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PROVIDING VERMICOMPOST TO INCREASE SOYBEAN GROWTH AND YIELD AND ORGANIC C CONTENT IN INCEPTISOL

Mindalisma*, Chairani Siregar, Ratna Mauli Lubis, Diapari Siregar, Yenni Asbur, Yayuk Purwaningrum and Rahmi Dwi Handayani Rambe

Universitas Islam Sumatera Utara, Faculty of Agriculture, Department of Agrotechnology, Jalan Karya Wisata Gedung Johor, Medan 20144, Indonesia.

***Corresponding Author: Mindalisma**
Universitas Islam Sumatera Utara, Faculty of Agriculture, Department of Agrotechnology, Jalan Karya Wisata Gedung Johor, Medan 20144, Indonesia.

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ABSTRACT
One effort to increase domestic soybean production and support the national food self-sufficiency program is to optimize the use of Inceptisol soil with infertile land characteristics. Regarding the potential use of Inceptisols soil, plant nutrient needs can be met by fertilizing, one of which is using organic vermicompost fertilizer. Vermicompost is compost made from the results of raising worms in compost. This research aims to determine the effect of applying vermicompost to increase soybean growth and yield as well as organic C content in Inceptisol soil. The research was carried out in the experimental garden of the Faculty of Agriculture, Islamic University of North Sumatra, Medan, North Sumatra using a Non-Factory Randomized Block Design with three replications with vermicompost doses as treatment, namely 0 t/ha (V0), 5 t/ha (V1), 10 t /ha (V2), and 15 t/ha (V3). The results showed that the application of 15 t/ha of vermicompost was able to increase the height of soybean plants by 16.70%, the number of productive branches by 20.75%, the number of pods per plant by 36.10%, the weight of the pods per plot by 33.17%, the weight of dry beans per plant plot. soybeans amounted to 24.08$, and soil organic C content amounted to 60.87%.

KEYWORDS: Soybean, inceptisol, vermicompost, organic C.

INTRODUCTION
Indonesia is the fourth largest country in the world and is a country in Southeast Asia which is crossed by the equator. The tropical climate means that Indonesia has abundant natural resources and is suitable for the growth of various types of plants, therefore, almost half of Indonesia's population makes a living in agriculture. The Indonesian economy is also supported by the agricultural sector through the export of products from the agricultural subsector, one of which is the food crops subsector.[1]

As part of the agricultural sector, the food crop subsector plays an important role in creating national food security, regional development, poverty alleviation, employment, and foreign exchange earnings. Apart from that, it also encourages the growth of upstream and downstream industries, each of which makes a significant contribution to national economic growth.[2] Among these food crops, including soybeans besides rice and corn. Currently, the food and feed industry made from soybeans in Indonesia is increasing. On the other hand, domestic soybean production tends to decline. This is partly due to the fact that many farmers still plant soybeans as a fallow crop after the rice planting season, as well as the decreasing productivity of food crop land due to the routine use of chemical fertilizers and pesticides.[3] Apart from that, Jaya et al.[4] states that land use without understanding the suitability conditions of the land being managed can increase the occurrence of erosion, critical land and land degradation.

One effort to increase domestic soybean production and support the national food self-sufficiency program is to optimize the use of Inceptisol soil with infertile land characteristics. Inceptisols are actually soil that has been widely used in Indonesia as agricultural land. The potential for Inceptisol soil for developing agricultural areas is quite large in Indonesia but the fertility level is not good.[5] According to Kasno[6], there are still 52.0 million hectares of Inceptisols that have the potential to be developed as new agricultural areas and these conditions are spread throughout Indonesia. Although, according to Nursyamsi and Suprihati[7] when compared with Oxisol and Andisol soil, the need for fertilizer for agricultural land with Inceptisol soil tends to be higher because Inceptisol soil has relatively low levels of nutrients available to plants.

Regarding the potential use of Inceptisols soil, plant nutrient needs can be met by fertilizing, one of which is using organic vermicompost fertilizer. Vermicompost is compost made from the results of raising worms in compost. Vermicompost contains worm waste mixed with organic materials such as banana stems, grass, and food scraps. According to Nusantara.[8] Vermicompost fertilizer is made from the digestive waste of earthworms which has a good effect on plant growth and the development of mycorrhizal symbiosis.

Vermicompost is generally used as a source of plant nutrition in organic farming systems which has the benefits of: (a) improving the physical, chemical and biological properties of soil.[9] thereby increasing the availability of water and essential nutrients for plants.[10,11] (b) environmentally friendly and improving the quality of harvests that are free of toxic nutrients, pests and plant diseases[12] the healthy; (c) odorless or smells like earth.[13] The research results of Batubara et al.[14] showed that the application of vermicompost can increase the growth and production of soybeans in ultisol soil. Likewise, the research results of Rezeki et al.[15] and Riwandi et al.[13] who reported that the application of vermicompost can improve the availability of soil carbon and N content and increase the growth and production of corn in entisol. However, the application of vermicompost to improve the growth and yield of soybeans and the availability of organic C in Inceptisol soil is still small, so this research aims to determine the effect of application of vermicompost to increase the growth and yield of soybeans as well as organic C content in Inceptisol soil.

MATERIALS AND METHODS

The research was carried out in the experimental garden of the Faculty of Agriculture, Islamic University of North Sumatra, Medan, North Sumatra at an altitude of ± 25 meters above sea level with flat topography.

The research used a non-factorial randomized block design with three replications with vermicompost doses as treatment, namely 0 t/ha (V0), 5 t/ha (V1), 10 t/ha (V2), and 15 t/ha (V3). The research was carried out in experimental plots measuring 1.2 m x 1.2 m with a soybean planting distance of 30 cm x 40 cm and 2 seeds per planting hole.

Vermicompost fertilizer is applied two weeks before planting (MST) at doses according to the treatment, namely 0 tons/ha, 5 tons/ha or 0.72 kg/plot, 10 tons/ha or 1.44 kg/plot, and 15 tons/ha or 2.16 kg/plot.

The variables observed were plant height, number of productive branches, number of pods per plant, pod weight per plot, dry seed weight per plot, and soil organic C availability.

RESULTS AND DISCUSSION

The results of analysis of variance showed that the application of vermicompost had a significant effect on soybean plant height at 5 weeks after planting (WAP), number of productive branches, pod weight per plot, and dry seed weight per soybean plant plot (Table 1).

Vermicompost application had a significant effect on soybean plant height at 5 WAP (Table 1). The highest soybean plant height was obtained in treatment V3 (15 t/ha), namely 57.50 cm, which was significantly different from treatment V0 (0 t/ha), namely 49.27 cm, and also significantly different from treatment V1 (5 t/ha) and V2 (10 t/ha), namely 50.96 cm and 53.54 cm respectively. In this case, there was an increase between without vermicompost fertilizer and the application of vermicompost fertilizer up to a dose of 15 t/ha (V3), which resulted in an increase in plant height of 16.70%. Based on the above, it can be said that the application of vermicompost fertilizer provides a positive response to the height of soybean plants.

Table 1: Plant height (cm), number of productive branches (branches), number of pods per plant (pods), pod weight per plot (g), and dry seed weight per plot (g) of soybeans with the application of various doses of vermicompost in inceptisol soil.

Treatments	Plant height	Number of Productive Branches	Number of Pods per Plant	Pod weight per plot	Dry seed weight per plot
V0	49.27c	9.06b	72.71c	594.43c	172.88c
V1	50.96bc	9.48b	85.65b	668.76b	178.47bc
V2	53.54b	10.48a	88.08b	773.87a	195.52b
V3	57.50a	10.94a	98.96a	791.59a	214.51a

Note: Numbers in the same column followed by different letters indicate significant differences at the 5% level based on Duncan's test V0: 0 t/ha; V1: 5 t/ha; V2: 10 t/ha; V3: 15 t/ha

The relationship between vermicompost application and soybean plant height at 5 WAP is linear (Figure 1).

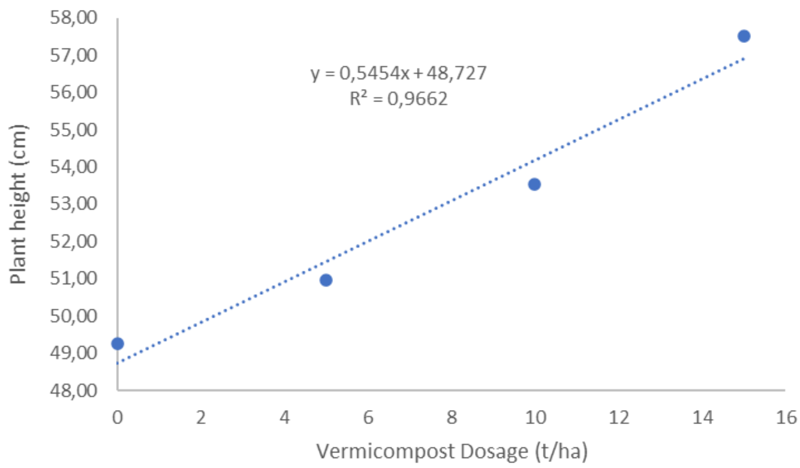

Figure 1: The relationship between soybean plant height and the dose of vermicompost given.

The form of the relationship between soybean plant height and vermicompost dose is linear (Figure 1) meaning that an increase in vermicompost dose will be followed by an increase in soybean plant height with the regression equation Y = 0.5454x + 48.727 with a coefficient of determination (R^2) 0.9662 which means that 96.62% increase in height soybean plants are affected by the application of vermicompost. This can be explained by the results of the analysis of vermicompost fertilizer, organic C 27.25%, N 1.00%, P_2O_5 1.89%, and K_2O 0.66% can affect plant height. This vermicompost fertilizer is a source of nutrients that can be used to increase plant growth. Its absorption has a positive effect on the photosynthesis process, namely it can increase the chlorophyll and nutrient content in the root zone thereby increasing plant height.[16]

Providing vermicompost also has a significant effect on the number of productive branches of soybean plants. The highest number of productive plant branches was obtained in treatment V3 (15 t/ha), namely 10.94 branches, which was significantly different from treatment V0 (0 t/ha), namely 9.06 branches, and also significantly different from treatment V1 (5 t/ha), namely 9.48 branches, but not significantly different from treatment V2 (10 t/ha), namely 10.48 branches. In this case, there was an increase between no vermicompost fertilizer (V0) and 15 t/ha vermicompost (V3) of 20.75%. Based on the above, it can be said that the provision of vermicompost provides a positive response to the number of productive branches of soybean plants.

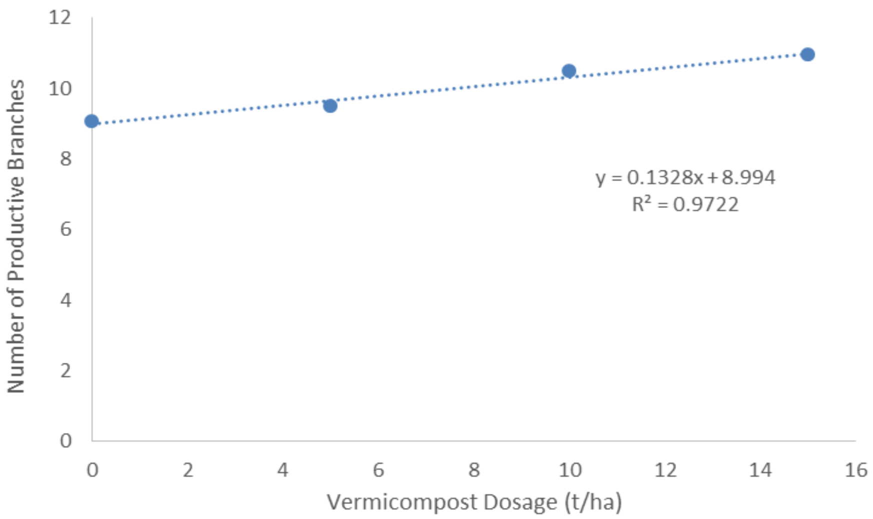

Figure 2: The relationship between the number of productive soybean branches and the dose of vermicompost given.

This can be seen from Figure 2 that the higher the dose of vermicompost given, the higher the number of productive branches of soybean plants produced. This result is linear with the equation $\hat{Y}$ = 0.1328x + 8.994 with a coefficient of determination (R^2) 0.9722, meaning 97.22% of the number of productive branches soybean plants are affected by vermicompost. This shows that the application of vermicompost as a soil amendment works well in increasing the soil's ability to retain water and increasing the activity of microorganisms in the soil, thereby increasing the availability of both macro and micro nutrients in the soil. This statement is in accordance with the opinion[17] that the availability of nutrients by plants is one thing that can influence plant growth, including the formation of the number of primary branches.

Providing vermicompost also had a significant effect on the number of pods per plant. The highest number of pods per plant was obtained in treatment V3 (15 t/ha), namely 98.96, which was significantly different from treatment V0 (0 t/ha), namely 72.71, and also significantly different from treatment V1 (5 t/ha), namely 85.65. and significantly different from the V2 treatment (10 t/ha), namely 88.08 pieces. The relationship between the treatment of vermicompost fertilizer and the number of pods per soybean plant can be seen in Figure 3.

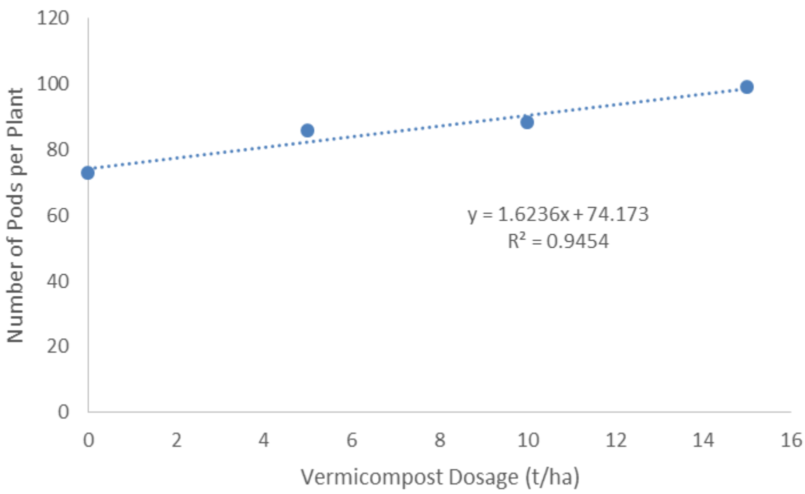

Figure 3: The relationship between the number of pods per soybean plant and the dose of vermicompost given.

Providing vermicompost up to a dose of 15 t/ha (V3) was able to increase the number of pods per soybean plant by 36.10% compared to without vermicompost application (V0). Based on the above, it can be said that the provision of vermicompost provides a positive response to the number of pods per soybean plant. This can be seen from Figure 3 that the higher the dose of vermicompost given, the more pods per soybean plant will be produced with the equation $\hat{Y} = 1.6236x + 74.173$ with a coefficient of determination (R^2) 0.9454, meaning that 94.54% of the number of pods per plant is influenced by vermicompost. which are given.

When soybean plants enter the pod formation and seed initiation phase, one of the nutrients that is really needed is the element P. The source of P that plants need is obtained from the vermicompost provided. Apart from vermicompost, plants also use P as a source of P bound in the soil. The addition of this organic material increases the availability of P in the soil. The effect of organic matter on P availability can be directly through the mineralization process or indirectly by helping the release of fixed P. The results of the decomposition of organic materials in the form of organic acids can form chelation bonds with Al and Fe ions so that they can reduce the solubility of Al and Fe ions, thereby increasing the availability of P. Organic acids produced from decomposition of organic materials can also release absorbed P so that P availability increases.[18] Sari[18] stated that simple organic acids such as oxalic acid are one of the important compounds in the process of releasing P adsorption. The mechanism of oxalic acid in increasing the availability of P can be by replacing the P that is adsorbed through ligand exchange on the Al and Fe oxide surfaces. Apart from that, it can also be done by dissolving the metal oxide surface and releasing the adsorbed P, and can also be done by complexing Al and Fe in solution, then preventing re-deposition of the metal P compound and adsorption of P by Al and Fe. The P element is very important for the formation and filling of pods and ultimately for seed formation. The more organic material available, the better the microbes work in releasing the P element so that it is available to plants and this shows that the number of pithy pods is getting higher.

Vermicompost application also had a significant effect on pod weight per plot. The heaviest pod weight per plot was obtained in treatment V3 (15 t/ha), namely 791.59 g, which was significantly different from treatment V0 (0 t/ha), namely 594.43 g, and also significantly different from treatment V1 (5 t/ha), namely 668.76 g. but it was not significantly different from the V2 treatment (10 t/ha), namely 773.87 g.

Providing vermicompost up to a dose of 15 t/ha (V3) was able to increase pod weight per plot by 33.17% compared to without vermicompost (V0). Based on the above, it can be said that the application of vermicompost provides a positive response to the weight of pods per plot of soybean plants. This can be seen in Figure 4 that the higher the vermicompost fertilizer given, the higher the pod weight per plot of soybean plants produced. This result is linear with the equation Ŷ = 13.932x + 602.67 with a coefficient of determination (R^2) of 0.9418, meaning 94.18% of the weight. pods per plot was influenced by the vermicompost applied.

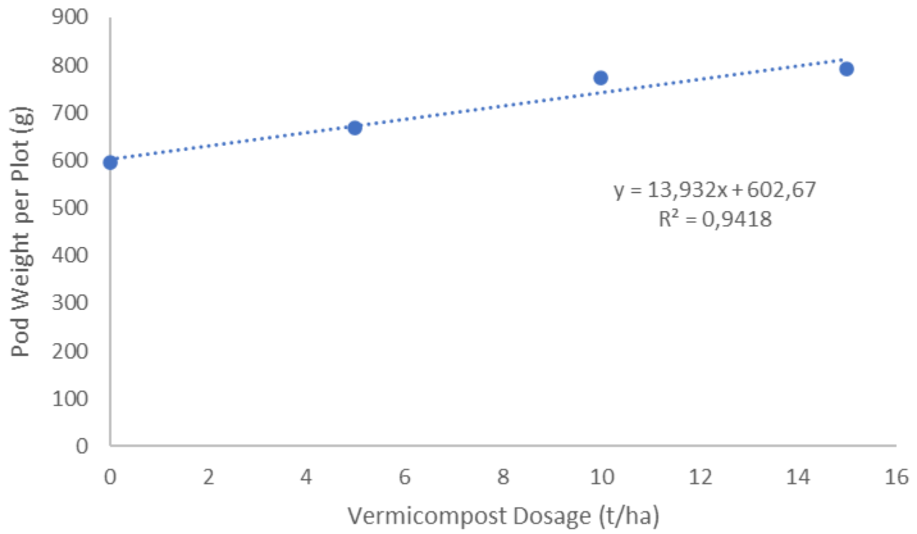

Figure 4: The relationship between pod weight per soybean plot and the dose of vermicompost given.

The conditions above indicate that the application of vermicompost at this dose is sufficient to provide the nutrients N, P, K, Mg, Ca that plants need for physiological and metabolic processes, thus physiological and metabolic processes in plants will stimulate plant growth, resulting in an increase in pod weight. The presence of nitrogen nutrients can stimulate the formation of auxin which functions to soften cell walls so that the ability of the cell walls increases followed by an increase in the ability of the water uptake process due to pressure differences. This causes the cell size to increase. The increase in pod weight will increase in line with the elongation and enlargement of the pods. N is a constituent of every living cell, because it is found in all parts of the plant. This element is also part of enzymes and chlorophyll molecules. P is also a constituent of every living cell. P plays a very active role in transferring energy within cells, converting carbohydrates and increasing the efficiency of chloroplast performance.[19]

Vermicompost application also had a significant effect on dry seed weight per plot. The heaviest dry seed weight per plot was obtained in treatment V3 (15 t/ha), namely 214.51 g, which was significantly different from treatment V0 (0 t/ha), namely 172.88 g, and also significantly different from treatment V1 (5 t/ha), namely 178.47 g and significantly different from treatment V2 (10 t/ha), namely 195.52 g.

Providing vermicompost up to a dose of 15 t/ha (V3) was able to increase dry seed weight per plot by 24.08% compared to without vermicompost application (V0). Based on the above, it can be said that the application of vermicompost provides a positive response to the dry seed weight per plot of soybean plants. This can be seen from Figure 5 that the higher the dose of vermicompost given, the greater the dry seed weight per plot of soybean plants produced with the equation Ŷ = 2.8388x + 169.05, and the coefficient of determination (R^2) is 0.9532 which means that 95.32% of dry seed weight per plot was influenced by vermicompost application.

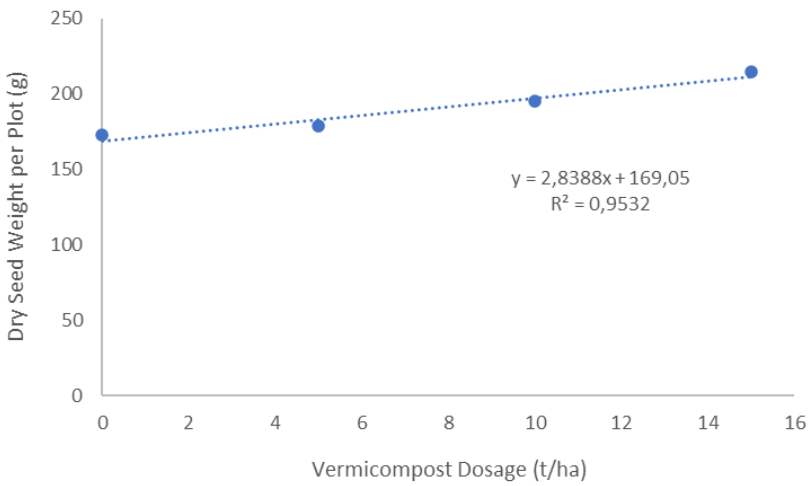

Figure 5: The relationship between dry bean weight per soybean plot and the dose of vermicompost given.

This real effect is thought to be because the higher the dose of vermicompost given, the more nutrients will be absorbed so that it can increase the availability of nutrients needed in the photosynthesis process so that it can increase the weight of seeds per plant. Providing vermicompost can improve the physical properties of the soil, making it more crumbly so that water and nutrients are quickly absorbed by plants. Water and nutrients absorbed by plants are used for metabolic processes in plants. An adequate nutrient supply helps photosynthesis occur in plants to produce organic compounds which will be converted into ATP during respiration, then this ATP is used to help plant growth. During reproductive growth there will be a spur to the formation of flowers, pods and seeds. Sirait[17] added that the high or low weight of the seeds depends on how much or how little dry matter is contained in the seeds. The dry material obtained comes from the photosynthesis process and during growth, the results of this photosynthesis will be used to fill the pods and seeds. Furthermore, Sarief[20] stated that the amount of nutrients absorbed by plants really depends on the fertilizer given, where the nutrients absorbed by plants will be used for the photosynthesis process which will ultimately affect growth and the results obtained.

Providing vermicompost has a significant effect on soil organic C content. The highest soil organic C content was obtained in treatment V3 (15 t/ha), namely 1.41%, which was significantly different from treatment V0 (0 t/ha), namely 0.99%, and significantly different from treatment V1 (5 t/ha), namely 1.22% but not significantly different from the V2 treatment (10 t/ha), namely 1.28% (Figure 6).

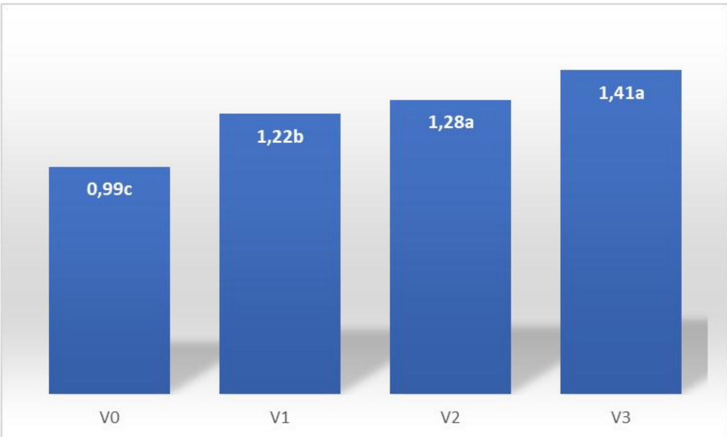

Figure 6. Effect of vermicompost application on soil organic C content (%).

Providing vermicompost up to a dose of 15 t/ha (V3) can increase soil organic C content by 60.87%. This is because vermicompost contains high organic C, namely 27.25%, so it can increase organic C levels in the soil. This increase in organic matter can improve the physical and biological properties of the soil. Biologically, organic matter is food for soil microorganisms. This increase in organic matter will increase the number of soil microorganisms and their activity will also be high. The activity of soil microorganisms can improve the physical properties of soil, namely soil looseness and aeration.[21]

CONCLUSION

The vermicompost provided provided a positive response to soybean growth and yield. Vermicompost dosage significantly affected plant height, number of productive branches, number of pods per plant, pod weight per plot, dry seed weight per plot of soybean plants, and inceptisol soil organic C content.

The response of plant height, number of productive branches, number of pods per plant, pod weight per plot, and dry seed weight per plot of soybean plants to the administration of vermicompost in various doses is linear positive, meaning that the increasing dose of vermicompost given will be followed by an increase in plant height. number of productive branches, number of pods per plant, pod weight per plot, and dry seed weight per plot of soybean plants.

Providing 15 t/ha of vermicompost was able to increase the height of soybean plants by 16.70%, the number of productive branches by 20.75%, the number of pods per plant by 36.10%, the weight of pods per plot by 33.17%, the weight of dry seeds per plot of soybean plants by 24.08$, and the soil organic C content was 60.87%.

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