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Analysis of Rhinoceros Beetle Infestation in Immature Plants at PTPN IV

Angga Surya Darma
Institut Teknologi Sawit Indonesia, Jl.Williem Iskandar,Kenangan Baru, Kecamatan Percut Sei Tuan,Kabupaten Deli Serdang ,Sumatera Utara,085215850880, 20371, Indonesia

Corresponding Author: anggasuryadarma1981@gmail.com

Abstract

Attacks by the rhinoceros beetle (Oryctes rhinoceros) on immature oil palm plants can cause crop damage and reduce productivity. This study aimed to identify the level of pest infestation and compare the effectiveness of three methods: the 6-plot zigzag census, the systematic census, and the plantation SOP sampling technique.The study employed a quantitative descriptive method and was conducted at PTPN IV's Gunung Bayu Business Unit in Simalungun Regency, North Sumatra, from May to July 2026.The results showed that the plantation SOP sampling technique yielded the highest infestation frequency (28.40%) and intensity (14.20%). In contrast, the systematic census recorded an infestation frequency of 22.98% and an intensity of 9.94%, while the 6-plot zigzag census showed a frequency of 22.15% and an intensity of 9.54%. Although the plantation SOP technique detected higher infestation levels, the systematic census was deemed the most effective method; it provided representative results while being more efficient in terms of sample size, time, and labor compared to the other methods.

Keywords: Rhinoceros beetle (Oryctes rhinoceros), immature plants (TBM), attack frequency, attack intensity, systematic census

INTRODUCTION

Oil palm (*Elaeis guineensis Jacq*) is a strategic plantation commodity that contributes significantly to Indonesia's economy. Beyond serving as a primary source of foreign exchange earnings through crude palm oil (CPO) exports, the oil palm industry plays a vital role in creating jobs and supporting economic development across various regions. Indonesia remains the world's largest palm oil producer, accounting for over 44% of global production; consequently, maintaining crop productivity is crucial for sustaining the competitiveness of the national

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plantation sector.(Pandiangan & Ernah, 2019)

Increasing oil palm productivity is influenced by various factors, including the use of superior planting material, crop maintenance, environmental conditions, and the control of plant pests. One of the most damaging pests affecting oil palms is the rhinoceros beetle (*Oryctes rhinoceros* L.), particularly during the immature (pre-productive) phase. During this stage, plant tissues are still young and thus more susceptible to pest attack. Adult *O. rhinoceros* beetles attack the growing point by boring into the base of the fronds and the shoot, resulting in characteristic symptoms such as V-shaped or triangular leaf cuts. Severe infestations can lead to damage to the growing point, stunted growth, a reduction in the productive plant population, and even the death of young palms.(Joni Handoko(1), 2017)

Significant economic losses due to *O. rhinoceros* attacks have been widely reported across oil palm plantations in Indonesia. This pest can reduce fresh fruit bunch production by 60–69% during the early production stage and cause a mortality rate of approximately 25% among young palms if proper control measures are not implemented. Furthermore, the expansion of oil palm plantations—dominated by monoculture systems—combined with the abundance of organic material from replanting activities and empty fruit bunches, provides a suitable habitat for *O. rhinoceros* larval development. These conditions create the potential for pest populations to surge unless plantation sanitation and field monitoring are carried out consistently.(Ingrid Ovie Yosephine et al., 2023)

Various control measures have been developed to suppress *O. rhinoceros* populations, including plantation sanitation, the use of pheromone traps, the application of biological agents such as *Metarhizium anisopliae* and *Oryctes rhinoceros* nudivirus (OrNV), and the implementation of Integrated Pest Management (IPM). In addition to these control measures, population monitoring and the identification of infestation levels are crucial components for determining the appropriate timing and methods of control. Monitoring data serve as the basis for decision-making, ensuring that control actions are carried out effectively, efficiently, and in alignment with the infestation levels observed in the field.(Susanto et al., 2020)

Research on *O. rhinoceros* has largely focused on aspects such as pest biology, insecticide efficacy, biological control, pheromone use, and integrated pest management techniques. Several studies have also reported infestation levels in oil palm plantations across various regions. However, information regarding the effectiveness of sampling methods for monitoring infestations at the operational plantation level remains relatively limited. This is significant because the chosen sampling method critically determines data representativeness, labor

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efficiency, observation time, and the accuracy with which field infestation conditions are depicted. An inappropriate choice of sampling method can result in observations that do not reflect actual population conditions, potentially influencing pest control decisions.(Prasetyo et al., 2019)

In oil palm plantations, several pest infestation monitoring techniques are employed, such as zig-zag censuses, systematic censuses, and sampling methods based on company standard operating procedures (SOPs). Each method differs in terms of sample size, the distribution pattern of the palms being observed, labor requirements, and implementation time. However, there is currently a lack of research directly comparing these three methods based on indicators such as infestation frequency, infestation intensity, and implementation efficiency. This situation highlights a research gap that requires further investigation to identify a monitoring method that is not only accurate but also practical for implementation across large-scale plantations.(Sulardi, 2022)

This research is significant because the success of pest control programs is heavily influenced by the quality of monitoring data. Representative observations yield more accurate information regarding infestation levels, enabling targeted control measures. Conversely, inefficient monitoring methods can increase operational costs, labor requirements, and the time needed for implementation without providing a meaningful improvement in precision. Therefore, evaluating various sampling methods is essential to identify the most suitable observation technique for routine monitoring in oil palm plantations.(Pedigo, L.P. dan Buntin, G.D. 1994.)

The novelty of this research lies in its comparison of three field observation methods—namely the six-plot zig-zag census, the systematic census, and the sampling technique based on plantation Standard Operating Procedures (SOP)—to evaluate *Oryctes rhinoceros* infestation levels in immature oil palm stands at PTPN IV's Gunung Bayu Business Unit. Unlike previous studies that typically reported only infestation rates or pest control efficacy, this research not only quantifies the frequency and intensity of infestations but also evaluates each sampling method's ability to generate representative data, while considering factors such as time efficiency, sample size, and labor requirements. Consequently, the findings are expected to provide technical recommendations regarding the most effective monitoring method to support the implementation of integrated pest management in oil palm plantations.

Based on the foregoing, this study aims to compare the effectiveness of the six-plot zig-zag census method, the systematic census method, and the plantation SOP sampling technique in identifying the level of *Oryctes rhinoceros* infestation in immature oil palm stands at PTPN IV's Gunung Bayu Business Unit. Furthermore, the study seeks to determine the most representative

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and efficient sampling method to serve as a basis for routine monitoring, thereby supporting effective, efficient, and sustainable decision-making within pest control programs. The findings are expected to serve as a reference for plantation companies and researchers in developing more accurate and practical pest monitoring systems.

RESEARCH METHODE

The research was conducted in the Immature Plant (TBM) 2 area of PTPN IV Regional II, Gunung Bayu Business Unit, Simalungun Regency, North Sumatra Province. The site was selected because it has a history of rhinoceros beetle (*Oryctes rhinoceros*) infestations affecting young plants and has not utilized Legume Cover Crops (LCC) for soil cover. The study was carried out over a three-month period, from May to July 2026.

The materials used in this study included immature oil palm plants (TBM 2) as the subjects of observation, as well as secondary data regarding the history of *Oryctes rhinoceros* infestations obtained from the plantation division. The equipment employed consisted of observation forms, writing instruments, a digital camera for documentation, a measuring tape, a machete or utility knife to assist in examining infestation symptoms on the plant's shoot, and a computer for data processing and analysis. All equipment used was standard for pest monitoring activities in oil palm plantations.

This study employed a quantitative descriptive method involving direct field observations to compare the effectiveness of three sampling techniques in identifying the infestation level of the rhinoceros beetle (*Oryctes rhinoceros*) in immature oil palm plantations. The three sampling techniques compared were the six-plot zig-zag census, the systematic census, and the technique based on the plantation's Standard Operating Procedures (SOP). Observations began with the selection of research blocks based on the history of pest infestations. In the systematic census method, observations commenced in the second row, with the first sample palm located at the fourth tree; subsequently, every tenth palm was examined sequentially until the entire observation transect was completed. For the six-plot zig-zag census, the observation area was divided into six sections, and the observer moved in a diagonal (zig-zag) pattern to ensure representation across all parts of the block. Regarding the plantation SOP sampling technique, observation points were determined according to the company's operational procedures, utilizing a "quincunx" (five-point) observation pattern at each sample location.

Each sample plant was observed for signs of *O. rhinoceros* attack, including boreholes in the spear leaf or the base of the frond, V-shaped damage to young leaves, and the overall level of

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plant damage. Attack severity was classified into four categories: score 0 (no attack), score 1 (light attack), score 2 (moderate attack), and score 3 (severe attack). The parameters observed included the number of attacked plants, the total number of plants examined, and the damage severity category for each plant.

The type of statistical analysis used:

The data were analyzed using descriptive quantitative methods by calculating the frequency and intensity of attacks for each sampling method. Attack frequency was calculated using the following equation:

$$\text{Attack frequency (\%)} = \frac{number\ of\ effected\ plants}{number\ of\ plants\ observed} \text{x100}$$

Meanwhile, the attack intensity is calculated using the formula:

$$\text{Attack intensity (\%)} = \frac{\sum(n \times v)}{N \times Z} \times 100$$

where: n = number of plants in each damage category, v = damage category score, N = total number of plants observed, and Z = highest damage category score (3). The results regarding attack frequency and intensity from the three methods were compared descriptively to evaluate each sampling technique's ability to characterize the *O. rhinoceros* infestation. The most effective method was determined based on data representativeness, the obtained frequency and intensity values, and operational efficiency in the field—specifically regarding sample size, observation time, and labor requirements. This approach was used to formulate practical monitoring method recommendations for integrated pest management in oil palm plantations.(Julkarnain et al., 2024)

RESULT AND DISCUSSION RESULT

Observations of rhinoceros beetle (*Oryctes rhinoceros* L.) attacks on immature oil palms (TBM 2) at PTPN IV Regional II (Gunung Bayu Business Unit) were conducted using three sampling techniques: a six-plot zig-zag census, a systematic census, and a technique based on the plantation's Standard Operating Procedures (SOP). These three methods were compared based on the number of palms observed, attack frequency, and attack intensity to determine the most representative and efficient monitoring method for supporting pest control activities on the plantation. The observation data are presented in Table 1.

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Table 1 Frequency and intensity of *Oryctes rhinoceros* attacks across three sampling methods

Sampling Method	Plants Observed	Affected Plants	Frequency (%)	Intensity (%)
6-Plot Zig-zag Census	324	72	22,15	9,54
Systematic Census	160	37	22,98	9,94
Plantation SOP Census	168	48	28,40	14,20

The results of this study reinforce the concept that the representativeness of the sample distribution is a more critical determinant of data quality than simply increasing the sample size.(Susanto et al., 2020) explain that pest monitoring activities in oil palm plantations require methods that are practical, easy to implement, and capable of providing a comprehensive picture of population conditions, thereby enabling rapid and accurate control decisions. Thus, the systematic census method aligns with the fundamental principles of integrated pest monitoring by yielding accurate data through more efficient resource utilization.

The findings of this study differ from some previous research, which generally focused on infestation levels or the effectiveness of *O. rhinoceros* control measuressuch as the use of pheromones, biological agents, or plantation sanitation. Few prior studies have evaluated the effectiveness of sampling techniques as a component of pest monitoring systems. Consequently, this study makes a novel contribution by demonstrating that the choice of sampling method influences the quality of information generated during field monitoring. This approach is significant because control decisions depend not only on the success of control technologies but also on the accuracy of the data serving as the basis for decision-making.

This study offers several advantages, notably the direct comparison of three sampling methods commonly used in oil palm plantations conducted at the same location and time thereby allowing for an objective comparison of the results. Furthermore, the study evaluates method effectiveness not only based on the frequency and intensity of infestations but also by considering time efficiency, sample size, and labor requirements. This approach provides companies with more practical information for selecting a monitoring method suitable for their operational activities.

DISCUSSION

This study aimed to analyze the level of rhinoceros beetle (*Oryctes rhinoceros*) infestation in immature oil palm stands and to compare the effectiveness of three sampling methods: the 6-

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plot zig-zag census, the systematic census, and the plantation SOP sampling technique. The results indicated differences in infestation frequency and intensity values across the sampling methods. The plantation SOP sampling technique yielded the highest infestation frequency (28.40%) and intensity (14.20%), whereas the systematic census showed a frequency of 22.98% and intensity of 9.94%, and the 6-plot zig-zag census resulted in a frequency of 22.15% and intensity of 9.54%. These differences demonstrate that the sampling technique influences the infestation values obtained in the field.The high infestation frequency and intensity values associated with the plantation SOP sampling technique suggest that this method is capable of detecting infested palms in infestation hotspots. However, these high values do not necessarily reflect the infestation population status across the entire area. This is likely because the SOP sampling pattern concentrates on specific points, thereby increasing the likelihood of overestimation. In pest monitoring, a sampling method must accurately represent the overall population status so that the results can serve as a reliable basis for making appropriate control decisions.Conversely, the 6-plot zig-zag census method offers a high level of precision because it involves a larger number of palms compared to the other methods. Observing 324 palms allows for a better representation of the variation in infestation conditions, resulting in greater accuracy. However, this method requires more time, labor, and operational costs, making it less efficient for routine monitoring across vast oil palm plantations. This aligns with the principle of pest monitoring sampling, which holds that while increasing the sample size can enhance precision, it also increases resource requirements.The research results indicate that the systematic census method yields frequency and attack intensity values very close to those of the 6-plot zig-zag census method, with a frequency difference of only about 0.83% and an intensity difference of 0.40%. This relatively small difference demonstrates that the systematic sampling pattern can generate representative data despite using a smaller number of samples. The even distribution of observation points across the entire area ensures that variations in plant conditions are well-represented, making this method more efficient without compromising the quality of the information obtained.The success of the systematic census method in this study supports the concept of integrated pest monitoring, which emphasizes the importance of using observation methods that are simple, practical, representative, and efficient. (Pedigo, L.P. dan Buntin, G.D. 1994.)stated that a good sampling method must accurately reflect population conditions, be easy to implement, save time, and provide information that can serve as a basis for control decisions. Similarly, (Susanto et al., 2020)explained that pest monitoring in oil palm plantations must be conducted periodically using methods that provide a comprehensive picture of attack conditions, enabling timely and efficient

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control actions. The results of this study reinforce this view, as the systematic census method satisfies both representativeness and operational efficiency requirements.In addition to the sampling method, environmental conditions are also believed to influence the level of *Oryctes rhinoceros* infestation. High rainfall during the study period likely increased environmental humidity and accelerated the decomposition of organic matter, which serves as a breeding medium for rhinoceros beetle larvae. Conversely, the presence of Legume Cover Crops (LCC) can improve agroecosystem conditions by enhancing biodiversity and supporting natural enemies, thereby potentially suppressing pest populations. Therefore, an integrated approach combining plantation sanitation management, the use of cover crops, and periodic monitoring is essential for effective and sustainable *Oryctes rhinoceros* control.Overall, this study demonstrates that the choice of sampling method is a crucial factor in monitoring rhinoceros beetle infestations. Although the plantation SOP sampling technique yields the highest infestation values and the zig-zag census offers high precision, the systematic census method provides the best balance of accuracy, representativeness, efficiency (in terms of time and labor), and ease of implementation. Therefore, the systematic census method is recommended for routine monitoring to support Integrated Pest Management (IPM) programs in oil palm plantations, particularly for immature palms.

CONCLUSION

Based on research analyzing the infestation levels of the rhinoceros beetle (*Oryctes rhinoceros*) in immature oil palm stands at PTPN IV's Gunung Bayu unit, it is concluded that infestation levels vary depending on the sampling method employed. The plantation's Standard Operating Procedure (SOP) sampling technique yielded the highest infestation frequency at 28.40% with an intensity of 14.20%; in contrast, the systematic census method showed a frequency of 22.98% and an intensity of 9.94%, while the 6-plot zig-zag census resulted in a frequency of 22.15% and an intensity of 9.54%.

Although the plantation's SOP sampling technique detected higher infestation levels, it does not fully capture the overall population status, as it carries the potential to overestimate infestation in specific locations. Conversely, while the 6-plot zig-zag census offers good precision, it requires significant time, labor, and sample sizes, making it less efficient for routine monitoring activities.

Considering data representativeness, time efficiency, labor requirements, and sample size, the systematic census method is the most effective approach for monitoring *Oryctes rhinoceros*

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infestations in immature oil palm stands. This method yields data comparable to the zig-zag census while allowing for more efficient execution; therefore, it is recommended as a routine monitoring method to support Integrated Pest Management (IPM) programs.

FUTURE DIRECTIONS

Based on the research findings, it is recommended that PTPN IV (Gunung Bayu Business Unit) adopt the systematic census method for routine monitoring of rhinoceros beetle infestations, as it is more efficient and yields representative data to inform pest control decision-making. Future research should be conducted over a wider observation area and a longer timeframe, while also considering factors such as the presence of Legume Cover Crops (LCC), natural enemy populations, and climatic conditions, to obtain more comprehensive information regarding the infestation dynamics of *Oryctes rhinoceros* and the effectiveness of control strategies.

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