**Growth and Pepper Yields (**Capsicum annuum** L.) by Giving a Formulation of Biological Fertilizer of Cellulolytic Bacteria Based on Organic Liquid Waste**

**Hapsoh**, I R Dini**, D Salbiah, dan Kusmiati**

1) Department of Agrotechnology, Faculty of Agriculture, Universitas Riau, Kampus Bina Widya KM 12,5 Simpang Baru Panam, Pekanbaru, Indonesia.

*Corresponding author : isnarahmadini19@gmail.com

**Abstract.** Red pepper production in 2016-2017 was increased. Although production has increased, demand for pepper will continue to increase, and efforts to increase soil fertility still need to be sought. To maintain and increase soil productivity, a combination of inorganic fertilizers with appropriate organic fertilizers is needed. One of the organic fertilizers is biofertilizers. This research aimed at finding out the formulation and dosage of biological fertilizers consortium of cellulolytic bacteria based on organic liquid waste that was appropriate for the growth and yield of red pepper plants. This research method used a Completely Randomized Design with 12 treatments, namely (5, 10, 15) ml of biological fertilizer of waste water washing rice, (5, 10, 15) ml of biological fertilizer of coconut water waste, (5, 10, 15) ml of biological fertilizer of tofu water waste, (5, 10, 15) ml of palm oil liquid fertilizer. The results showed that all biological fertilizer application based on organic liquid waste cellulolytic was able to give varied results on each parameter observed so that all wastes could be applied to pepper plants. Tofu wastewater biofertilizer with a dose of 10 ml give a good response to the production of pepper plants compared to other treatments.

**1. Introduction**

Red pepper (*Capsicum annuum* L.) is a type of horticultural commodity that is commercially cultivated. Pepper has high economic value, so it is planted in almost all regions of Indonesia, including in Riau Province. [1] reported that in 2016 land area is 1,775 ha with a total production of 12,003 tons of pepper plants so that productivity was 6.89 tons.ha-1 and in 2017 land area increased by 2,236 ha with a total production of 15,813 tons so that the productivity is 7.07 tons.ha-1. Although production has increased, the demand for pepper will continue to increase so it still needs to be sought to improve soil fertility.

Fertile land that has been used for pepper cultivation will also experience a decrease in fertility. According to [2], the decrease in soil fertility is due to the large use of inorganic fertilizers given, if it continues it will reduce soil quality and environmental health. Therefore, to maintain and increase soil productivity a combination of inorganic fertilizer and organic fertilizer is needed.

Organic fertilizer is fertilizer derived from dead plants, animal manure, other organic waste that has been through an engineering process, in the form of solid or liquid, can be enriched with minerals and microbes that are useful for increasing nutrient content and soil organic matter and improving physical, chemical properties, and biology [3]. One of the organic fertilizers is biofertilizer.
Biofertilizers are biologically active products consisting of microorganisms that can increase fertilizer efficiency, fertility, and soil health [4].

In making biological fertilizer, organic materials that can be used as ingredients for biological fertilizer include rice washing water, 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 plant growth and production and contain compounds or elements that can be used as a source of nutrients for microbes. Provision of liquid fertilizer-based formulations of liquid waste in the form of tofu waste physically improves soil structure, and increases soil capacity to store water [5]. Research results by Sujarwati et al. [6] showed that the administration of coconut water with a concentration of 50% was able to increase root weight and wet weight of female palm seedlings. According to the results of the study [7], the application of palm oil mill effluents showed that the organic matter contained in palm oil mill effluents could improve soil volume and porosity weight. The results of the study [8], the first rinse rice washing water affected the increase in the number of leaves and height of tomato and eggplant plants.

Before the organic material is turned into biological fertilizer, microbes are treated as decomposers so that the organic material is turned into biological fertilizer. The process of decomposition of liquid organic waste into biological fertilizer can utilize cellulolytic microorganisms (MOS) which have the ability to decompose organic matter into nutrients available to plants through the process of breaking down cellulose into simpler structures. This bacterium is able to hydrolyze cellulose both aerobically and anaerobically [9].

The use of a bacterial consortium has advantages in the decomposition process compared to a single bacterium, if the consortium bacteria selection is right. In this research, a bacterial consortium consisting of six potential cellulolytic bacterial isolates, namely 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), as well as two isolates from acacia litter (Providencia vermicola SA1) and (Bacillus cereus SA6) [10]. The six isolates are expected to become biological fertilizer agents from some of the wastes used so as to provide nutrients for the growth and yield of pepper plants. This study aimed to finding out the formulation and dosage of biological fertilizers consortium of cellulolytic bacteria based on organic liquid waste that was appropriate for the growth and yield of red chilly (Capsicum annuum L.).

2. Methodology
The research has been carried out in the experimental garden of Agriculture Faculty and the Soil Laboratory of Agriculture Faculty, Riau University, Bina Widya Campus 12.5 km, Simpang Baru Village, Tampan District, Pekanbaru City. The study was conducted in January to May 2019. The research was carried out experimentally arranged according to a non-factorial Completely Randomized Design (RAL) with 12 treatments and 3 replications so that 36 experimental units were used, each experimental unit consisted of 3 plants. The data obtained from this study were statistically analyzed by analysis of variance, after that further tests with Duncan (DNMRT) at 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 of biological fertilizer for rice water wastewater, (5, 10, 15) ml of biological fertilizer for coconut water waste, (5, 10, 15) ml of biofertilizers from tofu waste water, (5, 10, 15) ml of palm oil biofertilizers, biological fertilizers were given 3 times.

3. Results and Discussion
3.1. Physiology response
Based on the results of variability in the administration of biological fertilizer based on cellulolytic bacteria, organic wastewater did not significantly affect the rate of photosynthesis, stomata conductivity, CO₂ concentration, transpiration rate, and chlorophyll content in pepper plants. The results of Duncan's multiple range test at 5% level are presented in Table 1.
Table 1. Photosynthesis rate, stomata conductivity, CO$_2$ concentration, transpiration rate, and chlorophyll content of chilli plants that are given a bio-fertilizer consortium of cellulolytic bacteria based on organic wastewater at different doses

| Treatments                                | Photosynthesis rate (μmol CO$_2$ m$^{-2}$ s$^{-1}$) | Power of stomata (mol H$_2$O m$^{-2}$ s$^{-1}$) | CO$_2$ concentration (μmol CO$_2$ mol$_{-1}$) | transpiration rate (mmol H$_2$O m$^{-2}$ s$^{-1}$) | Total of Chlorophyll (μmol m$^{-2}$) |
|-------------------------------------------|-----------------------------------------------------|-----------------------------------------------|---------------------------------------------|-------------------------------------------------|----------------------------------------|
| 5 ml biofertilizers of rice wastewater     | 21,547 a                                            | 0,37 a                                        | 3,48 a                                      | 0,80 a                                          | 61,37 a                                 |
| 10 ml biofertilizers of rice wastewater    | 20,193 a                                            | 0,38 a                                        | 3,54 a                                      | 0,82 a                                          | 73,47 a                                 |
| 15 ml biofertilizers of rice wastewater    | 21,530 a                                            | 0,34 a                                        | 3,46 a                                      | 0,73 a                                          | 74,23 a                                 |
| 5 ml biofertilizers of coconut wastewater  | 20,317 a                                            | 0,36 a                                        | 3,53 a                                      | 0,77 a                                          | 64,83 a                                 |
| 10 ml biofertilizers of coconut wastewater | 21,627 a                                            | 0,46 a                                        | 3,01 a                                      | 0,99 a                                          | 67,40 a                                 |
| 15 ml biofertilizers of coconut wastewater | 23,353 a                                            | 0,51 a                                        | 3,11 a                                      | 1,07 a                                          | 73,57 a                                 |
| 5 ml biofertilizers of tofu wastewater     | 24,910 a                                            | 0,49 a                                        | 3,34 a                                      | 1,01 a                                          | 75,13 a                                 |
| 10 ml biofertilizers of tofu wastewater    | 22,653 a                                            | 0,43 a                                        | 3,39 a                                      | 0,90 a                                          | 63,23 a                                 |
| 15 ml biofertilizers of tofu wastewater    | 18,267 a                                            | 0,38 a                                        | 3,68 a                                      | 0,84 a                                          | 75,77 a                                 |
| 5 ml biofertilizers of palm oil mill effluent | 19,797 a                                      | 0,48 a                                        | 3,88 a                                      | 0,98 a                                          | 68,40 a                                 |
| 10 ml biofertilizers of palm oil mill effluent | 22,453 a                                      | 0,50 a                                        | 3,84 a                                      | 1,04 a                                          | 73,57 a                                 |
| 15 ml biofertilizers of palm oil mill effluent | 19,497 a                                      | 0,43 a                                        | 2,94 a                                      | 0,93 a                                          | 75,60 a                                 |

Note: The numbers followed by the same lowercase letters in the same column are not significantly different according to DNMRT further tests at the 5% level.

Table 1 shows that the application of biological fertilizer of cellulolytic bacteria based on organic wastewater with several doses gave varied results in all treatments tested. However, there are some wastes that show a fairly good response to the rate of photosynthesis, stomata conductivity, CO$_2$ concentration, transpiration rate, and chlorophyll content, one of which is biofertilizer with 10 ml dosage. Based on the results of the analysis of biological fertilizers obtained pH, N, P, and K as follows:
Table 2. 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  |

3.2. Photosynthesis rate

Photosynthesis rate is influenced by light intensity. Increased rate of photosynthesis occurs when light intensity increases. When the light intensity is low, the rate of photosynthesis decreases [11]. Apart from these factors, the rate of photosynthesis and chlorophyll content are growth benchmarks related to crop production. Chlorophyll is a pigment contained in chloroplasts and utilizes the light absorbed as energy for reactions in photosynthesis.

All wastes as a whole show varying results in the rate of photosynthesis, but there were a number of wastes that showed a reasonably good response, one of them was the biofertilizer of tofu waste water with a dose of 10 ml. Based on nutrient analysis of the formulation of biofertilizer from tofu wastewater containing N 0.04%, P 0.021%, K 0.09%. Nutrient elements in this formulation were thought to be available and sufficient in responding the photosynthesis rate quite well in red pepper plants. [12] stated that sufficient nutrients are available to stimulate plant height, stimulate the growth of the root system, increase leaf growth so that it can enhance photosynthesis and increase yields.

3.3. Power of stomata

According to [13], the power of stomata is greatly influenced by stomata cell openings. The greater the opening and closing of the stomata, the higher the power of stomata. [14] added that the leaves that grow optimally greatly affect the work of plant stomata in opening and closing for gas exchange. Apart from opening and closing stomata the power of stomata is also influenced by the element of potassium. According to [15], potassium acts as a solvent in stomatal guard cells.

Based on nutrient analysis of biofertilizers, tofu waste water contained 0.09% less K than coconut water, but the tofu potassium content was thought to be sufficient to meet the needs of plants in increasing the power of stomata. According to [16], the structure of the stomata influences the workings or effectiveness of the stomata during the metabolic process, the closer the stomata are, the process of opening and closing of the stomata is more inhibited and will affect the amount of CO₂ fixed by plants.

3.4. CO₂ concentration

CO₂ concentration is related to stomata power in which high stomata power will cause an increase in CO₂ concentration. In addition, the element potassium also plays a role in increasing CO₂ concentrations where, the element potassium is a solute that is needed in the guard cells of the stomata to stimulate the entry of water into the guard cell so that the stomata cells will open. This results in CO₂ gas going into the leaves through the open stomata guard cell [15]. Therefore, if the potassium element was not enough it would affect the absorption of CO₂ in the leaves of the red pepper plant. Based on the results of the analysis of tofu-based waste water biofertilizers, the K content was 0.09%. The concentration was thought to have been sufficient to support the increase in CO₂ concentration.
3.5. Transpiration rate
According to [17], the rate of transpiration occurs because it was influenced by the availability of water in the soil, in which the function of water to maintain the temperature conditions in plants through the process of transpiration. In addition to the availability of water, potassium also played a role in increasing the rate of transpiration. According to [15], the element potassium is a dissolved material in the cell which plays a role in stimulating the entry of water into the guard cell which causes the opening of the stomata resulting in an increase in the rate of transpiration. Therefore, if the potassium element was in its optimum state it would affect the opening of the stomata so that the transpiration rate was not too high. Based on the results of nutrient analysis on all biological fertilizers containing relatively the same K, so that all treatments showed relatively the same results. It was suspected that the content of K nutrients contained in biological fertilizers has been optimum and available in the soil to reduce the rate of transpiration compared to other treatments.

3.6. Total of Chlorophyll
Optimum watering causes the total of chlorophyll to vary in each treatment tested. As a result of the determination [19], the decrease in chlorophyll content is one of the physiological responses of plants that lack water. Decreased chlorophyll content when plants lack water is related to the activity of photosynthetic devices and decreases the rate of photosynthesis of plants [20].

Nitrogen is an essential element in various plant constituents, including chlorophyll constituents. Besides, the absorption of nutrients from the soil by roots is inhibited, thus affecting the availability of N and Mg elements that play an important role in chlorophyll synthesis [21]. According to [22] nitrogen and magnesium are macro nutrients which play a role as a constituent of chlorophyll. Based on the results of the analysis of biofertilizers, tofu waste contains N 0.04%, P 0.021%, K 0.09%. The results of the study [23], showed that the application of N fertilizer influenced the amount of chlorophyll in corn plants.

3.7. Growth Response
Based on the results of variability in the provision of biological fertilizer based on cellulolytic bacteria, organic liquid waste has no significant effect on plant height, dichotomous height, first flower (DAP), harvest age in chilli plants. Duncan's multiple range test results at 5% level are presented in Table 3.

Table 3. Plant height, dichotomous height, The first flower appears (DAP), harvest age of chilli plants that are given a biological fertilizer consortium of cellulolytic bacteria based on organic liquid waste with different dosages

| Treatments                          | Plant height (cm) | Dichotomous height (cm) | The first flower appears (DAP) | Harvest age (DAP) |
|-------------------------------------|-------------------|-------------------------|-------------------------------|-------------------|
| 5 ml biofertilizers of rice wastewater | 34,67 a           | 14,51 a                | 40,00 a                       | 75,89 a           |
| 10 ml biofertilizers of rice wastewater | 39,29 a           | 17,23 a                | 38,33 a                       | 73,67 a           |
| 15 ml biofertilizers of rice wastewater | 36,91 a           | 20,29 a                | 38,33 a                       | 77,22 a           |
| 5 ml biofertilizers of coconut wastewater | 34,69 a           | 15,78 a                | 39,22 a                       | 78,11 a           |
| 10 ml biofertilizers of coconut wastewater | 40,18 a           | 17,64 a                | 38,00 a                       | 78,11 a           |
| 15 ml biofertilizers of coconut wastewater | 38,60 a           | 17,60 a                | 39,67 a                       | 76,78 a           |
Table 3 shows that the application of a biological fertilizer consortium of cellulolytic bacteria based on organic liquid waste with several doses gives varied results in all treatments tested. However, there are several wastes that show a reasonably good response to plant height, dichotomous height, first flower (DAP) appear, harvest age of pepper plants.

3.8. Plant Height (cm)
Table 3 shows that the application of biological fertilizer based on cellulolytic bacteria based on organic wastewater with a number of different doses was not significant for all treatments tested. Overall, all organic fertilizer formulations based on organic wastewater and cellulolytic bacteria consortium were able to increase the height growth of red pepper plants. The availability of N in the soil can help plant height growth. This is based the statement [24], that nutrient nitrogen is a constituent component of amino acids, proteins and the formation of cell protoplasm which can function in stimulating plant height growth. Apart from these factors the IAA hormone influences plant height. This is consistent with the results of the analysis of low ultisol soil pH which inhibits the growth and activity of cellulolytic bacteria in producing IAA hormones so that they do not give different plant height results in all treatments.

Based on the results of nutrient analysis on tofu water biofertilizer containing N 0.04% (Table 2). This was consistent with the results of the overall analysis which could be seen in the nitrogen content in tofu which was high in the overall biofertilizer used, that was why in the application of biofertilizer tofu waste water at a dose of 15 ml gave a good response to the height of pepper plants. According to [25], protein in liquid waste knows that if it is broken down by soil microbes, it will release N compounds which will eventually be absorbed by plant roots. The research results of [26] showed that administration of several concentrations of tofu liquid waste significantly affected the height of pakcoy plants. Overall, the number of bacterial colonies in each waste was almost the same, but the performance of cellulolytic microbes that described organic matter in biological fertilizers was less than optimal so that nutrients were not sufficient for the whole plant, therefore plant height in each treatment gives the same response.

3.9. Dichotomous height (cm)
Table 3 shows that the application of biological fertilizer based on cellulolytic bacteria based on organic liquid waste did not significantly affect the height of the pepper dichotomus. However, there are some wastes that show a fairly good response to high dichotomus, one of which is biofertilizer with 15 ml of rice water waste. The results of the research [27], dichotomous height was positively
correlated to pepper plant height. Plant height was strongly influenced by nutrient nitrogen (N), if the nutrient N was fulfilled then plant height growth can reach a maximum.

Based on the analysis of nitrogen nutrient content in organic fertilizer based on organic cellulolytic bacteria consortium in rice water that was 0.04% (Table 2), in which the amount of N elements was higher than other wastes. The content indicated that N was used for plant dichotomous growth. According to [28], the N element is a major nutrient for plant growth and is generally very necessary for vegetative growth of plants namely leaves, stems and roots. The results of the study [29], showed that the water of leri or water used for washing rice can stimulate the growth of Adenium plant roots. This was because rice washing water contains vitamin B1 which functions to stimulate root growth and metabolism. The results of the study [8] first rinse rice washing water affect the increase in the number of leaves and height of tomato and eggplant plants.

3.10. The first flower appears (DAP)
Table 3 shows that the administration of biological fertilizer based on cellulolytic bacteria of organic liquid waste has no significant effect on the age of flowering in pepper plants. Based on table 3, it can be seen that the administration of coconut water waste at a dose of 10 ml gave the age of flower emergence faster than other treatments. This was presumably because the more dominant factor influencing the flowering phase was genetic factors compared to environmental factors. Age of flowering pepper plants ranged from 38.00 to 43.11 days after planting (DAP). According to [15], plants will produce flowers if they have sufficient reserves, but are more determined by the nature of the plant and the variety used. Flowering and fruiting of plants requires nutrients P if the nutrient needs are not available causing stunted plant growth. According to [30], phosphorus plays an important role in the transfer of energy in cells and plant growth, especially in parts related to generative development, such as flowering and seed formation. Based on the results of the analysis of biological fertilizers (Table 2) the content of phosphorus nutrients in water biofertilizers is 0.023%. This was suspected by giving 10 ml of coconut water a consortium can provide plant needs and accelerate the flowering process in red pepper plants compared to other treatments.

3.11. Harvest age
Table 3 shows that the administration of biological fertilizer based on cellulolytic bacteria based on organic liquid waste has no significant effect on the age of flowering in chilli plants. Giving biological fertilizer rice water waste with a dose of 10 ml faster accelerates the age of the harvest compared to other treatments. This was presumably because the harvest age of red pepper plants was more influenced by genetic factors and environmental factors of the plant. According to [31] the harvest age of a plant was influenced by genetic factors. The average age of pepper crop harvest ranged from 73.67 to 79.89 which was faster than the description. According to [32], stated that nutrient P has the role of accelerating the formation of flowers, ripening of fruits and seeds. Based on the results of the analysis of rice biological fertilizer formulations with a consortium of cellulolytic bacteria containing nutrients P0.028% (Table 2). Nutrient needs in biological fertilizers with a consortium of cellulolytic bacteria were thought to be insufficient for the needs of the crop at the age of the first harvest, thus causing premature ripening of red pepper which causes a decrease in the quality of chili.

3.12. Result response
Based on the results of variations in the application of biological fertilizer based on cellulolytic bacteria, organic liquid waste did not significantly affect the number of fruits per plant, fruit length. Significantly influenced the weight per fruit and weight per plant on pepper plants. Duncan's multiple range test results at the 5% level were presented in Table 4.
3.13. Total of fruit

Table 3 shows that the administration of biological fertilizer based on cellulolytic bacteria based on organic liquid waste did not significantly affect the number of fruits in the pepper plants. The provision of tofu waste water with a dose of 10 ml gives more fruit than the other treatments. The application of organic fertilizer based on organic material based on cellulolytic bacteria produced a relatively low number of chilies. This was because the element of potassium in biological fertilizers has not been able to meet the needs of plants. According to [33] the role of element K for plants is to increase the number and size of fruit. Element K also influenced the success of flowers into fruit, which in turn increases the number of red chilies. Good flower formation would bring out perfect fruit thereby increasing the number of fruits per plant.

The low number of peppers was also due to plants lacking P elements. It can be seen in (Table 2) the content of P elements in the biological fertilizer cellulolytic consortium based on organic liquid waste was thought to be insufficient for the needs of red pepper plants. In this phase the macro nutrients P and K play a role active, because the element P functions to accelerate flowering, cooking seeds, and fruit. According to [34], the P element was one of the essential nutrients needed for plants for growth and yield, if the plant's P element needs are met then the plant will produce lots of quality fruit.

The number of branches on the pepper plant affects the quality of the fruit. The slightest branch of the plant was thought to affect the quality of the fruit to be low. Branches on plants were an important part and were the initial stage before flowering plants. Flower plants grow on the ends of the branches, namely the shoots of plants and then form chilies. The large number of fruits per pepper produced was influenced by the width of the canopy. The wider the header, the number of branches would be more and more. Flowers or fruit appear at each end of the branching, so the wider the canopy, the more flowers and fruit are formed. The research results of Setiawan et al. [35], showed that pepper which had a large number of branches was able to produce more fruit. [36] explained that in the generative phase of fruit formation such as the number of fruits and fruit weight, of course it cannot be separated from the role of nutrients found in the soil and the addition of fertilizer.

Table 4. Number of fruits per plant, fruit length, weight per fruit and weight per plant of chilli plants which are given a biological fertilizer consortium based on organic liquid waste with different dosages

| Treatments                                | Number of fruits per plant | Fruit length (cm) | Weight per fruit (g) | Weight per plant (g) |
|-------------------------------------------|--------------------------|------------------|---------------------|---------------------|
| 5 ml biofertilizers of rice wastewater    | 3.96 a                   | 13.54 a          | 2.77 abc            | 11.35 bc            |
| 10 ml biofertilizers of rice wastewater   | 4.33 a                   | 14.54 a          | 3.33 a              | 11.94 b             |
| 15 ml biofertilizers of rice wastewater   | 5.00 a                   | 11.68 a          | 2.93 abc            | 11.36 bc            |
| 5 ml biofertilizers of coconut wastewater | 4.26 a                   | 12.16 a          | 2.73 abc            | 9.24 c              |
| 10 ml biofertilizers of coconut wastewater| 4.16 a                   | 12.98 a          | 2.71 abc            | 9.59 bc             |
| 15 ml biofertilizers of coconut wastewater| 4.83 a                   | 14.23 a          | 3.10 ab             | 12.03 b             |
| 5 ml biofertilizers of tofu wastewater    | 3.60 a                   | 12.43 a          | 2.63 bc             | 9.02 bc             |
| 10 ml biofertilizers of tofu wastewater   | 6.50 a                   | 13.49 a          | 2.91 abc            | 15.90 a             |
Table 3 shows that the application of biological fertilizer of cellulolytic bacteria based on organic liquid waste has no significant effect on the length of the fruit in pepper plants. This was evidenced from the results of research obtained, showing that pepper plants that were given a bio-fertilizer consortium of cellulolytic bacteria based on organic material have the same fruit length. According to [37], the appearance of variations can be influenced by genetic and environmental factors. If genetic factors had a stronger influence than environmental factors and the plant lives in any different environment it would not show morphological variations that were different from the place of origin. The appearance of the shape of a plant was controlled by the genetic characteristics of plants under environmental factors.

The length of the pepper was best seen in the application of rice water biological fertilizer at a dose of 10 ml producing a length of 14.54 cm compared to other formulation treatments. Formation of fruit length requires the availability of more nutrients to carry out metabolism properly, so that given a fertilizer of rice water waste with a dose of 10 ml can increase the length of red pepper as described. According to [38], the amount of P element would affect the total absorbed by plants, and has the role of accelerating the formation or refinement of fruit, flowers and seeds. In other treatments the formulation of organic fertilizer based on organic liquid waste with a cellulolytic bacterial consortium was smaller than the description, this was because the availability of nitrogen, phosphorus, and potassium nutrients was not enough available for the generative growth of plants in the extension of cell organs such as the length of red pepper.

According to [39], N deficiency can reduce protein content in seeds. P deficiency can cause poor seed and fruit development. According to [40], K deficiency causes fruit size to be smaller, fruit to fall out easily and uneven fruit color. [41] added that potassium works to increase protein synthesis and translocation of carbohydrates, thereby accelerating the ingestion of cell walls and strengthening flower stalks and fruit, but if plants that are deficient in potassium can result in poor quality fruit production.

3.15. Weight per fruit (g)
Table 3 shows that the administration of biological fertilizer based on cellulolytic bacteria of organic liquid waste has a significant effect on the weight per fruit in pepper plants. ml but not significantly different from other treatments. The application of rice water biofertilizer with a dose of 10 ml showed that the weight per fruit meets the description criteria compared to other treatments. This treatment was thought to be able to increase soil fertility because the bacteria contained in these doses can work optimally in remodeling and facilitating the intake of nutrients needed by plants. The results of research by Purnami et al. [42], giving rice washing water had a significant effect on increasing the wet weight of orchids around 900 grams.

The P element was an element that was needed in large quantities in fruit formation. [43] stated that the availability of sufficient nutrients at the time of growth causes plant metabolism to be more active so that the cell differentiation process will be better and ultimately will encourage increased fruit...
weight. The P content contained in rice water biofertilizer contains an element that was P 0.028% (Table 2) so it was suspected that the nutrient intake of P has been sufficient in the formation of fruit weights on red pepper plants. [44] stated that the availability of nutrients is one of the factors that can be absorbed by plants affecting plant growth and yield.

3.16. Weight per plant (g)

Table 3 shows that the application of biological fertilizer of cellulolytic bacteria based on organic liquid waste has a significant effect on the weight per plant on chilli plants. Based on the results of the study, it showed that the weight of fruit with the administration of tofu waste water at a dose of 10 ml gives the highest weight per plant and was significantly different against other treatments.

According to [45] for phosphorus and potassium and magnesium plays a role in the formation of flowers, seeds and fruit that can increase production yields. Based on the results of the analysis of biofertilizers from tofu wastewater containing P 0.021%, and K 0.09% (Table 2) have been able to provide the highest yields on the weight of fruit per plant of red pepper. Fruit weight per pepper was relatively low because the number of fruits in the pepper was very low. This was based on [46], added the more number of fruit formed the higher the weight per fruit of the plant produced.

The number of pepper plants produced in this study was small and the weight per plant pepper produced in this study was relatively low. This was because harvesting at the time of the study was carried out four times because some treatments were no longer able to produce due to lack of availability of plant nutrients and besides that it was also caused by whitefly infestation which caused plant tissue damage so that it could inhibit photosynthesis and photosynthate could not be distributed for growth generative plants in the formation of flowers and fruit. According to [47], as the development and spread of whitefly, the intensity of jaundice also increases, with a yield loss of 20-100%.

4. Conclusions

All biological fertilizer application of cellulolytic bacterial consortium based on organic liquid waste (rice washing water waste, tofu water waste, coconut water waste and palm oil liquid waste) was able to give varied results on each parameter observed so that all wastes could be applied to pepper plants. Tofu biological waste water with a dose of 10 ml gave a good response to the production of pepper plants compared to other treatments. The formulation of tofu biological fertilizer with a consortium of cellulolytic bacteria provided the best response to some parameters of the pepper plant compared to other biological fertilizers.

Acknowledgements

Thank you to KEMENRISTEKDIKTI through the Basic Research grant (Contract number: 732/UN.19.5.1.3/PT 01.03/2019) for funding this research. This research is part of the Basic Research grant.

References

[1] Badan Pusat Statistik Riau (BPS Riau) 2018 Riau dalam Angka 2018 (Pekanbaru)
[2] Isnaini M 2006 Pertanian Organik Kreasi Wacana (Yogyakarta) Hal 247-248.
[3] Peraturan Menteri Pertanian No. 70/Permentan/SR.140/10/ 2011 tentang Pupuk Organik, Pupuk Hayati, dan Pembenah Tanah.
[4] Permentan 2009 Permentan No 23 th 2009 Pupuk organik, pupuk hayati dan pembenah tanah Bab 1 Ketentuan umum, Pasal 1 ayat 2 dan 5. Hlm 3
[5] Krismawati 2008 Pertanian organik menuju pertanian berkelanjutan. Bayumedia Publishing. (Malang)
[6] Sujawarti, Fatonah S, Johani E and Herlina 2011 Penggunaan air kelapa untuk meningkatkan perkecambahan dan pertumbuhan palem putri (Veitchia merillii) J. Sagu vol 10 (2): 24-28
[7] Santoso P 2008 Pengelolaan limbah cair industry kelapa sawit (Elaeis guineensis Jacq.) di PT. Agrowiyana, Tungkal Ulu, Tanjung Jabung Barat, Jambi Skripsi Jurusan Agronomi Fakultas Pertanian Universitas Pertanian Bogor (Tidak dipublikasikan).

[8] Istiqomah N 2012 Efektivitas pemberian air cucian beras coklat terhadap produktivitas tanaman kacang hijau (Phaseolus radiatus L.) pada lahan rawa lebak. J. Ziraa’ah 1(33)

[9] Lynd L R, Weimer W H van Zyl and Pretorius I S 2002 Microbial Cellulose Utilization: Fundamentals and Biotechnology Microbiol Mol Biol Rev 66(3): 506-577

[10] Hapsoh, Wawan and Dini I R 2016 Aplikasi Pupuk Organik dengan Teknologi Mikrob Mendukung Pertanian Terpadu Berkelanjutan Berbasis Tanaman Pangan pada Lahan Gambut Laporan Akhir Tahun Hibah Kompetensi LPPM Universitas Riau (Pekanbaru)

[11] Anni I A, Saptiningsih E and Haryanti S 2013 Pengaruh naungan terhadap pertumbuhan dan produksi tanaman bawang daun (Allium fistulosum L.) di bendungan, Jawa Tengah J. Biologi. 2(3): 31-400

[12] Syarief 2005 Kesuburan dan Penupukan Tanah Pertanian (Pustaka Buana Bandung)

[13] Arman Z, Nelvia and Armaini 2016 Respons fisiologi, pertumbuhan, produksi dan serapan P bawang merah (Allium ascalonicum L.) terhadap pemberian trichokompos tandan kosong kelapa sawit (TKKS) terformulasi dan pupuk P di lahan gambut J. Agroteknologi 6(2): 15-22

[14] Ajeng L P, Ayu Y E H and Fauziyah H 2017 Pengaruh fitohormon alami terhadap perkecambahan dan pertumbuhan tanaman cabai rawit (Capsicum frutescens) Prosiding Seminar Nasional MIPA III Langsa-Aceh

[15] Lakitan B 2011 Dasar-dasar Fisiologi Tumbuhan Raja Grafindo Persada (Jakarta)

[16] Grant B and Vatnick I 2004 Environmental Correlates of Leaf Stomata Density Teaching Issues and Experiments in Ecology 1(1): 1-24

[17] Munawar A 2011 Kesuburan Tanah dan Nutrisi Tanaman Penebar swadya (Jakarta)

[18] Lestari G E 2006 Hubungan antara kerapatan stomata dengan ketahanan kekereringan pada somaklon padi gajahmungkur, towuti, dan ir 64 J. Biodiversitas 7(1): 44-48.

[19] Nio S A 2011 Biomasa dan Kandungan Klorofil Total Daun Jahe (Zingiber officinale L.) yang Mengalami Cekaman Kekeringan J. Ilmiah SAINS 11: 190-195

[20] Hendriyani I S and Setiari N 2009 Kandungan Klorofil dan Pertumbuhan Kacang Panjang (Vigna sinensis) pada Tingkat Penyediaan Air yang Berbeda J. Sains & Mat 17(3): 145-150

[21] Syafii S 2008 Respons Morfologis dan Fisiologis Bibit Berbagai Genotipe Jarak Pagar (Jatropha curcas L.) terhadap Cekaman Kekecewaan Tesis IPB (Bogor)

[22] Setyanti Y H, Anwar S and Slamet W 2013 Karakteristik fotosintetik dan serapan fosfor hijauan alfalfa (Medicago sativa) pada tinggi pemotongan dan pemupukan nitrogen yang berbeda Animal Agriculture Journal 2(1): 86-96

[23] Hokmalipour S and Maryam H D 2011 Effects of nitrogen fertilizer on chlorophyll content and other leaf indicate in three cultivars of maize (Zea Mays L.) World Applied Sciences Journal. 15(12): 1780-1785

[24] Lingga P and Marsono 2013 Petunjuk penggunaan pupuk Penebar swadya (Jakarta)

[25] Asmoro Y, Suranto and Sutoyo 2008 Pemanfaatan Limbah Cair Tahu untuk Peningkatan Hasil Tanaman Petsai (Brassica chinensis) Jurnal Biologi 5(2): 2

[26] Ahmad A A, Yulia A E and Nurbaiti 2017 Pemanfaatan limbah cair tahu untuk pertumbuhan dan produksi pakcoy (Brassica rapa L.) Jurnal Online Mahasiswa 4(2).

[27] Sugestadi H, Nurbaiti and Deviona 2014 Pemilihan kriteria seleksi untuk perakitan cabai di lahan gambut. Jurnal Online Mahasiswa Fakultas Pertanian Universitas Riau 1(1): 1-11.

[28] Setiadi 2008 Bertanam Cabai Penebar Swadya (Bogor)

[29] Andrianto H 2007 Pengaruh Air Cucian Beras pada Adenium Skripsi Fakultas Keguruan dan Ilmu Pendidikan Universitas Muhamadiyah Surakarta, Surakarta. (tidak dipublikasikan).

[30] Lingga P and Marsono 2003 Petunjuk penggunaan pupuk Penebar swadya (Jakarta)

[31] Mangoendidjo W 2003 Dasar-Dasar Pemuliaan Tanaman Kanisius (Yogyakarta)
[32] Munir R and Arifin Y 2010 Pertumbuhan dan hasil mentimun akibat pemberian pupuk kandang ayam dan gandasil B J. Jerami 3(2): 63-70
[33] Drotleff T 2010 Potassium is important Keep almond orchads well-fertilized to avoid potassium depletion J. Agric ProQuest 130(1): 3-4
[34] Allen B L and Mallarino A P 2006 Relationship between extracable soil phosphorus and phosphorus saturation after long term fertilizer and manure application. Soil Sci. Soc of Am. 70: 454-563
[35] Setiawan A B, Purwanti S and Toekidjo 2012 Pertumbuhan dan hasil benih lima varietas cabai merah (Capsicum annuum L.) di dataran menengah J. Vegetalika. 1(3): 1-11
[36] Lingga and Marsono 2007 Edisi Revisi Petunjuk Penggunaan Pupuk PT Penebar Swadaya (Jakarta)
[37] Suranto 2001 Study on ranunculus population: isozymic pattern. Biodiversitas. 2(1): 85-91.
[38] Makarim E P, Maria and Razil R 2007 Pengaruh pupuk NPK mutiara dan pupuk kandang sapi terhadap pertumbuhan dan hasil tanaman cabai merah keriting varietas arimbi (Capsicum annuum L.) J. Agrifor 8(2)
[39] Uchida R 2000 Essential nutrients for plant growth: nutrient function and deficiency symptoms. Plant nutrient management in Hawaii’s soil, approaches for tropical and subtropical agriculture Collage of Tropical Agriculture and Human Resources University of Hawaii. Manoa.
[40] Novizan 2002 Petunjuk Pemupukan yang Efektif Agro Media Pustaka (Jakarta)
[41] Hanafiah KA 2012 Dasar-Dasar Ilmu Tanah. Rajawali Press (Jakarta)
[42] Purnami N L G W, Yuswati H and Made Astiningsih A A 2014 Pengaruh jenis dan Frekuensi Penyemprotan Leri Terhadap Pertumbuhan Bibit Anggrek (Phalaenopsis sp.) Pasca Aklimatisasi E-Jurnal Agrotknologi Tropika 1 (3): 22-31
[43] Haryatini B A and Santoso M 2000 Pertumbuhan dan Hasil Cabai Merah (Capsicum annuum L.) pada Andisol yang Diberi Mikoriza, Pupuk fosfor dan Zat Pengatur Tumbuh. Tesis Program studi Ilmu Tanaman Pasca Sarjana Universitas Brawijaya (Malang)
[44] Puguh Faluvi Kurnadi, Husna Yetti, dan Edison Anom 2011 Peningkatan produksi kacang hijau (Vigna radiata L.) Dengan pemberian pupuk kandang ayam dan npk Karya ilmiah Universitas Riau 5 (2)
[45] Prely M J, Tuapatitnaya and Tutopoly F 2014 Pemberian pupuk kulit pisang raja (Musa sapientum) terhadap pertumbuhan dan produksi tanaman cabai rawit (Capsicum frutescens L.) j. floratek 7: 173-181
[46] Bernadius T W W 2002 Kiat mengatasi buah salah segaran (Salacca zalacca gaertner Voss) dengan perlakuan pra panen. Agritek vol 9 (4). Dosen Fakultas Pertanian UPN “Veteran” Jatim (Jawa Timur)
[47] Wagiman F X, Purbaningrum L and Simanjuntak D 2009 Eksplorasi, Karakterisasi, dan Potensi Musuh Alami Hama Bemisia tabaci di Ekosistem Cabai http://lib.ugm.ac.id/ Diakses pada tanggal 2 November 2017