Applications of mycorrhiza on potato growth and productivity

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Abstract. Mycorrhiza is a root plant symbiont functioning to increase mineral and nutrients absorption. Mycorrhiza fertilization to potatoes has to be monitored in order to observe the effects of mycorrhiza on the growth of potatoes. Therefore, the aim of this study was to analyze the effect of mycorrhiza on potato growth and production. This field research was conducted in Kledung village, Temanggung (1,138 masl) from 25 March to 25 June 2018. The method used was separated block design with 4 treatments and 20 replications in each plot. The first plot (P1) was the plot without treatment; the second plot (P2), positive control, was the plot treated with chemical fertilizer; the third plot (P3) was plot treated with organic fertilizer Bokasi and Trichoderma; and the fourth plot (P4) was fertilized using mycorrhiza. The data related to growth and production were analyzed using ANOVA and Tukey's test; while, to determine the best type of fertilizer among treatments t-test was used. The results showed that mycorrhizal application significantly increased height (20.12 cm \( p \leq 0.05 \)), the number of leaf (32.47, \( p \leq 0.05 \)), and potato production (213.70 gr). It can be concluded that the use of mycorrhiza significantly increased the growth and production of potato.

1. Introduction
In Indonesia, food development is designed as food security supported by variety of food resources, institution, and local culture. Among the food resources, potato has been considered a commodity supporting food diversification program and has become food alternative substitution for rice because it has high carbohydrate, protein, fat, and vitamin C (Suwardo, 2008). Potato plant (Solanum tuberosum), a short-lived vegetable crop, grows in the high altitude land of more than 1,000 meter above the sea level (MASL). According to Central Biro of Statistic/CBS (2015), the planting area of potatoes was 70,000 ha producing an average of 17 tons/ha.

In the environmental condition where potato grows well, pathogenic Phytophthora infestans. \( P. \) infestans, a hemibiotropic (a pathogen infecting live tissue), also grows well and triggers rot or blight on potato plants. As a result, potato production in the blight epidemic areas decreased significantly.

At present, \( P. \) infestans infection could be controlled by pesticide; although, its application is time consuming, expensive, and dangerous for both environment and users’ health. Therefore, to control the disease is carried out through integrated management practices including sanitation, certified seed utilization, breeding programs for cultivar resistance [4,6] and fertilization management [7].

Biological control agents such as Pseudomonas species, antagonistic fungi, and mycorrhizal fungi have been used to restrain Phytophthora disease. The use of biological agents in the form of mycorrhizal supplementation is most likely to be used as a prevention of Phytophthora infection. Therefore, the aim of this study was to analyze the role of mycorrhizae in preventing the occurrence of blight disease.
2. Method
The study was conducted in Kledung Village, Kledung District, Temanggung Regency of Central Java Province from 25 March to 25 June 2018. The altitude of the village is 1,138 meters above the sea level with an average temperature of around 18°C, and approximately 83% of air humidity. The research sample was potato seed (Solanum tuberosum L) of generation G-2, which was nationally certified by the Potato Seed Research Institute in Kledung Village, Temanggung.

A total of 160 potato plants were divided into 4 separated plots in one field (known as block B). Each plot was planted with 40 G-2 potato seeds, then covered by plastic mulch and leaved only a hole with a diameter of 10 cm to grow buds. The distance between two holes (as a stand) was 40 cm apart.

Each plot was loosened using manure, bokhasi, and Trichoderma. Watering plants and weeding were carried out every day. The application of herbicides and rodenticides was carried out once a week during the planting period. The first plot wasthe negative control (P1); a plot without being treated at all. The second plot wasthe positive control (P2); a plot treated with chemical/synthetic fertilizer using manufacturer's dosage; while, the third plot (P3); a plot treated only with an independent variable without chemical fertilizer. In the fourth plot (P4), potato plants were treated with mycorrhizae with a volume of 25 mg/L.

Observation was started a week after potatoseeds were planted, and was done once a week to measure plant height (cm), number of plants (stem), and number of leaves (strand). Meanwhile, the observation of the incubation period of leaf blight was done when the plant was approximately 30 days old. The number of tubers, the diameter of tuber, and the weight of tuber (gr) were measured at the time after harvesting.

The data obtained were analyzed using Analysis of Variants (ANOVA) at a 5% confidence level. If the treatments were significant, the comparison test (Tukey test at 5%) was conducted. To determine the best dosage of PGPR treatment, the groups that have significant differences in the Tukey test results were retested using t test, then, conclusion were taken. Meanwhile, the relationship between the growth and the productivity was analyzed using a one-way correlation test.

3. Result

Table 1. Statistical analysis of the effects of mycorrhiza on potato growth and production

| Plant | Leaves | Height (cm) | Production (gr) | Total Bulb |
|-------|--------|-------------|-----------------|------------|
| P1    | 2.33   | 18.03       | 7.70            | 103.60     | 6.10       |
| P2    | 2.90   | 25.78       | 18.12           | 216.00     | 11.40      |
| P3    | 2.40   | 30.58       | 15.82           | 210.90     | 9.90       |
| P4    | 3.30   | 32.47       | 20.12           | 213.70     | 12.30      |

Table 1 compares each treatment group consisting of control group (P1), without being applied with any treatment, synthetic fertilizer group (P2), bokhasi organic fertilizer + Trichoderma group (P3), and mycorrhiza enriched organic fertilizer group (P4).

The result of ANOVA analysis showed that fertilizer application did not have a significant impact on increasing the number of plants. The average number of plants from each treatment ranged from 2.33 to 3.30 stems. The highest number of plants was ± 3.30 stems obtained from the P4 group.

The application of mycorrhiza in the P4 group significantly affected the addition of leaves (32.47 strands), plant height (20.12 cm), and increase potatoes productivity by 213.70 gr when compared to the group without treatment (P1), which was equal to 103.60 gr. However, it was not significantly different from the synthetic fertilizer group (P2) of 216.00 gr and organic fertilizer allocation +
trichoderma 210.90 gr; therefore, it could be concluded that the application of mycorrhizal fertilizer had the same growth impact as synthetic fertilizers and growth enhancer’s gibberelin-auxin synthetic.

Although there were no significant differences in growth and productivity among treatment groups, the result of t test showed that organic fertilizer added with mycorrhiza was the best treatment as it triggered the growth and productivity of the potatoes.

4. Discussion
Mycorrhiza is a consensus of soil fungi that belongs to mold and yeast, which are able to symbiosis with roots of more than 80% of woody plants and agricultural crops [12]. Physiologically, the symbiosis between the roots of potato plants and mycorrhizae can increase the absorption of water, mineral, and compounds needed by plants. In other words, mycorrhizae are the extension of the roots in absorbing soil nutrients. The advantage obtained by mycorrhizae is the provision of nutrients, sugars and other compounds produced by plants to help the growth of mycorrhizae.

A number of studies reported that mycorrhizae is capable of reducing disease caused by pathogens. The reduced symptom identified in this study might be related to systemic resistance in the potato leaves occurring during the initial developmental stage of P. infestans. Recently, it was reported that tomato plants infected by B. cinerea [19] potato leaf genesin in response to P. infestans infections.

Conclusion
Based on the results, the application of mycorrhiza proves to be able to increase potato plant growth and seed productivity. Mycorrhiza is also proven to delay the occurrence of infection in potato, as protection system of the plant increases.

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