Organic shallot cultivation by using siam weed compost combined with biocontrol agent of avirulent *Fusarium Oxysporum F.Sp. cepae*

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**Abstract.** Increasing production cost of conventional shallot cultivation has promoted organic shallot production to develop by using natural resource potential such as siam weed that can be found everywhere in Indonesia. This research was done to determine the best combination of siam weed compost and biocontrol agent of avirulent *Fusarium oxysporum f. sp. cepae* for organic shallot cultivation. Shallot was cultivated by applying various combination of siam weed compost and the biocontrol agent with inorganic fertilizer application of Mutiara 16-16-16 as the control. The combination were 20 ton/ha of siam weed compost combined with 36.8 kg/ha of the biocontrol agent, 20 ton/ha of siam weed compost combined with 73.6 kg/ha of the biocontrol agent, 10 ton/ha of siam weed compost combined with 36.8 kg/ha of the biocontrol agent, and 10 kg/ha siam weed compost combined with 73.6 kg of the biocontrol agent. The results showed that shallot cultivation using siam weed compost combined with the biocontrol agent gave better growth and increased the shallot yield by 26% compared to the use of inorganic fertilizer of Mutiara 16-16-16.

1. Introduction

Shallot has a good potential to develop because of its high economic value and its increasing demand. Based on the demand calculation of 2012, average domestic consumption of shallot was 2,76 kg/capita/year with the national demand of 695.128 ton. So far, national production areas are concentrated in Java and Bali covering 77% of shallot area [1] with the highest production of 519.356 ton in Central Java and 293.179 ton in East Java and national productivity of 10.22 ton/ha during 2014 [2,3]. This productivity is actually still low when compared to its production potential of 20 ton/ha [2]. Meanwhile, B/C ratio of conventional shallot production is as low as 1.15 with the highest production cost of 38.6% (seed), 30.3% (labor), 8% (fertilizer), and 7.7% (pesticides). Conventional shallot production with higher production cost of inorganic fertilizer and chemical pesticides results in the lower farmer income.

Another shallot production constrain is destructive shallot diseases such as twisting disease (moler disease) caused by *Fusarium oxysporum f. sp. cepae*. During the period of 2003-2005, the acreage of the disease attack were 48.1, 116.8, and 268.1 ha respectively. It means that the disease management, so far, is still ineffective whereas the coverage of the disease management is increasing year by year: 4,569.1 ha (2003), 8,095.8 ha (2004), and 5,867.2 ha (2005). Therefore, it is very important to find a
more effective, cheaper, easier, and more environmentally friendly control method. Organic shallot cultivation is then becoming a good prospective solution. Indonesia has a good chance to develop organic farming to produce food with food safety attributes, nutritional attributes and eco-labelling attributes. One Indonesia’s potential in developing organic farming is its higher biodiversity including weed diversity that can be used as compost production material. Siam weed (Chromolaena odorata) is very potential used as compost production due to its higher content of nutrients and higher biomass production. Nutrient contents of siam weed are 2.65 % N, 0.53 % P dan 1.9 % K with biomass production of 11.2 ton/ha [4].

Related to moler disease control in developing organic shallot production, innovation in producing organic compost combined with biocontrol agent of avirulent F. oxysporum f. sp. cepae has been developed. Research done by [5][6] showed that the use of single formulation of siam weed compost and biocontrol agent of avirulent F. oxysporum f. sp. cepae increased shallot yield five fold compared to the control when planted in polybags. This research was done to find the best combination dose of siam weed compost and biocontrol agent of avirulent F. oxysporum f. sp. cepae for organic shallot cultivation.

2. Material and Method

2.1. Siacman compost preparation

Siam weed was collected from several areas in Bantul. The biomass was then chopped into small pieces before fermented. Before fermented, the chopped siam weed biomass was sprayed homogenly with EM4 solution. The solution was prepared by dissolving 5 ml EM4 and 8 g sugar in 1 L fresh water. The sprayed siam weed biomass was then fermented in the closed buckets for 3 days. After fermentation, the fermented siam weed biomass was dried under the sunlight for about 4 days so that the dried biomass can be crushed or powdered easily.

2.2. The biocontrol preparation

The biocontrol agent used in this research was avirulent F. oxysporum f. sp. cepae from the previous research. The pure culture of the biocontrol agent was rejuvenated by culturing the culture on PDA for about 4 days. A piece of the active growing colony was then cultured in an 250 ml erlenmeyer containing 100 ml of PDB for 2 weeks under the room temperature for mass production of the biocontrol agent inocula. The biocontrol agent was formulated in zeolite by mixing 8 g sterilized zeolite with 20 ml of the biocontrol inocula homogenly in sterilized petridishes. The mixture was incubated under the room temperature until air dried after which scrabbed into powder.

2.3. Single formulation preparation

Single formulation was prepared by mixing the siam weed compost with zeolite-formulated biocontrol agent in certain combination doses. The combination doses were: 20 ton siam weed compost with 36.8 kg/ha biocontrol agent, 20 ton siam weed compost with 73.6 kg/ha biocontrol agent, 10 ton/ha siam weed compost with 36.8 kg/ha biocontrol agent, and 10 ton/ha siam weed compost with 73.6 kg/ha biocontrol agent.

2.4. Shallot cultivation

Shallot was cultivated in Kretek, Bantul, Yogyakarta from July to September 2018 organically by using siam weed compost combined with biocontrol agent of avirulent Fusarium oxysporum f. sp. cepae with various combination doses as prepared previously. Inorganic fertilizer of Mutiara 16-16-16 with the dose of 500 kg/ha was applied as the control. Shallot was planted with 20 x 20 cm planting space in 11 m2 experimental plot with three replications.
2.5. Data collection
Data of plant height and leaf number were collected weekly starting from four week after planting until seven weeks after planting on five randomly sampled plants. Plant fresh weight and plant dry weight were weighed at seven weeks after planting. Data of bulb number, bulb weight per plant, and bulb weight per ha were also collected. Data was then analyzed using ANOVA.

3. Result and Discussion
The use of siam weed compost combined with biocontrol agent of avirulent Fusarium oxysporum f. sp. cepae with various doses gave better shallot growth (plant height and leaf number) when compared to the use of inorganic fertilizer of Mutiara 16-16-16 (Table 1 and Table 2). The dose of 10 ton/ha siam weed compost combined with 36.8 kg/ha biocontrol agent is the best formula giving the highest plant height and leaf number of shallot.

Table 1. Shallot plant height at various doses of siam weed compost combined with biocontrol agent of avirulent Fusarium oxysporum f. sp. Cepae

| Treatments                                      | Plant height at |
|------------------------------------------------|-----------------|
|                                                 | 4 wap  | 5 wap  | 6 wap  | 7 wap  |
| 20 ton/ha siam weed compost combined with       |        |        |        |        |
| 36.8 kg/ha biocontrol agent                     | 39.54a  | 46.81a  | 50.82a  | 51.20a  |
| 20 ton/ha siam weed compost combined with       |        |        |        |        |
| 73.6 kg/ha biocontrol agent                     | 39.71a  | 46.99a  | 53.89a  | 50.17a  |
| 10 ton/ha siam weed compost combined with       |        |        |        |        |
| 36.8 kg/ha biocontrol agent                     | 41.72a  | 48.75a  | 52.89a  | 52.25a  |
| 10 ton/ha siam weed compost combined with       |        |        |        |        |
| 73.6 kg/ha biocontrol agent                     | 42.11a  | 49.00a  | 52.03a  | 52.08a  |
| Inorganic fertilizer of Mutiara 16-16-16       | 38.58a  | 45.76a  | 48.49a  | 43.09b  |

Explanation: wap = weeks after planting

Table 2. Shallot leaf number at various doses of siam weed compost combined with biocontrol agent of avirulent Fusarium oxysporum f. sp. Cepae

| Treatments                                      | Leaf number at |
|------------------------------------------------|----------------|
|                                                 | 4 wap  | 5 wap  | 6 wap  | 7 wap  |
| 20 ton/ha siam weed compost combined with       |        |        |        |        |
| 36.8 kg/ha biocontrol agent                     | 34.80a  | 50.6a   | 53.00a  | 48.40b  |
| 20 ton/ha siam weed compost combined with       |        |        |        |        |
| 73.6 kg/ha biocontrol agent                     | 34.00a  | 48.87a  | 52.00a  | 44.80b  |
| 10 ton/ha siam weed compost combined with       |        |        |        |        |
| 36.8 kg/ha biocontrol agent                     | 36.73a  | 51.67a  | 54.33a  | 49.07a  |
| 10 ton/ha siam weed compost combined with       |        |        |        |        |
| 73.6 kg/ha biocontrol agent                     | 35.87a  | 49.53a  | 48.53a  | 41.40b  |
| Inorganic fertilizer of Mutiara 16-16-16       | 37.60a  | 47.33a  | 48.87a  | 38.13b  |

Explanation: wap = weeks after planting

In these treatments, the better performance of shallot growth parameters under the use of siam weed composts were due to supplying readily available macro and micro nutrients in the siam weed compost. These nutrients present in siam weed composts might be easily taken up by shallot plant. Nutrient content analysis of siam weed compost in the previous research showed the high content of N, P, and K of 2.45, 0.44, and 1.79% respectively. These results are in accordance with the findings of [7]. Effect of the use of siam weed compost combined with the biocontrol agent on fresh and dry weight of plant was presented in Table 3. Compared to the use of inorganic fertilizer of Mutiara 16-16-16, the organic treatments gave no significant different. It means that siam weed compost has a good potential to replace inorganic fertilizer in developing organic shallot production.
Table 3. Fresh weight and dry weight of shallot plant at various doses of siam weed compost combined with biocontrol agent of avirulent *Fusarium oxysporum* f. sp. *Cepae*

| Treatments                                           | Fresh weight (g) | Dry weight (g) |
|------------------------------------------------------|------------------|----------------|
| 20 ton/ha siam weed compost combined with 36.8 kg/ha biocontrol agent | 152.62a          | 15.96a         |
| 20 ton/ha siam weed compost combined with 73.6 kg/ha biocontrol agent | 155.76a          | 14.26a         |
| 10 ton/ha siam weed compost combined with 36.8 kg/ha biocontrol agent | 149.18a          | 15.17a         |
| 10 ton/ha siam weed compost combined with 73.6 kg/ha biocontrol agent | 161.97a          | 15.08a         |
| Inorganic fertilizer of Mutiara 16-16-16             | 130.84a          | 12.95a         |

The use of siam weed compost combined with the biocontrol agent gave also a good performance of shallot yield. Likewise on the parameters of plant height and leaf number, among the treatments, the combination of 10 ton/ha siam weed compost and 36.8 kg/ha biocontrol agent gave relatively higher yield on the parameters of bulb weight per plant, bulb number per plant, and bulb weight per ha as well as higher than inorganic fertilizer. The higher plant height and leaf number perhaps favoured the higher yield of shallot as reported by [8] and [7]. According to [8] reported that the use of siam weed compost increased soybean growth that was planted on reclaimed coalmine land, meanwhile [7] observed that the use of siam weed compost could improved growth and yield of finger millet (*Eleusine coracana*).

Table 4. Bulb weight per plant, bulb number per plant, and bulb weight per ha at various doses of siam weed compost combined with biocontrol agent of avirulent *Fusarium oxysporum* f. sp. *Cepae*

| Treatments                                           | Bulb weight per plant (g) | Bulb number per plant | Bulb weight per ha (ton) |
|------------------------------------------------------|----------------------------|-----------------------|--------------------------|
| 20 ton/ha siam weed compost combined with 36.8 kg/ha biocontrol agent | 113.647a                   | 13.13a                | 19.59a                   |
| 20 ton/ha siam weed compost combined with 73.6 kg/ha biocontrol agent | 110.705a                   | 12.73a                | 16.43a                   |
| 10 ton/ha siam weed compost combined with 36.8 kg/ha biocontrol agent | 106.937a                   | 13.33a                | 19.71a                   |
| 10 ton/ha siam weed compost combined with 73.6 kg/ha biocontrol agent | 104.949a                   | 12.6a                 | 19.44a                   |
| Inorganic fertilizer of Mutiara 16-16-16             | 76.492a                    | 10.13a                | 15.56a                   |

Similar findings were also made by [9] who reported that the use of siam weed compost improved soil chemical properties so that increased nutrient uptake and in turn can increase forage yield of rice. Similar results were also reported by [10], who observed that siam weed reduced soil bulk density and increased total porosity and soil water content. Siam weed also increased the soil nutrient levels and subsequently produced high growth of maize.

4. Conclusion
The study indicated that the use of single formula of siam weed compost combined with biocontrol agent of avirulent *Fusarium oxysporum* f. sp. *Cepae* gave better growth and yield of shallot than the application of inorganic fertilizer. The best dose was 10 ton/ha siam weed compost combined with 36.8 kg/ha biocontrol agent.

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