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The Impact Of Azotobacter Chroococcum And Liquid Organic Fertilizer On Nutrients Nitrogen And Phosphate

Gamaruddin, Arifin Tahir, Andi Suci Anita, Asri B

Abstract— The aim of this experiment was to determine the impact of Azotobacter chroococcum and liquid organic fertilizer to the cocoa, and to get the amount of nutrient adsorption of N and P. We use a randomized group design (RGD) are arranged in two factorials with three replications. The first factor is the Azotobacter chroococcum, with concentrations of 0 CFU, 10x106CFU, 20x106CFU, 40x106CFU and the second factor is a liquid organic fertilizer with a concentration of 0%, 10%, 20%, 30%. As a result, both of Azotobacter chroococcum and liquid organic fertilizer are very significant to the cocoa on nutrients N and P in the leaves and also in the soils. The concentration of treatment 40 x 106 CFU and 30% liquid organic fertilizer produced the highest yield of the nutrients N and P in the leaves. Furthermore, the nutrient N in the soil were the highest concentration of 40 x 106 CFU to produce the two treatments and liquid organic fertilizer 20%, 40 x 106 CFU and liquid organic fertilizer 30%. In addition, observation of N and P in the soil showed the highest result is the concentration of treatment combinations 30 x 106 CFU and liquid organic fertilizer 30%.Futhermore, the effectiveness of N and P adsorption is the highest in the treatment with Azotobacter chroccocum concentration of 40 x 106 CFU and fertilizers 30% organic liquid.

Keywords --- Nutrient N and P, Azotobacter chroococcum, liquid organic fertilizer, cocoa.

1 Introduction

Bantaeng Regency is a cocoa-producing area in South Sulawesi with a total area of 4,677 ha and a total production of 2,864 tons (Statistics of Bantaeng Regency, 2018). One cause of low productivity is land degradation. As a result of the use of anorganic fertilizers are too high and continuous so that they decreased productivity of plants[1].

According to (Makarim & Suhartatik, 2006), to address the decline in production and productivity of the land, the necessary farming technologies can reduce the use of synthetic fertilizers. By increasing the use of "Microbe Fertilizer Technology" as a biological nutrient source/biological fertilizer, and the use of organic materials. This technology is able to improve fertilizer efficiency and sustainability of production cocoa systems. The presence and microbial population in the rhizosphere can maintain plant root health, nutrient uptake, and increase plant tolerance to environmental stress (Chen et al., 2019; Nasaruddin, 2012a)[2]

One of these microbes is Azotobacter chroococcum, known as an agent of nitrogen-fixing that convert dinitrogen (N2) in the form of ammonium (NH3), which is able to tie up nitrogen in high enough quantities and is able to synthesize substances that are biologically active can improve seed germination, stand and the growth of plants such as vitamin B, indole acetic acid, gibberellins, cytokinins (Wedhastri, 2002) and various organic acids that play an important role in stimulating the growth of root hairs (Hindersah & Tualar, 2004).[3][4]

The main factors that must be considered in the application of Azotobacter chroococcum as a biological agent is organic matter content in the soil is a source of nutrients for the bacteria. Each type of soil microbes requires organic compounds that are different from other types of biota, so that the necessary diversity of plants as a source of organic matter (Nasaruddin, 2012b; Wakelin et al., 2012).[5][6]

Liquid organic fertilizer is a liquid organic material which have advantages compared to solid organic materials.Solid organic fertilizer weakness are some nutrients will dissolve first and lost along the water percolation or undergo fixation by soil colloids, which can not be absorbed by plants. In water-saturated conditions (rainy season) the infiltration process is not smooth to the soil which causes nutrients do not get to the roots of plants. Furthermore, liquid organic fertilizer is more effective fertilization and efsien because sprayed onto the leaves and be absorbed directly by the plant. In addition, the chemicals have a maximum of 5%, and contain certain materials such as microorganisms that are rarely found in solid organic fertilizer, and also contains amino acids and hormones that Giberelin, cytokinin and IAA (Parnata, 2004).[7][8][9]

The results showed liquid organic fertilizers on volume of 30 ml L-1 water gives the highest yield on the parameters plant height, leaf number and stem diameter (Nasaruddin & Rosmawati, 2011). In connection with the foregoing, by (Wedhastri, 2002) that inoculation Azotobacter chroococcum effective in increasing crop yields by 12% compared with control plants on soil fertilized with organic matter fairly. such as wheat, barley, corn, sugar beets, carrots, cabbage, and potatoes.

The same thing of the research results Nasaruddin (2012), showed that the use of Azotobacter chroococcum (20x103 CFU), (40x103 CFU) significantly affected the number of flowers and fruit. The higher the concentration given to the treatment the higher the number of flowers and fruit.From the description that has been said above, it is necessary to conduct further research by combining both the "Impact of Azotobacter chroococcum and Liquid Organic Fertilizer Against Nutrients N and P".[10]

2. Methodology

2.1. Materials and tools

This study was conducted in Bantaeng and at Laboratory of Plant Physiology and Soil Science, Faculty of Agriculture, University of Hasanuddin in Makassar.The plant material used in this study is the cocoa plant clones graft that entries of Sulawesi Two which have a uniform (area, age, type of soil and climate are the same), Azotobacter chroococcum material

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Equipment used includes tools for Inoculating Azotobacter chroococcum and manufacturing of liquid organic fertilizer as well as at the time of application (beakers, scales, flask and pipette), atomizer, oven and stationery supplies.

2.2. Research methods

This study used a Randomized Block Design method (RBD) of two factorials. First factor,Azotobacter chroococcum, on four levels of concentration. Second factors, Organic Liquid Fertilizer on four levels of concentration. Thus,they will be obtained 16 combination treatment with three replications so that the total treatment 48 pieces of experimental plots. Each treatment is taken 4 plants so that there are 192 units. The treatment is as follows: Treatment on the first factor, Azotobacter chroococcum, A0 = Without Azotobacter chroococcum (0 cfu), A1 = Azotobacter chroococcum 10 x 106 cfu, A2 = Azotobacter chroococcum 20 x 106 cfu, A3 = Azotobacter chroococcum 40 x 106 cfu. Next, the second factor, Liquid Organic Fertilizer, P0 = Without Liquid Organic Fertilizer (0%), P1 = Liquid Organic Fertilizer 10%, P2 = Liquid Organic Fertilizer 20%, P3 = Liquid Organic Fertilizer 30%, with variable observations include; of N in the leaves, of P in the leaves and in the soil of nutrients N and P nutrients in the soil.

2.3. Data analysis

Data from the observations were analyzed and processed statistically using Variety Analysis or variance analysis (ANOVA).If the interaction effect is real ($P < 0.05$) on the observed variables, then it is followed by Least Significant Difference (LSD) α of 0.05.

3. Result and Discussion

3.1. NutrientN in Leaves

LSD α of 0.05 in Table 1 shows that the interaction of treatment of 30% liquid organic fertilizer with the treatment of Azotobacter chroococcum 40x106 CFU (A3P3)showed more nutrient N and only significantly different from the A1P0 treatment combination, but it was not significantly different from the interaction treatment others.

Table 1. Average of N leaves.

PDC	Azotobacter chroococcum A0	A1	A2	A3	BNJ α 0,05
P0	1,99 a pq	1,73 b q	2,19 a p	2,27 c p	0,30
P1	2,09 a q	2,11 a q	2,32 a q	2,67 b p	
P2	1,98 a r	2,17 a qr	2,39 a q	2,76 b p	
P3	2,08 a r	2,32 a qr	2,48 a q	3,35 a p	
NP BNJ α 0,05	0,30				

Description: Numbers followed by the same letter in the column (abc) and the line (pqr) not significant at the level of 5%.

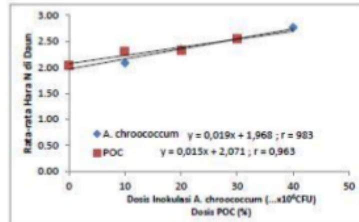

Figure 1. Graph of the regression relationship between Azotobacter chroococcum, Liquid Organic Fertilizer with an average of N in the leaves.

Regression test in Figure 1 shows that treatment of inoculation Azotobacter chroococcum and treatment of liquid organic fertilizer on nutrient N in the leaves follows the equation y = 0,019x + 1.968; r = 0.983 and y = 0,015x + 2.071; r = 0.963. The higher the concentration of the treatment, the higher the nutrient content of N in the leaves. Each increase of one unitAzotobacter chroococcum inoculation concentration and liquid organic fertilizer will show of N in the leaves as many as 0,019 at a constant Azotobacter chroococcum 1.968 and 0.015 liquid organic fertilizer at a constant 2,071. From the regression equation above can be interpreted that, the concentration value incremented by 1, then the average value of N in leaf tissue will grow 0.019 and 0.015, or any concentration value increased 10 then the average value of the results will increase 0.19 and 0.15.

3.2. Nutrient P in Leaves

LSD α of 0.05 in Table 2 shows that the interaction of treatment of 30% liquid organic fertilizer with the treatment of Azotobacter chroococcum 40x106 CFU (A3P 3) showed more nutrient P in

leaves and significantly different from the combination treatment A0P0, A0P2, A1P2, A2P1, and A2P2, but it is not significantly different from other treatment interactions.

Table 2.Average price or leaves.

PDC	Azotobacter chroococcum A0	A1	A2	A3	BNJ α 0,05
P0	0,41 b q	0,43 b pq	0,43 c p	0,44 d p	0,02
P1	0,42 ab r	0,46 a q	0,45 bc q	0,49 c p	
P2	0,40 b r	0,40 c r	0,47 b q	0,55 b p	
P3	0,44 a r	0,46 a r	0,52 a q	0,57 a p	
NP BNJ α 0,05	0,02				

Description: Numbers followed by the same letter in the column (abcd) and the line (pqr) not significant at the level of 5%.

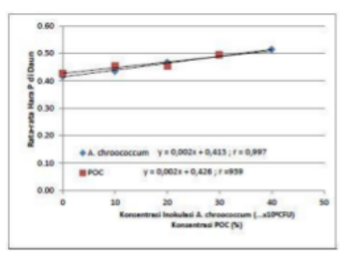

Figure 2. Graph of the regression relationship between Azotobacter chroococcum, Liquid Organic Fertilizer to the average of P in the leaves

Regression test in Figure 2 shows that the inoculation treatment A. chroococcum and treatment of liquid organic fertilizer to the nutrientP leaf follows the equation y = 0,002x + 0.413; r = 0.997 and y = 0,002x + 0.426; r = 0.939. The higher the concentration, the higher the treatment of P in the leaves. Each increase of one unit A. chroococcum inoculation concentration and liquid organic fertilizer will show the number of fruit per tree as much as 0,002 in the constants 0.413 and 0.002 at 0.426 constants. From the regression equation above can be interpreted that, the concentration value incremented by 1, then the average value of P in the leaf tissue will increase the concentration value of 0.002 or each added 10, the average value of the results will increase 0.02.

3.3. Nutrient N in Soil

LSD α of 0.05 in Table 3 shows that the interaction of treatment 30% organic liquid fertilizer with Azotobacter chroococcum treatment 40x106 CFU (A3P3) shows the nutrient of N in the soil more and significantly different treatment combinations A0P0, A0P1, A0P2, A1P0, A1P1 , A1P2, and A2P1, but had no significant interactions with other treatments.

Table 3. Average content of N in the soil.

PDC	*Azotobacter chroococcum*				BNJ α 0,05
	A_0	A_1	A_2	A_3	
P_0	$0,11^{c}_{r}$	$0,14^{c}_{q}$	$0,18^{ab}_{q}$	$0,18^{c}_{p}$	0,01
P_1	$0,13^{b}_{r}$	$0,16^{b}_{q}$	$0,17^{b}_{q}$	$0,21^{ab}_{p}$	
P_2	$0,13^{b}_{s}$	$0,16^{b}_{r}$	$0,19^{a}_{q}$	$0,20^{b}_{p}$	
P_3	$0,15^{a}_{r}$	$0,18^{a}_{q}$	$0,18^{ab}_{q}$	$0,21^{a}_{p}$	
NP BNJ α 0,05	0,01				

Description: Numbers followed by the same letter in the column (abc) and the line (pqrs) not significant at the level of 5%.

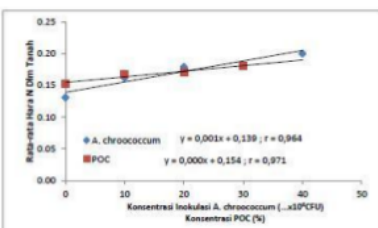

Figure 3. The graph of the regression relationship between Azotobacter chroococcum, Liquid Organic Fertilizer with an average of N in the soil

Regression test in Figure 3 shows that inoculation treatment Azotobacter chroococcum and treatment of liquid organic fertilizer to the soil nutrient N follows the equation y = 0,001x + 0.139; r = 0.964 and y = 0,000x + 0.154; r = 0.971. The higher the concentration of the treatment, the higher the nutrient content of N in the soil. Each increase of one unitAzotobacter chroococcum inoculation concentration and liquid organic fertilizer will show the content of N in the soil as much as 0,001 at a constant 0,139 and 0,000 at 0,154 constants. From the regression equation above can be interpreted that, the concentration value incremented by 1, then the average value of N in the soil will increase to 0,000 or 0,139 and each concentration value increased 10 then the average value of the results will increase 1.39 and 0.00.

3.4.Nutrient P in Soil

The observation of the average of P in the soil and the analysis of variance in appendix 14 showed that Azotobacter chroococcum very significantly, and treatment of liquid organic fertilizer very significant effect. Similarly, the interaction of the two treatments was highly significant.

Table 4.The average content of P in the soil.

POC	*Azotobacter chroococcum*				BNJ α 0,05
	A_0	A_1	A_2	A_3	
P_0	$9,04^{b}_{s}$	$9,73^{c}_{r}$	$10,60^{c}_{q}$	$11,15^{c}_{p}$	0,40
P_1	$9,31^{b}_{r}$	$11,51^{a}_{q}$	$12,35^{a}_{p}$	$11,79^{b}_{q}$	
P_2	$9,29^{b}_{r}$	$10,91^{b}_{q}$	$12,01^{ab}_{p}$	$11,65^{b}_{pq}$	
P_3	$9,87^{a}_{s}$	$10,98^{b}_{r}$	$11,76^{b}_{q}$	$12,78^{a}_{p}$	
NP BNJ α 0,05	0,40				

Description: Numbers followed by the same letter in the column (abc) and the line (pqrs) not significant at the level of 5%.

LSD α of 0.05 in Table 4 shows that the interaction of liquid organic fertilizer 30% with the treatment of Azotobacter chroococcum 40x106 CFU (A3P3) shows the nutrients of P in the soil more and significantly different treatment combinations A0P0, A0P1, A0P2, A1P0, A1P2 , A1P3, A2P0, A2P3, and A3P1, but had no significant interactions with other treatments.

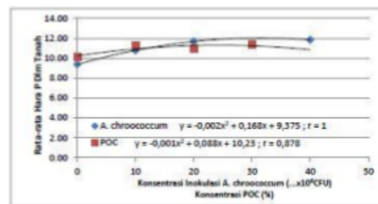

Figure 4. Graph the regression relationship between Azotobacter chroococcum, Liquid Organic Fertilizer with an average of P in the soil

Regression test in Figure 4 shows that inoculation treatment against Azotobacter chroococcum of P in the soil following the equation y = -0,002x2 + 0,168x + 9.375; r = 1, the higher the concentration of Inoculation Azotobacter chroococcum the higher the amount of P in the soil until it reaches a maximum at a concentration of 40x106 CFU Azotobacter chroococcum by the number of P maximum of 12.903 and will further decline. The treatment of liquid organic fertilizer to the soil nutrient P follows the equation y = -0,001x2 + 0,088x + 10.23; r = 0.878 (Figure 4), the higher the concentration of organic liquid fertilizer the higher the amount of P in the soil until it reaches a maximum at a concentration of 44% organic liquid fertilizer with the maximum amount of P 12.17 and will further decline.

3.5. Effectiveness of Nutrient adsorption of N and P

Based on laboratory analysis that the average N adsorption between 86.91% - 168.79% and interaction Azotobacter chroococcum 40x106 CFU and Liquid Organic Fertilizer 30% per tree showed the highest nutrient adsorption. P leaf nutrient content increased from 0.14% in the treatment without Azotobacter chroococcum and POC 0.42% to 0.57% with effective absorption of 97.54% to 140.98% (Table 5).

Table 5. Effectiveness of N and P adsorption cacao plants after administration of Azotobacter chroococcum and Liquid Organic Fertilizer

	Treatment	Nutrient levels Leaves		effectiveness of Nutrient Adsorption	
		N	P	N	P
1	A0P0	1,99	0,41	-	-
2	A0P1	2,09	0,42	105,03	102,46
3	A0P2	1,98	0,4	99,5	99,18
4	A0P3	2,08	0,44	104,7	107,38
5	A1P0	1,73	0,43	86,91	104,92
6	A1P1	2,11	0,46	106,38	112,3
7	A1P2	2,17	0,4	109,4	97,54
8	A1P3	2,32	0,46	116,78	112,3
9	A2P0	2,19	0,43	110,4	106,56
10	A2P1	2,32	0,45	116,78	109,84
11	A2P2	2,39	0,47	120,13	115,57
12	A2P3	2,48	0,52	125	127,05
13	A3P0	2,27	0,44	114,43	109,02
14	A3P1	2,67	0,49	134,56	121,31
15	A3P2	2,76	0,55	139,09	134,43
16	A3P3	3,35	0,57	168,79	140,98

The results showeds that treatment of Azotobacter chroccocum 40 x 106 CFU and Liquid Organic Fertilizer 30% showed an average of the top results in the treatment of N in the leaves, of P in the leaves, of N in the soil and nutrient P in the soil. Regression analysis also showed that the inoculation Azotobacter chroccocum and Organic Liquid Fertilizer positively correlated linearly on each masingparameter observations. This shows the real effect of the treatment showed that the higher the concentration of the treatment given, the higher the nutrient content in the soil to optimum limit each treatment which will then impact on the plant's ability to assimilate and mentranslokasikan nutrients to the leaves up around the plant.

Laboratory analyzes showed that the levels of N leaf tissue inoculation A. chroococcum on average higher than the leaf tissue of cocoa plants without inoculation A. chroococcum that only 1.99% of the dry weight of tissue were analyzed. Research William (1975) in Nasaruddin and Rosmawati (2011) reported that the nutrient content of nitrogen in leaf tissue of cocoa plants to grow normally> 2.00% and if the levels of N in leaf tissue is less than or equal to 1.50% of the dry weight the network being analyzed, the cocoa plant is already deficient N. According Loué et al. in Nasaruddin (2012) that the cocoa plant began showing symptoms of nitrogen deficiency when nutrient levels in leaf tissue N <1.80 to 2.00%, the higher the concentration of inoculation A. chroococcum the better the effect on plant growth.

Plant growth is likely to increase and show the results of the analysis are largely linear and quadratic showed that the plant is still in a state of non-adequacy of nutrients or nutrient deficiency. It is indirectly affected by the activities of Azotobacter chroccocum and liquid organic fertilizer that is able to quickly overcome nutrient deficiency, not problematic in nutrient leaching and nutrient rapidly.However able to provide optimum limit the provision of each treatment can be seen from the maximum value results before experiencing symptoms of toxicity shown by a decrease in the yield on each parameter of observation.

4. CONCLUSION

Giving either separately or together Azotobacter chroococcum and liquid organic fertilizer to cocoa impact very significant on nutrients N and P in the leaves and in the soil. The concentration of Azotobacter chroccocum treatment 40 x 106 CFU and 30% liquid organic fertilizer produced the highest yield of the nutrients N and P in the leaves. Instead the nutrient N in the soil to produce the two treatments were the highest concentration of Azotobacter treatment chroccocum 40 x 106 CFU and liquid organic fertilizer 20%, Azotobacter chroccocum40 x 106 CFU and liquid organic fertilizer 30%. On the other hand, observation of N and P in the soil showed the highest result is the concentration of Azotobacter chroccocumtreatment combinations 30 x 106 CFU and liquid organic fertilizer 30%. The effectiveness of N and P adsorption is the highest in the treatment with Azotobacter chroccocum concentration of 40 x 106 CFU and liquid organic fertilizer 30%. Thus, it is advisable to apply such treatment does not exceed the concentrations above.

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