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Controlling Horn Beetles Using Pineapple Fruits Trap in Palm Oil Plant

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Abstract. *Chemical insecticides are often used to control palm oil pests due to their effectiveness and rapid effects. However, these insecticides leave residues in palm oil, leading to the presence of harmful chemicals that damage the agricultural environment. This has led to the use of various alternatives, such as mechanical control (trap), which is cost-effective and nature-friendly. Therefore, this study aims to determine the potential of trap with different heights and various amounts of pineapple to control horned beetles in palm oil plant. The study procedures were carried out using a factorial random group design and a factorial scheme with 2 treatment factors and 3 repetitions. The first factor was the height of trap mounted with 3 treatments, namely P1 = 100 cm, P2 = 200 cm, and P3 = 250 cm. Meanwhile, the second factor was N1 = 50 grams per trap, N2 = 100 grams per trap, and N3 = 150 grams per trap. Data obtained were then analyzed using Analysis of Variance. When the results differed, analysis was continued with Duncan's Multiple Range Test at the 5% level. The parameters observed were the number of horn beetles trapped, sex ratio, and the species of horn beetles. The results showed that in height treatment, trap had a significant influence on the number of horn beetles over 3 and 9 days. Meanwhile, in pineapple treatment, weight had no significant effect on the number of horn beetles trapped and sex ratio. The results also showed that the interaction between both treatments had no significant impact.*
Keywords: *fruits-trap; horned beetles; mitigation; pineapple; sustainable agriculture.*

Type of the Paper: Regular Article.

1. Introduction

In the study of plant pathology, the primary focus is on the organisms that cause diseases and their impact on crop quality and yield. Fungi are often the predominant pathogens responsible for significant damage due to their rapid growth and decomposition capabilities. These organisms facilitate the spread of plant diseases and the production of pathogenic byproducts [1,2]. Fungi diseases can also hinder plant growth and reproduction, leading to abnormal swelling and increased susceptibility to secondary infections from other pathogens. Consequently, effective management is essential to prevent widespread damage and reduced agricultural productivity. Control measures include targeted treatments and preventive strategies to mitigate the spread of these harmful organisms [3].

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The use of chemical pesticides in developing countries can significantly reduce the risk of diseases. These pesticides have the potential to quickly and effectively control pests, reducing their resistance and preventing the spread of diseases. To prevent their negative impact, it is essential to use environmentally friendly methods as well as products that are safe and effective [4,5]. Pineapple is a type of pesticide that contains harmful chemicals, such as nitrate and volatile substances. The nitrate can damage the skin, cause skin rashes, and reduce pH levels. Several studies have also shown that it attracts pests and causes plant damage. To improve its effectiveness, there is a need for a combination with other products. Factors affecting the effectiveness of pesticides include aroma, color, and intensity. Environmental factors, such as humidity and temperature, have been reported to have a direct influence on intensity, which can also be affected by the color. High and fast angular temperatures can help pests quickly kill plant and its food source [6].

Since 1910, palm coconut has been cultivated commercially in Sumatra [7] due to the available land [8] and the appropriate agroclimatic conditions. The available land covers 26.3 million hectares, with plantation area reaching 8.4 million acres spread across Sumatra, Kalimantan, Sulawesi, and Papua [9]. To achieve sustainable palm coconut farming, it is necessary to improve the quality of production. However, this objective has been hindered by various components that cause inoptimal production and affect the productivity of crops.

Pest attack is a major barrier to palm coconut cultivation, which impedes production in both quality and quantity [7]. In the imago phase [10,11], pests engage in activities such as rubbing, sucking fluid [12], and spraying leaves, stems, and fruits [13,14]. These activities weaken plant, causing the leaves to be easily broken [7], while fruits become rotten and hollow [15]. Adult horned beetles attack [16] palm coconut in a pattern that leads to damage resembling the letter V on fruits [14].

In palm oil plantations, monitoring of horned beetles is often carried out through assessment of the attacks of the pests every month. This is performed by marking trees and census points on each hectare (US=sample unit, PS=seven sample trees in one hectare). The criterion for the infestation of horned beetles is assessed from the amount of drained discharge that is still wet or fresh in the affected portion of the pelvis. Standard Operational Procedures plant use chemical control techniques to control crocodile pests on moderate attacks. This method uses a contact insecticide and a gastric active ingredient of cypermethrin to spray the exudate and frictional parts [17].

Pests control of horned beetles uses chemical insecticides due to their high effectiveness and rapid effects compared to other methods. However, the use of insecticides leads to residues in palm fruits, leading to contamination with harmful chemicals and damage to the agricultural

environment. Alternatives for achieving environmentally friendly sustainable agriculture include the use of mechanical controls, such as trap, which are cost-effective and eco-friendly [18]. In addition, disrupting the life cycle of pests in the field is an important strategy [19]. Implementing proper sanitation measures is particularly effective in halting the life cycle of horned beetles, as their larvae cannot survive at elevated temperatures [20].

According to previous studies, pineapple can be used to control horn beetles as a substitute for pheromones. Pineapple are also more environmentally friendly and reduce plantation control costs due to the presence of volatile compounds that attract insects. These fruits have a very complex content with cold properties, a bright yellow color, and a very strong aroma when physiologically ripe. Male insects are attracted by the typical scent of pineapple, which is considered to be sex pheromones released by female insects. In pineapple, there are volatile compounds that can attract insects with their flavors, making the insects lie on the surface of fruits [21].

Pineapple have a yellow color that is attractive to insects, along with a striking scent believed to be emitted by females as a means of communication or sex pheromones [22]. According to Martina et al. [21], these fruits and their skins have volatile compounds, such as nitric acid. Several studies have shown that nitric acid has the ability to break down bacterial cell membranes, damage cell membrane, and maintain pH [23].

To increase the effectiveness of anthrax pineapple and attract more horned beetles, there is a need for a combination with trap. The flavor, color, and height of trap are some of the factors that affect its effectiveness. According to Fauzana et al. [7], high temperatures and wind speeds can accelerate evaporation, drawing insects faster to where the smell originates. Pheromones are an alternative way to control the population of horned beetles. These substances are transported by insects to their sexual partners, hostels, and breeding places. Ethyl-4 methyl octanoate has been reported to be the main component of synthetic pheromones. In addition to the chemical compounds that attract insects, pheromones can also be obtained vegetatively from the scent of fruits [24].

Vegetarian control is one of the methods that use parts of plant, such as stems, fruits, roots, and seeds containing secondary metabolite compounds with toxic properties against pests and diseases. The attractant is usually made of free amino acids, which also serve as a component for pineapple [25]. Integrated control, which combines multiple control methods, can also be used to manage bug pests at high attacks. There are many ways to control pests in an integrated way [6], such as using natural enemies [26], keeping plant areas clean, cultivating variety that is resistant to pests and diseases, and positioning trap at night with light or parts of plant with strong scents [19]. The current study specifically discussed the use of rhinoceros pests trap on palm coconut

plant by using light and pineapple fruits that can attract female horn beetles [27].

The study procedures were conducted on a two-and-a-half-year-old palm coconut plant in Kecamatan Rambutan, North Sumatra, April to July 2022. The materials used were 70% methanol, pineapple, bamboo rods, twenty liters, and wire [28]. Meanwhile, the tools included a multiplier, a meter, a scroll, a tray, a plastic bag, a typewriter, and a coordinate location. During the procedures, land surveys were carried out to prepare the treatment placement, followed by coordinate location assessment to determine trapping point.

This study used the Variance Analysis method with Factorial Group Random Design. A circuit test was performed using *Duncan's Multiple Range Test* (DMRT) *at the* 5% *level*, consisting of 3 parts of treatment and 3 repetitions. Trap High Factor Component P1 was 100 cm, P2 was 200 cm, and P3 was 250 cm. The Pine Fat Factor was N1 = fifty grams per trap, N2 was 100 grams for each trap, and N3 was 150 grams for each trap. The data obtained were then analyzed with an analysis of variance (ANOVA), followed by a chain test with DMRT *at the* 5% *level*. A total of 2 holes were made in the front and rear of 20 liters for the entry of horned beetles. Subsequently, bamboo pieces of 100, 200, and 250 cm were tied to the 20 liters to hang on the bamboo that had been prepared. The pineapple were then cut according to their weight, followed by insertion into the 20 liters.

Mounting of trap was carried out through various steps, including (1) count palm coconut rod section from one trap to another with a bamboo hole as deep as 30 cm, (2) cover the hole with rock or hard soil to ensure the bamboo is strong and does not collapse when the wind is strong, (3) put pineapple into the 20 liters based on weight of each trap, and (4) replace the pines every 3 days after the treatment.

The parameter for the monthly observation was pests in trap, which was recorded every 3 days once and 8 times in every 24 days at 4 p.m. BC. To maintain the scent emitted by the pests, the pineapple were put into trap. Each observation was carried out to determine the sex ratio of horned beetles by counting the number of male and female horned based on their characteristics. The males typically had horns on the head, while the females did not. In addition, the males horns were smaller and longer compared to the females. After horned beetles were combined and counted, each species was placed in a plastic bag to identify the species based on their morphology and body structure.

2. Materials and methods

2.1. Study Site

This study was carried out on a two-and-a-half-year-old palm coconut plantation in the Rambutan district of Serdang Bedagai, North Sumatra province from July 1 to 24, 2022.

2.2. Materials and Tools

Materials used in this study were 70% alcohol, plastic bags, pineapple, bamboo sticks, 20 liters of jerry can, and wire. The tools used were the meter, gauge, carriage, plastic bag, typewriter, GPS camera location coordinates, and GPS coordinate applications.

2.2. Experimental Design

The experiment was set in a factorial Randomized Block Design that consisted of 2 factors. The first factor was the height of trap with 3 treatments, namely P1 = 100 cm, P2 = 200 cm, and P3 = 250 cm, while the second factor was the weight of pineapple, where N1 = 50 grams per trap, N2 = 100 grams per trap, and N3 = 150 grams per trap. Consequently, the number of treatment combination was 3 x 3 = 9 combinations, namely P1N1, P1 N2, P1N3, P2 N1, P2N2, P2N3, P3N1, P3N2, and P3 N3. The treatments were replicated 3 times, hence, the total number of trap was 27, and the distance between them was 15 feet covering 1 hectare.

2.3. Data Analysis

Data obtained was analyzed by applying the ANOVA method following the Factorial RCBD procedure and continued with DMRT at 5% level confidence.

2.4. Study Procedure

How to make trap: The jerry can was made with 2 holes from the front and back. For the entry of the pests, the bamboo was cut according to the treatment (100 cm, 200 cm, and 250 cm), and then the jerry can was tied with a wire to be hung on the bamboo that had been prepared. Subsequently, pineapple was cut according to the weight of the treatment, and then inserted into the jerry can. The device was installed by digging a hole as deep as 30 cm by using tumbilang as a bamboo trap place. Trap hole was made in palm coconut branch with a distance of 15 m from trap to the other trap. Furthermore, the planting hole was covered with hard soil or stone to ensure the bamboo trappings were robust, preventing breakage during strong winds. Pineapple fruits was inserted into the jerry can with weight according to the treatment of each trap, and the pines were replaced every 3 days once. The jerry can was hung to the end of bamboo and given the marker according to treatment.

Data observations were conducted for 1 month and the interest of pests in trap was observed once every 3 days, totalling 8 observations in 24 days. Observations were conducted at 4 PM, simultaneously replacing pineapple on trap to keep the scent released and effectively attract the pests. The observed data were (1) Observing the number of beetles trapped every 3 days when there was a crown that entered trap and then counted. (2) Observation of the sex ratio by counting the numbers of male and female horns and looking at their characteristics. Furthermore, the male horn beetles had horn or horn on the head and the female did not, and the body of the male horn

beetles was smaller and longer while the females had a larger body (3) Observations of the kinds of horn beetles caught at observation 8 were combined and then counted as the pests of horn beetles per species, then, inserted into a plastic bag that was provided to determine the kind of horn beetles, which was observed from the morphology and body structure of such horn beetles.

3. Results and Discussion

Regarding the Number of Horn Beetles trapped: Observational data on the number of horn beetles trapped in three to twenty-four days with the prints of beetles. As showed in Table 1 by the ANOVA results with the Factorial Group Random Scheme, trapped horn beetles was different in each treatment. Trap had no visible impact on days 3, 6, 12, 15, 18, 21, and 24 when given high treatment. However, trap had a visible effect on 9 after the observation and did not affect the treatment of pineapple weights.

Table 1. Average Number of Horn Beetles Trapped with Some Trap Height and Weight of Pineapple

Treatment	Observation Day							
	3	6	9	12	15	18	21	24
Trap Height								
P1 : 100 cm	0.00	0.11	0.22ab	0.33	0.11	0.11	0.11	0.00
P1 : 200 cm	0.11	0.22	0.11a	0.56	0.11	0.22	0.22	0.11
P1 : 250 cm	0.22	0.56	0.89c	0.56	0.33	0.33	0.56	0.44
Pineapple weight								
N3 : 50 gram	0,11	0.33	0.44	0.33	0.22	0.22	0.11	0.00
N3 : 100 gram	0,11	0.22	0.11	0.22	0.22	0.00	0.11	0.11
N3 : 150 gram	0,11	0.33	0.67	0.89	0.11	0.44	0.67	0.44

Description: A number followed by an uneven letter in the same column differs real according to Duncan's Multiple Range Test at the level of 5%

The result showed on Table 1, that on day 9, treatment P3 had a real impact on the number of horned beetles at trap height of 250 centimeters. This treatment was different from the P2 treatment at a 200 cm height and the P1 treatment at a 100 cm height, but treatment P1 was not different from treatment P2.

The number of horned beetles increased by 100 cm in trap height, decreased by 200 cm in trap, and again increased to 250 cm trap. On the histogram chart, it was shown that the 100-cm trap had the highest horn beetles of 0.20 and the 200-cm trap of 0.10, which showed that the 100-cm trap corresponded to the height of palm coconuts in the field, where horn beetles [10,29] could damage plant. Due to a higher trap producing a stronger wind blowing that could bring the pheromone smell from pineapple, and higher temperatures also helped to absorb the pheromones faster, horned beetles were more quickly attracted to trap [22]. Supposedly because the weight of fruits was small, it was necessary to add weight to each trap, the number of beetles caught was not affected by the delivery of several pineapple.

The weights of N3, 150 grams, and N1, 50 grams received the lowest treatment, showing

that a lower pineapple fruits weight did not affect the amount of corner beetles caught [21]. Insects were attracted by the smell of pineapple (*Ananas comosus*). The contents of the volatile compounds in fruits became the information that could attract horn beetles allowing the image to fly toward the source of the scent.

When exposed to long sunlight and high temperatures, the volatile compound will expand and sting [30]. This suggested that the strong fruits smell was caused by more than just light. The results of this study showed that trapped pests showed different results at each observation for 24 days. In the first observation, the pests showed the lowest number of beetles, and in the fourth observation, the pesticides showed the highest number. The results of the pests capture changed during the study until their collection at the end of the observation.

The climate also played a role in the effectiveness of pineapple pheromones, by the end of the study, the weather became unstable and rain often fell at night, reducing the smell of trap. This was consistent with Sehlschlager et al. [31] noting that nocturnal pests were more active at night when it rained frequently [4].

As a result, the chemical compounds of the pheromones decreased, suggesting that evaporation made the pheromones less effective for use in the field. This also ensured that the smell of the pheromones [32] became less. At 21 days, the sex ratio of male horns was not affected by the height of trap or the weight of pineapple.

Table 2. Average MaleSex Ratio of Horn Beetles with Some Trap Height and Weight at 21 Days

Treatment	Trap			Total	Average
	P1	P2	P3		
Pineapple					
N1	0.0	0.00	0.33	0.33	0.04
N2	0.0	0.00	0.33	0.33	0.04
N3	0.3	0.33	0.67	1.33	0.15
Average	**0.1**	**0.11**	**0.44**		**0.67**

The results of the equation of the sex ratio of male beetles horns based on the Variance Analysis in Table 2, method using Factorial Group Random Design showed that the treatment of some trap' height and some pine fruits weights did not have a real influence on the sex rate of males beetles horns. In this study, the highest treatment on the weight of treatment P3N3 was (0.44) the male sexual ratio, and the lowest treatment at the treatment P1N1 and P2N2 was (0.11) the male sex ratio.

The relationship of the high treatment of trap with several pine fruits attracted horns of the male genital ratio, this was assumed because the high trap and scent of pineapple fruits [33] could attract male horns. [7,27] According to previous studies, the specific scent emitted by fruits pine was a source of information that could draw male genital insects closer to it. This was considered to be a pheromone emitted from a single fruits (women), but the source was similar to the flesh

and the volume of the skin and was followed by a genital resource. At 12 days, the height of trap or the weight of pineapple did not affect the sex ratio of the female horned beetles.

Table 3. Average Male Sex Ratio of Horn Beetles Pest with Some Trap Height and Weight at 21 Days

Treatment	Trap			Total	Average
	P1	P2	P3		
Pineapple					
N1	0.33	0.33	0.00	0.67	0.07
N2	0.33	0.33	0.00	0.67	0.07
N3	0.33	0.67	1.00	2.00	0.22
Average	**0.33**	**0.44**	**0.33**		**1.11**

According to the Table 3, the highest and lowest values for the average number of female beetles horned with high trap and several pineapple weights on observers to 4 or 12 days. The highest P3N3 value was 1.00, while the lowest P2N3 was 0.67. The lowest p3N1 and p3n2 values were 0.00 respectively.

During 24 days, more female horns were observed compared to male horns. This was shown in the male and female sex ratio table, with 34 female horns trapped compared to 25 male Horns.

Data from 1 to 8 observations over 24 days showed that 2 species of beetles (scarabidae) were trapped in pineapple trap. Both the *Xylotrupesgideon* and the *Oryctes rhinoceros* were trapped in a cage using pineapple pheromones [22]. The species found 49 horned beetles and 10 *Oryctes rhinoceros*, each with a shiny old brown color and a branched claw [34]. The *Oryctes rhinoceros* was oval-shaped and was about 3.5 to 4.5 cm long [35,36].

Field studies found that the high treatment of trap effectively affected the number of 9-day-old horned beetles pests at a height of 250 cm, the heavy treatment of pests did not affect all observation parameters. The treatment of high trap and the weight of pineapple fruits did not influence all the parameters of observation. Overall, 2 species of horned horn bettle pests, *Oryctes rhinoceros* and *Xylotrupesgideon,* were found.

4. Conclusion

In conclusion, field studies showed that (1) Treatment of the high trap affected the number of horned beetles (9 HSP) at a height of 250 cm; (2) Treating the weight of pineapple fruits did not affect the entire observation parameters; (3) There were 2 species of horn beetles found, namely *Xylotrupesgideon* with 49 tails and *Oryctes rhinoceros* 10 tails, and the high-treatment intrusion of trap and the weight of pineapple had no real impact on all observation parameters. Further study must explore the optimal pineapple weight to reduce the population of horned beetles in palm oil plant, instead of relying solely on pine.

Abbreviations

Not applicable.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Lita Nasution :Conceptualization, Methodology, Investigation, Writing –original draft, Writing –review and editing, Formal analysis; Rahmad Syukur Siregar: Data curation; Makhrani Sari Ginting: Supervision, Project administration, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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