The impact of white grub infestation on *sengon* plantation and traditional control by local communities

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Abstract. White grub causes severe crop failure in some *sengon* plantation areas. However, study regarding this pest on *sengon* plantations is still limited. Therefore, a survey to observe cultivation practice by local farmers in controlling white grub has been carried out in the *sengon* plantation area. An interview regarding the impact of white grub infestation and its traditional control methods was also carried out with the forest farmers group and the management officer of Perum Perhutani, State-Owned Forest Corporation, to observe the farmer’s knowledge regarding white grubs and their impact on the plantation. In addition, we also carried out sampling to observe the white grub population. The result showed that the average white grub population in the soil was extremely high. The average population was at 20.9 individuals plot⁻¹ (13.6 larvae m⁻²) and dominated by 6-8 cm in length larvae. Therefore, planting failure is expected due to its attack. The local farmer controls by applying marang, a rice bowl made of plastic with a small hole on all sides when planting the tree, and collecting white grub larvae during soil tillage, using light trapping. Application of marang was considered to effectively increase the success in planting activity by about 80-90%.

1. Introduction

Java Island is the center for *sengon* (*Falcataria moluccana* (Miq.) Barneby & J. W. Grimes) wood production in Indonesia. More than 90% of this wood production is produced from this island. Likewise, 54.8% of the wood commodity in Java is dominated by this tree species [1]. Moreover, its high productivity with short rotation [2] makes the tree an important commodity in demand to support various wood processing industries. Unfortunately, however, the plantations are facing problems of pest and disease attacks. Some of the important pests are the stem borers of the longhorn beetle (*Xystrocera festiva*) and the bagworm (*Pteroma plagiophleps*), which attack plants sporadically and periodically every year. Besides that, incidentally, it is sometimes attacked by the caterpillar pest *Eurema* sp. [3].

The plants are generally grown by communities and corporate companies in a monoculture or mixed plantation. Other than the pests mentioned above, we found white grub attack, larvae of the Scarabaeidae beetle, causing serious consequences in some areas. Our experience shows that white grub infestation in some areas causes the failure of young plants. White grub has previously been a problem in crops, especially sugarcane in various regions [4]. The report of white grub attacks on this tree species is not as new as previously reported [5]. However, it is still a serious problem that shows...
that the current control efforts still need to be improved. In this study, we provide an overview of population status and the impact of its attacks on sengon plants and expose traditional control efforts carried out by local communities in East Java.

2. Materials and Methods

2.1. Site description
White grub is collected from a forest area managed by Perum Perhutani, precisely in plot area 4A at Pandantoyo Forest Resort Area (first-line management unit), Pare, Kediri, East Java (Figure 1). This location is at an altitude of 400 m above sea level, with a land typology dominated by sand fractions, the influence of active volcanic activity. The soil characteristics in this location are described in the previous study [6]. This forest area is managed through the cooperation of the local community, with the main crops being sengon, 2 x 2 m spacing and pineapple intercropping, and a small portion of chili plants. At the time of observation, the sengon plantation was four months old.

![Figure 1. Study site.](image)

2.2. Grub collection and identification
We determined 24 plot points to observe the white grub population in the soil. The plots are 80 cm x 2 m in size with a soil depth of 50 cm, which is randomly scattered over a five-hectare plot. We collected the white grub and measured its length dorsally from the top of the head to the tip of the abdomen. A total of 5 individuals were reared in the laboratory using soil media taken from the location. The larvae are put into the soil in a box measuring 20 x 20 x 25 cm and given food in the form of sweet potatoes. The adult insects that emerged after two months were then identified morphologically. The distribution of larvae population was then analyzed using the standardized Morisita dispersion index method at alpha 2.5%.

2.3. Depth interview
We conducted interviews with members and administrators of forest farmer groups and management officers of Perum Perhutani. We focused on information about their perceptions of white grub, particularly their impact and control experiences.

3. Results and Discussion

3.1. Result
A total of 497 larvae of various sizes were collected. Larvae measuring 10-100 mm were dominated by larvae measuring 6-8 cm as many as 294 (59.2%) (Figure 2). Larvae are found at depths ranging from 3 cm to 45 cm in soil depth. During sampling, we found neither pupa nor imago. Several samples of larvae were cultured in the laboratory and developed into Lepidiota stigma.
The number of white grub populations in the field varies. The number of individuals ranges from 2 to 64 larvae per plot, with an average of 20.9 larvae plot$^{-1}$ (13.1 larvae m$^{-2}$). The analysis results show that the distribution of the larvae population is in groups with a standard Morisita index value of 0.529.

![Figure 2. Population structure of white grub collected from the soil.](image)

White grub feeds on small roots, especially root fibers, and generally leaves the main roots that are larger. In some cases, it feeds on the softer main root skin to the root neck. The observed symptoms are that the plant canopy was turning yellow, wilted, and even dry—the symptoms of wilting such as lack of water. However, watering or rainfall cannot restore plant vigor. The severity of the attack causes the plant to die. Thus, the dead plants must be replanted. This, of course, causes forest managers and farmers to pay higher production costs for planting plants in the field.

Our findings in the field show that white grub does not only attack young plantations. It also attacks plants that are older than three years old. Not only the larvae but adult beetles also damage the leaves and stems of plants.

Local people control white grub in various ways. The most common effort is to dismantle plants that are showing symptoms. Plants are uprooted, roots are removed, and soil is excavated. The larvae found are then collected and destroyed. Local people also use chemical insecticides which are applied to the soil. In addition, they use systemic insecticides and are in contact with the active ingredient carbofuran. However, this method is considered ineffective in controlling attacks. In addition, this method is also inefficient because it requires high costs.

Local people traditionally use a rice container called marang to prevent white grub attacks. Marang is a rice bowl made of plastic with mesh on all sides, in the form of a tube with a diameter of ± 20 cm and a height of ± 15 cm. This tool is quite effective in protecting the roots of sengon plants. The bowl is inserted into the planting hole, and the plant seeds are placed in it and then filled with soil. Based on observations and interviews, it can increase the survival rate by 80-90%. Meanwhile, conventional cultivation without it causes crop failure. Meanwhile, the price of a marang is IDR 500 piece$^{-1}$, so that the additional cost needed to control the white grub is IDR 1,250,000 ha$^{-1}$. The ways of control efforts of white grub attacks are described in Table 1.
Table 1. The ways of controlling white grub by local communities.

| Control method       | Description                                                                 |
|----------------------|-----------------------------------------------------------------------------|
| Chemical insecticide | The granule form is applied to the soil before planting, and the active ingredient carbofuran is applied two times the recommended dose |
| Marang               | Plastic bowl with perforated sides (netting), applied once at planting as a container or root protector for each plant in the soil |
| Soil tillage         | Plowing the land deeper into the soil reaches 50 cm before planting          |
| White grub collection| Collecting white grub larvae from around the roots of plants is done incidentally when a plant is attacked and during tillage |
| Beetles collection   | Performed when adult beetles approach the illuminated lights around the settlement during the adult emergence period, usually starting in September |

Another approach taken by the community is soil tillage. Usually, they cultivate the soil to a depth of 15-20 cm. As a result of the attack, the community tilled the land more deeply. The community cultivates the land to a depth of 20-30 cm. In cases where larvae and white grub eggs were found, the tillage was carried out deeper up to 50 cm.

In the fourth quarter of every year, generally adult insects, which are beetles, emerge from the ground. At this time, the community collected adult beetles that came to light sources in lighting lamps around the settlement. The collected adult insects are then destroyed. Some of them are used as poultry feed. However, the collection of adult insects is only spontaneously. The people never install lights as beetle traps.

3.2. Discussion

In a previous study, the body size of the white grub larva reaches 75 mm [4]. The body size of larvae found in the field can reach 10 cm. This difference may be due to a more suitable diet and habitat so that the larvae grow larger. Food factors can affect the growth of white grub larvae [8, 9]. Most of the larvae found were late instars. The population of white grub in some plots is relatively low, but it is quite high in other plots. This is in accordance with the previous research [9] that the distribution of the white grub population is clustered.

White grub attack caused loss of fiber and root bark and led the plants to fail to translocate nutrients [10]. Late instar larvae are the most destructive phase to plants which takes place in January-April [11]. In the next period, the larvae go into pupation and, in the end, adult emergence. Based on interviews with informants, the emergence of adult beetles began in September. At this time, the site is in the early period of the rainy season. The emergence of adult beetles which usually coincide with the arrival time of the rainy season at the end of the year, was also reported by other research [12].

The high population of white grub was also reported in sugarcane plants in Situbondo, East Java [13]. However, the high population in sengon stands is caused by several reasons. One of the findings is that the soil at the study site is mostly sandy soils, and this type of soil is favored by white grub. White grub likes light, sandy soils, rarely on heavy soils [15, 16]. This is because this soil type is generally easier for larvae to move in search of food and provides a suitable environment, such as soil moisture [9]. Hard soil harbored fewer larvae, while the light soil supported more larvae of white grub [16].

The high population is also influenced by the association of plants with pineapple intercropping. Pineapple plants are noted to be vulnerable to white grub attacks in various regions. There are at least a dozen species of white grub associated with pineapple plants [18-20]. This plant is characterized by
fibrous roots with soft roots and stems, so it is favored by larvae. In addition, dense planting makes it easier for larvae to move from one plant root to another to find food.

Local people also use organic fertilizers to increase the productivity of pineapple plants such as molasses, chicken and cow dung. The use of manure as a complementary fertilizer can increase the population in the field [20]. Manure that has not completely decomposed as indicated by high C/N ratio had higher attractiveness to white grub for oviposition [16].

Although it has a weakness in the aspect of plastic material that is difficult to degrade, the use of marang is considered an effective and efficient way. The additional costs required for this application are still considered rational. In several cases, we found a white grub inside it. This is due to two reasons. The upper surface of the marang is buried with soil and becomes the entryway for white grub to come into the attack. In addition, smaller white grub larvae come into the hole on the sides.

Pre-planting tillage is also an effective way because deeper tillage will decrease the risk of attack. Sun-exposed will also kill white grub. In addition, exposed larvae are also vulnerable to attack by predatory organisms such as ants. However, the effectiveness of tillage in controlling white grub is influenced by other factors such as the tillage period, larval development, the population and distribution of larvae in the soil [21].

White grub not only attacks crops but also attacks surrounding plants, including woody perennial plants. White grub in pineapples also attacks surrounding plants, including sengon. In Indonesia, several other white grub species such as Euchlora viridis, Holotrichia constricta, H. helleri, Leucopholis rorida have also been reported to attack forestry trees such as Albizia falcat (synonym of F. moluccana), Anthoceplalus cadamba, Leucaena glauca, Swietenia spp. and Tectona grandis [5]. In addition, L. stigma was also reported to attack Acacia mangium [22].

Although the damage is minor, adult beetles also cause damage to the sengon plant. Adult beetles feed on tree bark and leave as reported in Eucalyptus saligna and several forests tree species such as Ziziphus xylopyra, Accacia catechu and A. leucophloea [24, 25].

In the initial attack period, the abundance of collected larvae was used as an alternative food source for local communities. Some members of society can accept white grub as food. Later the larvae became popular among other members of society. Based on a study, white grub is rich in protein and is also high in fat and several other basic minerals [25]. However, their experience is that excessive consumption causes headaches.

The collected larvae can also be given as animal feed, especially for poultry. Others expose them to sunlight, so they die or are attacked by predators. Dead larvae change color to black.

4. Conclusion

The high population of white grub is due to the supporting factors of light sandy soil types, intercrop with pineapple plants, and the use of manure that has not yet been completely decomposed. Marang, which the local community uses, effectively prevents white attacks on sengon plants and can be applied technically and economically in other areas. In addition, this must also be supported by other integrated techniques.

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UW Darmawan and NE Lelana contributed equally as the main authors of this paper. All authors read, discussed, and approved the final paper.