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Growth Response of Palm Seedlings (*Elaeis guineensis* Jacq.) to Applying NPK Fertilizer (15-15-15) and Dolomite on Acid Soil in *Pre-Nursery*

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ABSTRACT: This research aims to determine the response of oil palm seedling growth in pre-nursery on acid soil to NPK fertilizer doses (15-15-15) and dolomite doses. The research was carried out at Educational and Research Garden of Stiper Agricultural Institute located in Maguwoharjo Village, Depok District, Sleman Regency, Yogyakarta, Indonesia from January to April 2023. This research used a factorial pattern experimental method which was prepared using a Completely Randomized Design (CRD) consisting of two factors. The first factor was the dosage of NPK (15-15-15) fertilizer which consists of 0 g (control) ; 2.5 g; 3 g and 3.5 g. Meanwhile, the second factor was the dose of dolomite fertilizer which consists of 0 g (control); 5 g; 10 g and 15 g. Each treatment was carried out in 5 repetitions. The number of seeds needed for this experiment is 4 x 4 x 5 = 80 seeds. The results showed that there was no signiticant interaction between the dosage of NPK fertilizer (15-15-15) and dolomite on all parameters. The dose of NPK fertilizer has an influence on the dry weight of the roots and the best at a dose of 3.5 g. Dolomite application has an influence on root fresh weight and leaf area with the best dose of 10 g/oil palm seedling in pre-nursery on acid soil.

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KEYWORDS: NPK (15-15-15), dolomite, acid soil, pre nursery

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is Indonesia's main plantation commodity. In the midst of the global crisis that is currently hitting the world, the palm oil industry is able to survive and make a significant contribution to the national economy. Apart from being able to create extensive employment opportunities, the palm oil industry is one of the largest sources of foreign exchange for Indonesia (Suherman *et al*, 2018). Outside their areas of origin such as Malaysia, Indonesia, Thailand and Papua New Guinea and are even able to produce higher products per hectare (Sirajuddin, 2013). Healthy seeds with normal growth are good initial capital for developing oil palm plantations. Providing the right ameliorant and fertilizer in terms of type, dose and application time is very important. Providing guano and NPK fertilizer can increase soil pH, organic C and N, available P and soil CEC (Mukhtaruddin *et al*, 2015). Fertilizer is a very important production factor to increase plant growth and production. Balanced fertilization is the key to successful land and plant management. Balanced fertilization means providing fertilizer with the dose and type of fertilizer according to the characteristics of the soil and the needs of the plant or age of the plant for nutrients. Preparing recommendations for fertilizing annual plants also requires nutrient uptake data. Dierolf *et al*, (2000) stated that the total nutrient uptake of N, P, K, Ca, Mg and S from oil palm plants is 30 kg/ha. Soil nutrient depletion occurs in soil that is fertilized at a lower level than nutrient uptake or plant needs (Sukristiyonubowo *et al*, 2015). Acid soil has a low pH and has many obstacles in the availability of nutrients, high soil acidity, and low levels of availability of phosphorus (P) and potassium (K) in the soil as well as high P uptake, the amount of K in peat soil is lower. The availability of mineral K and nitrogen (N) is unstable because it can undergo leaching, volatilization and denitrification. Efforts to overcome the problems that exist in peatlands, soil conditions that contain high organic acids can be done by adding dolomite (Ratmini, 2012). Dolomite functions to neutralize soil pH, kill several types of bad fungi and bacteria in the soil, thereby increasing soil fertility. Dolomite is produced using lime as raw material which has a high level or percentage of calcium (CaO) and magnesium (MgO). Dolomite contains 18-24% MgO; CaO 30%; water 0.19%;. $A1_2O_3$ + Fe_2O_3 <3% and SiO_2 <3%. The advantage of using dolomite is that it can neutralize soil pH, increase root growth and improve soil structure, improve qualities such as high yields and dense fruit, and can be used as basic fertilizer and complementary fertilizer (Kartono, 2010).

Growth Response of Palm Seedlings (Elaeis guineensis Jacq.) to Applying NPK Fertilizer (15-15-15) and Dolomite on Acid Soil in Pre-Nursery

Compound fertilizer (NPK) is an inorganic fertilizer that can be used very efficiently in increasing the availability of macro nutrients (N, P and K) replacing single fertilizers such as Urea, SP-36 and KCl which are sometimes difficult to obtain on the market and very expensive. NPK fertilizer (15-15-15) is one of the NPK fertilizer products that has been circulating on the market with a content of Nitrogen (N) 15%, Phosphorus (P_2O_5) 15%, Potassium (K_2O) 15%, Sulfur (S) 10% and a maximum water content of 2%. This compound fertilizer is almost completely soluble in water, so that the nutrients it contains can be immediately absorbed and used effectively by plants (Kaya, 2013). The element nitrogen is the main component in the plant body, especially in cell protoplasm, proteins, amino acids, amides and alcohols. Chlorophyll also contains nitrogen. Many vital processes in the body of oil palm plants are accompanied by phosphorus components, such as nucleic acids, which are largely involved in regulating plant development processes. Phosphorus also plays a role in physiological systems associated with nutrition and respiration, and influences fruit maturity. The element potassium is found in all parts of the oil palm plant. The element potassium generally functions to regulate processes in plants (Agrie Work Suport Team, 2009).

MATERIALS AND METHODS

Place and Time of research

The research was carried out at the Stiper Agricultural Institute's Educational and Research Garden, located in Maguwoharjo Village, Depok District, Sleman Regency, Yogyakarta, Indonesia at an altitude of 118 m above sea level. This research was conducted from January 2023 to April 2023.

Tools and materials

The tools used in this research were hoes, sieves, buckets, wood, bamboo, paranets, rulers or meters, hammers, analytical scales, knives, ovens, object glasses, cover glasses, writing utensils, measuring cups for the watering process. The materials used in this research were oil palm sprouts of the DxP Simalungun variety obtained from the Palm Oil Research Center (PPKS), acid soil (pH 5.29) originating from Rawa Pening Village, Ambarawa District, Semarang Regency, Central Java, fertilizer NPK Phonska (15-15-15), Dolomite and polybag measuring 20 cm x 20 cm.

Research design

The design used in this research was a Completely Randomized Design (CRD). This design consists of 2 factors. The first factor was the dosage of Phonska NPK fertilizer which consists of 0 g (P0); 2.5 g (P1); 3 g (P2) and 3.5 g (P3). Meanwhile, the second factor was the dose of dolomite fertilizer which consists of 0 g (D0); 5 g (D1); 10 g (D2) and 15 g (D3). Each treatment was carried out in 5 repetitions. The number of seeds needed for this experiment is 4 x 4 x 5 = 80 seeds.

Preparation of planting Medium

The planting medium used was acidic soil taken from soil originating from Rawa Pening Village, Ambarawa District, Semarang Regency, Central Java, Indonesia. Then the soil was sieved with a size of 2 x 2 mm. This was done to avoid root debris which can become a host for disease and has a crumbly soil structure. Next, it put a polybag measuring 20 cm x 20 cm.

Dolomite application

Dolomite was applied by sprinkling it around the surface of the polybag, then stirring and watering it until it dissolved in the soil. Dolomite was applied 1 week before planting the sprouts.

NPK fertilizer application (15-15-15)

NPK fertilizer was applied after the plants were 3 weeks old at doses of 2.5 g, 3 g and 3.5 g. Each dose was divided into 3 for repeated applications at 3 weeks, 6 weeks and 9 weeks. Fertilizer was applied by sprinkling it around the oil palm plants.

RESULTS AND DISCUSSION

The research data were analyzed using analysis of variance (Anova) at a level of 5%. Significantly different treatments were further tested with DMRT (Duncan Multiple Range Test) at a level of 5%.

Table 1. Effect of NPK dosage on the growth of oil palm seedlings on acid soil in the pre nursery

Parameter	NPK dosage (g/seedling)			
	0	2,5	3	3,5
Seedling height (cm)	21.23 p	22.04 p	21.91 p	23.12 p
Number of leaves (pieces)	2.45 p	2.45 p	2.55 p	2.65 p
Seed diameter (mm)	6.64 p	6.42 p	6.53 p	7.16 p
Fresh weight of crown (g)	3.16 p	2.92 p	2.99 p	3.27 p
Crown dry weight (g)	0.55 p	0.57 p	0.58 p	0.64 p
Root fresh weight (g)	1.13 p	0.96 p	0.99 p	1.20 p
Root volume (ml)	1.55 p	1.26 p	1.28 p	1.45 p

Root dry weight (g)	0.22 q	0.14 q	0.14 q	0.23 p
Leaf area (cm^2)	128.1 p	133.9 p	12.,9 p	137.9 p

Note: Mean numbers followed by the same letter in the same row are not significantly different based on DMRT at the 5% test level.

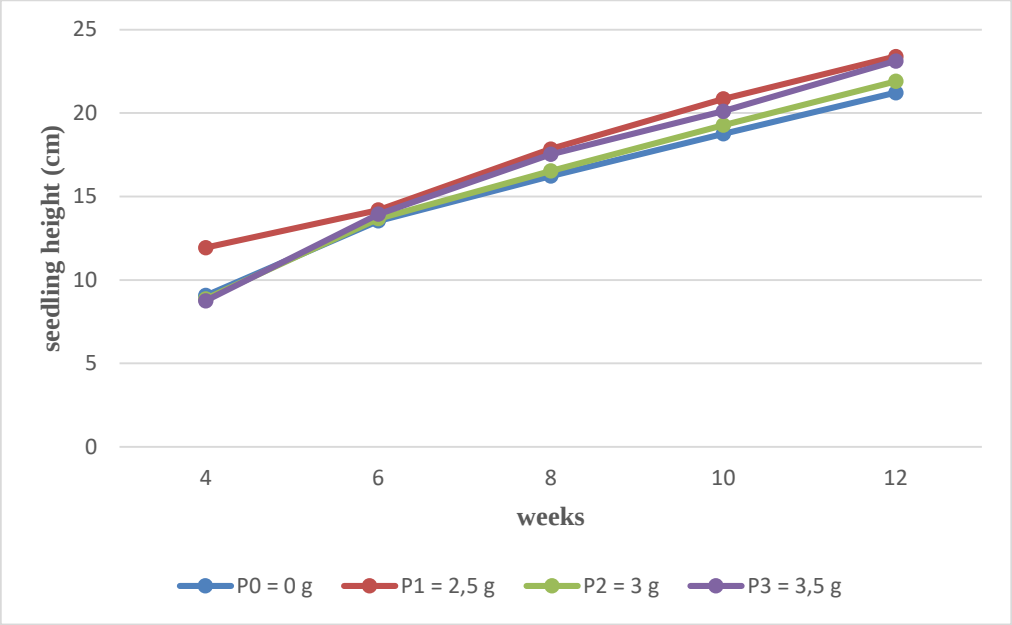

Figure 1. Effect of NPK fertilizer dosage on the height of oil palm seedlings on acid soil in pre nursery (cm).

In Figure 1 it can be seen that NPK fertilizer with a dose of 2.5 g shows a faster increase in seedling height from week 4-6 compared to NPK fertilizer treatment with a dose of 0 g; 3g and 3.5g. Then in weeks 6-12 NPK fertilizer with doses of 2.5 g and 3.5 g was relatively faster than NPk fertilizer with doses of 3 g and 0 g. Overall, from weeks 4 to 12, seedling height growth was relatively the same.

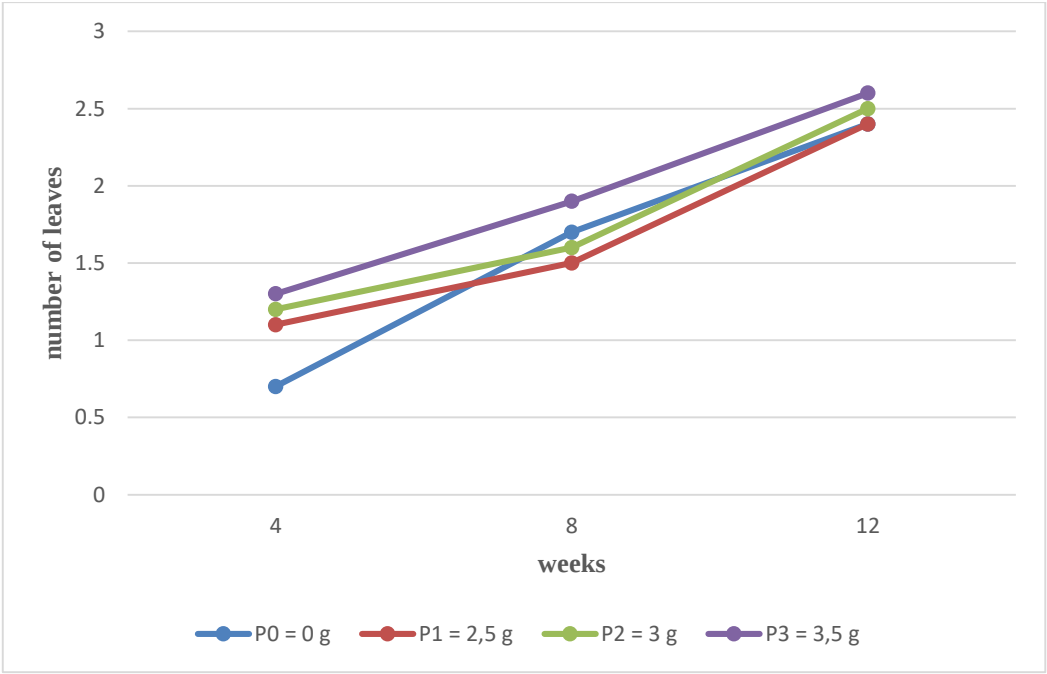

Figure 2. Effect of NPK fertilizer dosage on the number of oil palm leaves on acid soil in the pre nursery.

In Figure 2 it can be seen that NPK fertilizer treatment with a dose of 3.5 g at weeks 4-12 showed a relatively faster increase in the number of leaves. Then the 2.5 g and 3 g dose treatments at weeks 4-8 showed a relatively slower increase in the number of leaves compared to the 0 g dose treatment. Next week 8-12 at a dose of 0 g; 2.5 g and 3 g show the same increase.

Table 2. Effect of dolomite dosage on the growth of oil palm seedlings on acid soil in the pre nursery

Parameter	Dolomit dosages (g/seedling)			
	0	5	10	15
Seedling height (cm)	21.84 a	20.56 a	23.64 a	22.26 a
Number of leaves (pieces)	2.45 a	2.60 a	2.55 a	2.50 a
Seed diameter (mm)	6.47 a	6.55 a	6.94 a	6.80 a
Fresh weight of crown (g)	3.21 a	2.83 a	3.36 a	2.94 a
Crown dry weight (g)	0.54 a	0.56 a	0.66 a	0.58 a
Root fresh weight (g)	0.96 b	0.96 b	1.18 a	1.17 b
Root volume (ml)	1.23 a	1.21 a	1.45 a	1.65 a
Root dry weight (g)	0.20 a	0.14 a	0.19 a	0.19 a
Leaf area (cm^2)	123.0 b	132.5 b	145.1 a	129.2 b

Note: Mean numbers followed by the same letter in the same row are not significantly different based on DMRT (Duncan Multiple Range Test) at the 5% test level.

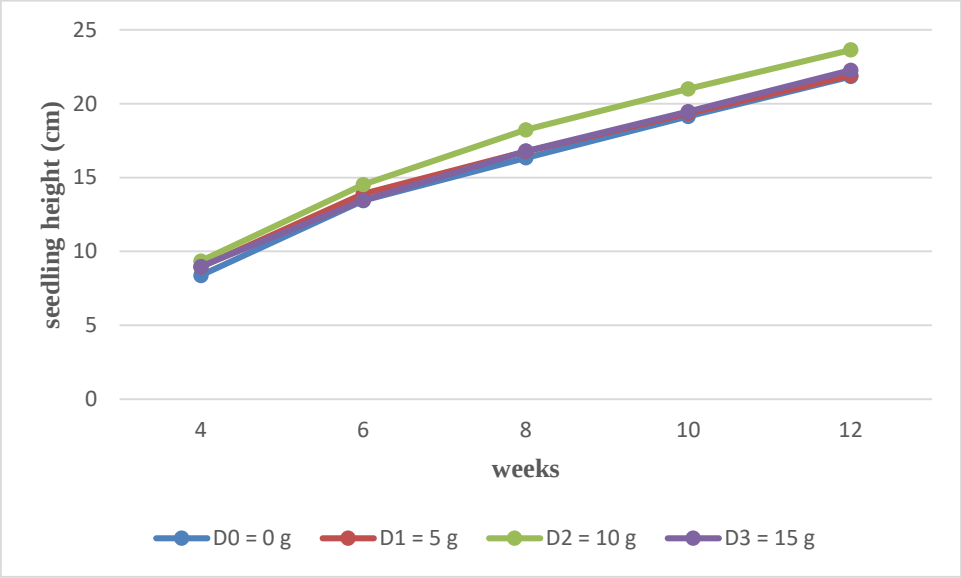

Figure 3. Effect of dolomite fertilizer dosage on the height of oil palm seedlings on acid soil in pre nursery (cm)

In Figure 3, it can be seen that all dolomite fertilizer dosage treatments showed a relatively similar increase in seedling height from week 4-6. Then, dolomite fertilizer treatment with a dose of 10 g at weeks 6-12 showed faster growth, while treatments at doses of 0 g, 5 g and 15 g at weeks 6-12 showed slower growth.

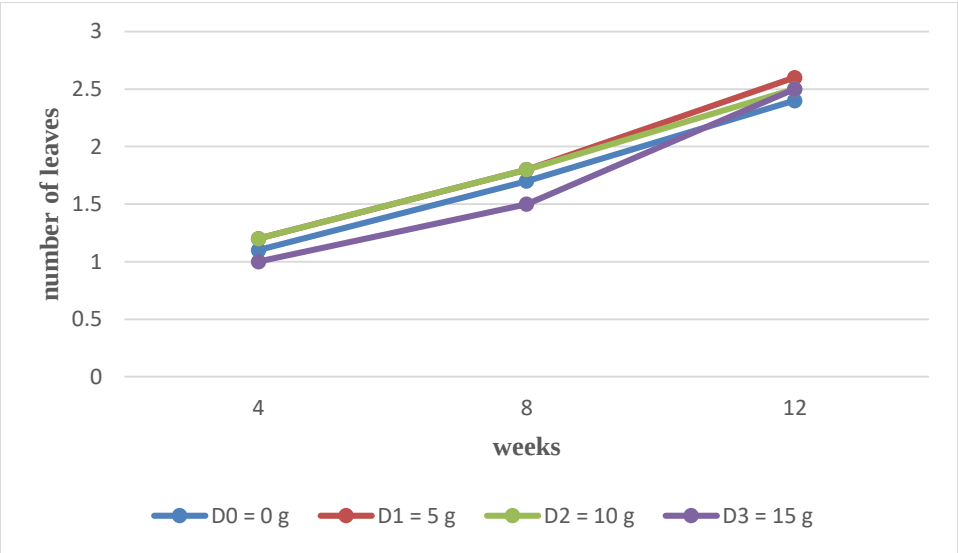

Figure 4. Effect of dolomite fertilizer dosage on the number of oil palm leaves on acid soil in the pre nursery

In Figure 4, it can be seen that dolomite fertilizer treatment with doses of 5 g and 10 g showed an increase in the number of leaves in weeks 4-8 relatively faster than with a dose of 0 g. Meanwhile, a dose of 15 g showed that the increase in the number of leaves in weeks 4-8 tended to be slower. Then dolomite fertilizer treatment with doses of 5 g, 10 g and 15 g showed an increase in the number of leaves in weeks 8-12 that was faster than the 0 g dose.

The results of the analysis showed that there was no significant interaction between the dose of NPK phonska fertilizer and the dose of dolomite on acid soil on seed height, number of leaves, seed diameter, fresh shoot weight, shoot dry weight, root fresh weight, root volume, root dry weight and leaf area. Of oil palm seedlings in pre nursery. This showed that each treatment had a separate influence on all growth parameters of oil palm seedlings.

The results of the analysis showed that the application of NPK phonska fertilizer had a significant effect on the dry weight of the roots of oil palm seedlings, the best at a dose of 3.5 g/seedling. This is because acidic soil is soil with a pH of less than 6.5, very high water retention capacity, high water suction capacity and very low N, P, K, Ca, Mo and Mg content. Meanwhile, the role of NPK can increase plant root growth, making it easier for plants to absorb more water and nutrients and increasing plant resistance to water shortages. This cauld be seen from NPK with the highest dose of 3.5 g dry root weight being the best. The role of the N element is the formation of plant cells, tissues and plant organs, the P element is a constituent component of several enzymes, proteins, ATP, RNA and DNA, the K element plays a role as a regulator of plant physiological processes such as opening and closing stomata or regulating the distribution of water in tissues and cells, photosynthesis, accumulation, translocation and transport of carbohydrates. This was reinforced by the statement by Sutejo and Kartasapoetra (1990) that the function of nitrogen for plants is to stimulate the growth of roots, stems and leaves, increase the chlorophyll content in the leaves so that the color is greener and improve the quality and quantity of results. The function of phosphate is to lengthen the roots so that the stems become stronger, accelerate fruit ripening, improve the quality and quantity of results. Meanwhile, potassium functions to increase plant growth, increase plant resistance to pest attacks and improve harvest quality.

The results of the analysis showed that dolomite application had a significant effect on fresh root weight and leaf area, best at a dose of 10 g/oil palm seedling in pre-nursery on acid soil. The application of dolomite as a soil amendment is able to increase the pH of acidic soil thereby reducing the solubility of micro metal elements while increasing the solubility of macro nutrients including phosphorus, thereby making the soil more optimal for the growth of oil palm seedlings. In accordance with the opinion of Sutedjo (2002) that dolomite which is used as a soil amendment, apart from increasing soil pH, also reduces the toxic influence of Fe, Al and Mn and increases the availability of nutrients. According to Barchia (2017), the magnesium content in dolomite is absorbed in the form of Mg^{2+} with an amount in plant tissue of around 0.04%, which is a macro nutrient that functions as a constituent of chlorophyll, an activator of the enzyme system in the process of carbohydrate metabolism, encouraging uptake and translocation. phosphorus and helps the movement of sugar within the plant. Supported by Naibaho (2003) that the application of lime is to increase soil pH to the desired level, and eliminate the potential for poisoning the elements Al, Fe and Mn, as well as providing Ca and Mg nutrients. According to Hardjowigeno (2010), application of lime increases soil pH, adds Ca and Mg elements, increases the availability of P and Mo elements, reduces Fe, Mn, Al poisoning, and improves the life of microorganisms and improves the formation of root nodules. Dolomite contains Ca and Mg which are very necessary for plants. In accordance with the opinion of Sutejo (1990) Ca is an essential element that is absorbed in the form of Ca^{++} which has a good effect on the growth of root tips and hairs. Ca can neutralize organic acids produced in metabolism and is able to neutralize acidic soil. The availability of sufficient water in the planting medium is needed to dissolve the nutrients from the fertilizer provided, as raw material for the photosynthesis process in the leaves, as well as the translocation of photosynthesis results from the leaves to all plant organs. Afrillah (2015) stated that the vegetative growth of seedlings in the *pre nursery* phase depends on the resources available nutrient in the seedling or plant body.

CONCLUSION

The results showed that there was no significant interaction between the dosage of NPK phonska fertilizer (15-15-15) and dolomite on all parameters. The dose of NPK fertilizer has an influence on the dry weight of the roots and is the best at a dose of 3.5 g. Dolomite application has an influence on root fresh weight and leaf area with the best dose of 10 g/oil palm seedling in pre-nursery on acid soil.

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