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# Vermicompost Application on Shallot (*Allium cepa*, L.)

*Aplikasi Vermikompos pada Bawang Merah* (*Allium cepa, L.*)

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## ABSTRAK

Vermikompos merupakan pupuk organik yang mengandung unsur hara makro maupun mikro yang dibutuhkan tanaman. Penelitian ini bertujuan untuk menentukan dosis terbaik dan waktu pemberian vermikompos yang tepat pada bawang merah. Penelitian dilaksanakan di Desa Air Duku, Kecamatan Selupu Rejang, Kabupaten Rejang Lebong, Provinsi Bengkulu pada ketinggian tempat 1054 m dari atas permukaan laut (dpl). Penelitian menggunakan Rancangan Petak Terpisah dengan 3 ulangan. Petak utama adalah waktu aplikasi vermikompos yang terdiri dari 10 hari sebelum tanam dan saat tanam. Selanjutnya anak petak adalah dosis vermikompos yang terdiri dari 0, 10, 20, 30, dan 40 ton/ha. Hasil penelitian menunjukkan bahwa vermikompos yang diaplikasikan pada 10 hari sebelum tanam pada dosis 40 t/ha menghasilkan tajuk bawang merah tertinggi (36,60 cm) dan jumlah daun terbanyak (28,20 helai). Vermikompos yang diaplikasikan 10 hari sebelum tanam menghasilkan jumlah umbi bawang merah lebih banyak (4,46 umbi), diameter umbi lebih besar (19,18 mm), bobot umbi lebih berat (4,75 g), dan bobot umbi/m$^2$ lebih berat (837.73 g) dibandingkan dengan aplikasi vermikompos saat tanam. Vermikompos pada dosis 40 t/ha menghasilkan jumlah umbi per tanaman 5,80 umbi, diameter umbi 18,96 mm, bobot umbi per tanaman 4,63 g dan bobot umbi per m$^2$ 1022.25 g, lebih tinggi dibandingkan dosis yang lebih rendah.

Kata kunci: pertanian berkelanjutan, pupuk organik, waktu aplikasi vermikompos

## ABSTRACT

Vermicompost is an organic fertilizer containing essential macro and micronutrients for plant growth. This study aimed to determine the dose and time of vermicompost application to the shallot. The study was carried out at an altitude of 1054 meters above sea level in Air Duku Village, Selupu Rejang District, Rejang Lebong Regency, Bengkulu Province. A Split Plot Design with three replications was used in the study. The main plot was the time of vermicompost application, which was ten days before and during planting. Sub-plots were vermicompost doses of 0, 10, 20, 30, and 40 tons/ha. Vermicompost applied ten days before planting at a 40 ton/ha resulted in the tallest shallot shoot (36.60 cm) and the highest number of leaves (28.20). Vermicompost applied ten days before planting produced more shallot bulbs (4.46 bulbs), larger bulb diameter (19.18 mm), heavier bulb weight per clump (4.75 g), and heavier bulb weight per $m^2$ (837.73 g) than vermicompost applied at planting. Vermicompost at a dose of 40 tons/ha resulted in 5.80 bulbs per plant, 18.96 mm bulb diameter, 4.63 g bulb weight per clump, and 1022.25 g bulb weight per $m^2$, higher than the lower dose. Therefore, vermicompost could benefit as a source of plant nutrients, comparable to synthetic fertilizers in shallot production.

Keywords: sustainable agriculture, organic fertilizer, vermicompost application time

## INTRODUCTION

Shallot (*Allium cepa* L.) was an horticultural crop commonly cultivated in Indonesia. According to Azmi et al. (2016), the potential yield of shallots was between 12-15 t/ha. Improving cultural practice, particularly soil fertility management, benefits to the improvement of shallot productivity and quality. Organic matter, which enhances the soil's physical, chemical, and biological attributes and serves as a source of nutrients that support plant growth, could increase soil fertility. Fertilizer was essential to improve soil fertility.

For decades, synthetic fertilizers have been the primary source of nutrients for enhancing soil fertility. However, long-term use could severely influence the ecosystem, resulting in decreased soil quality, altered soil structure, and pollution. Organic fertilizers were commonly used as an alternative to lessen the negative impact caused by the usage of synthetic fertilizers. Organic fertilizer could address the issue of soil physical qualities by improving water holding capacity, structure, aeration, and soil drainage, rendering it for shallot growth (Anisyah et al., 2014). Vermicompost was a an organic amendment commonly used to increase plant growth (Lim et al., 2014; Barker, 2012) .

Vermicompost contains growth regulators such as gibberellins, cytokinins, auxin, nutrients N, P, K, Mg, and Ca, and non-symbiotic N-fixing bacteria Azotobacter sp. N-fixing bacteria will raise the amount of N available to plants. This solid organic fertilizer has plant micronutrients, such as Fe, Mn, Cu, Zn, Bo, and Mo. Another advantage of vermicompost was that it could improve soil water retention, provides plant nutrients, improves soil structure, and neutralizes soil pH (Lim et al., 2014). Organic fertilizer application will increase plant growth and yield.

Chicken manure at 11.05 t/ha yielded higher sweet corn than cow and goat manures, which produced 8.52 t/ha and 8.08 t/ha, respectively. The growth and yield of sweet corn fertilized with manure applied at planting, two weeks before planting, and four weeks after planting had no significant effect on sweet corn growth and yield (Nurcahaya et al., 2017). Sompotan and Raintung (2017) reported a relationship between the source of organic matter and the time of fertilizer application on the number of leaves, fresh weight of mustard, N, P, and K content of the soil, and the timing of fertilizer application affects the plant height and leaf length of mustard greens. Another study showed that organic amendment could increase plant height, the number of leaves the fresh and dry weight of mustard greens at a dose of 2 t/ha applied five days after planting (Munar et al., 2018).

According to Putri et al. (2012), the application of vermicompost increased the number of tillers and the number of shallot leaves (*Allium cepa* L.). Fatahillah (2017) also suggested that the application of vermicompost using earthworm *Lumbricus rubellus* substantially affected pepper vegetative growth, including germination, plant height, number of leaves, number of branches, and stem diameter. A study by Setiawan et al. (2015) on pakcoy revealed that the application of vermicompost increased its growth and yield while also increasing soil pH and nutrient content. This study aimed to determine the best dose, time of vermicompost application, and the combination of dose and application time for the growth and yield of shallots.

## MATERIALS AND METHODS

### Experimental Site and Design

The study was carried out from February to April 2020 in Air Duku Village, Selupu Rejang District, Rejang Lebong Regency, Bengkulu Province, at an elevation of approximately 1.054 m above sea level (3°, 27', 30.38" South Latitude and 102°. 36', 51.33" East Longitude). The study employed Split Plot Design with three replications. The main plot was the time of vermicompost application, which includes:

$V_1$: 10 days before planting (DBP)
$V_2$: at planting time

The subplot was the dose of vermicompost consisting of:

$K_0$: Control (without vermicompost)
$K_1$: 10 t/ha
$K_2$: 20 t/ha
$K_3$: 30 t/ha
$K_4$: 40 t/ha

### Land Preparation and Vermicompost Application

After clearing the weed, the land was initially prepared by establishing three blocks for replicate plots with a distance of one meter between each replication. Following that, the soil was plowed, and experimental plots of 2.5 m × 0.8 m (l x w) were constructed, with a distance of 0.5 m between subplots and 1.0 m between main plots. After the experimental plot had been prepared, the silver-black plastic mulch was installed, and planting holes were prepared. Vermicompost was applied according to the treatments, which were V1: 10 DBP, $V_2$: at planting and subplots, the dose of vermicompost consisted of $K_0$: Control (without vermicompost); $K_1$: 10 t/ha, $K_2$: 20 t/ha, $K_3$: 30 t/ha, $K_4$: 40 t/ha. Vermicompost was applied to the planting hole according to the prescribed time and amount of treatment.

### Planting and Harvesting

Shallots were planted at a 10 cm × 20 cm spacing with a population of 100 plants per plot. Irrigation was employed to keep the soil moist, perished plants were replaced with reserve seedlings, weed control was carried out two weeks after planting, and wilted plants were manually handled. Eighty-five days after planting, plants were harvested, indicated by the turned leaves and hardened stems. Ten plant subsamples were randomly selected in the middle rows. Variables included plant height (cm), number of bulbs, bulb diameter (mm), the weight of fresh bulb per clump (g), and weight of fresh bulb per plot (kg) (converted from 10 plant samples).

### Data Analysis

The data were analyzed statistically by variance (ANOVA) F test at a 5% level. If the results of the F test were significantly different, further tests were carried out using the least significant difference test (LSD).

## RESULTS AND DISCUSSION

### Analysis of Variance

The analysis of variance results revealed that the timing of vermicompost application had a significant effect on plant height, the number of leaves, bulb diameter, and bulb weight per plot but had no effect on the number of bulbs or bulb weight per clump. Furthermore, the dose of vermicompost applied significantly affected plant height, number of leaves, number of bulbs per clump, and bulb weight per plot, but not on bulb diameter or bulb weight per clump. There was an interaction between the effect of the application time and vermicompost dose on plant height and leaves number (Table 1).

**Vermicompost Application Time and Dosage Interaction Plant Height**

The results showed that applying vermicompost at different doses at 10 DBP resulted in higher shallot plant height than applying at planting (Table 2).

The results indicated that the response of plant height to vermicompost was better when applied at 10 DBP than when applied at planting. At the application of 10 DBP, increasing the dose of vermicompost was followed by better plant growth. Vermicompost at a dose of 30 to 40 t/ha, the plant height was higher (34.30 cm and 36.60 cm) than the same dose applied at planting (28.93 cm and 31.13 cm). This result might have been associated with a slow release of plant nutrients from that vermicompost, necessitating incubation time in the soil to enhance nutrient availability. Vermicompost application at 10 DBP provided soil nutrients, particularly N, P, and K, more significant than at planting, resulting in taller plants. Najafpour (2012), nutrient N was a chlorophyll-forming molecule. Increasing the amount of chlorophyll increases the rate of photosynthesis, generating the energy required by cells for cell division, enlargement, and elongation activities. According to the findings of the Anarki (2019) study, the application of vermicompost 2 DBP produced higher mustard crops than the application at planting. According to Putri et al. (2012), vermicompost could raise the height of the shallot plant.

**Leaves Number**

The findings of this study revealed that shallots were more responsive to vermicompost at a dose of 20 t/ha at 10 DBP when compared at planting, as indicated by an increase in the number of leaves, being 23.46 leaves and 15.06 leaves, respectively (Table 3).

Table 1. Analysis of variance on the observed variables

| Variables | F-Calculated | | | CV (%) |
|---|---|---|---|---|
| | Application Time | Vermicompost Dose | Interaction | |
| Plant height | 28.06* | 60.90* | 3.15* | 5.09 |
| Leaves number | 62.61* | 55.30* | 3.38* | 9.37 |
| Bulb number per clump | 13.85 ns | 40.53* | 0.63 ns | 14.76 |
| Bulb diameter | 37.10* | 0.20 ns | 1.61 ns | 6.78 |
| Bulb weight per clump | 16.33 ns | 0.23 ns | 1.43 ns | 13.87 |
| Bulb weight per plot | 115.05* | 121.83* | 0.66 ns | 8.05 |

Note : * = significantly different ns = not significantly different, CV = Coevicient Variations

Table 2. Effect of interaction time of application and dose of vermicompost on shallot plant height (cm)

| Application Time | Vermicompost Dose (t/ha) | | | | |
|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 |
| 10 DBP | 22.67 c | 30.67 b | 30.53 b | 34.30 a | 36.60 a |
| | A | A | A | A | A |
| At planting | 21.00 c | 23.20 c | 26.00 b | 28.93 a | 31.13 a |
| | A | B | B | B | B |

Note: the numbers followed by the same capital letters vertically and the same lowercase letters horizontally mean that they are not significantly different at the 5% LSD level

Table 3. Effect of interaction time of application and dose of vermicompost on shallot leaves number

| Application Time | Vermicompost Dose (t/ha) | | | | |
|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 |
| 10 DBP | 13.93 c | 17.26 c | 23.46 b | 24.73 ab | 28.20 a |
| | A | A | A | A | A |
| At planting | 12.4 c | 14.20 c | 15.06 c | 20.73 b | 26.33 a |
| | A | A | B | B | A |

Note: the numbers followed by the same capital letters vertically and the same lowercase letters horizontally mean that they are not significantly different at the 5% LSD level

A 10-day incubation before planting resulted in decomposing vermicompost, enabling more nutrients to be available to plants and generating more leaves. Vermicompost could also improve the physical and biological qualities of the soil in addition to delivering nutrients. According to Mahmudah et al. (2017), Azolla compost applied seven days before planting (DBP) resulted in taller plants (23.47cm) and more leaves (11.78 leaves) than 14 DBP, 22.43 cm, and 10.98 leaves, respectively. Azolla compost at 6 t/ha produced taller plants (24.13 cm) than the 3 t/ha (22.63 cm) and 9 t/ha (22.80 cm) treatments. Furthermore, the availability of nutrients for plants promotes plant growth, as indicated by an increase in the number of leaves. According to Bhatt et al. (2019), organic matter could improve soil fertility by preserving nutrients gradually released to plants. In addition, the number of leaves was also influenced by plant height—the taller the plant, the more leaves. Table 2 showed that the application of vermicompost at 10 DBP at a dose of 40 t/ha produced the tallest plants and more leaves. The findings of this study were consistent with Tambunan et al. (2014), and Anisyah et al. (2014) result that the higher the shallot plant, the more leaves it produces.

**The Effect of Vermicompost Application Time on Shallot Yield**

The application of vermicompost 10 DBP resulted in a greater bulb diameter (19.18 mm) and a heavier bulb weight per plot (1,675.46 g) than the application at planting (Table 4). Vermicompost applied at 10 DBP increased bulb diameter by 6.14% and bulb weight per plot by 38.75% compared to the application at planting time. Furthermore, vermicompost applied at 10 DBP resulted in more bulbs per clump and a heavier bulb weight per clump than vermicompost applied at planting.

The findings of this study showed that when vermicompost was applied at 10 DBP, nutrients were more available to plants than when applied at planting. According to Roba (2018) and Ye et al. (2020), organic fertilizers were slow-release, which implies that the nutrients in fertilizers were released slowly and continuously over some time, so nutrients were not immediately available to plants. Mahmudah et al. (2017) found that applying Azolla 7 and 10 DBP resulted in higher pakcoy growth and yields than applying it at planting. Furthermore, Aisyah et al. (2018) observed that incubating goat manure for two weeks before planting increased spinach yield.

The 10 DBP vermicompost application time allows microorganisms to carry out the decomposition process. According to Muktamar et al. 2021 and Ravendran et al. 2016, the incubation process was carried out to enable microorganisms to proliferate and metabolize to degrade organic matter content into inorganic compounds that plants will absorb. Incubation of organic fertilizers could also increase soil pH (Siregar et al., 2017), increase available P and CEC, and decrease exchangeable Al and Al saturation (Pasaribu et al., 2018). Conversely, using vermicompost during planting may result in nutrient competition between decomposing microorganisms and plants. Plants will compete for nutrients with soil microbes during the decomposition process. In the competition for nutrients, plants were more likely to lose the competition, resulting in a deficiency of nutrients because soil microbes, for their metabolism, primarily need these nutrients.

**The Effect of Vermicompost Dose on Shallot Yield**

The application of vermicompost at a dose of 40 t/ha generated the most bulbs per clump, namely 5.80 bulbs, and the heaviest bulb weight per plot was 2044.50 g, which was significantly different from other doses. The application of 0 t/ha of vermicompost resulted in the fewest bulb per clump (2 bulbs) and the lowest bulb weight per plot of 771.33 g (Table 5).

These findings suggest that applying vermicompost at 40 t/ha may supply more nutrients to plants than other doses, resulting in higher crop yields. The findings of Situmorang's (2019) research also indicated that a higher dose of vermicompost increased the yield of shallots.

Vermicompost applied to the soil as an organic fertilizer could enhance the nutrient content, particularly N. P. and K., which affect plant growth. Nitrogen was required throughout the vegetative growth phase of plants for the development of leaves, stems, and roots (Jones, 2012). Nitrogen was essential for plant organs' growth in photosynthesis, specifically leaves. Plants receiving the necessary nitrogen supply create broader leaves with higher chlorophyll content, allowing them to synthesize carbohydrates sufficiently to support their vegetative growth. Root growth also requires phosphorus. More expanded roots will allow for greater nutrient absorption, improving the rate of photosynthesis and, as a result, plant development. Phosphate was a component of the protoplasm and nucleus essential for cell production and the development of apical meristem tissue (Jones, 2012; Cummings, 2014).

Potassium has an effect as a balancer when plants have excess nitrogen and increase the synthesis and translocation of carbohydrates, thereby increasing cell wall thickness and stem strength (Hafsi et al., 2014). The increase in crop yields was correlated to the rise in available K from organic matter decomposition (Widodo & Kusuma, 2018). Potassium was essential in plant growth because it influences photosynthesis regarding chlorophyll formation and seed filling and was required for carbohydrate formation (Hafsi et al., 2014).

The application of vermicompost may also improve soil physical properties. Soil organic matter from vermicompost will eventually improve soil structure, allowing a better proportion of soil air and moisture. Humic acid from organic matter decomposition will act as a bridging agent among clays to form soil aggregates; hence, the improvement of soil structure (Kobierski et al., 2018; Zhou et al., 2019; Simansky et al., 2022). Vermicompost also provides three important phytohormones (Indole 3-acetic acid, Gibberellic acid, and Kinetin) for plant growth (Ravendran et al., 2016). The addition of vermicompost to the soil will promote microbial activity and biomass as a critical component in the nutrient cycle and the production of growth regulators, resulting in increased plant growth (Ceritoglu et al., 2018).

Table 4. Effect of vermicompost application time on shallot yield

| Application Time | Bulb per Clump | Bulb Diameter (mm) | Bulb Weight/Clump (g) | Bulb Weight/m$^2$ (g) |
|---|---|---|---|---|
| 10 DBP | 4.46 a | 19.18 a | 4.75 a | 837.73 a |
| At planting | 3.29 a | 18.07 b | 4.18 a | 603.77 b |

Note: The numbers followed by the same letter in the same variable showed no significant difference in the LSD test at the 5% level

Table 5. Effect of vermicompost dose on shallot yield

| Vermicompost Dose (t/ha) | Bulb per Clump | Bulb Diameter (mm) | Bulb Weight per Clump (g) | Bulb Weight/m$^2$ (g) |
|---|---|---|---|---|
| 0 | 2.00 d | 18.40 | 4.45 | 385.67 e |
| 10 | 2.86 c | 18.48 | 4.30 | 537.33 d |
| 20 | 4.10 b | 18.51 | 4.42 | 748.17 c |
| 30 | 4.63 b | 18.77 | 4.51 | 910.33 b |
| 40 | 5.80 a | 18.96 | 4.63 | 1022.25 a |

Note: The numbers followed by the same letter in the same variable showed no significant difference in the LSD test at a 5% level (plot size 2.5 m x 0.8 m)

## CONCLUSIONS

Shallots fertilized with vermicompost at a rate of 40 t/ha produced more bulbs and had heavier bulbs than shallots fertilized at lower rates. Vermicompost applied ten days before planting produced larger tuber diameters and heavier tuber weights than vermicompost applied at planting. Applying vermicompost ten days before planting at a dose of 40 t/ha produced the highest plants (36.60 cm) and the highest number of leaves (28.20).

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