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APPLICATION OF VARIOUS BIOFERTILIZERS ON VEGETATIVE GROWTH IN OIL PALM SEEDLING

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Abstract

Continuous application of inorganic fertilizers has negative effects on the environment such as plants and soil. One of the efforts to reduce the use of inorganic fertilizers is the use of microbes as biological agents. This study aims to examine the effect of biofertilizer applications from brands A, B, C, and D on vegetative growth in oil palm seedling. This research was held at Bogor Agricultural Development Polytechnic. The study was arranged in a completely randomized design (CRD) followed by Duncan's test. The treatments consisted of 4 brands of biofertilizer with 3 doses (10, 20, and 30 mL/L water) and 8 replicates. The results showed that brand A had a significant effect on dry weight at a dose of 20 mL/L water with a dry weight value of 10.43 gram/plant. The highest root length significantly was the application of brand C at a dose of 20 mL/L of water, which was 39.06 cm/plant. However, the highest root volume significantly was fertilizer brand A with a dose of 10 mL/L of water, which was 12 cm3/plant.

Keywords: biofertilizer, doses, vegetative, oil palm seedling

Introduction

The palm oil industry is one of the largest foreign exchange in Indonesia. Palm oil can be processed into various products, including food raw materials, cosmetics, feed, energy and others (Ariyanti et al., 2019). The rapid development of the palm oil industry must be accompanied by an increase in productivity (Bindrianes et al., 2017). Currently, oil palm productivity is still not optimally achieved. This is because the production technology in cultivation has not been carried out effectively and efficiently. Oil palm cultivation is still very dependent on the application of inorganic fertilizers (Kamyab et al., 2017). When viewed from the fast availability of nutrients, inorganic fertilizers are better than organic fertilizers (Dimkpa et al., 2020).

The advantages of inorganic fertilizers have made farmers and oil palm plantations only pay attention to temporary interests with these applications. Farmers only prioritize high yields. This has a negative impact on the environment such as plants and soil in long term. From an economic side, dependence on inorganic fertilizers also increases operational costs in cultivation.

Microbes as biofertilizer can be used to decrease inorganic fertilizer. Biofertilizer will help the availability of nutrients (Ji et al., 2020). Thus, microbes also produce

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secondary metabolites in the form of organic acids, phytohormones (auxins, gibberellins), antibiotics, chitinolytics and others (Sun et al., 2020). Microbes will associate with plant roots so they can stimulate plant growth through this mechanism (Kamaruzzaman et al., 2020).

Palm oil seedling is from one to six months after sowing. Nurseries are one of the keys to successful productivity. Therefore, this study was conducted to examine the effect of biofertilizer application from brands A, B, C, and D on N uptake and P uptake in oil palm seedling.

Research Methods

Study Site- microbial experiment was conducted at Bogor Agricultural Development Polytechnic, Bogor, West Java, Indonesia which assigned and arranged in a Completely Randomized Design (CRD). seven-day old oil palm seedlings SP540 (Dura x Pisifera) were obtained from Oil Palm Research Center, Medan, North Sumatera, Indonesia have been used in this study.

Experimental Design **-** The experiment was carried out with thirdteen treatments and data taken at 5 months after treatment. Each treatment consisted of eight seedlings. Thus, the total number of seedlings used was 104 seedlings. All oil palm seedlings were grown in polybags (12x18 cm) containing a mixture of soil:compost:husk (2:1:1) and watered twice weekly. Root length, root volume, number of roots, leaf area and shoot length are measured.

Table 1. Experimental design of Vegetative Growth

		Parameter
Vegetative Growth		Root length
		root volume
		number of roots
		leaf area
		shoot length
No. of Treatment = 13	Time taken: 5 months	Total seedlings: 13x8
No. of seedling per treatment = 8	Biofertilizer Doses: 10, 20, 30 mL/L water	**104 seedings**

Thirdteen treatments have been conducted (Table 2). Four biofertilizers were applied to seedlings according to their treatment one month interval and alternate with foliar fertilizer (2 gram/litre water) to five months of experiment.

Table 2. Treatments of the study on the potential biofertilizer of vegetative growth

	Treatment
P0	Seedling treated with foliar fertilizer and uninoculated (positve control)
P1	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer “A” at doses 10 ml/l water
P2	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer “A” at doses 20 ml/l water
P3	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer “A” at doses 30 ml/l water
P4	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer “B” at doses 10 ml/l water

	Treatment
P5	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "B" at doses 20 ml/l water
P6	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "B" at doses 30 ml/l water
P7	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "C" at doses 10 ml/l water
P8	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "C" at doses 20 ml/l water
P9	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "C" at doses 30 ml/l water
P10	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "D" at doses 10 ml/l water
P11	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "D" at doses 20 ml/l water
P12	Seedling treated with foliar fertilizer and artificially inoculated with biofertilizer "D" at doses 30 ml/l water

Biofertilizers and foliar fertilizer cointained as shown in Table 3. Both biofertilizer "A" and "D" containing *Pseudomonas* genus.

Table 3. Composition of biofertilizers and foliar fertilizer

Biofertilizer		Foliar Fertlizer
A	a) *Bacillus pumillus* b) *Debaryomyces hansenii* c) *Bacillus thuringiensis* d) *Meyerozyma* sp. e) *Bacillus methylotrophicus* *Pseudomonas geniculata*	N Total 20% P_2O_5 15% K_2O 15% Magnesium (Mg) Mangan (Mn) Boron (B) Copper (Cu) Cobalt (Co) Zinc (Zn) Aneurine Lactoflavine Nicotinic Acid Amide
B	*Micrococcus* sp.	
C	*Rhodospeudomonas* sp	
D	*Pseudomonas aeruginosa*	

Statistical Analysis- Analysis of Variance (ANOVA, $p<0.05$) was used to determine if a statistically significance difference was observed between the treatments. Duncan test (at $p<0.05$) was applied to determine which means are statistically difference if the ANOVA was significant.

Results and Discussion

Root Length

In this study, root length was 5 months after sowing. P11 showed the highest average root length and significantly different as shown in Table 2.3. All biofertilizers were significantly different with control. Meanwhile, P4, P5, P6, P7, P8, and P9 were shorter than control (P0) and approximately contrasting over P0.

This suggested that P11 (seedlings artificially inoculated with biofertilizer "D" at doses 20 ml/l water) showed a better level of root length than P12 (seedlings artificially

inoculated with biofertilizer "D" at doses 30 ml/l water). In addition, P1, P2, and P3 revealed equal result although the doses each treatment were10 ml.l/ 20 ml/l, and 30 ml/l.

Table 4. Root length (cm)

Treatment	Root Length (cm)
P0	32,94 cd
P1	32,56 cd
P2	33,38 d
P3	33,19 d
P4	26,25 a
P5	29,50 b
P6	29,31 b
P7	25,38 a
P8	29,31 a
P9	30,00 bc
P10	33,69 d
P11	39,06 e
P12	33,25 d

Root Volume

Root volume was also assessed using Archimides Law. Seedlings artificially inoculated with biofertilizer "A" at doses 10 ml/l water (P1) showed the highest root volume value of 12 cm^3 and significantly different (Duncan test, $p<0.05$) compared with amongs their treatments as shown in Table 5.

Table 5. Root volume (cm^3)

Treatment	Root volume (cm^3)
P0	7,00 ab
P1	12,00 c
P2	9,38 b
P3	8,63 ab
P4	8,13 ab
P5	6,44 a
P6	8,75 ab
P7	7,13 ab
P8	7,25 ab
P9	7,63 ab
P10	7,88 ab
P11	8,13 ab
P12	8,38 ab

Number of Roots

P2 and P1 (seedlings artificially inoculated with biofertilizer "A" at doses 10 and 30 ml/l water) were the highest number of roots value of 9 strands but did not different significantly to all treatments as shown in Table 6.

Table 6. Number of roots (strands)

Treatment	**Number of roots (strands)**
P0	6,75 a
P1	9,00 a

Treatment	Number of roots (strands)
P2	8,63 a
P3	9,00 a
P4	8,25 a
P5	7,50 a
P6	8,88 a
P7	7,38 a
P8	8,25 a
P9	8,00 a
P10	7,63 a
P11	8,00 a
P12	8,88 a

Leaf Area

The table 7 below shows leaf area from 13 treatments in oil palm seedling. Overall, the highest leaf area was P2 (Seedlings artificially inoculated with biofertilizer "A" at doses 20 ml/l water) which was 275,16 cm^2. However, all treatments did not significantly different for leaf area result.

Table 7. Leaf area (cm^2)

Treatment	Leaf area (cm^2)
P0	214,19 a
P1	260,76 a
P2	275,16 a
P3	236,06 a
P4	212,96 a
P5	239,28 a
P6	265,97 a
P7	218,30 a
P8	202,95 a
P9	226,80 a
P10	217,56 a
P11	231,29 a
P12	273,02 a

Shoot Length (cm)

Shoot length also measured after 150 days after sowing. The result from 13 treatments were provided in Table 8 below. The highest shoot length was P3 (Seedlings artificially inoculated with biofertilizer "A" at doses 30 ml/l water) which was 35 cm. Meanwhile, all treatments did not different significantly to shoot length value. Overall, shoot length of oil palm seedling treatments (from P1 to P12) slightly more than control (P0).

Table 8. Shoot length (cm)

Treatment	Shoot length (cm)
P0	30,06 a
P1	32,50 a
P2	34,00 a
P3	35,00 a
P4	31,38 a
P5	32,94 a
P6	34,00 a

Treatment	Shoot length (cm)
P7	31,56 a
P8	31,00 a
P9	33,44 a
P10	32,63 a
P11	31,94 a
P12	34,70 a

Discussion

In this study, the value root length of P11 was the highest.It is suggested that seedlings artificially inoculated with biofertilizer "D" at doses 20 ml/l water shows a good potential to nutrient uptake of oil palm seedling. Biofertilizer "D" contains *Pseudomonas aeruginosa*. In addition, *P. aeruginosa* is known as agent of different diseases in plants (Rahme *et al*., 1995; Silo-Suh *et al*., 2002) This bacteria are known to induce peroxidase enzyme activity in soybean plants, thereby reducing the percentage of stunting (Siadi *et al*., 2017). Meanwhile, more than a few of the genus *Pseudomonas* have been widely utilized in bioremediation, and as plant growth-promoting and biocontrol agents (Sitaraman, 2015). In contrast, this have not remarkably increased root volume, number of root, leaf area and shoot length at doses of 10, 20, and 30 ml/l in this experiment.

The biggest average root volume was P1 (12 cm^3/plant).

P1 contains six species of bacteria which were *Bacillus pumillus, Debaryomyces hansenii, Bacillus thuringiensis, Meyerozyma sp., Bacillus methylotrophicus, Pseudomonas geniculate*.

Deng *et al.* (2022) reported that *Bacillus pumilus* can degrade cellulose and other complex organic matters. The mixture of animal manure media using *Bacillus pumilus* can increase the availability of media nutrients. Plants can absorb more nutrients which have an impact on biomass. This is indicated by root volume was significantly different for P1 and P2 treatments compared to P0 (positive control). Nevertheless, the dose of 30 ml/l was not different to P0.

Biofertilizer "A" also contains yeast namely *Debaryomyces hansenii*. This yeast is known to function as disease control and stimulate plant immune mechanisms. In addition, *Bacillus thuringiensis* also contained in biofertilizer "A" known to produce antibiotics and as PGPR (Plant Growth Promoting Rhizobacteria) which includes the production of biocontrol agents that inactivate or kill pathogens, providing a healthy environment for plants (Naik *et al*., 2019).

Pseudomonas geniculate PGPR bacteria are also present in biofertilizer "A". According to Gopalakrishnan et al. (2015), this bacteria can significantly increase root weight, stem weight and P content. The results of this study shows all microbes present in biofertilizer "A" significantly increased root volume with the best dose is 10 ml/l of water. Although, this treatment was not different to P0 in number of root, leaf area and shoot length at doses of 10, 20, and 30 ml/l in this oil palm seedling research.

Biofertilizer "B" contains *Micrococcus* sp. which is known to control the pathogenic bacterium *Sclerotium rolfsii* (Safriani et al., 2020). At dose of 10 ml/l and 30 ml/l of water, the results of root volume was bigger than the control. However, at doses of 20 ml/l showed root volume was smaller than control (P0).

Biofertilizer "C" contains *Rhodospeudomonas* sp. According to Koh *et al*. (2007), this bacteria can increase the dry weight, height, root length and percentage of germination of tomato plants. However, this biofertilizer did not increase significantly the

root length, root volume, number of root, leaf area and shoot length at doses of 10, 20, and 30 ml/l in this study.

Conclusion

Biofertilizer "D" had a significant effect of root length at dose of 20 ml/l. Furthermore, the best dose of biofertilizer "A" was P1 with dose of 10 ml/l for root volume growth. However, all experiment from four biofertilizers were not significant to increase number of root, leaf area and shoot length at doses of 10, 20, and 30 ml/l.

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