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Efficiency of Using NPK Fertilizer with Vermicompost Addition to Growth and Results of Soybean Plants

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Abstract

The continued use of chemical fertilizers and pesticides on agricultural land, causing damage to land which results in degradation of land productivity. Organic agriculture is a green revolution movement that reduces agricultural inputs in the form of the use of organic fertilizers and pesticides, by using local natural resources in a sustainable manner. This study aims to determine the use of vermicompost and chemical fertilizers on the growth and yield of soybean plants. This study used a randomized block design (RBD) with vermicompost (V) and NPK (NPK) treatment, the treatment of which was: (P0) 750.0 kg ha-1 NPK, (P1) 562.5 kg ha-1 NPK + 30 ton ha-1 V, (P2) 375.0 kg ha-1 NPK + 30 tons ha-1 V, (P3) 187.5 kg ha-1 NPK + 30 tons ha-1 V and (P4) without chemical fertilizer + 30 tons of tonnes ha-1 V. Each treatment combination is repeated 3 times, so 15 experimental units are obtained. The results showed that administration of 30 tons ha-1 gave unreal results with other treatments for the growth and yield of Glycine max.

Keywords: Efficiency, fertilizer, vermicompost, soybean

INTRODUCTION

The use of chemical fertilizers and an-organic pesticides that are continuously carried out on agricultural land, causing land damage which results in land productivity degradation. This organic farming is a green revolution movement caused by the problems of soil fertility degradation and uncontrolled continuous environmental damage. The use of organic agriculture can reduce agricultural inputs in the form of the use of organic fertilizers and pesticides, by using local natural resources in a sustainable manner.

Organic farming is an agricultural cultivation system based on improving the health of agricultural ecosystems, including biodiversity, biological cycles and biological activities of soil without using the Agricultural and Agricultural Organization of the United Nations 2015, Ray et al. (2014) said that in organic farming besides not using synthetic materials (fertilizers, pesticide hormones, feed additives, etc.), as much as possible based on crop rotation, utilization of crop residues, animals and plants, use of mineral rock additives, prioritizing biological aspects in nutrition and plant protection.

Application of organic fertilizer on agricultural land is the practice of using organic material that has been carried out in the land processing system from conventional models to sustainable agriculture to improve soil quality and plant growth (Carr, Gramig, and Liebig, 2013; Mahmood1 et al., 2017). Some experiments show that organic fertilizer can increase soil organic matter (SOM), Nitrogen (N), phosphorus (P) and soil permeability (Uzoma et al., 2011). Increased levels of N, P and organic matter in the soil are positively related to increased crop yields after organic fertilizer (Liu et al. 2013), indicating that the effects of manure can

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continue after administration (Dordas et al. 2008).

One way to improve soil quality is to provide input for organic fertilizer, because by providing organic fertilizer can improve both physical, chemical and biological soil. Some adverse economic and environmental impacts due to the use of agricultural chemical compounds in crop production have encouraged interest in using organic amendments such as compost or vermicompost for crop production (Follett, Murphy, and Donahue 1981). Utilization of earthworms can be an answer as environmentally friendly, economical and socially acceptable technology (Sharma et al. 2005).

This study aims to determine the effect of Streptomyces on vermicompost organic matter which will be produced by vermicompost with high Streptomyces content and used as a biological agent in Kascing organic fertilizer.

METHODS

The application of Streptomyces to vermicompost organic material is expected to have a positive effect on the biologically active ingredients produced from Streptomyces. The use of organic fertilizer from vermicompost with the addition of Streptomyces is one way of making organic fertilizers with Streptronces microorganisms as bio-organic organic fertilizers that are environmentally friendly and highly nutritious.

This research was conducted at the Experimental Garden of the Faculty of Agriculture UPN Veteran, East Java with a height of 10 m above sea level. The study began in April 2017 until July 2017. The research material used was the Kaba Varieties of Soybean Seeds. Biosensitive Organic Fertilizer, NPK Fertilizer, Clean Water. The tools used are Hoes, Labels, Bamboo, Lines, Cameras and Scales.

This research is an experiment using randomized block design (RBD). The types of treatment in this experiment are: (P0) 750.0 kg ha-1 NPK fertilizer without organic fertilizer (Control), (P1) 562.5 kg ha-1 + 30 tons ha-1 organic fertilizer, (P2) 375, 0 kg ha-1 + 30 tons ha-1 organic fertilizer, (P3) 187.5 kg ha-1 + 30 tons ha-1 organic fertilizer and (P4) without chemical fertilizer + 30 tons tons ha-1 organic fertilizer. Each combination treatment was repeated 3 times, so that 15 experimental units were obtained. Observation variables included: plant height, number of leaves, wet weight of stover, dry weight of stover, soybean production and P uptake.

RESULT AND DISCUSSION

Vermicompost which is added by Streptomyces microorganisms is the result of decomposition of organic materials that are decomposed (overhauled) by earthworms plus Streptomyces microorganisms, the end result of which is organic fertilizer with biological sense, can provide nutrients needed by plants for plant growth and development.

Efficiency of Fertilizer Use

Efficiency of using fertilizer ratio between nutrients that can be absorbed by plants with nutrients provided. As many nutrients are absorbed from the given fertilizer, the absorption efficiency is higher. Nutrients that cannot be absorbed by plants can be caused by loss due to yawning, being carried away by water, settling in the soil or erosion. Fertilization efficiency can be done by applying the right fertilizer (according to dosage, shape, time and method of application). The use of inorganic fertilizer together with organic fertilizer can improve nutrient uptake efficiency.

The results showed that there were various doses of the use of NPK fertilizer and organic fertilizer doses which could increase NPK fertilizer by several percent, depending on the level of use of inorganic fertilizers.

Table 1. Efficiency of using vermicompost fertilizer against the efficiency of NPK fertilizer doses

Level	Dose	Efficiency
P0	NPK 100%	0%
P1	NPK 75% + 30 ton ha^{-1} PO	25%
P2	NPK 50% + 30 ton ha^{-1} PO	50%
P3	NPK 25% + 30 ton ha^{-1} PO	75%
P4	30 ton ha^{-1} PO	100%

From the table above can be seen if we use 75% NPK fertilizer dose and added organic fertilizer, it can increase NPK fertilizer by 25%. The use of NPK fertilizer at a dose of 1.125 Kw / Ha and SP36 0.75 Kw / Ha can increase the yield of fertilizer which is usually carried out by farmers, so that we can reduce NPK and SP36 fertilizers up to 75%. In terms of economics, the use of NPK fertilizer without adding organic fertilizer is more expensive than the use of NPK fertilizer added with organic fertilizer. Sustainable agriculture is based on soil function and environmental quality, by looking at the results of organic fertilizer by reducing NPK fertilizer without NPK fertilizer to the impact of the application of management systems in agriculture that have been carried out (Andrews, Karlen, and Cambardella 2004). To find out the impact of sustainable agricultural use can be seen from inputs on land can be beneficial for soil function and environmental quality (Kremer and Hezel 2013). Land as a living system that provides sustainable soil quality functions, especially ecology, biodiversity and ecosystem stability (Doran and Zeiss 2000; Van Bruggen and Semenov 2000). Thus, good soil quality, its use aims to increase soil biological activity to achieve an increase in nutrient cycles, promotion of plant growth, suppression of disease and resistance to environmental stress (Altieri 2002).

The results of the study of the effect of organic fertilizer vermicompost vermicompost and reduction of NPK fertilizer can be seen in the observation of growth and yield of soybean crops. In addition, observations of N, P and K uptake were observed to determine the effect of treatment on soybean plants.

Soybean Plant Growth

The impact of biological sense vermicompost with the reduction of NPK fertilizer on indicator plants in the form of soybean plants is shown by observations on growth factor parameters which include plant height and number of leaves.

Plant height

The results of the analysis of the diversity of plants in the treatment of NPK fertilizer reduction and the addition of organic fertilizer did not show a significant difference in weeks 1 to 4, while at week 5, 6 and 7 after planting, showed significant differences between treatments with the highest yield obtained in P4, namely the administration of bio-compost vermicompost without the use of NPK fertilizer (Table 2 and Figure 1).

Table- 2. Average analysis of variance in real interactions on soybean varieties and fertilizer treatment

Treatment	Week observation		
	5th	6th	7th
P0	31,67 a	41,00 a	41,50 a
P1	33,50 a	43,00 a	46,83 abc
P2	38,17 a	52,33 ab	54,17 bc
P3	38,33 a	50,33 a	57,17 cd
P4	50,83 a	64,33 b	67,00 d
LSD 5%	9,47	12,05	10,79

Note: different letters in the same column show a real difference in LSD 5%.

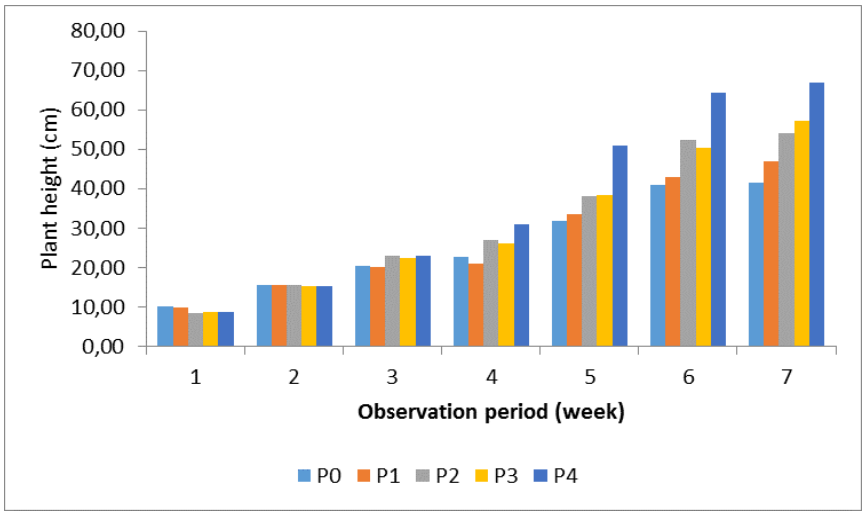

Figure 1. Graph of the height of soybean plants in observation during the growth period

In the first and second weeks showed that treatment P0 (giving NPK fertilizer 100%) showed the highest results, but statistically did not show a significant difference at the level of 5% until the 4th week treatment. Whereas in the 5th week until the end of the growth period showed a significant difference with the highest results in P4 treatment. Biological vermicompost giving has a significant effect on plant height, especially when plants can grow perfectly due to optimal nutrient availability for soybean plant growth. Baghbani-Arani et al. (2017) expressed the opinion that soybean growth is strongly influenced by the availability of nutrients in the soil, so the role of soil organic matter is very important for plants, can stimulate the growth of plants, micro-organisms and can have an important effect on soil characteristics both physically, chemically and biologically.

Number of Leaves

The results of the analysis of variance in the number of leaves on the interaction treatment of NPK fertilizer reduction and the addition of organic fertilizer did not show a significant difference. The results of observation of the number of leaves of soybean plants in the 1st to 7th week after planting (Figure 5.2).

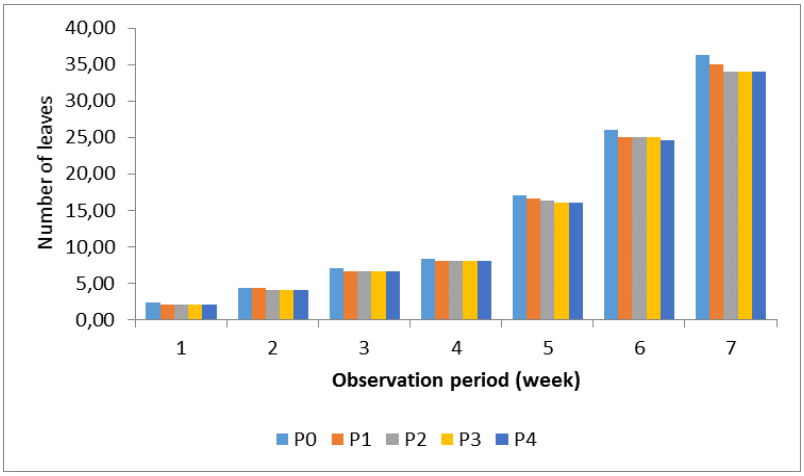

Figure 2. Histogram of the number of leaves of soybean plants in the NPK treatment bio-fertilized fertilizer

The number of leaves during vegetative growth did not show results that were significantly different, this shows that the application of biological suspensions with reduction and without the use of NPK. The number of leaves of soybean plants can grow optimally during the period of plant growth, the provision of nutrients from organic vermicompost fertilizer or organic vermicompost fertilizer with the reduction of NPK fertilizer or only NPK fertilizer does not provide a significant number of leaves. This shows that the availability of nutrient vermicompost absorbed for plants can be fulfilled such as the availability of nutrients derived from NPK fertilizer. So that the number of leaves of soybean plants do not give results that are significantly different, because of genetic factors of the plants themselves, according to Brutnell and Langdale (1998) argues that plant growth factors are strongly influenced by genetic factors while environmental factors such as soil fertility have an impact on the availability of nutrients for plants.

Weight of Dried Soybean Plant Brangkasan

The dry weight of soybean plants was measured based on the dry weight of soybean plants. The results of the analysis of variance in stover dry weight after reduction of NPK fertilizer and the addition of organic fertilizer showed no significant effect on the dry weight of soybean stover (Figure 3).

The results of the measurement of dry weight of plant stover as a result of the application of biological suspensions with the reduction of NPK fertilizer did not provide tangible results. The existence of biological intelligence verdicts has had an impact on the availability of plant nutrients such as the provision of NPK fertilizer, so that plants can grow optimally, this is evident in the results of measurements of dry weight of plant stover which is not significantly different. The highest results of the experiment were obtained in the treatment of P4, so that it was possible to provide biological-sensing vermicompost as organic fertilizer which had given optimal yield of dry weight

stover on soybean plants. According to Zhao et al. (2009) and Efthimiadou et al. (2010) suggested that organic fertilizer can improve soil environmental quality both in physical and chemical properties of soil. Furthermore, it was said by Jena, Vani, and Sankar (2014) that the effects of fertilizer application on soil can affect the accumulation of plant biomass, this is based on an increase in dry weight of plants.

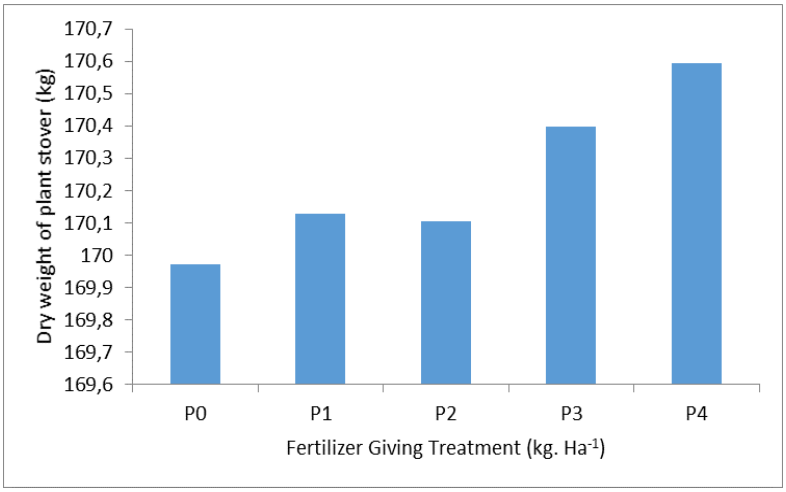

Figure 3. Dry weight histogram of soybean plant stover (kg) on NPK treatment biological-based Kascing fertilizer

Number of pods

The results of the analysis of variance in the number of pods per plant after the treatment of the reduction of NPK fertilizer and the addition of organic fertilizer showed an unreal effect on the number of soybean pods. Observations on the number of pods per soybean crop are presented in Figure 4.

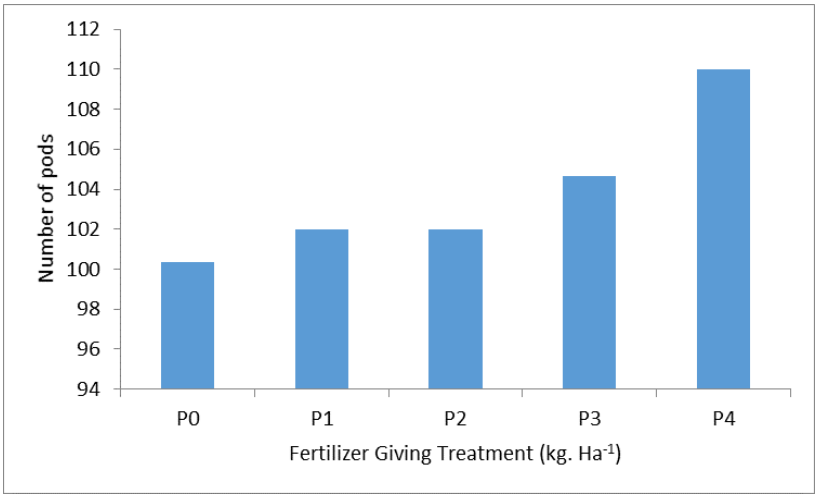

Figure 4. Histogram of the number of pods per soybean plant in the NPK treatment biological-based Kascing fertilizer

The effect of the treatment of biological flavored vermicompost fertilizer combined with the reduction of NPK fertilizer showed that the highest number of pods per plant was found in the P4 treatment (giving biological flavoring without NPK fertilizer). This shows that organic vermicompost fertilizer has been able to increase the availability of nutrients needed by plants in the soil, so that soybean plants can grow optimally even without NPK fertilizer. The availability of nutrients in increased soil will be able to support soybean plants to grow optimally. According to Slaton et al. (2013) that giving organic fertilizer will increase the availability of macro nutrients in the soil, the availability of plant nutrients will produce optimal plant growth.

Number of Seeds Per Plant

The number of seeds per soybean plant was measured based on the number of soybean seeds produced by soybean. The results of analysis of variance in the number of seeds per plant after the treatment of NPK fertilizer and organic vermicompost fertilizer showed an unreal effect on the number of seeds per soybean plant. Observations on the number of seeds per plant are presented in Figure 5.

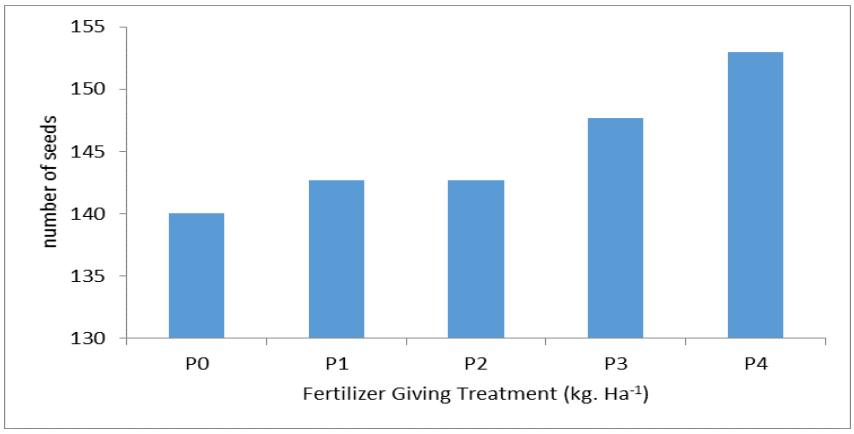

Figure 5. Histogram of the number of seeds per soybean plant in the NPK treatment biological-based Kascing fertilizer

The results of the number of seeds due to the highest treatment were found in the treatment of P4 (giving biological flavoring without NPK fertilizer). This shows that the provision of organic vermicompost-based fertilizer can have an optimal impact on soybean plant growth even without NPK fertilizer. Optimal growth in plants will produce good production. The application of organic fertilizer on the soil shows a large potential for increasing the harvest index (Mohsin et al. 2012; Muhumed et al. 2014). Organic fertilizers can affect the final yield of plants (Xiaoli et al. 2012). Improved crop yield index related to organic fertilizer input and availability of nutrients from organic fertilizers (Abera, Wolde-meskel, and Bakken 2013).

P-plant Uptake

Phosphorus is the main compound needed by plants (Ezawa, Yamamoto, and Yoshida 2002). This is because Phosphorus plays an important role in cell energy activity (ATP) and the structure of cells such as DNA, RNA and phospholipids (Schachtman, et al., 1998). P-Total measurement results of soybean crop uptake showed unreal results

between treatments, so it can be seen that the treatment giving did not show a significant difference in P-plant uptake.

The results of the statistical analysis showed that there were no significant differences between treatments indicating that the availability of P in the soil in the administration of biological vermicompost fertilizer was not lower than NPK fertilizer. The P-total absorption graph shows that P4 treatment has given high results compared to other treatments. The availability of P in the soil as a result of giving organic vermicompost fertilizer has an optimal impact on soil quality, so that plants can absorb P in the soil optimally as well.

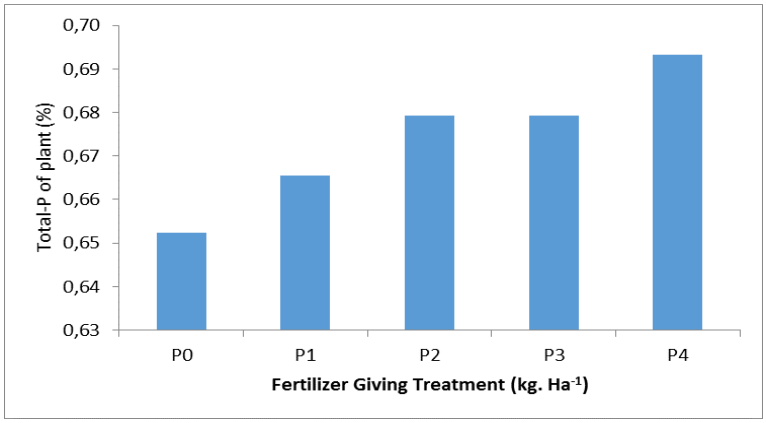

Figure 6. Histogram of P-total uptake of plants (%) in each treatment

According to Yang et al. (2015) states that the administration of vermicompost to plants can significantly affect the availability of P in the soil, the availability of P in the soil can have an impact on crop uptake which is shown in increasing growth and yield of crops.

K-total Plants

The results of measurement of K-total uptake of soybean plants obtained unreal results between treatments, so that it can be seen that the administration of the treatment did not show a significant difference in K-plant uptake.

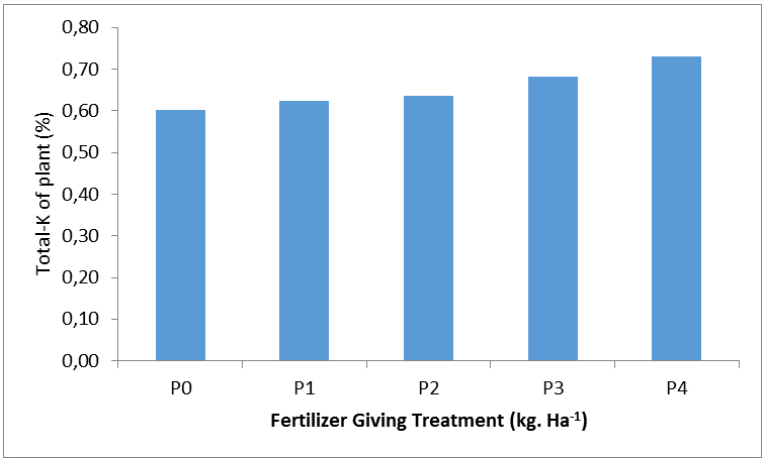

Figure 7. Histogram of K-total plant uptake (%) in each treatment

The results of the statistical analysis showed that there were no significant differences between treatments indicating that the availability of P in the soil in the administration of biological vermicompost fertilizer was not lower than NPK fertilizer. The K-total absorption graph shows that P4 treatment has given high yields compared to other treatments, this shows that the availability of potassium in the soil can be met by the addition of organic fertilizer (vermicompost) in the planting medium. According to Hanč et al. (2008) that the availability of potassium in the soil can be increased by providing organic fertilizer, Odlare, Pell, and Svensson (2008) adding that the continuous provision of organic fertilizer in agricultural cultivation can increase the availability of potassium in the land.

CONCLUSION

The results of the study can be concluded that:

1. The provision of bio-sensitive vermicompost combined with a reduction in NPK fertilizers has produced unreal results on the growth and yield of soybean crops.
2. The provision of biological suspended vermicompost combined with a reduction in NPK fertilizer has given unreal results on P-total and K-total uptake of soybean plants.
3. P4 treatment in the form of giving 30 tons of ha-1 PO, giving the highest yield on growth, yield and nutrient uptake in soybean plants.

Research on providing vermicompost with micro organisms as organic fertilizers with biological potential still needs to be studied further with applications on agricultural land and motivating farmers to prove that the use of organic fertilizer can provide results that are not different from NPK fertilizer.

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