Effect of Phosphate Solvent Bacteria to Growth and Production of Paddy (*Oryza sativa L.*) Plants Using Modified SRI

Arman Effendi AR[1], Anthony Hamzah[2], Elza Zuhry[3], Erlida Ariani[4], Irfandri[5]

[12345]*Faculty of Agriculture, University Riau*
Pekanbaru, 28293, Indonesia

Abstract

Phosphate Solvent Bacteria (BPF) is a group of soil microorganisms that can to dissolve P bound in the soil and convert it into an available form so that it can be absorbed by rice plants. This study aims to look at the effect of several BPF doses and get the best dose to increase the growth and production of lowland rice (Oryza sativa L.) using modified SRI. This research was conducted experimentally using a completely randomized design (CRD) consisting of 6 treatments and 3 replications so that 18 experimental units were obtained. Each unit consists of 5 plants so that the plant obtained as many as 90 plants. All plants in each experimental unit were sampled. The treatments tested were several doses of BPF consisting of no BPF administration, 10 ml per plant, 20 ml per plant, 30 ml per plant, 40 ml per plant and 50 ml per crop. The parameters observed were plant height, the number of maximal tillers, the number of productive tillers, the age of harvest, the number of rice grains with pan, the weight of 1000 seeds per clump. Provision of BPF affects the growth and production of lowland rice. Provision of 40 ml BPF per plant gives good results in increasing the number of maxillary tillers, the number of productive tillers, the total of rice grains per panicle, the weight of seeds, and can increase rice production by about 27.69% compared without BPF.

Keywords — *Rice paddy fields, phosphate, BPF, modified SRI.*

I. INTRODUCTION

Rice (*Oryza sativa L.)* is an important food crop commodity in Indonesia. Indonesians make rice a staple food. Rice can meet 63% of total energy adequacy and 37% of protein [1].

Paddy production in Riau Province in 2017 was 365,730.00 tons of the weight of seeds, whereas in 2018 it became 365,293.00 tons of the weight of seeds [2]. Rice production in 2018 has decreased from the previous year, so it is necessary to increase rice production to be able to meet the needs of the community.

One way to increase production is to use the *System of Rice Intensification* (SRI) method. The SRI method applies effective, efficient, natural and environmentally friendly intensification.

The SRI method has been proven to have succeeded in increasing rice productivity by 50% even in some places reaching more than 100% [3]. In addition to the application of cultivation techniques, environmentally friendly fertilizer is needed.

According to [4], biofertilizers are biologically active products consisting of microbes that can increase fertilizer efficiency, fertility and soil health. And according to [5], adding the mixture of biogas manure and tobacco compost on improving the productivity and tubers quality of the potato crop.

According to [6] one of the microorganisms that can be used is Phosphate Solvent Bacteria (BPF) which is can release P that is bound to be available to plants.

This study aims to look at the effect of several BPF doses and get the best dose to increase the growth and production of lowland rice (*Oryza sativa* L.) using modified SRI.

II. METHODOLOGY

This research was conducted at the Experimental Garden of the Faculty of Agriculture, University of Riau, Campus Bina Widya Km 12.5, Simpang Baru Panam Village, Tampan District, Pekanbaru. The implementation period lasted for 4 months starting from February to May 2019. The research was carried out experimentally using a completely randomized design (CRD) consisting of 6 treatments and 3 replications, to obtain 18 experimental units. Each unit consists of 5 plants so that the plants obtained are as many as 90 plants. The treatments tested were comprised of BPF dose without giving BPF, 10 ml per plant, 20 ml per plant, 30 ml per plant, 4 0 ml per plant, 5 0 ml per plant. The parameters observed were plant height, the maximum number of tillers, number of productive tillers, age of harvest, number of rice grains with panicle, the weight of 1000 seeds, the weight of seeds The data obtained were then continued with a Duncan distance test with a level of 5%.

III. RESULT AND DISCUSSION

A. Plant Height

Parameter observations of plant height after administration of phosphate solvent bacteria and tested further by DNMRT at 5% level can be seen in Table 1.

TABLE 1.
THE AVERAGE HEIGHT OF PADDY RICE VARIETIES OF BATANG PIAMAN VARIETIES BY THE ADMINISTRATION OF PHOSPHATE SOLVENT BACTERIA

Dosage of BPF (ml)	Plant Height (cm)
40	111.95 a
50	110.92 a
20	110.81 a
30	110.71 a
10	110.62 a
0	110.43 a

The numbers in each treatment column followed by the same lower case indicate no significant difference based on Duncan's Multiple Range Test at 5% level.

Table 1 shows that the administration of phosphate solubilizing bacteria at different doses gave significantly different results on rice plant height. This is presumably because plant height is more influenced by genetic traits.

According to [7], the height of the stems of plants is influenced by the nature of these plant varieties. The height of the plants produced ranges from 110.43 cm - 111.95 cm, this result is by following per under with the description of the Batang Piaman rice variety, which is between 105 cm - 117 cm.

[8] stated that plant growth also influences varieties because each variety has different genetic, morphological and physiological characteristics.

The more important element in plant height is the N element. According to [9], nitrogen is the basic ingredient needed to form amino acids and proteins that are used for plant metabolic processes and will ultimately affect the growth of organs such as stems, leaves and, roots. Better.

B. Number of Maximum Tillers

Parameter observation of the number of maximum tillering of plants after the administration of bacterial phosphate solvent and tested further by DNMRT p No level of 5% can be seen in Table 2.

TABLE 2.
THE AVERAGE MAXIMUM NUMBER OF TILLERS OF BATANG PIAMAN VARIETY IS BY PROVIDING PHOSPHATE SOLVENT BACTERIA

BPF dosage	Maximum number of tillers
40	40.44 a
50	38.77 b
30	38.22 bc
20	38.11 bc
10	37.77 bc
0	37.44 c

The numbers in each treatment column followed by the same lower case indicate no significant difference based on Duncan's Multiple Range Test at 5% level.

Table 2 shows that giving BPF at a dose of 40 ml per plant gave the highest yield of 40.44 stems, significantly different from other doses and the lowest dose of 0 ml per plant was 37.44 stems. This is presumably because the element P plays an important role in the metabolic process in plants. According to [10], the P element plays a role in the process of respiration and plant metabolism to be better so that the formation of amino acids and proteins for the formation of new cells can occur and can increase the number of tillers.

The maximum number of tillers produced was around 37.44 sticks to 40.44 sticks. The number of tillers produced was higher than the results of [11] research using Batang Piaman Vaerietas rice ranging from 11.70 stems to 22.25 stems. Increasing the maximum number of tillers due to using the modified SRI method to a water level of 10 cm below the ground surface. This is thought to be due to the presence of soil that has good aeration and sufficient nutrient content that allows plants to expand the roots to absorb nutrients and be transplanted to plants, one of its functions is to form saplings. [12] states that the need to maintain the soil to remain aerated and moist so that the roots can breathe and develop freely to support the growth of tillers.

C. Number of Productive Tillers

Parameters of observation of the number of productive tillers after administration of phosphate solvent bacteria and further testing with DNMRT at a level of 5% can be seen in Table 3.

TABLE 3.
THE AVERAGE NUMBER OF PRODUCTIVE TILLERS OF BATANG PIAMAN VARIETIES WITH THE ADMINISTRATION OF PHOSPHATE SOLVENT BACTERIA

Dosage of BPF (ml)	Number of Productive Tillers
40	34,33 a
50	32.66 b
20	32.55 b
30	32,33 b
10	31.44 b
0	31.44 b

The numbers in each treatment column followed by the same lower case indicate no significant difference based on Duncan's Multiple Range Test at 5% level.

Table 3 shows that giving BPF at a dose of 40 ml per plant produced the highest number of productive tillers, 34.33 stems which were significantly different from other doses. The number of productive tillers produced ranged from 31-34 stems, higher than the description of the rice varieties of Batang Piaman which were conventionally grown which ranged from 14-19 stems. This is presumably because the number of bacterial colonies at a dose of 40 ml BPF per plant produces IAA hormones and releases the P-element that is bound to become available P, so it can stimulate plant growth in the formation of saplings that will become productive offspring.

[13] states that the efficiency of P fertilizer can be increased by the use of phosphate solvent microbes. These microbes can produce phosphatase enzymes but can also release organic acids that can

cause effective dissolution so that fixed P can be available to plants.

The number of productive tillers produced ranged from 31.44 to 34.33. The results obtained are more than the description of Batang Piaman Varied lowland rice with the number of productive tillers ranging from 14-19 stems. This is thought to be due to using the modified SRI method with a pool height of 10 cm below the soil surface. According to [14], the provision of sufficient water can create microclimate conditions that support the reception of more sunlight, so that the process of photosynthesis takes place more optimally and produces enough assimilation to encourage the growth of saplings of rice plants.

D. Harvest Age

Parameters observation of harvesting crops after administration of bacterial phosphate solvent and tested further by DNMRT p No level of 5% can be seen in Table 4.

TABLE 4.
THE AVERAGE AGE OF HARVEST OF RICE PLANTS IN BATANG PIAMAN VARIETY WITH THE ADMINISTRATION OF PHOSPHATE SOLVENT BACTERIA

Dosage of BPF (ml)	Harvest Age
20	110.89 a
30	110.66 a
0	109.44 a
10	109.33 a
40	109.22 a
50	108.77 a

The numbers in the column for each treatment followed by the same lower case indicate no significant difference based on Duncan's Multiple Range Test at 5% level.

Table 4 shows that administering BPF at various doses gave significantly different results at the age of harvest. This is presumably because the age of the harvest is influenced by genetic factors of the plant itself, so the treatment of various doses of BPF does not affect the age of the rice crop. According to [15], plants will show a mature harvest if the total energy adopted has reached a certain level (growing degree day) and is different in each plant which is generally caused by genetic factors.

According to [16], sooner or later harvested plants are influenced by plant genetic factors that are more dominant than temperature, rainfall and light intensity received by plants. Harvesting time is influenced by the appearance of rice panicles, the longer the rice panicles come out, the longer the harvest time of the plants.

E. The number of rice grains per panicle

Parameters of observation of the number of grains of pithy rice starting plants after the administration of phosphate solubilizing bacteria and further testing with DNMRT at a level of 5% can be seen in Table 5.

TABLE 5.
THE AVERAGE NUMBER OF PADDY-GRAINED RICE GRAINS OF BATANG PIAMAN VARIETY BY GIVING PHOSPHATE SOLVENT BACTERIA

Dosage of BPF (ml)	Amount of Rice Grains per Panicle
40	97.12 a
50	84,70 b
20	84.42 b
30	84.08 b
10	71,15 c
0	68.38 d

The numbers in the column for each treatment followed by the same lower case indicate no significant difference based on Duncan's Multiple Range Test at 5% level.

Table 5 shows that administering BPF at a dose of 40 ml per plant gave significantly different results from other doses. The highest number of rice grains per panicle found at a dose of 40 ml per plant that is 97.12 grains and the lowest without BPF is 68.38 grains. This is presumably because the number of bacterial colonies found at a dose of 40 ml per plant can release bound P to be available to rice plants which is useful in early plant growth and the formation of plant reproductive parts.

[17] states that the amount of grain (pithed and hollow) formed is determined by the length of the panicle and the number of branches of the panicle, where each panicle will produce grain.

The amount of rice grains with high per panicle is very closely related to nutrient adequacy, especially P levels as a source of energy in the process of cell metabolism, which ultimately relates to filling seeds to become seeds. The amount of rice grains is a determinant of rice productivity.

F. Weight of 1000 seeds

Parameters of observation of weight of 1000 seeds of pithy rice plants after the administration of phosphate solubilizing bacteria and further testing with DNMRT at a level of 5% can be seen in Table 6.

TABLE 6.
THE AVERAGE WEIGHT OF 1000 SEEDS VARIETIES BATANG PIAMAN WITH THE ADMINISTRATION OF PHOSPHATE SOLVENT BACTERIA

Dosage of BPF (ml)	Weight of 1000 seeds (g)
40	26,19 a
50	25.96 a
20	25.79 a
30	25.72 a
10	25.60 a
0	25.23 a

The numbers in the columns for each treatment followed by the same lowercase letters show no significant difference based on Duncan's Multiple Range Test at 5% level.

Table 6 shows that the administration of BPF in various doses gave different results which were not

significant. This is presumably because the weight of 1000 seeds of pithy grain is influenced by the dry matter contained in the seeds. According to [18], the high and low weight of the seed depending on the lot, or at least dry matter contained in the seeds were obtained from the assimilated contained in the plant when growth takes place, which can then be used for charging the seeds obtained from the photosynthesis that could further used for filling seeds.

The weight of 1000 seeds of rice indicates the amount of biomass contained in the grain. The pithier of grain indicates the more biomass contained therein. The success of grain is largely determined by the availability of nutrients and the guaranteed physiology of plants. The more grain that is formed the higher the burden of the plant to form a grain containing (pithy). The characteristics of plants to produce pithy grain are also influenced by genetic factors, nutrient availability and guaranteed physiological processes of plants [19].

G. The weight of seeds

Parameters of the observation of the weight of seeds after the administration of phosphate solvent bacteria and further testing with DNMRT at a level of 5% can be seen in T table 7.

TABLE 7.
THE AVERAGE THE WEIGHT OF SEEDS OF BATANG PIAMAN VARIETY WITH THE ADMINISTRATION OF F- PHOSPHATE BACTERIA

Dosage (ml)	The Weight of Seeds (g)
40	97.76 a
50	84,64 ab
10	77.22 b
20	71.50 b
0	70.07 b
30	68.47 b

The numbers in each treatment column followed by the same lower case indicate no significant difference based on Duncan's Multiple Range Test at 5% level.

Table 7 shows that the administration of BPF at a dose of 40 ml per plant was not significantly different from the dose of 50 ml per plant and was significantly different from the dose of 0 ml per plant, 10 ml per plant, 20 ml per plant, 30 ml per plant. This is presumably because the higher the dose of BPF, the number of bacterial colonies will be more and more able to release P elements and cause plant leaves to grow wider so that the leaf surface is wider for photosynthesis.

According to [20], the P element has a positive influence in increasing grain production (grain), if the amount of P solubility is small as a result the plant is unable to produce.

Giving BPF at a dose of 40 ml per plant produces 97.76 g of the weight of seeds, whereas without BPF giving the weight of seeds is 70.07 g. These results indicate that the provision of BPF can increase crop production by about 27.69% compared without giving BPF.

This increase in rice production was also due to using modified SRI, which is a pool of 10 cm below the ground surface. The condition of the soil which has good aeration and sufficient nutrient content allows the plant to expand its roots to absorb nutrients.

IV. CONCLUSIONS AND RECOMMENDATIONS

The results of the study concluded that the administration of various doses of BPF has a significant effect on the maximum number of tillers, the number of productive tillers, the number of rice grains with per panicle, and the weight of seeds per rump, but the effect is not significant on the parameters of plant height, harvest age, the weight of seeds. The treatment of BPF at a dose of 40 ml per map plant increased rice production by about 27.69% compared to without BPF administration.

Based on the results of the study, researchers suggest to obtain good results, the cultivation of lowland rice is recommended to use BPF biological fertilizer at a dose of 40 ml per plant using modified SRI with a pool height of 10 cm below the surface of the soil.

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