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Utilization of Palm Solids In Increasing Growth And Results Soybean Plant (*Glycine Max* (L) Merril)

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ABSTRACT

The demand for soybeans in Rokan Hulu is on the rise due to the increasing population and the expanding array of soy-based products. However, the local farmers are unable to meet this growing demand as a result of diminishing arable land for soybean cultivation and declining soil fertility levels. Therefore, concerted efforts are required to boost soybean production in the region. It is believed that applying solid palm oil could potentially enhance soybean yields. A study was conducted to investigate the impact of various doses of solid palm oil on the growth of soybean plants. The study's findings analyzed using Duncan's multiple range test (DMRT α 5%), revealed that the application of solid compost did not significantly affect plant height, stem diameter, flower age, or the number of fruiting pods. However, a significant difference was observed in the number and weight of seeds per sample plant, with the optimal dose being 360 g per plot.

Keywords: *Compost, Growth, Solid, Soybeans, Yield*

1. INTRODUCTION

Soybean (*Glycine max L*. Merrill) is a leguminous plant that produces grains, serving as a valuable food crop with numerous advantages in terms of food, industrial applications, and animal feed. Soybean seeds are rich in nutrients, particularly vegetable protein, and boast a comprehensive amino acid profile. The demand for soybeans within Indonesia is on the rise, leading to the importation of nearly 3,000,000 tons annually due to insufficient domestic production. In 2019 the national soybean harvest area covered 840,350 hectares, yielding 3,005,000 tons (Cahyono, 2017). However, the national demand for soybeans in the same year stood at approximately 5 million tons annually. The limited soybean production in the country can be attributed to the inadequate soybean harvest area, suboptimal cultivation practices, and nutrient management, all of which negatively impact soybean yields. Soybeans are a crucial staple food crop with high nutritional value. They are essential commodities widely utilized in various food products like tofu, tempeh, soy milk, soy sauce, and Touco. Furthermore, soybeans are processed into animal feed due to their high protein and vegetable fat content. Consequently, soybeans hold significant importance in the Indonesian economy.

Based on the data provided by the Rokan Hulu Regency Food Crops and Horticulture Service (2017), soybean production in Rokan Hulu Regency exhibited fluctuations over the years. In 2013, the production stood at 939.48 tons/year, which experienced an increase in 2014, reaching 1,065.24 tons/year. However, in 2015, there was a decline in production, amounting to 768.53 tons/year. The subsequent year, 2016, witnessed a significant increase in soybean production, reaching 2,010.79 tons/year. Nevertheless, in 2017, there was a decrease in production, amounting to 881.34 tons/year. The availability of soybeans in the market has been a matter of concern. Given the rise in population, increase in per capita income, and growing public awareness of food nutrition, the demand for soybeans in Indonesian society is expected to continue increasing annually.

Soybeans offer numerous health benefits for humans, and with increasing demand, there is a need to focus on enhancing production through both intensification and extensification. Intensification can be achieved by implementing suitable cultivation practices, such as applying inorganic fertilizers. Fertilization, which involves the optimal use of organic and inorganic fertilizers, is a crucial activity in plant management to ensure optimal growth and yield. According to Novizan (2017), fertilization can be done using organic or inorganic fertilizers. Using organic fertilizers can enhance the soil's physical, chemical, and biological properties. One type of organic fertilizer that can be utilized is solid waste, known as solid, which is obtained from the processing of palm oil fruit into crude palm oil using a decanter system. Decanters are employed to separate the liquid phase (oil and water) from the solid phase until the last particle is removed. The solid waste released from the decanter is high in moisture content. It is brown and retains approximately 1.5% CPO oil (Pahan, 2018).

The organic fertilizer produced from Palm Oil Factory Solid Waste (LPPKS) contains a wide range of nutrients, albeit slowly available to plants. On the other hand, inorganic fertilizers provide nutrients that are readily available due to their high solubility. The analysis indicates that the Phosphorus (P) content in LPPKS is relatively low, necessitating the addition of inorganic fertilizers such as NPK fertilizer. Lingga and Marsono (2016) suggest that Phosphorus (P) plays a crucial role in stimulating plant root growth, enhancing flowering and seed ripening, and contributing to photosynthesis. NPK fertilizer offers the advantage of providing multiple nutrients in a single application, making it a more efficient option than individual fertilizers.

Panjaitan's (2018) study demonstrated that incorporating solid material along with NPK fertilizer can potentially decrease NPK fertilizer application by 25% of the recommended amount of inorganic fertilizer in oil palm nurseries. On the other hand, Okalia, Nopsagiarti, and Rover (2017) found that utilizing solid palm oil compost at a rate of 360 g/plot in soybean cultivation led to significant improvements in plant height (34.39 cm), leaf count (10.89 pieces), and fruit weight (107.78 gr/plant) compared to soybean plants grown without solid oil palm compost.

2. MATERIAL AND METHODS.

This research was conducted at the Experimental Garden of the Faculty of Agriculture, Pasir Pengaraian University, Kumuh St. Kumu Village, Rambah Hilir District, Rokan Hilir. The materials used in this research were the Anjasmoro soybean variety, palm oil solids, and NPK fertilizer as basic fertilizer. The insecticide and fungicide used in this research were Curacron (profenofos 500 g/l). Dithene M-45 (Mancozeb 80%). The equipment used was measuring tape, digital scales, calipers, machetes, hoes, scissors, knives, sample pans, transparent plastic, rope, and stationery to support this research.

Randomized Block Design (RAK) with 5 treatments, each treatment has 3 groups of plants, where each plot consists of 12 plants. The treatment is as follows: A0 = without administering solid palm oil, A1 = administering solid at a 160 g/plot dose, A2 = administering solid at a 260 g/plot dose, A3 = administering solid at a 360 g/plot dose, A4 = administering solid at a 460 g/plot dose

If the analysis of the variance test shows a real effect, then proceed with the DMRT test at the α = 5% level.

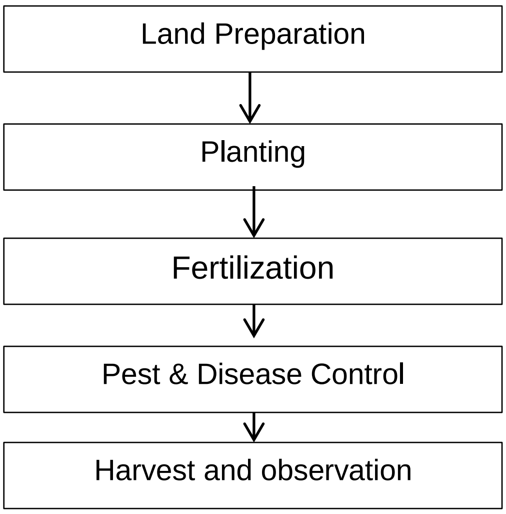

Figure 1. Flowchart of Research Implementation

Land Clearing

The land used for this research was first cleared of grass, then the soil was tilled using a hoe, then the soil was smoothed, then leveled by making plots measuring 1x1.5 meters. The distance between plants was 30 x 40 cm, while the distance between beds was 50 cm. As a basic fertilizer, goat manure is used, given 2 weeks before planting at a dose of 3.7 kg/plot mixed evenly with the soil.

Planting

Planting is done manually by digging to a depth of 2-3 cm, and then each hole is filled with two soybean seeds and covered with soil. Planting is done in the morning starting at 8.00 WIB and afternoon at 16.00 WIB.

Palm Oil Solid Application

The application of oil palm solids is carried out by inserting the solids into each hole where the soybeans will be planted 2 weeks before planting according to the designed dosage. Watering is carried out in the morning at 8.00 – 9.00 WIB starting when the plants are 10 days after planting (DAP) with intervals of 10 days until the plants are 42 DAT.

Fertilization

Fertilization is carried out with Urea (15.6 g/plant), TSP (9.96 g/plant), and KCl (15.6 g/plant), which are given when the plants are 20 DAP and 30 DAP using a single method with a distance between 10 cm from the soybean plant.

Pest and disease control

To protect against pest attacks, spraying is carried out using the insecticide Curacron 1.0 ml/liter of water, given when pests and diseases attack plants. To protect plants from disease, plants are sprayed using the fungicide Dhitane M-45 at a dose of 2 g/liter of water. For prevention, spraying is done once every 2 weeks.

Harvest

Harvesting occurs when 75% of the population in each plot shows the harvest criteria: the leaves have turned yellow and fallen off, the pods are dry and brown, and the stems of the soybean plants are starting to dry out. Harvesting is done when the sun is bright by cutting the base of the soybean stems using a sickle. The results of each plot are separated to be used as treatment results, then dried in the hot sun to facilitate the release of seeds from the soybean pods.

3. RESULT AND DISCUSSION

3.1 Soybean Plant Height

The results of the F test in the analysis of variance showed that the provision of solid oil palm had no significant effect on plant height at the ages of 21, 27, and 34 DAP. This result can be seen in the plants.

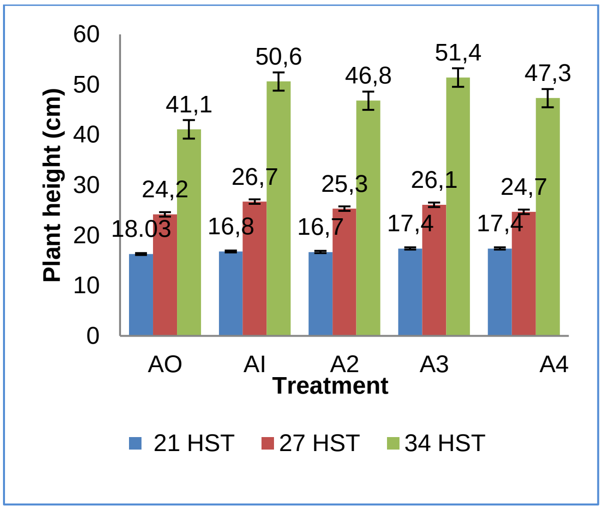

Figure 2. The average height of soybean plants (*Glycine Max (L)* Merrill) treated with several doses of solid oil palm.

According to Figure 1, it is evident that providing a solid dose of oil palm at each age leads to an elevation in the height of soybean plants. Specifically, administering a solid dose of oil palm in treatment A3 at 34 DAP resulted in a greater increase in soybean plant height compared to treatments A0, A1, A2, and A4 at 21 DAP. This disparity can be attributed to the fact that, despite not being significantly different, the dose of A3 (360 g/plot) at 34 DAP had the ability to enhance plant height.

The presence of a high nitrogen (N) content in solid compost has been found to impact seedlings' growth significantly. Daryadi et al. (2017) have stated that an adequate nitrogen supply is crucial for promoting overall plant growth, particularly during the vegetative growth stage, which includes the development of stems, shoots, and leaves. Nitrogen also plays a role in stimulating sprouting and increasing plant height. When solid compost with higher concentrations of nitrogen, phosphorus (P), and potassium (K) is provided, cocoa seedlings utilize these elements to enhance their height growth. This finding aligns with the statement made by Rajagukguk et al. (2014) that nitrogen is a fundamental component of chlorophyll. An increase in nitrogen uptake leads to an increase in chlorophyll content, thereby boosting photosynthesis and facilitating the allocation of chlorophyll for plant growth. Phosphorus is involved in the dark phase reactions of photosynthesis, respiration, and various metabolic processes. Potassium, on the other hand, acts as an activator for essential enzymes in photosynthesis and respiration, as well as in synthesizing proteins and starch.

3.2 Stem Diameter

Stem diameter measurements were carried out using a digital caliper. This diameter was taken when the first flower appeared on the plant by measuring from the neck of the plant at the boundary of the soil surface. Giving several solid doses of oil palm had no significant effect on the stem diameter of soybean plants (*Glycine. Max* (L) Merrill).

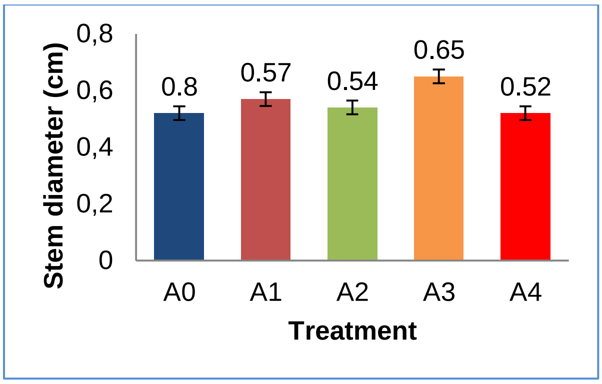

Figure 3. Average stem diameter of soybean plants (Glycine Max (L) Merrill) treated with several doses of solid oil palm.

Based on the data presented in Figure 2, the average stem diameter of the sample plants did not show a significant difference compared to the stem diameter of soybean plants. Specifically, the stem diameter of soybean plants (Glycine Max (L) Merrill) aged 92 hours after sowing (DAP) appeared to be higher in the A3 treatment (360 g/plot) at 0.65 cm, while the lowest result was observed in treatment A0 (0 g/plot) at 0.8 cm. The lack of significant difference in results between the sample plants and soybean plants may be attributed to the fact that soybeans require considerable time to increase their stem diameter. Therefore, the short duration of observation may not accurately reflect the actual outcomes. This finding aligns with the assertion made by Hakim et al. (2019) that the age of the plant is a crucial factor influencing stem diameter size. It is believed that as the plant ages, there will be a corresponding effect on the stem diameter size. A shorter lifespan of a plant tends to yield a smaller diameter, whereas a longer lifespan results in a larger diameter. Furthermore, the increase in stem diameter is also impacted by the availability of potassium, as potassium is a nutrient absorbed in a similar quantity to nitrogen. A potassium deficiency can impede plant growth. Hansen et al. (2017) have highlighted the essential role of potassium in enhancing plant strength, physiological processes, metabolic functions, nutrient absorption, transpiration, enzyme activity, and carbohydrate translocation.

3.3 Soybean Plant Flowering Age

The age of flowering plants was determined by measuring the duration from the onset of flowering until 50% of the plant population within each plot had flowered. The application of multiple substantial doses of palm oil did not yield any notable impact on the flowering period of soybean plants.

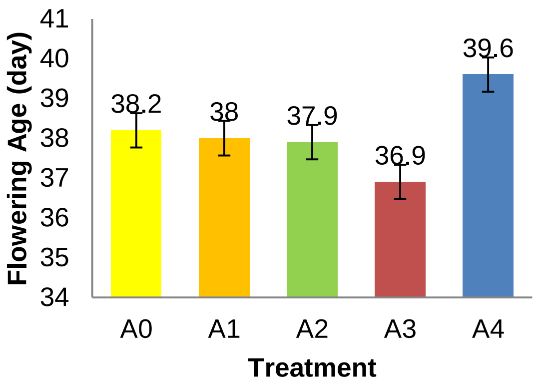

Figure 4. The average age of the flowering of soybean plants (*Glycine Max* (L) Merrill) with treatment with several doses of solid oil palm.

Figure 3 above shows that the results of the variance of giving several doses to soybean plants did not significantly affect the flowering age of soybean plants. The flowering age of soybean plants at 92 DAP tends to be faster in treatment A3 (giving solid oil palm at a dose of 360 g/plot), namely 36 days, while the longest results are in treatment A4 (giving solid oil palm at a dose of 460 g/plot), precisely 39 days.

Treatment A3 had the fastest flowering period due to the sufficient nutrient supply from the soil, meeting the nutrient requirements of soybean plants. The solid-dried decanter is suspected to have not undergone complete weathering, resulting in insufficient nutrients for plant absorption. This aligns with Rozak's (2015) assertion that solid-dried decanters generally decompose within 6 weeks. Astuti (2000) identified various factors influencing the decomposition rate of organic material, including the type and size of organic particles, microorganism type and quantity, availability of C, N, P, and K, soil moisture, temperature, pH, and aeration. Okalia et al.'s (2017) research supports the notion that higher doses of solid compost lead to increased organic matter contribution to the soil. Specifically, adding 30 tons/ha of solid compost resulted in a higher increase in soil organic C compared to 20 tons/ha and 10 tons/ha. However, if the dose of oil palm solita is less than 20 tons/ha, the soil organic C content will not meet the criteria for increasing soil organic C and will remain lower. Fitriatin et al. (2014) research indicates that Ultisol soil is characterized by acidity, low organic matter, low macronutrient levels, and very low P availability. Furthermore, Okalia et al.'s (2017) study confirms that higher doses of solid compost lead to a greater contribution of organic matter to the soil.

3.4 Number of Fertile Pods of Soybean Plants

The number of pods from a sample plant can be calculated from the number of pods planted by taking the sample plant pods and then selecting the fruity pods. Giving several solid doses of palm oil had no significantly different effect on the number of soybean plant pods.

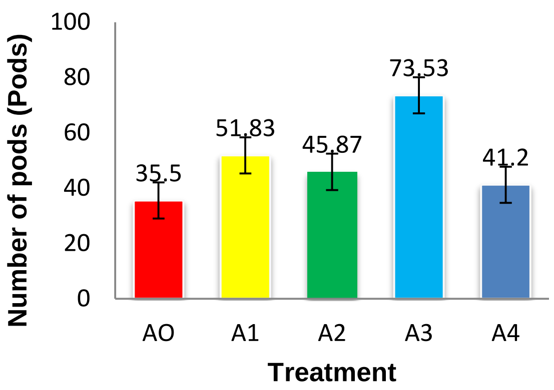

Figure 5. The average number of pods in samples of soybean plants (*Glycine Max* (L) Merrill) treated with several doses of solid oil palm.

Based on Figure 4 above, it can be seen that solid oil palms with A3 (360 g/plot) tend to be the best treatment compared to A0 treatments with an average pod weight of 73.53 g/plant. The addition of solid oil palm in treatment A3 compared to treatment A0 resulted in an increase in pod weight, namely 73.53 g/plant. Growth in treatment A3 was better because the content contained in solid oil palm fertilizer at a dose of 360/plot could meet the nutrient needs of soybean plants. The P nutrient content in solid compost fertilizer is 2.19, which can stimulate the growth of flowers and pods. This solid is not able to influence the condition of the Rhizobium, so it is completely effective, so some of the root nodules that have formed cannot collect N from the air. This follows the opinion of Suryantini (2012) who stated that the rhizobium population in soil can consist of various strains, from ineffective to very effective. Ineffective rhizobium can form nodules (infective) but cannot fix N. Thus, legume plants planted in soil containing natural rhizobium will experience nodules by several ineffective and effective rhizobium strains. The effectiveness pattern of the natural rhizobium population in the soil follows a normal distribution with an average effectiveness of only around 50% of the effectiveness of the selected rhizobium inoculum strain.

According to a study conducted by Kurniawan et al. in 2014, plants can effectively utilize nutrient P to enhance the quantity of soybean pods. The solid compost treatment with a combination of 30 tons/ha + 100% inorganic fertilizer significantly increased the number of pods planted. This can be attributed to the presence of macronutrients like P and K in the solid compost fertilizer, which stimulated the generative growth of soybean plants. Additionally, the higher the K content, the better the formation and filling of the pods, as stated by Hanibal et al. (2001).

3.5 Number of Seeds/Sample Plants

The number of seeds in a sample plant can be calculated by counting the number of seeds in a sample planting after obtaining the number of seeds planted. Giving several solid doses of palm oil significantly affected the number of soybean pods (*Glycine max* (l) Merrill).

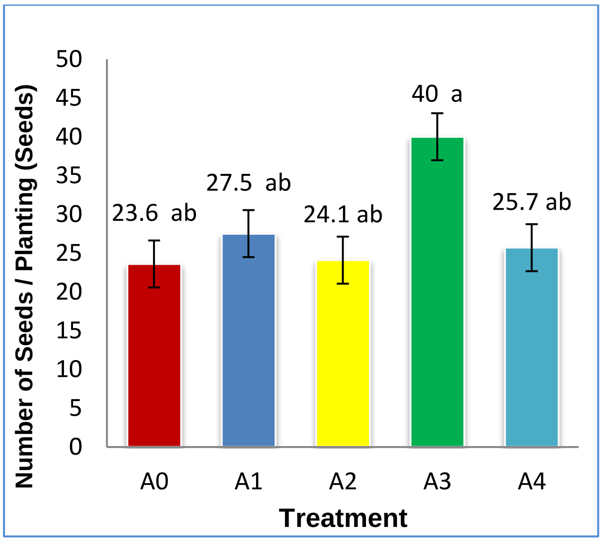

Figure 6. The average number of seeds in samples of soybean plants (*Glycine Max* (L) Merrill) treated with several doses of solid oil palm.

Figure 5 above shows that the number of soybean seeds (Glycine Max (L) Merrill) with the administration of several solid doses of palm oil has a significant effect. The number of seeds of soybean plants (Glycine Max (L) Merrill) aged 92 DAP tended to be greater in the

A3 treatment (360 g/plot), namely 40 seeds, while the lowest yield was in the A0 treatment (0 g/plot), namely 23.6 seeds. It is suspected that with this treatment, the soil condition is looser due to the addition of solids so that the gynophores can easily penetrate (enter) the soil.

According to AAK (1993), the presence of loose soil facilitates the penetration of glycoforms into the soil layer, resulting in a higher percentage of gynophores developing into pods. Thabrani (2011) asserts that adding organic material enhances soil biological activity, aiding in decomposition. This improved decomposition process increases plant nutrient availability, thereby boosting metabolic activity, particularly the photosynthesis process. Consequently, the photosynthate produced is also transported to support pod formation. Manipulating the solid dose, either increasing or decreasing it, can impact the number of pods formed.

3.6 Weight of sample seeds/plants

The weight of sample seeds or plants can be determined by tallying the number of seeds per sample plant, obtained by opening the plant pods and counting the number of fruity pods per plant. The weight of soybean seeds (Glycine max (Glycine max). l) Merrill) is notably influenced by administering multiple substantial doses of oil palm.

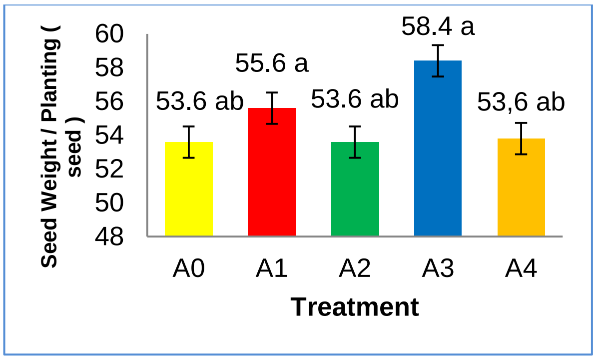

Figure 7. Average seed weight of soybean plants (Glycine Max (L) Merrill) treated with several doses of solid oil palm.

According to Figure 6, the average weight of seeds planted in the samples yielded significantly different results than the weight of soybean seeds. In the A3 treatment, which had 92 DAP-aged Glycine Max (L) Merrill soybean seeds, the number of seeds tended to be higher at 360 g/plot, specifically 58.4 g, while the lowest yield was observed in treatment A0 at 0 g/plot, specifically 53.6 g. These results indicate that the treatment significantly impacted seed weight in soybean plants, suggesting that the nutrient content found in auxin can enhance seed weight in soybean plants. The presence of the P element is crucial in the seed formation process, as legumes require substantial amounts of P nutrients during flowering and seed formation (Khalil, 2000). However, this finding contradicts Azyyati's (2016) statement that the concentration of liquid organic fertilizer does not significantly affect soybean seeds' weight.

It is suspected that the soil condition becomes looser with this treatment due to the addition of solids, allowing the gynophores to penetrate the soil easily. The treatment's effect further supports the notion that the nutrient content in auxin can contribute to an increase in seed weight in soybean plants. The presence of the P element remains crucial in the seed formation process, as legumes require substantial amounts of P nutrients during flowering and seed formation (Khalil, 2000).

4. CONCLUSION

According to the study's findings, it can be deduced that the utilization of solid compost does not have a noteworthy impact on the height of soybean plants, stem diameter, flower age, and the number of fruit-bearing pods. However, a significant difference was observed in the number and weight of seeds per sample plant when the optimal dosage of 360 g per plot was applied.

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