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The Effect of Color and Synthetic Pheromone Traps on Blooming Female Flowers of *Elaeis guineensis* Jacq on the Visit Intensity of *Elaeidobius kamerunicus* Faust.

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ABSTRACT

Elaeidobius kamerunicus is an effective pollinator of oil palm plants. The presence of oil palm pollinating beetles is inseparable from the presence of estragole compounds emitted by oil palm flowers. This study aims to examine the effect of color variations and estragole attractants from fennel oil on the population abundance and frequency of visits of *E. kamerunicus*. Data analysis used descriptive statistics, which involved counting pollinating insects that visited *E. kamerunicus* trapped in each trap, which was observed between 07.00 and 12.00. Parameters observed included the number of pollinating insects visiting flowers and other insects in each color per unit of observation time, with hourly intervals. The results showed that color variations of *E. kamerunicus* and the time of trap placement affected the population abundance and frequency of visits of *E. kamerunicus*. The highest visits were found in the yellow treatment with the addition of estragole attractant from fennel oil at an observation time interval of 10.00-11.00. The conclusion of this study indicates that the arrival of *E. kamerunicus* is influenced by the color and time of trap placement. This research is expected to provide new insights into promising methods in the field to improve oil palm pollination efficiency.

Keywords: Color trap, Elaeidobius kamerunicus, inflorescences, pollination

Introduction

One of the factors that influences oil palm production is the pollination process. This pollination process involves the role of the pollinating beetle *Elaeidobius kamerunicus* (Coleoptera: Curculionidae). Pollination by *E. kamerunicus* on oil palm plants can increase fresh fruit yields per bunch, increase bunch weight, and increase the number of bunches produced. The presence of the oil palm pollinator insect *E. kamerunicus* in plantations is beneficial in increasing the percentage of fruit formation by 15-20% (Yue et al., 2015). The average bunch weight increased from 14.1 kg to 28.6 kg. Fresh fruit yields per bunch increased by 12%, and seeds increased from 4.4% to 6.2% (Solin et al., 2019). In addition, since it was first released in Indonesia in 1982, it has significantly increased palm oil productivity from 40% to 60% (Aminah, 2011).

Biologically, the *E. kamerunicus* beetle is a monophagous insect, so it can only feed and reproduce well on one type of host plant, especially the male flowers of oil palm. This beetle reproduces well on male flowers, so it does not require re-dispersal in plantations. This beetle can reach female flowers located on the inner bunches, so that pollination is more perfect (Labarca et al., 2007). The effectiveness

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of *E. kamerunicus* pollination is influenced by several factors, including population abundance and frequency of visits to female flowers. When the *E. kamerunicus* population is high, fruit bunch production is high. Conversely, fruit bunch production is low if the *E. kamerunicus* population is low. In addition, *E. kamerunicus* has a high frequency of visits to female flowers compared to other pollinating insects (Kurniawan, 2010). In addition to population abundance and frequency of visits, the effectiveness of *E. kamerunicus* is also thought to be influenced by the decreasing aggressiveness of *E. kamerunicus* in Kalimantan (Prasetyo & Susanto, 2012).

In general, insect preferences or preferences are influenced by color and odor (Mardhotillah, S. 2012). Most insects have an ultraviolet light receptor system, making them more sensitive to light in this color range (Sihombing et al., 2013). Light in a certain brightness or intensity can attract insects. Meanwhile, the attraction of E. *kamerunicus* comes to oil palm flowers because of the presence of volatile compounds (Anggraeni et al., 2013). *E. kamerunicus* is reported to like certain concentrations of estragole (Fahmi et al., 2021). Identification of volatile compounds in male oil palm flowers reported the presence of undecanoic acid, palmitic acid, estragole, 2-nonanoic acid, and 1-dodecyne compounds, while in female flowers are farnesol, chlo roacetic acid, 4-tetradecyl ester, palmitic acid, and squalene (Anggraeni et al., 2013). Other research results reported that several synthetic attractant compounds that attract *E. kamerunicus* insects in sequence are estragole, farnesol, 1-dodecyne, squalene, 2-nonynoic acid, palmitic acid, chloroacetic acid-4 tetra decyl ester, and ethyl-undecanoic (Rahayu, 2009). Meanwhile, research results (Fahmi et al., 2016) showed that *E. kamerunicus* responded well to synthetic estragole at a concentration of 100 ppm in the laboratory. Studies on the effect of color on insect behavior have been widely conducted. However, there has been no research on the effect of the combination of the use of estragole as a synthetic pheromone and trap color on the attraction of oil palm pollinating insects, *E. kamerunicus,* and its relationship with the pollination process. This study can be measured from the behavior of visits to female flowers during blooming. Includes the rate of visits, the duration of visits per flower, and the length of activity in each treatment of attractant application and trap color.

Material and Methods

Research location

E. kamerunicus observation activity was conducted in an oil palm plantation in South Kalimantan from August to September 2025 in Block E35, covering an observation area of 9.58 hectares.

Materials and equipment

The equipment used during the research was a digital camera, a stopwatch, colored plastic bags (yellow, blue, and red) with dimensions 30 x 5 cm, to trap *E. kamerunicus* on female flowers, and an HTC-1 digital thermohygrometer to measure ambient temperature and humidity.

Experimental design

The research design used was a non-factorial Randomized Block Design (RBD), with six treatments and three replications. The factors studied were the combination of trap color and estragole (W), consisting of W1E = blue trap + 5 ml estragole, W2E = yellow trap + 5 ml estragole, and W3E = red trap + 5 ml estragole, W1N = blue trap + non estragole, W2N = yellow trap + non estragole, and W3N = red trap + non estragole.

Trap installation

Eighteen traps were set at each location and left in the field the following morning, with traps replaced every hour. A minimum distance of 27 meters between traps was maintained. Traps were placed on plants when the female flowers were fully open, up to seven days after blooming (Figure 1).

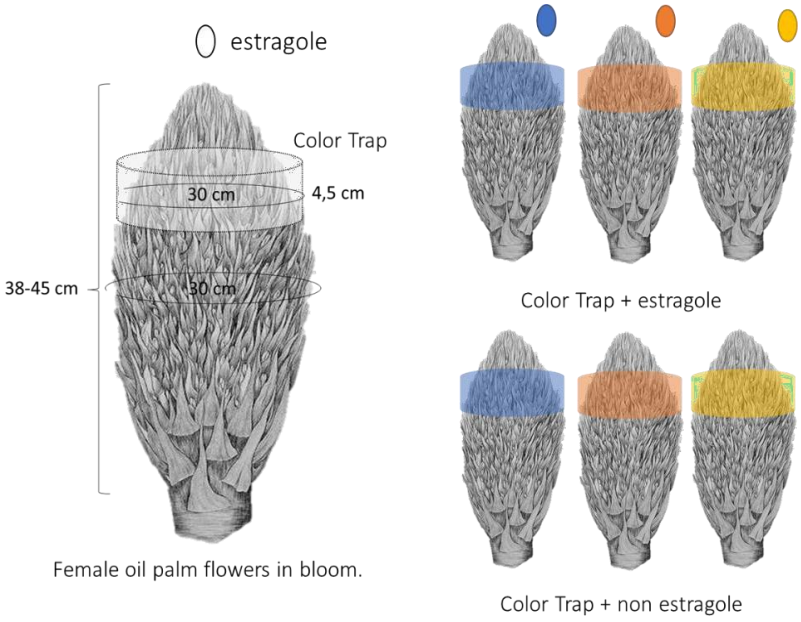


Figure 1. Illustration of trap installation

Observation of E. kamerunicus visit frequency

The female flowers used for observation were open (*receptive*) at blooming. Observations of *E. kamerunicus* visits to female flowers were conducted using the fixed sample method between 7:00 AM and 12:00 PM. During each time period, observations were made by setting traps for 1 hour. Insects caught in the traps were stored for counting (Kahono et al., 2012). In addition, temperature and humidity measurements were also taken using an HTC-1 digital thermohygrometer. In addition to observing the attraction during the morning-to-afternoon period, observations of the visiting activity of *E. kamerunicus* beetles to the pistils of female oil palm flowers were also carried out during a 1-week observation period starting from the receptive flower to the post- receptive flower.

Sample handling

Trapped insects were collected in collection bottles filled with alcohol and counted. The samples were then identified in the laboratory using insect identification books (Cholid & Winarno, 2006).

Data analysis

The number of insect species captured in each treatment was calculated, and the sex ratio. Data were processed descriptively and quantitatively.

Results and Discussion

The effect of color and synthetic pheromone traps on E. kamerunicus

Observations of insects were carried out in the morning until noon, from 07.00-12.00 WITA. Pollinators generally make visits in the morning, starting from 07.00-10.00, which coincides with the time when the flowers bloom (Cholid & Winarno, 2006). This is influenced by the concentration of nectar in flowers, which is high in the morning and continues to decrease until the afternoon, so that it affects insect visits to plants (Dudareva & Pichersky, 2006). Insects also have a daily biological clock, where the ability of insects to determine the time for insects when to carry out activities and when to rest. In addition, insects visit oil palm flowers because there are attractants, namely pollen and nectar (primary attractants) and the aroma of volatile compounds (secondary attractants) (Pratama, 2014).

The results of the study showed that the difference in color trap treatments with estragole and non-estragole affected the activity of *E. kamerunicus* beetles visiting the female flower pistils of oil palm. The yellow trap treatment with estragole was the most effective in attracting beetles compared to other

treatments. The highest visits occurred on the yellow trap with estragole, with a peak visit time of 10:00-11:00 WITA, with a temperature of 31.4 °C and a humidity of 84% (Figure 2). This is because the yellow color provides a high visual contrast that is easily detected by the *E. kamerunicus* beetle's vision system (Gintoron et al., 2023). In addition, the addition of synthetic estragole was able to attract *E. kamerunicus* beetles because its scent resembles the volatile compounds emitted by blooming female flowers. This is in line with research (Anggraeni et al., 2013) that the volatile compounds of female flowers are dominated by estragole compounds.

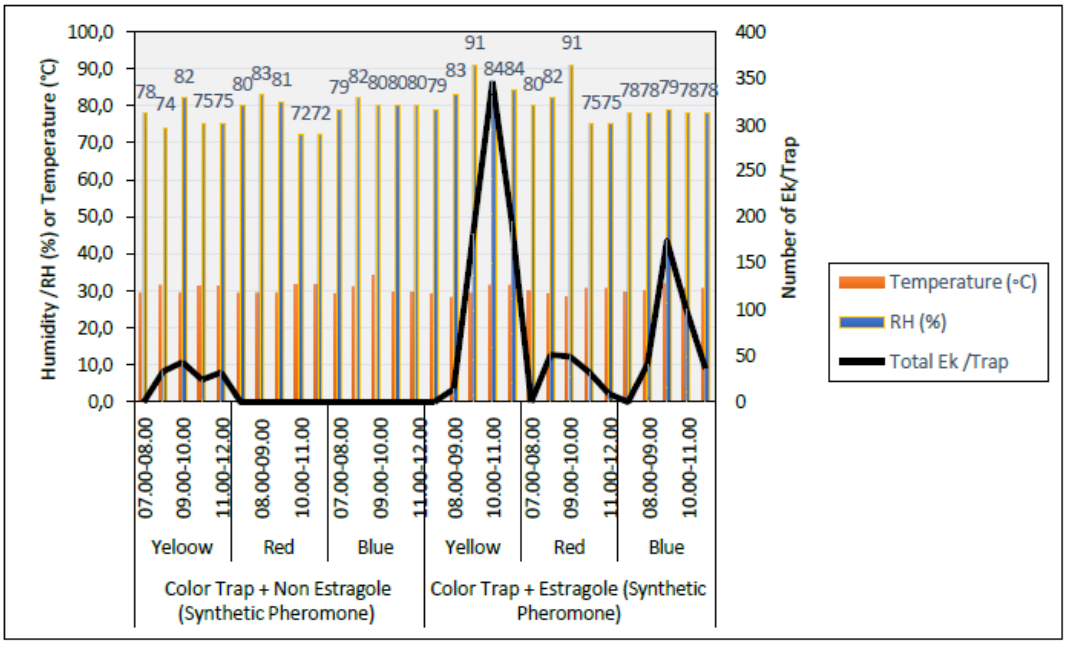


Figure 2. Average number of Elaeidobius kamerunicus captured per trap per hour

Daily Trap Catches of Weevils E. Kamerunicus

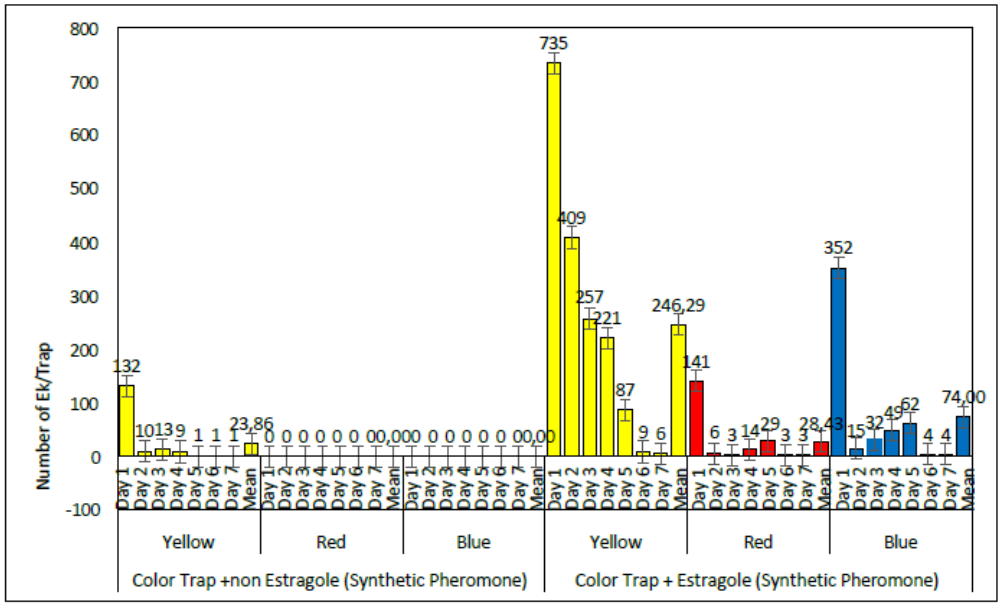


Figure 3. Daily mean catch of *Elaeidobius kamerunicus* per trap

This aims to investigate the effect of treatment on visiting activity at different phases of flower bloom. The results of the study showed a pattern of decreasing number of visits in line with changes in the flower phase from bloom to post-bloom. However, what is interesting in this observation is that the trap treatment with estragole was still able to attract visits from *E. kamerunicus* beetles even though they had passed the receptive phase. The results showed that the highest average daily catch of *E. kamerunicus* beetles during the 7-day study period occurred in the yellow trap treatment with estragole, amounting to 246.29 beetles (Figure 3). In general, the daily catch of the color trap treatment group with estragole, including both yellow, red, and blue, was higher than that of the group without synthetic estragole. The red and blue treatments without estragole were unable to catch beetles. Therefore, in the treatment without estragole, the yellow color was able to attract the arrival of *E. kamerunicus* beetles. This is in accordance with (Fahmi-Halil et al., 2021). Insects generally have a type of vision that can absorb bright yellow colors, which can influence their attraction and activity.

Influence of temperature and micro-humidity on the total catch of Weevils E. kamerunicus

In addition to the number of catches for each treatment trap, other parameters observed in this study were rainfall and light intensity measurements at the research location during the 7-day observation period. (Figure 4). This was done to see whether there was a relationship between environmental factors and the abundance of *E. kamerunicus* insects. According to Faradila et al. (2020), the activity of pollinator insects can be influenced by light responses, so that there are types of pollinator species that are active in the morning, afternoon, and evening. Sunlight is needed by insects and is used as a marker for certain activities. Specifically, insect vision is influenced by the intensity of light around it, so that light intensity can affect the presence of insects in the environment. Up to the 7-day observation period, solar radiation and rainfall conditions have not been related to the population or abundance of *E. kamerunicus* beetles that visited and were caught in traps while visiting female flowers during the observation period (Figure 4).

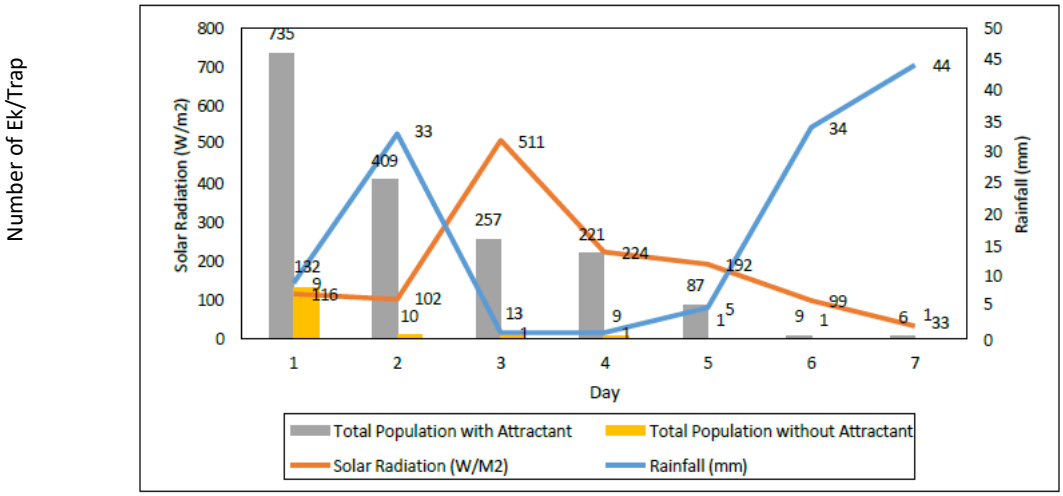


Figure 4. Relationship between solar radiation and rainfall on the weevil population

Several other environmental factors that can have an influence include temperature and humidity. This is as explained in research, where humidity affects the presence of insects, where the higher the humidity, the more insects, such as *E. kamerunicus*, that come. Humidity is the amount of water vapor contained in the air. In other words, the increasing population of *E. kamerunicus* insects that come around the anthesis of oil palm flower canopies is influenced by the more humid environmental conditions around the flower canopies (Chairudin et al., 2019). Insects have a certain body temperature range for insects to survival, and the insects can die if their body temperature exceeds the tolerance temperature. Insects are poikilothermic organisms, so their body temperature depends on the temperature of the surrounding environment. Changes in air temperature can affect the metabolism of insects. The minimum body temperature tolerance of insects is 15°C, and the maximum is at 45°C, while insects have an optimum

body temperature of around 25°C for breeding (Taradipha et al., 2019). Thus, humidity in the flower environment affects the population of pollinating in- sects. *E. kamerunicus* around the flower canopies on oil palm trees. However, in this study, the influence has not been seen.

Sex ratio of captured weevils E. kamerunicus

Sex ratio is a number that shows the comparison between male and female species in a population. The comparative value, among others, is related to the way they breed, which is very important in determining the rapid growth of the population. To identify and differentiate male and female *E. kamerunicus*, the available identification key is used (Walker 2011). The body length of male *E. kamerunicus* is 3–4 mm, while the body length of females is smaller, namely 2–3 mm. Male beetles have prints at the base of the elytra, while female beetles do not have prints. On the abdomen of males, there are fine hairs that are more numerous than female beetles, which only have a few fine hairs. The snout of male beetles is shorter than that of female beetles. Based on the results of servations, both male and female beetles are attracted to enter the trap. However, the capture rate of female beetles is much higher than that of females, namely the sex ratio value in the average experiment of 1:4, or 19% males compared to 81% (Figure 5). With this figure, if the food conditions are sufficient, the female's reproductive power is high enough, then its survival will be sustainable.

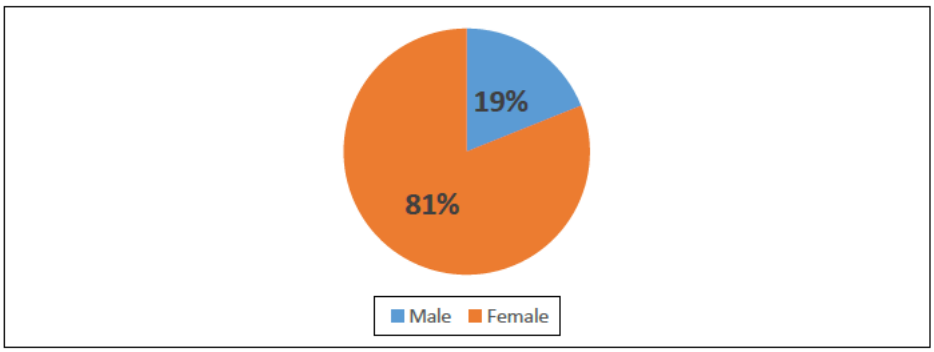


Figure 5. Sex composition of captured *Elaeidobius kamerunicus* over seven days of sampling (%)

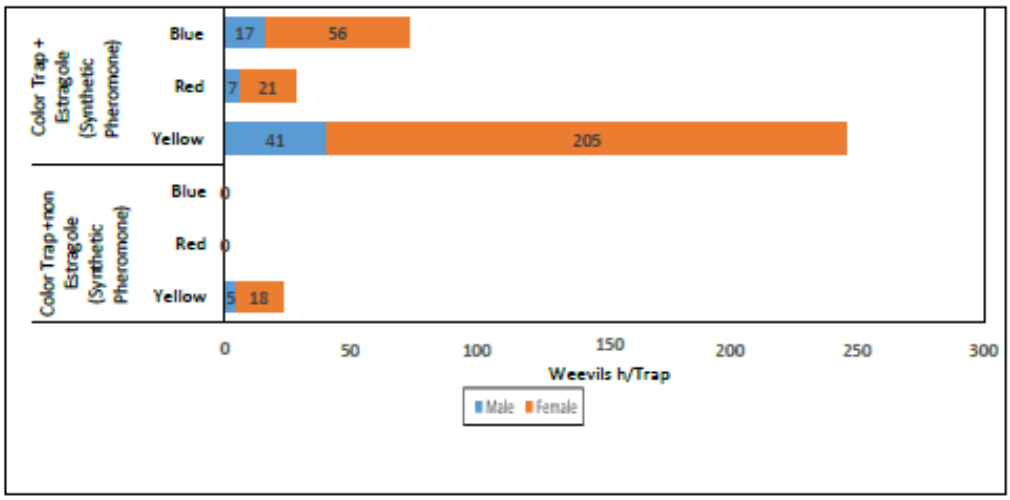


Figure 6. Mean catch of weevils' *E. kamerunicus* per trap

Meanwhile, when viewed from the distribution based on the treatment, the sex ratio value of females is indeed higher than that of males for all treatments, both color traps with estragole as a synthetic pheromone and color traps without estragole. The highest beetle collection results in the

yellow treatment with estragole indicate a sex ratio of 1:5 between males and females (Figure 6). The same sex ratio value was also found in the blue and red trap treatments with estragole, namely 1:3. This proportion value greatly influences the sustainability of insects in the generative phase. Estragole, in this case, can also provide the effect of the male aggregation pheromone used in this study, which can attract more female beetles. Females actively move and disperse more than males to find their mating partners to produce offspring.

Conclusion

The difference in color trap treatments with estragole and non-estragole affected the activity of E*. kamerunicus* beetles visiting the female flower pistils of oil palm. The yellow trap treatment with estragole was the most effective in attracting beetles compared to other treatments. The highest activity of *E. kamerunicus* beetle visits to the female flower pistils of oil palm was found at 10:00-11:00 WITA with a temperature of 31.4 °C and a humidity of 84% in the yellow trap treatment with attractant. Meanwhile, the highest yellow trap treatment without attractant estragole was found at 09:00-10:00 WITA with a temperature of 29.2 °C and a humidity of 82%. The conditions of solar radiation and rainfall had no relationship with the population of *E. kamerunicus* beetles visiting female flowers during the observation period.

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