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Effect of Indigenous Endophytic Bacteria on Growth of Palm Oil Seedlings (*Elaeis guineensis* Jacq) In The Nursery

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Effect of Indigenous Endophytic Bacteria on Growth of Palm Oil Seedlings (*Elaeis guineensis* Jacq) In The Nursery

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Abstract. Endophytic bacteria have the ability to colonize plant tissues and support plant growth and development. Oil palm produces more oil per unit area than other plants. Dharmasraya is a District in West Sumatera has a large palm oil plantation and needs good seeds to increase productivity. The productivity of oil palms might be increased by means of superior seeds or by utilizing environmentally friendly microorganisms that can help to increase the growth of plants, such as endophytic bacteria. The purpose of this study was to obtain indigenous endophytic bacteria, from oil palm root systems, that improve the growth of oil palm seedlings (*Elaeis guineensis* Jacq) in the pre-nursery. Two isolates (A2.2.1 and D5.2.1) increased the height of plants, total leaf area, fresh weight of seedlings and roots, and the dry weight of seedlings and roots.

1. Introduction

Oil palm plantations are expected to contribute to the economy. According to [1] this plant produces the highest oil per unit area compared to other types of plants with a potential yield of about 6-7 tons / ha / year. Palm oil production in Dharmasraya always fluctuates every year. Oil palm plantation farmers in this district still use a lot of windfalls for seeding oil palm crops, so the productivity is often low. To increase productivity, the use of superior seed is highly recommended. A good seedling is determined by the use of plant growth medium that can provide the nutrient needs of the plant. Limitations of soil fertility can be improved by utilizing environmentally friendly microorganisms that can help stimulate plant growth, such as endophytic bacteria.

Endophytic bacteria grow in plant tissue and can be found in the roots, leaves and stems of plants. Plant growth will benefit from the presence of endophytic bacteria [2] Endophytic bacteria are also known to have the ability to produce phytohormones, such as the hormone IAA [2], cytokines and gibberellins, by regulating hormone levels in the plant [3,4]. Increased growth, such as increased canopy and root weights, is caused by endophytic bacteria which can stimulate the formation of lateral roots and the number of roots so as to expand the absorption of nutrients [5].

IAA (Indole-3-Acetic-Acid) is a growth hormone which plays an important role for the growth and development of plants. Microbes which can produce IAA can increase growth and extension of the roots so that the root surface becomes more extensive [6] and eventually the plant is able to absorb more nutrients from the soil [7]. Increased growth of plants (plant height and biomass) has been reported for many plants inoculated with endophytic bacteria which can produce IAA [4,8,9]. In addition to endophytic bacteria producing IAA, endophytic bacteria are also capable of dissolving phosphate.

Phosphate dissolving endophytic bacteria play a role in dissolving organic and inorganic phosphate into soluble phosphate so that it can be used / absorbed by plant roots). Ref. [10] reported 4 isolates from rice plant roots (*Oryza sativa*) that can dissolve phosphate.



According to [11] obtained 40 isolates of indigenous endophytic bacteria from the roots of palm oil plants in Dharmasraya. Of the 40 isolates, 19 improved plant growth, produced IAA and dissolved phosphate. These 19 selected isolates were used in the present study.

2. Material and Methods

This study was conducted from March to October 2017 at the Microbiology and Experimental Laboratory of the Faculty of Agriculture, Andalas University.

The materials used for planting are Tenera varieties of oil palm derived from PPKS Medan, soil samples and healthy root samples in palm oil area, polybags 20 x 14 cm, flower plants at four (*Mirabilis jalapa*) and sterile soil. Soil was sterilised at 100°C. A completely randomized design with 20 indigenous endophytic bacterial isolates and 3 replicates was used.

2.1. Research Procedure

2.1.1. Propagation of Endophytic Bacteria

2.1.2. Introduction of Endophytic Bacteria and Planting

2.1.2.1 Production of Flourescent Compounds

2.1.2.2 Indole Acetic Acid (IAA) Production Ability to Dissolve Phosphate

3. Result And Discussion

3.1. Characterization of Indigenous Endophytic Bacteria

None of the 19 isolates of indigenous endophytic bacteria produced flourescents pigment, but all isolates were able to produce IAA. Just 2 isolates solubilised phosphate (Table 1).

Table 1. Characterization of The Endophytic Bacteria

Isolates	Flouresces Pigment	IAA Production (ppm)	Ability to dissolve phosphate
A2.2.2	-	1.0231	-
A2.2.1	-	0.6115	-
B5.1.1	-	1.5462	-
B1.1.1	-	0.4731	-
C5.1.1	-	0.4385	-
C3.2.1	-	0.5269	-
C5.2.1	-	0.4077	-
C2.2.1	-	0.9808	-
C4.2.1	-	0.4385	-
D5.2.1	-	0.3654	-
D4.1.1	-	3.1462	-
D3.1.2	-	0.4115	-
D4.1.2	-	0.7000	+
E4.1.2	-	3.2962	+
E3.1.1	-	0.3077	-
E3.1.2	-	0.4808	-
E4.2.2	-	0.7077	-
F2.1.1	-	0.5115	-
F3.1.1	-	0.3538	-

From the results of the endorsement of 19 indigenous endophytic bacteria that have been tested, all isolates of indigenous endophytic bacteria do not show bacteria that can produce fluorescens pigments. Testing of indigenous endophytic bacteria in producing fluorescens pigment to differentiate *Pseudomonas* bacteria from other bacteria [12]. The characteristics of bacteria produce water-soluble fluorescens pigments, which are yellow green pigments called pyocyanins and pyoverdins that spread to the media and fluorescent under ultraviolet light. Pyocyanins are blue phenazines. *Pseudomonas fluorescens* emits green, red, green, pink, and yellow pigments primarily on iron-deficient mediums. *P. fluorescens* form a fluorescent pigment known as fluorescein, now more widely used the term pyoverdin. Pyoverdin consists of a peptide of 5-8 amino acids and a chromophore of quinoline derivatives having a molecular weight of about 1,000. Pyoverdin has the ability as an iron-binding compound and iron carrier or siderofor [13]. The highest IAA production was found with isolate E4.1.2 (3.2962 ppm) and the lowest with isolate E3.1.1 (0.3077 ppm). The difference in IAA production is suspected to depend on the ability of each isolate to colonize the roots of the plant [14].

The mechanism of bacteria in increasing the IAA content in plants is by using natural tryptophan produced and excreted by the roots and then used for the synthesis of IAA. According to Ref. [15], IAA-producing bacteria are involved in some physiological processes of plants by including the IAA they produce into plants, so the plants are more sensitive in changing their IAA concentrations. The ability of bacteria in dissolving phosphate is one of the mechanisms to increase plant growth by bacterial endophytes.

3.2. Plant Growth

Seedling height, leaf number and total leaf area, after inoculation with the bacterial isolates, are shown in Table 2. The indigenous endophytic bacteria tested affected plant growth. The indigenous endophytic bacteria resulted in the highest average height of 21.9 cm with effectiveness of 41.29%, significantly different from that of indigenous endophytic bacteria control of 15.5 cm. Of the 19 isolates of indigenous endophytic bacteria in the application of 7 isolates showed the lowest average plant height value when compared with the control, ranging from 15 cm to 12.53 cm with minus effectiveness value. In this case some indigenous endophytic bacteria applied to increase the growth of this plant is suspected that the bacteria have the ability as PGPR (Plant Growth Promoting Rhizobacteria). Endophytic bacteria as PGPR are also reported to be able to stimulate the growth of rootstock seedlings of rubber plants [16] and increase the growth of sambiloto [17]. Increased plant height in oil palm crops in indigenous endophytic bacteria caused by the presence of IAA hormone produced by endophytic bacteria. IAA hormone function for plants, among others, increase cell growth, stimulate the formation of new roots, spur growth, stimulate flowering and increase enzyme activity [18]. The IAA function in cellular development can increase the height of oil palm crops. Generally the plant is unable to produce enough IAA for growth and development. Some strains of PGPR are capable of introducing IAA from precursors found in both root exudates and organic matter. This active compound can increase or inhibit plant growth depending on its concentration [19]. According to [20] the height of the plant stem will affect the number of nodes to which the leaf exits, so that if the plant has a size.

Long stems then the number of nodes will be more so that the number of plant leaves is also more. in isolate D5.2.1 with average total leaf area 111.19 cm³ and effectiveness value 156.49% and lowest F3.1.1 with average 24.85 cm³ with effectiveness value -42.69%. Of the 19 isolates of bacteria given 2 isolates (A2.2.1. D5.2.1) bacteria were able to increase the highest total leaf area ranging from 1001.35 cm³ to 111.19 cm³. the highest endogenous indigenous bacteria treatment The indigenous endophytic bacteria is capable of increasing the total area of palm oil leaves in pre nursery due to the indigenous endophytic bacteria capable of producing growth hormone and the availability of certain nutrients, fixing nitrogen, and mobilizing phosphate. Suspected of indigenous endophytic bacteria capable of blocking N₂ from the air, N₂ blocking endophytic bacteria can increase the nitrogen inhibition of air.

The ability of endophytic bacteria to have advantages that is: the overall product of the form fitohormon and N fixation can be used entirely by plants because endophytic bacteria are inside the plant tissue. Lakitan [21] stated that at the time of leaf growth, it is known that not all necessary nutrients

play a role directly on the formation of leaves. The most important nutrient effect on leaf growth and development is nitrogen

The effect of endophytic bacteria indigenous bacteria isolate on fresh weight of seedlings and fresh weight of oil palm plant roots in pre nursery has varied effects. By comparison with no indigenous endophytic bacteria isolate isolates, some isolates were able to perform better and differ significantly both in dry weight of seedlings and dry weight of palm oil plant roots (Table 3).

The varied results showed that indigenous endophytic bacteria administration had an effect on the growth of oil palm seedlings. The best result of fresh weight of seedlings and fresh root weight from indigenous endophytic bacteria is on isolate D5.2.1 and A2.2.1 with average fresh seed weight ranging from 5.51 gram to 5.53 gram and average fresh root weight value with the same isolates averaged 1.33 grams to 1.56 salts. This is in agreement with [22] which states that fresh weight of plants is influenced by plant height and leaf area, the higher and larger the leaf area the higher the fresh weight of the plant will be. The fresh weight of the root of the palm oil plant will increase due to nutrient absorption and water from the soil that plants can need for their growth, in accordance with that of [23], the increase of root plant growth is one of the main signs that can be observed when the plant has been inoculated by endophytic bacteria. From the results of this study, indigenous endophytic bacteria are applied to give a real effect on fresh weight of roots and oil palm seedlings, suspected endophytic bacteria can help the plant in the absorption of nutrients from the soil to plant growth so that the effect on fresh weight of seeds and plant roots.

Table 2. Seedling Height, Leaf Number and Total Leaf Area After Inoculation with The Bacterial Isolates

Isolates	Seedling height (cm)	Effectiveness (%)	Leaf Number	Effectiveness (%)	Total Leaf Area (cm ³)	Effectiveness (%)	
A2.2.1	21.90	a	41.29	3.67	-12.73	104.55 a 141.18	
D5.2.1	21.57	a	39.16	3.00	12.36	111.19 a 156.49	
B5.1.1	21.10	ab	36.13	3.33	24.72	101.35 ab 133.79	
D4.1.1	19.90	ab	28.39	3.00	12.36	71.54 ab 65.03	
E3.1.2	19.90	ab	28.39	2.67	0.00	52.65 ab 21.45	
F2.1.1	19.00	ab	22.58	3.00	12.36	85.03 ab 96.15	
C5.1.1	18.73	ab	20.84	3.33	24.72	47.43 ab 9.41	
C3.2.1	17.97	ab	15.94	3.00	12.36	51.54 ab 18.89	
B1.1.1	17.80	ab	14.84	3.33	24.72	87.11 ab 100.95	
C5.2.1	16.90	ab	9.03	2.67	0.00	47.43 ab 9.41	
D3.1.2	16.40	ab	5.81	2.33	-12.73	89.31 ab 106.02	
E4.2.2	16.07	ab	3.68	2.67	0.00	58.30 ab 34.49	
Control	15.50	ab	0.00	2.67	0.00	43.35 ab 0.00	
C2.2.1	15.30	ab	-1.29	2.33	-12.73	54.16 ab 24.94	
D4.1.2	14.83	ab	-4.32	2.67	0.00	47.70 ab 10.03	
C4.2.1	14.57	ab	-6.00	3.00	12.36	43.10 ab -0.58	
F3.1.1	13.73	ab	-11.42	2.33	-12.73	24.85 b -42.69	
E4.1.2	13.60	ab	-12.26	2.33	-12.73	56.48 ab 30.28	
E3.1.1	13.43	ab	-13.35	2.33	-12.73	46.61 ab 7.51	
A2.2.2	12.53	b	-19.16	2.33	-12.73	31.61 ab -27.08	
CV=	16.6%		CV =	19.56%		CV =	36.55%

Numbers in the same column followed by the same lower case letter are not significantly different (Honestly Significant Difference test at the 5% level).

Measurement of dry weight of seedlings and dry weight of oil palm root root is important to know the biomass weight of the result of plant photosynthesis with the help of indigenous endophytic bacteria applied to palm oil cultivation in pre nursery. The ability of endophytic bacteria to increase dry weight of seedlings and dry weight of palm oil plant roots shows varying results. By comparing control and provision of endophytic indigenous bacteria, some isolates were able to be significantly better and significantly different from dry weight of seedlings and root dry weight. The varied results indicated that giving endophytic bacteria indigenous bacteria had an effect on the growth of oil palm plant in pre nursery.

The highest dry weight of seeds and roots in the treatment of isolate A2.2.1 with dry seed average of 1.42 grams and 0.49 gram on dry weight of root of oil palm plant. The lowest dry seedlings and roots at F3.1.1 isolate treatment with average dry seed 0.17 gram and 0.03 gram at root dried weight. In general, indigenous endophytic bacteria from oil palm plants are able to stimulate plant growth.

Table 3. Effect of Endophytic Bacteria Indigenous Application on Fresh Weight of Seed and Root, Dry Weight of Seed and Root.

Isolates	Fresh Weight of Seed (gram)	Effectiveness (%)	Fresh Weight of Root (gram)	Effectiveness (%)	Dry Weight of Seed (gram)	Effectiveness (%)	Dry Weight of Root (gram)	Effectiveness (%)				
D5.2.1	5.53	a	115.18	1.33	ab	160.78	1.39	a	95.77	0.35	ab	105.88
A2.2.1	5.51	a	114.20	1.56	a	205.88	1.42	a	100.00	0.49	a	188.24
B5.1.1	4.90	ab	90.47	1.15	ab	125.49	1.21	ab	71.83	0.35	ab	102.94
D3.1.2	4.60	ab	78.99	1.16	ab	127.45	1.30	ab	83.10	0.37	ab	114.71
E3.1.2	4.54	ab	76.65	1.04	ab	103.92	1.15	ab	61.97	0.33	ab	94.12
B1.1.1	4.54	ab	76.65	1.19	ab	133.33	1.14	ab	60.56	0.34	ab	100.00
F2.1.1	4.54	ab	76.46	1.12	ab	119.61	1.11	ab	56.34	0.29	ab	67.65
C2.2.1	3.64	ab	41.63	1.12	ab	123.53	0.87	ab	22.54	0.32	ab	85.29
C5.1.1	3.37	ab	30.93	0.87	ab	70.59	0.89	ab	25.35	0.27	ab	58.82
D4.1.1	3.24	ab	26.07	0.97	ab	90.20	0.85	ab	19.72	0.29	ab	67.65
C3.2.1	3.04	ab	18.29	0.64	ab	25.49	0.91	ab	29.58	0.25	ab	47.06
E4.2.2	2.85	ab	10.89	0.80	ab	56.86	0.67	ab	-5.63	0.20	ab	14.71
Control	2.57	ab	0.00	0.51	ab	0.00	0.74	ab	0.00	0.17	ab	0.00
D4.1.2	2.54	ab	-1.36	0.72	ab	41.18	0.70	ab	-1.41	0.24	ab	41.18
E4.1.2	2.27	ab	-11.67	0.37	ab	-27.45	0.70	ab	-1.41	0.28	ab	64.71
C5.2.1	2.26	ab	-12.06	0.53	ab	3.92	0.65	ab	-8.45	0.19	ab	11.76
E3.1.1	2.04	ab	-20.82	0.44	ab	-13.73	0.52	ab	-26.76	0.12	ab	-29.41
C4.2.1	1.95	ab	-24.12	0.51	ab	0.00	0.54	ab	-23.94	0.19	ab	8.82
A2.2.2	1.06	ab	-58.75	0.18	b	-64.71	0.24	ab	-66.20	0.04	ab	-79.41
F3.1.1	0.86	b	-66.73	0.26	ab	-49.02	0.17	b	-76.06	0.03	b	-82.35

Numbers in the same column followed by the same lower case letter are not significantly different (Honestly Significant Difference test at the 5% level).

Endophytic bacteria spur the growth and development of roots, so plants can grow and develop well. Provision of endophytic bacteria in poplar hybrid plants can increase root biomass 84%, 38% canopy, and 48% leaf. Endophytic bacteria can improve root development both root length and dry weight of poplar root roots. The increase is allegedly not separated from phytohormones and compounds that regulate plant growth metabolism produced by endophytic bacteria.

Several studies have shown that in addition to producing endophytic bacteria fitohormon also play a role in binding N and can dissolve P as isolated from apple 24, sugar cane 8. The high dry weight values of plants indicate an increase in the process of photosynthesis because the required nutrients are

available. This is related to the results of photosynthates that are translocated to all plant organs for plant growth, thus giving a real effect on plant biomass.

4. Conclusion

From the results of the research that has been done, it can be concluded that potential indigenous endophytic bacteria can increase the growth of oil palm seedlings in Pre Nursery, namely isolates A2.2.1 able to increase plant height, total leaf area, fresh seed weight and fresh roots, dry seed weight and dry root, with a total effectiveness value of 867.09% and isolates D5.2.1 able to increase plant height, total leaf area, fresh seed weight, seed dry weight with a total effectiveness value of 685.62%.

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