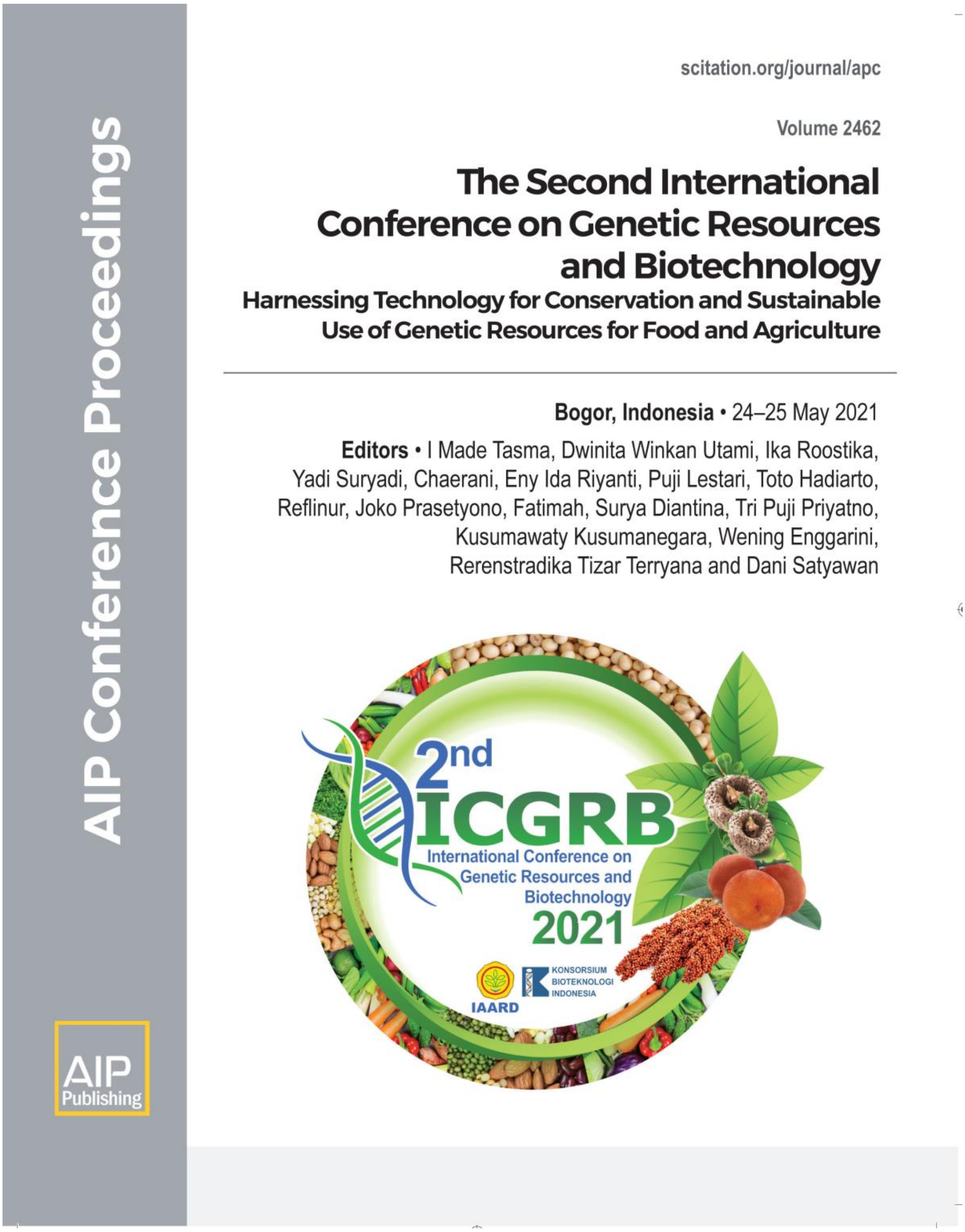

January 2022

THE SECOND INTERNATIONAL CONFERENCE ON GENETIC RESOURCES AND BIOTECHNOLOGY: Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture

Committees: The Second International Conference on Genetic Resources and Biotechnology

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Preface: The Second International Conference on Genetic Resources and Biotechnology

The Second International Conference on Genetic Resources and Biotechnology, which is the continuation of the first event held in 2018, focuses on topics related to advances in biotechnology to create more opportunities for effective conservation and sustainable utilization of genetic resources for food and agriculture. This year conference's theme is Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture. The conference was organized by Indonesian Agency for Agricultural Research and Development (IAARD), Ministry of Agriculture, Indonesia, in collaboration with Indonesian Biotechnology Consortium and held on 24^{th}-25^{th} of May 2021virtually due to the pandemic of COVID-19.

The conference aims to share and exchange current scientific information and technological developments on biotechnology and their applications for conservation and sustainable use of genetic, to encourage and promote quality, efficiency, and modernization of management and utilization of genetic resources, and to facilitate national and international collaboration among participants. There are five scopes discussed in this conference. They are effective management of conservation and sustainable use of genetic resources for food and agriculture, application of genomics and molecular markers for genetic resource conservation and crop adaptation to climate change, application of innovative crop improvement techniques for conservation and sustainable use of plant genetic resources for food and agriculture, plant cell and tissue culture for conservation and effective utilization of genetic resources, and the use of microbial genetic resources as biological control agents of agricultural pests and diseases, and for soil bioremediation.

Five speakers from the United States of America, Japan, India and Indonesia were invited to discuss about their expertise and knowledge on relevant subjects in the plenary sessions. This conference was attended by more than 100 participants including 75 presenters and 44 listeners worldwide. They came from diverse governmental, private, or academic institutions and also scientific communities. The presented materials have undergone peer review processes and only qualified papers were selected. Furthermore, all papers were subjected to double blind peer-review and expected to meet the scientific criteria of significance and academic excellence to be published in a conference proceedings indexed in a well-known, reputable service.

We would like to express our sincere gratitude to our speakers, presenters and all participants for their contributions in this conference. We would also like to express our appreciation for the generosity of our sponsors that support this conference: PT CropLife, PT ITS Science Indonesia, PT Fajar Mas Murni and PT Prima Instrument Analitika. Lastly, special thanks to all committee members for their exceptional work and contributions in the conference and publication.

Chair of Organizing Committee

Dr. Toto Hadiarto

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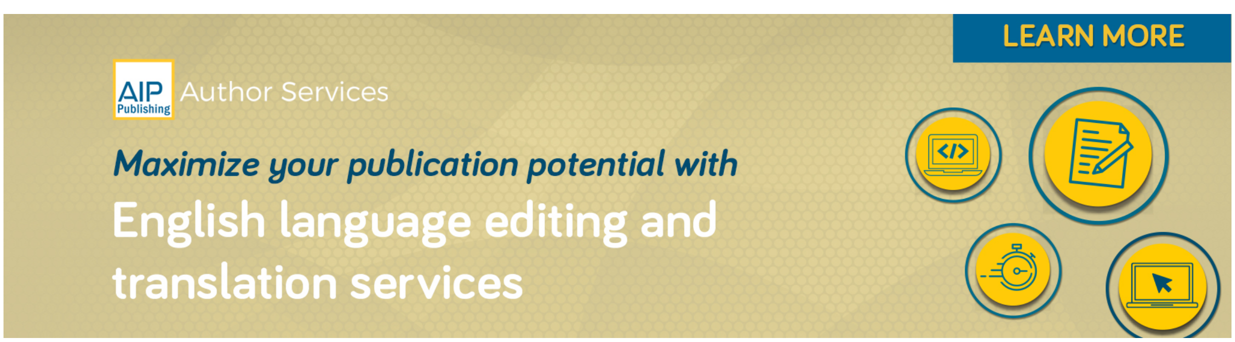

Effect of Nitrogen Fixation and Phosphate Solubilizing Bacteria on Growth and Yield of Lowland Rice in Different Soil Type

Ikhwani[1, a)], Higa Afza[2], Siti Yuriyah[2] and Waluyo[3]

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Abstract. Efficiency of nitrogen and phosphate fertilization in soil for rice cultivation could be improved using microorganism biofertilizer. This study aimed to investigate the effect of nitrogen fixation and phosphate solubilizing bacteria on growth and yield trait of lowland rice in alluvial and latosol soils. The experiment was conducted at greenhouse arranged in factorial randomize block design with two factors (soil type and bacterial isolates) and three replications. The first factor was two soil type consisted of alluvial and latosol soils. The results showed that alluvial soil type had the best results on growth and yield more than latosol soil. The filled grain on alluvial soil had number/plant highest of 1,755.5 more than latosol soil. The latosol isolate on alluvial soil had highest for plant height (9.50 cm), 3.33 of tiller number, and 2.0 of panicle number per plant more than alluvial isolate. The interaction of soil type and isolate effects showed no significant response for all traits at generative stage. In term of yield component trait, latosol isolate had better response for grain compared with alluvial isolate, both in alluvial and latosol soils. This finding had potential to latosol isolate further in alluvial and latosol soils.

INTRODUCTION

Rice (*Oryza sativa*) has pivotal role for more 3.5 billion people in the world [1]. Rice cultivation became intensive during green revolution because it used high yielding varieties, synthetic fertilizer, and pesticides [2] to achieve global food security. However, this practice has caused environmental pollution and deteriorated soil health [3]. Now days, rice cultivation is still depending on synthetic fertilizer to produce large food quantity that causes decreased soil condition and nutritional quality of crop. Therefore, it is a great challenge as well as opportunity to find for an alternative for ecofriendly and sustainable crop production [2]. Biofertilizers can become one of the alternative to ensure sustainable crop production in agriculture [4, 5]. A number of nitrogen fixation and phosphate solubilizing bacteria have been well-adapted and grown in variety of conditions [6]. The bacteria have such abilities are included in group of plant growth-promoting rhizobacteria (PGPR) [7] that are useful as biofertilizers [8]. Similarly, the amount of available soluble P is too low to support good plant growth [9]. P concentration in the soil is affected by the soil pH and soil type. The presence of such bacteria highly depends on the physical and chemical properties of the soil, organic matter, and phosphorus contents.

Being a tropical country, Indonesia is rich of diverse soil type along with its specific properties. Alluvial soil has characteristic slightly acid, high contents of P_2O_5 and K_2O, and low in organic matters [10] which was dependent on parent material factors of soil and have a grade of uniform fertility [11]. While, latosol soil in generally has poor nutrient, slightly acidic, and contains low levels of organic matter [12]. The different soil properties are affected by

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plant type, climate, and management practices [13]. Many researches were done in order to find out the elite strains of PGPR from the plant rhizosphere in different soil and applying them as biofertilizers [2, 13, 14, 15].

In Indonesia, the application of biofertilizer in rice have been developed by many researchers [4, 5]. Therefore, nitrogen fixation and phosphate solubilizing bacteria could have cross-functional abilities or beneficial traits that are essential for plants and can improve their growth [17]. This study aimed to investigate the effect of nitrogen fixation and phosphate solubilizing bacteria on growth and yield trait of lowland rice in alluvial and latosol soils.

MATERIALS AND METHODS

Plant Material and Description Experimental Site

Plant material used was Inpari 32 that was categorized as new plant type rice variety from Indonesian Center for Rice Research (ICRR), Indonesian Agency for Agricultural Research and Development (IAARD) in Subang, West Java. This rice variety is well-known to have a high yield potential, is resistant to pest and diseases, delicious taste, and widely planted by farmers. The study was conducted at greenhouse of the Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD), IAARD in Bogor, West Java from March to August 2020. The experimental site was located at 247.0 m above the sea level (m asl) (6°34’27”E, 106°47’4”N). Pots were arranged on a bench in wire-netting greenhouse under natural environmental conditions. The mean of annual minimum and maximum temperature were 24.2°C and 31.0°C in the morning. Meanwhile, the mean of annual minimum and maximum temperature were 24.6°C and 40.2°C in the afternoon.

Soil Sampling Analysis

Two locations of paddy field in Pusakanagara and Muara Experimental Stations were selected to obtain alluvial and latosol soil samples, respectively. The Pusakanegara Experimental Station was located at 23.1 m asl (6°25’42.4”S, 107°89’69.9”E), while Muara Experimental Station was at 291 m asl (6°36’54”S, 106°47’29.85”E).

Soil sample was collected at the soil depth up to 20 cm below soil surface to refer that the most active microorganisms are located within 15 cm below soil surface [18], in five spots for every location. The soil sample was then put into a sterile plastic, mixed to be a composite sample, and transferred to Soil Biology Laboratory, Indonesian Center for Agricultural Land Resources Research and Development (ICALRRD), IAARD using a cool box, following previous study method [19]. The observed soil properties prior to the experiment begun were texture, pH, organic C, N total, available P, cation exchange capacity (CEC), K-dd, Ca-dd, Mg-dd, Na-dd, Al^{+}-dd, reduced Fe, and fractionated P (Al, Ca, and Fe). In addition, some soil was prepared for bacterial population test. The abundance of the bacterial population was calculated using the petri dish counting technique. Afterwards, it was refined and tested for its phosphate solubilizing ability. The analysis of soil properties was held in the Soil Biology Laboratory, ICALRRD.

Nitrogen Fixation and Phosphate Solubilizing Bacteria Application

The isolates used in this study were obtained from our previous research. The highest PSB abundance was observed in Pikovskaya-rock phosphate (P-RP) and Pikovskaya-calcium (P-Ca) media for latosol and alluvial soil samples, respectively. Compared to alluvial soil isolate, latosol soil isolate contained a higher nitrogenase activity. There were three isolates proposed to have great PSB performances, i.e. isolate no. 4.2, 2.1, and 2.2 from latosol soil that could dissolved 14.398 mg/l, 12.648 mg/l, and 12.145 mg/l of phosphate. Three isolates proposed to have great qualitative nitrogenase activity performances, i.e. Alluvial 6, Latosol 4, and Latosol 9 with nitrogenase activity for about 1.1.E + 09, 1.7.E + 09, and 1.3.E + 09 (µmol/ml)/h, respectively [20].

Experimental Design and Observed Parameter

The experimental design was arranged in factorial randomize block design with two factors and three replications. The first factor was two different soil (T), i.e. T1 = alluvial and T2 = latosol. The second factor was three different isolate treatment (I), i.e. I0 = without bacterial isolate (control), I1 = alluvial bacterial isolate, and I2 = latosol bacterial isolate. One treatment unit consisted of one pot with three replications, so the total treatment units were eighteen pots. The Inpari 32 seeds were soaked for 24 h, brooded for about 12–24 h until the coleoptile appears on the seeds, and were soaked in each alluvial and latosol bacterial isolates liquid culture for 15–20 min. Then, seed treatment were sowed in alluvial and latosol soils. The seedlings were planted 28 days after sowing.

Parameters observed were divided into three different stage consisted of traits on seedling stage (seedling height, leaf number, leaf area, root fresh length, root fresh weight, leaf fresh weight, root dry weight, and leaf dry weight), traits on vegetative stage (plant height and tiller number at 7 day after planting [DAT], 21 DAT, and 35 DAT), traits on generative stage (plant height at 63 DAT, tiller number at 63 DAT, panicle number per plant, panicle length, filled grain number per plant, unfilled grain number per plant, filled grain weight, and weight of grain). Root and leaf at seedlings stage were dried at 60°C until constant weight, and weighted.

Statistical Analysis

The collected data of growth and yield component parameters were subjected to analysis of variance (ANOVA) according to experimental design. If there was a significant difference, Duncan's Multiple Range Test was performed at the level of 5% significance with SAS software program ver. 9.1.3.

RESULTS AND DISCUSSIONS

Soil Characteristics of Alluvial and Latosol Paddy Field

Based on analysis result of soil chemical properties conducted before experiment is presented in Table 1. The soil used in this experiment was classified as clay loam. Soil texture was dominated by fractions of clay (72%), dust (26%), and sand (2%) to alluvial soil, and clay (65%), dust (29%), and sand (6%) to latosol soil. The content of N total 0.14% for alluvial and 0.18% for latosol. These values were classified to be low for organic C, very high for nitrogen, medium for phosphorus, and low for potassium. The actual pH (pH H_2O) of alluvial (pH H_2O = 6.2) was higher than latosol (pH H_2O = 5.6) and so do the potential pH. The organic C content of two observed soil was categorized as low (alluvial organic C content = 1.37% and latosol organic C content = 1.85%) due to below 2%.

TABLE 1. Soil characteristics of alluvial and latosol paddy field*.

Soil characteristics	Alluvial	Latosol	Soil characteristics	Alluvial	Latosol
Sand (%)	2	6	K_2O HCl 25% (mg/100g)	35	12
Dust (%)	26	29	P_2O_5 (ppm) Olsen (ppm)	31	50
Clay (%)	72	65	K_2O (ppm) Morgan (ppm)	245	116
pH H_2O	6.2	5.6	Ca-dd (cmol[+]/kg)	15.53	7.55
pH KCl	5.0	4.5	Mg-dd (cmol[+]/kg)	7.58	2.26
Al-dd (cmol[+]/kg)	0.0	0.0	K-dd (cmol[+]/kg)	0.41	0.23
H-dd (cmol[+]/kg)	0.31	0.14	Na-dd (cmol[+]/kg)	0.91	0.31
C-organic (%)	1.37	1.85	Total	24.43	10.35
N total (%)	0.14	0.18	Cation exchange capacity (cmol[+]/kg)	29.58	15.02
C/N ratio	10	10	Base saturation (%)	83	69
P_2O_5 HCl 25% (mg/100 g)	83	190			

*Alluvial and latosol soil type were collected from Pusakanagara and Muara Experimental Stations, respectively.

The N total was 0.14% in alluvial soil and 0.18% in latosol soil. The P content was tested through two solvents, i.e. HCl 25% and Olsen. The P content that extracted with HCl solvent in alluvial and latosol soils were 83 mg/100 g and 190 mg/100 g, respectively. Meanwhile, Olsen extracted 31 ppm and 50 ppm P from alluvial and latosol soils, respectively. Both results showed that alluvial soil had lower P than latosol soil. Meanwhile, alluvial soil (29.58 cmol [+]/kg) had a higher cation exchange capacity (CEC) showed than latosol soil (15.02 cmol [+]/kg). The application of bacterial isolates from alluvial and latosol soils were expected to improve soil condition by increasing N and P nutrient. According to previous research, there were potential bacterial from alluvial and latosol soils. The ability to fix nitrogen and solubilize phosphates in several strains isolated from tropical soils [21]. The use of these bacteria as sourced of isolates had beneficial, such as the easiness to obtain because paddy field widely cultivated in those soil.

Response of Treatment in Seedling Stage

Analysis of variance showed that soil type effects were significant for root fresh weight and root dry weight (Table 2). Isolates effects were significant only for root fresh length. The interaction of soil type (T) and isolate (I) effects were significant for root fresh length, root fresh weight, and root dry weight (Table 2). This finding showed that the effect of isolate and soil type generally were not significant on seedling stage traits. This could be caused by many factors, such as isolate type or doses level treatment. The different type application of bacteria significantly affected on seedling height, root length, root dry mass, and shoot dry mass [22]. The application of bacteria at seedling stage aimed to enhance seedlings growth so they will grow healthy and obtain high productivity.

In alluvial soil, treatment of alluvial isolate had the highest value on seedling height, leaf area, root fresh weight, and root dry weight (Tables 3 and 4). However, those traits were not significant with control. In latosol soil, treatment of alluvial isolate had the highest value on seedling height, leaf number, leaf area, root fresh length, root fresh weight, leaf fresh weight, and leaf dry weight. As comparation, treatment of latosol isolate had higher value compared with control on seedling height, leaf area, and root fresh weight in alluvial soil. On the other hand, treatment of latosol isolate had higher value compared with control on seedling height, leaf number, leaf area, leaf fresh weight, and leaf dry weight in latosol soil.

TABLE 2. Mean square from analysis of variance for seedling stage traits.

Source of variation	Traits			
	Seedling height (cm)	**Leaf number**	**Leaf area (cm^2)**	**Root fresh length (g)**
Soil type (T)	9.82 ns	0.50 ns	30.42 ns	0.16 ns
Isolate (I)	19.85 ns	0.72 ns	40.99 ns	16.13**
T × I	2.09 ns	4.17 ns	2.32 ns	13.19**
CV (%)	9.47	19.25	22.35	15.29
Source of variation	**Traits**			
	Root fresh weight (g)	**Leaf fresh weight (g)**	**Root dry weight (g)**	**Leaf dry weight (g)**
Soil type (T)	0.22*	0.02 ns	0.01**	0.000 ns
Isolate (I)	0.12 ns	0.03 ns	0.00 ns	0.001 ns
T × I	0.06**	0.22 ns	0.00**	0.008 ns
CV (%)	31.51	29.46	28.20	30.20

*Significant at P<0.05. **Significant at P<0.01. ns = not significant.

TABLE 3. Treatment effect of soil type and isolate on seedling stage traits.

Treatment	Seedling height (cm)	Leaf number	Leaf area (cm^2)	Root fresh length (g)
Alluvial soil				
Control	40.53 a	9.00 a	17.01 a	15.90 ab
Alluvial isolate	43.07 a	8.00 a	22.20 a	15.20 ab
Latosol isolate	41.87 a	8.67 a	19.88 a	14.47 ab
Mean	41.82	8.56	19.70	15.19
Latosol soil				
Control	41.20 a	7.67 a	15.17 a	13.90 ab
Alluvial isolate	45.90 a	10.00 a	20.26 a	18.43 a
Latosol isolate	42.80 a	9.00 a	15.86 a	12.67 b
Mean	43.30	8.89	17.09	15.00

Values with different letters in a column are significantly different according to Duncan's Multiple Range Test (P≤0.05).

Even though alluvial isolate had higher trait value compared with latosol isolate, both in alluvial and latosol soils. However, alluvial isolate was not significant compared with latosol isolate. Researcher also found that the response phosphate solubilizing bacteria showed not significantly different for root length, seedling height, shoot dry matter, and root dry matter. However, the traits response was significant compared with control [22]. In addition, some researcher also reported that the application of bacteria enhanced shoot biomass and root biomass [23].

TABLE 4. Treatment effect of soil type and isolate on seedling stage traits.

Treatment	Root fresh weight (g)	Leaf fresh weight (g)	Root dry weight (g)	Leaf dry weight (g)
Alluvial soil				
Control	0.48 b	1.87 a	0.06 b	0.32 a
Alluvial isolate	0.59 b	1.62 a	0.07 b	0.28 a
Latosol isolate	0.52 b	1.75 a	0.06 b	0.31 a
Mean	0.53	1.75	0.07	0.30
Latosol soil				
Control	0.68 ab	1.44 a	0.13 a	0.25 a
Alluvial isolate	1.01 a	1.96 a	0.11 ab	0.36 a
Latosol isolate	0.56 b	1.65 a	0.10 ab	0.30 a
Mean	0.75	1.68	0.11	0.30

Values with different letters in a column are significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

Treatment Response on Plant Height and Tiller Number at Vegetative Stage

Treatment response of soil type and isolate on plant height at vegetative stage is showed in Fig. 1. There were no different treatment response between alluvial and latosol soils at 7 DAT, 21 DAT, and 35 DAT. In early stage at 7 DAT, alluvial isolate showed the same response, both in alluvial and latosol soils. After two weeks of isolate treatment, alluvial isolate showed good response on plant height, both in alluvial and latosol soils. Even though, the response was not significantly different. This finding showed that the application of bacteria can increase plant height at vegetative stage. According to Singh *et al*. [24], the use of fertilizer in most biological traits was able to stimulate on plant vegetative growth. Increase in rice height is completely dependent on nitrogen that can be absorbed in the soil [25].

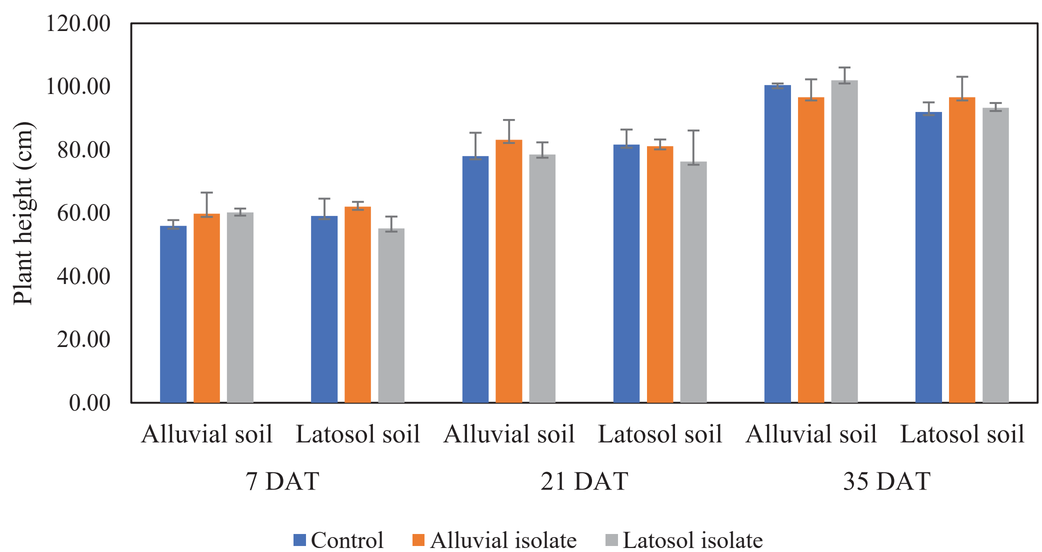

FIGURE 1. Treatment responses of soil type and isolate on plant height at vegetative stage. Vertical bars show standard errors of means of three replicates.

Treatment response of soil type and isolate on tiller number at vegetative stage is showed in Fig. 2. After one week treatment, there were no different response on tiller number, both in alluvial and latosol soils. Tillers number increased at 21 DAT and 35 DAT, especially in alluvial soil. In term of isolate type, latosol isolate showed higher value compared with alluvial isolate at 21 DAT and 35 DAT. Isolates treatment were not significantly higher compared with control on tiller number, both in alluvial and latosol soils, at 7 DAT, 21 DAT, and 35 DAT. Several strains of bacteria inoculation was reported to improve plant growth and yield in several crop plants such as rice [24]. Panicle number per unit area closely associated by tillering capacity and determines grain yield of rice [25]. Based on that result, we assumed that isolates treatment sourced from alluvial and latosol soils still could not impact on tiller number. We can only see, there were difference response between alluvial and latosol isolates based on tiller number.

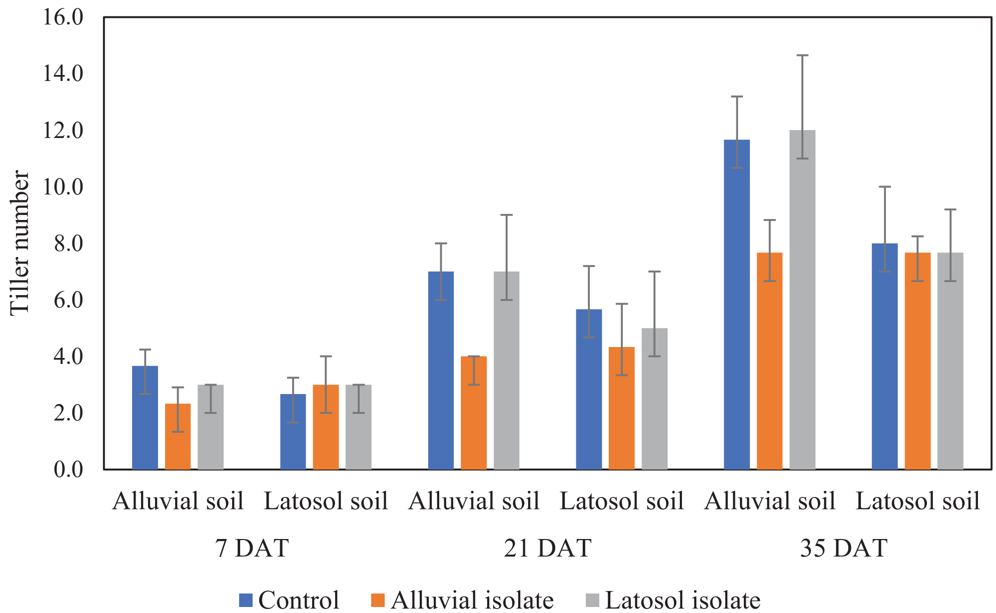

FIGURE 2. Treatment responses of soil type and isolate on tiller number at vegetative stage. Vertical bars show standard errors of means of three replicates.

Response of Treatment in Generative Stage Traits

Analysis of variance showed that soil type effects were significant for all trait at generative stage (Table 5). This result showed that alluvial and latosol soils had different characteristic based on soil analysis before treatment. Isolates effects were significant for plant height, unfilled grain number per plant, filled grain weight, and weight of grain. The interaction of soil type and isolate effects showed no significant response for all traits at generative stage. Other researcher also obtained the same finding [21]. This result revealed that treatment of alluvial bacterial isolate and latosol bacterial isolate had same response in alluvial and latosol soils. We guessed that the treatment of isolates in seed for 15–20 min not enough to give response because of low treatment dose.

Treatment of alluvial isolate had value lower for all trait compared with latosol isolate, both in alluvial and latosol soils (Tables 6 and 7). This finding in contrast with the result on seedling traits that showed better response. As comparison in alluvial soil, treatment of latosol isolate had the highest value for plant height, tiller number, filled grain number per plant, filled grain weight, and weight of grain. In latosol soil, treatment of latosol isolate had the highest value for plant height, panicle length, filled grain number per plant, filled grain weight, and weight of grain.

This finding told that latosol isolate had better response compared with alluvial isolate, both in alluvial and latosol soils. Even though, alluvial isolate had better response in seedlings stage. However, in term of impact in production latosol isolate had better response, so latosol isolate had potential to be developed further.

TABLE 5. Mean square from analysis variance for generative stage traits.

Source of variation	Traits			
	Plant height (cm)	**Tiller number**	**Panicle number/ plant**	**Panicle length (cm)**
Soil type (T)	10.43**	11.13**	8.31**	14.24**
Isolate (I)	4.02*	2.45 ns	2.51 ns	2.92 ns
T × I	2.20 ns	1.59 ns	1.53 ns	1.81 ns
CV (%)	3.37	15.81	18.96	3.59
Source of variation	**Traits**			
	Filled grain number/ plant	**Unfilled grain number/ plant**	**Filled grain weight (g)**	**Weight of grain (g)**
Soil type (T)	6.16**	27.68**	4.22*	5.74**
Isolate (I)	2.40 ns	4.06*	3.63*	4.29**
T × I	1.10 ns	1.45 ns	1.12 ns	1.13 ns
CV (%)	19.87	27.65	21.09	20.8

*Significant at P<0.05. **Significant at P<0.01. ns = not significant.

TABLE 6. Treatment effect of soil type and isolate on generative stage traits.

Treatment	Plant height (cm)	Tiller number	Panicle number/ plant	Panicle length (cm)
Alluvial soil				
Control	109.67 a	11.00 ab	10.33 ab	20.93 ab
Alluvial isolate	102.00 b	8.67 b	8.00 b	21.41 ab
Latosol isolate	111.50 a	12.00 a	10.00 a	21.73 a
Mean	107.72	10.56	9.44	21.36
Latosol soil				
Control	102.50 b	8.33 b	7.67 b	20.25 bc
Alluvial isolate	101.50 b	8.00 b	8.00 b	19.12 c
Latosol isolate	103.00 b	8.33 b	8.00 b	20.82 ab
Mean	102.30	8.22	7.89	20.06

Values with different letters in a column are significantly different according to Duncan's Multiple Range Test (P≤0.05).

TABLE 7. Treatment effect of soil type and isolate on generative stage traits.

Treatment	Filled grain number/ plant	Unfilled grain number/ plant	Filled grain weight (g)	Weight of grain (g)
Alluvial soil				
Control	878.33 ab	1.75 a	20.18 ab	21.93 ab
Alluvial isolate	675.00 b	1.03 b	15.01 b	16.04 b
Latosol isolate	970.67 a	2.14 a	23.45 a	25.60 a
Mean	841.33	1.64	19.55	21.19
Latosol soil				
Control	620.00 b	0.90 b	14.50 b	15.39 b
Alluvial isolate	647.67 b	0.40 b	15.12 b	15.52 b
Latosol isolate	730.67 ab	1.07 b	18.21 ab	19.28 ab
Mean	666.11	0.79	15.94	16.73

Values with different letters in a column are significantly different according to Duncan's Multiple Range Test (P≤0.05).

Latosol isolate enhanced filled grain weight around 56.2% compared with alluvial isolate and increased around 16.2% compared with control in alluvial soil. Meanwhile, in latosol soil latosol isolate enhanced filled grain weight around 20.4% compared with alluvial isolate and increased around 25.6% compared with control in latosol soil. Researchers also found that biofertilizer application can increase grain yield [4, 5, 22]. According to the result, we also found that latosol isolate was more compatible if they were applied in latosol soil. This finding showed that each bacteria had their own suitable environment. If we want to develop isolates for broad area. Those isolate must be tested further in different field area, so the finding in this research become important as preliminary result to obtain suitable bacteria to enhanced rice production.

CONCLUSION

The research concluded soil type effects were significant for all trait at generative stage. Isolate effects were significant for plant height, unfilled grain number per plant, filled grain weight, and weight of grain. This indicates that the use of biological traits according to soil condition and environmental factor will increase yield in rice. Alluvial isolate had good response for some traits at seedling stage. However, in generative stage traits latosol isolate had better response for plant height, panicle length, filled grain number per plant, filled grain weight, and weight of grain compared with alluvial isolate, both in alluvial and latosol soils. Even though, this finding was not significant with control, it had potential to be developed further in different field area.

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REFERENCES

1. Global Rice Science Partnership, *Rice Almanac* (International Rice Research Institute, Los Baños, 2013), pp. 117–135.
2. A. Kumar, B. R. Maurya, R. Raghuwanshi, V. S. Meena and M. T. J. Islam, Plant Growth Regul. **36**, 608–617 (2017).
3. E. Elkoca, M. Turan and M. F. Donmez, J. Plant Nutr. **33**, 2104–2119 (2010).
4. T. Simarmata, Hersanti, T. Turmuktini, B. N. Fitriatin, M. R. Setiawati and Purwanto, HAYATI J. Biosci. **23**, 181–194 (2016).
5. N. Marlina, N. Gofar, A. H. P. K. Subakti and A. M. Rahim, Agrivita **36**, 48–56 (2014).
6. L. M. Marra, C. R. F. Sousa Soares, S. M. de Oliveira, P. A. A. Ferreira, B. L. Soares, R. F. de Carvalho, J. M. de Lima and F. M. S. de Moreira, Plant Soil **357**, 289–290 (2012).
7. A. Hosseini, A. Maleki, K. Fasihi and R. Naseri, Int. J. Agric. Biol. Eng. **8**, 7–12 (2014).
8. J. S. Singh, V. C. Pandey and D. P. Singh, Agric. Ecosyst. Environ. **140**, 339–353 (2011).
9. A. E. Richardson, J. P. Lynch, P. R. Ryan, E. Delhaize, F. A. Smith, S. E. Smith, P. R. Harvey, M. H. Ryan, E. J. Veneklaas, H. Lambers, A. Oberson, R. A. Culvenor and R. J. Simpson, Plant Soil **349**,121–156 (2011).
10. Hikmatullah and M. Al-Jabri, Indones. J. Agric. Sci. **8(2)**, 67–74 (2016).
11. M. L. Alam, S. M. Saheed, A. Shinagawa and NM, "Chemical properties of general soil types of Bangladesh," in *Memoirs of the Faculty of Agriculture* (Kagoshima University, Kagoshima, 1993), pp. 75–87.
12. A. Perdanatika, S. Suntoro and P. Pardjanto, J. Soil Sci. Agroclimatol. **15(1)**, 29–34 (2018).
13. G. A. Estrada, V. L. D. Baldani, D. M. de Oliveira, S. Urquiaga and J. I. Baldani, Plant Soil **369(1)**, 115–129 (2013).
14. R. Hayat, S. Ali, U. Amara, R. Khalid and I. Ahmed, Ann. Microbiol. **60**, 579–598 (2010).
15. H. C. Kaymak, "Potential of PGPR in agricultural innovations," in *Plant Growth and Health Promoting Bacteria***,** edited by D. K. Maheshwari (Springer, Berlin, 2011), pp. 45–79.
16. V. S. Meena, B. R. Maurya, R. Verma, R. S. Meena, G. K. Jatav, S. K. Meena, R. Meena and S. K. Meena, Bioscan. **8(3)**, 931–935 (2013).
17. A. Tang, A. O. Haruna and N. M. A. Majid, Microorganisms **8**, 442 (2020).
18. R. M. Atlas and R. Bartha, *Microbial Ecology Fundamentals dan Applications* (Benjamin Cummings Publishing Company, San Francisco, 1998), pp. 11–13.
19. H. Kesaulya, Baharuddin, B. Zakaria and S.A. Syaiful, Procedia Food Sci. **3**, 190–199 (2015).

20. Ikhwani, ”Biological of fixing nitrogen and phosphate solubilizing bacteria and effectivity on growth rice variety at two wetland rice soils,” Magister thesis, Nasional University, 2020.
21. H. I. Taweil, M. B. Osman, A. A. Hamid and W. M. W. Yusoff, J. Agric. Biol. Sci. **4(1)**, 79–82 (2009).
22. A. Javaid and M. B. Shah, Afr. J. Biotechnol. **9(23)**, 3373–3381 (2010).
23. A. D. Bindra, B. D. Kalia and S. Kumar, Agri. Res. India **10**, 45–48 (2000).
24. R. K. Singh, N. Malik and S. Singh, Microb. Ecol. **66(2)**, 375–384 (2013).
25. A. A. Efisue, B. C. Umunna and J. A. Orluchukwu, J. Plant Breed. Crop Sci. **6(9)**, 119–127 (2014).