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Effect of coffee husk compost to increase peanut yield in inceptisol

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Abstract. The use of compost as an ameliorant has been shown to improve soil quality and increase crop yields. One of the organic materials that can be used as compost is coffee husk. Besides being able to increase the quality and yield of the plant, the rest of the coffee husk will also pollute the environment if it is not utilized. The aims of this study were to evaluate the effect of coffee husk compost application on Inceptisol and peanut yield. The field experiment was done on an Inceptisol, from March to December 2020. The experiment used a randomized block design with 6 treatments of coffee husk compost with various doses and 4 replications, namely without compost, 10 $Mgha^{-1}$, 15 $Mgha^{-1}$, 20 $Mgha^{-1}$, 25 $Mgha^{-1}$, and 30 $Mgha^{-1}$. The results showed that the application of 20 $Mgha^{-1}$ coffee husk compost was the best treatment in optimizing decreasing soil compaction, bulk density, and increasing porosity, while 15 $Mgha^{-1}$ coffee husk compost was the best treatment in increasing peanut yield.

1. Introduction

The need for peanuts continues to increase and is not followed by production so that peanut imports are needed in Indonesia. The number of peanut imports in Indonesia increased from 2014 to 2017 and there was a slight decrease in 2018. The number of peanut imports during 2014-2018 was 45,226 Mg, 66,415 Mg, 129,562 Mg, 254,039 Mg, and 244,066 Mg [1].

One of the reasons for the increase in peanut imports is the limited productive agricultural land for producing peanuts due to the conversion of agricultural land for food crops to oil palm plantations and non-agricultural land. One of the soils that has quite a lot of potential is Inceptisol, which is around 20.75 million ha or 37.5% of the total land area of Indonesia [2]. However, Inceptisols generally have low fertility, high sand content, low organic matter and high bulk density. The high soil bulk density describes the compacted soil that is not suitable for peanut plants.

Compacted soil will inhibit root movement in the soil. This will affect the ability of the soil to absorb water, air, and nutrients so that little is available to plants [3]. Soil compaction can be reduced by increasing the organic matter content of the soil.

One source of organic matter is coffee skin, which is a by-product of processed coffee that cannot be utilized optimally. Utilization of coffee husk waste in addition to improving soil properties [4] and increasing crop yields will also help protect the environment [5]-[6]. However, the problem is that coffee husk waste has a very high C/N ratio, 31 [7] so it will take a long time to decompose. Therefore, it is necessary to compost the coffee husk so that it can immediately be used to improve the soil and increase crop yields.

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Several studies have shown that coffee husk compost can improve soil properties and increase crop yields. The application of coffee husk compost could increase the production of shallots (*Allium ascalonicum*) [8], coffee [9], red pepper [10], lettuce [11], fruit [12], and chili pepper [13]. The addition of coffee husk compost can also improve soil chemical properties (increase C-organic, total N content, phosphorus and potassium) and soil physical properties (increase aggregate stability and decrease soil density) [14].

Although there have been studies using coffee husk compost in agriculture, no researcher has used peanut plants grown in the Inceptisol. Therefore, the aims of this research are 1) to study whether the application of coffee husk compost can improve soil compaction and at the same time increase peanut crop yields and 2) to find the most appropriate dose to improve soil compaction and produce peanut yield.

2. Methods

2.1. Compost

The compost is made using a mixture of ingredients: 240 kg of coffee husk, 80 kg of mature cow dung, 4 liters of EM4, 1 kg of shrimp paste and a little brown sugar. Materials are arranged in layers with a height of each layer of ± 15 cm in a tub measuring 1 m long, 1 m wide, and 1 m high. Each layer consists of a mixture of coffee skin and cow dung in a ratio of 3:1, shrimp paste and brown sugar, then is sprayed with EM4 solution until evenly distributed and then sprayed with water until the mixture is moist. The material that has been arranged in layers is covered, opened every week and stirring and watered. Compost is ready to be applied to the field after 4 months characterized by a blackish color and crumb structure. Husk coffee compost consists of organic-C 30.1%, N-total 1.71%, C/N ratio 17.6%, pH 7.36, and water content 23%.

2.2. Field experimental design

The field experiment was done on an Inceptisol, from March to December 2020. The soil is low of organic C (2.15%), porosity (45.67%), high bulk density (1.31 g cm^{-3}) and soil strength (18.83 N cm^{-2} on a 10 cm soil layer depth and 24.92 N cm^{-2} on a 20 cm soil layer depth).

The treatments were arranged in a randomized block design consisting of six treatments with the addition of coffee husk compost with 6 levels (without compost, 10 Mg ha^{-1}, 15 Mg ha^{-1}, 20 Mg ha^{-1}, 25 Mg ha^{-1}, and 30 Mg ha^{-1}) and repeated four times. The compost was applied based on dry weight, spread over the land according to the treatment, mixed and then incubated for two weeks. Peanut seeds were planted wih a spacing of 40 cm x 20 cm in plots measuring 3 mx 2m.

2.3. Measurement of soil compaction and plant height

Measurements of soil compaction and plant height were carried out at the eighth week. Soil compaction at a depth of 0-10 cm and 10-20 cm was measured using a penetrometer while plant height was measured from the base of the stem to the growing point of the plant.

2.4. Sampling and soil analysis

Soil samples were collected from each plot three day prior to harvesting. There were two kinds of soil samples disturbed and undisturbed. Disturbed soil sample to measure soil organic C which was determined by loss of ignition method. An undisturbed soil sample was taken with metal cores of 7.3 cm height and 4.0 cm diameter at the 0-20 cm depth to determine bulk density and porosity.

2.5. Sampling and plant analysis

The peanut was harvested 98 days after planting. The pod was cleaned and dry in the sun. The data on yield was recorded from all each plot.

2.6. Statistical analysis

The data from the results of research on soil strength and plant height at eight week, bulk density, porosity, organic-C, and yield were analyzed statistically by means of a confidence level (α = 5%). To find out the best compost dose, Duncan's Multiple Spacing test was used at a confidence level (α = 5%).

3. Results and discussion

3.1. The effect of coffee husk compost on soil organic matter content, bulk density, and porosity

The addition of coffee husk compost into Inceptisol had a significant effect on soil organic carbon content, soil bulk density, and porosity. Further tests using DMRT showed that the higher the dose of compost applied to the soil, the higher the C-organic content and porosity and the lower the soil bulk density but there was a decrease at doses of 25 and 30 Mg ha-1 of compost. The effect of the application of coffee husk compost on soil organic carbon content, soil bulk density, and porosity are shown in table 1.

Table 1. Organic-C content, bulk density and porosity due to the application of coffee husk compost.

Treatment	C-organik (%)		Bulk Density (g cm^{-3})		Porosity (%)	
Without compost	1.74	a	1.35	b	43.80	a
10 Mg ha^{-1} of compost	2.61	c	1.19	ab	46.31	a
15 Mg ha^{-1} of compost	2.76	cd	1.13	a	51.68	ab
20 Mg ha^{-1} of compost	3.19	d	1.08	a	58.68	c
25 Mg ha^{-1} of compost	2.90	cd	1.08	a	54.31	bc
30 Mg ha^{-1} of compost	2.18	b	1.23	ab	48.65	ab

Value with the same letters followed in the same column are not significantly different at the 5% level

Table 1 shows that the organic carbon in the treatment without compost was significantly different compared to the coffee husk compost in each treatment. The highest organic matter content was found in the application of coffee husk compost 20 Mg ha^{-1} (3.19%) which was significantly different from the treatment with coffee husk compost 10 Mg ha^{-1}, 30 Mg ha^{-1} and without coffee husk compost.

The lowest bulk density was found in the treatment of coffee husk compost 20 Mg ha^{-1}, which was significantly different from without coffee skin compost treatment but not significantly different from the treatment with coffee husk compost 10 Mg ha^{-1}, 15 Mg ha^{-1}, 20 Mg ha^{-1}, 25 Mg ha^{-1} and 30 Mg ha^{-1}. This is because coffee husk compost has been able to increase soil organic-C. The decrease in bulk density was followed by an increase in soil organic-C, this was in line with research [15] which stated that the application of compost and manure 10 Mg ha^{-1} to cassava was able to reduce soil bulk density by 9.82% in Alfisols.

The application of 20 Mg ha^{-1} coffee husk compost gave the highest value in soil porosity. The high value of porosity is due to the high content of soil organic-C. According to [16] the addition of organic material in the form of compost will increase the porosity of the soil so that the total value of the pore space is high.

Adding organic matter to the soil will increase the organic-C content. The increase in organic-C affects the value of bulk density and porosity. The less organic-C contained in the soil, the higher the bulk density and the lower the porosity. The results of this study are the same as those of [17] which stated that increasing soil organic matter content will reduce soil bulk density and increase porosity.

3.2. The effect of coffee husk compost on soil compaction

The effect of the application of coffee husk compost on soil compaction in the eighth week at a depth of 0-10 cm and a depth of 10-20 cm are shown in table 2.

Table 2. Soil compaction at a depth of 0-10 cm and 10-20 cm at week 8 due to the application of coffee husk compost.

Treatment	Soil compaction (Nm^{-2})			
	Depth 0-10 cm		Depth 10-20 cm	
Without compost	9.67	a	21.17	a
10 Mg ha^{-1} of compost	8.25	b	17.08	bc
15 Mg ha^{-1} of compost	6.33	c	15.75	cd
20 Mg ha^{-1} of compost	4.67	d	11.17	e
25 Mg ha^{-1} of compost	5.92	cd	12.50	de
30 Mg ha^{-1} of compost	9.25	b	20.08	ab

Value with the same letters followed in the same column are not significantly different at the 5% level

Based on Table 2, it can be seen that overall soil compaction at a depth of 10 cm and 20 cm has the same tendency, which occurs at the lowest rate of 20 ton ha^{-1} of coffee husk compost, which is significantly different from all treatments except for the treatment of coffee husk compost 25 tons ha^{-1}. According to [18] compost is able to improve several physical properties of the soil, namely increasing the ability of the soil to hold water, reducing soil compaction and increasing soil porosity so that it can help increase plant growth with good root growth.

The level of soil compaction can be characterized by high bulk density and low porosity. Soil compaction will continue to increase with increasing soil depth. It occurred due to the lower levels of organic-C in the soil. In addition, the dose of coffee husk compost up to a depth of 20 cm also causes high soil compaction. The increase in soil compaction is also due to the decreasing organic-C content so that the bulk density content increases with increasing soil depth.

3.3. The effect of coffee husk compost on height and yield of peanuts

The results of variance showed that the application of coffee husk compost on Inceptisol had a very significant effect on plant height and peanut yield.The effect of coffee husk compost on height and yield of peanuts are shown in tabel 3.

Table 3. The effect of coffee husk compost on height and yield of peanuts.

Treatment	Height of peanuts (cm)		Yield of peanuts (Mg ha^{-1})	
Without compost	62.13	a	1.69	a
10 Mg ha^{-1} of compost	66.78	b	1.89	ab
15 Mg ha^{-1} of compost	68.69	bc	1.97	b
20 Mg ha^{-1} of compost	72.25	d	2.03	b
25 Mg ha^{-1} of compost	70.00	cd	1.98	b
30 Mg ha^{-1} of compost	64.19	a	1.78	ab

Value with the same letters followed in the same column are not significantly different at the 5% level

Table 3 shows that the 20 ton ha^{-1} treatment was the best treatment in increasing plant height. The treatment of 20 ton ha^{-1} coffee husk compost showed a significant difference to all treatments. This is in line with the research of [19] that coffee husk compost was able to restore soil fertility and increase the growth of coffee seedling plant height compared to controls.

The treatment of the coffee husk compost 15 tons ha^{-1} was significantly different from the treatment without compost, the coffee husk compost 10 tons ha^{-1}, and the coffee husk compost 30 tons ha^{-1} but not significantly different from the coffee husk compost 20 tons ha^{-1} and the coffee husk compost 25 tons ha^{-1}. This result shows that the application of 15 ton ha^{-1} of coffee husk compost has been able to increase the yield of peanuts. This is presumably because the amount of organic matter in the 15 ton ha^{-1} treatment was able to increase the yield of peanuts.

The ability of the soil to absorb nutrients optimally increases due to the application of the coffee husk compost. [20] stated that compost can increase nutrients in the soil. This is in line with [7] stated that husk coffee compost can increase Phosphorus and Potassium. Composting can also create suitable soil conditions for plant growth by increasing soil organic matter, reducing soil compaction. These conditions support plant growth to have optimal growth and productivity.

4. Conclusions

Based on the results of the study it can be concluded as follows:

1. The application of coffee husk compost affects the organic C content, bulk density, porosity, soil compaction, height and yield of peanuts
2. The best treatment in reducing soil compaction from 9.67 N cm^{-1} to 4.67 N cm^{-2} is coffee husk compost 20 Mg ha^{-1}
3. The best treatment in increasing height and yield of peanuts is husk coffee compost 15 Mg ha^{-1}

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