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Original Article

Effect of Sludge and NPK Fertilizer on the Growth of Oil Palm (Elaeis guineensis Jacq.) Seeds in Main Nurseries

Arman Effendi[1], Elza Zuhry[2], Sukemi Indra Saputra[3], Ardian[4], Fiqh Alghamrawi[5]

[1,2,3,4,5]*Department of Agrotechnology; Universitas Riau, Pekanbaru, Indonesia.*

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Abstract *- The research aimed to determine the effect of sludge and NPK fertilizer and their combination to gain the best result in the growth of palm oil seedlings in the main nursery. This research used a factorial, completely randomized design. The first factor was sludge, which has three dosages: 10 g, 20 g, and 30 g per plant. The second factor was NPK fertilizer, which has three dosages: 5 g, 10 g, and 15 g per plant. Twenty-seven units of trials were obtained from 9 treatment combinations and three repetitions. Each trial unit consisted of 4 plants, with 108 experimental plants. The experimental parameters were plant height, number of leaves, stem diameter, root volume, plant dry weight, and crown root ratio. The practical result was analyzed using Duncan's Multiple Range Test at 5%. The findings indicated that adding sludge and 15:15:15 of NPK increased plant growth, namely plant height, number of leaves, stem diameter, root volume, plant dry weight, and crown root ratio in the main nursery. The combination of 30 g sludge and 15:15:15 NPK was the leading treatment in increasing the growth of palm oil seedlings.*

Keywords *- Oil palm, Main nursery, Sludge, NPK.*

1. Introduction

Oil palm (Elaeis guineensis Jacq.) is one of the plantation crops that plays an essential role as a mainstay commodity for export as well as an item that can improve the economy of farmers in Indonesia. In Riau Province in 2021, the oil palm plantation sub-sector controls the land area and the amount of production in the plantation sector in Riau Province, which is Rp.2 860,80ha for land area (Central Bureau of Statistics, 2022). The large size of oil palm plantations to be rejuvenated requires quality seeds. Optimizing good planting media, such as optimal fertilization, can increase the productivity of good oil palm seeds. Increasing the fertility of an excellent growing media can be done by providing organic sludge and NPK fertilizer.

Improving the quality of good oil palm seeds can be done in various ways, one of which is enhancing cultivation techniques through fertilization. Isroi (2008) states that the benefits of organic matter for soil and plants can increase soil fertility, improve soil structure and characteristics and increase good water holding soil capacity. Organic fertilizer that can be used is sludge. Sludge is the result of the deposition of liquid waste produced during oil extraction from palm oil mills in a ratio of 2-3 per ton of oil. According to Darmawati et al. (2014), sludge can be used as organic material which the average potential nutrient content per ton of sludge is 0.37% N (8 kg Urea), 0.04% P (2.90 kg RP), 0,91% K (18.30 kg MOP), and 0.08% mg (5 kg Kiserite), The main components of oil palm sludge are cellulose and lignin, so this by-product is referred to as lignocellulosic by-product.

The provision of sludge needs to be balanced with inorganic fertilizers, including NPK fertilizer. The use of sludge as organic fertilizer is relatively long available to plants and has low nutrient content, combined with NPK fertilizer because the nutrient content is relatively high and quickly available to plants. Kartasapoetra and Sutedjo (2001) stated that to grow properly, plants need NPK nutrients, essential elements that play a crucial role in plants, especially in the vegetative and generative phases.

This study aimed to determine the effect of giving sludge and NPK fertilizer to get the best dose of sludge and NPK fertilizer on the growth of oil palm seedlings in the main nursery.

2. Research Methods

The research was carried out in the experimental garden of the Faculty of Agriculture, Riau University, Jalan Bina Widya Km 12.5, Simpang Baru Village, Tampan District, Pekanbaru. This research lasted four months, from January 2021 to May 2021. The materials used were four-month-old Tenera Marihat Simalungun (DXP) oil palm seeds, topsoil, composted PKS (sludge) processing results, and compound NPK with 15:15:15 formulation, insecticide Thiodan, and

fungicide Dithane M45. The tools used are meters, machetes, raffia rope, knife cutters, hoes, paranet, polybags measuring 35 x 40 cm, gembor, hand sprayer, measuring cups, envelopes, ovens, digital scales, documentation tools, stationery, and calculators. The study was carried out experimentally using a completely randomized design (CRD) which was composed of 2 factors, namely: Factor I: The administration of sludge consisted of 3 levels: S1 = Sludge dose of 10 g per plant, S2 = Sludge dose of 20 g per plant, S3 = Sludge dose of 30 g per plant. Factor II: the provision of NPK consisted of 3 levels: N1 = NPK fertilizer 5 g per plant, N2 = NPK fertilizer 10 g per plant, and N3 = NPK fertilizer 15 g per plant. There were nine treatment combinations and three replications from the two factors, so 27 experimental units were obtained. Each experimental unit consisted of 4 sample plants, so the total number of plants was 108. Parameters observed were an increase in seedling height, number of leaves, wee diameter, root volume, dry seedling weight, and root crown ratio.

3. Results and Discussion

3.1. Seed height increase

The results of the advanced test of oil palm plant height with Duncan's multiple spacing test at a level of 5% can be seen in Table 1.

Table 1. Increase in plant height of oil palm seedlings (cm) with the application of sludge and NPK fertilizer

Sludge (g per plant)	NPK Fertilizer (g per plant)			Average
	5	10	15	
10	29.32 a	30.19 a	32.26 ab	30.59 a
20	32.58 ab	33.79 ab	33.81 ab	33.39 a
30	33.13 ab	39.65 c	36.88 bc	36.55 b
Average	31.68 a	34.32 a	34.54 a	

Description: The numbers in rows and columns followed by the same lowercase letters are not significantly different according to Duncan's multiple spacing test at the 5% level

Combination Lodge 30g per plant and NPK 10g per plant significantly increased seedling height compared to the combination of sludge and other NPK fertilizers, except with 30. Sludge per plant and NPK 15g per plant; this is due to the administration of a combination*sLudge*30g per plant and NPK 10g per plantable to meet the nutrient requirements for increasing the height of oil palm seedlings. Sludge organic matter can improve the soil's physical, chemical, and biological properties that are beneficial in nutrient absorption by plants for the growth process. The provision of inorganic fertilizers aims to maintain the availability of plant nutrients to remain balanced during the growth process. According to Pramana (2016), the provision of sludge can improve soil properties such as physical, chemical, and biological properties so that the application of NPK fertilizer effectively supports the vegetative growth of oil palm seedlings.

Giving sludge 30 g per plant significantly increased plant height compared to the sludge of 10 g per plant and 20 g per plant. It is because sludge of 30 g per plant has met the specific nutrient requirement for N to support the growth of oil palm seedlings. Sludge can increase the activity of microorganisms in the soil so that the planting media is loose and can hold water, humidity, and temperature of the growing media for the better so that nutrients can be adequately absorbed, which is helpful in plant vegetative growth. According to Tindaon (1994), sludge contains nitrogen, phosphorus, and potassium nutrients which function as nutrient enhancers. The element nitrogen plays a role in the vegetative growth of plants.

Giving NPK did not affect the increase in the height of oil palm seedlings. The nutrients N, P, and K at a dose of 5g per plant are sufficient for growing oil palm seedling height. According to Lingga and Marsono (2013), the element of N in sufficient quantities can accelerate plant growth, mainly stems and leaves. Element P plays a role in cell development, and K plays a role in enzyme activation so that it stimulates photosynthesis from leaves to other plant organs.

3.2. Increase in Number of Leaves

The results of the further test of increasing the number of leaves of oil palm seedlings with Duncan's multiple spacing test at a level of 5% can be seen in Table 2.

Table 2. Increase in the number of leaves (strands) of oil palm with the application of sludge and NPK fertilizer

Sludge (g per plant)	NPK Fertilizer (g per plant)			Average
	5	10	15	
10	6.18 a	6.22 a	6.25 a	6.22 a
20	6.33 ab	6.59 ab	6.63 abc	6.52 b
30	6.70 bc	7.18 d	7.03 cd	6.97 c
Average	6.40 a	6.64 b	6.66 b	

Description: The numbers in rows and columns followed by the same lowercase letters are not significantly different according to Duncan's multiple spacing test at the 5% level

A combination of sludge 30g per plant and NPK 10g per plant significantly increased the number of leaves compared to other combinations of sludge and NPK, except with the addition of 30. Sludge per plant and NPK 15g per plant are due to the provision of 30. Sludge per plant and NPK 10g per plant affect the chlorophyll content because nutrients from nitrogen fertilizers are needed to form chlorophyll. The provision of nutrients in sufficient quantities can potentially increase plant growth, such as the shape, size, and weight of the organs produced. According to Suharno et al. (2007), the availability of nitrogen is critical; this is related to the formation of chlorophyll which can synthesize carbohydrates to support plant growth.

Sludge feeding 30 g per plant significantly increased the number of leaves compared to the addition of 10. Sludge g per plant and 20 g per plant; this is due to the nitrogen (N) and phosphorus (P) nutrients from the 30. sludge treatment g per plant can meet the needs of N and P in plants and can be utilized by plants in the photosynthesis process. Lakitan (2010) states that plants that do not get additional nitrogen nutrients will grow stunted, and the leaves are also smaller, thinner, and have fewer leaves, while plants that receive additional nitrogen nutrients will have more and broader leaves.

Administration of NPK at a dose of 10g per plant increases the number of leaves compared to a dose of 5g per plant. It is due to the provision of NPK 10g per plant already meets plant growth and can increase the number of leaves of oil palm seedlings. The increase in the number of leaves is strongly influenced by the availability of macronutrients such as N, P, and K in the growing media. In addition, Prawiranata et al. (1995) stated that the rate of photosynthesis influences the number of leaves because the assimilation produced increases, thus accelerating the opening of new leaves.

3.3. Hump Diameter Increase

The results of the further test of increasing the diameter of the oil palm seedling with Duncan's multiple spacing test at a level of 5% can be seen in Table 3.

Table 3. Increase in the diameter of oil palm seedling bulbs (cm) with the application of sludge and NPK fertilizer

Sludge (g per plant)	NPK Fertilizer (g per plant)			Average
	5	10	15	
10	1.53 a	1.54 a	1.54 a	1.53 a
20	1.57 a	1.60 a	1.62 a	1.59 a
30	1.63 a	1.98 b	1.81 ab	1.80 b
Average	1.57 a	1.70 a	1.66 a	

Description: The numbers in rows and columns followed by the same lowercase letters are not significantly different according to Duncan's multiple spacing test at the 5% level

A combination of sludge 30g per plant and NPK 10g per plant significantly increases the diameter increase hump compared to the combination of sludge and other NPK fertilizers, except with the combination of 30. Sludge per plant and NPK 15g per plant. This is due to sludge as organic matter, and the addition of NPK fertilizer can meet nutrient needs. The availability of soil nutrients affects plant growth which will increase; this is related to cell division in plants and affects the increase in diameter hump plant. Jumin (1992) stated that hump is an area of accumulation of plant growth, the presence of nutrients can help in encouraging the rate of photosynthesis to produce photosynthate so that it can assist in the formation of stem weevil.

Giving sludge 30 g per plant can increase the wee diameter, compared to giving sludge at a dose of 10 g per plant and 20 g per plant. Due to sludge, 30 g per plant capable of meeting N, P, and K nutrient content can increase plant metabolism and photosynthetic activities, which act as assimilate producers. The resulting assimilate will be translocated for plant growth and development, especially on the plant weeds and the K element. According to Leiwkabessy (1988), potassium's role in increasing the weed's diameter is crucial, especially acting as a network that connects the roots and leaves in transporting nutrients. From root to leaf.

Giving NPK does not increase the diameter of the weevil of mustard seeds. It is due to NPK 5. fertilizer g per plant has fulfilled the nutrients for developing wee diameter so that the metabolic processes and assimilate accumulation can work properly. According to Lingga and Marsono (2013), element K strengthens plant vigor, which can affect the size of the stem circumference.

3.4. Root Volume

The results of the further test of oil palm seedling root volume with Duncan's multiple tests at the 5% level can be seen in table 4.

Table 4. Oil palm seedling root volume (ml) with sludge and NPK fertilizer

Sludge (g per plant)	NPK Fertilizer (g per plant)			Average
	5	10	15	
10	28.33 a	35.00 ab	38.33 ab	33.88 a
20	41.66 abc	40.00 abc	45.00 abc	42.22 a
30	55.00 bc	60.00 c	48.33 abc	54.44 b
Average	41.66 a	43.88 a	45.00 a	

Description: The numbers in rows and columns followed by the same lowercase letters are not significantly different according to Duncan's multiple tests at the 5% level

The combination of sludge 30g per plant and NPK 10g per plant significantly increased the root volume of oil palm seedlings compared to the combination of 10. Sludge per plant and NPK 5g per plant is due to the provision of 30. sludge per plant and NPK 10g per plant can improve the physical properties of the soil in forming pores as a space for root penetration, thereby increasing root expansion. With the addition of NPK fertilizer, the growth and development of plant roots will be better. According to Sarief (1986), nutrient N absorbed by plants plays a role in supporting vegetative growth such as roots, element P plays a role in the formation of the root system, and element K, which is at the tip of the root, will stimulate root elongation.

Giving sludge 30 g per plant can increase the root volume of oil palm seedlings compared to the sludge of 10 g per plant and 20 g per plant. It is due to the use of 30. Sludge g per plant will support better growth and root development

due to better growing media support. According to Isroi (2008), the benefits of organic matter for soil and plants can increase soil fertility, improve soil structure and characteristics and increase good water holding soil capacity. Sludge also plays a role in releasing phosphate compounds bound by Al and Fe in the soil so that phosphate elements are readily available and absorbed by plants as forming root systems.

The application of NPK did not increase the root volume of oil palm seedlings; this indicates that the ability of the roots to absorb nutrients contained in NPK fertilizer is relatively the same; this is due to the application of 5 g of NPK fertilizer per plant can meet the nutrients needed by plants. Factors that affect the ability of plants to absorb nutrients in the soil medium are root hairs. According to Pracaya (2011), The growth and development of the root system are influenced by the rate of division and cell enlargement in the roots, which can increase root volume. Roots function to absorb water and nutrients in the soil.

3.5. Seedling Dry Weight

The results of the further test of the dry weight of oil palm seeds (g) with Duncan's multiple spacing test at a level of 5% can be seen in table 5.

Table 5. The dry weight of oil palm seedlings with sludge and NPK fertilizer

Sludge (g per plant)	NPK Fertilizer (g per plant)			Average
	5	10	15	
10	24.60 a	24.60 a	29.39 ab	26.00 a
20	29.88 ab	30.46 ab	37.66 bc	32.67 b
30	37.57 bc	48.26 c	38.35 bc	41.39 c
Average	30.68 a	34.25 a	35.13 a	

Description: The numbers in rows and columns followed by the same lowercase letters are not significantly different according to Duncan's multiple spacing test at the 5% level

A combination of sludge 30g per plant and NPK 10g per plant significantly increased the dry weight of oil palm seedlings compared to the combination of 10g sludge per plant and NPK 5g per plant. It is due to the combination of 30g sludge per plant and NPK 10g per plant. It causes the absorption of nutrients from NPK fertilizers to be more effective in increasing because of the carrying capacity of the soil due to the addition of organic matter in the soil. Swandi and Chan (1982) stated that combining inorganic and organic fertilizers gave better plant growth to increase the plant's wet and dry weight.

Giving sludge 30 g per plant significantly increased the dry weight of oil palm seedlings compared to the sludge of 10g per plant. It is due to sludge with a dose of 20 g per plant being sufficient for nutrients to improve the soil's physical, chemical, and biological properties, increase soil microorganism activity, provide macronutrients and improve aggregates in the growing media to increase the dry weight of oil palm seedlings. According to Jumin (1992), dry weight production of plants is a process of assimilating accumulation through photosynthesis. If the availability of nutrients in the growing media increases, it will be seen in the increase in plant dry weight.

Giving NPK did not increase the dry weight of oil palm seedlings. It is due to the application of NPK fertilizer with a dose of 5 g per plant that has been able to meet the nutrient needs of the growth of oil palm seedlings so that the dry weight of oil palm seeds is relatively the same. The use of NPK fertilizer applied to soil media will add nutrients needed for plant growth, some of which are N, P, and K. According to Harjadi (2019), the availability of nutrients for plants is one of the critical factors in supporting plant growth and structure.

3.6. Root Root Ratio

The results of the root crown ratio test for oil palm seedlings with Duncan's multiple spacing test at a level of 5% can be seen in Table 6.

Table 6. Root crown ratio of oil palm seedlings with the provision of sludge and NPK fertilizer

Sludge (g per plant)	NPK Fertilizer (g per plant)			Average
	5	10	15	
10	1.82 a	2.36 ab	2.26 ab	2.15 a
20	2.59 bc	2.53 bc	2.76 bcd	2.63 b
30	2.90 bcd	3.36 d	3.14 cd	3.14 c
Average	2.44 a	2.75 a	2.72 a	

Description: The numbers in rows and columns followed by the same lowercase letters are not significantly different according to Duncan's multiple spacing test at the 5% level

The combination of sludge 30g per plant and NPK 10g per plant significantly increased the root crown ratio of oil palm seedlings compared to the combination of sludge administration at a dose of 10g per plant and NPK with a dose of 5g per plant. It is due to the combination of 30g sludge per plant and NPK 10g per plant; this causes the absorption of nutrients from NPK fertilizers to be more effective because of the carrying capacity of the soil due to the addition of organic matter in the soil. Therefore, the provision of sludge and NPK fertilizer can increase the productivity of soil microorganisms so that the root system of oil palm seedlings is getting better and increase the uptake of nutrients related to the photosynthesis process. According to Sarief (1986), the availability of nutrients absorbed by plants is one of the factors that can affect plant growth by increasing the weight of the plant crown. According to Harjadi (2019), growth is expressed as an increase in size that reflects the increase in protoplasm, characterized by an increase in the root crown ratio of plants.

Giving sludge 30 g per plant significantly increased the root-to-root ratio compared to giving 10g per plant; every increase in the dose of sludge experienced an increase in the root crown ratio of oil palm seedlings. It is due to the use of sludge with a dose of 20 g per plant has been able to be absorbed by plants to support plant physiological processes such as photosynthesis and transpiration so that the dry weight of the canopy is higher than the dry weight of the roots of oil palm seedlings. The root crown ratio shows how much photosynthesis has accumulated in the plant parts. The root crown ratio showed that the dry weight yield through photosynthesis was translocated to the canopy (stems and leaves) than to the roots of oil palm plants. Murut Gardner et al. (1991) that the ratio or root crown ratio has an understanding that the growth of other plant parts follows the growth of one part of the plant, and an increase will follow high root weight in the weight of the crown.

The application of NPK did not increase the root crown ratio of oil palm seedlings; this indicated that the ability of the roots to absorb nutrients contained in NPK fertilizer was relatively the same. It is presumably by giving NPK fertilizer with a dose of 5 g per plant that can meet the nutrients needed by plants in increasing the root crown ratio of oil palm seedlings. The increase in the root crown ratio is influenced by the fulfillment of nutrient needs and water availability for plants. According to Dwijosapoetra (1985), plant growth will be better if the required nutrients are sufficiently available in a form easily absorbed by plant roots. The better the growth of eating plants can increase the weight of the plant.

4. Conclusion and Recommendations

4.1. Conclusion

Based on the results of the research that has been done, it can be concluded that:

1. The provision of sludge and NPK increased plant growth, such as plant height; first, the addition of the number of leaves, increase in stem diameter, root volume, plant dry weight, and root crown ratio (RTA) of oil palm plants in the main nursery. Giving sludge 30 g per plant and 10 g NPK fertilizer g per plant gave oil palm seedlings the best growth and development.
2. The increase in sludge can increase plant growth, such as plant height, the number of leaves, stem diameter, root volume, plant dry weight, and root crown ratio (RTA). The application of 30 g of sludge per plant showed oil palm seedlings' best growth and development.
3. Giving NPK 10 g per plant to oil palm seedlings only increases the number of leaves of oil palm seedlings

4.2. Suggestion

Based on the research results, to increase the growth of Marihat oil palm seedlings aged 4-7 months which are good in the main nursery, it is recommended to use 30 sludge g per plant and 10 g NPK fertilizer per plant.

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