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Yield Potential of Shallots Bulbil Planting Materials with Liquid Organic Fertilizer Treatment out of Season

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ABSTRACT

The main problem with shallots in Indonesia is planting material. The use of consumption tubers as planting material is very high. Efforts are needed to replace consumption tuber planting material with other planting materials such as aerial tubers. This study examines the potential yield of aerial tuber planting material and consumption tuber with fertilization treatment. The study used a Completely Randomized Block Design with a split-plot pattern with two factors, namely: fertilizer (as the main plot) with two levels, namely: with liquid and chemical fertilizer. Types of planting material (as a subplot) with three levels, namely aerial tubers, large consumption tubers (1.93-2.05 cm) and small consumption tubers (1.04-1.29 cm). Repeat three times. Liquid organic fertilizer can be used to improve the chemical quality of the soil. The combination of bulbils planting material with chemical fertilizer resulted in the highest fresh weight of bulbs per plot and dry weight of bulbs per plot, namely 394.67 grams and 338.67 grams, respectively. However, the highest number of bulbs planted in the treatment of large consumption bulbs was 7 bulbs. The diameter of bulbs produced from bulbils planting material and bulb consumption was the same. Shallot bulbs have potential as planting material.

1. INTRODUCTION

Shallots (*Allium cepa* L. Aggregatum) is one of the most important horticultural productions for Indonesia. This is because shallots contain high levels of glutamic acid, arginine, and aspartic acid [1]. Based on the Central Bureau of Statistics, the production of shallots in Indonesia in 2020 was 1,815,445 tons, an increase of 12% compared to 2019, only 1,580,247 tons [2]. However, the per capita consumption of shallots during the 2002-2021 period also showed an increase with an average growth rate of 2.33% per year from year to year [3]. Total consumption is 1,086,029 tons/year and 10% of shallot consumption is used as planting material. The use of consumption tubers as planting material is inefficient and requires high planting material, namely in 1 hectare of land it requires 1.2-1.3 tons/ha which is equivalent to farming costs of 30-40%. Indonesian farmers use consumption tubers as planting material because the use of shallot botanical seeds as planting material is still difficult in Indonesia. Shallots are long days that require more than 12 hours of sunlight to flower and produce seeds [4]. The use of consumption as planting material can promote diseases caused by pathogens such as viruses, fungi, bacteria, and nematodes [5].

Planting material as the key to success in shallot cultivation. One technique to eliminate viral diseases and improve productivity in shallots is to use bulb planting material, commonly known as bulbils [6]. Bulbils can also be formed from injured plant parts due to impaired assimilate translocation [7]. Bulbils are vegetative parts that can be used for the benefit of seeds. Based on Triharyanto et al. [8] shallots can produce bulbils with various treatments, namely stem injury, vernalization, and gibberellin application. The results of research by Sumarni et al. [9] that bulbs in shallot can be used as planting material.

The problem in tuber research is that it is vulnerable to the environment, such as soil, temperature and rainfall [10]. Climate and soil conditions such as rainfall, humidity, soil air and temperature can affect plant growth and the risk of shallot farming [11]. Shallot production can be done by increasing the application of effective fertilization technology. Based on the results of research by Hantari et al. [12], the composition of chemical fertilization and gibberellins can increase the growth of shallots. However, the extensive use of chemical fertilizers causes serious collateral problems such as environmental pollution, pest resistance and decreased food safety [13]. Long-term fertilization causes ammonium-nitrogen (NH_4^+) and phosphorus residues available in excess in the soil, including the NH_4^+ structure, which results in soil acidification and changes in the bacterial community, while available phosphorus reduces fungal diversity [14]. Combining chemical fertilizers with organic fertilizers is one of the effective fertilization efforts to increase crop yields and soil quality [15]. Several studies have been carried out that liquid organic fertilizer can support the growth and production of shallots [16-20]. Liquid organic fertilizer coconut husk waste dose of 1000 L ha^{-1} can increase plant height, number of leaves per plant, number of tillers, and yield of shallot bulbs [21]. However, the study of the potential yield of some shallot planting materials with fertilization treatment has not been carried out. This study aims to examine the role of the combination of shallot planting materials with fertilization on shallot yield and soil quality.

2. MATERIALS AND METHODS

The research was carried out in Ngringo Village, Jaten District, Karanganyar Regency, namely at 07º 33' 009 "East Longitude and 110º 52' 136" South latitude with an altitude of 91 meters above sea level with alluvial soil types. The study was carried out outside the shallot growing season, namely February-May 2021. The research location had an average temperature of 31.88, an average rainfall of 970 mm/month and the number of rainy days was 22 days. The materials used were shallot consumption of the Bima Brebes variety with small sizes, large sizes, and bulbils, liquid organic fertilizer, chemical fertilizers (compound fertilizer namely nitrogen, phosphate and potassium fertilizer, SP36, and KCl). Liquid organic fertilizer is made with pineapple, green bean sprouts, tempeh, coconut water, molasses and Saccharomyces sp. The study used a Completely Randomized Block Design with a split-plot pattern with two factors, namely: fertilizer (as the main plot) with two levels, namely: with liquid fertilizer (the first fertilization dose was 30 $L.ha^{-1}$, the second and third fertilization doses were 16 L.ha-1), and chemical fertilizer (the first fertilization was nitrogen, phosphate and potassium fertilizer 500 kg.ha-1, SP36 50 $kg.ha^{-1}$, KCL 30 $kg.ha^{-1}$ and second and third fertilization was urea 180 kg.ha-1). Types of planting material (as a subplot) with three levels, namely bulbils, large consumption tubers (sizes 1.93-2.05 cm) and small consumption tubers (sizes 1.04-1.29 cm). This research used three replications.

Planting was carried out by making plots, with each plot containing 30 plants. The plant spacing used was 20x20 cm. The variables observed were initial soil analysis, final soil analysis and shallot yield variables which included: number of bulbs, the weight of bulbs planted, the weight of dry bulbs planted, the weight of bulbs per plot, weight of dry bulbs per plot and bulbs diameter. Soil nitrogen analysis was carried out using the Kjeldahl method. Elemental Phosphate in the soil by wet ashing method using a mixture of concentrated acid HNO3 and $HClO_4$ (Soil Research Institute, 2005) and measured using a spectrophotometer. Potassium by wet ashing with HNO_3 and $HClO_4$ and measured with a flame photometer. Data processing using SPSS (Statistical Product and Service Solution) version 16.0. The research data were analyzed using analysis of variance based on the F test with a test level of 5% (95% confidence level). If it has a significant effect, further analysis is carried out using Duncan's Multiple Range Test (DMRT) at the 5% level.

3. RESULTS AND DISCUSSION

3.1 Soil chemical analysis

Based on the analysis results, it was shown that the initial soil in the research area had 1.39% organic C, 2.39% organic matter, 0.17% total Nitrogen, 7.07 ppm available Phosphate and 0.24 me% exchanged Photassium (Table 1). The final soil with liquid organic fertilizer treatment was 2.12% organic C, 3.65% organic matter, 0.21% total Nitrogen, 11.94 ppm available Phosphate and 0.28 me% exchanged Photassium. The results showed that liquid organic fertilizer with the basic ingredients of pineapple, green bean sprouts, tempeh, coconut water, molasses and *Saccharomyces* sp. can improve soil chemical quality. These results are supported by the content of liquid organic fertilizer containing total Nitrogen (0.21%), total Phosphate (0.015%), total Photassium (1.08%), organic material (5.89%), C-organik (3.43%) and C/N ratio (16.41) [22]. Organic fertilizers help maintain a stable NO_3-N content and increase the population of soil microorganisms such as actinomycetes (Lee 2010). This shows that liquid organic fertilizer can preserve soil and plant health because it can increase nutrient use efficiency and reduce the risk of nutrient loss [21].

Chemical fertilizer treatment produced 2.18% organic C, 3.76% organic matter, 0.22% total Nitrogen, 12.71 ppm available Phosphate and 0.29 me% exchanged Photassium. This shows that liquid organic fertilizer has a comparable effect with chemical fertilizers soil quality. In addition, it is an environmentally friendly effort because it utilizes and recycles waste products effectively and serves as a rich source of nutrients for soil and plants [23]. However, the chemical properties of the final soil in the treatment of liquid organic fertilizers were lower than those with chemical fertilizers. This is because liquid organic fertilizers have slow-release properties and can be considered an environmentally friendly solution to avoid chemical pollution, especially by leaching or evaporating nutrients as occurs when chemical fertilizers [24].

Table 1. Results of initial and final soil chemical analysis

Code	Initial soil	Final Soil Liquid fertilizer application	Final Soil Chemical Fertilizer Application
C-Organic	1.39%	2.12%	2.18%
Organic material	2.39%	3.65%	3.76%
Nitrogen total	0.17%	0.21%	0.22%
phosphate available	7.07 ppm	11.94 ppm	12.71 ppm
Exchanged potassium	0.24 me%	0.28 me%	0.29 me%
Exchanged Sodium	0.42 me%	0.48 me%	0.52 me%
Exchanged Calcium	1.56 me%	1.66 me%	1.85 me%
Exchanged maghnesium	0.36 me%	0.49 me%	0.52 me%
pH	6.34	6.63	6.69

Source: Soil analysis results

3.2 Potential yield of shallot planting material with fertilization treatment

The results showed that the combination of bulbils with chemical fertilizers resulted in the highest bulb weight per plot, which was 394.67 g (Table 2). The results were significantly different from the treatment of large consumption bulbs with chemical fertilizers. This proves that the yield potential of shallots can be increased by using bulbils as planting material. Bulbils planting material is a planting material that is not contaminated with viruses and bacteria so that it can produce high yields. In addition, to support the production of bulbils, appropriate fertilization is needed. Chemical fertilization can increase the yield of plots of bulb weight because special compounds in chemistry such as chitin, humic and fulvic acids, as well as other biopolymers, can be biostimulants for plant [25, 26]. Based on a single factor, fertilization significantly affected tuber weight per plot (Table 2). The application of chemical fertilizers showed an increase of 68% compared to liquid organic fertilizers. This is because liquid organic fertilizer is slow-release, and nutrients absorbed by plants encourage plant growth [27, 28].

Table 2. Effect of combination treatment of planting material and fertilization on bulbs weight per plot (g)

Fertilization	Planting material			Average
	Bulbils	Large consumption bulbs	Small size consumption bulbs	
Liquid organic fertilizer	169.33 a	186.67 a	164.00 a	173.33 a
Chemical fertilizer	394.67 c	292.33 b	190.33 a	292.44 b
Average	282.00 b	239.50 ab	177.17 a	

Note: numbers followed by the same letter in the same column and row are not significantly different based on DMRT (α= 0.05).

Dried shallot bulbs with a moisture content of 25-30%. Based on the study results, the combination of bulbils planting material with chemical fertilizers resulted in the highest dry bulbs weight, which was 338.67 g (Table 3). However, the dry weight of the bulbs was reduced by 196% in the combination of bulbil treatment with liquid organic fertilizer compared to the combination of bulbil with chemical fertilizer. This is because there is a slow mineralization rate in the use of organic fertilizers so that crop yields on land given organic fertilizers are lower than those shown chemical fertilizers [29]. Therefore, the application of organic fertilizers in the form of liquid organic fertilizers during the growing season has been evaluated [30-32]. Liquid organic fertilizer if used regularly, can increase the content of microbial carbon biomass, nitrogen, phosphate, and fungal ergosterol in the soil and CO_2 production [33].

Table 3. Effect of combination treatment of planting material and fertilization on dry weight of bulbs per plot (g)

Fertilization	Planting material			Average
	Bulbils	Large consumption bulbs	Small size consumption bulbs	
Liquid organic fertilizer	114.33 a	156.00 ab	142.33 a	137.56 a
Chemical fertilizer	338.67 c	240.67 b	154.67 ab	244.67 b
Average	226.50 b	198.33 ab	148.50 a	

Note: numbers followed by the same letter in the same column and row are not significantly different based on DMRT (α= 0.05).

The results showed that planting material significantly affected the number of bulbs planted (Table 4). Planting material for large consumption bulbs showed the highest number of bulbs planted, namely seven bulbs. The number of bulbs was reduced by 17% with the use of bulbil when compared to large consumption bulbs. The difference in bulbs between bulbil and large consumption bulbs is caused by bulbs morphology [34]. However, the number of bulbs produced from bulbils planting material was not significantly different from small bulbs. These results indicate that bulbils have yield potential that can be used to replace consumption bulbs. Bulbs produced from bulbil planting material are free from viruses, although the size of the garlic depends on the time of planting and the size of the planting material. The chemical composition of garlic from bulbils, such as the concentration of protein, carbohydrates, fats, polyphenolic compounds, and antioxidant activity, is very high [35].

Table 4. Effect of combination of planting material and fertilization on the number of bulbs planted

Fertilization	Planting material			Average
	Bulbils	Large consumption bulbs	Small size consumption bulbs	
Liquid organic fertilizer	5.67	7.33	5.00	6.00
Chemical fertilizer	6.20	6.67	5.20	6.02
Average	5.93 a	7.00 b	5.10 a	

Note: numbers followed by the same letter in the same column and row are not significantly different based on DMRT (α= 0.05).

The results showed that fertilization had a significant effect on the diameter of the bulbs produced (Table 5). Fertilization with chemical fertilizers produced bulbs with the highest diameter of 2.189 cm. The bulb diameter was reduced by 29% with the treatment of liquid organic fertilizer. The study results do not align with Zewde et al. [36], namely the combination of liquid organic fertilizer with chemical fertilizers can increase bulb yield and bulb diameter. This is because organic fertilizers are slow release, so they need to be balanced with chemical fertilizers. The diameter of bulbs produced from bulbil planting material was not significantly different from other planting materials. These results indicate that bulbils have the same bulb yield potential as consumption bulbs. The research results by Triharyanto et al. [37] that garlic bulbs can be used as planting material with a diameter of bulbs produced of 2.60 cm were not significantly different from the diameter of consumption bulbs.

Table 5. Effect of combination of planting material and fertilization on bulb diameter (cm)

Fertilization	Planting material			Average
	Bulbils	Large consumption bulbs	Small size consumption bulbs	
Liquid organic fertilizer	1.61	1.75	1.72	1.70 a
Chemical fertilizer	2.23	2.14	2.20	2.19 b
Average	1.92	1.95	1.96	

Note: numbers followed by the same letter in the same column and row are not significantly different based on DMRT (α= 0.05).

4. CONCLUSIONS

Liquid organic fertilizer can be used to improve the chemical quality of the soil. The combination of bulbils planting material with chemical fertilizer resulted in the highest fresh weight of bulbs per plot and dry weight of bulbs per plot, namely 394.67 grams and 338.67 grams, respectively. However, the highest number of bulbs planted in the treatment of large consumption bulbs was 7 bulbs. The diameter of bulbs produced from bulbils planting material and bulb consumption was the same. Shallot bulbs have potential as planting material.

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