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Intermittent Irrigation for Improving Rhizobacteri Population Dynamics and Rooting of Local Rice Varieties

B.H. Isnawan, A. Astuti, Z. Abida,*

Agrotechnology Department, Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia

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CORRESPONDING AUTHOR

*E-mail: bambanghi@umy.ac.id

A B S T R A C T

Intermittent irrigation is one of the rice cultivation technologies developed in Indonesia and the world. This study aims to determine the interaction between superior rice varieties with a watering system and rhizobacteria population dynamics, root development, and rice yield. This research was conducted for four months. The study used experimental methods on land compiled with a Factorial 3x4 Strip-Plot experiment design with a Completely Randomized Block Design (RCBD). Factor I is a watering system consisting of 3 treatments i.e. conventional irrigation, intermittent irrigation ten days of dry 5-day watering, and intermittent irrigation seven days of dry 3-day watering. Factor II is rice varieties consisting of 4 i.e. Cempo Merah, Inpari 23, Sintanur, and Inpari 42. The results showed no interaction between the irrigation system and rice varieties to rhizobacteria populations, rooting, and rice yields. The 7-day drying watering system has a relatively larger population of Rhizobacteria in week 16 and increases the length of the roots than other watering treatments. Intermittent irrigation provides grain weight per clump, which is no different from conventional irrigation. Inpari 23 rice varieties have a population of Rhizobacteria week 16 more and weigh 1000 seeds higher than the varieties Inpari 42. Local Cempo Merah rice varieties yield less than superior varieties like Inpari 23, Sintanur, and Inpari 42. Intermittent irrigation is a viable method for cultivating the Inpari 23, Sintanur, and Inpari 42 varieties.

1. INTRODUCTION

1.1. Research Background

Rice (*Oryza sativa* L.) in Indonesia and some countries globally support people's food needs. To boost food production and self-sufficiency, the government uses rice as the primary crop [1]. The results showed that in Martapura, East Ogan Komering Ulu Regency, the rainfed lowland rice intensification program had an effect on lowland rice production, both partially and concurrently [2]. According to Banoc *et al.*[3] already looked at how different rice cultivars alter soil moisture through water use, root development, and dry matter production. Water availability is a critical factor that limits rice production globally under flood irrigation. As an alternative to regular, continuous irrigation, water suppresses the rice growth cycle [4]. Doni et al. have already examined and analyzed the use of RIS techniques and how such modifications to water, soil, plant, and fertilizer management affect the variety and population of soil microorganisms [5] discusses the role of advantageous microorganisms in boosting rice plants' resilience, yield, and growth. Countries with large populations face challenges in meeting the food needs of the people. For this reason, a policy of meeting food needs is needed in agricultural development. In addition, improved food supplies and better health conditions are required as the world population increases [6].

Indonesia produced 59,200 million tons of rice in 2018, 54,504 million in 2019, and 54,649 million tons in 2020. [7]. Indonesia produced 54,415 million tons of rice in 2021 and 55,670 million tons by 2022 [8]. One of the main grain crops is rice, and increased rice output is desperately needed to reduce reliance on rice imports [9]. Rice varieties in Indonesia consist of many varieties, including superior rice varieties and local rice. High levels of amylose were found in Jalahawara, Bendang Pulau, Sokan, Rojolele, and Batang Piaman, whereas low levels were found in Cisantana, Pandan Wangi, Ciherang, and Sidrap [10]. The examined root characteristics demonstrated a noteworthy rise in root density and lateral root emission for Catetão under drought treatment, which might be regarded as a crucial characteristic in choosing superior genotypes [11].

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1.2. Literature Review

Rice imports in Indonesia occur because rice production has increased only in some provinces and has not been evenly distributed. For this reason, efforts are needed to increase production in several areas. Rice production is a contributing factor because of the availability of water, which is not abundant in some provinces. The System of Rice Intensification (SRI) is one of the efforts to be implemented as a solution. SRI rice cultivation can provide water-saving, seed-saving, and fertilizer-efficient technology. As a result, SRI can increase rice productivity, which has been proven to increase rice productivity by 50%, even in some places, reaching more than 100%. It described how using SRI techniques affects the population and diversity of soil microorganisms as well as how water, soil, plant, and fertilizer management are affected [5]. Rice rooting capacity has been evaluated by attentively examining four parameters at the seedling stage: root length, root number, root growth ability, and maximum root length [12]. Rice seedlings' soluble sugar concentration before rooting influenced their capacity to root more than their nitrate-nitrogen level did [13]. With the help of our research, we were able to illuminate the murky world of root Verrucomicrobia and produce cultured strains that may be used to use reductionist methods to uncover causal linkages in plant-microbe interactions [14]. The bacterial community in the rhizosphere and the metabolites in the soil alter significantly between plants carrying the SST gene and those that do not during salt stress [15]. Microbial activity affects rice rooting. The microbial biostimulant affected the rice's agricultural characteristics [5]. It is also mentioned that transcriptional modifications for genes linked to the main metabolism, water and nutrient transport, and rice plant growth may be induced by the photostimulation of rhizobacteria. Rhizobacteria are some bacterial species associated with the rhizosphere of a plant. Some of them can encourage the growth of plants. Plant-enriched compost with rhizobacteria can support plant growth (Bacillus sp., Azospirillum sp, Pseudomonas sp., and Azotobacter sp.). It was utilized once as a material study for the Ciherang rice variety [16]. Nonbiotic nitrogen-fixing bacteria known as Rhizobacteri can spur plant growth.

We created cultured strains of Verrucomicrobia that could apply reductionist methods to find causal links in plant-microbe interactions and shed light on the dark world of root Verrucomicrobia [17]. Additionally, it was shown that four possible isolates could create siderophores, indole acetic acid, growth hormone, and solubilized phosphate. They may also accelerate the growth of rice seedlings [18]. Rice yields can be increased by 25.5% and 12.9%, respectively, with the PGPR application with 50% CF. Rhizobacteria can be applied to lessen the need for chemical fertilizers [19]. According to our findings, The amount of chemical N fertilizer required (S-7) or half (S-343 and S-611) can be replaced by bacterial inoculation, depending on the strains of bacteria and the growth environment. Nevertheless, under growth chamber settings, the control plants' $\delta^{15}N$ value was lower than that of the inoculated plants, suggesting that the bacteria support rice development by mechanisms other than biological nitrogen fixation [20].

1.3. Research Objective

This research aims to study the interaction between rice varieties and irrigation to rhizobacteria population dynamics. First, identify rhizobacteria population dynamics in some rice varieties. Second, identify rhizobacteria population dynamics in some irrigation systems.

2. MATERIALS AND METHODS

2.1. Materials and Tools

Tools used include an autoclave, Erlenmeyer, test tube, bunsen lamp, ose needle, drigalski, micropipette, stove, measuring glass, stirrer, analytical scales, Petri dish, injecting bottle, pH-stick, ruler, oven, and stationery—other tools such as necessities during rice planting.

Ingredients used in this study were rice seed varieties Cempo Merah, Inpari 23, Sintanur, Inpari 42 GSR, organic manure, tryptone, Yeast Extract, NaCl, agar, aquadest, cotton, rubber, umbrella paper and plastic.

2.2. Research Design and Analysis

This study used experimental methods on land compiled with a Complete Group Randomized Design (RCBD) with a 3x4 Factorial Strip-Plot experiment design. Factor I is a type of irrigation consisting of 3 treatments: conventional irrigation, intermittent irrigation, ten days of 5 dry days, and intermittent irrigation, seven days of 3 dry days of watering. Factor II is a plant variety consisting of 4 varieties of Cempo Merah, Inpari 23, Sintanur, and Inpari 42 GSR. There are 12 units of work. The superior rice varieties are Inpari 23, Sintanur, and Inpari 42 GSR. The local rice variety is red cempo as a comparison.

Planting materials are rice seeds soaked for 24 hours and then watered for one night. After watering, the seeds are planted into the nursery tub. Grain is grown for 14 days. The soil processing is carried out with the help of machinery (piracy) and scratches. According to the treatment, after the land management is completed, the land is made with a bed or block. The process of soil processing is given essential fertilizer, namely manure, with a dose of 10 tons/ha. Urea with an amount of 140 kg/ha, and SP36 with a dose of 125 kg/ha

Rice planting is done with a planting distance of 25 cm x 25 cm with three seeds per planting hole at the age of the seed 14 days. The planting method uses the tile method, which includes irrigation, weed weeding and pest control, and disease and fertilization. Harvesting is done after the plant is 115 days old. The criteria for plants ready to be harvested are: Malai is brownish yellow and has dried, but not much grain has fallen out.

Observations of Rhizobacteria include sterilization of tools, preparation of mediums, Isolation of Rhizobacteria, and Identification of Rhizobacteria. Parameters include Rhizobacteria population dynamics (CFU/ml), and root development includes root length (cm), proliferation, fresh weight, and dry roots (g). Observation results include grain weight per clump (g) and weight 1000 grains (g).

3. RESULTS AND DISCUSSION

3.1. Rhizobacteria Population Dynamics

The land used in this study is where tens of thousands of microorganisms live. Rhizobacterium is an example of bacteria that live in it. Rhizobacteria population dynamics and early conditions are presented in Table 1. The land has the same initial

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conditions as the absence of treatment, with an average population of 232.89 x 107 CFU / ml.

Table 1. Early Conditions of Rhizobacteria Soil

Irrigation	Population X 107 (CFU/ml)
Block 1	210.00
Block 2	316.00
Block 3	172.67
Average	232.89

Rhizobacteria population dynamics in the nursery: each variety in this nursery has relatively similar soil conditions. However, the population of the Sintanur variety has a somewhat higher population of 635 x 107 CFU/ml (Table 2).

Table 2. Rhizobacteria Seedling Population Dynamics

Varieties	Population X 107 (CFU/ml)
Cempo Merah	233.33
Inpari 23	302.33
Sintanur	635.00
Inpari 42	92.33

3.2. Identification Identification and Characterization of Rhizobacteria Cells

Identification and characterization were determined to determine the rhizobacteria cell type of isolates in 4 rice varieties (Red Cempo, Inpari 23, Sintanur, and Inpari 42) observed (Table 4).

The four isolates tested had different cell identification and characterization. Isolates A and d have a Baccil cell shape, while isolates b and c are Coccus-shaped (round or oval). The results of testing isolate with NaCl stress treatment or resistance to dampening obtained data that the four bacteria, namely isolates a, b, c, and d, are resistant to drought suppression until testing bacterial growth in LBA with NaCl 2M.

Table 4. Identification and Characterization of Rhizobacteria Cells

No	Isolate Characterization	Isolate			
		a	b	c	D
1	Cell Shape	Baccil	Coccus	Coccus	*Baccil*
2	Nature of Gram	Negatives	Negatives	Negatives	Negatives
3	Checked	v	V	V	V

The highest in week 4 and 16 varieties of Inpari 23 are 194.67 x 107 CFU/ml and 344.89 x 107 CFU/ml. In the 10th week, the Rhizobacteri population was highest in treating the Cempo Merah variety at 572.44 x 107 CFU /ml. No symbiotic relationships exist with certain functional rhizobial bacteria, so certain non-my corrosive plants, like canola and mustard, need to be fertilized more minerally [21]. Canola and mustard are plants not associated with rhizobacteria, which are non-mycorrhizal. These crops require additional N/S fertilizers, but their yield and value compensate for higher fertilizer investments [22].

3.3. Development of Rice Plant Roots and Rice Yields

Roots are essential organs in plants that absorb water and nutrients in the planting medium for the growth and development of rice plants. In soil water and nutrients, the root systems of rice play a significant function [23].

The results of the root length of the diversity in the 16th week showed no interaction between the irrigation treatment, variety, or both treatments. However, there is a real difference in irrigation treatment, namely in the treatment of 7 days and drying three days with the most extended average root length of 28.38 cm compared to the other two irrigation treatments. The treatment of varieties is no different. The entire length of the root of the three upland species was improved with moderate and high fertilization of the soil moisture fluctuations, while the lowland variation was decreased [24].

Root proliferation indicates how much root development a plant develops against the root's ability to reach and absorb water and nutrients in the soil. Root proliferation in weeks 4, 10, and 16 of irrigation treatment increases weekly. In the 4th week, the most proliferation was the conventional irrigation treatment 1.67. In the 10th week, the treatment of 10 days of drying, five days, and seven days of drying three days has an equally significant proliferation of 2.58. Finally, in the 16th week, the most significant proliferation in 7 days of drying three days amounted to 2.83.

The rhizobacteria population of irrigation treatment in the 4th week is best in conventional irrigation, 210.83 x 107 CFU / m. In the 10th week of the best irrigation treatment, the Rhizobacteria population is in 10 days of drying five days with a rapid increase as high as 340.17 x 107 CFU / ml. Rhizobacteria population at the 16th week of irrigation treatment is highest at seven days of drying three days, which is 328.92 x 107 CFU/ml (Fig.1.).

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Table 5. Average Root Length, Fresh Weight Roots, and Dry Weight Roots in Week 16

Treatment	Root length (cm)	Root Fresh Weight (g)	Root Dry Weight (g)
Irrigation:			
Conventional	20.64 b	36.22 a	7.48 a
Ten-day watering, five-day drying	24.29 b	30.44 a	9.86 a
Seven days of watering, three-day drying	28.38 a	26.16 a	7.75 a
Varieties:			
Cempo Merah	23.21 p	35.40 p	8.23 p
Inpari 23	24.34 p	32.62 p	8.59 p
Sintanur	24.41 p	27.00 p	8.90 p
Inpari 42	25.78 p	28.74 p	7.74 p
Interaction	(-)	(-)	(-)

The average value followed by the same letter shows no difference based on the Anova with error rates α = 5%. (-) indicates there is no significant interaction between treatments.

The results of the variance analysis in the fresh root weight in the 16th week showed no interaction between the irrigation treatment and variety. Between irrigation and variety, there is no real difference. The average weight of fresh roots in this type of irrigation is 30.94 grams (Table 5). Therefore, IRAT 109 and KDML 105 have improved efficiency when converting dry matter that is accessible for improved lateral root development in a well-watered control system [3].

The dry root weight analysis of variance results at week 16 showed no interaction between the irrigation treatment and variety. There is no real difference between the treatment of irrigation and variety. The average dry weight of the roots on the irrigation treatment is 8.36 grams. Drought stress lowered shooting and root dry weight [11].

The yield of a plant is the result of a cultivation activity. Therefore, high yields are a sign of the success of crop cultivation. The analysis of the variance of the variety of grain weights per clump showed no interaction between irrigation treatment and variety. In the treatments between irrigations, there is no real difference. However, the average grain weight per clump at the irrigation treatment is 30.40 grams, and there is a real difference in the treatment of varieties. The Cempo Merah variety has the lowest grain weight per clump value of 18.79 grams (Table 6). Therefore, the potential yield of the four varieties, namely Red Cempo, Inpari 23, Sintanur, and Inpari 42 varieties with the Red Cempo variety, has the lowest yield potential compared to the other three.

Table 6. Average Grain Weight per Rice Grove and Weight of 1000 Grains

	Grain Weight per Clump (g)	Weight of 1000 grain (g)
Irrigation:		
Conventional	30.38 a	22.71 a
Ten-day watering, five-day drying	32.79 a	22.17 a
Seven days of watering, three-day drying	28.02 a	21.98 a
Varieties:		
Cempo Merah	18.79 q	21.78 pq
Inpari 23	37.35 p	24.63 p
Sintanur	29.34 p	23.22 pq
Inpari 42	36.11 p	19.53 q
Interaction	(-)	(-)

The average value followed by the same letter shows no difference based on the ANOVA with error rates α = 5%. (-) indicates there is no significant interaction between treatments.

The 1000-grain weights show that the weight of 1000 grains does not interact well with irrigation and variety. The treatment of water is no different. The average weight of 1000 grains on the irrigation treatment is 22.29 grams. Between varieties, there are fundamental differences. For example, the average weight of 1000 grains of Inpari 23 varieties, amounting to 24.63 grams, is heavier than the Inpari 42 variety.

4. CONCLUSION

There is no interaction between rice varieties and irrigation on rhizobacteria population dynamics. Rice varieties have mixed results against rhizobacteria population dynamics. The Cempo Merah, Sintanur, and Inpari 42 varieties had the highest Rhizobacteri populations in week ten compared to weeks 4 and 16. In the Inpari variety, 23 people were highest at week 16

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compared to weeks 4 and 10. Rhizobacteria population dynamics of the Cempo Merah variety is highest in week ten at 572.44 x 107 CFU/ml. Conventional irrigation, 10-day inundation, 5-day drying, and 7-day inundation, as well as 3-day drying, have the highest Rhizobacteri populations in week ten compared to weeks 4 and 16. In the 10th week, the 10-day drying day has a population of Rhizobacteria of 393.83 x 107 CFU/ml. Seven days of drying and three days of watering have longer roots than other irrigations.

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