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The Effect of Planting Media and Types of NPK Fertilizers (Compound and Mixed) on the Growth of Oil Palm Seedlings in Pre-Nursery

Ivan Dwi Firmansyah[1], Sri Manu Rochmiyati[2], Fani Ardiani[3]*
[1,2,3]Department of Agrotechnology, Faculty of Agriculture, Insitut Pertanian STIPER Yogyakarta

Author Corresponding email: fani@instiperjogja.ac.id

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Abstract
This study aims to determine the effect of planting media composition and types of NPK fertilizers (compound and mixed) on the growth of pre-nursery oil palm seedlings. The study was conducted in September - November 2023 at the Instiper Yogyakarta Education and Research Garden. This study used a factorial experimental method arranged in a completely randomized design (CRD) consisting of two factors, namely the composition of the planting media (clay, sand, sand + clay + organic fertilizer, sand + clay, clay + organic fertilizer, sand + organic fertilizer) and types of NPK compound fertilizers (compound fertilizer 15-15-15 and mixed fertilizer 0.30g Urea + 0.30g TSP + 0.25 g MOP). The results showed that the treatment of NPK fertilizer types (compound and mixed) and planting media composition interacted significantly with the height of pre-nursery oil palm seedlings, where the combination of clay soil media with mixed fertilizers produced a plant height of 25.90 cm. The treatment of planting media composition significantly affects the number of leaves, where the composition of sand + clay + organic fertilizer produces the highest number of leaves, which is 4 strands. Furthermore, treating NPK fertilizer types (compound and mixed) also significantly affects the diameter of pre-nursery oil palm seedlings, where using mixed fertilizers gives the highest stem diameter results, which is 9.46 cm.

Keywords— Planting Media, Oil Palm Seedlings, Compound Fertilizer, Good Seedlings

Introduction

Oil palm cultivation is generally carried out in tropical areas with soil that is low in chemical fertility and diverse in physical properties (A. N. H. Manurung et al., 2024). The planting medium determines the quality of the seedlings (Sabrina et al., 2024) because it is a place for the growth and development of plant roots, which then also becomes a place for plants to absorb various nutrients needed for plant survival (Ariyanti et al., 2018). Meanwhile, good planting media can provide plants' primary needs: sufficient water, nutrients, and soil air circulation. Clay and sand are two types of planting media commonly used in oil palm nurseries at the pre-nursery stage. Clay has high nutrients and better water retention capacity, thus providing the moisture needed by oil palm seedlings. Although it has high water and nutrient storage capacity, clay soil has very slow drainage that can inhibit smooth root respiration. Sand has large pores (Sigalingging et al., 2024), so drainage is faster and avoids waterlogging that can cause roots to rot. However, sandy soil has low nutrient and water retention capacity, so if not watered sufficiently, plants can

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experience water stress (Julia, 2022). The weaknesses of these two soils can be improved by adding organic matter, optimizing the nutrient content of sandy and clay soils, and improving their ability to absorb nutrients and water. This also improves soil drainage and aeration, making the soil softer and easier for the roots to breathe, making it easier for the roots to respire. Maulana et al. (2023) research suggests that planting clay and sand produces better results in developing oil palm seedlings than planting media using only sand or clay separately.

In addition to the planting medium, seedling growth also requires sufficient nutrients through the fertilization process by adding nutrients to the planting medium. The nutrients needed are macronutrients such as nitrogen, phosphorus, and potassium. Fertilizers containing NPK can be given as compound fertilizers and mixed fertilizers. Compound fertilizers are fertilizers produced by factories that already include more than one essential nutrient element with a specific nutrient content, and the solubility is slower so that they are more durable, and nutrient loss due to evaporation or washing can be minimized because the granules are larger. Mixed fertilizers are fertilizers rich in basic nutrients obtained by mixing several single fertilizers, so the nutrient content and solubility depend on the original properties of each mixed fertilizer (Simbolon & Tyasmoro, 2020). This study aims to determine the interaction of types of NPK fertilizers (compound and mixed) and the composition of planting media on the growth of pre-nursery oil palm seedlings; determine the effect of planting media composition on the growth of pre-nursery oil palm seedlings and determine the effect of types of NPK fertilizers (compound and mixed) on the growth of pre-nursery oil palm seedlings.

Literature Review

Seed performance is one of the requirements for successful oil palm cultivation, which is influenced by the provision of nutrients at the start of growth (Setyawan et al., 2020). Quality seeds should be provided to increase oil palm productivity using the right fertilization method (Shifa & Utoyo, 2021). The nutrient requirements for Nitrogen (N), Phosphate (P), and Potassium (K) in oil palm nurseries are usually met with synthetic chemical fertilizers such as NPK fertilizers (Adileksana et al., 2020). Plants need nitrogen for leaf growth. Nitrogen fertilizer, especially with potassium, increases leaf growth and overall plant strength (Nor Kamal & Abd Manan, 2020). A study found that nitrogen application significantly increased chlorophyll levels in oil palm seedlings (Hassan, 2018). Phosphorus (P) plays an important role in the growth of oil palm seedlings, significantly affecting the development and absorption of nutrients. A study showed that different levels of P fertilization (up to 200% of the standard) positively affected the nutrient absorption of oil palm seedlings (A. N. H. Manurung et al., 2024).

In addition, the use of SP-36 fertilizer significantly increased growth parameters, indicating the importance of P in conjunction with nitrogen sources (A. I. Manurung et al., 2022). Nitrogen is an essential nutrient for vegetative growth and is one of the main ingredients in protoplasm, which is responsible for plant cell function, including leaf growth (Imansyah et al., 2023). Research by Dhani et al. (2014) found that plant leaf formation is greatly influenced by the availability of nitrogen and phosphorus nutrients in the soil or surrounding media. Potassium (K) influences oil palm plants' physiological and anatomical processes. Studies have shown that increasing potassium application under water stress conditions improves physiological parameters, including net photosynthesis and root anatomy, which are critical for water uptake (Irawan & Putra, 2020; Najihah et al., 2020). Potassium also maintains osmotic pressure in the guard cells of the stomata, which affects the opening and closing of the stomata, which impacts the regulation of transpiration and gas exchange (Adrianto et al., 2023).

Research Method

This research was conducted in September - November 2023 at the Instiper Yogyakarta

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Education and Research Garden. This study used a factorial design experimental method arranged in a Completely Randomized Design (CRD) consisting of two factors. The first factor is the composition of the planting media consisting of 6 compositions: sand, clay, sand + clay, sand + clay + organic fertilizer, sand + organic fertilizer, and clay + organic fertilizer. The second factor is the type of NPK compound fertilizer consisting of 2 types: compound fertilizer (NPK 15-15-15) and mixed fertilizer (0.30 g Urea + 0.30 g TSP + 0.25 g MOP). Data analysis using analysis of variance (Anova) at a 5% significant difference level; if there is a significant difference, then it is continued with the Duncan Multiple Range (DMRT) tests at a 5% significant difference level.

Results and Discussion

The analysis showed a real interaction between the composition of the planting media and the types of NPK fertilizers (compound and mixed) on the height of oil palm seedlings in the pre-nursery. The results of the analysis also showed that the treatment of the composition of the planting media had a real effect on the number of leaves. In contrast, treating the types of NPK fertilizers affected the diameter of the stems of oil palm seedlings in the pre-nursery. The treatment interaction table can be seen in Table 1.

Table 1. Interaction between the composition of planting media and the type of NPK fertilizer on the height of oil palm seedlings in the pre-nursery (cm)

Planting media composition	Various NPK fertilizer		Average
	Compound fertilizer (NPK 15-15-15)	Mix fertilizer (0.30g Urea + 0.30g TSP + 0.25 g MOP)	
Sand	21,92 g	24,32 c	23,12
Clay	19,32 j	25,90 a	22,61
Sand+Clay	21,64 h	21,66 h	21,65
Sand+Clay+Organic fertilizer	23,06 e	24,46 b	23,76
Sand+ Organic fertilizer	23,13 d	21,70 i	22,41
Clay+ Organic fertilizer	22,76 f	21,00 j	21,88
Average	21,97	23,17	(+)

Note: Numbers followed by the same letter in a row/column indicate no significant difference based on the 5% DMRT results.
(+) : there is a real interaction between treatments

Table 2. Effect of planting media composition on the number of leaves of oil palm seedlings in the pre-nursery

Planting media composition	Number of leaves (strands)
Sand	3,70c
Clay	3,40e
Sand + Clay	3,50d
Sand + Clay + Organic fertilizer	4,00a
Sand + Organic fertilizer	3,70c
Clay + Organic fertilizer	3,90b

Note: Numbers followed by the same letter in a column indicate no significant difference based on the 5% DMRT results.

Table 2 shows that the treatment of various planting media compositions significantly affects the number of leaves of oil palm seedlings in the pre-nursery. The combination of sand + clay + organic fertilizer planting media treatment gave the highest number of leaves, which was 4.00, and this result was significantly different from other planting media compositions. Sand, clay, and organic fertilizer composition significantly affect oil palm seedlings' growth, especially

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in leaf production. Habib Sinuraya et al. (2024) research highlights that varying latosol and beach sand proportions also affect leaf area and overall growth. In addition, applying organic fertilizer has been shown to significantly increase the number of leaves in oil palm seedlings (Andre Rigel et al., 2023; Husna et al., 2023).

Table 3. The effect of compound fertilizer types on the stem diameter of oil palm seedlings in pre-nursery

Various NPK fertilizer	Stem diameter (cm)
Compund fertilizer (NPK 15-15-15)	8,17p
Mix fertilizer (0.30g Urea + 0.30g TSP + 0.25 g MOP)	9,46q

Table 3 shows that the treatment of various NPK fertilizers significantly affects the diameter of oil palm stems in pre-nursery. The treatment of mixed fertilizer 0.30g Urea + 0.30g TSP + 0.25 g MOP gave the largest stem diameter of 9.46 cm. It significantly differed from the treatment of compound fertilizer NPK 15-15-15. This shows that the provision of mixed fertilizers (urea, TSP, and MOP) significantly affects the stem diameter of oil palm seedlings in the pre-nursery. Manurung's research states that urea and TSP are very important for oil palm seedlings through an optimal combination of 15 g SP-36 and 7 g urea, showing a synergistic effect on stem diameter. The efficiency of potassium use through modified fertilizers has been shown to increase seedling growth, including stem diameter, by up to 9.2% compared to standard care (Ginting et al., 2023). Furthermore, integrating organic and chemical fertilizers, including NPK with a specific combination, significantly increased stem diameter (Keni et al., 2023; R. Manurung et al., 2023).

Conclusion

This study concluded that the composition of planting media and types of compound fertilizers interact significantly with the growth of pre-nursery oil palm seedlings, especially plant height. Separately, the treatment of planting media composition significantly affects the number of pre-nursery oil palm seedling leaves. In contrast, the types of compound fertilizers have a significant impact on the diameter of the stems of pre-nursery oil palm seedlings.

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