Response Of Growth And Yield Of Rice (Oryza Sativa L.) To The Combination Application Of Biofertilizer And Biological Agens

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Abstract: This research was conducted experimentally using a randomized design with 10 treatments consisting of P1 (control), P2 (application of biofertilizer and biological agents aged 0 day after planting (DAP)), P3 (biofertilizer aged 0 DAP and biological agents aged 0 DAP and 30 DAP), P4 (biofertilizer aged 0 DAP and biological agenst aged 0 DAP, 30 DAP, and 60 DAP), P5 (biofertilizer aged 0 DAP and 30 DAP and biological agenst aged 0 DAP), P6 (biofertilizer aged 0 DAP and 30 DAP and biological agenst aged 0 DAP and 30 DAP), P7 (biofertilizer aged 0 DAP and 30 DAP and biological agenst aged 0 DAP, 30 DAP, and 60 DAP), P8 (biofertilizer aged 0 DAP, 30 DAP and 60 DAP,and biological agenst aged 0 DAP), P9 (biofertilizer aged 0 DAP, 30 DAP and 60 DAP, and biological agenst aged 0 DAP and 30 DAP), P10 (biofertilizer aged 0 DAP, 30 DAP and 60 DAP, and biological agenst aged 0 DAP, 30 DAP, and 60 DAP). The results showed that three times the application of a combination of biofertilizer from the consortium of cellulolytic bacteria based on washing rice and local biological agent Beauveria bassiana Vuillemin gave good results on growth and yield of rice plants.

Key words: Rice Plants, Combination, Biofertilizer, and Biological Agens

1. INTRODUCTIONS

Rice (Oryza sativa L.) is one of the most important food crops as an energy source in some parts of the world, especially Indonesia. The rice needed has increased but is not followed by an increase in rice production, it can be seen from the data on rice demand in Riau Province in 2014 which was 652,875 tons of dry milled grain (GKG) while the production yield was only 385,475 tons [1]. The current decline in production is caused by several factors, including the inefficient use of inorganic fertilizers which results in land degradation, environmental stresses such as drought, flooding, and pest (Plant Disturbing Organisms) disturbances [2]. One of the efforts to increase food production is in the field of fertilization [3]. One effort to overcome this problem is to reduce the use of inorganic fertilizers through the provision of biological fertilizers. Biological fertilizer is an active biological product containing microorganisms that can increase fertilization efficiency, soil fertility, and soil health [4]. The biological fertilizer used in this research is the biofertilizer of the consortium of cellulolytic bacteria based on rice washing water. The bacterial consortium used was derived from two bacterial isolates of rice straw (Bacillus cereus JP6 and Bacillus cereus JP7), two bacterial isolates of oil palm empty fruit bunches (Proteus mirabilis TKKS3) and (Proteus mirabilis TKKS7), and two isolates of acacia litter bacteria (Providencia vermicola SA1) and (Bacillus cereus SA6) [5]. (The presence of these six bacterial isolates is expected to be able to become biological agents from the rice water washing used so that it can provide the nutrients needed for the growth and yield of upland rice plants.

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According to [6] , one of the problems faced in rice cultivation is the attack of plant pest organisms (OPT) consisting of pests, plant diseases, and weeds. The high pest attack is caused by the inappropriate application of chemical pesticides at the beginning which results in the destruction of natural enemies and will cause resistance and resurgence in pests. One of the efforts that can be done to control these pests is to use the local entomopathogen Beauveria bassiana Vuillemin. Local Beauveria bassiana Vuillemin is an entomopathogenic fungi that is used as an environmentally friendly biopesticide. This is because it does not produce residues that can be harmful and do not cause pest resistance and resurgence [7]. Local B. bassiana Vuillemin is able to control pests from various levels ranging from eggs, larvae, pupae, and imago. The application of the entomopathogenic fungi B. bassiana has been carried out on rice plants [8]. Based on the results of research by [9] the application of local Beauveria bassiana Vuillemin with a concentration of 30 g/l of water caused a total mortality of 97.5% against the pest walang sangit for 12 days. The involvement of microbes as biological fertilizers and local B. bassiana Vuillemin fungi can be recognized by the public so that production results increase and are healthier and safer. This study aims to determine the effect of the combination of biological fertilizers and biological agents on the growth and yield of rice (Oryza sativa L.), and to determine the best application of fertilizers and biological agents for the growth and yield of rice (Oryza sativa L.).

2. MATERIALS AND METHODS

The materials used in the study were upland rice seeds of the Inpago 9 variety, top soil, rice washing water, isolates from a consortium of cellulolytic bacteria (Hapsoh et al., 2016), isolates of the local fungi B. bassiana Vuillemin (Hapsoh et al., 2016), Nutrient Broth (NB), Carboxymethyl cellulose (CMC), Nutrient Agar (NA), 70% alcohol, distilled water, water, spirit, Urea fertilizer, SP-36, KCl fertilizer, crushed corn, brown sugar, and granulated sugar. The tools used in the study were polybags measuring 35 cm x 40 cm, tape measure, hoe, sieve, raffia rope, scissors, knife,

gembor, lanjaran, polynet, label, analytical balance, test tube, erlenmeyer, measuring cup, hot plate, micro pipettes, autoclaves, ose needles, bunsen, laminar or enkas, stationery, documentation tools, and other supporting tools. This research was conducted experimentally which was arranged according to a completely randomized design (CRD) consisting of 10 treatments, each treatment with 3 replications. So that 30 experimental units were obtained, each experimental unit consisted of 6 rice plants. So the total number of plants is 180 plants. The application of biological fertilizers and biological agents consisted of 10 treatments consisting of: P1 (control), P2 (1 time application of biological fertilizers and 1 time application of biological agents 0 DAP (Day After Planting)), P3 (1 time biological fertilizers 0 DAP and 2 times applications of biological agents 0 DAP and 30 DAP), P4 (1 time application of biological fertilizer 0 DAP and 3 times application of biological agent 0 DAP, 30 DAP, and 60 DAP), P5 (2 times application of biological fertilizer 0 DAP and 30 DAP and 1 time biological agent 0 DAP), P6 (2 times application of biological fertilizer 0 DAP and 30 DAP and 2 times application of biological agent 0 DAP and 30 DAP), P7 (2 times application of biofertilizer 0 DAP and 30 DAP and 3 times application of biological agent 0 DAP, 30 DAP and 60 DAP), P8 (3 times application of biofertilizer 0 DAP, 30 DAP, and 60 DAP and 1 time application of biological agent 0 DAP), P9 (3 times application of biological fertilizer 0 DAP, 30 DAP, and 60 DAP and 2 times application of biological agent at 0 DAP and 30 DAP), P10 (3 times application of biofertilizer 0 DAP, 30 DAP, and 60 DAP and 3 times application of biological agent 0 DAP, 30 DAP, and 60 DAP)

3. RESULTS AND DISCUSSION

3.1 Physiological response

The results of variance showed that the combination of biofertilizers from a consortium of cellulolytic bacteria and local Beauveria bassiana Vuillemin biological agents had no significant effect on the rate of photosynthesis and the amount of chlorophyll in rice plants, which can be seen in Table 1.

Table 1. Physiological responses of upland rice plants to the application of biofertilizers from a consortium of cellulolytic bacteria based on rice water washing and the local Beauveria bassiana Vuillemin biological agent.

Treatment Biological fertilizer (BF) and Biological agent (BA)	Photosynthesis rate (µmol CO2m-2 s-1)	Chlorophyll density (µmol m-2)
P1	19,38	35,57
P2	23,66	37,33
P3	23,19	40,50
P4	23,16	42,67
P5	26,15	39,73
P6	23,66	46,73
P7	24,37	47,57
P8	25,93	42,97
P9	26,43	48,57
P10	30,57	49,07

Table 1 shows that the rate of photosynthesis and chlorophyll density of upland rice plants against the combination of biofertilizers from a consortium of cellulolytic bacteria based on rice washing water and local biological agents B. bassiana Vuillemin was not significantly different for all tested treatments, but the combination of biofertilizers was given to a consortium of cellulolytic bacteria. Based on rice washing water and local biological agents B. bassiana Vuillemin three times tended to increase the rate of photosynthesis and chlorophyll density in rice plants. The rate of photosynthesis and the density of chlorophyll are influenced by leaf area, amount of chlorophyll, and environmental factors [10]. Environmental factors that affect the rate of photosynthesis and chlorophyll density are soil conditions related to the availability of nutrients in the soil. Nutrients that have an effect on increasing the rate of photosynthesis and chlorophyll density are N. According to [11], element N serves to give a dark green color to the leaves, increase the chlorophyll component, increase leaf size, and increase plant growth. [12] added factors that influence the formation of chlorophyll, namely genes, light, elements of N, Mg, Fe which function to form and catalyze the synthesis of chlorophyll. If the chlorophyll content increases and other supporting materials in optimal conditions, the rate of photosynthesis will increase. Therefore, the N content of biological fertilizers is thought to provide N nutrients for the photosynthesis process. Factors that are also thought to be able to increase the rate of photosynthesis and chlorophyll density in addition to biological fertilizers are due to the provision of local B. bassiana Vuillemin biological agents. The provision of these biological agents can suppress pest attacks that usually attack during the vegetative phase. One of the pests that attack rice during the vegetative period is the wandering grasshopper (Locusta migratoria L.). The results of research by [13] showed that the administration of B. bassiana could reduce the attack intensity of the locust locust (Locusta migratoria L.) by 8.66% compared to no treatment, which was 17.53% on soybeans. [14] stated that grasshoppers attack rice plants during the vegetative period with symptoms of the attack of the first leaf being torn due to the bite of this pest. Therefore, by giving these biological agents it can reduce damage to plant leaves so that the rate of photosynthesis and chlorophyll density are not disturbed.

3.2 Growth response

The results of variance showed that the combination of biofertilizers from a consortium of cellulolytic bacteria and local Beauveria bassiana Vuillemin biofertilizers had no significant effect on plant height, maximum tiller number, number of productive tillers, panicle exit age, and harvest age of rice plants can be seen in Table 2.

Table 2. Response of rice plant growth with a combination of application of biological fertilizers and biological agents

Treatment Biological fertilizer (BF) and Biological agent (BA)	Plant height (cm)	Maximum number of tillers	Number of productive tillers	Age out malai (HST)	Harvest age (HST)
P1	72,19	33,00	16,83	78,33	120
P2	72,50	33,55	19,00	77,44	118,67
P3	73,70	35,44	19,77	77,56	118,33
P4	73,36	36,55	20,11	77,33	118,44
P5	76,50	35,00	19,99	77,33	118,11
P6	74,17	34,34	20,22	76,56	117,44
P7	75,26	37,89	20,22	77,11	117,45
P8	76,94	37,67	20,33	76,31	117,40
P9	77,68	34,89	20,33	75,89	116,78
P10	79,83	40,11	21,78	74,33	114,44

Table 2 shows that the combination of biofertilizers from the consortium of cellulolytic bacteria based on rice washing water and local B. bassiana Vuillemin biological agents were not significantly different from all treatments tested, but the combination of biofertilizers from the consortium of cellulolytic bacteria based on rice washing water three times and agents three times the local biodiversity of B. bassiana Vuillemin tended to increase plant height, maximum number of tillers, number of productive tillers, accelerated panicle age and harvest age in rice plants. The rice plant growth parameters are strongly influenced by the available nutrients. Nutrients N and P are elements that are needed by plants during the vegetative period. Based on the results of research by [15], the addition of element N can increase plant height, number of productive tillers, and grain production. Element N also functions in increasing the maximum number of tillers. This is in accordance with the opinion of [16] which states that the element N is an element that quickly affects plants because it can increase the maximum number of tillers and the number of grains per clump. [17] added that N element has a role in forming proteins that play a role in the photosynthesis process, P element has a function in helping assimilation and respiration and accelerating flowering, seed ripening, and fruit ripening. The biological fertilizers given in this study contained N nutrients of 0.04% and P of 0.028%. These nutrients were thought to contribute to increasing several parameters of rice growth so that three times the application of biological fertilizers resulted in quite good growth compared to no application and one or twice giving. The growth of rice plants due to the addition of cellulolytic consortium biofertilizers is also thought to be due to the presence of microbes contained in biological fertilizers that have the ability to produce IAA by Bacillus cereus bacteria [18]; [19], producing phosphate solvents. by the bacterium Providencia vermicola [20], producing the enzyme urease by the bacterium Proteus mirabilis which is able to decompose urea [21]. The ability of some bacteria to produce these metabolites is thought to be able to increase plant vegetative growth. This can be seen from the number of bacteria present in the soil with the application of biofertilizers three times higher than without application, and one or two applications. The more bacteria that grow, the more metabolites produced and plant growth will increase. The application of biological agents also affects the growth of rice plants. This is because biological agents are able to suppress pest attacks that can interfere with plant growth.

here are several types of pests that attack rice plants, one of which is the rice stem borer. During the vegetative period, rice stem borer larvae damage rice plants by eating the plant vascular system found in rice stems [22]. The application of the local Beauveria bassiana Vuillemin biological agent is thought to be able to suppress rice stem borer attacks. According to the results of [23], Beuaveria bassiana, Metarhizium anisopliae and neem leaf extract have the ability to suppress rice stem borer attacks, but B. bassiana tends to control stem borer pests better than M. anisopliae and neem leaves.

3.3 Yield component

The results of variance showed that the combination of biofertilizers from a consortium of cellulolytic bacteria and local Beauveria bassiana Vuillemin biological agents had no significant effect on panicle length, number of pithy grain per panicle, 1000 grain weight, percentage of pithy grain, and weight of milled dry grain per cluster of rice plants can be seen in Table 3.

Table 3. Response of rice yields with a combination of application of biological fertilizers and biological agents

Treatment Biological fertilizer (BF) and Biological agent (BA)	Panicle length (cm)	Number of pied grain per panicle (grain)	Weight 1000 grains (g)	Percentage of piggy grain (%)	Weight of milled dry grain (g)
P1	26	60,90	45,33	57	56,68
P2	27,42	76,73	45,71	57,85	59,07
P3	27,31	87,43	45,51	61,13	63,11
P4	27,13	90,92	45,81	61,64	66,18
P5	27,45	91,82	46,11	66,76	66,56
P6	27,57	97,92	46,41	66,86	68,79
P7	27,62	91,96	46,67	68,07	70,36
P8	27,75	100,24	47,08	69,01	70,57
P9	27,75	104,14	47,18	69,34	71,05
P10	28,32	104,51	47,24	78,71	77,76

Table 3 shows that the combination of biofertilizers from the consortium of cellulolytic bacteria based on rice washing water and the local Beauveria bassiana Vuillemin biofertilizer was not significantly different from all the treatments tested, however, the combination of biofertilizers from the consortium of cellulolytic bacteria based on rice washing water three times and biological agents. Local Beauveria bassiana Vuillemin three times tended to increase panicle length, number of panicled grain, 1000 grain weight, percentage of pithy grain, and dry milled grain weight (GKG) per clump in rice plants. The increase in some yield parameters with the amount of three times was suspected because the content of nutrients and microbes contained in biological fertilizers was able to increase yield parameters as well as growth parameters. According to [24], biological fertilizers have a role in facilitating the availability of nutrients, decomposition of organic matter, and providing a better rhizosphere environment for plants that will support growth and increase crop yields. Some macro nutrients such as N, P, and K nutrients are needed by plants for growth and filling of rice grains. The application of biological fertilizers is thought to be able to meet the N needs of plants. According to [25], the N element will affect the growth of panicle length, number of panicle grains, and number of pithy grains per panicle. In addition to N, P and K elements also affect physiological processes, fruit filling and ripening as well as increasing seeds, increasing translocation of plant physiological processes so that the weight of 1000 dry milled grains increases [26]. According to [27] element P has the function of stimulating root growth, accelerating the growth of young plants into mature plants, stimulating flowering, ripening of fruit, seeds and grain and increasing production. [28] added that element K functions in increasing the levels of carbohydrates and sugars in fruit, making plant seeds fuller and denser and fruit quality will increase. The availability of nutrients N, P, and K in the biofertilizer is thought to be able to increase several parameters of rice yields. The increase in several yield parameters in this study was also influenced by the provision of biological agents that were able to suppress pest attacks. One of the pests that attack rice plants during the generative period is walang sangit (Leptocorisa acuta).This pest attacks rice plants when panicles begin to appear until the grain filling phase. This pest can reduce yields up to 50% [29]. Several research results of the application of the fungi B. bassiana in suppressing the pest attack of the pest was reported by [9], [30], [31] who stated that the use of biological agents B. bassiana was able to suppress the attack of the pest pest on rice plants.

3.4 Percentage of affected plants

The results of variance showed that the application of local Beauveria bassiana Vuillemin biological agents had no significant effect on the percentage of plants affected in rice plants can be seen in Table 4.

Table 4. Observation of the percentage of plants affectedby application of biological agents.

Treatment Biological agent (BA)	Percentage of affected plants (%)	Decrease in percentage of affected plants (%)
Control	22.974	0
1 time AH age 0 DAP	17.29	24.73
2 times AH age 0 DAP and 30 DAP	15.27	33.52
3 times AH age 0 DAP, 30 DAP, dan 60 DAP	13.17	42.66

Table 4 shows that the administration of the local Beauveria bassiana Vuillemin biological agent was not significantly different from all the treatments tested, but the application of the local Beauveria bassiana Vuillemin biological agent three times reduced the percentage of plants attacked by pests by 42.66%. This is because the provision of biological agents is able to protect plants from attacks by plant pest organisms (OPT) so that plant growth and yields are not disturbed. There were several pests that attacked rice plants at thetime of the study, namely Walang sangit (Leptocorisa oratorius), rice leaf folding caterpillar (Cnaphallocrosis medinalis Gueene), rice stem borer (Scirpophaga incertulas Walker), brown planthopper (Nilapavarta lugens Stall), wandering grasshopper (Locusta migratoria), and armyworm (Spodoptera frugiperda). Existing pests begin to attack plants in the vegetative to generative phase. Observation of the percentage of pithy grain and milled dry grain weight (Table 3) with the treatment of B. bassiana administration of biological agents three times at the age of 0 DAP, 30 DAP, and 60 DAP obtained quite high results compared to the administration of one biological agent. Or twice. It is suspected that the administration of B. bassiana three times was able to suppress pest attacks so that the percentage of affected plants decreased which resulted in the percentage of pithy grain and dry milled grain weight increasing with the application of biological agents three times. Giving B. bassiana three times was able to reduce the percentage of plants that were attacked by pests. This is due to the contact between insects and spores of the biological agent B. bassiana when the insect lands on the surface of the plant that has been applied to the fungi B. bassiana, and eats the part of the plant that has been infected by the fungi or has been treated with the fungi. The fungi B. bassiana is able to infect pests because this fungi secretes toxic compounds. This is in line with the opinion of [32] the fungi B. bassiana that managed to enter the insect's body will release a toxin compound beauverisin which causes tissue damage in the insect's body, 2 days later the insect will die and mycelia of the fungi will grow on the insect's body.

5. CONCLUSIONS

The application of a combination of biofertilizers from a consortium of cellulolytic bacteria based on rice washing water and local biological agents B. bassiana Vuillemin had no effect on the parameters of growth and yield of rice plants. The number of applications of fertilizers and biological agents for good growth and yield of rice plants is three times.

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