Effectiveness of Netting Barriers on Immature Oil Palm Boundaries to Prevent *Oryctes* Imago Infestation

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Abstract

This research aims to compare the effectiveness of various barrier net installation heights on the borders of immature oil palm (*Elaeis guineensis* Jacq.) areas to prevent attacks by the imago of the *Oryctes rhinoceros* pest. A field experiment method was conducted using a Randomized Block Design (RBD) with three net height treatments (2 m, 2.5 m, and 3 m) and a control over an eight-week observation period at PTPN IV Regional 1 Gunung Para Estate. The analysis results indicated that variations in net height did not significantly affect ($p = 0.226$) the number of beetles found, with the highest average attack recorded in the control group (0.667). Conversely, the block location factor had a highly significant effect ($p = 0.006$), where Block N16A remained completely free from pest attacks (absolute 0 value). This study concludes that the installation of physical nets alone does not provide a significant difference in suppressing pest populations without considering spatial layout or the proximity of breeding sites around the plantation blocks.

Keywords: *Effectiveness, Netting, Oryctes, Oil Palm*

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Introduction

Oil palm (*Elaeis guineensis* Jacq.) is a primary plantation commodity in Indonesia that contributes significantly to the national economy. However, oil palm productivity is frequently threatened by pest infestations, particularly by *Oryctes rhinoceros*, commonly known as the rhinoceros beetle. The imago stage of the *Oryctes* pest can cause severe damage to immature oil palms (*Tanaman Belum Menghasilkan* / TBM) by boring into the growing points. This disrupts plant growth and can even lead to plant mortality [1].

Various control methods have been implemented, one of which is installing protective netting on immature oil palms. The use of netting is considered effective in preventing *Oryctes* imagos from entering the plant's growing points. The net size used is highly decisive for the efficiency and effectiveness of this pest control method [2]. This study aims to determine the most effective net size to be deployed along the boundaries of immature oil palm areas, providing a sustainable recommendation for oil palm plantation management.

Literature Review

Oil palm (*Elaeis guineensis* Jacq.) is a highly important plantation commodity in Indonesia, making a major contribution to the national economy and agricultural exports. However, successful oil palm cultivation is strongly influenced by environmental factors and infestations by plant-disrupting organisms, notably attacks by the rhinoceros beetle (*Oryctes rhinoceros*). This pest causes serious damage, especially to immature plants (TBM), necessitating effective control measures [3].

Oryctes rhinoceros is a major pest in oil palms that attacks the growing point of the plant, causing stunted growth and even the death of immature plants. *Oryctes* imago attacks on immature oil palms can significantly reduce plantation productivity. Therefore, controlling this pest is a top priority in oil palm plantation management [1].

Various control methods have been developed to suppress *Oryctes rhinoceros* populations, ranging from chemical pesticides and biological agents to physical methods such as installing protective nets on the plant's growing points. Physical methods are considered more environmentally friendly and can reduce the negative impacts of chemical usage on the plantation ecosystem [4].

Netting installation on immature oil palms is a highly effective control technique to prevent *Oryctes* imagos from entering and damaging the plant's growing point. However, the effectiveness of net installation is highly influenced by the mesh size used. A net size that is too large allows pests to enter, while a size that is too small can increase costs and complicate installation [2]. Research comparing net sizes for *Oryctes* pest control remains limited, particularly on a large plantation scale such as at PTPN4 Reg1 Kebun Gunung Para.

Research Methodology

This study utilized a field experiment method with a quantitative approach. The research was conducted in Gunung Para II Village, Serdang Bedagai Regency, North Sumatra, from October to December 2025. The materials used consisted of nets with three different dimensions: 2 m height × 100 m width, 2.5 m height × 100 m width, and 3 m height × 100 m width. The apparatus used included measuring tapes, cameras, and stationery.

Results

Table 1. Descriptive Statistics of Treatment Outcomes

Treatment	N (Sample)	Mean	Std. Deviation	Minimum	Maximum
Control (Untreated)	30	0.667	1.028	0	3
Treatment 1 (2-Meter Height)	30	0.267	0.450	0	1
Treatment 2 (2.5-Meter Height)	30	0.400	0.675	0	2
Treatment 3 (3-Meter Height)	30	0.433	0.858	0	3

Table 2. ANOVA Table (Tests of Between-Subjects Effects)

Source of Variation	Type II Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	p-value	Significance
Treatment (Height)	24.917	3	8.306	1.929	0.226	Not Significant
Block (Group)	118.167	2	59.083	13.723	0.006	Significant
Error (Residual)	25.833	6	4.306	-	-	-
Total	168.917	11	-	-	-	-

(Note: Hypothesis testing was conducted at a significance level of \(\alpha = 0.05\))

Effect of Height Treatment: Based on the ANOVA results, the significance value (p-value) for the Treatment factor was 0.226. Since this value exceeds the threshold (0.226 > 0.05), the test decision was to accept the null hypothesis (H0). This indicates that the variations in height treatment (2 meters, 2.5 meters, and 3 meters) and the control condition did not result in statistically significant differences regarding the measured variable. Descriptively, the Control group actually exhibited the highest mean value (0.667), followed by Treatment 3 (0.433), Treatment 2 (0.400), and Treatment 1 (0.267).

Effect of Block (Group): The significance value for the Block factor was 0.006. Since this value was below the threshold (0.006 < 0.05), the test decision was to reject the null hypothesis (H0). This demonstrates that environmental factors or site blocking (Blocks J17, N16A, and Q16A) had a highly significant effect on the observed results.

Blocks J17 (mean 0.700) and Q16A (mean 0.625) showed significantly higher data activity levels that were relatively homogeneous compared to each other, whereas Block N16A recorded an absolute value of zero across all samples. This is strongly attributed to the

spatial positioning of Block N16A, which is far removed from the primary breeding sites of the *Oryctes rhinoceros* beetle such as decaying oil palm trunks or replanting debri

According to [5], the flight range and attack preferences of adult *Oryctes* beetles are heavily concentrated on immature oil palm stands (TBM) directly adjacent to areas of unmanaged vegetation or uncleared replanting sites. High infestation levels in Blocks J17 (0.700) and Q16A (0.625) indicate proximity to the pest's epicenter; consequently, installing nets 2 to 3 meters high failed to significantly curb the rate of attack, as the beetles could fly above the netting or pass through gaps in the plantation's vegetation boundary.

Descriptive data reveal that the highest mean infestation level occurred in the Control group (0.667). A downward trend in infestation was observed in netted areas, with the lowest value recorded in Treatment 1 (2-meter height) at 0.267. This indicates that the netting acts as a primary mechanical barrier, limiting the beetles' direct physical access to the growing points of the immature palms. These findings align with [6], which noted that installing nets around immature palm areas reduces the frequency of adult *Oryctes rhinoceros* landing on young fronds.

The lack of statistical significance regarding net height is largely attributable to the rhinoceros beetle's own biomechanical flight capabilities. The pests were able to bypass nets installed at heights of 2 to 3 meters. A study by [7] indicates that adult *Oryctes rhinoceros* possess strong vertical and horizontal flight capabilities, capable of reaching the height of mature vegetation (>5 meters) while foraging or homing in on pheromones. Consequently, a 3-meter-high net is insufficient to intercept the pest's flight path toward the center of the plantation.

In stark contrast to the treatment factor, the block location factor exerted a highly significant influence on the number of adults (imagos) found (\(p = 0.006 < 0.01\)). This indicates the presence of spatial heterogeneity and extreme environmental variation among the observation sites at the Gunung Para Estate. This methodological assessment aligns with [8], which asserts that the population distribution of rhinoceros beetles in oil palm plantations is never homogeneous but rather highly dependent on the micro-ecological characteristics of each specific block.

The most intriguing phenomenon in this study was the condition of Block N16A, which recorded an absolute zero (0) infestation value across all samples. This suggests natural isolation or an absence of pest-attracting factors in the vicinity of the block. This hypothesis is supported by findings from [9], stating that oil palm plantation areas free from decaying organic matter and surrounded by dense boundary vegetation naturally avoid landing orientation by *Oryctes* adults.

The high beetle populations in Block J17 (mean 0.700) and Block Q16A (mean 0.625) demonstrate that these two locations are situated near pest epicenters. This condition is attributed to the presence of primary breeding sites, such as decaying piles of oil palm trunks left over from replanting operations. Research by [10] confirms that the rate of *Oryctes* infestation on young palms increases up to threefold when immature (TBM) blocks directly adjoin replanting areas where trunk sanitation has not been thoroughly implemented.

Given that environmental factors (block characteristics) play a far more dominant role in the success of pest suppression than net height, future control strategies must shift toward a spatial-based Integrated Pest Management (IPM) approach. This recommendation aligns with [11], which emphasizes that sustainable protection for immature oil palm stands requires integrating field sanitation (destroying breeding sites by covering stacked trunks with netting)the application of biological agents such as the fungus *Metarhizium anisopliae*, and the installation of pheromone traps along the outer block boundaries.

Conclusion

Height variation treatments (2-Meter Height, 2.5-Meter Height, 3-Meter Height, and Control) did not exert a statistically significant effect on the observed parameter values. The environmental conditions among Blocks had a highly significant effect on the parameter values, where Block N16A served as the primary differentiator by yielding zero values across all of its samples. Since the treatment factor was statistically non-significant, post-hoc examinations to determine the best treatment are unnecessary. Since the treatment factor is not significant, there is no need to conduct further tests to identify the best treatment**.**

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