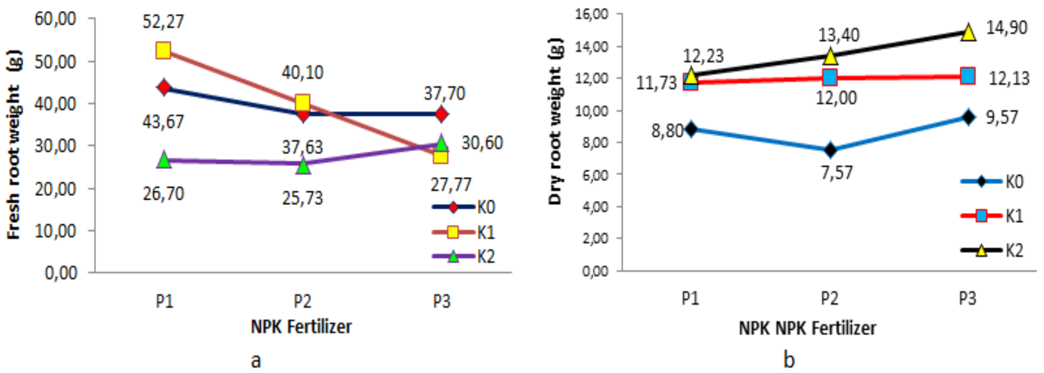

Figure 8. Effect of NPK on the root weight of oil palm seedling at 16 WAP for different compost application: (a) fresh; (b) dry

4. CONCLUSIONS AND RECOMMENDATION

Application of organic compost made from market vegetable waste at a dose of 200 g/polybag is the best treatment for the vegetative growth of oil palm seedlings. Application of NPK compound fertilizer at a fertilizer dose of 15 g/polybag was the best treatment for the vegetative growth of the main seedling oil palm plant. The interaction of the combination treatment of organic humus application of market vegetable waste at a dose of 200 g/polybag and compound fertilizer at a dose of 15 g/polybag resulted in the best vegetative growth of plants from oil palm seedlings in the main nursery.

Further research is needed to obtain more effective results and the best dose on the application of market vegetable waste organic compost and compound fertilizer in oil palm nurseries on Ultisol planting media, and also apply compound fertilizer according to the recommended dosage for oil palm nurseries.

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