

# Growth and Yield of Onion as Affected by Mulch Types and Vermicompost Dose

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## ABSTRACT

The productivity of shallots could be increased through environmental factors manipulation. Mulching may inhibit the growth of the weed and preserve soil moisture, causing to the improvement of plant growth. Besides, organic fertilizers such as vermicompost could be used to increase the productivity of shallots. This study intended to determine the effect of the types of mulch and the dose of vermicompost on the shallots' growth and yield. The research was carried out from October to December 2017 at the Experimental Station, Department of Crop Production, Faculty of Agriculture, The University of Bengkulu, at an altitude of  $\pm$  19 meters above sea level. The experimental design was a randomized complete block design (RCBD) with two factors. The first factor was the types of mulch, which consisted of no mulch as a control, oil palm leaf mulch, and black silver plastic mulch. The second factor was the vermicompost dose consisted of 0 ton/ha as a control, 10 and 20 ton/ha. The results showed that oil palm leaf mulch resulted in higher plant height and leaves numbers than black silver plastic mulch. The plants fertilized with vermicompost at a dose of 20 ton/ha had higher plants and more leaves than the control. It was also confirmed insignificant effect of either mulch types or compost dose on the shallot bulbs number or weight. The combination of oil palm leaf mulch and vermicompost at a dose of 20 ton/ha resulted in higher leaves number than other treatments.

**Keywords:** shallots, mulch type, vermicompost, oil palm mulch, plastic mulch.

## 1. INTRODUCTION

Both genetic and environmental factors influence plant growth and yields. Shallot (*Allium ascalonicum*) are not drought-tolerant crops because of their short root system. The plants are not resistant to saturated water during tuber growth and development [1]. The unfavorable growing environment can be manipulated with the application of mulch. Mulch prevents erosion, retains soil moisture, and inhibits weed growth [2,3,4,5]. Besides, mulch also decreases the soil temperature up to 3°C [6]. The application of mulch increased the growth of vegetable crops such as potatoes [7], chilies [8], cucumbers [3], and corn [4].

Two types of mulch are organic and inorganic. Sources of organic mulch include plant debris or other organic substances. Organic mulch type

includes the rice straw mulch, *Imperata cylindrica* mulch, rice husk mulch, and corn stem mulch [9]. Palm oil, including the fruit, stems and its waste, on the other hand, can be processed into different types of products. The production of solid and liquid waste from Indonesian palm oil processing plants has increased.

The increase in waste production is associated with the increased production of fresh fruit bunches and oil palm plantation. Oil palm biomass, such as fronds, roots, shells, mesocarp fibers and empty bunches have been used previously, but their utilization still needs to be improved. Oil palm leaves have not been used and are piled around the plant, causing the environmental problem. Oil palm waste can be used as a source of organic mulch in cultivated plants. Also, inorganic mulch has been commonly used as the similar purposes.

Several types of inorganic mulch include black, black silver, blue, and red plastic mulch [10,11,12]. Black-silver, silver, and black plastic mulches also increase the growth of potato [13]. Plastic mulch affects the growth and yield of melons [14]. Previous studies also reported that the shallots' growth and yield were higher in black silver mulch treatment than rice straw mulch and without mulch [15,16,17]. However, another study showed that mulching did not affect the growth and yield of shallots in the coastal environment [18].

Besides mulch, the application of organic amendments such as compost, vermicompost and other forms of organic matter has been commonly used to improve plant productivity [19,20,21,22,23,24]. Vermicompost is the deterioration of the organic material by earthworms [25,26]. Vermicompost contains growth hormones, including gibberellin 2.75%, cytokinins 1.05%, and auxins 3.80%, nutrients, and *Azotobacter* sp. N-fixing non-symbiotic bacterium enriching the plant's N required [27]. The application of vermicompost improves soil quality, available plant nutrients, organic matter, plant growth, and crop yield [28,29,30,31,32]. Vermicompost contained 1.1-4.0% N, 0.3-3.5% P, 0.2-2.1% K, 0.24-0.63% K, 0.3-0.63% K and 0.4-1.6% K (33,25). Study by [34] also concluded that vermicompost from dairy cattle wastes enhanced growth and yield of sweet corn.

This study's objectives were to determine the type of mulch for the growth and yield of shallot, determine vermicompost dose for the growth and yield of shallot, and determine the combination of the type of mulch and vermicompost for the growth and yield of shallot.

## 2. MATERIALS AND METHODS

The experiment was carried out in October - December 2017 at the Experimental Station Faculty of Agriculture, The University of Bengkulu, located at the altitude of approximately 19 meters above sea level. The study used a randomized complete block design (RCBD) with two factors. The first factor was the types of mulch, which were M0 (without mulch), M1 (oil palm leaf mulch), M2 (silver-black plastic mulch). The second factor was the vermicompost dose consisting of V0 (control treatment or 0 tons/ha), V10 (10 tons/ha), V20 (20 tons/ha). There were nine treatment combinations, and each combination repeated three times.

### 2.1. Land Preparation

The land was plowed to the depth of 20 cm and plots were established. The experimental plots' size was 1m x 1.2m, with a distance between plots of 50 cm and between replicates 50 cm. Vermicompost was applied one week before planting, while silver-black plastic mulch was installed at a planting date.

### 2.1. Field Experiment

Onion seeds were planted at a spacing of 20 cm x 20 cm, one seed per planting hole. Oil palm leaf mulch was inserted between the planting holes. Subsequent fertilization of urea at a dose of 0.3 g/plant, SP 36 0.22 g/plant, and KCl 0.3 g/plant was completed 10-15 days after planting (DAP). Irrigation was conducted to maintain the soil moist, and manual weeding was performed at 2 weeks after planting (WAP). Pests and diseases were chemically controlled with the active ingredient insecticide Metomil 25% in 1.5g/L dose, a fungicide with active ingredient Mankozeb 80% in 3 g/L dose, and Benlox 50% in 1.5 g/L dose. The shallots were harvested at 55 days after planting.

Observed variables included plant height, number of leaves, number of fresh tubers per plant, fresh weight of tubers per plant, and dry weight of tubers per plant. The soil temperature and precipitation during the experiment were collected from Badan Meteorologi, Klimatologi dan Geofisika (Board of Meteorology, Climatology, and Geophysics). Data were analyzed using the Analysis of Variance (ANOVA), F-test at a 5% level. Means of the treatment were separated using the LSD test at probability level of 5%.

## 3. RESULT AND DISCUSSION

The results showed that the types of mulch affected plant height at 3, 4, and 5 WAP, the number of leaves at 3 and 4 WAP, but did not affect other variables. On the other hand, the vermicompost dose affected plant height 3, 4, and 5 WAP and the number of leaves at 3 WAP. Interaction between mulch type and vermicompost dose was observed on the number of leaves at 3 WAP (Table 1).

**Table 1.** Analysis of variants of mulch types and vermicompost dose on shallot growth and yield.

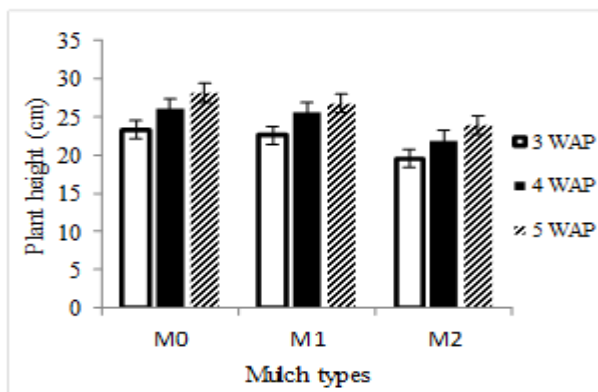
Variables	F-value			CV (%)
	Mulch	Vermicompost	Interaction	
Plant height (5 WAP)	4.81*	3.33*	1.45 <sup>ns</sup>	11.15
Leaves number (3 WAP)	11.68*	3.99*	3.32*	14.38
Leaves number (5 WAP)	0.27 <sup>ns</sup>	0.50 <sup>ns</sup>	1.47 <sup>ns</sup>	14.26
Bulb number	1.46 <sup>ns</sup>	0.67 <sup>ns</sup>	1.64 <sup>ns</sup>	11.76
Bulb fresh weight/plant	1.83 <sup>ns</sup>	2.45 <sup>ns</sup>	0.78 <sup>ns</sup>	19.94
Bulb dry weight/plant	2.59 <sup>ns</sup>	1.42 <sup>ns</sup>	0.55 <sup>ns</sup>	30.07

Note. \* = significantly different; ns = no significant different

### 3.1. Mulch Type and Vermicompost Effect on Plant Growth

Table 2 showed the combination of oil palm leaf mulch and vermicompost at a rate of 20 ton/ha produced more leaves than black-silver plastic mulch at a vermicompost dose of 10 ton/ha or without mulch with a vermicompost dose of 20 ton/ha. At a vermicompost dose of 10 tons/ha. the control treatment yielded a higher number of leaves than black silver mulch.

The treatment of oil palm leaf mulch in combination with vermicompost at dose of 20 tons/ha had the greatest plant height at 3 WAP in comparison to the other treatment combination. Black silver plastic mulch treatment yielded the lowest plant height for all dose of vermicompost. The lowest plant height was obtained from black silver mulch treatment. The plant height increased 12% in the oil



**Figure 2.** Mulch effect on plant height at 3, 4 and 5 WAP. M0: without mulch. M1: oil palm leaf mulch. M2: black silver plastic mulch.

**Table 2.** Mulch type and vermicompost effects on the number of shallots 3 WAP.

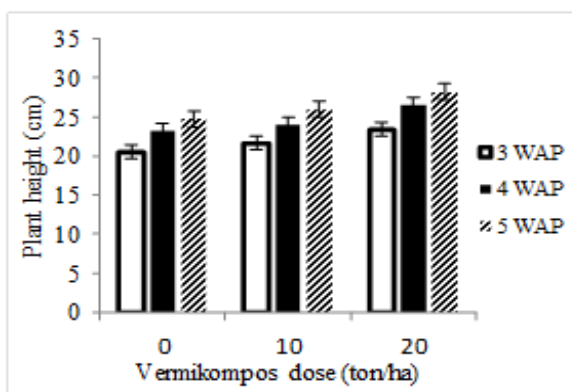
Mulch types	Vermicompost dose (ton/ha)		
	0	10	20
Control (no mulch)	9.8 bc (A)	12.2 ab (A)	10.3 bc (B)
Oil palm leaf mulch	9.13 cd (AB)	10.2 bc (AB)	13.1 a (A)
Black silver plastic mulch	7.4 d (B)	9.4 cd (B)	7.2 d (C)

Note: The same lowercase letter following the numbers at the same row designates insignificant differences. The same capital letter following the numbers at the same column indicates insignificant differences.

palm leaf mulch treatment than the black silver plastic mulch at 5 WAP. Meanwhile, those fertilized with vermicompost at a dose of 20 ton/ha. the plant height increased by 14.3% compared to control treatment (Figures 2 and 3).

There was no significant difference in vermicompost dose and the type of mulch on the leaves number at 5 WAP (Table 4). In general, the findings indicated that the black silver plastic mulch treatment produced fewer leaves than oil palm leaf mulch or without mulch. On the other hand the number of leaves was not substantially different when treated with vermicompost at a dose of 10 or 20 ton/ha (Figure5). 3.2. The influence of Mulch Type and Vermicompost on Crop Yield.

Table 5 shows no significant difference in the number of bulbs, bulbs fresh weight, or bulbs dry weight, both for non-mulching and mulching treatment or at different doses of vermicompost. 3.3.



**Figure 3.** Effect of vermicompost dose on plant height at 3, 4 and 5 WAP

**Table 3.** Mulch type and vermicompost effects on the number of leaves at 4 and 5 WAP

Treatment	Leaf number	
	4WAP	5WAP
Mulch types		
Control (no mulch)	12.8 a	12.9
Oil palm leaf mulch	13.5	13.7
Black silver plastic mulch	10.0 b	12.3
Vermikompost dose (ton/ha)		
0	10.8	17.8
10	12.7	13.5
20	12.8	13.4

Note: The same letter following the numbers at the same column indicate no significant differences at the 5% LSD test.

### 3.3. Discussion

#### 3.3.1. Interaction between mulch type and vermicompost dose on leaf number at 3 WAP.

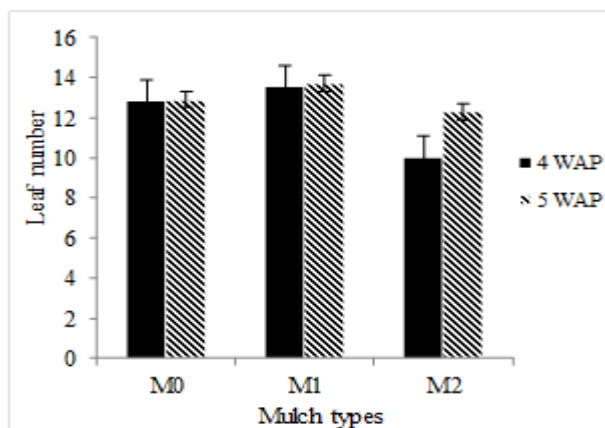
Interaction between mulch types and vermicompost dose on the number of leaves was observed at 3 WAP. Oil palm leaf mulch and vermicompost at a rate of 20 ton/ha yielded the highest number of leaves (as much as 13.1), while black plastic mulch silver with a vermicompost dose of 20 ton/ha had the least number of leaves (as much as 7.2) (Table 3).

Oil palm leaf mulch can maintain temperature and humidity around roots, and makes it suitable for plant growth. The use of mulch had a positive impact on plants due to soil temperature, soil humidity, and water availability for plant growth and nutrient translocation from roots to leaves [35]. The results indicated that vermicompost increased the number of leaves.

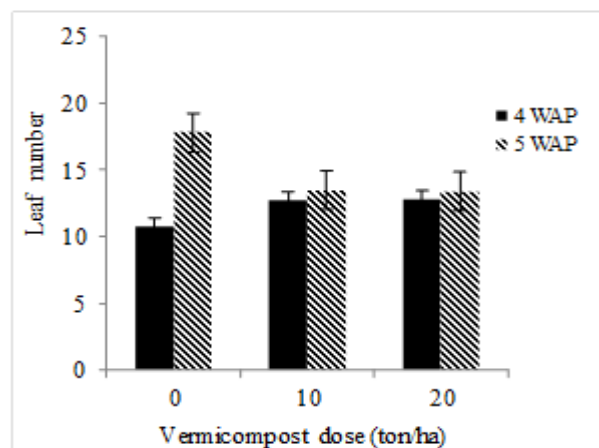
Application of vermicompost at the precise dose could increase the number of leaves due to the vermicompost content of essential plant nutrients such as N. P. K. Ca. Mg. S. Fe. Mn. Zn. Cu and B for plant growth and development. The nutrients affect the chlorophyll content of leaves and the photosynthesis process, bringing about an increase in the growth of roots, shoots, and fruit [36].

#### 3.3.2 Effect of mulch on the growth and yield of shallot.

The results indicated that except for plant height, the types of mulch treatment did not affect the number of leaves at 5 WAP and the yield shallot plants (Tables 5 and 6). Thus, manual weed control (control treatment) is effective in controlling weeds compared to the use of mulch, both oil palm leaf mulch and black silver plastic mulch.



**Figure 4.** Mulch effect on leaf number at 4 and 5 WAP. M0: without mulch. M1: oil palm leaf mulch. M2: black silver plastic mulch.



**Figure 5.** Effect of vermicompost dose on leaf number at 4 and 5 WAP

**Table 4.** Effect of mulch types and vermicompost dose on the number, fresh weight and dry weight of shallot bulbs

Treatment		Variables	
Mulch types	Bulbs number	Bulbs fresh weight (g)	Bulbs dry weight (g)
Control (no mulch)	4.8	9.2	6.1
Oil palm leaf mulch	5.4	10.0	6.8
Black silver plastic mulch	4.7	6.9	3.7
Vermikompos dose (ton/ha)			
0	4.6	6.6	4.0
10	5.3	9.8	6.6
20	5.0	9.6	6.1

In the control treatment, weeds were controlled manually so that there was no competition for nutrients between plants and weeds. As a result, nutrients are available for the growth and yield of shallots.

The increase in plant height observed at 3, 4, and 5 MST, both in the mulch treatment and the vermicompost dose. Control treatment and oil palm leaf mulch resulted in higher plant height than the silver black plastic mulch treatment. Figure 2 shows that plant height increased by 17% and 12% in the control treatment and oil palm leaf mulch than the silver black plastic mulch treatment respectively.

Figure 4 shows that palm oil leaf mulch treatment had more leaves than control. The mulch application enhances plant growth and yield. This result is in agreement with that found by [38] and [39]. Therefore, the oil palm leaf mulch can suppress the growth of weeds, maintain soil humidity, and create environmental conditions for plants' growth. Nonetheless, mulch does not affect the yields of shallots, although it affects plant height.

Table 5 shows that the mulch type has no significant effect on the yield of shallot plants. However, the number of bulbs produced by oil palm leaf mulch tended to be higher than the control treatment and black silver plastic mulch which is 5.4. This result was lower than the potential bulbs number of red onions Bima varieties, which is between 7-12. This result is primarily related to environmental condition such as high humidity and high soil temperature.

### 3.3.3. Vermicompost effect on growth and yield of shallot

Application of vermicompost at different doses only affected plant height, but did not influence the

number of leaves at 4 and 5 MST, number of tubers, and the weight of bulbs (Table 5). Higher dose of vermicompost leads to the greater plant height (Figure 3). The higher the fertilizer dose, the higher N of plants [40]. Nitrogen is an essential nutrient for plant growth, including for the development and division of cells in leaves, stems and roots. Vermicompost produced greater plant height at a dose of 20 tons / ha (28.18 cm) while in control treatment were 24.66 cm. However, the shallot variety Bima has plant height up to 44 cm.

Vermicompost does not influence the number of leaves, number of tubers, fresh weight of the plant, and dry weight of the plant. However, vermicompost fertilized plants yielded more than not fertilized plants. The leaves vary from 10.8 to 17.8. Vermicompost at a 10 ton/ ha dose produced more bulbs (5.3) and higher fresh and dry bulbs weight (9.8 and 6.6 g/plant). Nevertheless, the results are lower than potential number of leaves for Var. Bima which is 14-50 and the weight of fresh bulbs is 35-51 g/clump.

The growth and yield of vermicompost fertilized plants generally tend to be better than those not fertilized. These results show that vermicompost has a positive effect on shallot plants. However, during the study, environmental factors affected the growth of plants causing the yield of shallot yield less than its potential.

### 3.3.4. Environmental effect on the growth and yield of shallots

The high soil temperature and precipitation were among the reasons for the low yield of shallot in this study. During the study the rainfall was 359.9 mm/month, bringing about very high soil moisture and more likely to accelerate high infection of plant diseases.

In addition to high precipitation, high soil temperatures also influenced shallots' growth and yield. For the period of the study, the soil temperature averaged 36 °C. however, bulb formation of the shallot requires soil temperature between between 25-30 °C. This high temperature inhibits plants' growth and formation of bulb.

High humidity and soil temperature lead to the infection of plant diseases, including *Fusarium oxysporum* f.sp. cepae (Hanz.) Snyd. & Hans [41]. *Fusarium* wilt to develops rapidly in moist soils, high humidity, and low soil pH [42]. Symptoms of fusarium wilt disease include yellowing of the leaves, twisted leaves, and rotting roots [43].

Another reason for low yield of the shallot is low fertility of Ultisol, leading to that the plant has not reached the maximum productivity. Shallot prefer to grow well in soil with high organic matter, around neutral pH and good drainage/aeration [44].

#### 4. CONCLUSION

Oil palm leaf mulch produced higher leaves number, bulbs number, fresh and dry weight of bulbs than black silver plastic mulch. Vermicompost at dose of 20 tons/ha had greater plant height and number of leaves than that at dose of 10 tons/ha or without fertilization. The highest number of leaves was produced using oil palm leaf mulch treatment with a vermicompost dose of 20 tons/ha. Nonetheless. the result was lower than the potential yield of shallot var Bima.

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