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The effect of giving organic materials on increasing production of three black soybean varieties (*Glycine max* L.)

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Abstract. This research was conducted in the agricultural land of Simpang Selayang Village, Medan Selayang District, Medan City, North Sumatra Province, Indonesia. Conducted from December 2015 - March 2016. The study aimed to obtain high yielding black soybean varieties and suitable types of organic material. The experimental design used in the study was a randomized block design with two treatment factors and three replications. The first treatment factor is the variety consists of three types of varieties: Cikuray, Detam - 2 and Malikka. The second treatment factor is the type of organic material consisting of four treatments: no organic matter (control), rice straw compost (10 tons/ha), biochar (10 tons/ha) and bokashi (10 tons/ha). The results showed that the black soybean varieties which gave the highest production were found in Detam - 2 varieties (2.72 tons/ha) and the appropriate types of organic matter were found in rice straw compost with a dose of 10 tons/ha with production/ha which could be achieved 2.82 tons/ha.

1. Introduction

Black soybeans are one type of soybean plant besides yellow soybeans that are planted by farmers in Indonesia. Apart from being used for food such as other yellow soybeans, this type of soybeans is well used as the main raw material for making sweet soy sauce [3]. In general, soybean productivity in Indonesia is still relatively low. Because it needs various alternative efforts to increase productivity. The use of superior soybean varieties that have high production potential is one of the efforts that need to be applied. There are several superior black soybean varieties that have been recommended for cultivation. These varieties include the Cikuray, Detam-2 and Malikka varieties. Cikuray variety has a production potential of 1.7 tons / ha, 85 days of harvesting age, fall resistance, 35% protein content, 17% fat content, determinate growing type and tolerant leaf rust. For Detam - 2 varieties, the production potential of seed production is 2.96 tons / ha, harvest age is 82 days, protein content is around 45%, fat content is 15% and is somewhat drought resistant. Malikka varieties have a production potential of 2.3 tons/ha, indeterminate growth type, 90 days of harvesting age, 37% protein content, 20% fat content, adaptable to lowland areas to highlands both rainy season and dry season [10].

In addition, efforts to increase soybean growth and production can be applied by using various types of organic fertilizers such as compost of rice straw, black biochar / carbon and bokashi organic rice fertilizer. This organic material is known to improve soil conditions such as increasing K, N, P supply, micro element supply, soil microbial activity, improving soil structure, absorbing CO₂,



increasing cation exchange capacity and various physical, chemical and biological properties of the soil [4,5,7,12,15,16].

Rosmarkam and Yuwono [11] stated that the good properties of organic fertilizers on soil fertility include: Organic matter in the mineralization process will release complete plant nutrients (N, P, K, Ca, Mg, S and micro nutrients), improve soil structure, cause the soil to be light to be processed and easily penetrated by the roots, facilitate the processing of heavy soils, increase the power to hold water so that the ability of the soil to provide more water, the moistureness of the ground water is maintained, makes the soil permeability better increase cation capacity so that the ability to bind cations becomes higher, improve the biological life of the soil for the better because the availability of food is more secure and contains sufficient amounts of microbes which play a role in the process of decomposition of organic matter. Sutanto [15] also explained that organic matter added to the soil would be an energy and food source for various microorganisms in the soil. Various soil microorganisms become active through the food chain, then undergo a decomposition process to produce various organic and inorganic compounds. Based on the description above, it is necessary to conduct a study on how the effect of rice compost, boichar and bokashi compost organic fertilizer on the production of black soybean varieties is increased. The purpose of this study was to obtain high yielding black soybean varieties and suitable types of organic matter.

2. Materials and Methods

2.1. Place and time

The research was carried out in the agricultural land of Simpang Pemda Village, Medan Selayang District, Medan City, North Sumatra Province, Indonesia. The research took place from December 2015 to November 2016.

2.2. Materials and tools

The materials used in the study included the black soybean seeds of the Cikuray, Detam-2, and Malikka varieties, rice straw compost, biochar and bokashi rice straw, N, P, K fertilizers and pesticides. The equipment used consists of hoes, meter measuring instruments, analytical scales, sample scraps, stationery and others.

2.3. Research methods

The study used a randomized block design with two treatment factors, namely : Variety treatment factors consist of 3 types of varieties : V_1 = Cikuray, V_2 = Detam – 2, V_3 = Malikka. Organic material treatment factor consists of 3 levels : B_0 = Control/without organic matter, B_1 = Compost rice straw (10 tons/ha), B_2 = Biochar (10 tons/ha), B_3 = Bokashi (10 tons/ha). The study consisted of 3 replications / blocks with a total number of treatment plots 36 plots with the size of each plot 160 cm x 120 cm. There are 24 plants in each plot with 4 samples per plot. Soybean spacing on each experimental plot 40 cm x 20 cm. Experimental data was processed using the Variance Analysis Method (Fisher's test) and the mean Duncan Multiple Range Test (DMRT) difference at the real test level of 5% [14].

2.4. Implementation of research

The site of the research was first cleaned of weeds that grow manually. Then make experimental plots with the length, width and height of each plot : 160 cm x 120 cm x 30 cm. The distance between plots and experimental blocks is 50 cm each. The total number of experimental plots of 36 plots with the number of research blocks is 3 replications/blocks. After completing the experimental plots, biochar organic fertilizer, rice straw compost and bokashi rice straw were carried out on experimental plots according to the treatment planned by mixing with the soil in the experimental plot evenly. Giving to three types of organic fertilizer is done, one week before soybean planting is done. Planting soybean seeds in the experimental plot was carried out with a spacing of 40 cm x 20 cm with the number of seeds of 2 seeds per planting hole. Planting the seeds is done manually and then covered with soil.

Fertilization is done when planting with macro fertilizer N, P, K respectively 0.3 g, 0.2 g and 0.4 g/plant. Plant maintenance carried out is watering plants, weeding weeds, controlling pests and plant diseases and harvesting the yield of black soybeans. Watering is done in the morning and evening if there is no rain. Weed weeding is done once a week by manual method on experimental plots, while outside the experimental plot area, weeding is carried out mechanically using hoes. Pest and disease control is carried out by using organic plant pesticides, carried out by spraying plants and combined with manual methods, namely by taking pests on affected plants and removing parts of the plants affected by the disease. Harvesting is done by cutting plants. Harvesting criteria if the pods of soybean are 95% brownish yellow in color.

3. Results and Discussion

3.1. Number of productive pods

The parameters of the number of productive pods have not been significantly affected by the treatment of varieties, types of organic matter and their interactions based on the results of data analysis in Table 1. However, we can see that there is a tendency for varieties to be treated, the best number of productive pods per plant is in the Cikuray variety, while the Detam-2 and Malikka varieties have relatively the same number of productive pods. For the treatment of types of organic matter, the best types of organic matter have an effect on the number of productive pods found in organic biochar and bokashi ingredients with doses of 10 tons / ha and for interaction, the best is in the Cikuray variety with three types of organic ingredients namely biochar, straw rice and bokashi.

Table 1. Number of productive pods per plant in the treatment of varieties and types of organic matter

Variety	Types of organic materials				Average
	Control (0 tons/ha)	Rice straw (10 tons/ha)	Biochar (10 tons/ha)	Bokashi (10 tons/ha)	
Cikuray	7.56	9.76	10.51	9.44	9.31
Detam – 2	6.97	9.42	7.92	9.48	8.45
Malikka	7.56	7.36	8.67	9.08	8.17
Average	7.36	8.85	9.07	9.33	8.64

Description : The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of $\alpha = 5\%$.

There are differences in the number of productive pods from the three varieties tested, this is because the three varieties have differences in genetic composition factors whose responses are different to the environmental conditions in which these varieties grow [8]. Giving organic ingredients to the soybean varieties tested gives a number of productive pods that are better than without the provision of organic ingredients. It is known that organic materials such as rice straw compost, biochar and bokashi can improve soil fertility conditions such as soil structure, increase soil cation exchange capacity, increase soil macro and micro nutrients, increase soil biological activity, increase CO₂ absorption [5,6,7,12]. This condition will increase all plant growth and development so that plant productivity can be better including the number of productive pods from the soybean varieties tested.

3.2. Seed dry weight per plant

In the parameters of dry weight per plant, it is significantly affected by the types of organic matter treatment factors (Table 2). Whereas the variety treatment factors and interactions did not have a significant effect on the seed dry weight per plant. In the treatment of types of organic matter, the best treatment effect on the dry weight of seeds per plant is organic rice straw and biochar with a dose of 10 tons/ha. In the treatment of varieties, the best was found in Detam-2 varieties for dry weight of seeds per plant.

Table 2. Seed dry weight per plant (g) in the treatment of varieties and types of organic matter

Variety	Types of organic materials				Average
	Control (0 tons/ha)	Rice straw (10 tons/ha)	Biochar (10 tons/ha)	Bokashi (10 tons/ha)	
Cikuray	22.20	35.74	30.60	23.64	28.05
Detam – 2	12.90	38.47	38.70	25.12	28.80
Malikka	21.72	30.83	23.10	33.30	27.24
Average	18.94 b	35.01 a	30.80 ab	27.35 ab	28.03

Description : The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of $\alpha = 5\%$.

As for interactions, the best effect on seed dry weight per plant was found in the combination of the Detam-2 variety treatment with organic rice straw and biochar ingredients. Then for the Cikuray variety, the best effect on the dry weight of crop seeds is also found in the types of organic materials of rice straw and biochar. Whereas for the Malikka variety, the best combination with the type of organic material on the effect on seed dry weight per plant was found in bokashi organic matter and rice straw with 10 tons / ha of organic ingredients. The differences in production achievements in the three black soybean varieties tested were still related to the presence of different genotypes of this variety [8]. The provision of organic material for rice straw compost, biochar and bokashi rice straw is still better to give the seed dry weight per plant than without the provision of organic ingredients. It is clearly known that the administration of organic matter increases soil fertility whether from the aspect of soil physical properties, the supply of macro and micro nutrients and beneficial biological activities of the soil [5,7,11,12]. This all increases plant growth and production.

3.3. Dry weight of 100 seeds

For 100 seeds dry weight, it is significantly affected based on Table 3 below by varieties treatment factors and not significantly different from the type of organic matter treatment and the interaction of varieties with organic material types.

Table 3. Dry weight of 100 seeds (g) in the treatment of varieties and types of organic matter

Variety	Types of organic materials				Average
	Control (0 tons/ha)	Rice straw (10 tons/ha)	Biochar (10 tons/ha)	Bokashi (10 tons/ha)	
Cikuray	9.78	10.93	11.55	10.31	10.64 b
Detam – 2	17.37	18.59	16.34	19.02	17.83 a
Malikka	12.12	10.95	10.66	11.65	11.34 b
Average	13.09	13.49	12.85	13.66	13.27

Description : The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of $\alpha = 5\%$.

The treatment of varieties, the best effect on the dry weight of 100 seeds was found in Detam-2 varieties compared to among the three varieties tested. The treatment of organic materials gave the best effect on the dry weight of 100 seeds in the treatment of organic bokashi and rice straw. In the treatment of combinations of varieties with organic types, for the Cikuray variety, the best is in organic biochar and rice straw, for the Detam - 2 variety, the best is in bokashi and rice straw organic materials, and for the Malikka variety, the best is in bokashi organic material and rice straw. All with a dose of 10 tons of organic ingredients / ha. The difference in dry weight of 100 seeds from the three fixed varieties was caused by differences in genotype so that the response to environmental conditions

where the varieties were planted would be different [8,13]. Organic ingredients of rice straw compost, biochar and bokashi are still better than without giving organic ingredients at all to the dry weight of 100 soybean seeds tested. Giving organic ingredients as a whole has been known to improve soil fertility conditions from physical, chemical, biological and environmental aspects [2,6,7,11].

3.4. Production

The parameters of seed production per ha are significantly influenced by the treatment of varieties and types of organic matter from the results of the data analysis shown in Table 4. The effect of the interaction of varieties and types of organic matter has not yet had a significant effect.

Table 4. Seed production per ha (tons/ha) in the treatment of varieties and types of organic matter.

Variety	Types of organic materials				Average
	Control (0 tons/ha)	Rice straw (10 tons/ha)	Biochar (10 tons/ha)	Bokashi (10 tons/ha)	
Cikuray	1.73	2.89	2.31	1.90	2.21 ^b
Detam – 2	2.70	3.08	2.89	2.22	2.72 ^a
Malikka	1.72	2.48	1.81	1.86	1.97 ^b
Average	2.05 ^b	2.82 ^a	2.33 ^b	2.00 ^b	2.30

Description : The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of $\alpha = 5\%$.

In the treatment of varieties, the highest production was found in Detam - 2 varieties compared to the other two varieties. The treatment of types of organic material has the effect of increasing the best production found in organic matter biochar and rice straw with a dose of 10 tons / ha. For the treatment of a combination of varieties and types of organic matter, the treatment of the Cikuray variety the best combination with organic ingredients was found in organic rice straw and biochar, in the Detam - 2 variety found in rice straw and biochar organic matter and in the Malikka variety found in rice straw organic matter.

Among all combination treatments, the best treatment effect on production per ha was found in a combination of the treatment of Detam-2 varieties with the type of organic rice straw material with 3.08 tons / ha of soybean production. The difference in production capability per ha of the three varieties studied in this experiment was due to the existence of different adaptive abilities which caused differences in the genotype composition of the varieties [8,13]. The provision of organic material at a dose of 10 tons/ha is still better production per ha compared to without the provision of organic ingredients, both organic straw rice compost, biochar and bokashi ingredients for the production of black soybean varieties planted. Giving organic material is better without the provision of organic ingredients because with the provision of organic ingredients the soil media conditions will be more loose, better soil air system, better soil moisture, more stable soil temperature, more complete chemical conditions, soil CEC increases, and better soil macro and micro activities [15,11,4,9,6].

4. Conclusions

Based on the results of the study it can be concluded that the black soybean variety which provides the highest production is found in the Detam - 2 (2.72 tons/ha) variety and the best organic material found in rice straw compost with a dose of 10 tons / ha with a production of 2.82 tons/ha. For the combination of treatments, the best varieties and types of organic matter on the production of black soybean per ha (3.08 tons/ha) were found in a combination of the treatment of Detam-2 varieties using 10 tons/ha of rice straw compost.

5. Recommendation

One of the technologies for cultivating black soybean varieties that can be used to increase black soybean production based on the results of this study can use the Detam-2 variety with 10 tons/ha of rice straw compost organic fertilizer.

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