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Response of Soybean (*Glycine Max*) to The Reduction of Inorganic Fertilizer with Palm Oil Factory Waste Decanter Cake

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Abstract. This research was conducted to determine the response of soybean plants when inorganic fertilizers were reduced and replaced with palm oil mill waste decanter cake . This research was conducted at Farmers' Land in Harapan Makmur Village, Rantau Rasau District, Tanjung Jabung Timur Regency. This study uses a one factor randomized block design, namely decanter cake and inorganic fertilizer (NPK) consisting of 7 levels, namely: 100% NPK fertilizer, Trichoporiza Plus (TP) 5, 10 and 15 ton/ha, TP 15 ton / ha + 50% NPK dose, TP 10 tons /ha + 50% NPK dose, and TP 5 tons / ha + 50% NPK dose. The parameters observed were plant height, number of leaves, number of branches and number of pods. The results showed that the response of plants to the reduction of 50 percent inorganic fertilizers substituted with TP 15 tons per hectare give the highest of plant height, number of leaves and number of branches but TP 10 ton /ha give the highest number of pod. All parameters shows that there is no significant difference between 10 tons per hectare and 15 tons per hectare of TP in the reduction of 50 percent NPK fertilizer.

1. Introduction

Soybean is the second food commodity that has important role in Indonesia because it is a basic ingredient of Indonesian food products, so the availability of soybeans can affect national food security. The relatively high population growth of 1.3 percent per year will have an impact on increasing soybean production in the next 10-20 years. For this reason, the government through the Ministry of Agriculture is still continuing a sustainable soybean self-sufficiency program. In line with this, the Governor of Jambi provide program to increase Soybean production, which continues until 2025 (Dinas Pertanian Tanaman Pangan, Provinsi Jambi, 2015). Until now, Jambi Province has not been able to independently fulfill soybean consumption needs.

The average soybean productivity at the farm level is 0.7-1.5 tons/ha, depending on the land conditions and technology. This means that soybean production can still be improved by improving land and technological innovation to increase productivity. The soybean center in Jambi Province is generally on peat land, tides, acidic, dry land and on irrigated rice fields. Intensive land use and high input of chemical fertilizers for a long time cause land degradation. Land recovery efforts need to be carried out so



that the plants are able to produce optimally. One effort to improved soil quality is to use biological organic fertilizers whose basic materials are from agricultural waste.

Agriculture waste from oil palm factory is mostly found in Jambi Province. With the rapid expansion of oil palm plantations, in line with the high, global demand for crude palm oil (CPO), palm oil mill waste produced in a year, especially decanter cake, can reach 40 million tons (4 million tons of dry material). This amount will continue increase with the increase in the amount of palm oil production and factory. In general, factories have not utilized the waste optimally even though some factories left it around the factory and plantation area. From all oil palm waste, decanter cake is a waste that is very biodegradable. In general, decanter cake will decay within 6 weeks by applying biodecomposers. Compared to other palm oil waste, empty fruit bunches, seed shells and fiber from the mesocarp, the percentage of decanter cake nutrients is higher and is significantly influenced by the level of water content itself (Pahang, 2010).

Oil palm waste (decanter cake), containing elements of N, P, K and Mg which is very potential to be used as compost and basic materials of organic fertilizer because of its abundant amount and high levels of nutrients. Decanter cake as organic fertilizers were found could increase the paddy production and vegetables such as lettuce plants showed an increase in yield of 30 percent compared to chemical fertilizer (Duaja, 2012), celery plants (Duaja et al. 2013), peppers (Duaja and Saputra, 2009), potato (Duaja and Sanno, 2010), paddy (Duaja dan Cronika (2014 and 2016). Those situations are made high nitrogen and micro nutrients content from the decanter cake. The results of the nutrient content analysis from decanter cake showed an N content 1.56%. In 100 kg decanter cake with a moisture content of 35 percent equal to 10.56 kg of urea. Hence this research was carried out to evaluate whether decanter cake can reduce the use of chemical fertilizers and increase the yield of soybeans grow on peat lands and to approve the recycled oil palm wastes as useful organic materials for agriculture aspects.

2. Materials and Methods

This experiment was carried out in farmer's field at Harapan Makmur village, Rantau Rasau district from July to October 2018. The oil palm wastes decanter cake was collected from PT Bukit Bintang Sawit Oil Palm Factory, Tanjung Jabung Barat Regency.

2.1. Experimental design and Growing of Soybean

This experiment lay out was Completely Randomized Block Design (CRBD) with seven treatments and three replicates. The treatment is inorganic fertilizer, decanter cake 5 ton/ha, 10 and 15 ton/ha, decanter cake 5 ton/ha+ inorganic fertilizers 50% (from recommended dose), decanter cake 10 ton/ha+ inorganic fertilizers 50%, decanter cake 15 ton/ha+ inorganic fertilizers 50%. Before planting, the soil sample from the cultivation area was taken. All the sample was put into plastic bag and it is chemical properties were analyzed.

2.2. Preparation of decanter cake for organic fertilizer

The oil palm waste, decanter cake was prepared as organic fertilizer by mixing with lime stone, wood chips, rock phosphate, Trichoderma sp, propagul of mikoriza sp. These components are thoroughly mixed and left 100 days to obtain the well decayed organic fertilizers.

2.3. Data collection and analysis

The vegetative data collected is plant height, number of leaves, number of branches and generative data is number of pods and number of seed. The mean separation was done by Least Significant Different Test (Gomez and Gomez, 1984). The data were analyzed using STAT software package

3. Result and Discussion

Availability of nutrients in soil and plants affect plant growth and production soybean. Soil nutrient content generally shows criteria for low to very high. The result of soil analysis before the study showed that the soil reacted acidically, the total N of the soil was very low (0,08 %), P₂O₅ which is very high (73

mg 100g⁻¹), K₂O medium (24 mg 100g⁻¹), classified as moderate soil fertility. Organic C content on land used 0.55% which is included in the very low category and C/N ratio with a value of 20, high category

3.1. Plant height

The results of the statistical analysis showed that the fertilizer treatment influenced the height of soybean plants at each measurement time. The development of soybean plant height in 14 days after planting until to 49 days is showed at Table 1.

Table 1. Soybean plant height in each treatment

Treatment (ton/ha)	Plant height increase (cm)					
	Days after planting (DAP)					
	0-14	14- 21	21-28	28-35	35-42	42- 49
Inorganic fertilizer (IF)	7.33 a	10,23 a	15,57 ab	20,44 a	29,21 a	36,87 a
Decanter cake 5	7.29 a	14,20 c	18,04 bc	22,92 a	33,44 a	39,15 b
Decanter cake 10	8.34 b	13,54 b	17,70 b	23,54 b	32,76 a	39,30 b
Decanter cake 15	8.00 ab	11,20 a	14,32 a	20,35 a	28,75 a	41,51 b
Decanter cake 5+ IF 50 %	8.25 b	10,11 a	14,76 a	24,01 b	31,27 a	39,26 b
Decanter cake 10 + IF 50 %	8.90 b	13,20 b	17,13 b	25,28 b	31,05 a	39,35 b
Decanter cake 15 + IF 50 %	7.24 a	14,36 c	19,29 c	26,09 b	35,55 b	47,62 c
The number followed by the same letter in the column shows that there is no significant difference in the LSD at the level of 5 percent						

From Table 1, it is known that the highest increase in plant height at 35-42 DAP, and the treatment that gives increase highest plants height are in decanter cake 15 tons / ha + 50 percent inorganic fertilizers (IF). The height of soybean plants after 39 DAP shows the increase began to decline, because the vegetative phase is maximally achieved. The decanter cake combination with inorganic fertilizers causes the plant height at each measurement time to be higher than only decanter cake and inorganic fertilizers (IF), but no significant difference between treatment decanter cake 15 ton/ha+ IF 50 % and decanter cake 10 ton/ha+50 % IF. Organic materials from palm oil factory, decanter cake are effective sources of nutrients because of their application to the soil which enhanced the plant height of soybean. The presence of organic material as a source of nutrition for soybeans plus an inorganic fertilizer 50 percent more increases nutrient availability for plants, the addition of decanter cake to soil increased soil pH, because decanter cakes are organic in origin. Plant growth is influenced by soil pH in two ways, the direct effect of hydrogen ions and indirect effects, the unavailability of certain nutrients and the presence of toxic nutrients. Nutrient availability is strongly influenced by pH, therefore an increase in pH value with organic matter is very important to improve nutrient availability. The research of Akande et al. (2003) findings, application of organic materials could improve slightly acidic tropical soil for increase crop production. This statement was agreed with Omoti et al. (1990) and Obatoolu (1999) who report that oil palm waste applied at 15 ton/ha increased plant height of Cocoa seedling. These findings were agreed with that of Adv-Dapph et al. (1994) and Folorunso (1999) who report that oil palm factory waste were good source of N, P, K, Ca, and Mg to the soil for uptake of coffee and crops.

3.2. Leaves Number

The results of the statistical analysis showed the fertilization treatment influenced number of leaves of soybean plants at each measurement time except at 0-14 DAP. The development of leaves number from the 14 days after planting until to 49 days showed at Table 2.

Table 2. Soybean number of leaves in each treatment

Treatment (ton/ha)	Number of leaves increase					
	Days after planting					
	0-14	14-21	21-28	28-35	35-42	42-49
Inorganic fertilizer (IF)	2,45 a	3,28 a	3,97 a	6,43 a	11,40 a	12,67 a
Decanter cake 5	2,33 a	4,00 a	5,27 b	7,43 a	12,03 a	16,37 b
Decanter cake 10	2,54 a	3,67 a	4,87 a	7,90 a	11,63 a	14,87 a
Decanter cake 15	2,00 a	3,00 a	4,07 a	7,07 a	10,90 a	16,27 b
Decanter cake 5 + IF 50 %	2,00 a	3,28 a	4,30 a	7,40 a	10,97 a	14,70 a
Decanter cake 10 + IF 50 %	2,54 a	4,34 b	5,57 b	8,97 b	13,83 b	18,50 c
Decanter cake 15+ IF 50 %	2,66 a	4,78 b	5,37 b	8,17 b	11,97 a	20,40 c
The number followed by the same letter in the column shows that there is no significant difference in the LSD at the level of 5 percent						

The number of leaves has a role to increase soybean yield because photosynthesis occurs in the leaves. Leaves are the organ where photosynthesis takes place, indirectly has a large role in soybean yield. The organic fertilizers from decanter cake 10 ton/ha +IF 50 % and 15 ton/ha +IF 50% gave the highest number of leaves. The high number of leaves correlates with the amount of photosynthate produced. Photosynthate from the vegetative phase will translocated to generatives phase and will be stored as reserves foods in the form of carbohydrates which are in the form of seeds. The higher photosynthates are available for seed development, and it will increase seed yield.

3.3. Branches Number

The results of the statistical analysis showed the fertilization treatment influenced number of branches of soybean plants significantly at each measurement time except at 14-21 DAP. The increase of branches number from the 14 days after planting until to 49 days showed in Table 3.

Table 3. Number of branches in each treatment

Treatment (ton/ha)	Number of branches increase					
	Days after planting					
	0-14	14- 21	21- 28	28-35	35- 42	42-49
Inorganic fertilizer (IF)	2,03 a	2,79 a	3,97 a	6,60 b	11,37 b	11,87 a
Decanter cake 5	2,11 a	3,14 a	3,97 a	6,37 b	7,77 a	10,60 a
Decanter cake 10	2,03 a	2,21 a	3,10 a	5,87 a	7,80 a	9,13 a
Decanter cake 15	2,40 a	2,99 a	3,10 a	5,40 a	8,23 a	12,23 a
Decanter cake 5 +IF 50 %	2,03 a	2, 65 a	2,90 a	5,10 a	8,07 a	10,37 a
Decanter cake 10 +IF 50 %	2,31 a	3,09 a	4,57 b	7,70 b	12,10 b	16,50 b
Decanter cake 15 +IF 50 %	2,54 a	3,67 a	4,37 b	5,90 a	7,20 a	18,57 b
The number followed by the same letter in the column shows that there is no significant difference in the LSD at the level of 5 percent						

The number of branches of soybeans is determined by genetics (Kumudini et al., 2007) and environmental factors such as soil fertility. The number of branches and plant height has a direct influence and has a significant contribution to soybean yield (Hapsari et al. 2010). Table 3, showed decanter cake 10ton/ha +IF 50%, inform the highest number of branches at almost every measurement time, and trend to be higher than inorganic fertilizers. The use of decanter cake can improve soil fertility and improve the efficiency inorganic fertilizer, accelerates plant growth and increasing the branches number. Organic material improve the physical properties of the media allows nutrients to be easily

absorbed by plant roots. Moyin (2002) reported that one important mechanism to improve nutrient recycling is true the use of applied organic inputs and retention of crop residue.

3.4. Pods Number

The results of the statistical analysis showed the fertilizer treatment influenced pods number at each measurement time. The increase of pods number from 35 days after planting until 63 days showed at Table 4.

Table 4. Pods number in each treatment

Treatment (ton/ha)	Number of pods increase			
	Days after planting			
	35-42	42 -49	49-56	56-63
Inorganic fertilizer (IF)	23,67 a	36,43 a	48,73 a	55,11 a
Decanter cake 5	33,90 b	54,87 b	73,27 b	79,22 ab
Decanter cake 10	30,63 b	57,13 b	82,00 b	85,11 b
Decanter cake 15	22,97 a	37,83 a	55,13 a	62,21 a
Decanter cake 5 + IF 50%	32,57 b	60,80 c	73,27 b	79,80 a
Decanter cake 10+ IF 50 %	31,13 b	58,77 b	73,33 b	80,11 b
Decanter cake 15+ IF 50 %	33,67 b	69,63 c	85,43 b	90,23 c

The number followed by the same letter in the column shows that there is no significant difference in the LSD at the level of 5 percent

Pods number is a component of soybeans that can describe soybean yield. The development of pod number shows that the application of organic material decanter cake combined with inorganic fertilizers trends to provide a higher number of pods at each measurement time than without inorganic fertilizers. The highest increase in the number of pods is at 49-56 DAP at treatment decanter cake 15 ton /ha +IF 50% but no significant difference with decanter cake 10+IF 50% and 5+50% IF.

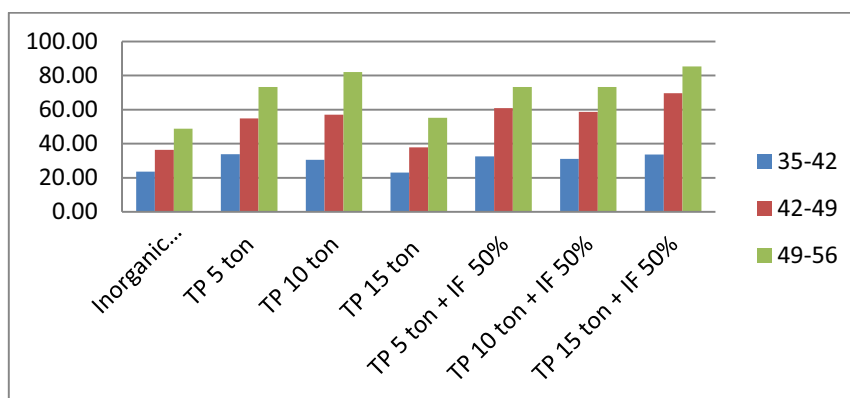


Figure 1. Effects of fertilizer differences on increasing of soybean pods number

3.5. Seed weight and weight of 100 seeds

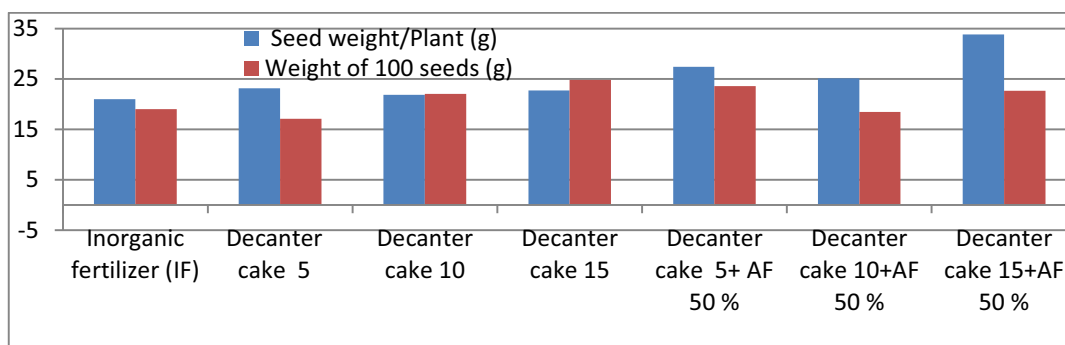
The results of the statistical analysis showed the fertilizer treatment influenced seed weight per plant and weight of 100 seeds at each measurement time and shown in Table 5. There were significant differences observed among the treatment.

Table 5. Seed weight per plant and weight of 100 seeds

Treatment (ton/ha)	Seed weight/ Plant (g)	Weight of 100 seeds (g)
Inorganic fertilizer (IF)	20.98 a	19.04 a
Decanter cake 5	23.15 a	17.09 a
Decanter cake 10	21.87 a	22.07 a
Decanter cake 15	22.74 a	24.83 b
Decanter cake 5+ AF 50 %	27.45 b	23.60 b
Decanter cake 10+ AF 50 %	25.14 b	18.49 a
Decanter cake 15+ AF 50 %	33.86 c	22.68 a

The number followed by the same letter in the column shows that there is no significant difference in the LSD at the level of 5 percent

The response of seed weight per plant to the treatment combined application of organic material from decanter cake with inorganic fertilizers has significant differences. Significantly ($P < 0.05$) highest value of seed weight per plant (33.86 g) were recorded in decanter cake 15ton/ha +IF 50 %. The results of this experiment show that average seed weight per plant that are fertilized by decanter cake 15 ton/ha + IF 50% higher than the other treatments. Plants that get enough nutrients will improve photosynthesis, thereby increasing photosynthates which will be translocate for seed development.

**Figure 2.** Effects of fertilizer differences on seed weight per plant and 100 seed weight

The weight of 100 soybean seeds can explain the size of soybean seeds and the potential yield of soybean. According to marketable size of soybean seeds is grouped in three size groups, small size (6-12 g), medium-sized (12-14 g), and large (more than 14 g). In Table 5, the weight of 100 seeds in this research informs in the large size. The average weight of 100 varieties of seeds can reach 17-24 g. Weight of 100 dry seed is very closely related with the results achieved. High yields of soybeans are supported by the high seed weight per plant and weight of 100 seeds. High production can be achieved through improvement weights of 100 seeds or seed size.

4. Conclusion

Oil palm factory waste are organic in origin, they are rich in plant nutrients. Compositing of wasted is a good practice as it useful to recycling useful plant nutrient. Recycling organic waste which is harvested from oil palm factory is organic waste and can be used as a source of nutrition for plants. Decanter cake is one of the palm oil factory wastes and contains nutrients that are often used as fertilizer to reduce the

use of chemical fertilizers. The results showed that decanter cake combined with 50 percent from recommended dosage with inorganic fertilizers affected the growth and yield of soybeans.

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