1 Article_IOP Growth Response

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Growth Response and Yield of Saline Tolerant Rice Varieties to Bio-fertilizer Application at Central Java North Coastal Saline Paddy Field

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Abstract. Extension of rice production to coastal area of some islands in Indonesia is subjectd to problems that include: high salinity, poor soil fertility and limited number of available saline tolerant varieties. A field experiment was carried out to study the growth response and yield of several saline tolerant rice varieties to bio-fertilizer application at northern coastal area paddy field of Pemalang, Central Java, Indonesia. Four rice varieties that consisted of saline tolerant varieties Inpari Unsoed 79 Agritan, Inpari 34 Salin, and Banyuasin, and one saline intolerant variety Ciherang, were grown and treated with foliar application of commercial bio-fertilizers Bio-P60, Herbafarm and Biofarm which are known to contain active microorganisms. These rice varieties and bio-fertilizers were arranged in Randomized Complete Blocked Design with three replicates. Rice crop management were carried out following recommendation of locale rice management practice. The results demonstrated that BioP60 and Biofarm have greater effect on leaf chlorophyll content as compared to Herbafarm. The lowest percentage of empty grains per panicle was found on Biofarm application (19.6%). No significant diference was observed on the effect of bio-fertilizers on other growth variables and yield. Growth performance and yield variation were observed among the four rice varieties when grown on saline paddy field (EC of 0.65 dS/m, 6.7 pH, 5.37 cmol/kg exchangeable-Na). Ciherang and Inpari Unsoed 79 Agritan demonstrated greater grain weight per effective plot and greater grain weight per hectare. No interaction effect between bio-fertilizer application and varieties was observed on all growth variables and yield of the rice.

Keywords: bio-fertilizer, rice, varieties, salinity, saline paddy field

1. Introduction

As the stapple food of the majority of Indonesian people, rice and its production has got a serious attention from the government. Despite intensification and extensification that have been carried out to meet rice self-sufficiency, rice production is challenged by the increasing land convertion from agriculture to non agricultural uses, such as housing and industrial area, as well as highway. It is predicted that not less than 40,000 ha per year of wetland in Java are converted to non agricultural uses [2]. This phenomenon could threaten food security because Java is well known as the main rice producing area in Indonesia. Therefore, rice production is now extended to sub-optimal area that includes saline wetland area.

Salinity is among a stress condition which is found in about 20 percent of total agricultural land and 50 percent of irrigated wetland in the world. With a total of wetland area of about 8.09 million Hectare, about 965,262 Hectare is located in Central Java and some of which is spread along the north coastal area. During dry season, the irrigation water in this area is affected by seawater intrusion such that the water and soil salinity rises [9]. Soil salinity affects the nutrients availability and transport in plant. Excessive accumulation of Na^+ and Cl^- in the soil influences ionic homeostatic results in nutrients deficiency [7] due to compeyiyion between Na^+ and Cl^- with K^+, Ca^{2+}, Fe^{2+} and Mg^{2+} [3].

Addition of bio-fertilizer is expected to be a solution for nutrient deficiency as it contains a more readily available nutrients. One ml bio-fertilizer is equal to one Kg five month-fermented solid organic fertilizer [10]. Foliar application of bio-fertilizer could prevent loss due to leaching so that it is effective solution for plant nutrient deficiency.

The objectives of this research are: 1) to know the effect of different bio-fertilizers applicatiom on the growth and yield of some rice varieties, 2) to know the growth and yield performance of several rice varieties on salin paddy field of Petarukan, Pemalang, Central Java, and 3) To know if there is an interaction effect between bio-fertilizer and rice varieties on growth and yield of rice.

2. Research Method

This research was carried out at paddy field of Loning Village of Petarukan District, Pemalang, Central Java during the month December-April 2019. The average salinity during the experiment was 0.65 dS/m ($EC_{1:5}$) and categorized as moderate saline [4][5], 5.37 exchangeable Na, ph pf 6.76 and average daily temperature of 32^0C day-time and 28^0C night-time. Saline tolerant rice varieties of Inpari Unsoed 79 Agritan, Inpari 34 Salin Agritan, Banyuasin, and a control non-tolerant variety of Ciherang wer evaluated under field condition upon application with three different commercial bio-fertilizers, namely: Bio-P60, Herbafarm and Biofarm. Bio-fertilizer was applied foliarly on 20, 40, 60, and 80 days after planting, with the application dosage was following application recommendation of the respective bio-fertilizer. A regular basic fertilizers of 250 Kg Urea (46% N), 50 Kg KCl (60% K_2O), and 75 Kg SP-36 (36% P_2O_5) per Ha were also applied.

The experimental treatments (rice varieties and bio-fertilizer) were arranged using Randomized Complete Block design (RCBD) with three replications. Each experimental plot covered an area of 4x3 m^2. The observed variables included: plant height, leaves area, leaves area index, leaves chlorophyll content, total tillers number, productive tiller number, panicle length, seeds number per panicle, filled seeds number per panicle, percent of empty seeds per panicle, thousand seeds weight, seed dryweight per effective plot and seed dryweight per Hectare. The observed data were analyzed using ANOVA, followed pairwise comparison using Duncan Multiple Range Test (DMRT) with confidence level of $P \leq 0.05$.

3. Result and Discussion

3.1. Effect of Bio-fertilizer Application

Bio-fertilizer application affected the cholorophyll content (mg g^{-1}) (CV 11.15%) and percent of empty seeds number per panicle (CV 17.13%) (Figure 1). BioP60 and Herbafarm had 3.32% greater effect on chlorophyll content than Biofarm. Effect of Bio-fertilizer was not significant on plant height, leaves area and leaves area

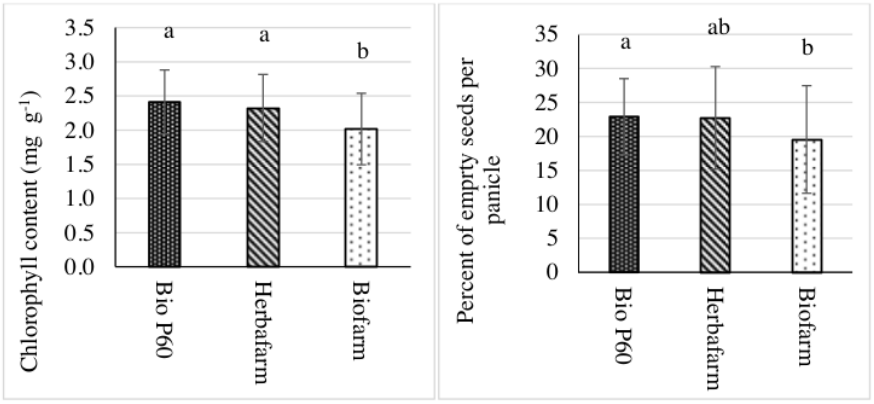

Figure 1. Effect of Bio-fertilizer application on chlorophyll content (mg g^{-1}) and percent of empty seeds per panicle

Bio-P60 is known to content *Psedomonas fluorescent* bacteria. *P. fluorescent* produces *Indole Acetic Acid* (IAA) which has a positive effect on plant growth. *Psedomonas* has also been reported to result in significant increase of chlorophyll content of basil leaves [6].

Plant treated with Biofarm demonstrated lower percentage of empty seeds per panicle, as compared to Herbafarm and Bio-P60. It was stated [8] that percentage of empty seed per panicle could be reduced by Nitrogen application or organic matter amendment.

Table 1. Effect of Bio-fertilizer application on plant height (cm), leaves area (cm^2) and leaves area index (LAI)

Bio-fertilizer	Plant height	leaves area	LAI
Bio-P60	131,49	44,04	1,76
Herbafarm	131,45	48,43	1,94
Biofarm	132,77	45,39	1,82

3. 2. Effect of varieties

Among the evaluated varieties, significant different on plant growth and yield were observed. Depending on each genetic background, each variety carries different inherent growth and yield, as well response to environment [1]. Table 2 shows different growth performances among varieties.

Table 2. Different growth performances among varieties

Variety	Plant height	Panicle length	Leaves area	LAI
Inpari Unsoed 79 Agritan	130,63 b	26,96 a	51,19 b	2,05 b
Inpari 34	146,46 a	27,03 a	65,96 a	2,64 a
Banyuasin	131,12 b	23,74 b	55,89 b	2,24 b
Ciherang	119,42 c	23,67 b	50,16 b	2,01 b
CV (%)	2,94	2,70	12,02	12,02

Note: numbers in the same column followed by similar alphabet indicate no significant different ($P \leq 0.05$)

Among the evaluated varieties, yield performances were significantly different. This correlated well with the different in yield components i.e.: total tiller numbers, productive tiller numbers, percentage of empty seed per panicle, thousand seed weight, seed dryweigth per effective plot and seed dryweigth per hectare (Table 3). Greater yield in Inpari Unsoed 79 Agritan and Ciherang obviously correlated with greater seed dryweight per effective plot (1.0**), and this was because greater thousand seed weight (0.6**), productive tiller numbers (0.63**), but not much by lower percentage of empty seed numbers (0.17) (Table 4).

Table 3. Different yield components and yield performances of the evaluated varieties

Variety	Total tiller numbers	Productive tiller numbers	Percentage of empty seeds per panicle	Thousand seed weight	Seed dryweigth per effective plot	Seed dryweigth per hectare
Inpari Unsoed 79 Agritan	21,38 a	18,18 a	20,63 b	21,61 b	7,51 a	6,27 a
Inpari 34	19,98 ab	16,47 b	25,09 a	21,81 b	5,53 b	4,61 b
Banyuasin	19,82 b	16,73 b	28,56 a	21,12 b	5,89 b	4,90 b
Ciherang	20,58 ab	17,56 ab	12,62 c	24,55 a	8,22 a	6,85 a
KK (%)	6,71	7,11	17,13	4,47	15,64	15,64

Note: numbers in the same column followed by similar alphabet indicate no significant different ($P \leq 0.05$)

Table 4. Correlation coefficient among growth and yield components as responses to bio-fertilizer application

Variable	PH	CC	TTN	PTN	PL	LA	LAI	TSW	SWEP	SWPH	FSN	PESP	SNPH
PH	1	-0,32	-0,01	-0,15	0,57**	0.66**	0,66**	-0,49	-0,59	-0,59	-0,49	-0,59	-0,07
CC		1	0,23	0,16	0,07	-0,34*	-0,34*	0,27	0,37*	0,37*	0,29	-0,46**	-0,21
TTN			1	0,90**	0,12	-0,33*	-0,33*	-0,07	0,52**	0,52**	0,33*	-0,15	0,22
PTN				1	0,08	-0,31	-0,31	0,10	0,63**	0,63**	0,36*	-0,14	0,22
PL					1	0,31	0,31	-0,26	-0,09	-0,09	0,08	0,16	0,18
LA						1	1**	-0,12	-0,51**	-0,51**	-0,52**	0,42**	-0,31
LAI							1	-0,12	-0,51**	-0,51**	-0,52**	0,43**	-0,31
TSW								1	0,6**	0,6**	0,28	-0,67	-0,21
SWEP									1	1**	0,84**	-0,63**	0,38*
SWPH										1	0,84**	-0,63**	0,38*
FSN											1	-0,51**	0,70**
PESP												1	0,17
SNPH													1

Note: **= highly significant; *= significant; PH= Plant height; CC= Chlorophyll content; TTN= Total tiller numbers; PTN= Productive tiller number; PL= Panicle length; LA= leaves area; LAI= Leaves Area Index; TSW= Thousand Seed Weight; SWEP= Seed dryweight per effective plot; SWPH= Deed dryweigth per hectare; FSN= Filled seed numbers; PESP= Percentage of empty seed per plot; SNPH=Seed numbers per hill.

4. Conclusion

Based on the discussion on research data analysis, the following conclusion may be drawn:

4.1. Bio- P60 could effectively be used to increase chlorophyll content of rice. If in this experiment the bio-fertilizer effect on the growth and yield performances of the evaluated variety was not significant, it could be because dosages of application need to be increased.

4.2. The evaluated varieties have different growth and yield performance when grown on moderate field saline condition of Loning Village, Petarukan, Pemalang, Central Java. Inpari Unsoed 79 Agritan and Ciherang demonstrate the greatest yield performances as compared to Inpari 34 and Banyuasin.

4.3. No interaction effect between Bio-fertilizer application and varieties on the growth and yield of the evaluated rice could be observed in the experiment.

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