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EFFECTIVENESS OF NPK 15-15-15 FERTILIZER COMBINED WITH EGG SHELL FLOUR ON THE GROWTH OF OIL PALM (*Elaeis Guineensis* Jacq.) SEEDLINGS

EFEKTIVITAS PUPUK NPK 15-15-15 YANG DIKOMBINASIKAN DENGAN TEPUNG CANGKANG TELUR TERHADAP PERTUMBUHAN BIBIT KELAPA SAWIT *(Elaeis Guineensis* Jacq.)

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Abstract

Oil palm (*Elaeis guineensis* Jacq) is a domesticated plant with promising industrial potential in domestic and international markets. This study aims to determine the effect of a 15-15-15 NPK fertilizer mixture and eggshell powder on the growth parameters of oil palm seedlings. This study used a non-factorial randomized block design (RAK) with 5 treatments and 5 replicates, resulting in 25 experimental units, with the following treatment sequence: P0: Control (without fertilizer) NPK 15-15-15 and eggshell flour, P1: NPK 15-15-15 fertilizer (2 g/polybag) + 50 g eggshell flour, P2: NPK 15-15-15 fertilizer (2.25 g/ polybag) + 50 g eggshell powder, P3: NPK 15-15-15 fertilizer (2.50 g/polybag) + 50 g eggshell powder, P4: NPK 15-15-15 fertilizer (2.75 g/polybag) + 50 g eggshell powder. The parameters observed were soil pH, number of leaf sheaths, plant height, and stem diameter. The results showed that the NPK 15-15-15 treatment combined with eggshell flour had a significant effect on stem diameter at 40 DAP but no significant effect on stem diameter growth at 50-60 DAP, on the number of leaf sheaths, on plant height, or on soil pH. The coefficient of variation obtained was below 25%.

Keywords: *Eggshells, Palm Oil, NPK Fertilizer*

Abstrak

Kelapa sawit (*Elaeis guineensis* Jacq) merupakan tanaman hasil domestikasi yang memiliki potensi industri yang menjanjikan di pasar domestik dan internasional. Penelitian ini bertujuan untuk mengetahui pengaruh campuran pupuk NPK 15-15-15 dengan tepung cangkang telur terhadap parameter pertumbuhan tanaman bibit kelapa sawit penelitian ini menggunakan Rancangan Acak Kelompok (RAK) non faktorial dengan 5 perlakuan dan 5 ulangan sehingga diperoleh 25 satuan percobaan, dengan urutan perlakuan yaitu P0: Kontrol (tanpa pupuk) NPK 15-15-15 dan tepung cangkang telur, P1: Pupuk NPK 15-15-15 (2 gr/polybag) + 50 gr tepung cangkang telur, P2: Pupuk NPK 15-15-15 (2,25 gr/ polybag) + 50 gr tepung cangkang telur, P3: Pupuk NPK 15-15-15 (2,50 gr)/ polybag + 50 gr tepung cangkang telur, P4: Pupuk NPK 15-15-15 (2,75 gr/ polybag) + 50 gr tepung cangkang telur. Parameter yang diamati pH tanah, jumlah pelepah daun, tinggi tanaman dan diameter batang. Hasil penelitian menunjukan bahwa perlakuan NPK 15-15-15 yang dikombinasikan dengan tepung cangkang telur berpengaruh nyata terhadap diameter batang 40 HSPT dan tidak berpengaruh nyata terhadap pertumbuhan diameter batang 50-60 HSPT, jumlah pelepah daun, tinggi tanaman dan pH tanah. Nilai koefisien keragaman yang diperoleh dibawah 25%.

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Kata Kunci: Cangkang telur, Kelapa Sawit, Pupuk NPK

INTRODUCTION

Oil palm *(Elaeis guineensis* Jacq*)* was introduced to Indonesia by the Dutch East Indies government in 1848, when four oil palm seedlings were brought from Mauritius and Amsterdam and planted in the Bogor Botanical Gardens. The first oil palm plantations were located on the east coast of Sumatra (Deli) and Aceh (Abdul, 2023). Based on data from the Directorate General of Plantations, the provisional area of oil palm plantations in Indonesia in 2023 reached 16.83 million hectares, consisting of 37.37% or 6.29 million hectares of smallholder plantations, 51.08% or 8.60 million hectares of large private plantations, and only 3.24% or 545,710 hectares of large state plantations, while there is also an area of 8.31% or 1.40 million hectares that will be confirmed (Ministry of Agriculture, 2024).

Proper fertilization during this period is crucial for supporting plant development and achieving high future production potential (Pamungkas *et al*., 2023). Therefore, adjusting the type and dosage of NPK fertilizer appropriately is very important for supporting the maximum growth of oil palm seedlings, especially during the main nursery stage, which plays a crucial role in determining plant quality when they are transferred to the field (Hafidh *et al*., 2025).

NPK 15-15-15 fertilizer is often used because it contains the main macro nutrients, namely nitrogen (N), phosphorus (P), and potassium (K), which are needed by plants in large quantities. According to research conducted by Syamsuwirman *et al.* (2023), the application of NPK fertilizer to oil palm seedlings in the pre-nursery stage showed a significant increase in seedling growth. Nitrogen enhances vegetative growth, such as leaves; phosphorus is important for root development; and potassium aids photosynthesis and water regulation in plant cells. The study found that applying 2.25 grams of 15-15-15 NPK fertilizer per seedling produced better growth.

According to Renfiyeni (2022), the use of organic fertilizer is an alternative that can reduce the negative impacts of chemical fertilizers and address fertilizer shortages. Organic fertilizer can improve soil fertility and its physical and biological properties. In this case, organic fertilizer plays an important role in increasing nutrient levels, loosening the soil, increasing the population of microorganisms, and enhancing water absorption and storage capacity. Chicken eggshells are a material with potential to be used as an organic fertilizer because they contain nutrients plants need. According to Elinda *et al.* (2023), organic fertilizer is one alternative for sustainable, environmentally friendly agricultural technology.

The results of Silaban's (2021), research show that applying 125 g of chicken eggshell powder per polybag, combined with 450 g of chicken manure per polybag, produced the best growth across all cocoa seedling growth variables. In addition to promoting cocoa seedling growth, chicken eggshell fertilizer also benefits other plants. This is similar to the statement by Rosmalinda *et al*. (2022) that applying chicken eggshell flour affects stem diameter growth, plant height, root length, leaf number, and dry weight in Robusta coffee plants. The optimal dose of chicken eggshell flour is 17.50 g per polybag, which affects vegetative growth across all

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observed parameters. This occurs because eggshells contain calcium in the form of calcium carbonate (CaCO3) or lime. Applying eggshell powder to an NPK 15-15-15 fertilizer mixture is expected to increase the fertilizer's effectiveness.

RESEARCH METHODS

Place and Time of Research

This research was conducted at the experimental garden of the Plantation Management Study Program at the Politeknik Indonesia Venezuela. The research was conducted over two months, from January to February 2025.

Tools and materials

The tools used in this study were scales, hoes, buckets, dippers, pH meters, books, pens, digital calipers, scissors, and rulers. The materials used in this study were Sriwijaya 1 variety oil palm seedlings, soil, 15-15-15 NPK fertilizer, organic fertilizer (eggshell powder), water, 30 x 25 cm polybags, and small plastic ice cubes.

Research Plan

This study used a Non-Factorial Randomized Block Design (RBD) with 5 treatments and 5 replicates, resulting in 25 experimental units, with the following treatment sequence:
P0: Control (without fertilizer) NPK 15-15-15 and Eggshell Powder
P1: NPK 15-15-15 fertilizer (2 g/polybag) + 50 g Eggshell Powder
P2: NPK 15-15-15 fertilizer (2.25 g/polybag) + 50 g eggshell flour
P3: NPK 15-15-15 fertilizer (2.50 g)/polybag + 50 g eggshell flour
P4: NPK 15-15-15 fertilizer (2.75 g/polybag) + 50 g eggshell flour

Research Implementation

Site preparation began with thoroughly cleaning the research area, then placing the oil palm seedlings in polybags under shade. The three-month-old Sriwijaya 1 variety oil palm seedlings were obtained from a community-owned oil palm plantation in Panton Reu Subdistrict, West Aceh Regency. The seedlings were planted in polybags filled with soil and placed in the middle of each bag at a depth of 7 cm. They were then arranged and placed under shade. A total of 25 seedlings were used. The NPK 15-15-15 fertilizer used was the Phonska Plus brand, obtained from the CV. Aria Usaha store in Ingin Jaya District, Aceh Besar Regency. This NPK fertilizer was applied for the first time when the seedlings were transferred from small polybags to medium-sized polybags, the second time when the seedlings were 30 days old after transplanting (DAT), and the third time when the seedlings were 50 days old after transplanting (DAT). The NPK fertilizer was applied by spreading it in a circular pattern. The NPK fertilizer dosage was in accordance with the predetermined treatment for each group.

The eggshell powder fertilizer used was purchased online from the Abee Umee Store in Pare District, Kediri Regency, East Java Province. This eggshell powder was applied for the first

time when the seedlings were transferred from small polybags to sedan polybags, the second time at 30 DAT, and the third time at 50 DAT. The eggshell powder was applied in the morning or afternoon by mixing it into the soil around the plants. The dosage of eggshell flour applied is in accordance with the predetermined treatment for each plant. Watering of oil palm seedlings is carried out in the morning or afternoon as needed, using a bucket and a dipper. Watering is not done when it rains the previous day. Weed control is done manually by pulling weeds inside and around the polybags. Weed control is done once a week.

Parameters observed

Observations made on these oil palm seedlings included: soil pH, number of fronds, plant height, and stem diameter.

Data Analysis

ANOVA analysis was conducted on observational data from variable growth, with a significance level of 95%. If there was a difference between treatments, different tests were conducted, and the smallest difference (BNT) was used.

RESULTS AND DISCUSSION

Soil pH

The results of soil pH analysis before applying NPK 15:15:15 combined with eggshell flour showed that the growing medium was slightly acidic (6.18-6.52). The application of NPK 15:15:15 combined with eggshell flour showed no significant effect on the pH of oil palm seedling soil. The average soil pH values for oil palm seedlings are shown in Table 1.

Table 1. Average Soil pH Measurement Results for Oil Palm Seedlings

Treatment	Soil pH	
	40 DAT	60 DAT
P0	6,40	6,90
P1	6,52	6,96
P2	6,44	7,00
P3	6,18	6,74
P4	6,24	6,88

Source: Data processed, 2025

The table above shows that the pH of 40 DAT, when applied with 15:15:15 NPK fertilizer combined with eggshell flour, falls within the slightly acidic range (6.18-6.44) and the neutral range (6.52). The soil's chemical properties, specifically the pH in the growing medium, are suitable, as oil palm seedlings can grow well within this pH range. This is consistent with Hariadi (2021), who states that oil palm seedlings can grow in soil with a pH of 4.0 to 6.5 (slightly acidic to neutral).

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Based on the results of the analysis of variance of NPK 15:15:15 application combined with eggshell flour, there was no significant effect on the pH of oil palm seedling soil. The soil pH measurement criteria at 60 HSPT were neutral. Soil pH is a very important factor because it affects nutrient availability. Many factors, including rainfall, soil type, organic matter, and fertilizer use, influence soil pH. One way to improve soil pH is to add a fertilizer containing lime (Wasir *et al*., 2022).

Neutral soil pH can increase nutrient availability, whereas acidic soil pH can decrease it. According to Safitri (2020), low soil pH can reduce nutrient availability, such as phosphate, and decrease biological activity, which plays an important role in increasing soil fertility. Factors that affect soil pH are the soil system's optimization by H^+ ions, which makes the soil acidic. The causes of soil acidity are H^+ and Al_3^+ ions in soil solution, elements contained in the soil, H^+ and OH ion concentrations, soil minerals, organic matter, soil texture, rainwater, and parent material (Adetunji *et al.,* 2021).

Eggshell flour has benefits as an organic fertilizer for plants and as a source of calcium. Eggshell flour is high in calcium, so it can help increase calcium content in the soil and prevent plants from calcium deficiency. Calcium is needed to help plants strengthen their stems and leaves and improve soil quality. Eggshell flour can also help improve soil quality, structure, and air circulation, making the soil more fertile and better able to absorb nutrients (Sinurat & Jumin, 2024).

Number of Leaf Sheaths

Based on the results of the analysis of variance, the application of NPK 15:15:15 combined with eggshell flour did not have a significant effect on the increase in the number of leaf sheaths for observations of 40-60 DAT. The average number of oil palm seedling leaf sheaths is shown in Table 2.

Table 2. Average Number of Oil Palm Seedling Fronds 40-60 DAT

Treatment	Leaf Sheaths (Quantity)		
	40 DAT	50 DAT	60 DAT
P0	4,4	5	5,8
P1	4,6	4,6	5
P2	5,2	5,4	5,6
P3	5,6	6	6,2
P4	5,2	5,6	5,6

Source: Processed data, 2025

The table above shows that the application of NPK 15:15:15 combined with eggshell flour did not differ significantly from the control and between treatments. This is thought to be because the NPK fertilizer applied was not suitable for oil palm seedlings. NPK 15:15:15 is a compound fertilizer containing 15% N, 15% K, and 15% P. If applied in sufficient quantities to meet the plant's needs, it can increase growth, especially leaf count.

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The macronutrients from the 15:15:15 NPK fertilizer in this treatment supported the plants' physiological processes, namely transpiration and photosynthesis, resulting in more efficient nutrient utilization. The dry weight of plants depends on the amount of nutrients they take up during growth. The macronutrients from the NPK 15:15:15 fertilizer in this treatment support plant physiological processes, namely transpiration and photosynthesis, resulting in more efficient nutrient utilization. Marpaung *et al*. (2023) stated that the application of NPK 15:15:15 can increase the number of oil palm seedlings. This can occur because NPK 15:15:15 fertilizer contains macro nutrients that roots can absorb to meet the needs of oil palm seedlings.

Plant Height

Based on the results of the analysis of variance, the application of NPK 15:15:15 combined with eggshell flour had no significant effect on the height increase of oil palm seedlings aged 40-60 days after planting. The average height of oil palm seedlings is shown in Table 3 below.

Table 3. Average Height of Oil Palm Seedlings 40-60 DAT

Treatment	Plant Height (cm)		
	40 DAT	50 DAT	60 DAT
P0	29,04	30,80	32,80
P1	24,30	27,18	30,00
P2	29,50	31,20	32,32
P3	28,64	29,30	29,60
P4	32,30	33,80	35,80

Source: Processed data, 2025

The table above shows that applying NPK 15:15:15 combined with eggshell flour did not yield significant differences between treatments or replicates. However, oil palm seedlings were able to grow and develop after the application of NPK fertilizer and eggshell flour. The average height of the tallest plants at 60 days after planting was in treatment P4 (35.80 cm), followed by the control (P0) with a height of 32.80 cm, and the lowest was P3 (29.60 cm). These results are thought to be due to the slower effect of eggshell powder compared to the effect of compound NPK fertilizer on the growth of oil palm seedlings in the main nursery. There was no interaction effect between the eggshell powder and compound NPK treatments, which may be because the oil palm plants were not yet able to respond to the application of eggshell powder and compound NPK until 60 DAT.

Increasing the height of oil palm seedlings can be achieved not only by applying NPK fertilizer but also by applying eggshell powder. Eggshell powder contains calcium in the form of calcium carbonate ($CaCO_3$) or lime. Calcium in the soil comes not only from lime and added fertilizers but also from rocks and minerals that form the soil. Calcium is one of the main cations in the exchange complex, so it is closely linked to soil acidity and liming issues. It is the most suitable cation for reducing acidity (neutralizing soil pH) or increasing soil pH and improving soil fertility (Afrianti, 2024).

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Stem Diameter

Based on the analysis of variance results, the application of NPK 15:15:15, combined with eggshell flour, had a significant effect on age at 40 DAT. It did not have a significant effect on the increase in the diameter of oil palm seedlings aged 50-60 DAT. The average diameter of oil palm seedlings is shown in Table 4.

Table 4. Average Height of Oil Palm Seedlings 40-60 DAT

Treatment	Stem Diameter (Inches)		
	40 DAT	50 DAT	60 DAT
P0	0,28	0,32	0,38
P1	0,27	0,30	0,32
P2	0,29	0,30	0,35
P3	0,32	0,34	0,38
P4	0,29	0,33	0,41

Source: Processed data, 2025

The table above shows that applying NPK 15:15:15 combined with eggshell flour did not yield significant differences among treatments, replicates, or controls. However, the data showed a significant effect at 40 days after planting. These results suggest that the roots of the oil palm seedlings did not absorb the nutrients sourced from NPK 15-15-15 fertilizer and eggshell flour. Soil nutrients can be affected by rainfall, and the high rainfall during the study period may have led to increased nutrient loss through leaching. The application of NPK compound fertilizer and eggshell flour is thought to have led to high nutrient loss through leaching.

An increase in the diameter of oil palm seedlings can occur if sufficient nutrients are available in the soil. The nutrients N, P, and K contained in NPK fertilizer, and the K in eggshell powder, are essential for plants, especially during their growth and development phases. The function of N is to support overall plant growth, namely protein formation, chlorophyll synthesis, and metabolic processes. P is a component of ATP, an energy-rich molecule used in metabolic processes such as protein synthesis. K acts as an enzyme activator, maintains osmotic potential and water uptake, and facilitates the translocation of photosynthetic products from leaves to sinks (Hendarto *et al*., 2021).

CONCLUSION

Based on the results of this research, it can be concluded that the application of NPK 15:15:15 combined with eggshell flour did not have a significant effect on the pH of 60 DAT soil, the number of leaf sheaths, plant height, and stem diameter of oil palm seedlings. The best treatment was obtained in P4 (2.75 g NPK + 50 g eggshell flour), and the resulting coefficient of variation was below or < 25% (low CV), meaning that the data tended to be concentrated around the mean value, or the variation in growth was relatively small (homogeneous).

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