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Effect of Biofertilizers Application on Growth and Production of Cherry Tomatoes (*Solanum lycopersicum* var. cerasiforme)

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Abstract. This study aimed to evaluate the effect of dose and timing of bio organic fertilizer application on the production of cherry tomatoes (*Solanum lycopersicum* var. *cerasiforme*). The experiment was carried out in the greenhouse of the Laboratory of Ecology and Plant Production, Department of Agriculture, Faculty of Animal and Agricultural Sciences, Diponegoro University, in April-September 2019. A factorial experiment based on a completely randomized design with two factors viz. the first factor consisted of 0, 10, and 20 ml of bio organic fertilizer/plant and the second factor was the time of application of bio organic fertilizer at the time of planting, 0, 20 and 40 days after transplanting with three replications was tested throughout the experiment. Parameters observed included the number of fruit, the yield of fresh weight and the percentage of dried weight of fruit, diameter, and length of fruit, and the content brix of fruit. The data obtained were analyzed statistically by analysis of variance. The results showed that there was no significant effect due to the treatment of bio organic fertilizer dose, time of application and the interaction between those two treatments on all parameters observed. The dose and the time of bio organic fertilizer application have not been able to generate available nutrients to support the growth and yield of cherry tomato plants. Based on the results of the study it may be concluded that factors such as environmental characteristic and climate elements should be taken into account when the bio organic fertilizer will be applied in the cultivation of cherry tomatoes.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a major food source of antioxidants with many health benefits such as a reduced risk of cardiovascular disease and cancer [1], containing dietary fiber, phenolic compounds, flavonoids, protein, minerals and vitamins [2]. Tomatoes also contain various important nutrients such as lycopene, potassium, and ascorbic acid which were beneficial for human health [3], lycopene acts as an intermediary for carotene biosynthesis [4].

Cherry tomato (*Solanum lycopersicum* var. cerasiforme) is a horticultural plant with round or elliptical shape, red or yellow in color, small in size with a diameter ranging from 10-15 mm, easy to adapt, resistant to disease and root rot, although to achieve optimal production, especially increasing yield and fruit quality needs to be treated seriously [5]. Cherry tomatoes play a major role in human nutrition by providing essential amino acids, vitamins, and minerals. Rich in vitamin C and contains lycopene, an antioxidant that is vital in preventing cancer [6,7].

Cherry tomato's production in Indonesia during 2010-2014 was fluctuated by 891,616 tons, 954,046 tons, 893,463 tons, 992,780 tons and 915,987 tons in 2010, 2011, 2012, 2013 and 2014, respectively [8]. Most tomatoes contain sugar, but initially the choice of tomato cultivar and postharvest practices adopted by the industry was primarily aimed at reducing crop loss and extending shelf life rather than prioritizing sweetness. However, recently the sweet taste indicated by the brix content in tomatoes is also a concern of most industries. This may be due to the fact that a growing recognition among consumers that taste, and flavor were key components of the marketability of tomatoes [6]. Therefore, the parameter of brix content in tomatoes is important so that in every tomato research, the brix content should also be the focus of observation.

Utilization of liquid organic fertilizer (LOF) based on cow urine is possible in organic farming practices because it contains high macro elements such as N, P and K so that it may be used as a substitute for nutrients in the soil [9]. Liquid organic fertilizer made from animal manure, urine, milk, curd, bean flour and brown sugar contains essential

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nutrients, vitamins, growth promoters such as IAA and GA and other beneficial microorganisms [10]. At the end of the LOF fermentation process made from agro-industrial waste, phytohormones such as auxins and cytokinins, organic acids and plant growth promoters were found [11]. The application of LOF increases plant growth and yield both quantitatively and qualitatively [10]. Liquid organic fertilizer incubation time of 1, 2 and 3 weeks at a dose of 72 kg N/ha or equal to 1,200 ml liquid organic fertilizer/plant. may be recommended for cherry tomato cultivation [12]. The quality of LOF may be improved through incubation by empowering local microorganisms (LoM) that may be produced from rotten fruit and vegetables. The quality of LoM may be affected by factors such as the fermentation medium and time, the shape and nature of the active microorganisms in the fermentation process, pH, temperature, content of raw materials or substrates and the C/N ratio requirements for the LoM process [9].

MATERIAL AND METHODS

The experiment was carried out in the screen house of the Laboratory of Ecology and Plant Production, Department of Agriculture, Faculty of Animal and Agricultural Sciences, Diponegoro University, from April to September 2019. The experimental locations are located at 6°50'-7o10'LS and 109°35 '-110°50'E with an altitude of 125 meters above sea level, with average daily air temperatures ranging from 26°C-32°C during the day and 25°C-28°C at night, and humidity ranging from 65%-96% [13]. The soil used was a reddish-brown latosol soil type, soil pH was 5.7, with each nutrient content of 0.18%N, 0.18% P, 0.23% K, 1.5% organic-C and C/N ratio 8.4.

A factorial experiment based on a completely randomized design with two factors and 3 replications was used throughout the experiment. The first factor consisted of 0, 10, and 20 ml of biofertilizer/plant, respectively, for D0, D1, D2. The second factor was the bio-organic fertilizer (BOF) BOF application time at the time of planting, 20 and 40 days after transplanting (DAT) consecutively for B0, B1 and B2.

The soil used was taken from the experimental field of the faculty. The soil was drained, then sieved through a 20-mesh filter to obtain a homogeneous soil condition. A total of 8 kg of dry soil was then put to a polybag, and 2 kg of organic fertilizer was added into the polybag.

The BOF used in the study was produced by the Indonesian Institute of Sciences (IIS) researchers, and contained various microorganisms such as *Rhizobium sp., Azotobacter sp., Pseudomonas sp., Bacillus sp., Thricorderma sp., Klebsiella sp., Streptomyces sp., Aspergillus sp., Penicillium sp.,* and *Burkholderia sp.* BOF contains 10^6-10^7 CFU/ml. The microbes in the BOF play a role in carrying out biocatalyst activity, fixing N, dissolving P and K, producing growth regulators (IAA, Cytokinin, Gibberellin) and biocontrol. In addition to increasing soil nutrients, BOF also maintains plant resistance to disease, increases plant chlorophyll, thereby increasing the rate of photosynthesis and crop yields.

Cherry tomato seeds were sown on organic growing media on March 15, 2019. Sowing was carried out for 14 days, and on March 29, cherry tomato crop was transplanted into the prepared planting medium. After transplanting, the crops were treated with B0 treatment (BOF application at transplanting time) according to the predetermined treatment. Cherry tomato plants then were allowed to grow. At 20 DAT and 40 DAT, treatment B1 and B2 were carried out, respectively.

Parameters observed included number of fruits, fresh weight and percentage of dry matter of fruit, fruit diameter and length, and brix content. Tomatoes were harvested regularly once a week and it was carried out 9 times during the harvest period. The first harvest was carried out when the tomato plants were 75 days after transplantation (DAT). At each harvest, the number of fruits was counted and then tomatoes were weighed to determine the fresh weight of the fruit. Samples were taken randomly and oven at 105°C for 24 hours to determine the dry weight of the fruit. Fruit diameter and length were measured using a digital caliper. To determine the diameter and length of the fruit, a sample of five tomatoes was taken randomly with the exception of plants with the yield of number of fruits was less than 5 or equal to 5 fruits were taken all. At the last harvest, the tomato was selected which physically contained good and abundant fruit juice to determine its brix content. The data obtained were processed statistically with analysis of variance (ANOVA). Further tests were not carried out because there was no significant effect of the dose and time of application of bio-organic fertilizer and the interaction of the two treatments on all observed parameters. and continued with Duncan's Multiple Range Test at the 5% level.

RESULT AND DISCUSSION

The results showed that the treatment dose and time of BOF application as well as the interaction of the two treatments did not show significant differences in all observed parameters. The effect of treatment on the parameters

of fruit number, fruit fresh weight and percentage of dry matter of fruit/harvest/plant were presented at Tables 1 and 2. While fruit diameter, fruit length and fruit brix content were shown at Table 3 and, respectively.

TABLE 1. Effect of treatment on the number of fruits, percentage of DM of fruits, and fresh yield of fruit

Treatments	Numbers of fruit -----harvest/plant-----	Percentage of DM of fruits ----------%/plant----------	Fresh yield of fruit --------g/plant--------
B0D0	6.7±7.8	264.2±49.9	47.0±43.4
B0D1	4.3±4.1	45.8±40.0	48.3±31.9
B0D2	10.6±11.3	42.0±52.6	35.8±32.6
B1D0	8.1±8.8	95.7±70.4	39.1±12.0
B1D1	5.1±0.9	165.8±145.6	37.1±32.8
B1D2	11.2±1.8	142.3±83.7	47.9±2.8
B2D0	3.7±3.3	117.5±118.8	31.4±44.7
B2D1	11.9±4.5	234.2±224.4	38.6±34.0
B2D2	15.5±2.9	94.8±164.3	46.7±42.6

TABLE 2. Effect of treatment on diameter, length and the brix content of fruit

Treatments	Diameter of fruit ----------mm----------	Length of fruit ----------mm----------	Brix content ----------%----------
B0D0	7.7±6.2	10.7±9.3	5.4±4.7
B0D1	7.3±6.4	10.7±9.2	6.5±5.6
B0D2	6.7±5.8	11.0±9.5	4.6±4.1
B1D0	8.3±7.4	10.3±9.1	7.7±1.6
B1D1	8.3±7.2	11.3±9.8	3.1±5.4
B1D2	11.3±1.2	15.7±0.6	7.5±1.6
B2D0	7.7±6.7	12.7±11.4	3.4±5.9
B2D1	7.7±6.7	11.0±9.5	5.8±5.2
B2D2	8.0±6.9	12.0±10.4	6.3±5.4

The results showed that the dose and time of BOF application and the interaction between the two treatments had no significant effect on all observed parameters. This was probably because the BOF dose has not been able to affect the availability of soil nutrients. It was suspected that the application dose of BOF was lower than the recommended dose that should be applied. In accordance with previous research that the treatment of various doses of either LOF or BOF was not significantly different on the number of fruits and the yield of fresh tomatoes [9,12,14]. Another possibility was that the beneficial components and microorganisms contained in BOF did not find a suitable soil environment so their exact role could not be demonstrated properly. In addition, it was reported that the application of BOF combined with inorganic fertilizers on the growing media did not significantly affect the number and yield of tomato plants. In this study, the planting medium used was a combination of soil and solid organic fertilizer.

Throughout the experiment there was no nutrients added including inorganic fertilizers. This may affect the availability of nutrients in the growing media as the nutrient content in the initial soil was classified as low [15]. Therefore, it was suspected that the soil media was not able to meet the nutrient requirements of the plant, so that the yield of cherry tomatoes in the treatment was not significantly different from the control. On the other hand, tomato growth and yield were strongly influenced by the availability of nutrients in the growing media [16]. In addition, the time of BOF application also had no significant effect on all parameters observed during the study. The beneficial microorganisms and components contained in the BOF were suspected to have an incompatible environment in either the control (0), 20 or 40 DAT. This condition was suspected to cause the BOF unable to play a role in increasing the availability of soil nutrients as hypothesized. Therefore, the presence of BOF at 20 and 40 DAT did not show a significant effect compared to the control. At the end, this experiment found that the application of BOF did not affect the growth and yield of tomatoes as indicated by the observed parameters such as number, fresh weight, percentage of dry matter, tomato diameter, tomato length and brix content of the fruit.

The availability of nutrients in the growing media affects generative growth, including fruit yield and the total soluble solids or known as the percentage of fruit brix. Brix is a measure of refractive index that reflects the total fruit soluble solids. In tomatoes, the dominant dissolved solid components include sugars and organic acids [17, 18], but other metabolites may also contribute [19].

Photosynthate is a source of sugar which is reflected in the percentage of fruit brix. In this study, the treatment did not significantly affect the percentage of tomato brix which only ranged from 5-6%, lower than the percentage of cherry tomato brix which ranged from 9-11% [19]. This happens because the supply of soil nutrients that should be generated by the role of BOF was not optimal so that the optimal rate of photosynthesis cannot be achieved. This resulted in poor photosynthetic results (total soluble solids or brix) as indicated by the lower percentage of tomato fruit brix.

It was found that organic fertilizer had a significant effect on the brix content of tomato in the 2014 and 2016 studies, where the highest brix content was achieved at 4.34 and 4.43, respectively [20]. This was consistent with previous studies that cropping with organic fertilizers had higher brix content than those cultivated with inorganic fertilizers [21,22,23]. In addition, showed an increase in the percentage of the brix from 5.25 to 5.4 when the nitrogen fertilization rate decreased from 392 to 168 kg N/ha [24]. In contrast, It was reported that with increasing nitrogen fertilization rate, the brix value increased and peaked at a rate of about 100 kg N/ha, and beyond that value, the brix value tended to decrease [25]. In the study, there was no significant difference in the effect of dose and time of BOF application on the brix content. The difference between the results of the study and previous studies was thought to be due to the different research locations which give different environmental characteristics and climate elements. As a comparison, it was found that irrigation had a significant effect on the brix content of tomatoes. The percentage of the brix of tomatoes was affected by irrigation indirectly by inducing more and larger fruit and thus having a diluting effect on the material. It was indicated that optimal water supply resulted lower brix content [26].

CONCLUSION

The dose and the time of BOF application have not been able to generate available nutrients to support the growth and yield of cherry tomato plants. Further research should be carried out with increasing the dose of BOF and shortening the interval of BOF application is highly recommended. Based on the results of the study it may be concluded that factors such as environmental characteristic and climate elements should be taken into account when the BOF will be applied in the cherry tomatoes cultivation.

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