Research article

Effects of Plant Growth-Promoting Rhizobacteria and Trichoderma sp. on Potato Growth on Medium Plains

Susiana Purwantisari*, Rejeki Siti Ferniah, Yulita Nurchayati, Siti Nur Jannah

Universitas Diponegoro, Semarang, Indonesia

ORCID
Susiana Purwantisari https://orcid.org/0000-0003-0934-1146

Abstract.
The potato is a horticultural commodity with a high economic value and a consistent selling price. Indonesian potato production, however, remains lower than that of other Asian countries. One reason for this is that environmental sustainability has influenced the expansion of potato cultivation on a plateau, so medium plains have become an alternative. Aside from high-quality seeds, using plant growth-promoting rhizobacteria (PGPR) and *Trichoderma* sp. as an organic fertilizer is a strategic effort to boost potato yields on medium plains. The focus of this research was to examine how PGPR and *Trichoderma* sp. affect the growth of potatoes on medium plains. This study was carried out in Temanggung and Sawangan, Magelang, Jawa Tengah, at an altitude of 480 m.a.s.l, using the a complete random design with four different treatments: P0 = control, Treatment P1 = PGPR 20 ml/10 liter water, Treatment P2 = PGPR 40 ml/10 liter water, Treatment P3 = *Trichoderma* 80 gram/10 liter water, Treatment P4 = *Trichoderma* 150 gram/10 liter water, and Treatment P5 = PGPR 20 ml/10 liter water + *Trichoderma* 80 gram/10 liter water. The study found that a combination of PGPR and *Trichoderma* sp. treatment resulted in better growth than a single PGPR treatment.

Keywords: biopesticide, organic fertilizer, PGPR

Corresponding Author: Susiana Purwantisari; email: susiana_purwantisari@yahoo.co.id

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1. Introduction

Potato (Solanum tuberosum L.) is an annual crop. Its considered carbohydrate vegetables by Indonesian people, it has high economic value with a stable selling price, but the production is still not good enough. According to the Statistic Indonesia, more than 15.40 tons/ha of potato is produced in 2019 [1]. Its lower than other Asian countries production. These causes are infertile soil, low availability of macro and micro nutrients, pest and disease, unbalanced fertilization, using high concentrations chemical fertilizers, and improper cultivation. Potato crop usually planted on a plateau, but its cause erotion. Therefore, planting potatoes on medium plains is an alternative to avoid environmental damage. The medium plains area becomes an alternative for developing of potato plant. So that the planting area on a plateau is getting limited [2].

Application of Plant Growth Promoting Rhizobacteria (PGPR) and *Trichoderma* sp. is the one of effort to improve potato productivity. PGPR is a beneficial microbe/bacterium found in the roots rhizosphere that stimulate plant growth and against plant pathogens [3]. The research Soesanto et al., (2013) revealed that the biological agents in PGPR are stimulate the growth of plant, number of leaves, number of tillers and suppress pathogens [4]. So the plants are growing without pathogens infected. PGPR also produce phytohormones, such as auxins and cytokinin. Auxins and cytokinin are booster hormone for plant growth that play a role in the process of cell division and elongation for better growth [5].

Trichoderma harzianum and *Trichoderma viride* also controlling soil pathogenic fungi, soil decomposers and strengthen the resistance of potato plant by availability for nutrients for producing of bulbs in the soil [6]. Antagonist of *Trichoderma* sp. plays a blocking role of other pathogenic fungi, because its produce chitinase enzymes, which more effective than chitinase enzymes produced by other organisms for obstructing of various pathogenic fungi [7,8], The research aim to determine that the combination treatment of PGPR and Trichoderma sp. on the Potato Vegetative Growth on Medium plains impacted to the local potato farmer.

2. Methodology

This study was conducted at Sawangan, Magelan on altitude 480 m.a.s.l, from April up to July 2021

2.1. Materials and Tools

The materials used are soil media with a pH of 6 organic manure, 18 sacks of rice husks, TSP fertilizer, 5 kg pearl fertilizer, 10 kg KCL fertilizer, 15 kg phonska fertilizer, 10 kg ZA fertilizer, PGPR fertilizer, Trichoderma fertilizer, water and G2 potato seeds. The tools used are silver plastic, hoe or soil processing tool, stirrer, fertilizer container, measuring cup, electronic scale, meter, ruler, and name tag or marker.

This research using random group system with 6 treatments and 16 replications for each treatment, as follow :

P0 :Controling

P1 : PGPR 20 ml/10 liters of water

P2 : PGPR 40 ml/10 liters of water

P3 : Pouring Trichoderma 80 grams / 10 liters water

P4 : Pouring Trichoderma 150 grams / 10 liters water,

P5: Pouring PGPR 20 ml / 10 liters of water + Trichoderma 80 grams / 10 liters water

2.2. Research Implementation

The first stages is preparing plant media by mixing soil and manure with a pH approx. 6. Then organic fertilizers, rice husks, chemical fertilizers consisting of TS fertilizer, KCL fertilizer, pearl fertilizer, and ZA fertilizer put alternately on top of the plant media. The distance between the seedling plant is 60 x 60 cm, with 16 holes for planting of potato seeds in each treatment, then planted potato seeds are made into glutan then covered by plastic mulch. The typing of treatment will be done after planting the G2 potato seeds. Observations will be done 1 week after planting (MST). Observations of plant growth consist of plant height, number of leaves, and number of shoots

2.3. Data Analysis

Obtained datas will be analyzed by the Analysis of Variance (ANOVA) with a significance level of 5%. Statistical analysis done by the Microsoft Excel program. The ANOVA distribution is intended to determine the effect of treatment factors on the diversity of experimental data.

3. Result and Discussion

3.1. Plant Height

Based on variance analysis (ANOVA), its revealed that $F_{calculation} < F_{table}$, so the application of PGPR fertilizer had not affected on the height of potato plants. This is in line with Firmansyah, et al (2018) that the planting media and PGPR fertilizer dose did not impacted a significant difference in the parameters of live percentage, plant height, plant diameter, number of leaves, and plant sturdiness of *Gyrinops versteegii* [9]. The plant height of each treatment seen in Figure 1. The reseach revealed that application of PGPR did not resulted a significant difference between treated potato plants and potato plants without treatment or control.

However, the treatment of PGPR combined with *Trichoderma* sp. effected to the plants higher than plants treated by PGPR its self or the plants that not treated by

PGPR, so the combination of PGPR and Trichoderma resulted optimum potato plant height.

The average of highest plant was revealed in the treatment of P5 plants (pouring PGPR 20 ml/10 liters of water + Trichoderma 80 grams/10 liters of water) resulted an average plant height during 42 DAP is 29.09 cm. This happens because *Trichoderma* degrade organic matter becomes nutrients for improving plant growth properly, Trichoderma also plays a role as an antagonist microbe to suppress the expanding of pathogenic microbes, so the potato plants are free from disease and growing optimally. *Trichoderma* is proved effectively controlling the growth of pathogenic fungi, especially in late blight disease [10] . Antagonistic of *Trichoderma* sp. able to be used as an alternative control of environmentally friendly pathogens. According to Purwantisari (2018), the advantages of using *Trichoderma* sp. is adapted of natural conditions and not invasive [8]. Purwantisari (2009) noted that *Trichoderma* sp. also plays a role in accelerating plant growth and increasing crop yields [11].

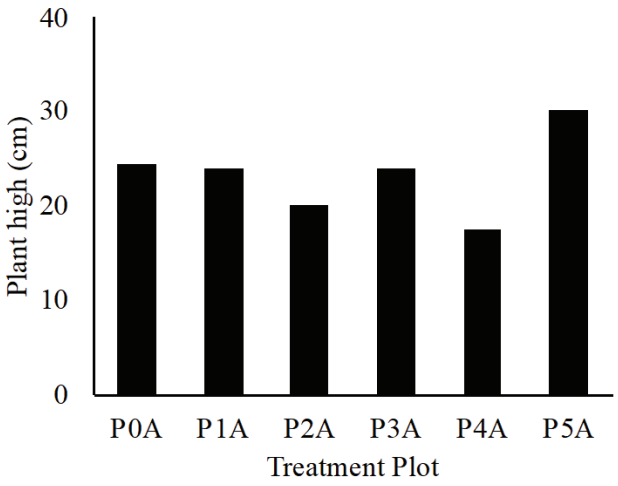

Figure 1: The average potato plant height was 42 HST on the administration of PGPR and the combination of Trichoderma sp.

3.2. Number of Leaves

The observations revealed that the number of leaves continues to grow from the second week until the end of the study. It proves the difference impact of PGPR and *Trichoderma* sp. application on the number of leaves. Combination treatment of PGPR and Trichoderma sp. resulted an increasing number of leaves from 14 DAP until the end of the study.

Based on diversity analysis (ANOVA) it was proven that there was no significant impact of using a certain level of PGPR concentration on the number of leaves of potato plants, seen in Figure 2. The study outcomes showed that using or not using of PGPR has not significant difference affected to the increasing number of leaves. However, the combined treatment of PGPR with Trichoderma sp. resulted more number of leaves than using PGPR itself or not using PGPR.

The average highest number of leaves at 42 DAP was happened on the P5 treatment (pouring PGPR 20 ml/10 liters of water + Trichoderma 80 grams/10 liters of water) which was 16.1875 leaves. This is presuming that Trichoderma sp. caused the soil ecology around plant roots suppressing soil pathogenic fungi such as *Phytopthora infestan* who attack the leaf tissue of potatoes.

A previous study from Muhibbudin et. al., (2021) revealed that *Trichoderma harzianum* and *T. viride* other than playing a role in controlling of soil pathogenic fungi also playing a role in soil decomposers and providing nutrients for a forming bulb in the soil [12]. This is in accordance with the opinion of Singh et. al., (2021) that *T. harzianum, T. hamatum, T. viride,* and *T. reesei* are able to act as decomposers for increasing soil fertility, so they can stimulate plant growth and production. Purwantisari (2021) adds, the application of T. harzianum significantly effect on increasing of potato productivity [13].

The best treatment for increasing number of leaves is on the P5 treatment, is Pouring PGPR 20 ml/10 liters of water + *Trichoderma* 80 grams/10 liters of water which reached the average of 16.2 leaves high. This best result was cause of an appropriate relation between two treatments, so they gave the most optimum results. These results are in accordance with the research of Wang et. al., (2019) that the treatment of *Trichoderma* and PGPR had an interaction with the intensity of leaf rot of onion plants at 42 DAP [14] .

3.3. Number of shoots

Mostly, the number of shoots of potato better formed by application of PGPR . This happened because of the role of microorganism it self. The ability of microorganisms in PGPR produce a phytohormones to makes the plants improve the surface area of fine roots, shoot formation and increasing of nutrients in the soil [3]. Base on the analysis of variance (ANOVA) of potato plants is Fhit>Ftable, so application of PGPR and Trichoderma effected significantly different impact between the treatments.

The number of shoots of potato plants for each treatment seen in Figure 3. The study revealed that using PGPR and Trichoderma influencing the number of shoots of potato

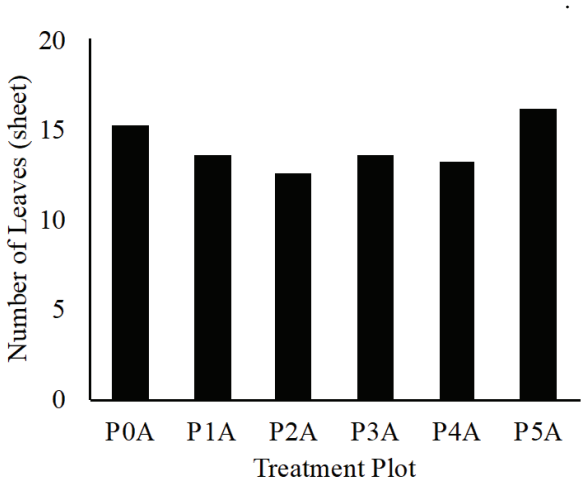

Figure 2: The number of leaves of potato plants was 42 DAP on the administration of PGPR and the combination of Trichoderma sp.

growth . The high number of shoots growth mostly by P1 treatment (Pouring PGPR 20 ml/10 liters of water) which was 1.93 shoots. This is in accordance with Rante (2015) that the single treatment of PGPR compare to the combination treatment of PGPR and *Trichoderma* sp. significantly increase the number of shoots formation. The highest number of shoots resulted by the PGPR treatment was 6.25 shoots and the lowest one was 2.20 shoots in the controlling treatment [5].

This study are in accordance with Purwantisari (2019) that using of PGPR increasing the number of shoots of potato plants. Cause the secretion of auxin, gibberellins and cytokinins produced by bacteria in PGPR stimulate the formation of shoot of potato plants [15].

4. Conclusion

The application of single treatment of PGPR in various doses has no impact for the plant height and leaf number of potato plants growth. The combination treatment of PGPR and Trichoderma sp resulted a significant impact for plant height and number of leaves growth. The combination treatment of PGPR and Trichoderma sp resulted the growing of height of potato plants optimally. The study revealed that the application of combination treatment of PGPR and Trichoderma sp influencing the number of shoots of potato plants growth . The high number of shoots growth mostly by P1 treatment (Pouring PGPR 20 ml/10 liters of water) which was 1.93.

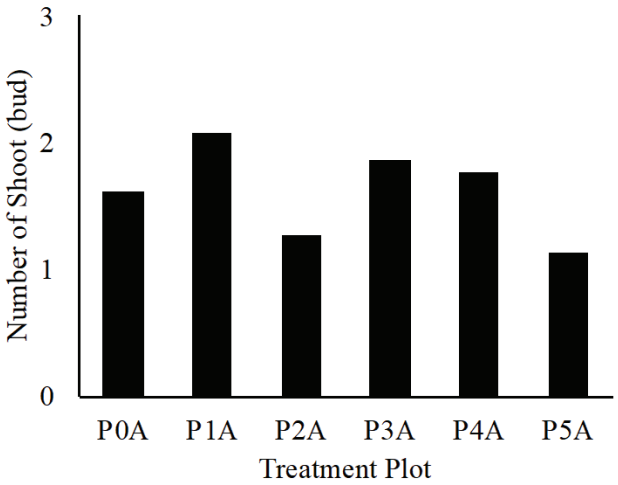

Figure 3: The number of potato shoots was 42 DAP on the administration of PGPR and the combination of Trichoderma sp.

References

[1] [BPS], Badan Pusat Statistik. Luas Panen dan Produksi Kentang 2017-2019. [Online]. Available: https://jateng.bps.go.id/indicator/55/731/1/luas-panen-dan-produksi-kentang.html. [Accessed: 14-Oct-2020].

[2] Djuariah D, Handayani T, Sofiari E. Toleransi Tanaman Kentang (Solanum tuberosum) terhadap Suhu Tinggi Berdasarkan Kemampuan Berproduksi di Dataran Medium [Heat Stress Potato (Solanum tuberosum) Tolerance Based on Tuber Production in Medium Altitude] Jurnal Hortikultura. 2017;27(1):1–10.

[3] Zaidi A, Khan MS. Role of nitrogen-fixing plant growth- promoting Rhizobacteria in sustainable production of vegetables: Current Perspective. in A. Zaidi, M.S. Khan (eds.). Microbial strategies for vegetable production (pp: 43-79). Springer International Publishing AG 2017

[4] Ekin Z. Integrated use of humic acid and plant growth promoting rhizobacteria to ensure higher potato productivity in sustainable agriculture. Sustainability. 2017:11(12):1-13.

[5] Nasiri A, Yarnia M, Hassanpanah D, Farahvash F, Khalivand E. The response of different potato cultivars to plant growth-promoting rhizobacteria (PGPRs) and chemical fertilizers in aeroponic culture conditions. Journal of Plant Nutrtition. 2022;45(11):1–11.

[6] Waghunde RR, Rahul MS, Ambalal NS. Trichoderma: A significant fungus for agriculture and environment African Journal of Agricultural Research. 2016;(11)22: 1952–1965.

[7] Kai K, Mine K, Akiyama K, Ohki S, Hayashi H. Anti-plant viral activity of peptaibols, trichorzins HA II, HA V, and HA VI, isolated from Trichoderma harzianum HK-61 Journal of Pesticide Science. 2018;43(4): 283–286.

[8] Purwantisari S, Priyatmojo A, Sancayaningsih RP, Kasiamdari RS, Budihardjo K. Systemic inducing resistance against late blight by applying antagonist Trichoderma Viride Journal of. Physic: Conference Series. 2018;1025(1):1-6.

[9] Firmansyah A, Markum DM, Indriyatno I. Pengaruh komposisi media tanam dan pemberian dosis pupuk PGPR (plant growth promoting rhizobacteria) terhadap pertumbuhan semai ketimunan (Gyrinops versteegii) cabutan [The effect of the composition of planting media and the giving of PGPR (plant growth promoting rhizobavteria] Jurnal Belantara. 2018;1(1) 30–34.

[10] Silva RN, Monteiro VN, Steindorff AS, Gomes EV, Noronha EF, Ulhoa CJ. Trichoderma/pathogen/plant interaction in pre-harvest food security Fungal Biology. 2019;123(8): 565–583.

[11] Purwantisari S, Hastuti B. Uji antagonisme jamur patogen Phytophthora infestans penyebab penyakit busuk daun dan umbi tanaman kentang dengan menggunakan Trichoderma spp. Isolat Lokal. Jurnal Bioma. 2009;11(1): 24-32.

[12] Muhibbudin A, Setiyowati EM, Sektiono AW. Mechanism anatagonism of Trichoderma viride against several types of pathogens and production of secondary metabolites Agrosaintifika. 2021; 4(1): 243–253.

[13] Singh RP, Gangwar SK, Kundu MS. Trichoderma spp.: An eco-friendly approach for disease management, Agriblossom, 2021;1(9): 3–14.

[14] Wang Z , Li Y, Zhuang L, Yue Y, Liu J, Zhang L, Gao Z, Wu Y, Gao W, Ding GC, Wang Q, A rhizosphere-derived consortium of Bacillus subtilis and Trichoderma harzianum suppresses common scab of potato and increases yield Computational and Structural Biotechnology Journal. 2019;17(1): 645–653.

[15] Purwantisari S, Parman S, Karnoto K, Budihardjo K. The growth and the production of potato plant supplemented by plant growth promoting rhizobacteria (PGPR). Journal of Physic: Conference Series. 2019;1217(1): 1-6.