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The Effect of Plant Growth Promotion Rhizobacteria Inoculation To Agronomic Traits of Aromatic Rice (*Oryza sativa* CV. Inpago Unsoed 1)

Purwanto¹, T Agustono¹, Mujiono¹, T Widiatmoko¹, and B R Widjonarko¹

¹Departement of Agrotechnology, Faculty of Agriculture Jenderal Soedirman University
Jl. Dr. Suparno KP 125 Purwokerto Central Java Indonesia

Email : purwanto.unsoed@gmail.com

Abstract. The aim of this research was to study the effect of Plant Growth Promotion Rhizobacteria to improve agronomic traits of rice plant. The research was held in Agronomy and Horticulture Laboratory from September 2017 until March 2018. The research was arranged with randomized block design with three replications the treatment consisted of 9 isolates of PGPR and control. The observed variables including plant height, leaf area, number of tillers, leaf greenness, root dry weight, plant dry weight, total roots length, number of productive tillers, panicle length, number of grains per panicle, weight of 1000 seeds and grain yield. The result showed that inoculation of PGPR gave the effect on number tillers, plant height, but did not gave the effect on rice yield. Isolate R11 was the the best isolates that gave the effect on rice plant growth.

Keyword : rice, PGPR, inoculation, agronomic, trait

1. Introduction

Rice is the main food crops as a source of carbohydrates, protein, and vitamins for the people of Indonesia. As a source of vitamins, rice is capable of a source of niacin, riboflavin with vitamin content ranging from 27-32% [1] The increase in population has spurred the increase in demand and the level of national rice consumption. Indonesia ranks 5th world with rice consumption per capita reaching 132 kg [2]. Fulfillment of national rice needs is pursued through the intensification program with very intensive agrochemical inputs, and lately it has led to the levelling-off symptoms in rice production. This condition is a weakness of intensive agriculture so sustainability is very limited due to soil sickness which causes pests in the soil, disturbances in physico-chemical physical properties, and autotoxicity [3]

An environmentally friendly technology approach in rice production can be carried out with the application of bioameliorant through the application of useful organic manure and beneficial microorganism that can increase growth and health of plants. The use of bacteria or often called Plant Growth Promotion Rhizobacteria (PGPR) can increase plant growth through nitrogen fixation activities, nutrient solubilization, antibiotic production and production of growth regulators. [4] reported that application of bioameliorant combined with a consortium of bacteria and *Trichoderma* sp. has increased rice productivity and induced systemic resistance of the rice plant to brown spot, sheath rice blight and bacterial leaf blight diseases.

The strategy for obtaining adaptive PGPR and being able to stimulate rice plant growth is carried out by isolating it from plant rhizosphere so that bacteria indigenous to paddy fields will be obtained. [5] stated that application rhizobacteria as biofertilizers have potential as biofertilizer to replace chemical fertilizers and pesticides for rice production. Various PGPR have been isolated from paddy soil such as *Rhizobium* sp. LM-5, *Herbaspirillum* sp., *Burkholderia* sp., *Pseudacidovorax* sp., *Azospirillum* sp. [6,7]. [8] reported that *Bacillus megaterium* and *Arthrobacter chlorophenolicus* showed positive result in N₂ fixation and phosphate solubilization. Inoculation of *Azotobacter chroococcum*, and *Azpspirillum brasiliense* in rice production gave significant effect on plant growth



attributes, yield and also saving of 50 percent of chemical fertilizer [9]. The aims of this research was to study the effect of indigenous PGPR on rice growth attributes and yield.

2. Materials and Methods

Pots experiment was conducted in Green House of Experimental Farm, Agriculture Faculty of Jenderal Soedirman University Purwokerto from September 2017 until January 2018. Inceptisol soil was used as growth medium.

The experimental design was a randomized completely block design with three replications. The treatments were 9 the isolates of PGPR from rice rhizosphere and control without inoculation of PGPR. The strains of PGPR were used in this research consisted of 9 isolates of PGPR and control. Before the application, PGPR was grown in NB medium (Himedia). One ose of isolate was strike into NB medium and then shaking for 72 hours with 120 rpm. Rice seeds was sterilization by using ethanol for 1 minute and soaking with sterile aquades. Rice seeds was germinated in petridish. Rice seedling was transplated at 21 days after sowing. Rice seedling were inoculated by soaking of seedling in to PGPR solution for 5 minutes, and then planted with 2 seedling per polybag. Fertilizer application consisted of urea 50 kg ha⁻¹, Super Phosphate (SP-36) 150 kg ha⁻¹, and KCl 150 kg ha⁻¹.

The observation variables were plant height, number of tillers, leaf area [10], plant biomassa, leaf greenness (measured with SPAD-502 Plus Chlorophyll meter, Conica-Minolta), number of productive tillers, panicle lenght, number of grains per panicle, 1000 grains weight, grains yield (at 14 % of water contents). The data were analysed by ANOVA (SAS 9.1), if the result significant different was continued by Duncan Multiple Range Test at 95% confidence level.

3. Result And Discussion

3.1. Effect of PGPR inoculation on rice plant growth

Plant Growth Promotion Rhizobacteria as useful microorganisms for the growth of rice plants can affect plant growth through colonization in root areas. The ability to colonize and dominate the rhizosphere will have mutually beneficial interactions between plants and microbes so that plant growth increases. The treatment of inoculation through soaking the roots of rice seedlings showed a significant effect on plant growth through plant height and the number of tillers per clump in the maximum vegetative phase

Inoculation with isolate R04 showed the highest plant height reached 80.76 cm (Figure 1). PGPR inoculation can stimulate the growth of very large plant heights. Increased plant height ranged from 14.81 - 26.23 percent to control. This condition indicates that PGPR inoculation in rice plants can increase vegetative growth well. This is also seen in the variable number of tillers per clump. The number of tillers of rice plants increased in the provision of PGPR inoculation compared to without inoculation. The increase in the number of tillers increased by 113 percent against the control without PGPR inoculation. The highest number of total tillers was generated in the R08 isolate inoculation treatment of 12.42 tillers, although there were no significant differences with the inoculations of P10 and R01 isolates 12 and 12.33 tillers per clump respectively (Figure 2).

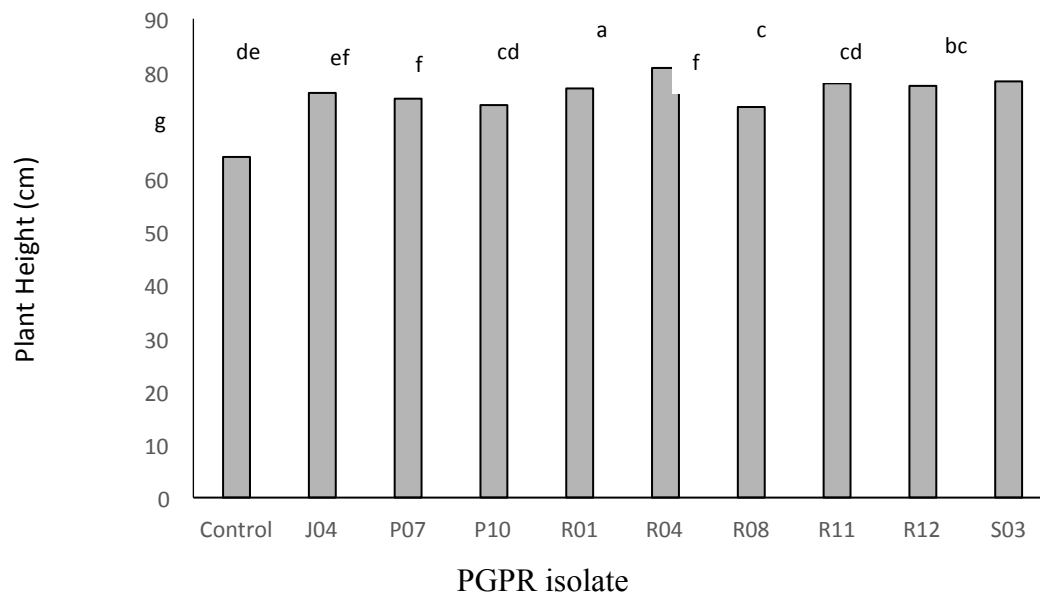


Figure 1. Effect PGPR inoculation on plant height of rice plant

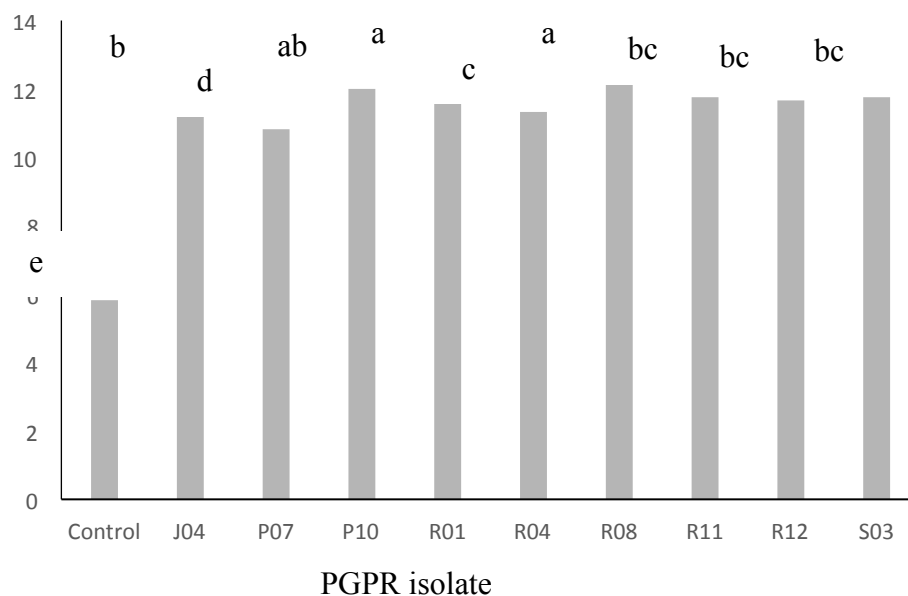


Figure 2. Effect PGPR inoculation on number of tiller per clump

Tillers in rice plants are the development of leaf axils on each unelongated node on the main stem or from other tillers in the vegetative phase [10]. The status of employment is very influential on plant height and number of tillers per clump. Besides that, physiological factors, especially hormonal levels of plants, are very influential. The ability of PGPR to produce growth regulators is very important for the supply and hormonal balance of plants. Bacteria colonize plant roots and utilize root exudates to synthesize IAA as a growth regulator. Bacteria are able to balance plant hormones levels by synthesizing and secreting phytohormones and thus increasing plant growth.

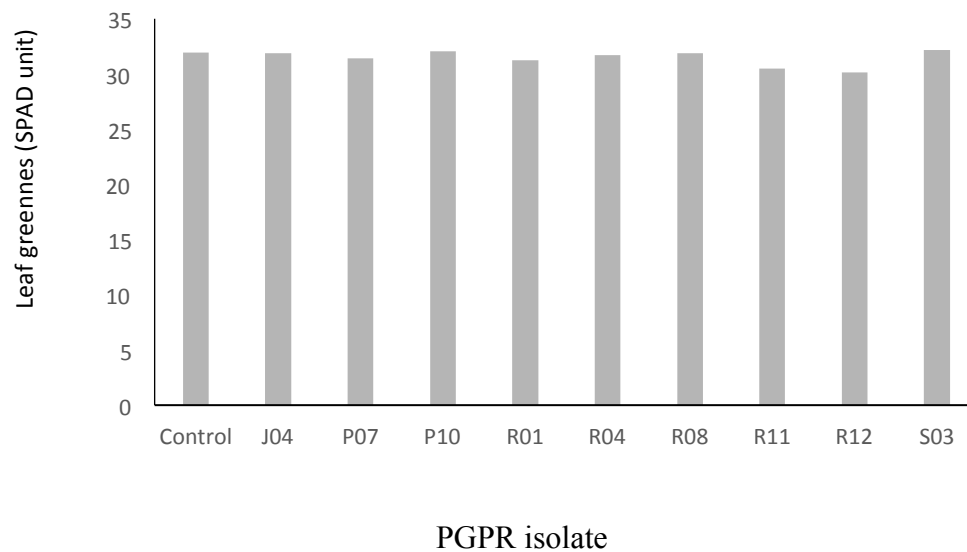


Figure 3. Effect PGPR inoculation on leaf greenness of rice

Inoculation of PGPR in rice has not given a significant effect on the variable greenness of leaves, leaf area, and root length. In the greenness of the leaves, it was seen that the greenish value of the leaves ranged from 30.12 to 32.14 obtained in the inoculation of S03 isolates. The greenish value of leaves is one of the factors that influence C assimilation activity, where the main constituent of leaf properties is the chlorophyll pigment. Chlorophyll acts as a reaction center for photosynthesis. Chlorophyll levels are more influenced by leaf N levels. Inoculation has no effect on leaf greenness due to the supply of N derived from inorganic fertilizer or soil which have been able to supply sufficient N plants. In conditions of N nutrient adequacy, the activity of soil microorganisms such as fixation activities will be disrupted, and plant chlorophyll is highly influenced by N nutrients derived from inorganic fertilizers [11].

PGPR inoculation has an effect on increasing leaf area. PGPR inoculation can increase leaf area to 91.10 percent compared to control. The higher leaf area reached in the treatment of PGPR isolates J04 and R08 reached 838.15 cm² and 823.54 cm² respectively (Figure 4). The increase in leaf area of the plant has to do with the increase in the number of tillers in the PGPR inoculation treatment. The ability of PGPR to colonize roots so that they can utilize root exudates and produce fitohormones, especially IAA, can increase root length so that nutrient uptake of plants increases.

The data show that the treatment of various PGPR isolates was able to increase the total root length to 94.56 percent compared to control. The rice plants treated with PGPR inoculation had an average root length of 2509.54 cm, while the root length of the control plants only reached 1289.88 cm. The longest root length of rice plants was achieved in the inoculation treatment with R08 isolates reaching 3209.64 cm (Figure 5). PGPR affects the root growth of rice plants with an increase outside the root surface and root length. [12] stated that the content of fitohormones such as IAA had a positive effect on plant growth and development such as root growth so as to increase the uptake of water and mineral absorption from nutrient-rich pool of soil. Inoculation of bacteria was able to stimulate the growth of rooting of wheat plants where an increase the number of root tips and branches was 60 and 68 percent respectively.

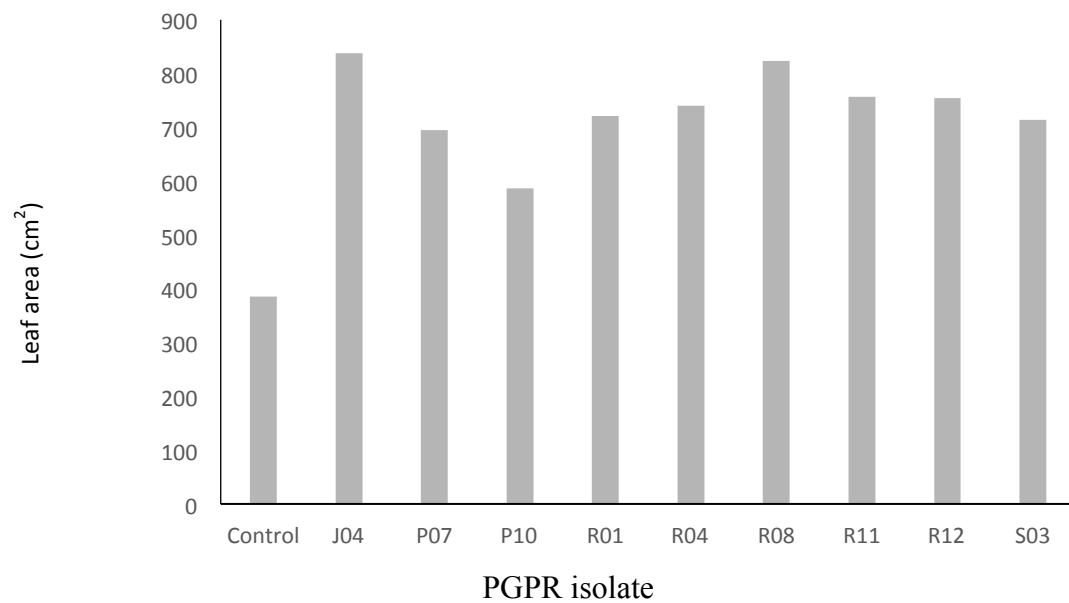


Figure 4. Effect PGPR inoculation on leaf area

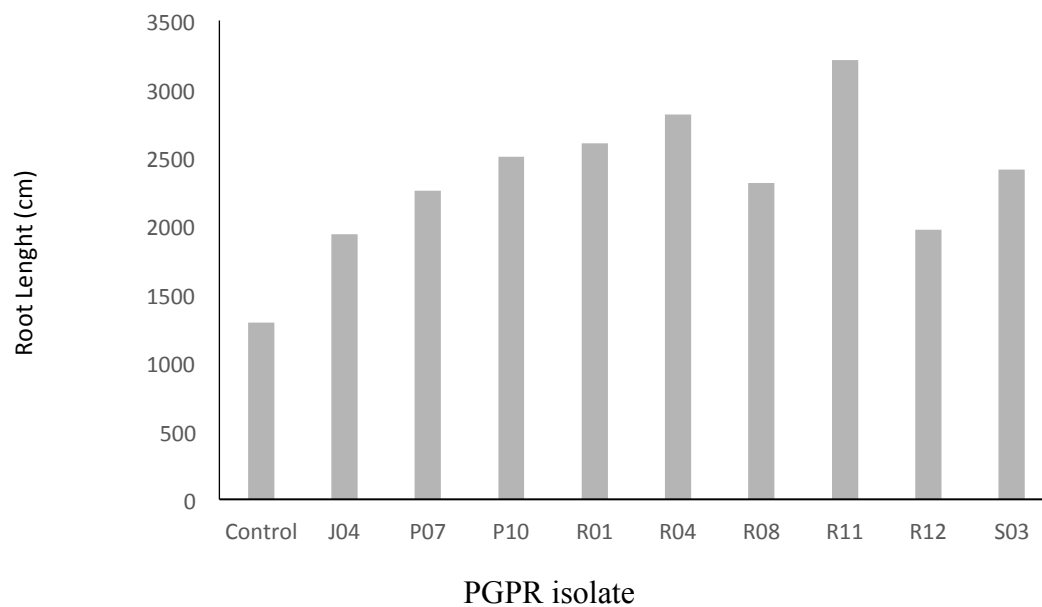


Figure 5. Effect PGPR inoculation on root length

3.2. The Effect of PGPR inoculation on yield and yield components of rice.

The yield of rice plants in general is determined by variations in yield components such as the number of productive tillers, panicle length, and the weight of 1000 seeds. The results showed that inoculation bacteria had no effect on the variable number of productive tillers, panicle length, and weight of 1000 seeds (Table 1).

The number of tillers in the generative phase will decrease from the total number of tillers formed in the vegetative phase. Nutritional status plays a role in determining the small number of productive tillers. Availability of nutrients from inorganic fertilizers both in the treatment of PGPR and control caused no differences effect in the variable number of tillers, panicle length, and weight of 1000 seeds.

Table 1. Effect of PGPR inoculation in yield component of rice

Treatments	Number of Productive Tillers	Weight of 1000 seeds (g)	Panicle Length (cm)
Control	6,11a	24,46a	20,91a
J04	7,78a	27,02a	21,38a
P07	8,89a	26,23a	21,50a
P10	7,67a	26,42a	21,92a
R01	8,22a	26,37a	21,10a
R04	7,89a	25,80a	21,59a
R08	8,33a	26,91a	21,58a
R11	9,22a	26,00a	21,63a
R12	8,00a	26,53a	21,32a
S03	7,67a	26,69a	21,72a

Remarks: the numbers followed by the same letters in the same column are not significantly different according to DMRT 5%.

The results showed that inoculation of bacteria did not provide significant differences on rice yields. The grain yield per clump in the inoculation bacteria treatment was able to reach an average of 12.27 g, while in control plants it only produced an average of 8.45 g per clump. This indicates an increase in yield of 45.19 percent towards control. The highest yield was obtained from the isolate R11 treatment reached 12.94 g per clump, followed by the treatment of isolates P10, R08, and J04 capable of producing grain of 12.57, 12.32, and 12.32 g per clump respectively (Figure 6).

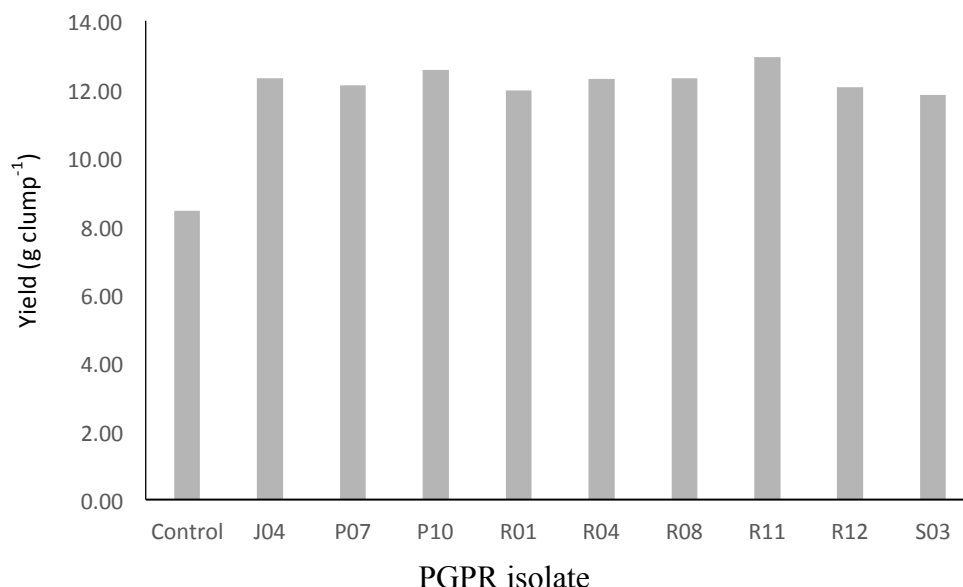


Figure 6. Effect PGPR inoculation on rice yield

4. Conclusions

Inoculation of indigenous PGPR was able to increase the growth of rice plants, especially plant height, and the number of total tillers, however, the treatment of PGPR inoculation has not been able to increase the yield of aromatic rice (*Oryza sativa* cv. Inpago UNSOED 1). The isolate R11 treatment gave the highest grain yield of 12.94 g per clump.

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