THE EFFECT OF APPLICATION METHOD AND DOSAGE OF MANURE ON GROWTH AND YIELD OF TRUE SHALLOT SEED IN WEST SUMATERA

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Abstract*. To increase shallot productivity, it is necessary to apply true shallot seed (TSS) cultivation technology. This study aimed to determine the suitable method of application and dosage manure in increasing the bulb yield of true shallot seed. The research was conducted at the Experimental Garden of Sukarami AIAT, West Sumatera (altitude 1000 m above sea level and soil type Andosol). The research arranged using a Split Plot Design in randomized blocks, each with 3 replications. Main plot treatment (A) is a application method of manure which consists of 2 types, namely: A1 (given in a spread) and A2 (given in the planting hole). While the treatment of subplots (B) was the dosage of cow manure consisting of 6 types, namely: B1 (0 t/ha), B2 (5 t/ha), B3 (10 t/ha), B4 (15 t/ha), B5 (20 t/ha) and B6 (25 t/ha). The seeds of the Lokananta variety were six weeks after sowing, planted at a spacing of 10x10 cm, 1 seedling/planting hole, on a plot measuring 5x1 m. The results showed that there were highly significant interactions were only found in bulb weight per clump and bulb diameter. The highest dry bulb yield was obtained at a dosage of 15-25 t/ha of manure. In order to make farming activities more efficient, it is recommended to use 15 t/ha of cow manure with the application method by spreading or in planting holes in the cultivation of true shallot seed in West Sumatera.*
Keywords: *cow manure; cultivation; productivity; true shallot seed (TSS)*

1. Introduction

The area for planting shallots (*Allium ascalonicum* L.) in Indonesia has increased from year to year. During the 2014-2018 period, there was an increase of 29.89%, from 120,704 ha in 2014 to 156,799 ha in 2018. Meanwhile in West Sumatera, the increase in the area of shallot planting was even higher, at 74.95%, from 5,941 ha in 2014 to 10,394 ha in 2018 (BPS, 2016; BPS, 2019). The five largest districts in shallot cultivation are Solok, Agam, Solok Selatan, Tanah Datar, and Lima Puluh Kota, respectively, 8,879 ha, 661 ha, 400 ha, 230 ha, and 142 ha (BPS West Sumatera, 2019).

According to Atman (2021), as the space available for planting shallots grows, so does the need for high-quality seeds from bulbs, necessitating the use of true shallot seed (TSS) as an alternative. True shallot seed cultivation provides a number of advantages in addition to its high production, comprising: (1) seeds can be stored for a long time (> 1 year); (2) higher productivity than shallot cultivation from bulbs; (3) bulbs produced are more uniform, especially in shape and size; (4) the procurement of seedlings from seeds is cheaper (IDR 15 million/ha) than seedlings from bulbs (IDR 45 million/ha); (5) no seeds were found to be attacked by insects and diseases transmitted by

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seeds; and (6) planting seeds can be done at any time (Rosliani, 2015).

Several studies have shown that the application of native shallot cultivation technology can increase bulb yields to 30 t/ha (Kusumasari, *et al*., 2019), and can even cover 30-40 t/ha (Suwandi, *et al*, 2016). Basuki (2009) found that the cultivation of true shallot seed can increase bulb yields 2 times and increase net income to reach IDR 60-70 million/ha. While Sahara, *et al*. (2021) found that the productivity of shallots from seeds reached 21.09 t/ha with a profit of IDR 180 million/ha. The yield of this bulb is much higher than the productivity of shallots in Indonesia which only reached 9.5 t/ha and in West Sumatera it was 10.95 t/ha in 2018 (BPS, 2016; BPS, 2019).

However, the technology for cultivating true shallot seed has not yet developed in West Sumatera in particular and in Indonesia in general. This is owing to a scarcity of information on the technology used to grow true shallot seed (Atman, 2021). For West Sumatera, it has been recommended to use the Lokananta variety (Atman, *et al*., 2021a) with the use of cow manure in the range of 10-25 t/ha (Atman, *et al*., 2021b). Balitbangtan (2020) recommends that the application of manure for true shallot seed cultivation is 4-6 t/ha. Nationally, Suwandi, *et al*. (2016) recommend the application of 4-5 t/ha of manure. In Central Java, Kusumasari, *et al*. (2019) recommends applying 20 t/ha of manure. Meanwhile, Atman, *et al*. (2021b) found that the application of manure to the cultivation of true shallot seed will be beneficial when using manure >5 t/ha, 10-25 t/ha is recommended.

The different fertilizer recommendations for manure and the response of true shallot seed provide an opportunity to study the proper application and dosage of manure for true shallot seed in West Sumatera. This study aims at finding out the best method of application and dosage manure for boosting true shallot seed bulb yield in West Sumatera.

2. Methods

Sukarami Experimental Garden, Solok Regency, West Sumatera Province, Indonesia, was the site of the study. This study was carried out from January to June 2021. The research location has an altitude of about 1,000 m above sea level (asl). and type of soil Andosol (Hermanto and Syarifuddin, 1983). Prior to conducting the study (4 weeks before planting), soil nutrient content analysis was carried out. The nutrient content was found as follows: pH H_2O (6.16; vaguely sour), C-organic (4.45%; high), N (1.1%; very high), P_2O_5 Bray I (7.22 ppm; low), K-dd (1.02 Cmol/kg; very high), and C/N (4.04; very low) (Balai Penelitian Tanah, 2009).

The research was arranged using a split-plot design in a randomized block. The main plot treatment was the application method of manure (A), which consisted of 2 types of treatment, namely: A1 (given in a spread) and A2 (given in the planting hole). While the treatment of sub-plots was the dosage of manure (B), which consisted of 6 types, namely: B1 (0 t/ha), B2 (5 t/ha), B3 (10 t/ha), B4 (15 t/ha), B5 (20 t/ha), and B6 (25 t/ha). Each treatment was repeated 3 replications so that 36 experimental units were obtained.

The manure used is derived from mature cow manure, with nutrient content, namely: pH H_2O (9.24), N (1.62%), P (2.13%), K (1.50%), C (18.56%), and C/N (11.45). The application method and dosage of manure were adjusted according to the treatment. In the A1 treatment (given in a spread), namely: dolomite lime and SP_{36} fertilizer and cow manure, they were spread over the plots, then mixed with soil. Furthermore, the plots are covered using black silver plastic mulch (BSPM). In treatment A2 (given in planting hole), namely: dolomite lime and SP_{36} fertilizer were spread over the plots, then mixed with soil. Furthermore, the plots are closed using BSPM. Then, cow manure is given in the planting hole and covered with soil.

Application of dolomite lime base fertilizer (500 kg/ha) was given 4 weeks before planting. Three weeks before planting, cow manure was given according to the treatment and 150 kg P_2O_5/ha (417 kg SP_{36}/ha). Seedlings of the Lokananta variety which were aged 6 weeks after sowing were planted as many as 1 seedling per planting hole in a 5x1 m plot. One week before planting, the seedlings are cut by 1/3 of the leaf so that the leaf become stiff and thick.

When the shallot plants reached 15 and 30 days after planting (DAP), N fertilizer was given as a suplementary as much as 200 kg/ha (65% of Urea fertilizer and 35% of ZA fertilizer) or equivalent to 283 kg Urea/ha and 333 kg ZA/ha. Also given K fertilizer as much as 150 kg K_2O/ha (250 kg KCl/ha). The supplementary fertilizer is given ½ part of the dosage individually around the plant and covered with soil. When it comes to planting, Carbofuran 3% insecticide was applied to the planting hole. Insects and diseases control is then carried out as recommended (1x1 week to 2x1 week). Meanwhile, weeding was done 3 times, at the age of 15, 30, and 45 DAP manually. Harvesting is done by pulling the plants, then collected on the plot, then air-dried using indirect sun for a week. The characteristics of harvestable shallots are: (a) yellow leafs (about 80%); (b) most of the bulbs have appeared above the soil surface; (c) there has been the formation of a characteristic red pigment; (d) the bulbs have formed a dark red or purplish red color.

The observed variables include: (a) plant height; (b) leaf number per clump; (c) leaf number per bulb; (d) bulb number per clump; (e) bulb weight per clump; (f) weight per bulb; (g) bulb diameter; (h) bulb height; (i) wet biomass yield; (j) dry biomass yield; (k) dry bulb yield; (l) shrinkage of biomass (wet biomass yield-dry biomass yield); and (m) shrinkage of bulb (wet biomass yield-dry bulb yield). On the observed data, tabulation and analysis of variance (F test) were performed, and if significant differences were detected, Duncan's Multiple Range Test (DMRT) at the 5% level was used (Gomez and Gomez, 1984).

3. Results and Discussion

3.1. The Effect of Application Method and Manure Dosage on Growth Components, Yield Components, and Yield

Table 1 shows that there was not significant interaction between the application method and the dosage of manure on the variables of plant height, leaf number per clump, leaf number per bulb, bulb number per clump, bulb weight per clump, bulb height, wet biomass yield, dry biomass yield, shrinkage of biomass, shrinkage of bulb, and dry bulb yield. The very significant interaction of application method and the dosage of manure was only found on the variables of bulb weight per clump and bulb diameter.

Table 1. Summary of variance analysis (F test) of the effect of application method and dosage of manure on growth components, yield components, and yields of shallots from seeds.

Variables	Application method (A)	Manure dosage (B)	Inter-action (A x B)
Plant height	2.93^{ns}	2.76^{*}	1.21^{ns}
Leaf number per clump	0.90^{ns}	20.76^{**}	1.19^{ns}
Leaf number per bulb	10.64^{ns}	2.13^{ns}	1.56^{ns}
Bulb number per clump	20.14^{*}	5.65^{**}	1.22^{ns}
Bulb weight per clump	79.36^{*}	40.63^{**}	4.15^{**}
Weight per bulb	0.64^{ns}	14.65^{**}	1.47^{ns}
Bulb height	3.54^{ns}	1.07^{ns}	0.26^{ns}
Bulb diameter	0.13^{ns}	77.94^{**}	4.41^{**}
Wet biomass yield	0.30^{ns}	6.71^{**}	0.66^{ns}
Dry biomass yield	0.87^{ns}	21.86^{**}	0.80^{ns}
Shrinkage of biomass (wet biomass yield-dry biomass yield)	1.67^{ns}	14.95^{**}	0.69^{ns}
Shrinkage of bulb (wet biomass yield-dry bulb yield)	7.19^{ns}	8.31^{**}	0.89^{ns}
Dry bulb yield	4.70^{ns}	12.98^{**}	1.00^{ns}

*Note: ^{ns} not significantly different, * significantly different at the 5% level, ** significantly different at the 1% level.*

3.2. Growth Components

The results of statistical analysis showed that there was not significant interaction between the application method and dosage of manure on plant height, leaf number per clump, and leaf number per bulb. The application method of manure also had no significant effect on plant height, leaf number per clump, and leaf number per bulb. On the other hand, the dosage of manure had a significant effect on plant height and leaf number per clump. Meanwhile, the leaf number per bulb was not significantly different. In the treatment of manure dosage, plant height ranged from 47.5 to 50.5 cm. The highest plant was found at a dosage of 25 t/ha (50.5 cm) and the lowest was at a dosage of 0 t/ha (47.5 cm). Furthermore, the leaf number per clump ranged from 10.3-13.1 cm. The highest leaf number per clump was also found at a dosage of 25 t/ha (13.1 sheet) and the lowest at a dosage of 0 t/ha (10.3 sheet) (Table 2).

Table 2, it can be seen that the higher the dosage of manure given, the higher the plants and the higher the leaf number per clump. Research Atman, *et al.* (2021b) and Latarang and Syakur (2006) also got the same results. According to Limin (1993), increasing the dosage of manure will improve soil physical properties and increase macro and micro nutrients. In addition, soil C absorption also increased (Shahzad, *et al*., 2017) and soil N-total and C-organic values increased significantly (Padmanabha, *et al*., 2014).

Table 2. Effect of application method and dosage of manure on plant height, leaf number per clump, and leaf number per bulb.

Manure treatments	Plant height (cm)	Leaf number per clump (sheet)	Leaf number per bulb (sheet)
Application method (A)			
A1 (spread)	49.6 a	12.1 a	4.3 a
A2 (planting hole)	48.6 a	11.8 a	3.9 a
CV (%)	3.40	8.35	10.62
Dosage (B)			
B1 (0 t/ha)	47.5 B	10.3 B	3.8 A
B2 (5 t/ha)	48.3 B	10.6 B	3.9 A
B3 (10 t/ha)	49.4 AB	12.4 A	4.1 A
B4 (15 t/ha)	49.4 AB	12.6 A	4.2 A
B5 (20 t/ha)	49.5 AB	13.0 A	4.3 A
B6 (25 t/ha)	50.5 A	13.1 A	4.3 A
CV (%)	3.14	5.49	8.29

The numbers in the same column followed by the same uppercase or lowercase letters were not significantly different at the 5% DMRT level.

Furthermore, Table 2 also shows the significant effect of manure application on plant height and leaf number per clump compared to no manure application, which was obtained at a dosage of 10 t/ha. Research Atman, *et al.* (2021b) found a significant effect at a dosage of 5 t/ha for plant height and 10 t/ha for the leaf number per clump on true shallot seed. Meanwhile, in shallot from bulbs, Subandi and Ismiyati (2007) found a dosage of 15 t/ha had a significant effect on plant height and leaf number per clump.

3.3. Yield Components

The results of statistical analysis showed that there was no significant interaction between the application method and the dosage of manure on the bulb number per clump, weight per bulb, and bulb height. The method of application of manure also had not significant effect on weight per bulb and bulb height, while on the bulb number per clump had a significant effect. Furthermore, the dosage of manure treatment had a significant effect on the bulb number per clump and weight per bulb, while the bulb height was not significant effect. In the treatment with the application method of manure, the highest bulb number per clump was found in the application method of manure in the planting hole (3.1 piece) and the lowest in the spread method (2.8 piece). Meanwhile, the bulb number per clump in the treatment dosage of manure ranged from 2.7 to 3.1 pieces and the weight per bulb ranged from 3.43 to 5.35 g. The highest number of bulb per clump was found at a dosage of 10-25 t/ha (3.1 piece) and the lowest at a dosage of 0 t/ha (2.7 piece). The highest weight per bulb was also found at a dosage of 25 t/ha (5.35 g) and the lowest at a dosage of 0 t/ha (3.43 g) (Table 3).

Table 3. Effect of application method and dosage of manure on bulb number per clump, weight per bulb, and bulb height.

Manure treatments	Bulb number per clump (piece)	Weight per bulb (g)	Bulb height (cm)
Application method (A)			
A1 (spread)	2.8 a	4.41 a	23.5 a
A2 (planting hole)	3.1 b	4.45 a	23.1 a
CV (%)	6.38	11.18	2.55
Dosage (B)			
B1 (0 t/ha)	2.7 B	3.43 C	22.5 A
B2 (5 t/ha)	2.8 B	3.85 C	23.2 A
B3 (10 t/ha)	3.1 A	4.47 B	23.1 A
B4 (15 t/ha)	3.1 A	4.90 AB	22.7 A
B5 (20 t/ha)	3.1 A	4.83 AB	24.1 A
B6 (25 t/ha)	3.1 A	5.35 A	24.2 A
CV (%)	5.93	10.22	7.25

The numbers in the same column followed by the same uppercase or lowercase letters were insignificantly different at the 5% DMRT level.

In Table 3, it can be seen that the increase in the bulb number per clump and weight per bulb due to the application of manure ranged from 3.7-14.8% and 12.2-55.9%, respectively. The significant effect of manure application on the bulb number per clump was seen at a dosage of 10 t/ha, while on the weight per bulb at a dosage of 15 t/ha. There was a tendency that the more manure was applied, the bulb number per clump and weight per bulb also increased. This is due to the application of manure can increase the levels of humus and nutrients in the soil. According to Sarief (1993), the application of manure has an effect on changes in the physical, chemical, and biological properties of the soil, and contains macro and micro nutrients so that the more manure is given, the higher its availability for plants.

The significant interaction between the application method and the dosage of manure treatment was only found in bulb weight per clump and bulb diameter. Bulb weight per clump in the spreading application treatment ranged from 8.8 g to 15.7 g, the highest at a dosage of 25 t/ha (15.7 g) and the lowest at a dosage of 0 t/ha (8.8 g). While the treatment in the planting hole ranged from 9.8 g to 16.7 g, the highest at a dosage of 25 t/ha (16.7 g) and the lowest at a dosage of 0-5 t/ha (9.8 g). Furthermore, the bulb diameter in the spread application treatment ranged from 18.2 mm to 23.9 mm, the largest at a dosage of 20-25 t/ha (23.9 mm) and the smallest at a dosage of 0 t/ha (18.2 mm). While the treatment in the planting hole ranged from 18.5 mm to 24.0 mm, the largest at a dosage of 25 t/ha (24.0 mm) and the smallest at a dosage of 0 t/ha (18.5 mm) (Table 4).

Table 4 also shows that the increase in bulb weight per clump ranged from 26.1-78.4% in the spreading application and 0.0-70.4% in the planting hole application. Meanwhile, the bulb diameter increased from 14.3-31.3% in the spreading application and 0.5-29.7% in the planting hole application. There is a tendency that increasing the application of manure can increase the bulb weight per clump and increase the bulb diameter both in the treatment of manure that is given in a spread or in the planting hole. Increasing the application of manure can increase the bulb diameter of true shallot seeds (Atman, *et al*., 2021b) and increase the bulb weight per clump of shallots from bulbs (Latarang and Syakur, 2006).

Table 4. Interaction of application method and dosage of manure on bulb weight per clump and bulb diameter.

Manure dosage (B)	Application method (A)			
	Spread (A1)		Planting hole (A2)	
	Bulb weight per clump (g)			
B1 (0 t/ha)	8.8	d	9.8	c
B2 (5 t/ha)	11.1	c	9.8	c
B3 (10 t/ha)	12.1	bc	14.7	b
B4 (15 t/ha)	13.3	b	16.4	ab
B5 (20 t/ha)	13.3	b	16.5	ab
B6 (25 t/ha)	15.7	a	16.7	a
CV (%) = 7.97				
	Bulb diameter (mm)			
B1 (0 t/ha)	18.2	d	18.5	c
B2 (5 t/ha)	20.8	c	18.6	c
B3 (10 t/ha)	21.4	c	22.1	b
B4 (15 t/ha)	22.6	b	23.4	a
B5 (20 t/ha)	23.9	a	23.7	a
B6 (25 t/ha)	23.9	a	24.0	a
CV (%) = 2.92				

The numbers in each of the same variables and columns followed by the same letters were insignificantly different at the 5% DMRT level.

3.4. Yield

The statistical analysis results showed that there was not significant interaction between the application method and dosage of manure on the wet yield biomass, dry yield biomass, shrinkage of biomass, shrinkage of bulb, and dry bulb yield. The insignificant effect was also seen in the treatment of manure application method. On the other hand, the dosage of manure had a significant effect. In the treatment dosage of manure, the wet biomass yield ranged from 14,892-16,851 kg/ha, dry biomass yield ranged from 8,632-11,293 kg/ha, shrinkage of biomass ranged from 32.97-42.04%, shrinkage of bulb ranged from 47.54-60.70%, and the dry bulb yield ranged from 5,856-8,838 kg/ha. The highest wet biomass yield was at a dosage of 25 t/ha (16,851 kg/ha) and the lowest was at a dosage of 0 t/ha (14,892 kg/ha), the highest dry biomass yield at a dosage of 25 t/ha (11,293 kg/ha) and the lowest was at dosage of 0 t/ha (8,632 kg/ha), and the highest dry bulb yield was at a dosage of 25 t/ha (8,838 kg/ha) and the lowest was at a dosage of 0 t/ha (5,856 kg/ha). On the other hand, the highest shrinkage of biomass was at a dosage of 0 t/ha (42.04%) and the lowest was at a dosage of 25 t/ha (32.97%) and the highest shrinkage of bulb was also at a dosage of 0 t/ha (60.70%) and the lowest was at a dosage of 25 t/ha (47.54%) (Table 5).

In Table 5 it can also be seen that the application of manure can increase the wet biomass yield, dry biomass yield, and dry bulb yield in the range of 5.4-13.2%, 6.0-30.8%, and 9.8-50.9%, respectively. On the other hand, the application of manure can reduce the percentage shrinkage of biomass and bulb in the range of 0.8-21.6% and 2.8-21.7%, respectively. The significant effect of manure application was seen at a dosage of 10 t/ha on the wet biomass yield, dry biomass yield, and biomass and dry bulb yield shrinkage. While on shrinkage of bulb, the significant effect was seen at a dosage of 15 t/ha.

Table 5. Effect of application method and dosage of manure on wet biomass yield, dry biomass yield, biomass bulb shrinkage, and dry bulb yield.

Manure treatments	Wet biomass yield (kg/ha)	Dry biomass yield (kg/ha)	Shrinkage (%)		Dry bulb yield (kg/ha)
			Biomass	Bulb	
Application method (A)					
A1 (spread)	16,054 a	10,052 a	37.50 a	56.06 a	7,070 a
A2 (planting hole)	16,118 a	10,207 a	36.83 a	52.77 a	7,657 a
CV (%)	2.19	4.92	4.21	6.76	11.03
Dosage (B)					
B1 (0 t/ha)	14,892 C	8,632 C	42.04 A	60.70 A	5,856 D
B2 (5 t/ha)	15,696 BC	9,151 C	41.71 A	58.99 A	6,432 CD
B3 (10 t/ha)	16,120 AB	9,910 B	38.52 B	56.61 AB	7,006 BC
B4 (15 t/ha)	16,312 AB	10,642 A	34.73 C	51.58 BC	7,899 AB
B5 (20 t/ha)	16,647 A	11,151 A	33.01 C	51.06 C	8,151 A
B6 (25 t/ha)	16,851 A	11,293 A	32.97 C	47.54 C	8,838 A
CV (%)	4.18	5.62	7.16	8.02	10.40

The numbers in the same column followed by the same uppercase or lowercase letters were insignificantly different at the 5% DMRT level.

Meanwhile, the best dosage of manure in reducing shrinkage of biomass and shrinkage of bulb was 15-25 t/ha. Meanwhile, to increase the wet biomass yield in the range of 10-25 t/ha, and dry biomass yield and dry bulb yield ranged from 15-25 t/ha. The same results were obtained in the research of Latarang and Syakur (2006) on shallot from bulbs. Santoso (2018) received a dosage of 15 t/ha to increase the dry bulb yield on shallot from bulbs. While Atman *et al*. (2021b) obtained a dosage of 10-25 t/ha on true shallot seed. The increase in dry bulb yield in this study was due to the application of manure to increase the growth and yield components, as well as reduce shrinkage of bulb.

Furthermore, it was generally seen that the application method of manure had not significant effect on all observed variables, except for the bulb number per clump and bulb weight per clump. This is because the narrow spacing (10x10 cm) causes the distribution of manure in the soil to be relatively the same so that the impact on soil fertility is also the same, especially the C-organic content of the soil. C-organic is a functional part of organic matter that plays a role in determining soil fertility and productivity through its influence on physical, chemical, and biological properties of the soil. According to Islam (2006), productive soil requires organic matter content ranging from 2.5-3.0%. Meanwhile, Lal (1994) stated that the soil has a good productivity when the organic matter content ranges from 8-16% or C-organic 4.56-9.12%.

4. Conclusions

It was found that there was a highly significant interaction between the application method and the dosage of manure on true shallot seed on the bulb weight per clump and bulb diameter. The treatment of manure application method only had a significant effect on the bulb number per clump. Except for the leaf number per bulb and bulb height, the manure dosage treatment had a significant to highly significant effect on other variables.

The suitable dosage of manure in increasing the dry bulb yield of true shallot seed ranges 15-25 t/ha which is given in a spread or in planting holes. This is due to the increase in the value of the growth components and yield components. On the other hand, there was a decrease in shrinkage of biomass and shrinkage of bulb. However, in order to make farming activities more efficient, it is recommended to use 15 t/ha of cow manure with the application method by spreading or in planting holes in the true shallot seed cultivation in West Sumatera, Indonesia.

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