Application of *Streptomyces* sp. and *Trichoderma* sp. for Promoting Generative Plants Growth of Cherry Tomato (*Lycopersicum cerasiformae* Mill.)

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ABSTRACT
Production of cherry tomatoes in Indonesia is still low, which might be due to the inappropriate planting and maintenance processes. This research applied biological agent microorganisms *Streptomyces* sp. and *Trichoderma* sp. as Plant Growth Promoting Microorganisms (PGPM) in sustainable agricultural systems. This study aimed to determine the effect of the concentration of microorganisms *Streptomyces* sp. and *Trichoderma* sp. on the growth and production of cherry tomato plants on the polybag scale. The study was arranged with different concentrations of microorganisms *Streptomyces* sp. and *Trichoderma* sp. These concentration applied consisted of 1 : 0 ; 0 : 1 ; 2 : 2 ; 3 : 1 and without PGPM, each repeated four times. The results showed that the treatment of PGPM *Streptomyces* sp. and without *Trichoderma* sp. (1:0) resulted in the shortest flowering period (33.99 days after planting). Meanwhile, the treatment without *Streptomyces* sp. and *Trichoderma* sp. (0 : 1) produced the highest solid weight fruit (69.82 grams/plant).

Keywords: Biological, Growth, Microorganisms, Production

INTRODUCTION

Indonesian people know the Cherry tomato plant for its nutritional content and good benefits for health. Cherry tomato plants belong to annual plants that can be harvested many times in one year. Cherry tomato crop production reached 962,849 tons in 2017 (*Kementerian Pertanian, 2017*). The declining tomato crop production can occur due to the decreasing agricultural land (*Pusat Data dan Sistem Informasi Pertanian, 2014*). Therefore, an effort is needed to change the strategy to get optimal results.

In addition to paying attention to the environmental conditions, the cultivation of cherry tomato plants also needs to consider the needs of nutrients in plants, as well as providing fertilizers containing micronutrients and macro nutrients...
that function as activators for various enzymes and help the plant growth and development (Yanti et al., 2013). One of the efforts that can be made to improve the quality and quantity of cherry tomato plants is to add microorganisms that act as PGPM and biological agents. The application of these microorganisms is considered the most promising technology for sustainable agriculture. However, it requires effective adoption and standardization of bio formulations for applications in the field. PGPM also acts as a biological agent and is very promising for successful implementation in sustainable agriculture (Verma et al., 2019).

Trichoderma sp. is an antagonistic fungus that has a role as a biological agent and decomposing organism of organic matter. Trichoderma sp. use can increase shallot plants’ growth and control diseases that attack plants (Yanti et al., 2019). The filtrate from Trichoderma viridae VKF3 derived from mangrove soils can produce a fairly high IAA and suppress pathogens’ development (Kumar et al., 2017). Putri et al., (2018) reported that using Streptomyces sp. as a growth booster could increase plant height, the number of productive branches, and the roots volume by 27.3%, 24.3%, and 20.7%, respectively. According to Tamreihao et al., (2016), in addition to acting as a biocontrol, the biological agency Streptomyces sp. has a role in increasing plant growth. Using biological agents Streptomyces sp. as a growth promoter can increase plant height, the number of productive branches, and root volume.

The use of bacteria Streptomyces sp. as biological agents has a role in reducing the application of inorganic fertilizers. The isolates of Streptomyces sp. are the biological agents of the fruit fly Bactrocera sp., which are potential as a PGPB for tomato and chili plants and can increase plant height, number of flowers, and number of fruits (Suryaminararsih et al., 2019). Streptomyces griseorubens, Gliocladium virens and Trichoderma harzianum are compatible, and the association of these microorganisms can precipitate fusarium wilt disease (Suryaminarsih et al., 2015). Streptomyces sp. is a bacterium that has a role as a biological agent.

The use of microorganisms as biological agents and PGPM for plants can reduce the use of inorganic fertilizers because using microorganisms with good habitat management will be able to decompose organic matter into nutrients available for plants. These microorganisms as decomposers will also be available at all times, mainly used in sustainable agricultural systems so that it is expected that the needs of nutrients in plants can be met. The application of biological agents Streptomyces sp. and Trichoderma sp. at the proper doses and concentrations are expected to spur the growth and production of cherry tomato plants (Lycopersicum cerasiformae Mill.). Thus, this study aimed to determine the concentration of Streptomyces sp. and Trichoderma, which can promote the growth of cherry tomato plants in a sustainable and environmentally friendly farming system.

MATERIALS AND METHODS

The research was conducted in the trial field of the Faculty of Agriculture, Universitas Pembangunan Nasional Veteran East Java, from November 2020 to March 2021. This study used cherry tomato plants cv. Juliet and Plants Growth Promoting Microorganism Streptomyces sp. and Trichoderma sp. obtained from the Plant Health Laboratory of the Faculty of Agriculture, Universitas Pembangunan Nasional Veteran East Java. This study was arranged in a Randomized Block Design (RBD) with one treatment factor, namely the PGPM formula consisting of several concentrations and combinations of Streptomyces sp. and Trichoderma sp., namely without the administration of PGPM (Control), PGPM 1 (ST 1:0) containing Streptomyces sp., PGPM 2 (ST 0:1) containing Trichoderma sp.,
PGPM 3 (ST 2:2) containing *Streptomyces* sp. and *Trichoderma* sp. with a concentration of 2 : 2 and PGPM 4 (ST 3: 1) containing *Streptomyces* sp. and *Trichoderma* sp. with a concentration of 3 : 1.

Production Media and PGPM

The production media were made of Sugar Potato Extract (SPE). The composition of the SPE media was 250 grams of potatoes, 22.5 grams of sugar, and 1 liter of sterile distilled water. The manufacture of PGPM used the ratio of *Streptomyces* sp. and *Trichoderma* sp., which were propagated in the production media. A colony of *Streptomyces* sp. and *Trichoderma* sp. isolates were cut using a cork borer with a diameter of 0.5 cm. In the treatments of single biological agents, four colonies of *Streptomyces* sp. (PGPM1) and *Trichoderma* sp. (PGPM2) were added in 150 mL of SPE media. In the combination treatment of PGPM 3, two colonies of *Streptomyces* sp. and *Trichoderma* sp. were added in 150 mL of SPE media (ST 2:2). In the combination treatment of PGMP 4, the colonies of *Streptomyces* sp. and a colony of *Trichoderma* sp. were added in 150 mL of SPE media (TS 1:3). Meanwhile, in control treatment was prepared without addition of bioagents (K). Each treatment was shaken using IKA Yellow line RS 10 for 14 days.

Planting and Maintenance

Seeds of cherry tomato plants were sown on a soil medium and composted in a ratio of 1:2 using tray pots for 21-28 days. Afterward, the seedlings were transplanted to polybags measuring 35 cm x 35 cm containing garden soil planting media and compost (Ramdani et al., 2018). Transplanting was carried out after the seedlings were 30 days old, with one cherry tomato seedling/polybag. Fertilizing was carried out using 2 grams NPK fertilizer in each polybag seven days after planting (DAP) and 5 grams on 15, 30, 45, and 60 DAP.

The Application of PGPM Streptomyces sp. and Trichoderma sp.

PGPM *Streptomyces* sp. and *Trichoderma* sp. applied had been dissolved at 20 mL of PGPM in 980 mL of distilled water. PGPM solution was given at the time of transplanting by casting (200 mL/plant) and spraying (100 mL/plant) according to treatment at 7, 21, and 35 DAP.

Observation and Data Analysis

The variables observed in the effect of biological agents on the generative growth of cherry tomato plants include the flowering period, the number of flowers per plant, the number of fruits, and the weight of fruits per plant. The data were analyzed using ANOVA (software, type, year) and followed by an HSD test at 5% (Rochman, 2008).

RESULTS AND DISCUSSION

Number of Flowers, Number of Fruits, and Weight of Fruits per Plant Period 1

Based on the ANOVA results, there was no significant effect of the treatment of PGPM (Plants Growth Promoting Microorganism) *Streptomyces* sp. and *Trichoderma* sp. on the number of flowers, the number of fruits per plant, the number of fruits per plant, and the weight of the total fruits per plant. However, the final observation on the number of flowers and fruit weight in cherry tomato plants treated with PGPM *Streptomyces* sp. showed larger average values than those without the application of PGPM and with the application of other PGPM concentration formulas. (Table 1).

The highest number of flowers (40.32) was obtained in the treatment of PGPM *Streptomyces* sp., while the lowest number of flowers (38.24) was in the treatment without PGPM. The highest number fruits per plant (5.37) was observed in the combination treatment of PGPM *Streptomyces* sp. and *Trichoderma* sp. (3: 1), while the lowest number
(4.41) was in the treatment without PGPM. The highest total number of fruits (34.08) was obtained in the treatment of PGPM Streptomyces sp., while the lowest total number of fruits (31.74) was in the treatment without PGPM. Meanwhile, the average total weight of fruits was the highest (447.96) in the treatment of PGPM Streptomyces sp. and the lowest (388.92) in the treatment without PGPM.

The administration of PGPM (Plants Growth Promoting Microorganism) Streptomyces sp. and Trichoderma sp. at several different concentrations with a dose of 200 mL/plant by casting and 100 mL/plant by spraying has not been able to increase the number of flowers, the number of fruits per plant, the total number of fruits, and the weight of fruits. This can be because the dose and concentration of PGPM is less than optimal and less effective in increasing plant growth and production. This follows the opinion of Ardiyanto et al., (2017), stating that the frequency of administration and the concentration used are related to the process of plant growth and production. The results of the study that have been registered as a simple patent IPR Application Number: S00202005990 claim that the application of multi-antagonist Streptomyces narbonensis and Trichoderma harzianum (3:1) on tomato, melon, and chili plants is effective with application dose of 200 mL/plant and 300 mL/plant in vertisol (Suryaminarsih et al., 2019).

Flowering Period and Weight of Fruits per Plant Period 2

Based on the results of ANOVA, there was a significant effect of biological agents Streptomyces sp. and Trichoderma sp. on the flowering period and weight of fruits period 2. The average values of flowering period and weight of fruits due to biological agent treatment (PGPM) is presented in Table 2.

The latest flowering period (37.58 DAP) was obtained in the treatment of PGPM Trichoderma sp., while the earliest (33.99 DAP) was in the treatment of PGPM Streptomyces sp. The application of biological agents Streptomyces sp. and Trichoderma sp. significantly affected the weight of fruits for period 2, which was the highest (69.82 grams) in the treatment of Trichoderma sp. and the lowest (43.08 grams) in the control treatment. This follows Putri et al., (2018), stating that the use of 20 ml of PGPM influences the weight of fruits. Trichoderma sp. is a fungus that has a role as a biological agent that can increase the growth of shallot plants due to the application carried out directly to the planting media (Yanti et al., 2019). According to Kumar et al., (2017), the filtrate / soluble substance from Trichoderma viridae VKF3 derived from mangrove soils can produce a fairly high IAA and can suppress the development of pathogens.

The cherry tomato plants in this study were not attacked by Fusarium sp. because at the begin-

### Table 1. The average flowering period and weight of fruits per plant at period 2

<table>
<thead>
<tr>
<th>Concentration of PGPM Streptomyces: Trichoderma</th>
<th>Parameter</th>
<th>Flowering period (35 days after planting)</th>
<th>Weight of fruits per plant (gram)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without PGPM</td>
<td></td>
<td>35.16ab</td>
<td>43.08a</td>
</tr>
<tr>
<td>ST (1:0)</td>
<td></td>
<td>33.99a</td>
<td>54.93ab</td>
</tr>
<tr>
<td>ST (0:1)</td>
<td></td>
<td>37.58b</td>
<td>69.82b</td>
</tr>
<tr>
<td>ST (2:2)</td>
<td></td>
<td>37.53b</td>
<td>65.88b</td>
</tr>
<tr>
<td>ST (3:1)</td>
<td></td>
<td>34.31a</td>
<td>60.31 ab</td>
</tr>
<tr>
<td>BNJ 5%</td>
<td></td>
<td>2.88</td>
<td>17.55</td>
</tr>
</tbody>
</table>

Remarks: Means followed by the same letters are not significantly different based on HSD test at 5%, S = Streptomyces sp., T = Trichoderma sp.
ning of planting, biological agents of Streptomyces sp. and Trichoderma sp. were added to the soil in polybags. Trichoderma sp. is also a fungus that can degrade organic matter. Streptomyces sp. is a gram-positive bacterium functioning as a biofertilizer, bioremediation, and biological control agents that effectively controls plant disease pests. Streptomyces sp. and Trichoderma sp. are biological agents combined to be used as Plants Growth Promoting Microorganism (PGPM) to determine the increase in plant growth when the Plants Growth Promoting Microorganism (PGPM) has been given to cherry tomato plants. This follows Sutarman (2016), stating that Trichoderma sp. is a parasite fungus taking nutrients from other fungi. Widodo (2016) states that using PGPM can protect plants from pathogen infections. According to Keliat & Iftari (2017), the fungus Trichoderma sp. is a fungus found in all types of soil. Trichoderma sp. can be used as biological agents because of their ability to control pathogens that attack plants to reduce the presence of pests and plant diseases. According to Dendang (2015), Trichoderma sp. produces the enzyme $\beta$ - (1-3) glucanase and chitinase, which can cause exolysis able destroy the cell walls of the fungus Fusarium. Trichoderma sp. use can increase shallot plants’ growth and control diseases that attack plants (Yanti et al., 2019). Suryaminarsih et al., (2015) found that multi antagonist Trichoderma sp. can be applied to horticultural crops because it can help increase crop production. Trichoderma sp. can function as a fertilizer that is usually packaged in the form of compost as P and K solvents, increasing plant root growth and height. The Streptomyces sp. application at a dose of 30 ml, 20 ml, and 10 ml showed that the height, number of productive branches, root volume, diameter, and weight of fruits harvested in chili peppers tended to be better than control plants or without treatment. Plant height, the number of productive branches and the volume of roots increased by 27.3%, 24.3%, and 20.7%, respectively, with the application of Streptomyces sp. (Putri et al., 2018). The biological agent Streptomyces sp. is an actinobacterium that can produce bioactive compounds containing antibiotics, antiparasitics, and antifungals (Ekundayo et al., 2014). According to Purnomo et al., (2017), Streptomyces sp. can interfere with cell membrane function and synthesis of proteins and nucleic acids so that it can inhibit the growth of pathogenic fungi.

**CONCLUSION**

The application of Streptomyces sp. and Trichoderma sp. at a dose of 200 mL/plant by casting and 100 mL/plant by spraying with several different concentrations has not been able to promote the generative growth of cherry tomato plants. The application of Trichoderma sp. resulted in the latest

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**Table 2. The average plant height, number of leaves, number of flowers, number of fruits/plant, total fruits/plant, and weight of fruits/plant**

<table>
<thead>
<tr>
<th>Concentration of PGPM: Streptomyces: Trichoderma</th>
<th>Plant height</th>
<th>Number of leaves</th>
<th>Number of flowers</th>
<th>Number of fruits/plant</th>
<th>Total fruits/plant</th>
<th>Weight of fruits/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without PGPM</td>
<td>116.33</td>
<td>15.66</td>
<td>38.24</td>
<td>4.41</td>
<td>31.74</td>
<td>388.92</td>
</tr>
<tr>
<td>ST (1:0)</td>
<td>126.91</td>
<td>17.24</td>
<td>40.32</td>
<td>4.58</td>
<td>34.08</td>
<td>447.96</td>
</tr>
<tr>
<td>ST (0:1)</td>
<td>120.24</td>
<td>15.58</td>
<td>39.58</td>
<td>4.74</td>
<td>32.7</td>
<td>435.03</td>
</tr>
<tr>
<td>ST (2:2)</td>
<td>123.45</td>
<td>15.87</td>
<td>39.49</td>
<td>4.95</td>
<td>32.7</td>
<td>417.55</td>
</tr>
<tr>
<td>ST (3:1)</td>
<td>188.62</td>
<td>15.24</td>
<td>39.33</td>
<td>5.37</td>
<td>32.45</td>
<td>424.87</td>
</tr>
</tbody>
</table>

Remarks: SD = Standard deviation S = Streptomyces sp., T = Trichoderma sp.
flowering period (37.58 DAP), while the application of Streptomyces sp. produced the lowest one (33.99 DAP). The administration of PGPM has an influence on the weight of fruits which has the highest weight of fruits (69.82 grams) was obtained in the treatment of Trichoderma sp., while the lowest (43.08 grams) was in the control treatment.

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