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by U. Isnatin

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Growth and nutrients uptake of soybean (*Glycine max* L.) in response to cajeput waste compost and inorganic fertilizer

U. Isnatin[1]*, Muhammad[1], Rahayu[2], D. Purnomo[2]
[1] Faculty of Science and Technology, Study Program of Agrotechnology, Universitas of Darussalam Gontor, Jl Raya Siman Ponorogo, East Java, Indonesia
[2] Faculty of Agriculture, Prodi Agroteknologi, Sebelas Maret University Surakarta, Jl Sutami 36A Surakarta, Central Java, Indonesia

E-mail: umiagrounida@yahoo.com

Abstract. Productivity of Soybean in sandy soils is still low and cajeput waste is increasing in number. The purpose of this study was to determine the effect of the use of compost from cajeput waste and inorganic fertilizers to increase the growth and nutriens uptake of soybean. This research was conducted using a randomized block design, with treatment : control, NPK 150 kg/ha, compost 6 t/ha, compost 6 t/ha + NPK 50 kg/ha, compost 6 t/ha + NPK 100 kg/ha and compost 6 t/ha + NPK 150 kg/ha The results showed that soybeans fertilized by compost alone have dry weight of stem, N uptake and K uptake higher than without fertilizing at 26.19%, 23.21% and 36.11% respectively. Increasing the dose of NPK fertilizer combined with compost can increase N and K uptake, but reduce the number of root nodules. The highest dry weight of stem, N uptake and K uptake in compost fertilizer combined with NPK of 150 kg/ha were respectively 2.31 g / plant, 0.076 g / plant and 0.056 g / plant.

Keyword: Compost, NPK fertilizer, soybeans, nutrient uptake

1. Introduction

Productivity of Soybean in marginal land Ponorogo is still low at 1.2 t/ha. The optimum yield of soyben is 2.68 t/ha. The increasing of soybean yield in marginal land was conducted by using inorganic fertilizers. On the other hand the use of inorganic fertilizers will disrupt the activity of rhizobium bacteri which have a role in providing nitrogen for soybean plants. Rhizobium is a bacterium that is able to bind nitrogen from the air and translocated to plants. Rhizobium bacterial activity depends on the content of soil organic matter [1]. The content of soil organic matter in marginal land is low (2.46 – 2.72%). The optimum soil organic matter for plant growth is 3 – 5%, besides that each marginal land has different constraints in supporting the growth of soybean plants.

The problems that exist in marginal land are mostly caused by low soil organic matter, but there are specificities in each field. Sandy land has a high speed of water flow so that inorganic fertilizers are more easily washed [2]. Improvement of marginal land can be done by using organic fertilizers, one of which is compost [3]. The use of compost can improve soil physical and biological properties so that nutrient availability for plants can be improved [4].

[1] E-mail: umiagrounida@yahoo.com.

This study aims to examine the use of compost from cajeput waste and NPK ferilizer in increasing growth and nutrient uptake of soybeans. The specific purpose is to obtain the application method for composting cajeput waste in sandy land. The land has the potential to develop soybean plants.

2. Method

The study was conducted in the Brotonegaran village area of Ponorogo Regency. The type of soil is alluvial soil with a height of 100 m above sea level. The study was conducted in May - August 2019. The study was conducted in a randomized block design with 3 replications. The treatment is A0 = without fertilizer, A1 = NPK 150 kg/ha, A2 = Compost, A3 = Compost 6 t/ha + NPK 50 kg/ha, A4 = Compost 6 t/ha + NPK 100 kg/ha, A5 = Compost 6 t/ha + NPK 150 kg/ha

The study was conducted on sandy soil. The land is processed and made of 18 plots with a size of 1.2 x 8 m. The plot distance is 60 cm. The land is planted with soybeans with a spacing of 20 x 20 cm. each hole is planted with 1 seed. Each plot was given compost and NPK fertilizer according to the treatment. Plants are treated for pest and disease control. Sampling is carried out at flowering (age 60 days after planting). Plant samples were cleaned and then observed plant height, canopy dry weight, root dry weight, number of nodules, amount of chlorophyll, nutrient uptake (N, P, K).

Plant samples for the analysis of N, P and K levels of plants were taken from the top of the plants, then dried in oven with temperaure of 80°C until the moisture content is constant, then crused and stored before analysis of the plant tissue. Analysis of N levels with the Kjeldah Method, analysis of P content using a spectrophotometer and K using a flame-meter.

Data analysis was performed using ANOVA with SPSS 16. If there were significant differences, the analysis continued with the LSD test to find differences between treatments.

3. Results and Discussion

Soil organic matter in the study area is 2.72%, while optimum soil organic matter for plant growth is 3-5%. Adding organic material to the soil in the research field affects growth of soybean.

3.1 Plant height, stem dry weight and root dry weight soybean

The treatment of compost from cajeput waste and NPK fertilizer did not affect plant height and root dry weight. Plant height ranged from 34.67 to 39.67 cm and root dry weight was 0.67-0.99 g/plant. Stem dry weight using NPK fertilizer and cajeput waste compos was higher than without fertilizing, namely 27% and 26% respectively. The combination of cajeput waste compost and NPK fertilizer with the highest stem dry weight was A5, which was 2.31 g / plant (Table 1).

NPK fertilization of 150 kg/ha and cajeput waste compost alone have stem dry weight, higher N uptake and K uptake than without fertilization. The results of this study was supported by the research of Hillary et al. [5] which states that soybeans that control have lower N and K leaf content than those manure and NPK fertilizer on Eshirali acid soil, increasing N levels respectively by 16.5% and 9.39%, while K levels were 21.37% and 6.11% respectively. Soil P levels do not increase significantly, this means that the addition of compost and NPK fertilizer cannot increase soil P availability. This can be due to low P content in both materials so it cannot increase P absorption.

The combination of cajeput waste compost and NPK fertilizer of 150 kg/ha has stem dry weight higher than just using cajeput waste compost. This is supported by Yamika and Ikawati, [6] that the combination of petroganic fertilizer and NPK fertilizer can increase soybean dry weight at 44 days after planting on Alfisol soil. Increasing the dose of NPK fertilizer (75 kg/ ha to 225 kg / ha) applied together with 1 t/ha petroganic fertilizer can increase the weight of soybean slag from 4.5 g/plant to 7.7 g/plant.

Table 1. Plant height, stem dry weight and root dry weight

	Plant Height (cm)	Stem Dry weight (g)	Root Dry weight (g)
A0	35.50±4.50 a	1.68±0.31 a	0.67±0.17 a
A1	39.61±1.61 a	2.14±0.26 bc	0.89±0.17 a
A2	37.83±3.18 a	2.12±0.14 b	0.71±0.21 a
A3	39.67±2.13 a	1.95±0.23 b	0.75±0.04 a
A4	36.00±3.04 a	2.10±0.25 bc	0.82±0.11 a
A5	34.67±3.68 a	2.31±0.17 c	0.99±0.35 a

Note: Numbers in the same column and followed by the same letters are not significantly different based on the LSD 5% further test. A0 = without fertilizer, A1 = NPK 150 kg/ha, A2 = compost 6 t /ha, A3 = compost 6 t /ha + NPK 50 kg/ha, A4 = compost 6 t /ha + NPK 100 kg/ha, A5 = compost 6 t /ha + NPK 150 kg/ha

3.2 N, P and K uptake of Soybean

P Uptake plants is not affected by the treatment of cajeput waste compost and NPK fertilizer. The average P uptake is 0.54 g / plant. N uptake plants control has lower N uptake compared with NPK fertilization and cajeput waste compost, respectively at 7.67% and 23.04%. The combination of cajeput waste compost and NPK fertilizer which has the highest N uptake is A5 and the lowest is A3. NPK fertilization results in higher K uptake of plants than without fertilization (55.97%). The combination of cajeput waste compost and NPK fertilizer in all three treatments (A3, A4, A5) had an average K uptake of 5.03 g / plant (Table 2).

The combination of cajeput waste compost and NPK fertilizer of 150 kg/ha has N and K uptake is not different were compared to using only compost or NPK fertilizer independently. This is different from the opinion of Bandyopadhyay et al., [7] that the combination of NPK fertilizer (30 N, 26 P, 25 K kg / ha) and manure (4 t/ha) can increase soybean N uptake compared to without fertilizer (63.3%) and manure (18.25%) in its own sensiveness, while the K content when compared to manure and NPK fertilizer itself, is 64.78% and 88.49% respectively. The combination of manure (10 t/ha) and NPK fertilizer (20:30:60 kg/ha) can increase the N content when compared to manure and NPK fertilizer on its own, each of which was 119.43% and 133.83% [5].

Table 2. N, P and K uptake

	N uptake (g/plant)	P uptake (g/plant)	K uptake (g/plant)
A0	0.056±0.006 a	0.004±0.001 a	0.036±0.001 a
A1	0.072±0.007 bc	0.006±0.002 a	0.057±0.005 b
A2	0.069±0.001 bc	0.005±0.001 a	0.049±0.007 ab
A3	0.064±0.009 ab	0.005±0.001 a	0.045±0.008 ab
A4	0.071±0.006 bc	0.006±0.001 a	0.050±0.007 ab
A5	0.076±0.005 c	0.006±0.001 a	0.056±0.008 b

Note: Numbers in the same column and followed by the same letters are not significantly different based on the LSD 5% further test. A0 = without fertilizer, A1 = NPK 150 kg/ha, A2 = compost 6 t /ha, A3 = compost 6 t /ha + NPK 50 kg/ha, A4 = compost 6 t /ha + NPK 100 kg/ha, A5 = compost 6 t /ha + NPK 150 kg/ha

3.3 Total chlorophyll and noduls of Soybeans

Soybean without fertilization has a higher total chlorophyll than cajeput waste compost (102.24%) and NPK fertilizer (124.32%). The use of cajeput waste compost and NPK fertilizer simultaneously can increase the total chlorophyll of soybeans when compared with NPK fertilizer and single cajeput waste compost. Increasing the dose of NPK fertilizer will reduce total chlorophyll (Figure 1). The number of soybean nodules without fertilization was lower than that of fertilizing cajeput waste compost (148.6%) and NPK fertilizer (82.33%). Increasing the dose of NPK fertilizer will reduce the number of root nodules (Figure 2).

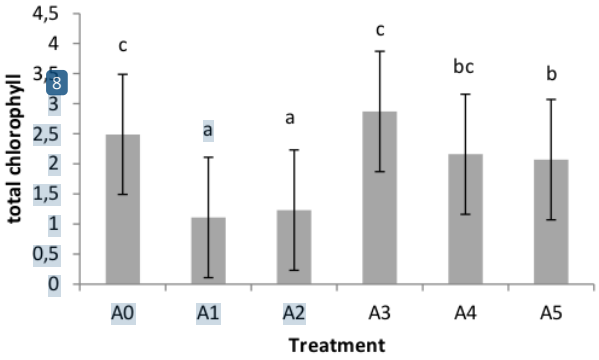

Figure 1. Total chlorophyll (A0 = without fertilizer, A1 = NPK 150 kg/ha, A2 = compost 6 t/ha, A3 = compost 6 t/ha + NPK 50 kg/ha, A4 = compost 6 t/ha + NPK 100 kg/ha, A5 = compost 6 t/ha + NPK 150 kg/ha)

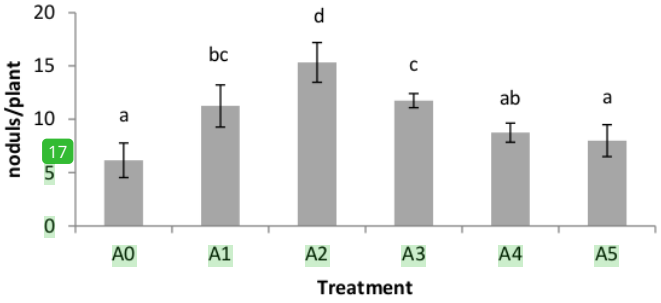

Figure 2. Noduls soybean (A0 = without fertilizer, A1 = NPK 150 kg/ha, A2 = compost 6 t/ha, A3 = compost 6 t/ha + NPK 50 kg/ha, A4 = compost 6 t/ha + NPK 100 kg/ha, A5 = compost 6 t/ha + NPK 150 kg/ha)

The number of root nodules treated without fertilization was lower than cajeput waste compost or NPK fertilizer. This is in line with Mandal et al. [8] research that the number of soybean root nodules without fertilization was lower than NPK fertilizers and manure fertilized, each of 47.61% and 45.85%. Compared to the controls, the application of biochar can increase nodules amount to 156%, while the application of NPK can increase the number of root nodules by 343% [9]. However, it is different from the study of Ruth et al., [10] that treatment without fertilization has a greater number of root nodules compared to the use of compost and NPK fertilizer alone.

Increasing the dose of NPK fertilizer combined with cajeput waste compost can reduce the number of root nodules. It is also revealed by Ruth et al., [10] that the combination of NPK fertilizer (50 kg/ha) and cassava compost (3.5 t/ha) in soybean plants reduced the number of root nodules/plants by 14.35% compared to NPK fertilization (4 nodules / plants). Rhizobium is more rapid in soils with lower N nutrients.

4. Conclusion

Fertilizing cajeput waste compost and NPK fertilizer affects the growth and nutrients uptake of soybeans. Soybeans fertilized with cajeput waste compost 6 /ha and NPK fertilizer 150 kg/ha have the best of stem dry weight (2.3 g/plant) and N uptake (0.076 g/plant).

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