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Effect of Banana Peel and Tomato Compost on the Growth of Oil Palm Seeds (*Elaeis guineensis* Jacq.) Prenursery Stage

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ABSTRACT

Continuous use of inorganic fertilizers that do not follow Good Agricultural Practices causes soil damage. Organic fertilizers are complementary fertilizers that can maintain soil moisture and fertility, increase the soil water-holding capacity, and increase the amount of water available to plants. The purpose of this study was to determine the effect of compost prepared from banana peel and rotten tomato (10:3) and different watering intervals on the growth of oil palm seedlings at the pre-nursery stage. The experiment was conducted from February 2022 to August 2022 in Kedokan Agung Village, Kedokan Bunder District, and Indramayu Regency. The experiment used a Randomized Block Design consisting of nine treatments and three replicates, with each treatment consisting of two plants. The combination of treatments used compost with intervals of watering the oil palm seedlings. The results showed that the application of 1 kg/plant compost with daily watering resulted in the best growth and significantly affected plant height, trunk circumference, number of leaves, and leaf area. This treatment produced a growth response that was as good as that of plants given inorganic fertilizers.

Keywords: compost, organic fertilizer, prenursery, watering interval

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is one of the largest oil-producing crops in the world. The oil produced by this plant is in the form of cooking oil, industrial oil, or biodiesel. The production of Crude Palm Oil (CPO) in Indonesia accounts for 53.4% of the total worldwide CPO (Purba and Sipayung 2017). Rapid development of the palm oil industry is expected to disrupt the sustainability of oil palm plantations. Intensive land management that is not in accordance with Good Agricultural Practices (GAP), such as the continuous application of inorganic fertilizers without the application of organic fertilizers, causes soil damage, such as decreased pH, reduced loose properties, and plant poisoning. When applied continuously, inorganic fertilizers result in degraded soil organic matter, acidity, and environmental pollution (Roba 2018).

There are various types of organic fertilizers, including compost, manure, and green fertilizers. Organic fertilizers are used as complementary fertilizers and as a source of nutrients for plants. In addition, organic fertilizers are expected to preserve the environment and achieve sustainable oil palm plantations. Organic products are a rich source of nutrients for plants (Phibunwatthanawong and Riddech 2019). Organic matter, which is the main constituent element of organic fertilizers, originates from 'living' materials. Agricultural waste is a potential source of organic matter (OM). Waste is recycled to produce organic matter, which is then transferred to the plant in a form that is easily absorbed by the plant. During composting, a bioactivator is required to accelerate the decomposition process. Thus, tomatoes can be used as bioactivators in composting organic matter. Based on the research of Wulandari (2015), the percentage of shrinkage in the volume and physical quality of compost with the addition of bioactivators from tomato waste is not much different from using EM-4 (Effective Microorganism 4). Effective microbes, known as bioactivators, are activating agents in the form of small bodies that function by converting the physicochemical properties of organic matter into smaller molecules (Sukanto 2013). Tomatoes are widely available in both traditional and modern markets. The short shelf life of tomatoes makes them a potential market waste in the form of rotten tomatoes. The use of rotten tomatoes as bioactivators is a good step, in addition to tomatoes being easy to obtain, and can also play a role in reducing agricultural waste, which is then processed into more useful materials for use as bioactivators equivalent to EM4.

The study of organic matter in agriculture is inseparable from its use as organic fertilizer. Several studies have shown the positive influence of organic fertilizers, both from waste and other materials, on plants. Organic fertilizers have a significant effect on the wet weight of the roots, wet weight of the leaves, dry weight of the roots, dry weight of the trunks, and dry weight of the oil palm leaves (Koryati 2010). Banana

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peel can be used as an organic fertilizer. According to Islam et al. (2019), the use of banana peel biochar is another way to overcome the use of chemical fertilizers, and a good way to use agricultural waste through recycling Ani *et al*. (2015) stated that the nutrient content in banana and tomato peel compost is 2.45% N, 0.36% P, and 15.2% K with a C/N ratio of 16.73.

In oil palm plants, the application of 30 g banana peel compost provided the best results for plant growth (Nasution *et al*. 2014). Based on Ernawati *et al*. (2018), the application of 50 g of *nipah* peel waste compost provided the highest wet and dry weights of chickpea plants. In addition, Anhar *et al*. (2021) stated that the application of 50 mL/L liquid organic fertilizer of *kepok* banana peel had a positive effect on the growth of oil palm seedlings in the pre-nursery stage. Another benefit of using organic fertilizers is an increase in the water-holding capacity of the soil. This state is related to the supply of water to the plants to support their life processes. Water needs for plants are met by rainwater for plants planted in the field and by water for plants grown in a sheltered environment. In this study, we examined how the application of organic fertilizers derived from banana and tomato peels is related to the ability of the planting medium to retain water and ensure water supply to plants.

The application of organic fertilizer at certain watering intervals is expected to create ideal conditions for optimal oil palm seed growth. Water regulation is related to the efficiency of plant water use. The longer the watering interval without inhibiting plant growth, the less water will be needed to water the plant, so that it will be more efficient. Generally, plants are watered daily to meet their water requirements. According to Ichsan *et al*. (2012), the interval of watering every three days still has a positive effect on the growth of oil palm seedlings, especially on the height of seedlings aged 30, 60, and 90 DAP (days after planting). These conditions can save water for the oil palm seedlings.

This study aimed to provide information on the influence and dosage used in the application of banana and tomato husk organic fertilizer, as well as watering intervals that show good oil palm seed growth at the pre-nursery stage.

METHODS

The experiment was conducted inside a plastic house building in Indramayu at an altitude of 30 m above sea level. Based on data from the Class III Meteorological Station Kertajati Majalengka, the average temperature of the site was 28 °C and the average humidity was 83%. The trial was conducted from February 2022 to August 2022. The tools and materials used in the experiment were a 30 × 30 cm polybag, a sack as a composting bin, an analytical scale, a ruler, a cloth meter, an oven, oil palm sprouts of the D × P Simalungun variety, NPP fertilizer (16:16:16), jackfruit banana peel, and rotten tomatoes. The method of making compost started by chopping the banana peels and tomato into smaller pieces measuring ± 2 cm and then the two are mixed with a ratio of 10 parts of banana peel with three parts of tomatoes (10:3) and the same for a ratio of 10:1. The mixtures were put into porous boxes that had been filled with soil 1/4 of the way and then after the mixture of organic material were inserted, the boxes were covered with soil. The boxes were then covered with cloth and stored in a shady place for several weeks. During the composting period, stirring and reversing compost was carried out every two days. Mature compost was characterized by a blackish-brown color resembling soil, crumbly texture, and does not smell bad.

The research method used was an experimental method arranged in a Group Random Design consisting of nine treatments and three replicates. Each treatment consisted of two plants and 54 oil palm seedlings. The treatment provided includes: A = NPK inorganic fertilizer 68.5 g/plant, daily watering; B = 0.5 kg/compost 10:1, daily watering; C = 0.5 kg/compost 10:1, watering once every five days; D = 0.5 kg/compost 10:3, watering daily; E = 0.5 kg/compost 10:3, watering once every five days; F = 1 kg/compost 10:1, daily watering; G = 1 kg/compost 10:1, watering once every five days; H = 1 kg/compost 10:3, watering daily; I = 1 kg/compost 10:3, watering every five days.

Observations were made on oil palm growth variables, including seedling height, number of leaves, trunk circumference, and leaf area every month for six months of observation. The seedling height was measured from the base of the trunk to the highest part of the plant. The circumference of the trunk was measured using a cloth meter from the base of the trunk of an oil-palm seedling. The number of leaves that opened perfectly was recorded. Leaf area was determined by measuring the leaf length and width using formula $L = p \times l \times$ constant (0.52). The data obtained were then analyzed using the Fisher test at a significance level of 5%, and if there was a significant difference, it was followed by Duncan's Multiple Range Test at a significance level of 5% using the SASM-Agri application.

RESULTS AND DISCUSSION

Plant Height

The results of the statistical analysis of the oil palm plant height upon application of banana peel and tomato compost with different watering intervals (Table 1) did not have a noticeably different effect on oil palm seedlings at 1, 2, 3, 4, and 5 MATs. The height of the seedlings continued to increase because of the need for sufficient nutrients for plant growth. This is in

Table 1 The effect of banana peel and tomato composting and different watering intervals on height of oil palm seedlings

Treatment	Height of oil palm seedling (cm)					
	1 MAT	2 MAT	3 MAT	4 MAT	5 MAT	6 MAT
A	16.4 a	23.5 a	29.5 a	34.6 a	41.4 a	47.5 ab
B	16.1 a	20.8 a	26.7 a	30.6 a	37.1 a	43.8 ab
C	15.5 a	20.5 a	25.1 a	29.7 a	35.0 a	42.8 b
D	15.5 a	22.3 a	29.0 a	36.5 a	41.3 a	50.1 ab
E	14.2 a	19.2 a	25.5 a	29.6 a	32.8 a	36.6 b
F	15.4 a	23.0 a	30.4 a	34.6 a	48.5 a	57.6 a
G	14.4 a	19.2 a	25.0 a	30.4 a	33.1 a	38.8 b
H	19.5 a	25.7 a	33.0 a	38.1 a	50.6 a	58.0 a
I	16.1 a	22.2 a	27.3 a	32.5 a	38.1 a	45.8 ab

Remarks: The average value followed by the same letter in the same column shows no real difference based on the Duncan Multiple Range Test at a significant level of 5%. MAT = months after treatment; A = NPK inorganic fertilizer 68.5 g/polybag, watering daily; B = 0.5 kg/compost of banana peel and tomato (10:1), watering daily; C = 0.5 kg/compost of banana peel and tomato (10:1), watering every five days; D = 0.5 kg/compost of banana peel and tomato (10:3), watering daily; E = 0.5 kg/compost of banana peel and tomato (10:3), watering every five days; F = 1 kg/compost of banana peel and tomato (10:1), daily watering; G = 1 kg/compost of banana peel and tomato (10:1), watering every five days; H = 1 kg/compost of banana peel and tomato (10:3), daily watering; and I = 1 kg/compost of banana peel and tomato (10:3), watering every five days.

accordance with the findings of Ichsan *et al*. (2012), who found that plants grow well if the required nutrients are sufficiently available.

The plants that were given compost, accompanied by different watering intervals, began to show a noticeable difference at 6 MAT. The highest plant growth was observed after treatment with 1 kg compost 10:3 and daily watering (treatment H), and showed a significant effect under treatments (C), (E), and (G), but was not significantly different from other treatments with 1 kg of compost 10:3 with watering every five days (treatment I) compared to treatment A (inorganic fertilizer only) and compost treatment in the same ratio but accompanied by daily watering intervals (H treatment). This suggests that the use of 1 kg/plant compost with a higher proportion of tomatoes as bioactivators can reduce the need for water. In addition, compost in the form of a mixture of banana peels and tomatoes can replace inorganic fertilizers in terms of their effect on the growth of oil palm seedlings. There was an increase in plant height (22.1%) with the application of banana peel and tomato compost (10:3) compared to that of seedlings treated with inorganic fertilizer alone.

Tomatoes mixed with organic fertilizers are used as bioactivators where their role is to aid the decomposition process by activating the microbes involved in the process. According to Fitria *et al*. (2008), organic waste is converted by microbes into simple compounds such as sugars, glycerol, fatty acids, and amino acids. Compost contains organic matter and can provide nutrients for the growth of oil palm seedlings. The benefits of organic fertilizer application to the soil are not limited to nutrients alone (Purnomo *et al*. 1992) but also contribute to other factors, such as improving structure, aeration, groundwater holding capacity, influencing or regulating soil temperature, and providing substances that can help plant growth. The results of the laboratory analysis in this study indicated that the 10:3 compost contained 0.68% N; 0.76 ppm P_2O_5, 2.69 ppm K_2O, and a C/N ratio of 17.42. Nutrient content, especially N, P, and K, in the compost contributed to the supply of nutrients for oil palm seedlings. Teshome *et al*. (2014) explained that the contribution of compost to soil fertility is the release of macro- and micronutrients and optimization of microorganisms in the soil. Setyorini *et al*. (2020) suggested that the nutrients N, P, and K play an important role in the vegetative growth of oil palm seedlings, especially at seedling height. N and P play a role in cell division during the formation of plant organs and root growth at the beginning of growth, and K plays a role in spurring the activity of growth points in plants.

The application of compost from 1 to 5 MAT had the same tendency to support the growth of oil palm seedlings, although they differed in the watering interval. Sarief (1989) found that organic matter can increase the water-holding capacity and volume of water contained and stored in the soil, which means that it will increase the water available to plants. Plant height is a component of vegetative growth and is always considered when determining the quality of oil palm seedlings. Seeds that grow well will also grow well once planted in the field, especially when supported by the optimal climatic and soil conditions. This state is supported by the genetic growth of plants.

Number of Leaves

Statistical analysis of the number of oil palm seedlings that were treated with compost prepared from banana peels and tomatoes at different watering intervals (Table 2) did not result in a significant difference in the number of oil palm seedling leaves at 1, 2, 3, and 6 MAT. A significant effect of the treatment is shown in 4 MAT and 5 MAT. Application of compost (10:3) with daily watering (H) showed a markedly different effect with all treatments except treatments (D)

and (F) at 4 MAT and 5 MAT. The effect of applying compost at different watering intervals was evident in four and five MATs, respectively. At that time, the application of compost with daily watering intervals showed a noticeable effect from other treatments accompanied by a five-day watering interval.

The application of compost produced a high number of leaves, particularly in treatment H, where the effect was significantly different from the control treatment (A) at 4 MAT and 5 MAT. Macronutrients such as N, P, and P play major roles in the growth of oil palm leaves. Compost contains organic matter that plays a role in increasing groundwater holding capacity (Purnomo *et al*. 1992). The ability of the planting medium to retain water with banana and tomato peel compost is suspected to have begun to decline at 4 MAT and 5 MAT; therefore, watering once every five days is not recommended for use on oil palm seedlings with more than 3 MAT. Banana peel and tomato compost are suspected to only be able to retain groundwater at 1 to 3 MATs, and additional composting needs to be carried out at 4 MAT to maintain the compost's ability to absorb groundwater up to 6 MAT.

Trunk Circumference

Table 3 shows the significantly different effects of compost treatments on the growth of oil palm seedling trunk circumference in the 3 MAT. A dose of 1 kg/polybag of compost 10:3 and daily watering (H) showed better growth of trunk circumference than other treatments, except for the control treatments (A), (D), and (F).

Daily watering intervals resulted in better growth in trunk circumference than five-day watering intervals, except for treatment B at 3 MAT. This result is in line with that of Damanik *et al*. (2014), who found that water

Table 2 The effect of banana peel and tomato composting and different watering intervals on the number of leaves of oil palm seedlings

Treatment	Number of leaves of oil palm seedlings					
	1 MAT	2 MAT	3 MAT	4 MAT	5 MAT	6 MAT
A	3.0 a	3.3 a	5.0 a	5.3 bcd	6.3 bc	7.6 a
B	2.6 a	3.0 a	4.3 a	5.0 cd	6.0 bc	8.3 a
C	3.0 a	3.6 a	4.3 a	5.3 bcd	6.0 bc	8.3 a
D	3.0 a	3.6 a	5.0 a	6.0 abc	6.6 abc	8.3 a
E	2.6 a	3.3 a	4.0 a	4.6 d	5.6 c	7.3 a
F	3.0 a	3.6 a	5.0 a	6.3 ab	7.3 ab	9.3 a
G	2.6 a	3.0 a	4.0 a	5.0 cd	5.6 c	7.3 a
H	3.0 a	4.0 a	5.3 a	7.0 a	8.0 a	8.6 a
I	2.6 a	3.0 a	4.0 a	5.3 bcd	6.0 bc	8.0 a

Remarks: The average value followed by the same letter in the same column shows no real difference based on the Duncan Multiple Range Test at a significant level of 5%, MAT = months after treatment; A = NPP inorganic fertilizer 68.5 g/polybag, watering daily; B = 0.5 kg/compost of banana peel and tomato (10:1), watering daily; C = 0.5 kg/compost of banana peel and tomato (10:1), watering every five days; D = 0.5 kg/compost of banana peel and tomato (10:3), watering daily; E = 0.5 kg/compost of banana peel and tomato (10:3), watering every five days; F = 1 kg/compost of banana peel and tomato (10:1), daily watering; G = 1 kg/compost of banana peel and tomato (10:1), watering every five days; H = 1 kg/compost of banana peel and tomato (10:3), daily watering; and I = 1 kg/compost of banana peel and tomato (10:3), watering every five days.

Table 3 The effect of applying banana peel and tomato compost and different watering intervals on the trunk of oil palm seedlings

Treatment	Trunk circumference of oil palm seedling (cm)					
	1 MAT	2 MAT	3 MAT	4 MAT	5 MAT	6 MAT
A	2.1 a	2.9 a	4.1 ab	5.2 a	5.5 a	7.1 a
B	1.8 a	2.1 a	3.1 bc	4.2 a	5.5 a	7.0 a
C	2.1 a	2.2 a	3.2 bc	4.0 a	5.3 a	6.7 a
D	1.9 a	2.5 a	3.5 abc	4.8 a	6.4 a	8.4 a
E	1.7 a	2.2 a	2.5 c	3.7 a	4.6 a	6.1 a
F	1.9 a	2.6 a	3.6 abc	5.7 a	6.2 a	8.6 a
G	1.8 a	2.1 a	2.8 bc	3.9 a	4.7 a	5.8 a
H	2.2 a	3.1 a	4.6 a	6.1 a	7.1 a	8.8 a
I	2.1 a	2.5 a	2.9 bc	4.8 a	5.9 a	7.6 a

Remarks: The average value followed by the same letter in the same column shows no real difference based on the Duncan Multiple Range Test at a significant level of 5%. MAT = months after treatment; A = NPP inorganic fertilizer 68.5 g/polybag, watering daily; B = 0.5 kg/compost of banana peel and tomato (10:1), watering daily; C = 0.5 kg/compost of banana peel and tomato (10:1), watering every five days; D = 0.5 kg/compost of banana peel and tomato (10:3), watering daily; E = 0.5 kg/compost of banana peel and tomato (10:3), watering every five days; F = 1 kg/compost of banana peel and tomato (10:1), daily watering; G = 1 kg/compost of banana peel and tomato (10:1), watering every five days; H = 1 kg/compost of banana peel and tomato (10:3), daily watering; and I = 1 kg/compost of banana peel and tomato (10:3), watering every five days.

availability directly affected the vegetative growth of seedlings. The five-day watering interval with the application of two types of banana peel and tomato compost and different doses were not able to reduce water use in pre-nursery oil palm nurseries against the growth of seedling trunk circumference at 3 MAT.

The application of compost did not result in a noticeable difference between the 4 MAT and 5 MAT treatments. In general, the compost has the same effect as inorganic fertilizer on the growth of oil palm trunks. This is influenced by the mixture of planting media used in oil palm nurseries, and based on the results of the analysis, the banana peel compost has relatively high nutrients such as N, P, and P, which can meet the nutrient requirements for the growth of oil palm trunk circumference and showed an effect that is not significantly different from that of NPP inorganic fertilizer. Table 3 shows that the application of 1 kg/polybag of compost 10:3 to seedlings watered daily (H) was not significantly different from the treatment with inorganic fertilizers (A). Therefore, the combination of organic fertilizers can be used as an alternative to fertilization in oil palm nurseries during the pre-nursery stage. The increase in the growth of the trunk circumference of oil palm seedlings reached 8% compared to the treatment with NPP inorganic fertilizer (68.5 g/polybag).

Leaf Area

The leaf area data in Table 4 show that the application of compost with different watering intervals had significantly different effects on the leaf area of oil palm seedlings at 4 and 6 MAT. At 6 MAT, the compost application of banana peel and tomato (same ratio) and the same dose resulted in a leaf area that did not differ significantly between daily and once every five days. This shows that composting can hold water in the soil for a longer period so that it can adequately meet the water needs of the plant. The same situation occurred in its effect on leaf area, which was at 4 MAT, except for the treatment of 1 kg with the same ratio (F and G) and (H and I). In this treatment, the daily watering interval had a noticeable difference in oil palm seedlings compared to the five-day watering interval. A higher compost dose does not necessarily have a positive influence on the ability of the soil to store water. Physical compost is a differentiating material in the ability of the planting medium to retain water and is porous enough to have a good effect on plant root growth. Good root growth causes the roots to absorb water and nutrients, which directly affects the overall growth of the plant. Daily watering intervals showed better leaf area growth than five-day watering intervals, especially at 4 MAT and 6 MAT. This situation is closely related to the function and availability of water for the plants (Damanik 2014).

Compost from banana peels and tomatoes with two nutrient ratios, 10:1 and 10:3, can be used as an alternative fertilizer for oil palm seedlings. This compost has the same effect as inorganic fertilizers in its effect on the growth of leaf area in the range of 1–6 MATs. In addition, compost from banana peels and tomatoes is useful in reducing the provision of water for palm oil plants.

CONCLUSION

The use of household waste from banana peels and rotten tomatoes as organic fertilizer in the form of compost can be used as an alternative to inorganic fertilizers in oil palm nurseries during the pre-nursery stage. Application of the compost and different watering intervals affected the growth parameters of the oil palm seedlings. The application of 1 kg/polybag of banana peel and tomato compost (10:3),

Table 4 The effect of applying banana peel and tomato compost and different watering intervals on the leaf area of oil palm seedlings

Treatment	Leaf area of oil palm seedlings (cm^2)					
	1 MAT	2 MAT	3 MAT	4 MAT	5 MAT	6 MAT
A	28.8 a	53.3 a	79.7 a	90.0 bc	145.5 a	182.2 ab
B	27.2 a	39.4 a	62.6 a	94.1 bc	137.9 a	163.5 b
C	19.7 a	36.2 a	54.5 a	67.8 c	101.3 a	160.2 b
D	24.0 a	43.7 a	71.1 a	91.4 bc	145.7 a	206.7 ab
E	19.5 a	30.5 a	50.0 a	68.2 c	114.4 a	134.7 b
F	25.6 a	50.6 a	87.3 a	155.1 a	224.0 a	301.2 a
G	25.3 a	37.2 a	56.6 a	70.4 c	100.1 a	128.7 b
H	32.5 a	61.8 a	101.7 a	149.4 ab	235.1 a	294.6 a
I	29.9 a	47.5 a	73.4 a	85.1 c	130.3 a	175.8 ab

Remarks: The average value followed by the same letter in the same column shows no real difference based on the Duncan Multiple Distance Test at a significant level of 5%. MAT = months after treatment; A = NPP inorganic fertilizer 68.5 g/polybag, watering daily; B = 0.5 kg/compost of banana peel and tomato (10:1), watering daily; C = 0.5 kg/compost of banana peel and tomato (10:1), watering every five days; D = 0.5 kg/compost of banana peel and tomato (10:3), watering daily; E = 0.5 kg/compost of banana peel and tomato (10:3), watering every five days; F = 1 kg/compost of banana peel and tomato (10:1), daily watering; G = 1 kg/compost of banana peel and tomato (10:1), watering every five days; H = 1 kg/compost of banana peel and tomato (10:3), daily watering; and I = 1 kg/compost of banana peel and tomato (10:3), watering every five days.

accompanied by daily watering, showed the best oil palm seed growth with respect to plant height, number of leaves, trunk circumference, and leaf area and showed the same effect as the application of NPP inorganic fertilizer.

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