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

Parwi*, U. Isnatin, M. Hamawi, and U. Etica
Agrotechnology Department, Universitas of Darussalam Gontor, Indonesia
* p.parwi@yahoo.com

Abstract. Increased shallot yield with application of organic fertilizer. Cajeput waste as a source of organic fertilizer is very abundant in Ponorogo. Research aimed to study the application of organic fertilizers and Trichoderma asperellum to increase 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 treatment of 3 ton ha$^{-1}$ of cajeput waste compost + 3 ton ha$^{-1}$ of rabbit manure without Trichoderma asperellum increased plant height 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 estimated to increase [1]. Chemical fertilizers are generally used excessively by farmers to increase the yield of shallot. Excessive use of chemical 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 productivity 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 **Procedure**. 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 height, 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**. Observational data were statically analyzed using the analysis of variance procedure to assess the differences of treatment. 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 biofertiliser 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 height of 40 cm that highest 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 highest 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 significantly different from treatment combination 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 standard errors

| Treatment Combinations | Plant Height (cm) | Dry 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 column were not significantly different based on the 5% LSD test. 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, 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 treatments produced highest of wet weight of bulb, and not significantly different with treatment of cajeput waste compost + rabbit manure. However, treatment combination of cajeput waste compost + rabbit manure produced highest of bulbs diameter.

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 significantly 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 treatment 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 increased number of tillers on shallot [15]. Treatment of rabbit manure fertilizer increased number of branches per plant on Periwinkle (*Catharanthus roseus* 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 granular organic fertilizer can increased plant height, bulb diameter, and bulb weight on shallot [17] [18] [19]. Generally high bulb yield on onion may be due to the increase in photosynthesis process rate and the assimilation of such products in plant tissue [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 treatment of 3 ton ha$^{-1}$ of cajeput waste compost + 3 ton ha$^{-1}$ of rabbit manure without *T. asperellum* increased plant height 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 yield and diameter of shallot bulbs.

Acknowledgments
University of Darussalam Gontor has funded this program at 2019.

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