

# TESTING THE EFFECTS OF OIL PALM REPLANTING PRACTICES (WINDROWING, FALLOWING AND POISONING) ON INCIDENCE OF GANODERMA

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**ABSTRACT:** A field *Ganoderma* trial was set up in 2001 on an oil palm field in Dolok Estate (Sei Bejangkar Division) PT. PP. London Sumatra Indonesia Tbk (Lonsum). The North Sumatra site had very serious *Ganoderma* incidence previously with a mean of 52% of vacant trees (assumed due to *Ganoderma*) plus a mean of 6% *Ganoderma* infection symptoms in standing trees. The trial investigated the effect of windrowing, fallowing and poisoning practices conducted at replanting on subsequent infection by *Ganoderma* in the replanted oil palms.

Percentage *Ganoderma* infection was assessed on 50 palm/plots with 4 replicates per treatment and using a split plot design with 2 main plots and four sub plots. The main plot compares windrow 1:1 (every previous row) and windrow 2:1 (alternate previous planting row / current system) and sub plots consisted of factorial combinations between fallowing and poisoning.

Seven years of observation showed that the infection in windrow 1:1 without additional treatments (no poisoning and immediate planting) resulted in up to 41% infection while windrow 1:1 with no poisoning and fallowing for 1 year resulted in infection of ca. 10%. Where palms were planted immediately on the windrow 1:1 system with poisoning, 28.5% palms were infected. The windrow 2:1 system is the usual estate practice on Lonsum estates. Treatment of windrow 2:1 without any treatments added (unpoisoned-immediate planting) showed infection ca. 28% at the end of 2009 compared to 32% infection in the treatment of windrow 2:1 system (combined with poisoning and immediate planting). In contrast where treatment windrow 2:1 was combined with poisoning and fallowing for a year, only 3% infection was observed and infection in the treatment of fallowing without poisoning plus windrow 2:1 system also remained low (6%).

**KEYWORDS:** *Ganoderma*; Poisoning, Windrowing, Fallowing

## 1. INTRODUCTION

Most severe losses of oil palm from *Ganoderma* infection occur in Indonesia and Malaysia with lower incidences recorded in Africa, Papua New Guinea and Thailand (Idris *et al.*, 2004). The disease (caused by *Ganoderma* sp) has long been known in Malaysian coastal areas, but levels of disease incidence of 30% on 13-year-old palms have been reported in both inland and peat soils (Rao *et al.*, 2003). High incidences of *Ganoderma* infection has also been reported from Indonesian oil palm plantations. In Lonsum estates in North Sumatra, where most oil palm plantings have been planted after rubber, palm losses due to *Ganoderma* disease begin to occur after about twelve years and start to reduce yields when the palms are about 18 years old. Any

reduction in stand density below 110 palms per hectare will start to have an effect on yield. At about 25 years after planting, typically 50% of palms will have been lost (mostly due to *Ganoderma*) forcing early replanting (Foster, pers comm. in Flood, Hasan and Foster, 2002).

When oil palm is replanted as second generation in Lonsum estates, the old palms are pushed over and the boles lifted out of the ground. The trunks and boles are then pushed into windrows and the new seedlings planted between them. Very occasionally, *Ganoderma* infects a seedling planted too close to a windrow in the first few years, but otherwise up to 15 years, there is no evidence from Lonsum estates that *Ganoderma* infection is worse in fields planted after oil palm compared with rubber provided that the boles are not left in the ground. However, if boles are left in the ground, up to 25% of the new planting may become infected within 6 years. Reports from other plantations in North Sumatra have indicated greater palm losses in replants compared to the first generation planting but in these cases it is not clear whether or not the boles of the previous planting were left in the ground (Flood, Hasan and Foster, 2002).

The latest *Ganoderma* census was conducted in Bah Lias (one of Lonsum's estates) using the novel approach of GPS (Global Positioning System) to observe the incidence of trees infected by *Ganoderma* and assess numbers of vacant points; *Ganoderma* infection was assumed to be the primary factor in >90% of the incidence of missing palms. In oil palm fields (1 - 4 year old), *Ganoderma* incidence was recorded as 0 to 0.1% while in 5 - 14 year old oil palms, infection was 0.1 to 20.4% and the highest incidence of infection was in older palms (more than 15 years old) where an incidence of 4.5 up to 69.8% infection was recorded.

One strategy aimed at minimizing the effect of *Ganoderma* involves the application of good sanitation practices at replanting. Poisoning is commonly employed by Lonsum and other plantation companies throughout North Sumatra. The old palms are injected with chemicals to increase that rate of decay and aid felling. After the felling process is conducted, then the boles from all palms (whether infected or symptomless) are dug out, and the boles and trunk materials are windrowed.

Windrowing is a replanting technique based on the same principles as clean clearing. It involves removal of all primary sources of inoculums from the soil by digging out the bole and as much of the root system as possible. Palms are then planted in inter-rows at a recommended distance of at least 3 meters from windrow material (Flood, Keenan, Wayne, and Hasan, 2005; Lonsum, 2009).

After windrowing has been conducted, further preparation of the ground continues e.g. digging the new planting holes to receive the replants and ploughing can also be conducted.

In Lonsum estates, these activities take around 2 - 3 months to complete so there is a short fallow period (between the time of felling and bole removal and the replanting of the new generation). However, even relatively small pieces of infected material can act as inoculums for young palms. Infected wood (6x3x3cm) induced infection in the nursery at Sumatra Bioscience (SumBio) and even smaller pieces of infected rubber wood and oil palm wood (3x3x3cm) induced symptoms in young seedling palms under glasshouse conditions in the UK although in the latter case, the wood was attached to single roots (Rees, 2006; Rees, *et al.*, 2007 and Rees *et al.*, 2009). Consequently, removal of all infected debris from the planting holes is very difficult at an estate practice level so

additional treatments such as use of a longer fallow period was investigated. *Ganoderma* is not a good competitor in soil as thus, exposure to competitive microorganisms in the soil, in the absence of its host, could further reduce the inoculum level. ).

This paper reports the results of one field trial which has examined the effects of various replanting practices on *Ganoderma* incidence following replanting. The site chosen had had very serious *Ganoderma* incidence previously with a mean of 52% of vacant trees (assuming due to *Ganoderma* infection) plus a mean of 6% *Ganoderma* infection in standing trees. The specific objectives were to investigate the effect of windrowing, fallowing and poisoning practices conducted at replanting on subsequent infection by *Ganoderma* in the replanted oil palms.

## **2. MATERIAL AND METHODS**

Experiments were planted on (Field Number 00400, Ex-OP 72400) Dolok Estate (Sei Bejangkar Division) of London Sumatra in North Sumatra (99<sup>0</sup> East Longitude and 3<sup>0</sup> North Latitude).

Percentage *Ganoderma* infection was assessed on 50 palm/plots with 4 replicates per treatment and using a split plot design with 2 main plots and four sub plots. The main plot compares windrow 1:1 (every previous row) and windrow 2:1 (alternate previous planting row / current system) and sub plots consist of factorial combinations between fallowing (fallow for one year and immediately planting) and +/- poisoning.

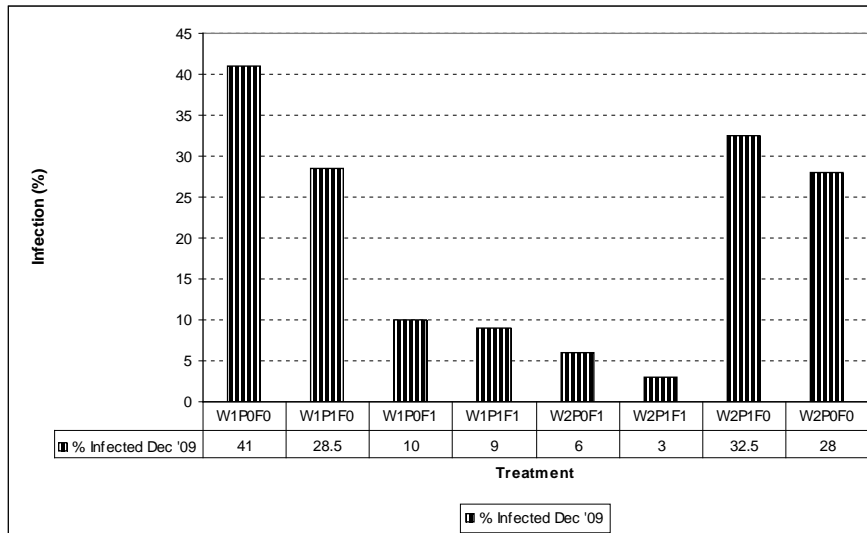
Observations of *Ganoderma* infection were conducted every 3 months for all palms in each plot. Palms were considered to be infected by *Ganoderma* i.e. having Basal Stem Rot (BSR) when basidiocarps (fruiting bodies) of the pathogen were found in the lower part of the trunk.

## **3. RESULTS**

### **1.1 Percentage of Infection**

The trial was initiated in January 2001. The results (Figure 1) show that infection in replanting system windrow 1:1 without additional treatments (no poisoning and immediate planting) resulted in up to 41% (last observation in December 2009). Windrow 1:1 with no poisoning and fallowing for 1 year resulted in infection of about 10%. 28.5% of palms become infected when palms were planted immediately on windrow 1:1 system with poisoning. Lower percentage infection was found in the application of windrow 1:1 combined with other treatments (poisoned and one year fallow) with only 9% of seedlings which was infected by *Ganoderma*.

Results from the windrow 2:1 system without any treatment added (unpoisoned-immediate planting) showed BSR infection around 28% to the end of 2009. In the treatment of windrow 2:1 system (combined with poisoning and immediate planting), the infection was 32.5% to the end of 2009.



**Figure 1:** Percentage of Infected Seedlings in each treatment

In contrast, in the treatment of windrow 2:1 combined with poisoning and fallowing for a year, very little infection has been found to date (3%) and the treatment of fallowing without poisoning on this windrow system also resulted in very low infection (up to the end of 2009). Only 6% infection was observed in this treatment (Figure 1).

In order to further investigate the effects of poisoning, windrowing and fallowing, a split-plot statistical analysis using *Genstat* was conducted with an arcsin transformation of the proportion infected. Significance is taken here at the 5% level.

### 1.2 Effects of poisoning in replanting system

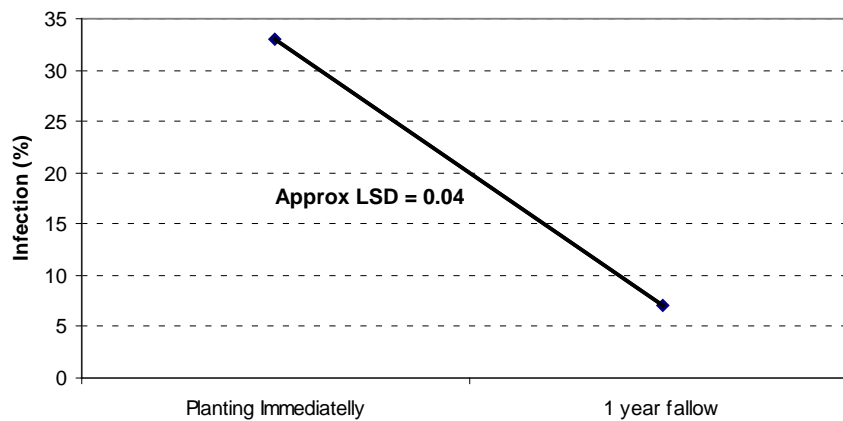
Statistical analysis revealed no significant effects amongst treatment (poisoned or unpoisoned) to the *Ganoderma* incidence with  $p$ -value = 0.134. It seems that the biggest advantage of poisoning palms at replanting is to encourage faster degradation of the trunks so making felling easier; there is no significant effect on *Ganoderma* incidence in the next generation.

### 1.3 Effects of windrowing in replanting system

Windrowing 1:1 (every previous row) and windrow 2:2 (alternate previous planting row / current system) was compared in this trial. Statistical analysis showed there was no significant effect of windrow system on *Ganoderma* incidence in the next generation  $p$ -value = 0.106 for effect of windrow 1:1 and windrow 2:1 on *Ganoderma* incidence.

### 1.4 Effects of fallowing in replanting system

The effects of fallowing were also statistically analyzed and analysis revealed that fallowing in replanting systems had significant effect on later disease incidence  $p$ -value < 0.001. There was a significant reduction in infection after fallowing in both windrow systems as compared to immediate planting. Fallowing in windrow 2:1 system resulted in very little disease (3%) even after 9 years while fallow in windrow 1:1 resulted 9% *Ganoderma* infection.



**Figure 2:** Effects of fallowing in replanting systems

#### 4. DISCUSSION

*Ganoderma* diseases of oil palm e.g. BSR are one of the biggest constraints to oil palm production in SE Asia (Flood, *et al.*, 2000) and sustainable management practices are essential. These practices could include breeding for tolerance/ resistance to the pathogen as well as improving cultural practices at replanting.

The long term field trial on oil palm replanting systems (testing windrowing, fallowing, and poisoning practices) reported here has been observed for 7 years and is a contribution to our knowledge on improving cultural practices at replanting. The results show that there is no significant effect of windrowing system on *Ganoderma* incidence. Also, poisoning palms as part of the procedures of replanting, has no significant effect on *Ganoderma* incidence (compared with the non poisoned treatment). Poisoning speeds up trunk decay so aids felling but has no significant effect on the disease. However, fallowing for one year has had a significant effect on *Ganoderma* incidence in the next generation - only 3% *Ganoderma* infection in the windrow 2:1 system and 9% infection in windrow 1:1 after 7 years.

The reason for this reduction in levels of infection is likely linked to reduced soil inoculums at the time of replanting. Other field trials conducted at SumBio which have investigated delayed planting of palms close to large sources of inoculums concur with the result presented here; delayed planting reduces incidence of disease.

Under normal estate practice in Lonsum, at replanting, (second generation oil palms) the old palms are pushed over and the boles lifted out of the ground. The trunks and boles are then pushed into windrows and the new seedlings planted between them. If inadequate sanitation is conducted e.g. where boles were not removed properly in the field, seedling palms can be exposed to large amounts of infected debris close to their planting points (Flood *et al.*, 2000) and will rapidly develop characteristic symptoms. However, even when boles are removed properly, it is very difficult to ensure all fragments of infected debris are removed. There will remain a considerable amount of root debris and this debris is capable of being a significant inoculums for seedlings (Hasan & Turner , 1998; Flood *et al.*, 2000). The root system of a mature individual oil

palm is considered to spread over 16m<sup>3</sup> of soil (Darmono, 2000) so a large amount of root material is available for colonisation by the pathogen. Also, material accumulates in soil from self pruning (Jourdan & Rey, 1996) and large numbers of fine quaternary roots are present in the upper layers of the soil. The source of this inoculum in roots could be due to contact with other infected palm roots or from spore colonization as postulated by Flood *et al.*, 2002. Even small quantities or small pieces of debris remaining in the field pose a threat to young replants. Ariffin *et al* (1995) showed that artificial inoculum only slightly bigger than an average oil palm root could cause infection of seedling oil palms while Singh (1991) traced and demonstrated infection of some palms had been initiated from small bundles of diseased roots from a former stand of oil palm. More recently, Rees (2006) demonstrated that small fragments (3x3x3cm) of infected oil palm and rubber wood was sufficient to induce symptoms in young palms under glasshouse conditions. It would be unrealistic to expect that in the field, all such debris could be removed.

However, *G. boninense* is a poor competitor in non-sterile soil or organic debris (Rees *et al.*, 2007) so it is likely that any *Ganoderma* inoculum remaining in the field in the absence of its host but in the presence of antagonistic soil microorganisms, would be reduced. A fallow period provides this opportunity for natural antagonistic micro-organisms to destroy *Ganoderma* inoculum more thoroughly than trying to remove all the infected debris and this is the likely reason for the observed effect of fallow. Nevertheless Khalid *et al.*, 2000 reported that most oil palm residues can naturally decompose in 18 months but roots can take up to 25 months to decay so even after 1 year not all the infected debris will have decayed but the inoculum will be substantially reduced.

These studies are continuing to examine different length of fallow and the potential to use other crops during the fallowing period to reduce the economic impact of delayed planting.

## 5. ACKNOWLEDGEMENTS

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