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Growth and yield of Shallot (*Allium cepa* L.) in respons of organic fertilizers and *Trichoderma asperellum*

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Abstract. Increased shallot yield with aplication of organic fertilizer. Cajeput waste as a source of organic fertilizer is very abundant in Ponorogo. Research aimed to study the aplication of organic fertilizers and *Trichoderma asperellum* to incerase growth and yield of shallot. The experiment was laid-out in factorial randomized completely design with 3 replications and eight treatment combinations. The first factors is organic fertilizer (without organic fertilizer; 6 ton ha^{-1} of cajeput waste compost, 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure, 6 ton ha^{-1} of rabbit manure). The second factors is *Trichoderma asperellum* (without *T. asperellum* and 1 L ha^{-1} of *T. asperellum*). The results of this study showed that treatmen of 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure without *Trichoderma asperellum* increased plant hight and leaf dry weight of shallot by 25% and 135,66%. The application of combination rabbit manure and without *T. asperellum* increased shallot tillering number by 9,67 tillering. The application of 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure increased shallot yield and diameter of shallot bulbs.

1. Introduction

Shallot production in Indonesia from 2016 to 2020 extimated to increase [1]. Chemical fertilizers are generally used excessively by farmers to increase the yield of shallot. Excessive use of chemicl fertilizers exceeds the recommendations causing accumulation of fertilizer mineral salts which causes soil degradation. Significant soil degradation affects soil structure and nutrient uptake [2]. That it has an impact on soil health and shallot productifity in the next growing season.

Long-term use of chemical fertilizers and pesticides will reduce the potential for land production and increase the toxic effects on crop yields [3]. Reducing the dependence of chemical inputs in agriculture is very important with increasing the utilization of organic fertilizers and beneficial microorganisms. The use of beneficial microorganisms that are applied as biofertilizers and/or biocontrol agents is an important tool for controlling plant diseases and reduction of chemical fertilizers [4]. Fungi as biofertilizers have the potential to significantly increase shallot yield [5].

The application of organic fertilizers 20 ton ha^{-1} can reduce 50% the dose of anorganic fertilizers [6] Cajeput (*Melaleuca leucadendron*) waste has the potential to be used as raw material for organic fertilizer. A Significant increase in soybean production with application of cajeput waste compost [7]. The amount of nutrients in the cajeput waste compost is small so it needs to be combined with other sources of organic matter such as rabbit manure. Rabbit manure can increase yield of barley (*Hordeum vulgare*) [8]. The organic manure from rabbit manure mixed with rice straw helps seed growth [9].
There are many reports that *Trichoderma sp*. as biofertilizer increases crop yields such as wheat (*Triticum aestivum*)[10], Rice (*Oriza sativa* L.) [11], Sugarcane (*Saccharum officinarum* L.) [12], Mustard (*Brassica rapa* L.) and Tomato (*Solanum lycopersicon* Mill.) [13].

This research was undertaken to determine the effect of cajeput waste compost as organic fertilizer and *T. asperellum* as biofertilizer on growth and yield of shallot. The application of organic fertilizer from cajeput waste compost and *T. Asperellum* was expected to provide information in increasing the effectiveness of shallot fertilization

2. Materials and Methods

The experiment was conducted in Greenhouse, Agrotechnology Department, University of Darussalam Gontor, Ponorogo, Indonesia from Mei 2019 to July 2019.

2.1 Material

The tool used in research are : polybag, calipers, analytic scales, centimeter rulers, scissors, oven. The materials used in the study are : cajeput waste compost, rabbit manure, *Trichoderma asperellum*, soil, NPK fertilizer (15-15-15), Bauji variety of shallot.

2.2 Research Experimental Design

The experiment was laid-out in factorial randomized completely design with 3 replications and eight treatment combinations. The first factors is organic fertilizer with 4 kinds of organic fertilizer (K0 = without organic fertilizer; K1 = 6 ton ha^{-1} of cajeput waste compost; K2 = 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure; K3 = 6 ton ha^{-1} of rabbit manure). The second factors is *Trichoderma asperellum* with 2 levels (T0 = without *T. asperellum*; T1 = 1 L ha^{-1} of *T. asperellum*).

2.3 Methodology

2.3.1 *Prosedure*. Soil as a growing medium was put into polybags as much as 3 kg per polybag. The fresh bulb was hand planted at polybags with one bulb per polybag. The polybags was irrigated every day. NPK fertilizer (15-15-15) of 150 kg ha^{-1} was applied at two days before planting. Bulbs are harvested at 85 days after planting. In organic fertilizer application, we applied 6 ton ha^{-1} of cajeput waste compost (K1); 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure (K2); and 6 ton ha^{-1} of rabbit manure (K3) 7 days before planting by mixing organic fertilizer with soil. In *T. Asperellum* application, we applied 1 L ha^{-1} at 1 day after planting,

2.3.2 *Observations*. The data of growth parameters recorded include : plant hight, leaves dry weight per plant, and number of tillers per plant. Plant hight is measured when the shallot crops are in a state of maximum height. That is at the age of one month after planting by extending from ground level to tip of longest leaf (when held vertically). Leaves dry weight was weighed leaf from leaf until leaf sheath after harvesting. The leaf was dried in oven then weigh it. The number of tillers were counted at one month after planting.
The date of yield parameters recorded consist of wet weight of bulbs per plant and bulbs diameter per plant. The bulb separated from each polybag was weighed of bulb yield per plant. The bulb after harvest was measured bulb diameter using calipers.
2.3.3 *Data Analysis*. Obsevational data were statically analyzed using the analysis of variance procedure to assess the differences of treatmen. Test the significant differences among treatment means using Least Significance Different Test.

3. Results

This study evaluated the effect of cajeput waste compost as organic fertilizer and *T. asperellum* as biofertilifer on growth and yield of shallot. According to table 1, there was a significant difference among treatment combinations on observations of plant height, dry weight of leaves, and number of tillers. Treatment combination of cajeput waste compost + rabbit manure without *T. Asperellum* was produced plant hight of 40 cm that heighest and significantly different than the other treatment combinations. Treatment combination of cajeput waste compost + rabbit manure without *T. Asperellum* was produced dry weight of leaves of 3.37 g that heighest and no significantly different than the other treatment combinations as treatment combination of *T. Asperellum* without organic fertilizer (2.67 g), treatment combination of cajeput waste compost with T. Asperellum (2.48 g), and treatment combination of rabbit manure without *T. Asperellum* (2.38 g). The highest number of tillers was treatment combination of rabbit manure without T. Asperellum (9.67 tillers), however not significanly different from treatmen combinaton of cajeput waste compost without *T. Asperellum* (8.67 tillers).

Table 1. Effect of treatment combinations on growth performance of shallot in term of measured values and standart errors

Treatment Combinations	Plant Height (cm)	Dray Weight of Leaves (g)	Number of Tillers (tillers)
K0T0	32.00 ±1.00 a	1.43±0.96 a	6.75±0.90 a
K0T1	35.67±2.51 b	2.67±0.34 bc	7.25±0.25 a
K1T0	32.00±1.00 a	2.05±0.59 ab	8.67±1.04 bc
K1T1	37.00±1.00 b	2.48±0.65 abc	7.00±0.25 a
K2T0	40.00±1.00 c	3.37±1.42 c	7.83±1.25 ab
K2T1	36.00±2.00 b	2.30±0.50 a	6.50±0.91 a
K3T0	30.33±4.72 a	2.38±0.40 abc	9.67±0.52 c
K3T1	37.00±6.56 b	1.64±0.30 ab	7.00±0.25 a

Data followed by the same letter in the same colum were not significantly different based on the 5% LSD test. Ko = without organic fertilizer, K1 = 6 ton ha^{-1} of cajeput waste compost, K2 = 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure, K3 = 6 ton ha^{-1} of rabbit manure, T0 = without *T. Asperellum*, T1 = with *T. Asperellum*

Figure 1. show that treatment combinations organic fertilizer with *T. Asperellum* were no significantly difference on yield performance of shallot in term of measured wet weight of bulbs and bulbs diameter. However treatment of organic fertilizer was on yield performance of shallot in term of measured wet weight of bulbs and bulbs diameter. Rabbit manure treatmen produced highest of wet weight of bulb, and not significantly difference with treatment of cajeput waste compost + rabbit manure. However, treatment combination of cajeput waste compost + rabbit manure produced hieghest of bulbs diameter.

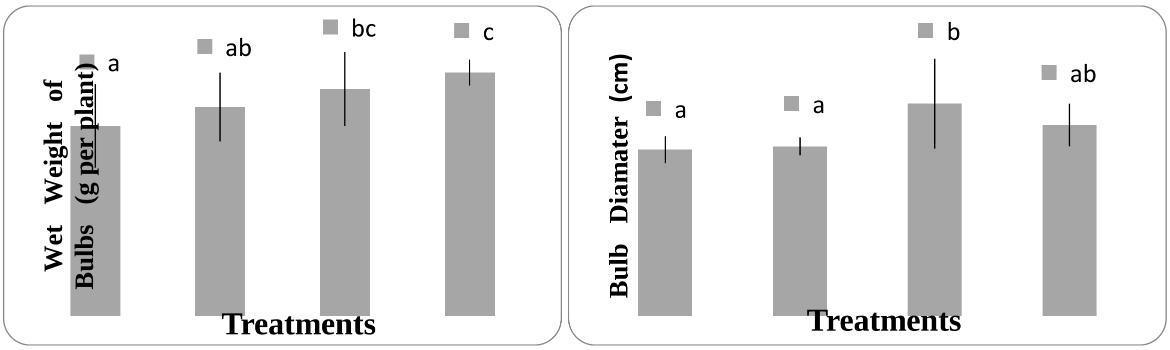

Figure 1. Wet Weight of Bulbs and Bulbs Diameter of Shallot under different treatment

4. Discussion

Understanding how shallot responds to the organic fertilizer from cajeput waste compost and *T. asperellum* is essential for further effectiveness of fertilizer on shallot. The results of experiments showed that organic fertilizer from cajeput waste compost + rabbit manure without *T. asperellum* were significanly able to improve growth in shallot through plant height, and dry weight of leaves. This treatment increased plant height by 8.11 % until 25.00 % compared to all treatment combinations. This is different from the results of the study reported that treatmen of Organic fertilizer + *Trichoderma spp*. increased plant height on red onion [14].

The highest number of tillers was found in treatment combination of rabbit manure without *T. Asperellum* (9.67 tillers per plant). Rabbit urine treatment incresed number of tillers on shallot [15]. Treatment of rabbit menure fertilizer incresed number of branches per plant on Periwinkle (*Catharanthus roseu*s L.) [16] and help seed growth [8].

The application of organic fertilizer was a significantly difference at wet weight of bulbs and bulb diameter. The application of Rabbit manure produced wet weight of bulbs and bulbs diameter on shallot which not significantly difference with treatment of cajeput waste compost + rabbit manure. There are many reported that cuttle dung, agriculture wast, compost of mushroom growing media, and granural organic fertilizer can incresed plant height, bulb diameter, and bulb weight on shallot [17] [18] [19]. Generally hight bulb yield on onion may be due to the increase in photosynthesis process rate and the assimilation of such products in plant tissu [20]. A number of organic fertilizers in the root zone can increase nutrient availability in soil solution that support plant growth, so increasing yield of shallot [21].

Treatment of *T. Asperellum* can't increase wet weight of bulbs. This is different from the results of research which explains that onion with Tricoderma treatment can increase wet weight of bulbs compared with control [22]. Seed Treatments with Trichoderma increase shallot yield on sandy coastal [23]. *Tricoderma spp*. have the ability to synthesize cellulose enzymes [24] so there is a possibility that the *T. Asperellum* is applied to function as decomposers of cajeput waste that has not been completely decomposed. Trichoderma can be used as biological fertilizer [9], organic decomposers [24], biocontrol agents [25].

5. Conclusion

In conclusion, the results of this study showed that treatmen of 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure without *T. asperellum* increased plant hight and leaf dry weight of onion by 25% and 135,66%. The application of combination rabbit manure and without *T. asperellum* increased shallot tillering number by 9,67 tillering. The application of 3 ton ha^{-1} of cajeput waste compost + 3 ton ha^{-1} of rabbit manure increased shallot yiled and diameter of shallot bulbs.

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