

Agronomic effect of empty fruit bunches compost, anorganic fertilizer and endophytic microbes in oil palm main nursery used *Ganoderma* endemic soil

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Abstract. Using of *Ganoderma* endemic soil in oil palm main nursery is not recommended because produce bad quality seedling. The application of organic and anorganic fertilizer and endophytic microbes are the alternative for solving the problem. The objective of this research is to evaluate the effect of empty fruit bunches compost, anorganic fertilizer and endophytic microbes on growth of oil palm seedling in main nursery. This research used factorial randomized block design. The first factor was combination of empty fruit bunches compost and anorganic fertilizer, The second factor was endophytic microbes consisting of *Trichoderma* and *Aspergillus*. The results showed that interaction effect of the both treatment factor used increased growth of seedling in third and fourth month after application. The best growth of seedling was on the treatment of empty fruit bunches compost combined with anorganic fertilizer 150% recommended dosage and *Trichoderma viride*.

1. Introduction

One of the significant plantations commodity in Indonesia is oil palm (*Elaeis guineensis* Jacq.) because its contribution in increasing foreign exchange and the supply of vegetable oil. The oil palm plantation area in Indonesia and the average production of crude palm oil was 8.91 million hectares in 2011 [1] and around 31 million ton per year [2] respectively.

The main problem as that causes major damage to oil palm plantations especially the oil palm plantation of the people in the area is *Ganoderma*. *Ganoderma* caused the basal stem rot disease. It is happened in many properties land. The pathogen does not only attack the produced plant but also attack plants that have not produced even in plants seedling nursery. On land which has high sand content (>50%), basal stem rot disease has spread with the level of disease incidence between 0.71% to 50% in vary years old oil palm. The symptoms of the basal stem rot disease are chlorotic leaves, the appearance of fruiting body, collapsed plants, and the existence of holes on the basal stem [3]

On the plants that are 15 years of age which replanted with underplanting technique, the basal stem rot can reach 33% and reduce the oil palm production to 35% [4].

Commonly, the infection rate of *Ganoderma* in the soil which endemic *Ganoderma* especially textured sandy is high [5] and poor nutrition [6]. Although soil has many risks but many farmers in community's plantations such as in Bukit Kijang Village in Sumatera Utara Province use the soil as nursery planting media. Generally the seedling quality is very poor.

The seedling growth planted use *Ganoderma* endemic soil can be improve by minimizing the infection rate of *Ganoderma*. The improvement of the endemic soil with *Ganoderma* can be done through the integrated methods namely the use of the combinations of organic and anorganic fertilizers and microbial antagonists. The organic fertilizer will improve soil properties and increase nutrition absorption from anorganic fertilizer. Microbial antagonists as endophytic fungus such as *Trichoderma* sp, *Aspergillus* sp. and *Penicillium* sp. showed antagonistic reaction with *Ganoderma* [7], [8]. The effectivity of microbe determined themicrobe types.

Generally, farmer used compound fertilizer that contain N, P, K and Mg in ratio 15-15-6-4 or 12-12-7-2. It is difficult to supply nutrition need because nutrition composition determined. So, beside that, it is too used single fertilizer. Compost application as organic matter can be reduced the problem. Compost is very important material to give in seedling growth media Empty fruit bunches contain 42.8 % C, 2.90% K₂O, 0.80% N, 0.22% P₂O₅, 0.3% MgO 10 ppm B, 23 ppm Cu, 51 ppm Zn [9]. The objective of this research is to compare the effect combination of empty fruit bunches compost and anorganic fertilizer and endophytic microbes on oil palm growth in main nursery seedling

2. Material and methods

2.1. Determination of the location

The research was done in 'community' oil palm plantations in Desa Bukit Kijang, Gunung Melayu, in Sumatera Utara, Indonesia. The location is at N 02°42'34.6"E 099°30'38.2°, plant number is 350, plant age is seventeen years old and disease incidence is 50%.

2.2. Material: Endophytic Microbes, Compost, Soil Sample

The research use pure cultures of three isolates of Endophytic Microbial namely *Trichoderma koningii*, *Trichoderma viride*, *Aspergillus* sp as collection Phytopathology Laboratory of Universitas Sumatera Utara isolated from oil palm trees in the village of Gunung Melayu, Asahan, Sumatera Utara-Indonesia. Propagation endophytic fungus carried on the carrier grits. After that reproduced by using a zeolite with a ratio of 1: 9 (fungus endophyte in corn flour: zeolite). Soil sample is taken from location determined which textured sandy loam (64.82% sand, 21.47% silt and 13.71% clay) and pH 5.31. Compost of empty fruit bunches is taken from PT. Socfindo.

2.3. Analysis of empty fruit bunches compost and soil sample

The result of empty fruit bunches compost and soil analysis is showed in Table 1.

Table 1. Properties of empty fruit bunches compost and soil sample

No	Properties	Empty fruit bunches compost	Soil sample s
1	C-Organic (%)	17.79	2.26
2	N-Total (%)	1.27	1.54
3	P ₂ O ₅ (%)	0.02	-
4	P-available (ppm)	-	13.96
5	K ₂ O (%)	0.286	-
6	K-exch (me/100)	-	0.628
7	MgO (%)	0.529	-
8	Mg-exch (me/100)	-	0.438

2.4. Experimental design

This research used factorial randomized block design. The first factor was the combination of empty fruit bunches compost and anorganic fertilizer. The treatment consisted of compost, 100% dosage of NPKMg fertilizer, compost and 50% dosage of NPKMg fertilizer, compost and 100% dosage of NPKMg fertilizer, compost and 150% dosage of NPKMg fertilizer. The second factor is type of

endophytic microbes that consist of control (no endophytic microbes), *T.koningii*, *T. viride* and *Aspergillus sp.*

2.5. Procedure of compost, fertilizer and endophytic microbes application

Each polybag contained 5 kg of soil sample taken from the location. The dosage of compost and endophytic microbes respectively were 600 g of compost in each polybag and 30 g of endophytic microbes inoculant. The application of compost and inoculation of endophytic microbes adapted to the treatment that has been compiled. It is done at transplanting time of seedling four months years old. The anorganic fertilizer also adapted to the treatment that has been compiled used PT Socfindo recommendation (Table 2). The fertilizer is applicated around the stem in 10 cm space

Table 2. The dosage of NPKMg compound fertilizer for seedling since 4 to 7 months years old

Old of the seedling (month)	Application Time (weeks)	NPKMg (g/polybag)		
		50%	100%	150%
4	17	2	4	6
	19	3,75	7,5	12,5
5	21	3,75	7,5	12,5
	23	3,75	7,5	12,5
6	25	3,75	7,5	12,5
	27	3,75	7,5	12,5
7	29	5	10	15
	31	5	10	15

2.6. Leaf- Sampling

Leaf sample was taken from each unit of the treatment. It is done at seedling 8 month years old. The sample is dried in oven at 70°C for two days until the weight is constant.

3. Results and discussion

The compost treatment enriched endophytic fungi at various doses of NPKMg fertilizer did not affect plant growth until 2 months after application but the real influence started to occur at 3 month age crop. The main effects of endophytic fungi and the interaction effect between fertilizer and endophytic fungus did not affect plant height, but significantly affected the stem circumference and number of leaves. The diversity of plant growth is shown in Table 3, Table 4 and Table 5.

Table 3 showed that generally in the treatment of each type of endophytic fungus, the amount of midrib does not differ between treatments of fertilizer combination. Similarly, in each treatment of fertilizers, the effect of endophytic fungi on the number of stem is also the same, At the age of 8 months of plants, the highest number of barks is found in the treatment of 100% inorganic fertilizer recommendations. The effect was no different from the treatment that received compost input and various recommendation doses and also was inoculated with endophytic microbes.

Table 4 showed that the main effects of endocrine fungal application of *T.viride* increase the highest stem circumference compared to *T. koningii* and *Aspergillus*. Furthermore, in 8-month-old plants, from the interaction effect it is known that the highest stem circumference was found in combination of *T.viride* and compost treatment with 150% recommended inorganic fertilizer.

Table 3. Effect of combination empty fruit bunches compost and anorganic fertilizer and kind of endophytic microbe on number of leaf

3 month after fertilizer application (7 months years old)						
Treatment	Compost	100% NPKMg	Compost + 50% NPKMg	Compost + 100% NPKMg	Compost + 150% NPKMg	Average
.....the number of leaf.....						
Control	5.67 e	7.67 abcd	8.00 abc	7.67 abcd	6.67 cde	7.13 y
<i>T. viride</i>	8.00 abc	7.67 abcd	8.33 abc	8.33 abc	8.00 abc	8.07 x
<i>T.koningii</i>	7.67 abcd	6.00de	7.33 bcde	8.67 ab	8.33 abc	7.60 xy
<i>Aspergillus</i>	9.00 a	8.00 abc	7.33 bcde	8.33 abc	8.67 ab	8.27 x
Average	7.58	7.33	7.75	8.25	7.92	
4 month after fertilizer application (8 months years old)						
Control	7.67 d	10.00 abc	9.33 abcd	10.00 abc	8.67 bcd	9.13 y
<i>T. viride</i>	9.67 abc	10.67 a	10.33 ab	9.67 abc	10.33 ab	10.13 x
<i>T.koningii</i>	9.67 abc	8.33 cd	9.33 abcd	10.00 abc	10.00 abc	9.47 xy
<i>Aspergillus</i>	10.33 ab	10.00 abc	9.33 abcd	8.67 bcd	10.00 abc	9.67 xy
Average	9.33	9.75	9.58	9.58	9.75	

Note: The number in same rows followed the same notation represent not significant differences based on Duncan's Multiple Range Test (p = 0.05)

Table 4. Effect of combination empty fruit bunches compost and anorganic fertilizer and kind of endophytic microbe on stem circle

3 month after fertilizer application (7 months years old)						
Treatment	Compost	100% NPKMg	Compost + 50% NPKMg	Compost + 100% NPKMg	Compost + 150% NPKMg	Average
.....the stem circle (cm).....						
Control	4.43	4.93	4.93	5.10	4.70	4.82 c
<i>T. viride</i>	5.23	5.63	5.63	6.57	6.63	5.94 a
<i>T.koningii</i>	5.70	4.50	4.90	5.27	5.77	5.23 bc
<i>Aspergillus</i>	6.13	5.90	4.93	5.57	6.10	5.73 ab
Average	5.38	5.24	5.10	5.63	5.80	
4 month after fertilizer application (8 months years old)						
Control	5.27 d	8.13 ab	7.17 abcd	6.93 abcd	6.33 bcd	6.77 x
<i>T. viride</i>	6.97 bcd	7.70 abc	8.33 ab	8.37 ab	9.20 a	8.11 y
<i>T.koningii</i>	7.20 abcd	6.23 bcd	6.53 bcd	7.07 abcd	7.50 abc	6.91 y
<i>Aspergillus</i>	8.00 ab	8.23 ab	5.73 cd	6.83 bcd	7.57 abc	7.27 xy
Average	6.86	7.58	6.94	7.30	7.65	

Note: The number in same rows or same coloms followed the same notation represent not significant differences based on Duncan's Multiple Range Test (p = 0.05)

There is no interaction effect between the combination of compost - inorganic fertilizer and endophytic microbe to shoot dry weight (Table 5) . Conversely, the dry weight of the shoot is influenced by major factors of endophycytic microbial inoculation and compost and inorganic fertilizer combination. The highest shoot dry weight is affected by the *T. koningii* treatment. Meanwhile, in the treatment of fertilizers, the highest shoot dry weight is affected by combination of organic fertilizer and inorganic fertilizer dose 100% recommend.

Table 5. Effect of combination empty fruit bunches compost and anorganic fertilizer and kind of endophytic microbe on shoot dry weight

Treatment	Compost	100% NPKMg	Compost+ 50% NPKMg	Compost + 100% NPKMg	Compost + 150% NPKMg	Average
Control	67.62	70.47	71.72	79.17	63.57	70.51 c
<i>T. viride</i>	62.13	67.84	63.15	77.49	77.84	69.69 c
<i>T.koningii</i>	73.69	83.50	77.47	82.19	81.27	79.62 a
<i>Aspergillus</i>	78.58	79.17	68.19	82.53	74.84	76.66 b
Average	70.50 c	75.24b	70.13 c	80.34 a	74.38 b	

Note: The number in same row or same colom followed the same notation notation represent not significant differences based on Duncan's Multiple Range Test ($p = 0.05$)

The results showed that compost and fertilizer compound fertilizer NPKMg compound cause better growth response than compost only or microbes only. Even when viewed from the circumference of the stem and the amount of midrib is known to have an interaction effect between the combination of compost and fertilizer as well as microbial endophytic. This is because compound fertilizers have a certain nutrient composition while the soil used also has a low nutrient status when the plants need nutrients that are higher than those available in the soil and from the fertilizer. The positive effects of compost given are related to the quality of the compost. This means that the compost that is given has good quality, among others, from the initial analysis, it is known that the C / N ratio is about 14 and contains high N, K and Mg nutrients. The addition of organic materials with low C / N will increase the fertility of the soil more quickly because the organic matter is more easily decomposed [10]

This study showed that the interaction effect of treatment factor on plant growth is seen after the plants are 8 months or 4 months after application. This is in line with Riniarti's study [11] which showed agricultural waste such as bagases and empty fruit bunches that have been more biodegradable, at incubation 3 weeks. On the other hand, growth indicators. Plant stem diameter and dry weight significantly influenced by combination treatment of compound fertilizer and compost of empty fruit bunches. This is because the compost used has been ripe so as not to cause nutrient immobilization in the soil.

Based on this research it is known that to increase plant growth on endemic soil require compost and organic fertilizer according to recommendation even up to 1.5 times recommendation. This means that the requirement of plant nutrients in biotic stress conditions is higher than the ideal state as one of the mechanisms to increase disease resistance.

The results also showed that endophytic microbial administration can improve plant growth and there are differences in effect between microbial types. The presence of endophytic microbes in addition to increasing plant resistance to *Ganoderma* is also associated with improved nutrient status for plants [12] thereby increasing the growth of stem circumference and number of plant leaflets [13]

The quality of seeds from the results of this study is still below the standard. It is known that the standard 8-month-old palm seedlings have 11.5 cm in height and 64.3 cm in diameter and 3.6 cm in diameter [14]. This indicates that additional ameliorants such as lime are still needed because the soil pH used in this research is classified as acid. Lime can increase soil pH and increase the nutrients Ca and Mg.

4. Conclusions

The interaction effect of the both treatment factor used increase growth of seedling in third and fourth month after application. The best growth of seedling is on the treatment of empty fruit bunches compost combined anorganic fertilizer 150% recommended dosage and *Trichoderma viride*.

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