Effects of mulch on growth and yield of garlic bulbils at various fertilizing doses

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Abstract. Climate change hurts garlic cultivation. Appropriate technology needs to be created to get good quality tubers, one of them using bulbils. Bulbils are tubers formed from other parts of a plant. In garlic, bulbil grows at the stem, with very small embryo size hence it is necessary to control the environmental conditions in the nurseries. The study aimed to examine the garlic cultivation model using tubers with mulch treatment and a combination of fertilization. Sealing and mulching were conducted to avoid direct solar heat and to control the soil microclimate, respectively. The study used a split-plot design consisting of main plots with mulching and without mulching. The sub-plots were by applying the combination of organic and inorganic fertilizers at several levels, namely: Farmer Recommendation/P1 (50% Organic + 100% Inorganic), P2 (75% Organic + 25% Inorganic), P3 (50% Organic + 50% Inorganic), P4 (25% Organic + 75% Inorganic) and P5 (100% Organic). The results showed there are interactions between mulching and a combination of fertilizers on plant height and root length. Mulch application can stabilize soil temperature and provide better results on growth and yield, but the combination treatment of fertilization has no significant effects on growth variables and yields.

1. Introduction
Recently the attack of plant-disturbing organisms on garlic (Allium sativum L.) has increased due to climate change. Climate change is associated with an increase in CO2 levels so that it has an impact on global temperatures. it can make pest and disease attacks on garlic and affect quality. Garlic seeds usually use consumption bulbs that used continuously so that the impact affects tuber yields [1]. In addition to environmental factors, tuber quality can decrease due to lack of nutrients, and pathogenic viruses that infected the seedlings. The use of consumption bulbs as planting material requires large quantities thereby increasing production costs.

Bulbil is a tuber that formed from other parts of garlic. Bulbils come from the axillary node on the stem. Bulbils have intact embryos, so they can use as plant material [2]. The location of the bulbils on the stems above the soil surface makes the bulbs free from viruses and soil-borne diseases. Bulbil has not used as planting material. Whereas the use of bulbil as a planting material can reduce production costs. Bulbil has a very small size. The results of the survey at the beginning of the planting of garlic bulbils showed the need to control environmental factors, namely containment. The enclosure was a need because very small bulbils cannot withstand temperature changes. Control of the environment on
the ground also needs to be done with mulch. The use of mulch on horticultural crops is reported to increase and improve yield quality and allow off-season planting [3,4]. Bulbil growth is strongly influenced by nutrient availability. Utilization of organic fertilizer today has become crucial in improving soil quality. The source of organic fertilizer comes from plant compost or plant residues or livestock manure [5,6]. Combination of organic and inorganic fertilizers can provide all nutrients in balanced amounts [7]. The study aimed to examine the potential of bulbil as a garlic planting material through several doses of fertilization and the effect of mulching on the quality of tuber yields.

2. Material and methods

2.1. Time and place

The research was held from June to December 2017 in Pancot, Karanganyar, Indonesia. The altitude of research site was ± 1300 m asl on Gromosol soil types. Research materials include bulbils, silver black plastic mulch, UV plastic, manure (max dose: 30,000 kg ha⁻¹) and NPK (max dose: 400 kg ha⁻¹). Research tools such as microscopes, thermometers, ruler, analytical scales and cultivation equipment.

2.2. Research design

The study used a split-plot design with two treatment factors. The first factor is the use of mulch. The second factor is the fertilizer combination. Fertilization consists of: Farmer Recommendation/P1 (50% Organic + 100% Inorganic), P2 (75% Organic + 25% Inorganic), P3 (50% Organic + 50% Inorganic), P4 (25% Organic + 75% Inorganic) and P5 (100% Organic). Each treatment was repeated 3 times.

2.3. Observation

Land preparation consists of making mounds and installing plastic mulch according to treatment. The seeds in the form of bulbil were soaked in Retadens for 1 hour then planted in the soil. Plant maintenance was carried out by watering, weeding and fertilizing according to the treatment. Watering, weeding and fertilizing activities were adjusted according to the treatment. Plant height and number of leaves measured by ruler weekly. Stem diameters measured by calipers twice a week. Tuber weight and root length were measured at 90-120 days. The data were analyzed with T-test and DMRT at 5% of the level.

3. Results and discussion

3.1 Planting environment

The results of environmental temperature measurement in the morning, afternoon and night at 12.68, 24.48 and 31 °C respectively. The humidity of the environment around the plantations in the morning, afternoon and night were recorded at 72, 45 and 60%. Some reports indicate that garlic plants are suitable for planting at an average temperature of 24-30 °C [8].

Table 1 The results of measurements of soil temperature and humidity showed that the giving of mulching in garlic plants tends to maintain temperature and soil moisture stability. In contrast to the garlic plants without mulching there is a marked increase in temperature between morning, afternoon and night.

| Treatments | Soil Temperature (°C) | Soil Humidity (%) |
|------------|-----------------------|------------------|
|            | Morning | Afternoon | Night | Morning | Afternoon | Night |
| M0         | 8.83    | 30        | 23.83  | 35.75    | 48.25     | 35.83 |
| M1         | 11.83   | 27        | 21.83  | 41.33    | 61.33     | 42.50 |

Note: M0 (Without Mulching), M1 (With Mulching)

The plant still grows well at humidity below 40% because it is the optimum range for microbial metabolism at the Rhizosphere [9]. The ideal humidity for garlic plants planted in the highlands ranges...
from 40-65% [5,9]. High humidity is also not good for plant growth because it is susceptible to pathogens.

3.2 Plant height, number of leaves and root length

Results showed that mulching tends to increase plant height in all fertilizer combination treatments (P <0.05). Microclimate control can significantly increase garlic growth (Table 2). Organic fertilizer can increase plant height both independently and in combination with inorganic fertilization. The results also showed that garlic without mulching has decreased growth. It happened because without triggering there was great evaporation of water by the activity of organic matter so that the application of organic fertilizer does not affect the growth of the garlic. The soil has not covered with mulching affected the organic nutrients can be lost through evaporation [10].

Table 2. Effects of mulching and fertilizing doses on the growth of garlic plants

| Treatments | Plant height (cm) | Number of Leaves | Stem diameter (mm) | Rooth length (cm) |
|------------|------------------|------------------|--------------------|-------------------|
|            | Mo M1            | Mo M1            | Mo M1              | Mo M1             |
| P1         | 27.25abcd 30.12ab| 3.92 4.39        | 3.76 4.44          | 9.91a 8.61ab      |
| P2         | 29.44abc 26.98abcd| 4.16 3.99        | 4.07 3.9          | 9.99a 8.99ab      |
| P3         | 23.87cd 31.42a   | 3.66 4.53        | 3.11 4.43         | 8.80ab 9.80a      |
| P4         | 24.23bcd 31.35a  | 3.46 4.43        | 3.25 4.31         | 10.09a 8.00ab     |
| P5         | 22.79cd 31.92a   | 3.43 4.59        | 3.13 4.81         | 6.37b 10.67a      |

Note: Farmer Recommendation/P1 (50% Organic + 100% Inorganic), P2 (75% Organic + 25% Inorganic), P3 (50% Organic + 50% Inorganic), P4 (25% Organic + 75% Inorganic) and P5 (100% Organic); M0 (without Mulching), M1 (With Mulching); The number followed by the same letter is not significantly different based on DMRT 5%.

The use of mulching and combination fertilization on leaves number parameters did not show a significant effect (P> 0.05) (Table 2). 100% organic fertilizer application without the addition of organic fertilizer can increase the number of leaves to 4.59 with mulching treatment. However, precisely without mulching the number of leaves at least compared to other treatments. This indicates that the use of organic fertilizer is optimal at controlled soil temperatures and humidity through the management of microclimate. The results showed no significant difference between treatments on stem diameter (P> 0.05). Garlic without mulching in almost all treatment combinations showed a lower stem diameter compared to mulching. The use of plastic mulch with 100% organic fertilization can maximize the root length to 10.67 cm (Table 2). Mulching can increase root lengthening because it was able to prevent evaporation when plant need water during its growth [5]. However, the shortest roots was only 6.37 cm without mulching.

3.3 Bulb weight

The results showed the fertilizer dosage did not affect the fresh weight of tubers (P> 0.05) (Table 3). Giving 30 tons / ha of manure can save the use of inorganic fertilizers reaching 55-77% [11]. This is the fact that the plant has fulfilled its nutrient elements by organic fertilizer that has a complete nutrient content.
Table 3. Effect of mulching and fertilizing dose on tuber weight

| Fertilizing doses | M0   | M1   |
|-------------------|------|------|
| P1                | 16.44| 16.47|
| P2                | 16.02| 17.19|
| P3                | 11.61| 17.95|
| P4                | 15.13| 16.32|
| P5                | 11.31| 16.18|

Note: Farmer Recommendation/P1 (50% Organic + 100% Inorganic), P2 (75% Organic + 25% Inorganic), P3 (50% Organic + 50% Inorganic), P4 (25% Organic + 75% Inorganic) and P5 (100% Organic); M0 (without Mulching), M1 (With Mulching); The number followed by the same letter is not significantly different based on DMRT 5%.

Manure was reported to be able to increase the rate of infiltration and water absorption due to increasing soil aggregate size [12]. The factors that influence the absorption of organic matter in the soil are moisture, temperature and soil aeration. Organic fertilizers provide various elements that are useful for vegetative and generative growth [13,14,15].

4. Conclusion
Bulbil can grow better with the use of plastic mulch and 100% organic fertilizer. The use of plastic mulch tends to increase plant height, number of leaves and the diameter of the garlic stems. The use of mulch on horticultural crops was reported to increase and improve yield quality. Generally, temperature changes do not affect bulbil.

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