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Hosting of Hendersonia against Ganoderma *(Ganoderma boniense)* disease in oil palm (*Elaeis guineensis* Jacq)

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Abstract
Ganoderma disease still become a big tricky of oil palm development in Indonesia. The problem occurs almost throughout the country from Sumatra to Papua, and it has been one of the foremost factors of decline the production of palm oil recently. As an interface between field and laboratory study, in this research we address to one research question, does *Hendersonia* work to control expansion of Ganoderma in established oil palm and seedlings that warrant a new approach in cultivating. We studied 16 plants represented of seedlings and matured in two different locations, PT. IKS at Petapahan Village, Riau Province, January to April, 2017 and PT. INEC at Air Molek, Riau Province also Januari to April 2017. We used sub-soil system for both matured and seedlings. After one year we took some parts of roots the plants as samples in laboratory. Results of the study shown, *Hendersonia* found and grow up appropriately both in roots of seedlings and fully grown plants. In established plants the Hendersonia found in 4-7 parts of roots or around 14%-28% and in seedlings the fungus found almost same, 6-7 parts or 24%-28%. Nevertheless, none of Hendersonia found in plants of control

Keywords: palm oil, Ganoderma, Hendersonia, GanoEF, reduce production

Introduction

There are two problems that are central of oil palm cultivation study recently, poverty of land and Ganoderma attacking. The poblems are cause of decline productivity of oil palm in Asian countries, particularly Indonesia and Malaysia that contributing 85-90% of world's palm oil (Indonesia-Investment, 2017., Susanto, 2011., Ishaq, 2014) [3, 39, 17]. Indonesian Assembly of Oil Palm Enterpreneurship *(Gabungan Pengusaha Kelapa Sawit Indonesia/* GAPKI) note that total production of Indonesian oil palm in 2016 is drop 3% than 2015, 31.5 million tons to 43.5 million tons. From that amount, *Crude Palm Oil* (CPO) is 31.5 million tons and Palm Kernel Oil (PKO) 3 million tons. The declinations were discounting of government plantation moratorium policies (Antaranews.com. 2017) [1], also of Ganoderma disease.

In Indonesia, Ganoderma has been a national tricky because of its economical and non economical disadvantages (Sawit Indonesia, 2014). It was influencing of community life, mostly those who rely of oil palm as a main income. Oil palm has a positive impact to economic income and life standart of all stakeholders who are getting involve in it (Suseno Budidarsono, *et al.* 2013, Ferdous Alam, *et al*. 2016) [10]. In this research we address to one research question, does *Hendersonia* work to control expansion of Ganoderma in established oil palm and seedlings that warrant a new approach in cultivating?

Ganoderma is Basal Stem Root (BSR) caused of *Ganoderma boninense* (Susanto, 2011, Susanto *et al*. 2013, Lisnawita *et al*. 2016) [39, 40, 20]. The disease has dispersed almost troughout Indonesian archipelago from Sumatra to Papua (Agus Susanto, 2011, Susanto, 2009) [39, 38]. Symptoms of the disease is signed by death and dry of oil palm and followed by termite occupation. Generally, the plants attacking by Ganoderma is in plain view, but commencement symptoms can not be detected (Naher *et al*. 2015) [26]. Leafs' color of the seeds change or dry and when it occurs half of the stem of oil palm has been eradicated by the Ganoderma. In initial plants, since the symptoms observed the plants will expire within seven to twelve months, and in established plants will expire in two years. When the canopy symptoms are shown, usually half of the tissue inside the stem has been death. The Other internal symptom is Basal Stem Root. In the putrid tissue, injury can see from brown area followed by dark area like ribbon's shadow generally termed resin reaction zone (Lisnawita *et al*. 2016., Semangun, 1990) [20, 31].

The wide of Indonesian oil palm is continuing growth. Directorate General of Plantation Ministry of Agriculture (2015) noted, wide estimation of Indonesian oil palm is 33.500.691 ha with the area that has been produced is 11.300.370 ha i.e. 7.139.060 ha in Sumatra, Jawa 33.578 ha, Kalimantan 3.639.737 ha, Sulawesi 370.675 ha, and Maluku Islands and Papua is 117.320 ha. The data show that Sumatra is a largest oil palm plantation area with total of production is 21.365.846 tons (Dirjen Kementan, 2015). However, Ganoderma disease is also list a highest and massive in the island.

In North Sumatra for example, potential lose of the disease is 70 plants of 130 per hectare. If one plant projected to Rp 2,6 million, total of lose would be Rp 182 million per hectare and the average of Ganoderma attacking is approach to 20% (Sawit Indonesia, 2014). The disadvantages will be even biger when accounted with losing of livestocks nourishments that is

integrated with oil palm (see: Hamdi Mayulu, *et al.*2013).
Meanwhile, nationally when the degree of Ganoderma attacking is 1%, the disadvantage would be more than two quitillion Rupiah per year. The degree of Ganoderma attacking would be even more than 2% especially in area that is replanting several times. An Estimation of Ganoderma disease in the area of replanting more than two generation is 60%-80% (Agus Susanto, 2011, Ishaq, 2014) [39, 17]. To keep optimalization produced of oil palm therefore, control Ganoderma is urgent programs to fix include using biofertilizer product of Gano EF Hendersonia.
GanoEF is one of biotechnological fertilizers product as well as biofungisides, a combination of endofitic Hendersonia that beneficial in soil fertile and prevent of Ganoderma attacking in oil palm (Seman, 2010) [32]. The oil palm that is threated of GanoEF Hendersonia is more fruitful and defence of Ganoderma attacking.
The roots infected of Ganoderma is not function optimally (Defitri, 2015) and in heavy aggressive with destroy over 30% will cause expire of the plants. Nevertheless, if early detection did, the plants with degree of contagion 0-10% or maximum 25% still can be safe (Ishaq, 2014) [17]. Threatment by GanoEF is not for qurative action, but more to prevent and upsurge immunity of the plants from Ganoderma attacking. To evade of Ganoderma aggressive, introduce fungus endofitic Hendersonia of GanoEF to the plants is needed since in the sapling phases. In this research, to prove endofitic fungus of Hendersonia effectively works, soil and substracts that is used as growing medium is really endemic of Ganoderma.
There are a lot of approachs to take control of Ganoderma recently but oftenly unefective (Izzati and Abdullah, 2008, Soepena *et al.* 2000) [18, 36]. While the disease is constantly growing and distribute debauched, thus research of efectivety of endofotic fungus of Hendersonia against Ganoderma *(Ganoderma boniense)* on oil palm *(Elaeis guineensis* Jacq*)* seeds and established plants in Air Molek, Riau, Sumtra is required.

Methodology
This research conducted in two difference locations. First, PT. IKS Riau Province, January to April 2017, especially to know colonization of Hendesonia in established plants (around 12 years old). Several activities did:

- Finding plants which positive infected of Ganoderma
- Finding potential plants that would be infected by Ganoderma (Figure 1)

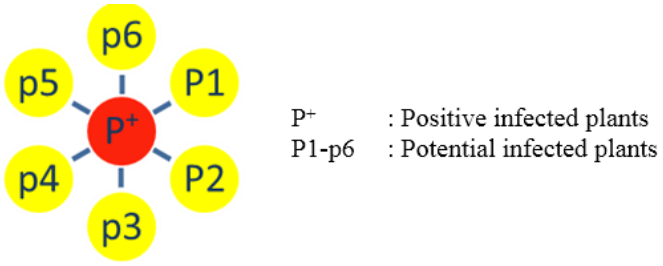

Fig 1: Illustration of plants growing as samples of the research

- Introducing of *Hendersonia* to the potential plants.
- Each of potential plant took 4 kg Herdesonia which is divided into four holesubsoil i.e 1 kg per hole. The

subsoilhole spread around the base plants that appropriate proportion of roots dispersal.

- Four mounth later, roots samples taken from potential plants to inspect in the laboratory. The procedure of captivating roots are make sure that all equipments are clean and steril, the roots samples should be primary roots with using glove, roots cut in 10-20 cm by scissors. Then the sample wash using the mineral water or steril aqua tobe clean. The clean and steril samples then put on plastics and branded based on the threatments. To keep fresh, the samples put into the ice termos.

Meanwhile, the second location was PT. INEC in Air Molek, Riau Province, January to April 2017. The research in the location is to know colonization of Hendersonia in sapling plants. There are 10 plants got the threatments of GanoEF Hendersonia. Fixing hole was made and put on 750 gr per plant of Hendersonia before establishing. When the plants are 12 months old, its roots was taken as samples in laboratory. The procedures of taking the root was identical to thing had done in the first location.

In laboratory, the sampels were chequered by the following steps: 1) roots surface were sterilized by chlorox 10% in 1 minute 30 seconds, 2) the roots were sterilized again with etanol 70% in 1 menute 30 second, 3) then the samples cleaned in sterilized tray using destilation water, 4) the spotless roots separated in small size and place on the minor sterilized glass tray or weight plastic plate, 5) the root split again in each of plate using sterilize blade or scissors, 6) perform the small splited roots, 7) positioned the roots on the Rose Bengal Chloramphenicol Agar (RBCA) as much as 5 roots per tray, 8) and let it inside within three days, then accounted percentage of colonization.

Analyse Data

The data that was analysed is pure the results of laboratory's observation particularly about found or not Hendersonia colonization in the small split roots. High form of Hendersonia colonization percentage is displaying that the plants have strong defence against Ganoderma. The data would be presented in tables after accounted by the following formulation (adapted from Campbell & Madden, 1990) [12]:

$$\text{Percentage of colonization} = \frac{\text{Amount of fungus in targeted roots}}{\text{Entire amount of small split roots}} \text{x}100\%$$

Results

After doing inspection to seven samples of established plant's root from reseach location 1 and 10 samples from the location 2, obtained results in Table 1and Figure 2-4. In established plants amount of roots parts found growing of colonization of Hendesoni around 4-7 parts or 14%- 28% from total of 25 splits roots which is observed in each sample. While in seedlings, colonization of Hendersonia relatively poises about 6-7 parts or 24% - 28%. Colonization of Hendersonia in control is not found at all (control/Figure 4.C). Except of variety in percentages, pattern growing of Hedersonia in seedlings are relatively more solidity (Figure 4A /4B) than in established plants that is only well developed in some parts of the roots (Figure 2 dan 3).

Table 1: Percentage colonization of *Hendersonia* in roots of oil palm plants in PT IKS, PT. INEC S: 2/5, dan PT. INEC MO 2, 5, 8

Sample	No. of root Sections	No of roots colonized by Hendersonia sp.	Hendersonia sp. Root Colonization (%)
PT IKS 5:1	25	5	20.0
PT IKS 5:3	25	6	24.0
PT IKS 5:5	25	6	24.0
PT IKS S2	25	7	28.0
PT IKS S4	25	4	16.0
PT IKS S6	25	6	24.0
PT INEC S: 2/5	25	6	24.0
PT INEC MO 2,5,8	25	7	28.0
PT IKS Control	25	0	0.0

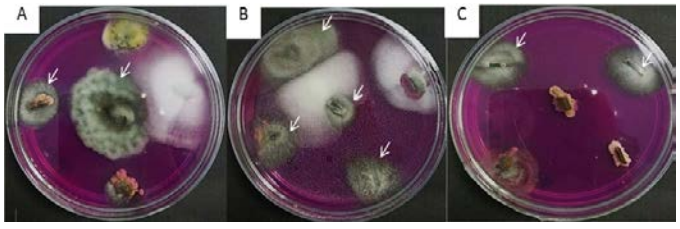

Fig 2: Grey to black Hendersonia colonies growing from surface sterilized root samples from A. PT IKS 5:1; B. PT IKS 5:3; C. PT IKS 5:5

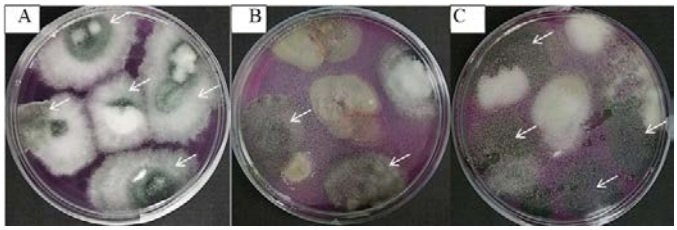

Fig 3: Grey to black Hendersonia colonies growing from surface sterilized root samples from A. PT IKS S2; B. PT IKS S4; C. PT IKS S6

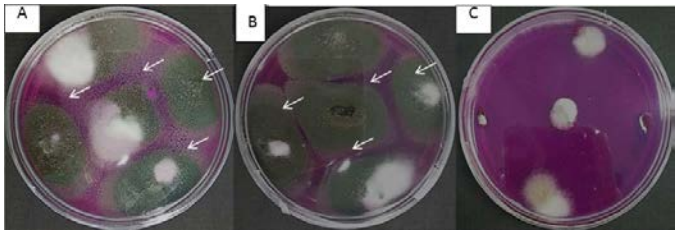

Fig 4: Grey to black Hendersonia colonies growing from surface sterilized root samples from A. PT INEC S:2/5 and B. PT INEC NO 2,5,8. No grey to black Hendersonia colonies growing from surface sterilized root sample from C. PT IKS Control.

Discussion

Among fungus that can be triggered of Basal Stem Root (BSR) by *Ganoderma spp* is *Ganoderma boninense*. Generally the fungus bouts any kinds of palm, forestry plants, dan fruit plants (Kandana *et al*. 2008) [23]. One of palms that massively bouted is oil palm. That is a reason Ganoderma is continuing studied and did the action of controlling its dispersals.

A lot of strategies to control of BSR disease comprises using fungicides (Soepena *et al*. 2000) [36], conventional practices such as sanitation repairing, and through and burn the infection plants (Sahebi *et al*. 2015) [30]. However, the methods can not permanently use because of environmentally reasons and less effective, infact those are very high costs (Breton *et al*. 2006) [11]. Using chemical *carboxin* and quintozene effectively reducing the *Ganoderma boninense* (George *et al*.1996) [16], but the actions can not aplicate since the same chemical things also murder the valuable microba in the soil, so deemed destroy environments (Sahebi *et al*. 2015) [30]. Therefore using other alternative such as resistant pathogens and control biological agents include anthagonism species, *Aspergillus spp.*, *Trichoderma spp.*, *Penicillum spp* against Ganoderma (Badalyan *et al*. 2004) [9], as well as *Hendersonia* in this research.

Results of this research shows that *Herdersonia* also effective to control expansion of Ganoderma, both in established plants or seedlings (Tabel 1 dan Figure 2-3). All the plants that are threaten by Hendersonia GanoEF shows that there is colonization and grow of *Hendersonia*, while in control plants are nothing. When the environmental is appropriate, the Hendersonia that has been colonized in the roots will be remaining and grow and develop until the plants established. The oil palms that mutually symbiosis with Hendersonia would conceivably evade of Ganoderma disease. Colonization of Hendersonia in oil palm would give positive impact on growing and development of the plants. In long term, the oil palm will evade of Ganoderma so that productivity stage of the plants would be longer than those in control.

Generally, results of the research shows that there are 4-7 parts of split roots colonized by *Hendersonia* or 16% - 28%. While in control colonization of *Hendersonia* is nothing. Growing speed of Hendersonia is not presented in this research because the samples were observed only once time i.e after three days the specimens in Rose Bengal Chloramphenicol Agar (RBCA). Phim-Phin Chong *et al* (2016) [24] reported that several biological control agents have been used to control G. boninense, *Penicillium simplicissimum*, *Trichoderma harzianum*, *Aspergillus spp.*, *Streptomyces sundarbansensis*, *Streptomyces spp.*, and *Pseudomonas aeruginos*. Alexander & Chong (2014) [6] combining numerous biological control agents from microbiology product to control expansion of G. boninense either in seedlings or established oil palm in fixing area. The three products are combination of *Bacillus spp* and *Trichoderma spp*; combination of *Bacillus spp.*, *Pseudomonas spp* and *Aspergillus sp.*, and the combination of *Lactobacillus*, *Nattobacillus* and *Saccharomyces cerevisiae*. Those microorganism combinations are accomplishment reducing expansion of G.boninense sapling and nursering of oil palm compered with the control. Futhermore, combination of *Bacillus spp*. and *Trichoderma spp* noted as the most effective both in sapling/ nursering and established plants. However, either Alexander & Chong (2014) [6] or Khim-Phin Chong *et al* (2016) [24] were not used biological control agents of *Hendersonia* in their research. Infact, the *Hendersonia* is one of atagonise funguses that is also effective in prevent the speed of infection by the Ganoderma. Results of this research show that *Herdersonia* is well growing on both seedling/ sapling or in established plants.

Hendesonia have excesses compared with other biological control agents as: 1) an endofitic antagonist fungus against G. boninense in oil palm that is live and development in the roots, 2) found from nursemaid plants of oil palm, thus less negative impact if it is used to control G. boninense in oil palm plants, 3) and Hendersonia has no spores that potentially infect to other plants surround.

Ganoderma is a facultative parasite that is live as saprofite in roots' growing spot when nursemaid is appropriate such as oil palm, the fungus will colonize into the nursemaid and life as a parasite (Sanderson *et al*., 2005; Paterson, 2007) [29, 27]. The Ganoderma is also can life in died fall oil palm with remains the root in the soil, then infect other plants by roots contact or spore and causing diseases (Paterson 2007) [20, 27]. Environmental condition is one of the significant factors that influence distribution of the disease (Naher *et al*. 2013) [25]. The Ganoderma can be infected oil palm from any stage, either seedlings or even established plants. Symptom of the disease is slow develope but usually the infected plants end with died. The disease develop from roots of the plants but appear symptom of Basal Stem Roots in seedlings, whereas on side of the plants is yellow color or leafs withered then dry (Kandan *et al*., 2010) [22]. The roots of infected plants dishevelled and the tissue inside become very dry and brittle. Since the symptoms rise, the seedling will die in 6-24 months and in established plants will die in 2-3 years (Arrifin *et al*., 2000) [8].

Conclusion

Efforts to solve Ganoderma disease is not completely success yet. Therefore, numerous research especially using biological control agents against the disease continuingly have done include using fungus of Hendersonia. The endofitic fungus of Hendersonia shows can colonize and well develop in the roots and if the environmental is appropriate, it can be life until the oil palms growing into established plants. Hendersonia can be well colonized in both seedlings and established plants. Occupation of Hendersonia in the roots of oil palm might be

able the plants allowed from Ganoderma attacking until the production stage is longer. Application of Hendersonia can be done in sub-soil system either for seedling or established plants.

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