Application of PGPR Jakaba to Increase Growth and Yield of Rice Plants (*Oryza sativa* L.)

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Abstract

The aims of this research was to study the macro-nutrient in PGPR Jakaba and the effectiveness of giving PGPR Jakaba to increase growth and yield of rice plants. This reseach was arranged in Randomized Block Design (RBD) with four treatments and six replications. The parameters were observed are number of offspring, number per panicles per clump, leght of panicle, number of grains per panicle, weight per 1000 grams grains of grain (gram), and tilling. Data were analyze by ANOVA followed with DMRT test for mean comparison between group. The result showed that application of PGPR Jakaba have an effect on number of offspring mean 31, number of panicles per clump mean 49, leght of panicle mean 21,25 cm, number of grains per panicle mean 119, weight per 1000 grains of grain mean 29,92 grams, and yield of grain estimated to reached 8,2 tons of harvested dry grain per hectare.

Keywords: Paddy, PGPR Jakaba

1. Introduction

Rice is staple food of the majority of Indonesian people, which comes from rice plants (*Oryza sativa* L.) and the need for rice every year is increasing along with the increasing in the existing population. The reason why people consume rice as a staple food beside corn, tubers, sago, and sorghum is because it contributes 40% - 80% of calories and 45% - 55% of protein [1].

Rice plants require an adequate supply of nutrients to support their growth so that grain production runs optimally. Plants need macro and micro nutrients but plant need more macro-nutrients such as nitrogen (N), phosporus (P), and potassium (K) [2]. To support need for nutrients for these plants, fertilization activities are carried out, namely the application of fertilizers to plants. Fertilizer contains ingredients needed for plant growth and development [3].). Based on the chemical composition contained in fertilizers, fertilizers are divided into two, namely organic fertilizers and inorganic fertilizers. Organic fertilizers are fertilizers that come from the decomposition process of plant and animal waste, while inorganic fertilizers are fertilizers that are produced in factories and contain certain nutrients, but if given in excess, inorganic fertilizers can damage soil, plants and the environment [2].

Increasing of population means that rice production must be increased too. One way to support rice crop production is to carry out fertilization activities using organis fertilizer or chemical fertilizer. Using anorganic or chemical fertilizer in high use and for long term can decrease the quality of plant [4]. But so many farmer still use anorganic fertilizer because that has been declining to use and more efficient. One way to support rice plants growth and yiled is the application of organic fertilizer such as PGPR (*Plant Growth Promoting Rhizobacteria*) Jakaba. Jakaba is a fungus that acronym of perennial luck mushroom derived from fermentation of rice washing water and has physical shape as a coral reef but easy to destroy [5]. The aims of this research was to study the

macro-nutrient in PGPR Jakaba and the effectiveness of giving PGPR Jakaba to increase growth and yield of rice plants.

2. Materials and Method

This experiment was conducted in Rambiuji Village, Rambipuji Subdistrict, Jember Regency, East Jawa, Indonesia from Januari until April 2023. Rice variety was planted Inpari 32 HDB and the age of transplanting from nursery was 28 days. Experiment was conducted using Randomized Block Design (RBD) with four treatments and six replications. The treatment were; P0: control (not using PGPR Jakaba), P1: using 20ml/L of water, P2: using 40ml/L of water, P3: using 60ml/L of water.

PGPR Jakaba was made from PGPR stems from 100 grams of bamboo roots soaked in 1 L rainfall water, 9 L of rainfall water, 1 kg of fine bran, 200 grams of shrimp paste, 400 grams of sugar, and 100 grams of monosodium glutamat. Boil 3 L of rainfall water and pour all of the the ingredients except the PGPR stems until a small explosion comes out than pour 5 L of rainfall water into the mixture. When the mixture has cooled the PGPR stems can be added and stir.

Then cover it with clean cloth and placed it protected place from direct sunlight for about 21 days until it smell characteristic of fermentation and grows mushrooms that resemble coral reef.

Before tillage, sprayed the land with PGPR Jakaba for 16L volume of sprayer used 1L of PGPR Jakaba, the remaining of rice plants from previous cultivation can be immersed in soil during the first tillage and the second tillage can be done after 7 days from the first tillage. Than the third tillage can do the leveling the field. Plot the field with an area 1,5 x 1,5 meters and plant with rice weeds in 20 x 20 cm. Once a week do weeding on plot area and applicate PGPR Jakaba, pest control was using biological agents name Trichoderma sp.

To know the macro nutrient from PGPR Jakaba, a laboratorial test was carried out in East Java Agricultural Instrument Standardization Agency laboratory and to know the effectiveness from application of PGPR Jakaba in rice plant is observations during the process of growing rice plant to harvest. The observed parameters were the number of offspring, number of panicles per clump, leght of panicle, number of grains per panicle, weight per 1000 grains of grain, and tilling. Data was analyzed by ANOVA with the help of SPSS software and followed by DMRT at α=5% for mean comparison.

3. Result and Discussion

Based on result analysis of macro nutrient in PGPR Jakaba, it shows that PGPR Jakaba contain with Nitrogen (N) 0,04%, Phosporus (P_2O_5) 0,01%, and Potassium (K_2O) 0,02%.

Table 1. Result of Macro-nutrient Test

Parameter Test	Mark	Unit	Method
Macronutrient			
Nitrogen	0,04	%	Kjeldahl; Titrimetry
P_2O_5	0,01	%	Wet Oxidation (HNO3+HClO4); Spectrophotometer
K_2O	0,02	%	Wet Oxidation (HNO3+HClO4); AAS

Source : East Java Agricultural Instrument Standradization Agency Laboratory, March 2023

Stems growth from the leaves of rice plant, increases the number of tillers, the number of grains and clump caused by the Nitrogen. Phosporus is to stimulate the formation of flowers and grains on panicles, decrease unfilled grain, growth of roots and fine roots, strengthen the straw so that it doesn't collapse easily, and increase the quality of grain. Whereas the Potassium is an enzim activator caused the strengthen for the plant, stimulate root growth, can overcome a certain amount of water shortage, reduced the maturity caused by Phosporus, improve grain quality, and strengthen form pest and disease [6].

Based on data analysis, its shows that application of PGPR Jakaba has an effect on number of offspring, number of panicles per clump, leght of panicle, number of grains per panicle, weight per 1000 grains of grain, and tilling. Beside that, the bacteria contained in PGPR can also help plants to absorb nutrients that exist in nature.

Table 2. The Effect of PGPR Jakaba on Number of Offspring

Given PGPR Jakaba Consentration	Number of Offspring at Plant Age				
	1st WAP	2nd WAP	3rd WAP	4th WAP	5th WAP
Control (P0)	6,6000 a	11,4000 a	21,3333 a	26,1000 a	29,3667 a
20 ml/L (P1)	6,8833 a	13,0333 b	22,0333 ab	26,3333 ab	30,8333 ab
40 ml/L (P2)	6,7667 a	13,000 b	23,7000 bc	29,1333 b	33,0333 b
60 ml/L (P3)	6,9333 a	12,3000 ab	24,3000 c	29,1000 b	33,5333 b

Remark : The number following by same letter in the same colomn and treatment were not significant different according DMRT 5%

Table 3. The Effect of PGPR Jakaba on Number of Panicles

Given PGPR Jakaba Consentration	Number of Panicle
Control (P0)	39,2000 a
20 ml/L (P1)	41,9333 ab
40 ml/L (P2)	46,6667 bc
60 ml/L (P3)	50,9667 c

Remark : The number following by same letter in the same colomn and treatment were not significant different according DMRT 5%

Table 4. The Effect of PGPR Jakaba on Leght of Panicle

Given PGPR Jakaba Consentration	Leght of Panicle
Control (P0)	21,5317 a
20 ml/L (P1)	21,3200 a
40 ml/L (P2)	20,7467 a
60 ml/L (P3)	21,4100 a

Remark : The number following by same letter in the same column and treatment were not significant different according Turkey 5%.

Table 5. The Effect of PGPR Jakaba on Number of Grain per Panicle

Given PGPR Jakaba Consentration	Number of Grains per Panicle
Control (P0)	113,1333 a
20 ml/L (P1)	123,4000 a
40 ml/L (P2)	114,5667 a
60 ml/L (P3)	125,8400 a

Remark : The number following by same letter in the same column and treatment were not significant different according Turkey 5%.

Table 6. The Effect of PGPR Jakaba on Wieght per 1000 Grains of Grain

Given PGPR Jakaba Consentration	Weight per 1000 Grains of Grain
Control (P0)	29,0667 a
20 ml/L (P1)	30,6333 a
40 ml/L (P2)	29,2333 a
60 ml/L (P3)	30,7667 a

Remark : The number following by same letter in the same column and treatment were not significant different according Turkey 5%.

Table 7. The Effect of PGPR Jakaba on Tilling

Given PGPR Jakaba Consentration	Tilling
Control (P0)	1,2000 a
20 ml/L (P1)	1,3000 a
40 ml/L (P2)	1,4333 b
60 ml/L (P3)	1,6500 c

Remark : The number following by same letter in the same column and treatment were not significant different according DMRT 5%.

Previously study, According to Ampong and De Datta [7] nitrogen can stimulate vegetative growth quickly including an increase in height, number of offspring, and leaf size, while phosporuscan stimulate root development and increase the number of offspring so that with good and strong rice plant root conditions it will benefit rice plants in taking nutrients from the soil rather than weeds. Conducted reseach by Kumari [8] that PGPR contain various bacteria which have a good effect on plants, including binding nitrogen gas in the free airto be converted into ammonia which is absorbed by plants (nitrigen fixation), making the phosporus into simpler so that it is easily absorbed by plants, and produces several growth hormones. Same with the reasech by Wang et al, [9] which states that PGPR contains bacteria and is more enviromentally friendly and cheaper alternative compared to using nitrogen fertilizers to increase the growth of rice plants. Adding PGPR in rice field can increase grain yield compared to treatment without application of PGPR. The PGPR consorsium can stimulate root growth and increase nutrient absorbtion in the form of nitrogen, phosporus, and potassium [10]. Another study conducted by K. Giri, et al [11] stated that the rice yield of rice plants observed increased signivianclty after being treated with PGPR. The application of PGPR to rice and bean plants produces high yields because biological nitrogen fixation by plants makes the soil more fertile and increase plant productivity. Same with reseach by Harry Jay M., C., et al [12] which concluded that the bacteria found in PGPR can produce compounds that stimulate growth so that plant growth increases because they recieve growth stimulation based on reseach conducted under controlled conditions in screenhouse. Their research obtain promising data on yields from application of PGPR on plants even thought stastistically it dowsn't show significant result at all, but it can be an alternative to saving fertilizer on rice fields which are conrained by nutrient so that it can be used as an option to reduce the level of use of anorganic fertilizzers among the farmers.

Althought it is known that the amount of macro-nutrients contained in PGPR Jakaba is very small, based on the result of the ANOVA test, the effectiveness result in P3 treatment, namely giving a consentration of PGPR Jakaba in 60ml/L. Because from the application, had an effect on the number of offspring mean 31, number of panicles per clump mean 49, leght of panicle mean 21,25 cm, number of grains per panicle mean 119, weight per 1000 grains of grain mean 29,92 grams, and yield can be reached for 8,2 tons harvested dry grain per hectare. This it is caused by various factors, including the nutrient contained in the soil of the experimental plots which may be sufficient for the nutrients needed by rice plants, weeding is carried out regularly so that the competition for nutrients with weeds is smaller, and the macrobial was contain in PGPR Jakaba which can fixes

nitrogen in free air and provides 85% of nitrogen in today's agricultural world [13]. In addition, other microbes contained in PGPR, one of of which is Bacillus and Pseudomonas, can disolve phosphates, where phosphates are available in nature in the form of insoluble minerals salts, therefore phosphate-dissolving bacteria serve as solven ts that free organic phosphates from inorganic phosphates that can't be dissolved [14]. Maybe PGPR Jakaba is an elicitor, which is a chemical substance that signals plants to produce secondary metabolite cells as plant protectors from biotic and abiotic stresses [15].

Conclution

1. PGPR Jakaba contain with 0,04% of nitrogen, 0,01% of phosporus, and 0,02% of potassium.

2. Application of PGPR Jakaba in rice plants had an effect on the parameters were observed there are the number of offspring mean 31, number of panicles per clump mean 49, leght of panicle mean 21,25 cm, number of grains per panicle mean 119, weight per 1000 grains of grain mean 29,92 grams, and yield can be reached for 8,2 tons harvested dry grain per hectare.

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