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The Effect of Organic NPK and Auxin on the Growth of Oil Palm Seedlings (*Elaeis guineensis* Jacq.) in Peat Soil Media in Pre Nursery

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Abstract: This study aims to determine the effect of interaction and the main organic NPK and auxin on the growth of oil palm seedlings (*Elaeis guineensis* Jacq.) in peat soil media in the pre-nursery. The study was conducted at the Experimental Garden of the Faculty of Agriculture, Riau Islamic University, Pekanbaru. This study lasted for 4 months from March to June 2024. This research use factorial complete randomize design of two factors. The first factor is organic NPK consisting of 4 levels, namely 0, 25, 50 and 75 g/plant and the second factor is auxin consisting of 4 levels, namely 0, 3, 6 and 9 ml/l. There are 16 treatment combinations with 3 replications. The parameters observed were plant height, number of leaf, longest leaf stalk length, stem diameter, primary root length, root volume and plant dry weight. The data were analyzed statistically and continued with the 5% HSD test. The results showed that the interaction of organic NPK and auxin had a significant effect on the parameters of root volume and plant dry weight. The best treatment was given a combination of organic NPK 75 g/plant and auxin 6 ml/l of water. The main effect of organic NPK gave a significant effect on all observation parameters with the best treatment of organic NPK at a dose of 75 g/plant. The main effect of auxin gave a significant effect on all parameters except the number of leaf stalks with the best treatment of auxin at a dose of 6 ml/l of water.

1. Introduction

The oil palm plant (*Elaeis guineensis* Jacq.) is one of the plantation crops that is widely cultivated in Indonesia and is the largest producer of palm oil in the world and the industry has become a mainstay in the economy because palm oil is one of the sources of foreign exchange earnings from agricultural exports. According to the Central Statistics Agency (2023), the area of oil palm plantations in Riau has increased from year to year, in 2020 it had a land area of 1,446,050 hectares with a production of 3,669,732 tonnes, then in 2021 it had an area of 1,614,004 hectares, with a production 3,701,856 tons, and in 2022 it will increase again with an area of 1,732,748 hectares with production of 4,090,825 tons. This shows that public interest, especially farmers, is very high in cultivating oil palm plants. According to the Riau Province Plantation Service (2023), the total land that will be rejuvenated is 10,000 hectares. Therefore, it is necessary to make efforts to seed oil palms for plants that will be replanted.

In this research, the focus is more on the pre nursery because to get quality plant growth it is necessary to pay attention to growth from the start until entering the next nursery stage. Apart from genetic factors, the provision of nutrients at the beginning of seedling growth has an important role in determining the overall appearance of the seedlings. Topaz variety can be planted in peat land, because it is one of the varieties that is tolerant of peat soil. Peat soil had several obstacles, were having a low pH level, having a high cation exchange capacity, low base saturation, having a low content of N, P, K, Ca, Mg elements and also having micro nutrients such as Cu, Zn, Mn (Aryanti et al., 2016). Therefore, improvements are needed to increase the fertility of peat soil, namely with organic fertilizer.

The organic NPK fertilizer is made from organic materials or from plant residues which contain high levels of N, P and K. Organic NPK fertilizer has a Nitrogen content of 6.45%, P2O5 0.93%, K2O 8.86%, C-Organic 3.1%, Sultur 1.60%, CaO 4.10%, MgO 1.70%, Cu 33.98 ppm, Zn 134.94 ppm, Iron 0.22%, and Boron 94.75 ppm (Sumitro et al., 2018). Organic NPK fertilizer is very suitable for use in oil palm nurseries using peat soil, apart from supplying the availability of nutrients, it can also improve the physical and biological properties of the soil (Usmardianto and Jahari, 2016). The fact that often occurs in oil palm nurseries is that it leads to abnormalities, this needs to be taken into account because it can result in stunted vegetative growth (Kristalization et al., 2023). To support uniform growth of oil palm seedlings, growth regulators (ZPT) can be given.

Growth regulators (ZPT) are organic compounds that are not plant nutrients which are active in low concentrations (can be < 1 mM) to stimulate, inhibit or change plant growth and development quantitatively and qualitatively. Can be produced by plants (natural/endogenous) or synthetic (exogenous). The growth regulator that can be used is auxin. Auxin as a growth hormone for plants has a role in plant growth and development. This growth hormone can influence cell development, phototropism, geotropism, apical dominance, root growth, parthenocarpy and abisission (Wiraatmaja, 2017). So the use of auxin in oil palm plant nurseries can speed up the seedling growth process and get seedlings that grow uniformly before entering the main nursery phase.

This study aims to determine the effect of interaction and the main organic NPK and auxin on the growth of oil palm seedlings (*Elaeis guineensis* Jacq.) in peat soil media in the pre-nursery.

2. Research Methods

2.1 place and time

The research was carried out at the experimental garden of the facultry of agriculture, Riau Islamic University, jalan khairudin Nasution Km 11, Air cool village, Bukit Raya Distric, Pekanbaru city. This research was conducted for four months starting from march to june 2024.

2.2 Material and tools

The material used in this research were oil palm sprouts of the DxP Topaz variety (Appendix 2), peat soil, water, organic NPK fertilizer, auxin from dekamon 22,43L, polybag 20 x 25 cm (3kg polybag), paranet 75%, zink plate, paint, raffia rope, wood and pesticides. Manwhile, the tools used in this research were hoes, measuring tape, analytical scales, treatment plates, oil paint, brushes, nails, hands sprayer, gembor, sscissos, 100 ml measuring cup, camera, writing tools.

2.3 Methods

This research used a factorial Completely Randomized Design (CRD) consisting of 2 factors. The first factor is the organic NPK dosage (N) consisting of 4 levels, namely 0, 25, 50 and 75 g/plant and the second factor is auxin consisting of 4 levels, namely 0, 3, 6 and 9 ml/l. There are 16 treatment combinations with 3 repetitions, so there are 48 experimental units. Each unit consisted of 4 plants and 2 were used as samples, so the total number of plants was 192 plants.

The parameters observed were plant height, number of leaf stalks, longest leaf stalk length, stem diameter, primary root length, root volume and plant dry weight. The data were analyzed statistically and continued with the 5% BNJ test.

3. Result and Discussion

Table 1. Plant height, number of leaf, longest leaf length, stem diameter, primary root length of oil palm seedling treated with organic NPK and auxin

Treatment	Plant Height (cm)	Number of Leaf	Longest Leaf Length (cm)	Stem Diameter (mm)	Primary Root Length (cm)
Organic NPK (g/plant)					
0 (N0)	22,81 b	4,66 b	23,17c	9,71 c	22,73 c
25 (N1)	23,82 b	4,85 b	24,56 bc	10,97 b	24,44 c
50 (N2)	24,40 b	5,20 a	26,25 b	11,97 a	27,41 b
75 (N3)	27,49 a	5,35 a	28,83 a	12,51 a	31,26 a
Auxin (ml/l)					
0 (A0)	23,61 b	4,92	24,40 b	10,85 b	25,39 b
3 (A1)	24,21 ab	5,03	26,02 ab	11,11 ab	26,42 ab
6 (A2)	25,64 a	5,17	27,00 a	11,98 a	28,23 a
9 (A3)	25,05 ab	4,95	25,40 ab	11,21 ab	25,79 b

Numbers in rows and columns followed by the same lowercase letters are not significantly different according to the HSD test at the 5% level.

3.1 Plant Height (cm)

The results of analysis of variance showed that the interaction of organic NPK and auxin had no significant effect on plant height, but main effect it had a significant effect on plant height of oil palm seedlings (Table 1). Table 1 showed that the organic NPK ferilizer doses 75 g/plant (N3) treatment gave the highest plant height, is 27.49 cm and was significantly different for other treatments.

Providing organic NPK 75 g/plant is able to improve the physical properties of the soil so that it can increase the growth and development of oil palm seedlings. According to Yogastya (2017) organic fertilizer has several benefits, firstly increasing soil fertility because it contains macro and micro nutrients which can improve soil composition. Second, improving the physical, chemical and biological conditions of the soil, organic fertilizer can facilitate the system of binding and releasing ions in the soil so that it can increase fertility in the soil. This is in accordance with the characteristics of the peat soil used in this research because peat soil is known to have low nutrients so it needs to add fertilizer to support the plant's nutrient needs. Peat soil has a low pH and has many obstacles in the availability of nutrients, high soil acidity, as well as low levels or levels of availability of phosphorus (P) and potassium (K) in the soil and high P uptake, the amount of K in peat soil is lower than K Soil minerals and nitrogen (N) are unstable in their availability, because they can experience leaching, volatilization and denitrification (Sani, 2021). So that giving Organic NPK can meet the needs of plants in peat soil.

The main effect of auxin treatment also had a significant effect on plant height (Table 1). The highest treatment was found in the 6 ml/l, is 25.64 cm (A2) and was not significantly different from treatments 9 and 3 ml/l but significantly different from treatment A0. This is because the auxin concentration must be appropriate to support optimal plant growth. Concentration auxin 6 ml/l gives the tallest plants, namely 25.64 cm compared to other treatments. Auxin given at optimal concentrations and supported by environmental conditions will accelerate physiological processes which cause cell division to become faster so that plant height growth will develop optimally (Rona et al., 2023). Auxin plays a role in plant height growth, where it can accelerate cell division and elongation at appropriate concentrations, which will stimulate plant height growth, but in excessive amounts it can inhibit plant growth (Nurfauzan et al., 2022).

3.2 Number of Leaf (leaf)

The results of analysis of variance showed that the interaction and main effect of auxin did not have a significant effect on the growth of the number of leaf, but the main effect of organic NPK had a significant effect on the number of leaf. The data in Table 1, showed that the main effect of organic NPK fertilizer 75 g/plant (N3) gave the highest number of leaf on oil palm plants, was 5.35 (N3) and was not significantly different from the N2 treatment but was significantly different from the others. The plant with the lowest number of leaf was without treatment, was 4.66 (N0).

Fitriani et al., (2014) stated that the physiological process of leaf formation begins with the division stage in the growing point cells through shoots which are stimulated by hormones and nutrients. Organic NPK fertilizer gives sufficient doses can increase leaf growth because the nitrogen (N) element for plants stimulates the growth of branches, stems and leaves. Apart from that, nitrogen also plays an important role in the formation of chlorophyl which is very useful in the photosynthesis process (Iqbal, 2020). The P element plays a role in regulating protein synthesis, so this nutrient is very important in cell division and the development of new tissue in the formation of leaves. The element potassium (K) plays a very important role in every plant metabolism, namely in the synthesis of amino acids and proteins from ammonium ions in the process of photosynthesis, because if there is a lack of potassium in the leaves, the speed of carbon dioxide assimilation will decrease and will affect the formation of leaf buds. new. The nutrient potassium is needed in the vegetative phase in large quantities because it plays a role in leaf formation (Saimara and Arthur, 2021).

3.3 Longest Leaf Length (cm)

The results of analysis of variance showed that the interaction between organic NPK and auxin had a significant effect on longest leaf length, but main effect of both organic NPK and auxin had a significant effect on longest leaf length (Table 1). The organic NPK fertilizer doses 75 g/plant (N3) treatment had a significant effect on longest leaf length, was 28.83 cm and was significantly different from others. It is because organic NPK at a dose of 75 g/plant can provide sufficient nutrients for oil palm plants in the pre-nursery for vegetative growth, especially containing the elements N, P and K which function to stimulate sprouting and increase plant height, nitrogen also plays a significant role in accelerating overall plant growth, especially stems and leaves (Sabri, 2019).

Adding organic matter to the soil also improve the soil water content. This is because organic materials have the ability to store water four times greater than their weight. If the water content in the soil is adequate, the plant's water needs will be met. By fulfilling the plant's water needs, the plant's adaptation to environmental conditions will be better (Schjoning et al., 2017). Organic fertilizers also play a major role in efforts to improve the physical, chemical and biological properties of soil such as improving the structure of soil pores, the ability to bind water, and retaining microorganisms in the soil so that they can accelerate vegetative growth and also have a positive impact on plant growth in the soil peat.

In terms of main effect, auxin treatment had a significant effect on longest leaf length of oil palm seedlings (Table 1). The auxin treatment with concentration on 6 ml/l, gave the longest of the longest leaf length was 27.00 cm (A2), and was not significantly different from the treatment of 9 ml/l (A3) and 3 ml/l (A1), but was significantly different from that without treatment. (A0). This is because giving auxin at the appropriate dose will help plant growth. This is in accordance with the statement of Prameswari and Bayu (2021), apart from playing a role in shoot formation, shoot height and root formation, it also plays a role in leaf growth and the speed with which shoots appear will affect the length of plant leaves.

3.4 Stem Diameter (mm)

The results of analysis of variance showed that the interaction of organic NPK had no significant effect on stem diameter of oil palm seedlings, however, the main effects of organic NPK and auxin treatment had a significant effect on stem diameter (Table 1). The organic NPK doses 75 g/plant (N3) give the highest stem diameter, namely 12.51 mm and was not significantly

different from the 50 g/plant (N2) treatment, but was significantly different from the other treatments. The smallest stem diameter without treatment was 9.71 mm (A0).

This is in accordance with the opinion of Kurniawan (2022), that the availability of nutrients in sufficient quantities causes the metabolic activities of the plant to increase, as well as the accumulation of assimilate in the stem area will increase resulting in enlargement of the stem. Siregar and Nurbaiti, (2020) stated that the stem is an area of accumulation of plant growth, especially in younger plants, so that the presence of nutrients can encourage plant vegetative growth, including the formation of chlorophyll in the leaves, which will increase the rate of photosynthesis. The higher the rate of photosynthesis, the photosynthate produced will ultimately give a large stem diameter. The nutrients in organic fertilizer can increase plant growth, but in optimal doses to get optimal results. The faster the rate of photosynthesis, the photosynthate produced will give a larger stem diameter. According to Azlansyah (2014), one indicator of good growth of oil palm seedlings can be seen from the hump, the better the height of the stem and the number of leaf will be followed by the greater growth of the hump and stem of the oil palm seedling.

Based on this comparison, it can be concluded that applying organic NPK fertilizer can increase the diameter of oil palm trunks by administering the right dose. This is also supported by the statement by Aryanti et al., (2016) that the nutrients P and K can improve vegetative growth such as stem diameter. The elements P and K play a very important role in increasing the diameter of plant stems. Plant stem diameter reflects the nutritional status of a plant (Simanulang et al, 2017). Vitta (2014) states that phosphorus (P) functions to accelerate root development, cell division processes and plant metabolism, thereby encouraging plant growth rates, including stem diameter. Element K plays a very important role in increasing stem diameter, especially in its role as a tissue that connects roots and leaves. This is because potassium plays a very important role in the process of transporting minerals, including water.

In terms of the main effect, auxin treatment had a significant effect on the stem diameter of oil palm plants (Table 1). The largest stem diameter was found at concentration 6 ml/l, was 11.98 mm (A2) and was not significantly different from the 9 ml/l water treatment (A3) and 3 ml/l water (A1), but significantly different from without treatment (A0). The lowest plant stem diameter was 10.85 mm (N0).

This is because the function of auxin in plant growth is to regulate cell enlargement and trigger cell elongation in the area behind the tip of the meristem so that it can influence the enlargement of oil palm plant stems. Auxin plays an important role in growth, so it can be used to speed up the growth rate of plant seeds in intensive cultivation (Razali and Agung, 2019). Alfiansyah and Khoiri (2015) stated that one of the roles of auxin is to stimulate or accelerate cell elongation. Providing exogenous auxin will increase the activity of endogenous auxin already present in plants, thereby encouraging cell division and causing shoots to appear earlier. Auxin is a plant hormone that can regulate many physiological processes such as growth, cell division and differentiation as well as protein synthesis.

3.5 Primary Root Length (cm)

The results of analysis of variance showed that the interaction of giving organic NPK and auxin had no significant effect on the length of the primary roots of oil palm seedlings. However, in terms of the main effects, organic NPK and auxin had a significant effect on the length of the primary roots of oil palm seedlings. The data in Table 1, showed that treatment of organic NPK fertilizer doses 75 g/plant (N3) has the longest primary root 31.26 cm and was significantly different for all treatments. The lowest primary root length was without treatment, namely 22.73 cm (N0). This is because giving organic NPK treatment can improve the physical properties of the soil and contains nutrients that play an important role in root development so that it can increase the growth of oil palm seedlings and produce optimal root length in pre-nursery oil palm seedlings.

Sarief (2015), stated that the N element absorbed by plants plays a role in supporting the vegetative growth of plants such as roots. The role of element P is to stimulate root growth,

especially lateral roots and hair roots. Element K is a nutrient whose function is to form and stimulate the synthesis of proteins and carbohydrates, stimulate root growth and development, increase root turgor pressure and increase nutrient absorption. Plant roots have an equally important role as the crown because the function of the roots is to absorb water and nutrients dissolved in the soil and transport them to the shoots. Plants must have roots and a root system that is large enough to be able to obtain nutrients and water according to the plant's needs so that the plant will grow well. The longer and wider the plant roots, the more optimal the absorption of nutrients will be (Prayoga, 2021).

The main effect of auxin treatment had a significant effect on the length of primary roots of oil palm seedlings (Table 1). The longest root length was found in the 6 ml/l (A2), namely 28.23 cm and was not significantly different from the 3 ml/l (A1), but was significantly different from the other treatments. It can be concluded that giving auxin at the appropriate concentration can increase the length of primary roots in oil palm seedlings in the pre-nursery. Rikardo et al., (2019) stated that by administering auxin at optimal concentrations it can stimulate root development because of the auxin flowing from the apical meristem to the bottom of the plant, carbohydrates in the plant will collect to stimulate root formation and plant root elongation.

3.6 Root Volume (cm^3)

The results of analysis of variance showed that the interaction and main treatment of organic NPK and auxin had a significant effect on root volume. The data in Table 2, observing root volume, shows that the interaction between organic NPK and auxin treatment has a significant effect on the root volume of oil palm plants in the pre-nursery. The combination of organic NPK treatment of 75 g/plant and auxin 6 ml/l (N3A2) gave the highest on average root volume of 15.53 cm^3 and was not significantly different from the N3A1 treatment but was significantly different from the other treatments.

Table 2. Average root volume of oil palm seedling with organic NPK and auxin treatments (cm^3).

Organic NPK (g/plant)	Auxin (ml/l)				Average
	0 (A0)	3 (A1)	6 (A2)	9 (A3)	
0 (N0)	3,13 h	3,37 gh	3,57 fgh	3,23 h	3,33 d
25 (N1)	4,07 fgh	5,53 def	6,73 cde	5,33 efg	5,42 c
50 (N2)	7,10 cde	7,40 cd	8,70 c	7,13 cde	7,58 b
75 (N3)	11,73 b	13,67 ab	15,53 a	13,30 b	13,56 a
Rata-rata	6,51 c	7,49 b	8,63 a	7,25 b	
KK = 8,97 %		BNJ NA = 2,04		BNJ N&A= 0,74	

Numbers in rows and columns followed by the same lowercase letters are not significantly different according to the BNJ further test at the 5% level.

Hartika (2020) stated that organic fertilizer given through the soil can increase the activity of microorganisms in the soil so that the soil structure will be better and will add nutrients to the soil so that the nutrient needs absorbed by the roots will be met and can be utilized by plants to increase seedling growth. Naibaho (2022) states that roots are an important factor in growth which reflects the ability to absorb nutrients and metabolic processes that occur in the soil. Fulfilling the nutritional needs of plants determines the increase in root development.

The oil palm seedlings are able to respond to the provision of the nutrients N, P and K contained in organic NPK fertilizer to accelerate cell division and root formation. Fauzi and Fifi (2017) stated that the N element absorbed by plants plays a role in supporting plant vegetative growth such as roots, P plays a role in forming a good root system and the K element at the root tip stimulates root elongation.

Auxin also has a role in root elongation which is in accordance with the opinion of Rikardo et al (2019) who state that by administering auxin at optimal concentrations it can stimulate root

development because of the auxin flowing from the apical meristem to the bottom of the plant, carbohydrates in the plant will collect to Stimulates root formation and plant root elongation. The longer and wider the plant roots, the maximum nutrient absorption will be, the more plant roots there are, the higher the root volume will be. In this way, the plants produced will be of good quality too. Panjaitan et al (2014) stated that auxin functions to increase rooting, induce root initiation, improve root quality and help root uniformity. In Table 2 it can be seen that giving excessive concentrations of auxin can inhibit plant growth, this is in accordance with the statement by Nurfauzan et al., (2022) that as an organic compound that can be used in plants, auxin actively works at low concentrations.

3.7 Dry Weight (g)

The results of analysis of variance showed that the interaction and main treatment of organic NPK and auxin had a significant effect on the dry weight of oil palm seedlings. Data in Table 3, showed that the interaction of organic NPK and auxin treatment has a significant effect on the dry weight of oil palm plants in the pre-nursery. Treatment of the organic NPK treatment of 75 g/plant and auxin 6 ml/l of water (N3A2) produces the highest dry weight is 9.13 g which is not significantly different from the N3A3 treatment but is significantly different from the other treatments. The lowest dry weight was found in the N0A0 treatment, is 3.52 g.

Table 3. Average dry weight of oil palm seedling treated with organic NPK and auxin (g)

Organic NPK (g/plant)	Auxin (ml/l)				Average
	0 (A0)	3 (A1)	6 (A2)	9 (A3)	
0 (N0)	3,52 h	3,67 h	4,20 gh	3,69 h	3,77 c
25 (N1)	3,61 h	3,85 gh	4,33 fgh	3,97 gh	3,94 c
50 (N2)	4,67 efg	5,10 def	5,87 d	5,26 de	5,23 b
75 (N3)	7,00 c	8,17 b	9,13 a	8,43 ab	8,18 a
Rata-rata	4,70 c	5,20 b	5,88 a	5,34 b	
KK = 5,54 %	BNJ NA = 0,89		BNJ N&A= 0,32		

Numbers in rows and columns followed by the same lowercase letters are not significantly different according to the BNJ further test at the 5% level.

Organic NPK fertilizer contains nutrients that are really needed during the vegetative period of plants and will increase plant growth in peat soil. In Table 3 it is also seen that giving high amounts of auxin inhibits plant growth with low plant dry weight at high auxin concentrations. This is in accordance with the opinion of Razali and Agung (2019) that stimulation and inhibition of growth depends on the auxin concentration. Different tissues respond differently to auxin levels which can stimulate or inhibit growth and auxin also works actively at low concentrations.

Based on the results of this research, the highest dry weight of oil palm seedlings was obtained, namely 9.13 g in the treatment of 75 g/plant and 6 ml/l water (N3A2). These results are higher when compared to previous research, the results of research by Razali and Agung (2019) produced a dry weight of oil palm seedlings of 6.10 g with ZPT auxin treatment and various planting media for oil palm seedlings in the pre-nursery. This proves that giving organic NPK 75 g/plant and auxin 6 ml/l can increase the dry weight of oil palm plants.

Arwin et al., (2022) stated that plant dry weight indicates the plant's pattern of accumulating products from the photosynthesis process and is integrated with nutrient availability in the soil, so root dry weight is closely related to root volume. The higher the root volume, the heavier the dry weight of the roots. Plants that are able to absorb nutrients optimally will produce a heavier dry weight. According to Permadi and Haryati (2015), nitrogen is needed in relatively large amounts for every growth. Especially at the vegetative growth stage such as increasing the number of leaves. The P element plays a role in the division and formation of plant

organs. The elements N and K play a role in the formation of new cells and are the main components of organic compounds in plants which influence the vegetative growth of plants so that they can affect the dry weight of plants.

4. Conclusion and Suggestion

The interaction between organic NPK and auxin treatment had a significant effect on root volume and plant dry weight. The best treatment was organic NPK 75 g/plant and auxin 6 ml/l water (N3A2). The main effect of organic NPK has a significant effect on all parameters with the best treatment at a dose of 75 g/plant (N3). The main effect of auxin has a significant effect on plant height, longest frond length, stem diameter, root length, root volume and dry weight. The best treatment is at a concentration of 6 ml/l water (A2).

Based on the results of the research that has been carried out, the author suggests carrying out further research on oil palm plants in the pre-nursery by providing organic NPK 75 g/plant and auxin concentration of 6 ml/l water to obtain more optimal growth and results.

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