The Increasing of N, P, and K Nutrient in Palm Oil Under Prenursery Seedling By Application of Palm Oil Waste Compost and Endofitic Microbes

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Abstract
Improvement of palm oil nutrient status since at the nursery is one of the efforts to improve plant resistance to Ganoderma attacks. Compost from palm oil waste and potentially endophytic microbes could potentially increase plant nutrients, especially N, P and K. This study aims to determine the potential of oil palm waste compost and endophytic microbes in increasing N, P and K in the plant oil palm under prenursery seedling. The study was conducted in a factorial experiment with the factors tested were types of compost, type and time of endophytic microbial inoculation. Research results indicating that the levels of N, P and K plants are not affected by the main factors and factor interactions of three factors. The concentration of of N, P, K soil is influenced by the interaction effect of two factors. The empty fruit bunch compost enriched every type endophyte showed better effects than compost midrib in increasing levels of P and K nutrient in plants and plant growth The application endofitic microbe after and before Ganoderma application inreased phosphor and potassium in plant and growth plant.
Keywords: *N, P, K, empty fruit bunches compost, compost midrib*

Introduction

Ganoderma is a fungal pathogen that causes major damage to oil palm plantations. Plants are attacked by decay and eventually die. Ganoderma is not only attacking the plant produces or old plants are planted on land formerly used for replanting but also attack plants that have not produced even in plants seedling nursery. Oil palm plantations in the village of Gunung Melayu, Bukit Kijang, District Rahuning, Asahan already infected stem rot disease caused by the fungus *Ganoderma* an incidence rate of mild to severe disease (0.71% - 50%). Symptoms of the disease found in young plants (4 years old) to the second generation of older plants (33 years) first generation (Lisnawita et al., 2014). In the oil palm replanting, Ganoderma attacks can reach 22% in the year to 10, rising to 40% four years later (Singh, 1990).

Rapid progression of the disease and the weight on nutrient-poor soil, especially that contain lots of sand fraction. Susanto et al (2013) reported an infection rate of *Ganoderma* in the planting medium sand is more rapid onset and a higher incidence than in the planting medium-textured clay. Hanum et al (2014) reported that the nature of the soil under stands of palm are attacked Ganoderma has a wide range. Soil pH values in the range of criteria very acid until slightly acidic, organic-C levels of criteria is very low to very high, levels of N-soil of the criteria is very low to low, and the texture of sandy loam soil, sand and loamy sandy clay loam.

Various control measures have been carried out but have not provided satisfactory results. Improvement of oil crops nutrient status since in the nursery through the use of organic fertilizers and microbial antagonists are effective control methods and environmentally friendly. which can increase plant resistance to *Ganoderma* attacks. The role of soil organic matter to improve soil properties, especially soil nutrient status will promote plant growth and development of microbial antoganis. Various endophytic fungus has been reported to be effective biocontrol agents such as *Trichoderma* (Sariah, 2003) and Penicillium (Dharmaputra et al., 1989), which showed antagonistic-reaction-with-Ganoderma.

Compost of empty fruit bunches and palm midrib can be used as a source of organic fertilizer and reducing the need for chemical fertilizers. In 100 kg of empty fruit bunches compost contained N, P and K respectively equivalent to 5,09 kg of urea, 1.97 kg of SP-36, and 11.85 kg of KCl (Firman, 2010). How the potential of compost from palm oil waste in the supply of nutrients and increase growth at prenursery seedling in relation to the inoculation prenursery endophytic microbes need to know more. This study aimed to compare the effect of the interaction between compost and inoculation of endophytic microbes to increase N, P and K plant oil palm on prenursery seedling.

Materials and Methods

Studies using pure cultures of *Ganoderma* and three isolates of Endofitic Microbial namely *Trichoderma* sp1, *Trichoderma* sp 2, *Aspergillus* sp as collection Phytophatology Laboratory of University of North Sumatra isolated from oil palm trees in the village of Gunung Melayu, Asahan, North Sumatra-Indonesia, sterile soil materials, compost empty fruit bunches, palm midrib compost palm age 1 month. Experiments carried out at the home of gauze Faculty of Agriculture, University of North Sumatra Medan Indonesia, using a factorial randomized block design. The first factor is the time of inoculation *Ganoderma* and endophytic microbes, namely the introduction of ganoderma, 2 weeks after the application of compost berendofit (W1) and the application of compost berendofit, 2 weeks later application ganoderma (W2). The second factor is the application of compost, consisting of no compost (K0) composts empty fruit bunches (K1), and compost palm fronds (K2). The third factor is composed of endophytic microbes without endophytic microbes (E0), Trichoderma sp1 (E1), Trichoderma sp 2 (E2) and Aspergillus sp (E3). Endophytic microbes used was based on the results of in vitro tests (Lisnawita, et al, 2014).

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). Ganoderma propagated in the trunk of rubber wood. Rubber rod planed to dispose of bark, after it was cut into pieces with a size of about 5 cm. Pieces of rubber rods boiled to remove the tannin content after it is sterilized with NaOCl 5.25% for 5 minutes, followed by 95% ethanol for 30 seconds. Once it is rinsed with sterile water 3 times. The next piece of rubber rods inserted in an oven at a temperature of 100 ° C for about 60 minutes. After that piece of rubber rods immersed in media mealt extract agar (MEA) and sterilized by using autoclaf (Nur Ain Izzati and Abdullah, 2008). Ganoderma inoculation is done by attaching a piece of pure cultures of Ganoderma in the top of the piece of rubber rods. Cultures were incubated at room temperature for 4 weeks.

The application of compost and the introduction of *Ganoderma* and inoculation of endophytic microbes adapted to the treatment that has been compiled. Inoculation is done on a pre nursery of oil palm seedlings that are ready moved to the main nursery. 300 g of compost mixed with 30 g of endophytic fungi are given in each polybag size of 10 kg of soil. Timing of compost and *Ganoderma* and also endophytic microbe adapted to treatment, there are compost with endofitic microbe given at the beginning of the plant by mixing with planting medium. On the other treatments compost with endofitic microbe given 2 weeks after the application of *Ganoderma*. Applications *Ganoderma* done by direct contact *Ganoderma* on pieces of old rubber trees with palm roots. Inorganic fertilization is not done. Experiments carried out until the plants are 6 months old. The parameters measured were observations of N, P and K plant and crop growth. Data were analyzed using analysis of variance and Duncan test at 5%.

Results and Discussion

The results showed that the main effect of endophytic microbes do not affect the nutrient levels and plant growth but the effect becomes apparent if combined with other factors, especially the type of compost. Furthermore, it is known that the interaction of compost and types of endophytic and interaction compost and inoculation time endophytic affect the levels of N, P and K in plant and plant growth. The time difference inoculation and types of endophytic affect N plant and plant growth. While the effects of the interaction of three factors tested treatment does not affect the levels of N, P, K plants and plant growth (Table 1).

Table 1. Effect of organic fertilizer, the type and time of application of endophytic microbes on levels of N, P, K in plant, and the growth of palm seedling aged 6 months

treatment	N (% dry matter)	P- (% dry matter)	K- (% dry matter)	High Plant (cm)	Total midrib (g)	girth (mm)
K	ns	**	**	**	ns	**
W	ns	ns	ns	**	ns	**
E	ns	ns	ns	ns	ns	ns
KxE	*	**	**	**	ns	**
KxW	*	**	**	**	*	**
WxE	*	ns	ns	**	**	**
KxWxE	ns	ns	ns	ns	ns	ns

Note:
*:Significant, **: very significant, ns: not significant
K0: Without compost, K1: Compost empty fruit bunches, K2: Compost palm frond
W1: Introductions Ganoderma, 2 weeks after inoculation of endophytic microbes

W2: endophytic microbial inoculation, 2 weeks later introduction Ganoderma
E0: without microbial endophyte, E1: endophytic microbes type 1 (Trichoderma sp1
E2: endophytic microbes type 2 (Trichoderma sp2), E3: endophytic microbes (Aspergillus)

Differences in levels of N, P, K in plant and plant growth as the effect of the interaction between the factors of the type of compost and types of endophytic microbes can be seen in Table 2.

Table 2. Effect of organic fertilizers and types of endophytic microbes on levels of N, P, K in plant and plant growth

treatment		N canopy (%)	P-canopy (%)	K- canopy (%)	High Plant (cm)	Total midrib (g)	girth (mm)
Without compost	Without Endophytic	2.03 ab	0.165 b	1.113 de	53.80 b	9.50	67.67 b
	Trichoderma sp1	2.08 ab	0.187 ab	1.084 de	52.52 b	9.33	67.71 b
	Trichoderma sp2	1.95 ab	0.168 ab	1.277 cde	56.70ab	10.00	72.45 ab
	Aspergillus sp	2.08 ab	0.167 ab	1.045 e	56.35 ab	9.67	73.63 ab
compost Bunches	Without Endophytic	2.05 ab	0.194 ab	1.639abc	60.08 ab	9.50	76.41 a
	Trichoderma sp1	1.75 b	0.208 ab	2.018 a	58.28 ab	9.50	73.50 ab
	Trichoderma sp2	1.97 ab	0.195 ab	1.651 abc	60.63 ab	10.17	77.15 a
	Aspergillus sp	1.64 b	0.214 a	1.875 ab	60.87 ab	10.33	78.05 a
compost Midrib	Without Endophytic	2.26 a	0.176 ab	1.466 cde	59.52 ab	9.83	74.06 ab
	Trichoderma sp1	1.95 ab	0.191 ab	1.457 cde	61.52 a	9.83	74.57 ab
	Trichoderma sp2	2.16 a	0.173 ab	1.455 cde	63.47 a	10.17	75.75 a
	Aspergillus sp	1.77 b	0.185 ab	1.554 bc	53.80 b	9.83	72.54 ab

Description: The number in the same column followed by the same letter are not significantly different according to Duncan test at α 5%

Levels of N canopy tends to decline with endophytic enriched compost application. Instead endophyte-enriched compost application increases levels of P and K in plant. P in plant highest levels found in compost treatment combinations empty fruit bunches and endophytic types of *Aspergillus* sp. K in plant highest levels found in the combination treatment of empty fruit bunches compost enriched *Trichoderma* sp 2. Growth increased with the application of compost enriched microbial endophyte, and every kind of endophytic show the same effect. Decreasing levels of N headline on this study due to the limited availability of soil N that does not meet the needs of the plants while urea is not given. Besides compost is applied have C / N ratio is still somewhat high at 22.32 (empty fruit bunches compost) and 25.6 (compost midrib). Empty fruit bunches have a high fiber content which is difficult to decompose, which is approximately 45.95% cellulose; hemiselulose approximately 16.49% and approximately 22.84% lignin (Darmosarkoro and Winarna, 2003). That organic materials with C/N have the longer the effect in increasing soil fertility (Stevenson, 1984).

Better plant growth was reached by the application of compost and endophytic microbes. Compost adds nutrients to the plant and microbial endophyte, and endophytic microbes thought to increase plant resistance to pathogen attack. The importance of the role of organic materials reported Herliyana et al (2011) reported growth of plant seedlings at 8 MST sengon highest in the treatment of organic materials applications without Trichoderma and Trichoderma smallest value in the treatment without organic matter, plant showed signs of nutrient deficiencies, especially-nutrient-N-(Herliyana et al., 2011).

From this research it is known that compost enriched endophytic microbes potential to improve the nutritional status of low to medium P and K nutrient status increased up to a high level. The range of P and K nutrient status are said to be for oil crops respectively 0:17 to 0:18% and 1-1.3% (Dierolf, et al., 2001). There are differences in nutrient content of P and K on the used compost, compost ingredient in empty fruit bunches (1:16% P, 1.93% K) higher than compost palm fronds (0.30% P, 1:22% K).

Improvement of plant nutrient status P also maybe caused their role in helping microbes Endophytic increase the availability of P soil through dissolution mechanism. Elfiati, et al (2014) reported the SP-36 fertilizer dosage and application of phosphate solvent fungi Aspergillus and Penicillium promote growth and nutrient uptake P nursery of suren. P-dissolving mechanism by microbial soil phosphate

solvent through the production of organic acids that can chelated soil aluminum (Rashid, 2004) and the enzyme phosphatase (Fitriatin et al., 2008). Differences in levels of N, P, K canopy and plant growth as the effect of the interaction between the factors of the type of compost and microbial inoculation time can be seen in Table 3.

Table 3. Effect of endophytic microbes application time and the type of compost on levels of N, P, K in plant and plant growth

Treatment		N (% dry matter)	P- (% dry matter)	K- (% dry matter)	High Plant (cm)	Total midrib (g)	girth (mm)
Ganoderma	without compost	2.17 a	0.18 ab	1.12 d	51.33 b	9.33 b	65.73 a
then	compost tankos	1.82 b	0.20 a	1.82 a	59.18 a	10.00 a	76.83 b
Endophytic	compost midrib	2.07 ab	0.18 ab	1.57 ab	57.96 a	9.75 ab	74.03 b
Endofit	without compost	1.90 ab	0.16 b	1.14 c	58.35 a	9.92 ab	75.00 b
then	compost tankos	1.88 ab	0.20 a	1.77 ab	60.75 a	9.75 ab	75.72 b
Ganoderma	compost midrib	2.00 ab	0.19 ab	1.39 bc	63.00 a	10.08 a	74.43 b

Description: The figure in the same column followed by the same letter are not significantly different according to Duncan test at 5% α

Applications of both types of compost namely empty fruit bunches and palm midrib enriched endophytic microbes before introduction Ganoderma inoculation better effect than the enriched endophytic after the introduction of Ganoderma in increasing levels of P and K canopy and also the growth of plants, but not so against N canopy. Effect of compost is better than the empty fruit bunches of palm midrib compost. This difference is due to the compost bunches containing organic C, P and K were higher. The effect of Organic fertilizer on plant responses also determined to the incubation period and specified types organic fertilizer. In this study, organic fertilizer incubated 2 weeks. Riniarty (2013) Showed that the sugar agro waste (bagasse) effect on plant height is better than empty fruit Bunches Palm Oil (Tankos); waste Incubation period is 3 weeks performed better on the character of dry weight, ratio of crown root and seedling growth rate. Bagas incubated 3 weeks influential the best in plant height of oil palmseedlings in the main nursery. The role of compost in this case in addition to increasing the plant nutrients also creates physical and chemical conditions that foster endophytic microbes were inoculated first, especially before the introduction of *Ganoderma*. According Priyatmojo (2009), an increase in the population of endophytic fungi that act as biological control agents can be enhanced by the provision of fertilizer-derived-from-organic-materials.

Differences in levels of N, P, K in plant and plant growth as the effect of the interaction between factors endophytic microbes and time of inoculation can be seen in Table 4. Microbial endophytic *Trichoderma* sp2 and *Aspergillus* sp inoculated before the introduction of *Ganoderma* tend to reduce levels of N canopy, but microbial inoculation endophyte after introduction *Ganoderma* not affect N canopy. Inoculation of any kind endophytic microbes either before or after the introduction of *Ganoderma* same effect in improving the growth of plants.

Table 4. Effect of endophytic microbes and time inoculation on levels of N, P, K in plant and plant growth

treatment		N (% dry matter)	P- (% dry matter)	K- (% dry matter)	High Plant (cm)	Total midrib (g)	girth (mm)
Ganoderma	Without Endofit	2.29 a	0.17	1.437	51.33 b	9.33 b	72.96 ab
Then	Trichoderma sp1	2.12 abc	0.20	1.489	59.18 a	10.00 a	70.29 b
Endofit	Trichoderma sp2	1.85bcd	0.18	1.564	57.96 a	9.75 ab	74.41 ab
	Aspergillus sp	1.81 cd	0.19	1.535	58.35 a	9.92 ab	71.13 b
Endofit	Without Endofit	1.93abcd	0.18	1.375	60.75 a	9.75 ab	72.47b
Then	Trichoderma sp1	1.73 d	0.19	1.550	63.00 a	10.08 a	73.57 ab
Ganoderma	Trichoderma sp2	2.21 ab	0.17	1.358	51.33 b	9.33 b	75.83 ab
	Aspergillus sp	1.85bcd	0.19	1.447	59.18 a	10.00 a	78.35 a

Description: The number in the same column followed by the same letter are not significantly different according to Duncan test at 5% α

Based on the results of this study note that the inoculation of *Aspergillus* before the introduction of *Ganoderma* can improve plant growth. Meanwhile, if *Ganoderma* introduced first, then the inoculation of *Trichoderma* sp 2 gives a better effect. Based on in vitro test known endophytic fungus *Trichoderma*

sp1., Trichoderma sp 2, and *Aspergillus* sp. has a higher inhibitory against *Ganoderma* than *Fusarium* sp. and *Penicillium* sp. (Lisnawita, et al., 2014). *Trichoderma* are known to have antagonistic reaction with *Ganoderma* (Sariah, 2003). Potential antagonistic also determined the type of microbe. Based on the test antagonist in vitro as biological agents, *Trichoderma* T38 and T39 were able to inhibit the growth of *Ganoderma*. *Trichoderma* isolates T39 has the potential antagonistic stronger than *Trichoderma* T38 (Herliyana et al., 2011)

Conclusion

Empty fruit bunches and midrib compost enriched endophytic microbes increase the levels of P and K in plant and seed growth under prenursery seedling. An improvement of P levels of plants from low to medium and K nutrient levels of medium to high, while N levels was low. Applications of both types of compost namely empty fruit bunches and palm midrib enriched endophytic microbes wich applicated before introduction *Ganoderma* have better effect than the enriched endophytic wich applicated after the introduction of *Ganoderma* in increasing levels of P and K canopy and also the growth of plants. *Trichoderma* sp1, *Trichoderma* sp2 and *Aspergillus* inoculated either before or after the applicated of *Ganoderma* have same potential in improving the growth of plants. There was no interaction effect between compost, type and time of *endophytic* microbial inoculation.

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References

Dharmaputra, OS., Tjitrosomo, H.S., Abadi. A.L. (1989). Antagonistic Effect of Four Fungal Isolates to *Ganoderma boninense*, The Causal Agent of Basal Stem Rot of Oil Palm. *J. Biotrop,* 3: 41–49.

Darmosarkoro. W.E., Sutarta, S., Winarna. Eds . (2003). *Land and Fertilization Palm Oil : The use of TKS and TKS Compost to Improve Growth and Production Plant*. Oil Palm Research Center. Medan.

Dierolf, T., Fairhurst, T., Mutert, E. (2001). *Soil Fertility Kit: A Toolkit for Acid, Upland Soil Fertility Management in Southeast Asia-Handbook Series*. Oxford Graphic Printers. P 418.

Elfiati, D. , Hanum, H., Hotlan, R. (2014). Applications Solvents Phosphate and Fertilizer Mushroom P to Boost Growth Seeds Hara P and Suren (Toona suren) on Ultisol soil. In *Proceedings of the National Seminar on Environment*, 94-100. University of Northern Sumatra. Medan

Firmansyah , F.A. (2010) . Composting techniques . *Papers* in Training Smallholder Oil Palm in Sukamara , Centre Kalimantan.5 October 2010 .

Fitriatin, B.N., Joy,B., T.Subroto. T., (2008). The Influence of Organic Phophorus Substrate on Phosphatase Activity of Soil Microbes. *Paper* presented on International Seminar of Chemistry. Bandung 30-31 Oktober

Hanum, H. Lisnawita, Tantawi, A.R. (2014). The Soil Characteristis Under Palm Oil which Infected *Ganoderma*.. In *Proceeding of "The 3rd International Conference of Multidisciplinary Research,* 71-74 North Sumatra Islamic University. Medan.

Herliyana, EN , Taniwiryono , D. , Minarsih , H. , Firmansyah , MA , Dendang , B . (2011) . Attacks control of *Ganoderma spp* (60-80 %) in Crop Plants Sengon as Patron Coffee and Cocoa . *Journal of Agricultural Science Indonesia*, 16 (1) : 14-27

Lisnawita, Hanum, H. , Tantawi , A.R. (2014) . Test Against Antagonism of Endophytic Fungus Ganoderma spp . Stem Rot Disease Causes Base oil palm Plant . In Proceedings of the National Seminar on Plant Disease Control Sustainable Agriculture , 244-252 . Gajah Mada University . Yogyakarta.

Nur Ain Izzati MZ , Abdullah F. (2008) : Disease-infected Ganoderma suppression in oil palm seedlings treated with Trichoderma harzianum. *Plant Protec. Sci.* , 44 : 101-107.

Priyatmojo , A. (2009). Role of Fungi in Plant Pathology . *Papers* in position Inauguration Speech Professor of Plant Pathology at the Faculty of Agriculture , University of Gadjah Mada.2 July 2009 .

Rashid, M. (2004). Organic and Production and Solubilization by Phosphate Solubilizing Microorganism Under In Vitro Condition. Pakistan *Journal of Biological Sciences,* 7 (2):187-189.

Riniarty , D. , Kusumastuty , A. , Tahir , M . (2013). Effect of Agro Industrial Waste type Against Main Performance of Oil Seed Nursery on Ultisol. *Applied Agricultural Research Journal* , 13 (2) : 123-130.

Sariah M. (2003). The potential of biological management of basal stem rot of oil palm seedlings by calcium nitrate. *The Planter,* 73: 359–361

Singh G. (1990). *Ganoderma* - The scourge of oil palm in the coastal areas. In *Proceedings of the Ganoderma Workshop,* 11 September, (Arifin, D and Jalani, S, eds.). Palm Oil Research Institute of Malaysia, Kuala Lumpur. 7 – 35.

Stevenson, J. (1984). *Humus Chemistry; Genesis, Composition, Reactions*. Second Edition. John Willey and Sons, Inc New York.

Susanto , A. , Prasetyo , A.E. , Wening , S. (2013). The infection rate of Ganoderma to the four classes Soil Texture . *Journal of Phytopathology Indonesia* , 9 (2) : 39-46