Application of biofertilizer consortium formulation of cellulolytic bacteria based on organic liquid waste on yield of upland rice (*Oryza sativa* L.)

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Abstract. Rice production in Riau Province is lower than demand. One of the efforts made is the use of organic fertilizer based on organic liquid waste, in addition to reducing the use of inorganic fertilizers. The method that can be applied to support rice yield is the use of cellulolytic bacterial consortium applications. This study aimed to finding out the formulation and dose of biological fertilizer based on cellulolytic bacteria based on the organic liquid waste that was good for growth and yield of upland rice. This research used a Completely Randomized Design which consisted of 12 treatments, namely of biofertilizer of rice washing water, biofertilizer of coconut water, biofertilizer of wastewater tofu, biofertilizer of palm oil mill with doses 5, 10, 15 ml. The result showed that all biofertilizers based on organic wastewater cellulolytic consortium could provide varied results on all parameters of observation so that all biological fertilizers could be applied to upland rice plants with the use of inorganic fertilizers at half the recommended dose. Biofertilizers from rice washing water with a dose of 10 ml gave a good response to the growth and yield of upland rice compared with other treatments.

1. Introduction

Rice (*Oryza sativa* L.) is an important food crop because it has become a staple food for more than half of the world's population [1]. The weight needed every year increases with increasing population. On the other hand, production is lower than the need, one of them can be seen from the need for rice in Riau Province in 2014 reached of 652,875 tons of Dry Grain (GKG), while production was only 385,475 tons [2]. This shows that Riau has experienced a rice deficit of around 60% of the needs.

Now, the rate of increase in rice production is decreasing due to several factors such as inefficient use of inorganic fertilizers, land degradation, environmental stresses such as drought, flooding, and pest disruption [3]. Agriculture on dry land is one of the potential alternatives to be developed in increasing production and meeting food needs. Upland rice is one of the food crops that has the potential to be developed in the dry land. This increase in production is inseparable from the role of the use of fertilizers as an important factor of production, but the high price of inorganic fertilizers circulating in the community often makes farmers not routinely carry out fertilization so that the growth and yield of their crops become low [4]. Other factors are needed to support the supply of nutrients that are affordable to farmers, one of them is the use of biological fertilizers from organic liquid waste.

According to [5], biofertilizer is a fertilizer that contains living microorganisms which, when applied to seeds, plant surfaces, or soil, can stimulate the growth of these plants. Utilization of biological
fertilizers for plants is very beneficial because it can suppress the use of chemical fertilizers. Besides, the utilization of organic waste can also reduce the impact of environmental pollution that can damage human health.

This research utilized several organic materials that could be used as materials for making biological fertilizer including rice washing water waste, tofu liquid waste, coconut water waste, and palm oil liquid waste. This waste can also be used as organic fertilizer that can improve soil fertility, increase growth and production plants and contain compounds or elements that can be used as a source of nutrition for microbes. One of the new methods that can be applied to support rice yield is the use of a cellulolytic bacterial consortium application [6]. [7] stated a bacterial consortium is a collection of several similar organisms so that it forms a community of several different populations.

In this study, a bacterial consortium used were two bacterial isolates from rice straw (Bacillus cereus JP6 and Bacillus cereus JP7), two bacterial isolates from oil palm empty fruit bunches (Proteus mirabilis TKKS3) and (Proteus mirabilis TKKS7), and two isolates from acacia litter. (Providencia vermicola SA1) and (Bacillus cereus SA6) [8]. This was based on the ability of the six isolates to produce cellulose enzymes as seen from the high cellulolytic index in qualitative tests in previous studies. These isolates were expected to be biological fertilizer agents of some waste was used to provide nutrients for growth and yield of upland rice. This study aimed at finding out the formulation and dosage of a biological bacterial consortium based on the organic liquid waste that was good for the growth and yield of upland rice (Oryza sativa L.).

2. Materials and methods

This research has been carried out in the Experimental Garden at the Agriculture Faculty, Riau University, Binawidya Campus Km 12.5, Simpang Baru Village, Tampan District, Pekanbaru. This research has been carried out for four months, starting from February to June 2019.

The materials used in the study were Inpago 9 varieties of upland rice seeds, ultisol soil in Batu Belah Kampar District, tofu water liquid waste, coconut water liquid waste, rice washing water liquid waste, and palm oil liquid waste, cellulolytic bacterial consortium, Nutrient Agar media (NA), Nutrient Broth (NB), 70% alcohol, plastic wrap, plastic, tissue roll, label paper, spritus, aquades, molasses, water, Urea fertilizer, SP-36 and KCl, insecticides and fungicides.

The tools used in this research were polybags, hoes, sieves, hand sprayers, raffia ropes, scissors, knives, sheeting, shading, shading net, labels, tubs, ruler, analytic scales, Petri dishes, test tubes, stirring rods, Erlenmeyer, measuring cup, beaker glass, ose needle, bunsen, hot plate, micropipette, autoclave, laminar or enkas, stationery and documentation tools.

Six cellulolytic bacterial isolates were isolated in the Nutrient Agar (NA) medium by using the scratch method. Then, it was inoculated into the Nutrient Broth (NB) and incubate for 2 x 24 hours. The formulation of biofertilizer of cellulolytic bacterial consortium made from organic liquid waste (rice washing, coconut water liquid, tofu liquid waste, and palm oil mill liquid waste) was carried out prior to the study and incubated for 21 days.

This research was conducted experimentally by arranged according to a non-factorial Completely Randomized Design (CRD) consisting of 12 treatments with 3 replications so that there were 36 experimental units. Each unit consisted of 3 plants. Data obtained from this study were analysed systematically with a variety of analyses, after which further tests were carried out with Duncan (DNMRT) at the 5% level.

The factor used as a treatment in this study was the use of several doses of biological fertilizer at the level (5, 10, 15) ml biofertilizers of rice wastewater, (5, 10, 15) ml biofertilizers of coconut wastewater, (5, 10, 15) ml biofertilizers of tofu wastewater, (5,10,15) ml biofertilizers of palm oil mill effluent. Biofertilizers were given 3 times.

3. Results and discussion

Based on the results of the analysis of biological fertilizers, the pH and nutrient content of N, P and K are as follows:
Table 1. Results of biological fertilizer analysis

| No. | Biological fertilizer                                 | pH  | N (%) | P (%)  | K (%) |
|-----|------------------------------------------------------|-----|-------|--------|-------|
| 1.  | Rice wastewater + Cellulolytic bacterial consortium  | 4.85| 0.04  | 0.028  | 0.10  |
| 2.  | Coconut wastewater + Cellulolytic bacterial consortium | 5.02| 0.04  | 0.023  | 0.23  |
| 3.  | Tofu wastewater + Cellulolytic bacterial consortium  | 5.02| 0.04  | 0.021  | 0.09  |
| 4.  | Palm oil mill effluent + Cellulolytic bacterial consortium | 4.61| 0.02  | 0.017  | 0.12  |

3.1. Result response
The results of the analysis of variance showed that the application of biological fertilizer based on cellulolytic bacteria based on organic liquid waste did not significantly affect panicle length, several grains of pith per panicle, the weight of 100 grains, percentage of pithed grain, the weight of dried unhusked rice per clump. The results of further growth response tests with Duncan's multiple range test at 5% can be seen in Table 2.

3.1.1. Panicle Long. Table 2 shows that the length of the upland rice panicle by giving organic fertilizer based on cellulolytic bacteria consortium based on organic liquid waste did not significantly affect all treatments tested. Providing biological fertilizer based on wastewater washing rice with a dose of 15 ml tended to give the longest panicle yield compared to the treatment the other. This was because biofertilizers based on rice washing water waste contain nutrients that can meet the needs of plant nutrients so that they can support the process of plant metabolism to increase the length of the upland rice panicles compared to other treatments.

This was based on the opinion [9], which stated that all the contents present in rice washing water generally serves to assist plant growth. The content functions as a growth regulator (carbohydrate content). The carbohydrates present in the rice washing water-mediated the formation of hormones auxin and gibberellins. Both of these hormones were widely used in artificial growth stimulants. Auxin was useful to stimulate shoot growth and the emergence of new shoots while gibberellins were useful for root stimulation. [10], added that the auxin hormone has an important role in the process of cell elongation in plant physiological processes. This affected the lengthening of plant organs such as the length of the upland rice panicles.

Based on the analysis of nutrient elements based on rice washing water wastewater contained element P 0.028%. The total of these elements can be sufficient in increasing the length of the upland rice panicle. P element was one of the ingredients that play a role in the formation of ATP. The results of the analysis [11], showed that the application of P fertilizer as much as 90 kg. ha-1 was able to increase the panicle length in wheat plants which was 12.83 cm.

3.1.2. Total of pithy grain per panicle. Table 2 shows that the total of rice grain per panicle of upland rice plants with the application of biological fertilizer of cellulolytic bacteria based on organic liquid waste has no significant effect on all treatments tested. This was due to the application of biological fertilizer based on organic liquid waste has not been able to increase the pH of acidic ultisol soil so it did not have a significant effect on all treatments tested on the total of puffed rice per panicle of upland rice. This was in line with the opinion [12], which stated that the application of organic fertilizer can increase the pH of acidic soil but its ability was limited because it had a very saturated base limited. High soil acidity affected the availability of nutrients such as P, K, Ca and microelements were limited. Some macronutrients such as P and K are urgently needed in the soil for growth and replenishment of upland rice plants.
Table 2. The response of upland rice crop yields by applying biofertilizers consortium based on organic liquid waste

| Treatments                                      | Panicle long (cm) | Total of pithy grain per panicle (grain) | Weight of 1000 grain pithy per plant (g) | Percentage of pithy grain (%) | Weight of milled unhusked rice per clump (g) |
|------------------------------------------------|-------------------|------------------------------------------|------------------------------------------|------------------------------|---------------------------------------------|
| 5 ml biofertilizers of rice wastewater         | 30.11 a           | 94.26 a                                  | 27.87 a                                  | 81.60 a                      | 39.40 a                                     |
| 10 ml biofertilizers of rice wastewater        | 29.33 a           | 89.44 a                                  | 29.87 a                                  | 78.88 a                      | 38.26 a                                     |
| 15 ml biofertilizers of rice wastewater        | 32.55 a           | 76.94 a                                  | 28.22 a                                  | 80.06 a                      | 34.86 a                                     |
| 5 ml ml biofertilizers of coconut wastewater   | 29.55 a           | 79.63 a                                  | 29.42 a                                  | 79.42 a                      | 36.28 a                                     |
| 10 ml biofertilizers of coconut wastewater     | 28.55 a           | 85.60 a                                  | 27.50 a                                  | 82.23 a                      | 33.89 a                                     |
| 15 ml biofertilizers of coconut wastewater     | 28.55 a           | 84.34 a                                  | 28.35 a                                  | 82.58 a                      | 34.48 a                                     |
| 5 ml biofertilizers of tofu wastewater         | 28.89 a           | 96.40 a                                  | 26.89 a                                  | 82.07 a                      | 36.32 a                                     |
| 10 ml biofertilizers of tofu wastewater        | 30.22 a           | 90.56 a                                  | 25.85 a                                  | 81.42 a                      | 33.36 a                                     |
| 15 ml biofertilizers of tofu wastewater        | 29.33 a           | 111.61 a                                 | 26.87 a                                  | 83.05 a                      | 37.02 a                                     |
| 5 ml biofertilizers of palm oil mill effluent  | 29.55 a           | 93.36 a                                  | 27.32 a                                  | 83.54 a                      | 31.79 a                                     |
| 10 ml biofertilizers of palm oil mill effluent | 30.33 a           | 90.45 a                                  | 26.85 a                                  | 82.49 a                      | 35.93 a                                     |
| 15 ml biofertilizers of palm oil mill effluent | 28.33 a           | 100.25 a                                 | 27.25 a                                  | 85.50 a                      | 33.69 a                                     |

Note: The numbers followed by the same lowercase are not significantly different based on Duncan's multiple range test at the 5% level.

Phosphorus is a macro element that is needed by plants in the formation of ATP which acts as energy in plant metabolism [13]. The energy formed in plant tissues plays a very important role in various metabolic processes that cause the formation of assimilates that are translated into the grain. This was in line with research [11], showed that the administration of 90 kg. ha-1 P fertilizer can increase the weight of seeds i.e. 48.16 g in wheat plants. Generative growth of plants is also influenced by nutrients such as potassium. According to [14], element K is used to regulate carbohydrate translocation, potassium elements needed by plants in protein and carbohydrate synthesis and translocation of carbohydrates more smoothly. Metabolic yields that are formed will be translocated throughout plants such as grain and form seeds.

The results of this study indicated that the administration of tofu-based liquid wastewater with a dose of 15 ml tended to give a higher number of paddy grains per panicle compared to other treatments. Based on the results of the nutrient analysis carried out the formulation of biofertilizer-based liquid waste tofu water contained an element of P 0.021%.

In this study, the total of rice grains per panicle did not correlate positively with panicle length. This was because when the upland rice was entering the milk-ripening phase, upland rice was attacked by plant-disturbing organisms such as pests and bugs. Even though sangit attacked many rice plants during
the milk cooking phase, the grains of rice that were sucked by the stinky rice pest would cause the grains to fail to become pithy or hollow. This can reduce the production yield of rice plants. Therefore, the longest panicle did not produce the highest amount of rice grain. According to [15], based on the nature of the attack from pest pest, rice grains are generally empty because the fluid of rice cells that are being filled is inhaled so that the rice grains become half empty and will easily break if entered into the mill. Loss of liquid caused the rice seeds to become small, but rarely empty because they do not empty the entire contents of the growing seeds.

3.1.3. Weight of 1000 Grain Pithy per Plant. Table 2 shows that the weight of 1000 grains of rice grain per upland rice with the application of biological fertilizer based on cellulolytic bacteria based on organic liquid waste did not have a significant effect on all treatments tested. rice grains per plant heavier than other treatments. This was because the nutrients contained in the waste water-based biological fertilizer rice washing contains nutrients that were more sufficient to increase the weight of 1000 grains of rice grains per upland rice plant.

Potassium was an element that has an important role in the process of plant metabolism. The element potassium acted as an activator of various enzymes in the process of plant physiology. Besides, the element K also plays a role in the transportation of energy from the leaves to all plant organs. [16] This was based on [17], which stated that the element K plays an important role in increasing the size and weight of seeds. Based on the results of the analysis of nutrients based on wastewater washing water contained rice element K 0.10%.

3.1.4. Percentage of Pithy Grain. Table 2 shows that the percentage of paddy grain per upland rice plant with the provision of biological fertilizer of cellulolytic bacteria based on organic liquid waste has no significant effect on all treatments tested. This was presumably due to the low nutrient content contained in ultisol soils to increase the percentage of rice grain in all treatments. Nutrient deficiency, especially P, can affect the percentage of rice grain. According to [18], stated that soil lacking P can cause most of the grain formed to be empty, rice grains not formed, 1000 grain weight was low and grain quality was also low.

Element P was needed to increase nutrient absorption which would affect grain formation. This was consistent with the opinion [19], stated that sufficient P elements for plants can develop more roots if more roots are formed by plants, then nutrients are absorbed more. According to [20], the P elements in plants can stimulate the formation of flowers and grain, so that the element P is needed in sufficient quantities.

The provision of biological fertilizer based on palm oil mill effluent at a dose of 15 ml tended to give a higher percentage of rice grain compared with other treatments. Based on the analysis of nutrient elements based on rice washing water wastewater containing element P 0.028%, coconut water waste contained element P 0.023%, tofu water waste contained element P 0.021 and palm oil mill liquid waste contained element P 0.017%. The results of the analysis were categorized as low and the P was still in the total P contained in biological fertilizer and not as available N that can be utilized by plants. The difference that was not too high from the results of the P analysis of each biological fertilizer also gave results that were not different for the percentage of rice grain per plant.

3.1.5. Weight of milled unhusked rice per clump. Table 2 shows that the weight of unhusked rice per Gump of upland rice plants by administering biological fertilizer of cellulolytic bacteria based on organic liquid waste has not significantly affected all treatments tested. According to [21], ultisol analysis data from various regions in Indonesia showed that the soil has a very acidic soil reaction characteristic (pH 4.1-4.8). The content of thin topical organic material (8-12) cm was generally low to moderate. The content of N, P and K varied very low to low, both the upper and lower layers. This condition was thought to have not been able to be improved by giving some organic fertilizer based on organic liquid waste so that it did not give the weight of the milled unhusked rice per clump that was significantly different for all treatments.
The P element was very instrumental in the formation of ATP which acted as a source of energy in plant metabolic processes [13]. According to [22], the formed ATP will trigger various biochemical processes in plant tissues. This will affect the results of the assimilate which will be distributed to all plants so that spurred grain growth in upland rice plants. [16], element K has a role as an activator of enzymes and energy formation interrelations. Enzymes have an important role in the process of accelerating metabolism such as the formation of carbohydrates produced from photosynthesis. Carbohydrates produced to act as raw materials in the formation of energy, the energy produced is used by plants for grain growth in upland rice plants.

Giving biological fertilizer based on rice washing water waste with a dose of 5 ml tended to give the weight of the milled dry grain per clump heavier than the other treatments. This was because the nutrients contained in the biological fertilizer based on wastewater washing rice were more sufficient to increase the weight of grain dry milled per clump. The results of the analysis of nutrients based on wastewater washing rice contained a P element of 0.028%.

4. Conclusions
Giving all biological fertilizers based on organic liquid waste (cellulolytic wastewater, coconut water wastewater, tofu wastewater, and palm oil wastewater) could provide varied results on all parameters of the observation so that all biological fertilizers could be applied to upland rice plants with the use of inorganic fertilizers half of the recommended dose. Biological fertilizer waste rice washing water with a dose of 10 ml gave a good response to the yield of upland rice compared with other treatments.

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