Proceeding of International
Conference on Science and Technology
Lembaga Penelitian Pengabdian kepada Masyarakat dan Dakwah Islamiyah, Universitas Islam Kuantan Singingi, Indonesia, November 10th 2022
DOI : https://doi.org/10.36378/internationalconferenceuniks.v0i0.2823
ISSN 2985-8739
Page: 49-55

Response of Turnera subulata cuttings to various types of compound fertilizers and growing medium

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Abstract

The presence of leaf-eating caterpillars is one of the most common concerns in oil palm fields. Besides the use of insecticides, the growth of beneficial plants such as T. subulata can assist in fighting caterpillar infestations. This is owing to the plant's capacity to generate nectar, which attracts predators such as leaf-eating caterpillars. The purpose of this research is to determine the effect of combining various types of compound fertilizers, namely NPK Mutiara 16-16-16, NPK Grower 15-09-20+TE, and Nitrophoska special 12-12-17 (+2+6) +TE, with modified growing medium consisting of rice husk ash and compost. The application of NPK Mutiara in combination with rice husk ash addition as a growing medium was shown to have the ability to accelerate the flowering age of T. subulata and to increase the root fresh weight. This is due to the fact that the incorporation of NPK Mutiara 16-16-16, in combination with the improvement plant roots, results in superior nutrient uptake and root penetration in comparison to the usage of NPK Grower or NPK Nitrophoska. In addition, when compared to soil+compost, the addition of rice husk ash to ultisol was able to increase the flower and root number by 48% and 38%, respectively.

Keywords: rice husk ash, compost, flowering age, Turnera subulata cuttings, oil palm plantation, sustainable agriculture.

1. Introduction

Leaf-eating caterpillars on oil palm plantation, such as Sycanus sp., Eocanthecona furcellata, Cantheconidea javana, Parasitoid Spinaria spinator, Chlorocryptus purpuratus, and Apantales, are one of the issues that are frequently discovered in oil palm plantations. This is due to the fact that caterpillars have the potential to limit the performance and production of oil palm plants. In most cases, insecticides in the appropriate dosages are used in order to stop the attacks that are carried out by these caterpillars. Planting beneficial plants that serve as hosts for predatory insects around the oil palm plantation field is one method for reducing the population of these caterpillars. Cassia cobanensis, Antigonon leptopus, Turnera subulata, and T. ulmifolia are four examples of useful plants that are now being cultivated. Through the nectar that it generates, T. subulata has the ability to attract Trichogrammatoidea thosea, which are predators of caterpillars that devour palm leaves [1]–[8]. There are two methods for the propagation of T. subulata: generative propagation, which involves the use of seeds, and vegetative propagation, which involves the use of cuttings. Cuttings are the most common method of propagation for T. subulata in oil palm plantations. This is due to the fact that seeds of this plant are fairly difficult to obtain, and the rate of growth in large quantities is significantly accelerated by using cuttings [5], [6], [8], [9].

Growing medium is a place to live for plants consisting of soil and organic matter added in an appropriate proportion. Because in general, the growing medium needs to be able to hold the roots of the plant in order for the plant to be able to stand upright and not readily collapse when blown over by the wind or when subjected to other types of disturbances. One of the common soils type found in oil palm plantations is ultisol soil. An ultisol is a type of soil that has experienced weathering and as a consequence has lost its alkaline cations. Ultisol has a loose consistency, a texture that ranges from clay to loam, well-structured soils that allow for adequate gaseous exchange and free root water penetration, and clay to loam texture. The mineralogy, parent material, drainage, age of the soil, and climatic circumstances all have a role in determining the color of the soil in an Ultisol, however, it is typically red in hue [10]–[15].

It is required to change the growing medium in order to support healthy plant growth. One approach to achieve this is by adding rice husk ash, for instance. Rice husk ash is an effective growing medium that promotes healthy plant growth. Ash produced from rice husks is obtained from the combustion of rice husk biomass. Rice husk ash has the ability to improve soil chemical characteristics, raise soil pH, contain complex macronutrients, and improve soil physical and biological qualities as well. These benefits can be achieved because of rice husk ash's multifunctional nature [13], [14], [16]–[20]. Compost is typically one of the additional components that are put into growing medium alongside rice husk ash. The term "compost" refers to any organic substance that has been broken down by the action of microorganisms

or bacteria that thrive in organic matter and cause it to deteriorate. Grass, straw, plant wastes, animal manure, and leaf fall are all examples of organic resources that can be used in composting. The action of microbes in a moist environment will lead to the breakdown of all of these organic molecules into their component elements. Compost contains a number of nutrients, some of which are released more slowly than others, making it particularly beneficial for the growth of plants and soil when it is used. Compost is important for a number of reasons, one of which is that it raises the soil's water-binding capacity, allowing it to hold groundwater for a longer period of time and ensuring that the soil's moisture content is maintained. In addition, compost can assist preserve the health of plant roots, making it easier for plant roots to grow, and contribute to the plant's ability to absorb nutrients and water [14], [21]–[24].

In order to promote healthy plant growth, fertilization is an essential requirement. The most frequent type of fertilizer applied to soil is a complete compound fertilizer that contains NPK. There is a wide variety of compound fertilizers available on the market, which each offers a range of different grades [14], [25]–[28]. There is no information available at this time regarding the effect that various grades of compound fertilizers would have on T. subulata plants if they were grown in a variety of growing medium. As a result, the purpose of this research is to investigate how the growth of T. subulata cuttings is affected by the interaction between the application of various compound fertilizers and a variety of growing medium.

2. Research Methods

2.1 Experimental Design

This experiment was carried in the periods of December 2021 and February 2022 utilizing a completely randomized design with a total of four replications and two factors. The first independent variable was the type of compound fertilizer, which were NPK Mutiara 16-16-16, NPK Grower 15-09-20+TE, and Nitrophoska special 12-12-17 (+2+6) +TE at 3 g/shoots. The growing medium, which included soil, soil combined with rice husk ash (soil+rice husk ash), and soil combined with compost (soil+compost), was the second component. Soil was used in this experiment was classified as Ultisol.

After combining the sifted topsoil from Gunung Kidul in Yogyakarta, Indonesia, with the rice husk and compost at 1:1 ratio, the mixture was filled in 18 x 18 cm polybags. Prior to planting, the polybags that have been loaded with media are given an adequate amount of water till they attain the capacity of the field. Polybags are arranged inside of a greenhouse that is covered in UV plastic and has a front height of 2 meters, a back height of 1.6 meters, and a width of 1.6 meters. T. subulata stem cuttings were collected from a parent plant that was in good health and was approximately a year old when they were taken. The cuttings that have been selected are both straight and green. Cutting material start at the top of approximately 2-3 segments and cut them to a length of less than 15 cm, leaving 2-3 leaves. After that, the cuttings were sliced at an angle of 45 degrees, and then they were submerged for half an hour in a solution of Atonic growth regulator (PT. Oat Mitoku Agrio, Cikarang, Indonesia), which had a concentration of 1%. The plant was fertilized starting in the second week, and additional applications have been made at regular intervals of three weeks. The practice of weeding entails the routine eradication of weeds that have developed in and around polybags. This is done in order to keep the area clear. Pest control was handled manually through a process known as hand-picking. During the first two weeks of growth, T. subulata cuttings were watered twice daily in an effort to lower the death rate. After a period of two weeks, watering occurs once a day between the hours of 4-5 in the afternoon.

2.2 Plant Analysis

The increase of plant height, number of shoots, number of leaf, number of flower, flowering age, shoot fresh weight, shoot dry weight, roots fresh weight, roots dry weight, number of root, and root length were measured. After the seedlings had been growing for one week, measurements of their height, number of shoots, and leaves had been taken once per week until harvest at 7 weeks after transplanting. While observations of other parameters were made at harvest. Determining the height of the seedling by measuring from the base of the plant to the top. A total number of leaves be determined from the leaves that have fully opened. The fresh weight of the shoots and roots was assessed at harvest time by using an analytical balance to weigh each component separately. The dry weight of the plant sample was obtained after drying it in an oven at 70°C for 48 hours.

2.3 Statistical Analysis

To determine the differences between treatments, a one-way ANOVA was used. Tukey's HSD (Honestly Significant Difference) was employed as a post hoc test, with the statistical difference level set at 5%. SPSS version 26 was used for all statistical analyses (IBM Corp., Armonk, New York, USA).

3. Results and Discussions

There were significant interactions found between flowering age and several types of compound fertilizers and growing media (Table 1). It took

only 14.33 days for NPK Mutiara fertilizer with soil and rice husk growing media to exhibit a shorter age when T. subulata began to flower, which was a shorter age than any other fertilizer treatment. This value was varied depending on whether the growing medium consists just of soil or soil combined with compost. In addition, when compared to all of the combinations that used NPK Nitrophoska fertilizer, the results of employing NPK Mutiara fertilizer in conjunction with soil and rice husk demonstrated a significant differences. This is due to the fact that NPK Mutiara fertilizer has a fertilizer grade of 16-16-16, which ensures that nitrogen and phosphorus requirements are more satisfactorily met than when merely application of NPK Nitrophoska fertilizer, which has a grade of 12-12-17. Therefore, the use of NPK Mutiara fertilizer in combination with soil and rice husk growing medium proved to be the most effective treatment. It is envisaged that the benefits of T. subulata as a predatory host plant for oil palm leaf-eating caterpillars will be fast realized because the flowering phase for this plant occurs more swiftly. Additionally, the interaction was observed in the fresh weight parameters of the T. subulata roots (Table 2).

When compared to the other treatments, the application of NPK Mutiara 16-16-16 compound fertilizer with growing medium soil+rice husk ash demonstrated the highest root fresh weight value. This demonstrates that the combination is able to not only decrease the amount of time it takes for T. subulata to begin flowering, but it is also able to increase the amount of root fresh weight.

Table 1. Interaction of types of compound fertilizers and growing medium on the flowering age of T. Subulata

Growing medium	Type of compound fertilizer			Average
	NPK Mutiara	NPK Grower	Nitrophoska	
Soil	17.50 ± 1.29 b	20.75 ± 0.50 cd	22.25 ± 0.96 d	20.17 ± 2.25
Soil + rice husk	14.33 ± 0.58 a	16.25 ± 1.26 ab	22.75 ± 2.63 d	18.09 ± 4.11
Soil + compost	18.50 ± 3.11 bc	19.00 ± 1.83 bc	21.25 ± 2.63 cd	19.58 ± 2.64
Average	17.00 ± 2.57	18.67 ± 2.27	22.08 ± 2.11	

Remarks: the value followed by the same letter indicate no significant difference in the Tukey's HSD test with a 5% level.

Table 2. Interaction of types of compound fertilizers and growing medium on root fresh weight of T. Subulata

Growing medium	Type of compound fertilizer			Average
	NPK Mutiara	NPK Grower	Nitrophoska	
Soil	3.49 ± 1.39 b	5.14 ± 1.35 b	2.99 ± 0.67 b	3.87 ± 1.44
Soil + rice husk	11.8 ± 2.65 a	4.87 ± 1.05 b	4.67 ± 1.93 b	7.32 ± 4.01
Soil + compost	3.75 ± 0.73 b	4.60 ± 0.88 b	4.20 ± 1.62 b	4.27 ± 1.14
Average	6.87 ± 4.59	4.87 ± 1.03	3.95 ± 1.55	

In addition to root fresh weight and flowering age, two parameters that exhibited interactions, additional parameters indicated a separate effect between the type of compound fertilizer treatment and the growing media that was utilized. When compared to NPK Grower, the addition of NPK Nitrophoska fertilizer demonstrated a significant increase in root dry weight. When compared to NPK Grower fertilizers, which only contain 9% P2O5, the amount of P2O5 contained in Nitrophoska is 12%, which means that NPK Nitrophoska has the more potential to raise the dry weight of the roots. It is abundantly clear that phosphorus plays a significant part in the process of raising root parameters; this effect was observed in the root dry weight parameters of this study. In the meantime, other root parameters, such as the number of roots and the length of the roots, have not showed any significant differences between the three types of compound fertilizers.

Other parameters on compound fertilizer application have not showed a significant effect. T. subulata plant height ranged from 71.92 to 76.58 cm under all compound fertilizer treatment (Table 3). Meanwhile, the number of shoots and leaves ranged from 18.58–22.33 shoots to 71.91–81.75 leaves, respectively. The number of flowers did not different significantly between the three fertilizers grade treatments, with an average of 3.30–3.60 flowers. The fresh and dry weights of the shoots did not differ significant, with ranges of 23.74–32.75 g and 4.47–6.37 g, respectively. Meanwhile, the number of roots and root length are not statistically different, at 24.00–30.40 and 18.33–20.36 cm, respectively.

Plant height demonstrated no significant difference, with soil medium generating 75.75 cm while soil+rice husk ash and soil+compost at 72.33 and 74.17 cm, respectively (Table 4). The number of shoots produced by the three growing media treatments did not differ significantly, with a range of 19.33-20.92. Leaf number has no significant

different between the three growing media treatments, with the number of leaves ranging from 70.64 to 87.83 leaves. The fresh and dry weights of the shoots varied from 22.27-31.67 g and 4.10-5.94 g, respectively, with no statistically significant difference between the three growing medium treatments. Furthermore, there was no significant difference in root dry weight and root length, which were 1.27-1.75 g and 19.17-20.30 cm, respectively. Meanwhile, the number of T. subulata flowers differed significantly, with the highest values on soil and soil+rice husk media reaching 3.45 and 4.00 flowers, respectively, notably different from soil+compost, which had an average flower number of 2.70. Soil+rice husk also had a larger number of roots of 30.67 than soil+compost, which was 22.30.

Table 3. The effect of the type of compound fertilizer on the growth of stem cuttings of T. subulata

Parameters	Type of compound fertilizer		
	NPK Mutiara	NPK Grower	Nitrophoska
Plant height (cm)	76.58 ± 10.48 a	71.92 ± 7.42 a	73.75 ± 12.66 a
Number of shoots	22.33 ± 6.29 a	19.50 ± 2.35 a	18.58 ± 4.01 a
Leaf number	81.18 ± 16.32 a	71.91 ± 11.63 a	81.75 ± 28.72 a
Number of flower	3.60 ± 1.07 a	3.30 ± 0.67 a	3.33 ± 0.65 a
Shoot fresh weight (g)	32.75 ± 13.32 a	23.74 ± 7.74 a	28.19 ± 11.63 a
Shoot dry weight (g)	6.37 ± 3.27 a	4.47 ± 1.48 a	4.72 ± 2.45 a
Root dry weight (g)	1.53 ± 0.51 ab	1.07 ± 0.33 b	1.99 ± 0.63 a
Number of roots	30.40 ± 9.58 a	29.58 ± 7.43 a	24.00 ± 6.19 a
Root length (cm)	20.36 ± 3.88 a	20.00 ± 3.13 a	18.33 ± 3.47 a

Remarks: the value followed by the same letter in the same row indicate no significant difference in the Tukey's HSD test with a 5% level.

Table 4. Effect of growing medium on the growth of stem cuttings of T. subulata

Parameters	Growing medium		
	Soil	Soil + rice husk	Soil + compost
Plant height (cm)	75.75 ± 7.50 a	72.33 ± 11.47 a	74.17 ± 11.96 a
Number of shoots	20.92 ± 6.14 a	19.33 ± 3.06 a	20.17 ± 4.59 a
Leaf number	75.82 ± 14.52 a	87.83 ± 26.31 a	70.64 ± 14.98 a
Number of flower	3.45 ± 0.52 a	4.00 ± 0.77 a	2.70 ± 0.48 b
Shoot fresh weight (g)	22.27 ± 8.01 a	30.25 ± 9.15 a	31.67 ± 14.48 a
Shoot dry weight (g)	4.10 ± 1.54 a	5.47 ± 1.80 a	5.94 ± 3.66 a
Root dry weight (g)	1.27 ± 0.42 a	1.75 ± 0.80 a	1.63 ± 0.55 a
Number of roots	29.67 ± 7.92 ab	30.67 ± 8.97 a	22.30 ± 3.59 b
Root length (cm)	19.25 ± 3.28 a	19.17 ± 2.82 a	20.30 ± 4.64 a

Remarks: the value followed by the same letter in the same row indicate no significant difference in the Tukey's HSD test with a 5% level.

T. subulata plant height began to rise in the third week and continued to rise until the seventh week in both the compound fertilizer treatment (Figure 1A) and the growing media type (Figure 1B). *T. subulata* showed a significantly moderate increase in height at the start of its growth because the plants required adaption time when they were initially planted. After 3 weeks of cuttings, the growth rate of *T. subulata* plants began to accelerate. The number of *T. subulata* shoots followed the same pattern (Figures 1C and D). There were no additional shoots in the first two weeks. The addition of new shoots was noted in the third week and continued to increase until the last week of observation. The addition of NPK Mutiara fertilizer resulted in a trend of more shoots than the other treatments, albeit this did not indicate a significant difference in the last week of observation. Longer observations are required to evaluate whether the application of NPK Mutiara will considerably increase the number of shoots at a later plant age or not.

In the fourth week, there was an increasing trend observed in both the number of leaves produced by NPK Mutiara and Nitrophoska (Figure 1E). Although the NPK Grower exhibits a trend that is slightly lower than the others, such as NPK Mutiara and Nitrophoska, it does not demonstrate a significant difference. The growing media showed

an increasing trend after the fourth week, with the highest trend in soil+rice husk, followed by soil (Figure 1F). Meanwhile, soil+compost has a lower trend than other treatments. Although the three treatments did not show a significant difference.

Fertilizers typically have varying quantities of the macronutrients and micronutrients that it contain. The grade of the compound fertilizer is what determines the difference in the amount of nitrogen, phosphorus, and potassium that is contained in the fertilizer. The NPK Mutiara compound fertilizer has grade of 16-16-16, means it contains 16% N (nitrogen), 16% P_2O_5 (phosphorus oxide) , and 16% K_2O (potassium oxide). The NPK Mutiara content appears to same in percentage for N, P_2O_5, and K_2O, in contrast to the NPK Grower 15-09-20, which has a P_2O_5 content of just 9%, while the K_2O content is highest at 20%. The difference between the two fertilizers may be seen in the fact that NPK Grower with more potassium are more suited when directed at plant commodities, plant stages, or soil characteristics that require high potassium levels. According to the findings of this research, the value of *T. subulata* increased significantly when NPK Mutiara was applied rather than NPK Grower. This was feasible due to the fact that an excessive amount of potassium is not required during the early stages of *T. subulata* cuttings plant development. More nitrogen is required while the plant is first starting to grow, whereas more phosphorus is required when the plant is flowering [14], [15], [27], [28]. In consequence of this, *T. subulata* treated with NPK Mutiara and given the appropriate growing medium in the form of a mixture of soil and rice husk ash was able to demonstrate higher values than various growing medium treated with NPK Grower (Tables 1 and 2).

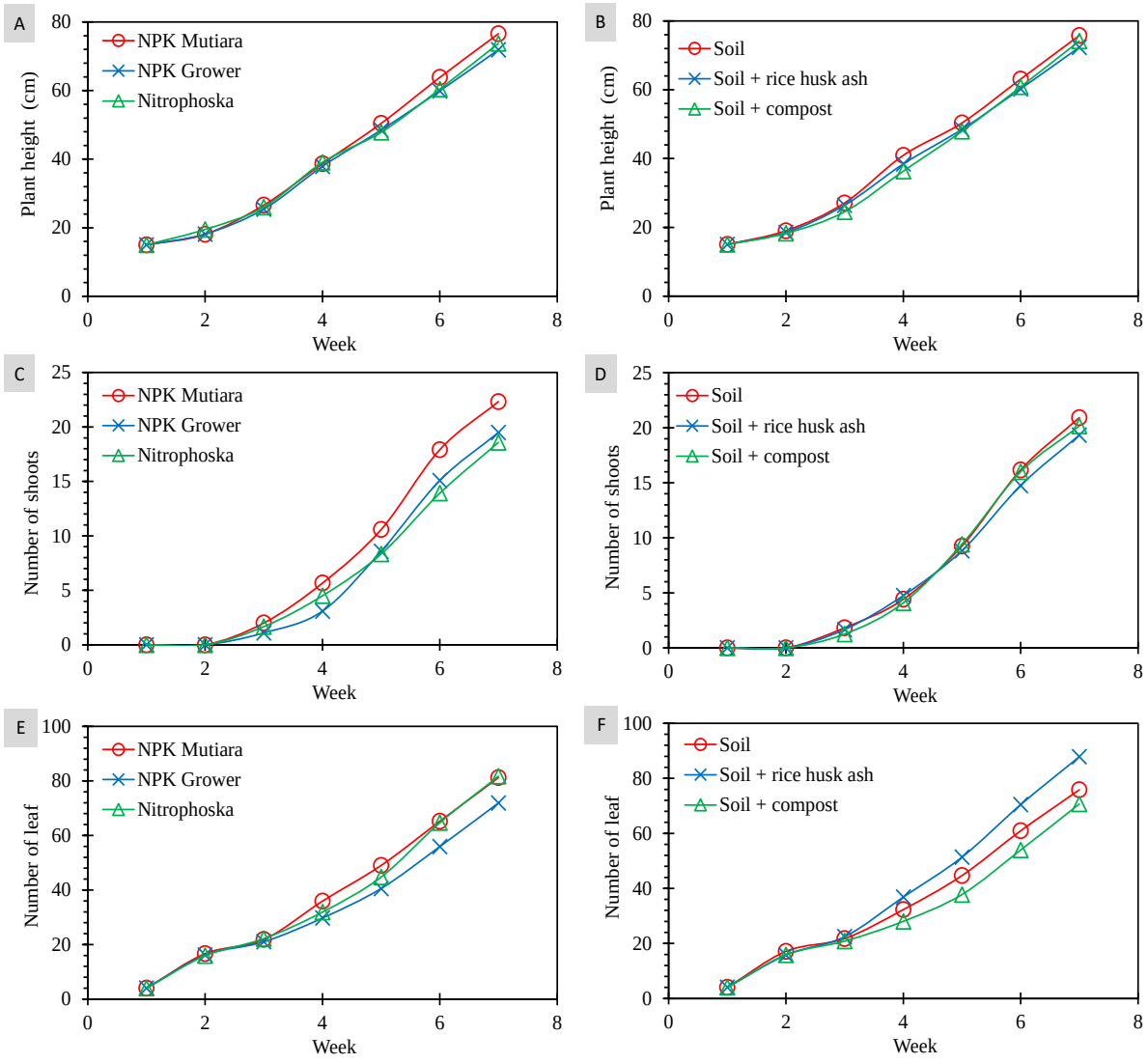

Figure 1. Effect of type compound fertilizer (A, C, E) and growing medium (B, D, F) in plant height (A, B), number of shoots (C, D), and number of leaf (E, F) of T. subulata.

According to this study the addition of husks can increase the amount of numerous factors, including the number of blooms and the number of roots. According to Gustia's [16] investigation, it was discovered that adding rice husk ash to soil growing medium at a ratio of 1:1 resulted in higher yields of plant height, number of leaves, leaf length, leaf width, and wet weight when compared to soil growing media without addition of husks. Additionally, husks ash have a high carbon content, which causes the growing medium to be more friable [11], [13], [20]. Therefore, the characteristics of a suitable growing medium for T. subulata plants are soils with the addition of rice husk ash could facilitate the roots in absorbing water and nutrients for the growth and development of T. subulata cuttings.

4. Conclusion

Application of NPK fertilizer with the right grade combined with improved growing medium was able to produce better growth of T. subulata cuttings. This can be seen in the application of NPK Mutiara combined with the addition of rice husk ash to ultisol soils that can accelerate the flowering age and fresh weight of T. subulata roots. The flowering age parameter is one of the important parameters in T. subulata as a beneficial plant because the flower is able to attract predators who can become natural enemies of leaf-eating caterpillars on oil palm plantation.

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