



Effect of Vermicompost Chicken, Goat and Cow Manure on Growth Response and Yield of *Brassica juncea* L. on Ultisols

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ABSTRACT

Improvement of Ultisol soil chemical properties can be done by adding organic matter. In this study, vermicompost was used from various animal wastes (chickens, goats and cows), and the optimal growth parameters and nutrient uptake were observed. Research results showed The chicken manure vermicompost had the maximum available P, the goat manure vermicompost had the highest available K, and cow manure vermicompost had the highest total N value. In terms of pH, goat manure vermicompost had the highest pH and the chicken manure vermicompost had the most excellent C/N ratio. Analysis of variance (Anova) showed that the type and dosage of vermicompost had a significant effect on growth parameters (plant height, number of leaves and stem width) and nutrient uptake of N, P and K.

Keywords: vermicompost, mustard, compost

INTRODUCTION

The development of areas of agricultural centers in Indonesia faces various obstacles, especially the decrease in harvested area due to land conversion and land capability degradation, due to reduced soil organic matter. Based on data from the Kementerian Pertanian (2015) land conversion in the last 10 years from productive land to non-productive land was recorded at around 100,000 ha/year. The decrease in organic matter occurs due to the intensive use of land for agricultural activities, while the input of organic matter by farmers is very rare and in small quantities.

The low input of organic matter into the planting area is due to the process which makes it difficult for farmers. The organic material commonly used by farmers is livestock waste, namely livestock manure. In utilizing livestock manure, farmers need it in large quantities, the maturation process takes a long time and is complicated, requires additional space, creates odor pollution and increases production costs. As a result, agricultural lands have decreased their ability to produce optimally.

Dry land is one of the land resources that has great potential in supporting agricultural development in Indonesia, both in terms of its area which reaches almost 144 million ha, as well as the opening up of opportunities for the production of various agricultural commodities (Abdurachman, 2005). About 24.3% of dry land area in Indonesia is dominated by Red Yellow Podzolic (Ultisols). In terms of soil chemistry, Ultisol soil type is infertile, has an acid reaction, contains high amounts of Al, Fe and Mn which can poison plants. Acidic soils are generally poor in organic matter and macro nutrients such as N, P, K, Ca and Mg (Subandi, 2007). Therefore, increasing the productivity of Ultisol soil can be done through soil improvement (amelioration), fertilization and the provision of organic matter (Prasetyo & Suriadikarta 2009).

One of the organic materials that have good potential for soil improvement is vermicompost. Vermicompost can be used as organic fertilizer and soil amendment because it contains complete macro and micro elements and can improve soil physical and biological properties. This vermicompost process will convert or change an organic material into other products that are more useful and have

added value by utilizing the biological processes of the living things in it. In this process earthworms act as the main biodegradator which completes the degradation of organic matter which has previously been degraded by microorganisms.

Vermicompost is an organic fertilizer that is environmentally friendly and has its own advantages compared to other composts that we know so far (Mashur, 2001). The advantages include (1) increasing the absorption of nutrients, (2) the ability to absorb and store water in the soil will increase, (3) there are beneficial microorganisms in large quantities, (4) can improve soil structure (Sallaku *et al.*, 2009).

In this study, three types of manure were used, namely cow, goat and chicken manure. The manure was chosen because it is widely circulated and used by the community. However, in its utilization there have been no efforts to increase the added value of the manure so that apart from being a soil enhancer, it can also be used as a source of nutrients for plants. So this research is needed to find and compare the nutrient status and response of vermicompost to improving the chemical properties of ultisols and plant growth. Mustard plants are used as indicator plants to study the effect of vermicompost on growth, production and plant nutrient levels.

MATERIALS AND METHODS

The research was conducted at the Wire House and Soil Science Laboratory, Faculty of Agriculture, University of Bengkulu. This research was conducted from March to November 2019. The main tools used in this research were tools for vermicomposting, tools for the observation process, laboratory tools for analysis, tools for planting mustard greens and tools for collecting questionnaire data. The main materials used in this study included: *Lumbricus rubellus* earthworms, fresh manure (cows, goats and chickens), mustard seeds, urea, SP-36, and KCl as well as chemicals needed for analysis in the laboratory.

The wire house experiment was a single factor experiment with 10 treatments and three replications to obtain 30 experimental units, which were placed in a completely randomized design. The treatment in question is: V_0D_0 (without vermicompost (control)); V_1D_1 (10 ton ha^{-1} chicken manure vermicompost), V_2D_1 (10 ton ha^{-1} goat manure vermicompost), V_3D_1 (10 ton ha^{-1} cow manure vermicompost), V_1D_2 (20 ton ha^{-1} chicken manure vermicompost), V_2D_2 (20 ton ha^{-1} goat manure vermicompost), V_3D_2 (20 ton ha^{-1} cow manure vermicompost), V_1D_3 (30 ton ha^{-1} chicken manure vermicompost), V_2D_3 (30 ton ha^{-1} goat manure vermicompost), and V_3D_3 (30 ton ha^{-1} cow manure vermicompost).

Soil preparation

Soil collection was carried out on Ultisol soil by cleaning the soil surface from plant residues and taken to a depth of 20 cm. The soil was air-dried, crushed and sieved using a 5 mm sieve. To find out the characteristics of the soil used, a preliminary soil analysis was carried out. Soil preparation was made into 2 sets, namely: 1) soil for planting media was weighed as much as 3.5 kg BKU. Then put into a polybag; 2) Soil for analysis in the laboratory is taken in a composite manner and the soil sample is not disturbed.

Treatment of the planting medium was carried out by mixing the soil with vermicompost in a homogeneous manner according to the treatment. Then watered with water at field capacity conditions. Then left for 2 days. The planting medium is then taken, air-dried, crushed, and stored in a labeled plastic bag for chemical analysis.

Preliminary soil analysis consist of : Total N (Kjeldahl), available P (Bray I), available K (NH_4OAc 1N pH 7.0), organic C content (Walkey and Black), CEC (NH_4OAc 1N pH 7.0) and pH (colorimetric). Vermicompost analysis consist of : Total N (Kjeldahl), available P (Bray I), available K (NH_4OAc 1N pH 7.0), organic C content (Walkey and Black), and pH (colorimetric). And plant growth parameters consist of plant height, number of leaves, stem diameter, nitrogen, phosphorus and potassium levels.

Calcification and fertilization

Liming is given after incubating the soil with vermicompost. Lime is given as much as $1 \times Al$ -dd soil with an incubation period of 7 days. Basic fertilizer is given at the time of planting, namely after planting mustard seeds. The basic fertilizers used are urea, SP-36, and KCl. Based on the results of Manulu's research (2008), the dose given was 50% each to 50 kg Urea/ha, 50 kg SP-36/ha and 37.5 kg KCl/ha. The method of administration is in rows next to the planting hole where the mustard seeds have been planted.

Planting

Mustard seeds are planted directly into the pot. Each pot was planted with 4 seeds which were maintained until harvest. Maintenance carried out includes watering which is carried out every day, namely in the morning or evening and trying to keep the water content at field capacity conditions.

Harvesting

Harvesting is done when the plants are 45 days after planting (DAP) by spraying the planting medium with water to see plant roots and cutting the

top of the plant (shoots) to determine the wet weight of the mustard plant.

Data analysis

Observational data were analyzed statistically using Analysis of Variance (ANOVA) with F test at 5% alpha level. If the treatment had a significant effect, it was continued with the Duncan Multiple Range Test (DMRT) at an alpha level of 5%.

RESULTS AND DISCUSSION

Ultisols properties according to the criteria set by Balittanah (2005) that Ultisols had a pH 5.3 which means that Ultisols is classified as a acidic soil with exchangeable Aluminum content 26.54 me 100 g⁻¹ (very low), organic C content 1.77 % (low), total N 0.14% (low). The levels of exchangeable P 9.23 ppm (low), exchangeable K 0.29 me 100 g⁻¹, and CEC 12.12 me 100 g⁻¹ (low) (Table 1).

Ultisol is a type of acid mineral soil which has a large enough area and if properly managed has the potential to contribute to increasing production so that food supports food security. The land area of Ultisols in Indonesia is 45,794 ha or about 25% of the total land area Indonesia (Prasetyo & Suriadikarta, 2006). To overcome the problem of low fertility of Ultisols, organic matter is added, for example vermicompost.

Table 1. Preliminary soil sample analysis results

Observation Parameters	Units	Value
pH	-	5.3
Organic C content	%	1.77
Exchangeable Aluminum	me 100 g ⁻¹	26.54
Total Nitrogen	%	0.14
Exchangeable P	Ppm	9.23
Exchangeable K	me 100 g ⁻¹	0.29
CEC	me 100 g ⁻¹	12.12

Tables 2 demonstrate that the *Lumbricus rubellus*-assisted composting process could enhance the chemical properties of animal manure. The chicken manure vermicompost had the maximum available P (2.90%), followed by goat and cow manure vermicompost. Meanwhile, the goat manure vermicompost had the highest available K, followed by chicken and cow manure vermicompost. Cow manure vermicompost had the highest total N value followed by goat and chicken manure vermicompost. In terms of pH, goat manure vermicompost had the highest pH followed by cow and chicken manure vermicompost (7.29). For the most excellent C/N ratio, the chicken manure vermicompost

goat manure vermicompost, and cow manure vermicompost values were closest to the soil C/N ratio, respectively. The nutrient content in animal manure is also affected by type of livestock, also depending on food, water given, age and physical form of livestock (Hartatik & Widowati, 2012).

Table 2. The results of the analysis of the chemical properties of various vermicomposts

Parameter	Chicken Manure Vermicompost	Goat Manure Vermicompost	Cow Manure Vermicompost
Total N (%)	1.49	1.90	1.98
Available P (%)	2.90	0.90	0.70
Available K (%)	2.70	3.05	3.03
Organic C (%)	26.77	34.65	31.22
C/N ratio	17.93	18.22	18.78
pH	7.29	8.27	7.83

The response of various doses and types of vermicompost to plant growth was carried out by observing growth parameters including plant height, number of leaves, and stem diameter. Based on the results of the analysis of variance, the treatment given had a significant effect on all growth parameters. The best plant height parameter was the treatment of 30 tons ha⁻¹ of cow dung vermicompost, but this treatment was not significantly different from all types of vermicompost at a dose of 10 tons ha⁻¹ (Table 3). Here it can be concluded that various vermicomposts have the same effect on plant height parameters at the same dose. For the parameters of number of leaves and stem diameter, vermicompost doses of 20 tons ha⁻¹ and 30 tons ha⁻¹ did not show significant differences for all types of vermicompost. Based on the data above, it is recommended to use vermicompost doses of 20 tons ha⁻¹ to increase the growth of mustard greens.

Good growth proves the existence of optimal nutrient absorption by plant roots. Vermicompost is able to provide the nutrients needed by plants to grow and produce. The composting process with worms is known to improve the quality and nutrient content of vermicompost. This is due to the presence of microbes carried from the digestive organs of worms which are beneficial for plant growth. Earthworms also play a role in converting insoluble nutrients into dissolved forms, namely with the help of enzymes found in their digestive organs. These nutrients are contained in vermicompost, so that they can be absorbed by plant roots to be carried to all parts of the plant (Mashur, 2001).

According to Manivannan *et al.* (2009), improvement growth and yield of plants resulting from the application this vermicompost occurs because of improvements soil quality and availability of micro-nutrients and macro, as well as increased microbial activity land. Likewise the results of Romaniuk's *et al.* (2011) research, vermicompost application can improve biochemical and biological properties land. In addition, it increases the microbial population in the soil (Jayakumar & Sakthivel, 2012). Increased microbial populations (both types and numbers) lead to increased mineralization of soil organic matter and nutrient availability for plants. The ability of vermicompost to change soil biological properties in a positive direction thereby increasing the microbial population that benefits plants makes plants grow healthier and produce higher compared to control plots of mustard plants that are not fertilized with vermicompost.

Table 3. Effect of various doses of vermicompost on plant growth

Sample	Plant Height (cm)	Number of Leaves	Stem Diameter (mm)
V ₀ D ₀	23.13 d	6.00 b	3.47 d
V ₁ D ₁	32.10 bc	8.00 b	4.37 c
V ₂ D ₁	32.83 abc	7.33 b	4.55 c
V ₃ D ₁	35.23 ab	7.33 b	5.88 ab
V ₁ D ₂	31.57 bc	11.67 a	5.66 ab
V ₂ D ₂	31.53 bc	12.00 a	6.30 a
V ₃ D ₂	33.20 abc	12.00 a	5.86 ab
V ₁ D ₃	31.90 bc	10.67 a	5.30 b
V ₂ D ₃	29.63 b	11.00 a	5.23 b
V ₃ D ₃	37.43 a	11.00 a	5.45 b

Note : Numbers in the same column followed by the same letter are not significantly different alpha level 5 % (Duncan Multiple Range Test)

The effect of various types and doses of vermicompost on levels of nitrogen, phosphorus and potassium in plant tissue was highest in the cow dung vermicompost treatment at a dose of 30 tons ha⁻¹. Statistically, this treatment was significantly different from other treatments. Nutrient uptake is an indicator of nutrient availability in the soil. The higher the availability of nutrients in the soil, the more nutrients absorbed by plants.

Research by Nurhidayati *et al.* (2015) states that the addition of organic matter to the soil can improve the physical and biological qualities of the soil such as the soil structure becomes more crum-

bly, making it easier for plant roots to absorb nutrients from the soil. The application of vermicompost can improve soil chemical properties and availability of N, P and K in the soil, as well as increase the microbial population in the soil (Pathma & Sakthivel, 2012). Increased microbial populations (both types and numbers) lead to increased mineralization of soil organic matter and nutrient availability for plants (Arancon *et al.*, 2006), resulting in increased nutrient uptake

Table 4. Effect of vermicompost on N, P and K nutrient levels in plant tissues

Sampel	Nitrogen (%)	Phosphorus (%)	Potassium (%)
V ₀ D ₀	2.08 c	0.73 c	1.63 c
V ₁ D ₁	2.13 bc	0.84 bc	1.80 bc
V ₂ D ₁	2.14 bc	0.71 bc	1.93 bc
V ₃ D ₁	2.15 bc	0.71 bc	1.89 bc
V ₁ D ₂	2.18 bc	0.76 bc	1.95 bc
V ₂ D ₂	2.24 bc	0.73 bc	2.01 b
V ₃ D ₂	2.24 bc	0.67 bc	1.89 bc
V ₁ D ₃	2.33 b	0.94 b	2.01 b
V ₂ D ₃	2.35 b	0.88 b	2.12 b
V ₃ D ₃	2.64 a	0.91 a	2.02 a

Note: Numbers in the same column followed by the same letter are not significantly different alpha level 5 % (Duncan Multiple Range Test)

CONCLUSION

The chicken manure vermicompost had the maximum available P (2.90%), the goat manure vermicompost had the highest available K, and cow manure vermicompost had the highest total N value. In terms of pH, goat manure vermicompost had the highest pH and the chicken manure vermicompost had the most excellent C/N ratio. Analysis of variance (Anova) showed that the type and dosage of vermicompost had a significant effect on growth parameters (plant height, number of leaves and stem width) and nutrient uptake of N, P and K.

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