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UTILIZATION OF PALM OIL SOLID WASTE AS ORGANIC FERTILIZER TO SUBSTITUTE COMBINED INORGANIC FERTILIZER WITH PLANTING DISTANCE TO IMPROVE THE GROWTH AND PRODUCTION OF SOYBEAN PLANTS (Glycine max L.)

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Abstract

This study aims to determine the effect of organic compost fertilizer and planting distance on the growth and production of soybean plants. This study uses a randomized block design (RBD) factorial with two treatment factors, namely compost fertilizer and planting distance. The first factor, compost fertilizer, consists of five levels: S0 = No treatment, S1 = 75% inorganic NPK fertilizer + 25% organic compost fertilizer, S2 = 50% inorganic NPK fertilizer + 50% organic compost fertilizer, S3 = 25% inorganic NPK fertilizer + 75% compost organic fertilizer, S4 = 100% compost organic fertilizer. The second factor is planting distance, which consists of three levels: J1 = 20 cm x 30 cm planting distance, J2 = 20 cm x 40 cm planting distance, J3 = 25 cm x 40 cm planting distance. The observed parameters were plant height, leaf chlorophyll content, root nodule count, pod count, filled pod count, empty pod count, weight of 100 seeds, seed yield per plot, wet pod weight, and dry pod weight. The results of the study indicate that the application of compost fertilizer has a significant effect on soybean plant height, leaf chlorophyll content, and root nodule count. Planting distance has a significant effect on empty pod weight, 100-seed weight, and dry pod weight. The interaction between compost fertilizer and plant spacing had no significant effect on plant height, leaf chlorophyll content, root nodule number, pod number, filled pod number, empty pod number, 100-seed weight, seed yield per plot, wet husk weight, and dry husk weight.

Keywords: ***Palm oil solid waste, inorganic substitution, planting distance, soybeans.***

INTRODUCTION

Soybeans (Glycine max L.) are the third most widely cultivated food crop in Indonesia and are a major source of protein. Soybeans have been cultivated in East Asia for 3,500 years (Maesyaroh, et al., 2021). The primary global sources of plant-based protein and vegetable oil are supplied by soybean seeds. The Central Statistics Agency reported in 2022 that soybean production over the past two years (2020–2021) has been quite fluctuating. In 2020, the harvested area was 381,311 ha (33.66%), with production reaching 632,326 tons (49.06%) and productivity at 16.58 tons/ha. ha, 9.72%. In 2021, the harvested area was 362,612 ha, a decrease of 4.90% from the previous year, with production reaching 613,318 tons, a decrease of 3.00% from the previous year, and productivity reaching 16.91 Ku/ha, an increase of 1.99% (Hafni et al., 2022). Based on this data, efforts need to be made to increase soybean production through better cultivation techniques, such as the use of high-quality seeds, ideal planting distances, adequate fertilization, and improving and paying attention to soil structure. One such effort is to improve soil structure. Soil conditioners are applied to the soil with the aim of accelerating the process of restoring soil quality, namely improving the physical, chemical, and biological qualities of the soil. Palm oil mill waste, which contains high levels of organic matter, has the potential to be used as a soil conditioner. According to Maryani (2018). The use of organic fertilizers should be combined with inorganic fertilizers to complement each

other (Sirrapa and Razak 2010). The application of organic fertilizers combined with inorganic fertilizers can increase crop productivity and improve fertilizer use efficiency (Farida and Hamdani, 2001). Most farmers prefer to use inorganic fertilizers rather than organic fertilizers. This is because inorganic fertilizers are easy to use and contain macro nutrients (NPK) that plants need in large quantities. As a result, farmers only think about production yields without considering the impact of continuous use of inorganic fertilizers. According to Suwahyono (2011), inorganic fertilizers cannot improve soil quality, unlike organic fertilizers, which can function as soil conditioners and improvers. Planting distance is an important factor in efforts to increase soybean yields. According to Srihartanto et al. (2015), a soybean planting distance of 40 cm x 20 cm is the optimal spacing to increase soybean productivity by 2.94 tons/ha of dry seeds.

LITERATURE REVIEW

Soybeans (Glycine max L.Merrill) are a type of legume from the leguminosae family that are used as a food supplement because they are high in protein (Girsang 2020). Fertilizer is a material containing one or more nutrients, both organic and inorganic, added to the growing medium or plant to ensure that the required nutrients are sufficient to meet its needs, enabling the plant to reproduce effectively (Rajiman, 2020). Fertilization aims to replace lost nutrients and replenish the supply of nutrients needed by plants to enhance production and quality. The availability of complete and balanced nutrients that can be absorbed by plants is a determining factor in plant growth and production (Dewanto et al., 2013). Efforts to increase plant productivity can be achieved through the application of fertilizers, both organic and inorganic (Dewanto et al., 2013). Generally, fertilizers are divided into two groups based on their origin: organic fertilizers and inorganic fertilizers. Organic fertilizers are derived from the decomposition of plant residues and animal manure. Examples include manure, compost, and humus. Inorganic fertilizers, on the other hand, are manufactured by fertilizer plants by blending high-nutrient chemical (inorganic) compounds. Examples include urea (nitrogen fertilizer), TSP or SP-36 (phosphorus fertilizer), and KCl (potassium fertilizer) (Wibowo, 2017).

METHOD

This study was conducted from July to October 2024. The design used in this study was a randomized block design (RBD) with three replicates. The treatments tested consisted of two factors arranged in a factorial design. The factors were as follows: First factor: inorganic fertilizer + compost (S): S0 = No treatment; S1 = 75% inorganic NPK fertilizer + 25% organic compost fertilizer; S2 = 50% inorganic NPK fertilizer + 50% organic compost fertilizer; S3 = 25% inorganic NPK fertilizer + 75% organic compost fertilizer; S4 = 100% organic compost fertilizer. The second factor is planting distance (J), with the following levels: J1 = Planting distance 20 cm x 30 cm ; J2 = Planting distance 20 cm x 40 cm; J3 = Planting distance 25 cm x 40 cm. There are 15 levels of treatment, each repeated three times, resulting in a total of 45 plots of plants studied. The data obtained were analyzed using analysis of variance (ANOVA) at the 5% level, and if there was a significant effect, it was followed by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

1. Plant Height (cm)

Plant measurements were taken when the plants were 2, 4, and 6 weeks old after planting. Plant height was measured from the base of the stem to the tip of the growing point of the sample plant. The average plant height at 6 weeks after planting (WAP) can be seen in Table 1 below.

Table 1. Effect of Compost and Planting Distance on Plant Height (cm) Soybean 6 WAP

Compost	Planting distance (cm)			Average S
	J1 (20 x 30)	J2 (20 x 40)	J3 (25 x 40)	
S0 (Control)	54,9	56,3	56,3	55,8b
S1 (75% NPK + 25 % Compost)	62,6	60,1	59,6	60,8a
S2 (50% NPK + 50 % Compost)	60,7	60,5	60,5	60,6a
S3 (25% NPK + 75% Compost)	61,5	61,9	60,1	61,2a
S4 (100% Compost)	58,3	62,3	53,6	58,1b
Average J	59,6	60,2	58,0	

As shown in Table 1, compost treatment significantly affects soybean plant height at 6 weeks after planting. The highest average plant height was observed in S3 at 61.2 cm, which was significantly different from S0 at 55.8 cm and S4 at 58.1 cm. However, there was no significant difference among S3, S2, and S1.

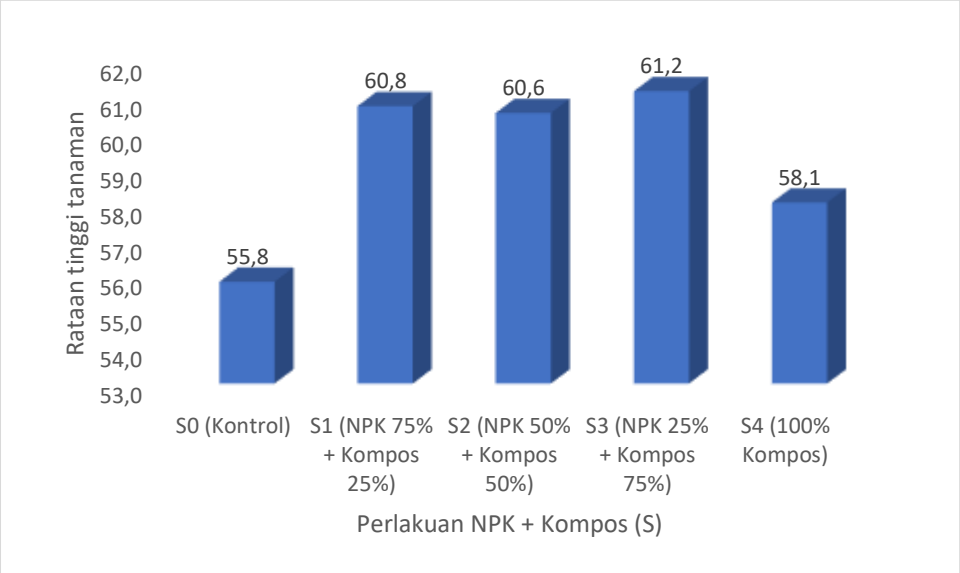

Figure 1. Effect of Compost on Plant Height 6 MST

Organic waste fertilizer contains elements needed by plants, including nitrogen, phosphorus, and potassium. This is in line with the statement by Arzita et al. (2023), who stated that the addition of nitrogen nutrients can stimulate vegetative growth, namely branches, stems, and leaves, as well as plant height. The positive effect of organic material application on plant growth is also mentioned by Hitijahubessy and Siregar (2016), who found that organic material application accelerates plant growth.

2. Seed Weight per Plot (g)

The average data on soybean seed weight per plot under compost treatment and planting distance, as analyzed by analysis of variance (ANOVA) for seed weight per plot, is presented in the appendix below.

Table 2. Analysis of variance (ANOVA) for soybean seed production per plot.

SK	Df	JK	KT	F-Calculated	F-Table 0.05%
S	4	464,531	116132,8	1,54tn	2,71
J	2	27867,22	1393360,9	1,49tn	2,34
S * J	8	897,375	112171,9	1,48tn	2,29
Repetition	2	2041,445	1020722,5		
Error	28	2109,778	75349,2		
Total	45	247469,886			

FK = 74,6%
KK = 60,1%
Notes :
tn = Not Signifacantly different
* = Significantly different at the 5% level.

The results of the observations and analysis of variance show that the compost treatment had no significant effect on the seed weight per plot of soybean plants. The planting distance treatment had a significant effect on the seed weight per plot, while the interaction was not significantly different. In Table 2, the planting distance treatment had no significant effect on the seed weight per plot of soybean plants. The highest seed weight per plot was obtained in treatment J1 at 1.56 tons/ha, and the lowest average was in treatment S3 at 1.32 tons/ha. There was no interaction between these two combinations. Description: Dega 1, potential yield 3.82 tons/ha, highest production only 1.56 tons/ha. The development and productivity of cultivated plants are greatly influenced by planting distance. (Asro and Indrayanti, 2010). Research results from Lestari et al. (2019) indicate that planting distance with appropriate density can influence plant appearance and production, particularly because better light utilization coefficients can enhance plant growth processes.

CONCLUSION

Compost treatment significantly affects soybean plant height and pod weight. The best compost type was in the S4 compost treatment, and planting distance treatment did not significantly affect plant height. The best planting distance was in the J2 treatment, and the interaction between compost and planting distance in the study did not significantly affect plant height or pod weight per plot.

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