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POPULATION OF POLLINATING INSECTS (*Elaeidobius kamerunicus* Faust) ON OIL PALM PLANTS IN SIMALUNGUN REGENCY NORTH SUMATRA

Eka Bobby Febrianto[1*], Chairul Maulana Nasution[1], M. Yusuf Dibisono[2], Gali Rakasiwi[3]

[1]Department of Plantation Cultivation, Vocational Faculty, Institut Teknologi Sawit Indonesia, Medan, Indonesia

[2]Department of Plant Protection, Faculty of Science and Technology, Institut Teknologi Sawit Indonesia, Medan, Indonesia

[3]Department of Agrotechnology, Faculty of Agriculture, Universitas Al Azhar Medan, Medan, Indonesia

Email: eka_bobby@itsi.ac.id

*korespondensi

Abstract

The population of the oil palm pollinating beetle, Elaeidobius kamerunicus Faust, is an important biological indicator for assessing the adequacy of pollination and fruit set formation in oil palm plantations. This study aimed to measure the population and sex ratio of E. kamerunicus on male oil palm flowers in the anthesis phase from two planting years, namely 2013 and 2016. The study was conducted at PT. Perkebunan Nusantara IV Regional II, Afdeling VI, located in Dolok Batu Nanggar Subdistrict, Simalungun Regency, North Sumatra Province. The study took place from June to September 2023. It employed a survey method, and no experimental treatments were applied. Data analysis utilized descriptive statistics (mean and standard deviation) as well as Welch's t-test to compare the two planting years. The results showed that the 2016 growing season had a slightly higher number of male inflorescences per observation plot, while the 2013 growing season had a significantly higher number of grains per panicle and a significantly higher estimated population of E. kamerunicus. The average population in the 2013 growing season reached 29,017.69 adult individuals ha^{-1}, whereas in the 2016 growing season, the average was 19,098.41 adult individuals ha^{-1} and slightly below the commonly used minimum threshold of approximately 20,000 adult individuals ha^{-1}. The sex ratio was dominated by females in both growing seasons, with no significant difference between them.

Keywords: oil palm, Elaeidobius kamerunicus, pollinator population, sex ratio, anthesis, planting year

Abstrak

Populasi kumbang penyerbuk kelapa sawit, Elaeidobius kamerunicus Faust, merupakan indikator biologis penting untuk menilai kecukupan penyerbukan dan pembentukan fruit set pada perkebunan kelapa sawit. Penelitian ini bertujuan untuk mengukur populasi dan rasio jenis kelamin E. kamerunicus pada bunga jantan kelapa sawit fase antesis dari dua tahun tanam, yaitu 2013 dan 2016. Penelitian ini dilakukan di PT. Perkebunan Nusantara IV Regional II, Afdeling VI, yang berlokasi di Kecamatan Dolok Batu Nanggar, Kabupaten Simalungun, Provinsi Sumatera Utara. Penelitian berlangsung dari bulan Juni hingga September 2023. Penelitian ini menggunakan metode survei dan tidak ada perlakuan eksperimental yang diterapkan.Analisis data menggunakan statistik deskriptif (rata-rata, dan simpangan baku) serta uji t Welch untuk membandingkan dua tahun tanam. Hasil penelitian menunjukkan bahwa musim tanam 2016 memiliki jumlah perbungaan jantan yang sedikit lebih tinggi per petak pengamatan, sedangkan musim tanam 2013 memiliki jumlah butir per malai yang jauh lebih tinggi dan perkiraan populasi E. kamerunicus yang jauh lebih tinggi. Populasi rata-rata pada tahun tanam 2013 mencapai 29.017,69 individu dewasa ha^{-1}, sedangkan pada tahun tanam 2016 rata-rata 19.098,41 individu dewasa ha^{-1} dan sedikit di bawah ambang batas minimum yang umum digunakan yaitu sekitar 20.000 individu dewasa ha^{-1}. Rasio jenis kelamin didominasi betina pada kedua tahun tanam, tanpa perbedaan yang signifikan di antara keduanya.

Kata Kunci: Kelapa sawit; Elaeidobius kamerunicus; populasi penyerbuk; rasio jenis kelamin; antesis; tahun tanam

1. Pendahuluan

Oil palm (Elaeis guineensis Jacq.) is a monoecious crop in which male and female inflorescences are borne on the same palm, but anthesis of male and female flowers commonly occurs at different times. This flowering pattern promotes cross-pollination and makes pollen transfer by insects essential for adequate fruit formation (Adam et al., 2005; Sukariawan et al., 2021).

Elaeidobius kamerunicus Faust (Coleoptera: Curculionidae) is widely recognized as the major pollinator of oil palm. The weevil develops and feeds on anthesising male inflorescences and subsequently visits receptive female inflorescences, enabling pollen transfer. Pollination effectiveness is influenced by multiple factors, including the abundance of E. kamerunicus, climatic conditions, planting material, inflorescence phenology, and the sex ratio of oil palm inflorescences (Yousefi et al., 2020).

Low fruit set remains an important concern in several oil palm-growing areas because inadequate pollination can reduce bunch weight and the proportion of developed fruits (Lubis et al., 2017). Previous studies reported that oil palm fruit set is related to the density and activity of pollinating weevils, and a minimum population of approximately 20,000 E. kamerunicus individuals per hectare has frequently been used as a practical threshold for adequate pollination in the field (Riley et al., 2022).

The population of E. kamerunicus is closely associated with the availability and quality of anthesising male inflorescences, because these structures provide feeding and breeding resources for the weevil. Older palms may produce larger male inflorescences with more spikelets, while the abundance and composition of flower-visiting insects can also vary with tree age, flower type, planting material, and environmental conditions (Rizali et al., 2019).

Although studies on E. kamerunicus have been conducted in several Indonesian and international oil palm plantations, local field information remains necessary because pollinator abundance may vary among regions and management systems. Many previous studies have documented the abundance of E. kamerunicus in various oil palm-growing regions, but research from Simalungun Regency remains limited, particularly within PT. Perkebunan Nusantara IV Regional II. Simalungun Regency is one of the intensively managed oil palm-producing areas in North Sumatra, where oil palm trees. Therefore, this study aimed to quantify the population and sex ratio of E. kamerunicus on anthesising male inflorescences of oil palm from two planting years (2013 and 2016) in Simalungun, North Sumatra. The study specifically compared the number of anthesising male inflorescences, spikelets per panicle, estimated weevil population per hectare, and the proportion of male and female weevils.

2. Bahan dan Metode

2.1 Place and Time of Research

The study was conducted at PT. Perkebunan Nusantara IV Regional II, in Division VI, located in Dolok Batu Nanggar Subdistrict, Simalungun Regency, North Sumatra Province. The study took place from June until September 2023.

2.2 Tools and Materials

The materials used in this study included anthesis male flowers, 96% alcohol, and Eladobius kamerunicus insects.

The tools used in this study included pruning shears, clear plastic bags, small spray bottles, lidded containers, a hand counter, a magnifying glass, and rubber bands.

2.3 Research Design

This study used a survey method and did not involve any experimental treatments; therefore, the planting year was treated as the primary field grouping factor. Sampling was conducted purposefully by selecting blocks containing male inflorescences that were in bloom during the observation period. The observation units consisted of 67 plot observations: 51 plots from the 2016 growing season and 16 plots from the 2013 growing season. The 2016 growing season comprised 25 sample blocks, while the 2013 growing season comprised 8 sample blocks.

Within each observation plot, anthesising male inflorescences were identified and counted. For each selected male inflorescence, the total number of spikelets per panicle was recorded. To estimate E. kamerunicus population, three spikelets from each of the lower, middle, and upper sections of the panicle were sampled, giving nine spikelets per panicle, following the sampling principle used by Asmawati et al. (2019). Adult weevils collected from the sampled spikelets were counted and separated by sex using morphological characteristics.

2.4 Implementation of Research Phases

The research process began with selecting sample locations, identifying male flowers in anthesis on the plants, counting the number of male flowers in anthesis per hectare, and counting and identifying male and female beetles.

2.5 Observation Parameters

The observed parameters were: (1) number of anthesising male inflorescences per observation plot, (2) number of spikelets per male inflorescence panicle, (3) estimated population of adult E. kamerunicus per hectare, and (4) percentage of male and female E. kamerunicus per hectare.

2.6 Data analysis

Data were analysed using descriptive statistics, including mean, standard deviation, minimum, and maximum. Comparisons between the 2013 and 2016 planting years were performed using Welch's independent-samples t-test because the number of observation units differed between groups. A probability value of $p < 0.05$ was considered statistically different. Because this study was observational and conducted in a single plantation division, statistical results were interpreted as field-level comparisons rather than causal experimental effects. The population of E. kamerunicus per panicle was estimated by multiplying the average number of adult weevils per sampled spikelet by the total number of spikelets in the panicle:

$$\text{Population per panicle} = \text{Mean number of E. kamerunicus per sampled spikelet} \times \text{Total number of spikelets per panicle} \quad (1)$$

The estimated population per hectare was calculated by multiplying the estimated population per panicle by the number of anthesising male inflorescences per hectare:

$$\text{Population per hectare} = \text{population per panicle} \times \text{number of anthesising maleinflorescences per hectare} \quad (2)$$

The sex percentage was calculated using the following formulas:

$$\text{Male (\%)} = (\text{number of male E. kamerunicus} / \text{total E. kamerunicus population}) \times 100 \quad (3)$$

$$\text{Female (\%)} = (\text{number of female E. kamerunicus} / \text{total E. kamerunicus population}) \times 100 \quad (4)$$

3. RESULTS AND DISCUSSION

3.1 Anthesis of Male Inflorescences and Spikelet Number

Table 1. Anthesising male inflorescences and spikelet number by planting year

Planting Year	n	Male Inflorescences (mean ± SD)	Spikelets Panicle (mean ± SD)
2013	16	3.75 ± 0.58	147.69 ± 4.01
2016	51	4.16 ± 0.54	86.57 ± 2.40

Based on Table 1, the number of anthesising male inflorescences per observation plot was slightly higher in the 2016 planting year (4.16 ± 0.54) than in the 2013 planting year (3.75 ± 0.58), and the difference was statistically significant (Welch's t-test, $p = 0.020$). However, the 2013 planting year had a much higher number of spikelets per panicle (147.69 ± 4.01) than the 2016 planting year (86.57 ± 2.40), with a significant difference ($p < 0.001$). This indicates that the older palms did not necessarily produce more anthesising male inflorescences per observation plot. Still, each male inflorescence had a larger reproductive structure, as reflected by the higher number of spikelets.

This result is consistent with the biological relationship between oil palm reproductive development and pollinator resources. Anthesising male inflorescences are important because they provide pollen, food, and breeding sites for E. kamerunicus. Rahardjo et al. (2018) reported that increasing oil palm age affected the population of E. kamerunicus on male inflorescences. Sari and Emmi (2023) emphasized that pollination effectiveness depends not only on the presence of weevils but also on inflorescence phenology, climate, and plantation-level conditions. Therefore, the larger number of spikelets in the 2013 planting year may have increased the available habitat and resource surface for E. kamerunicus.

The field trend is shown in Figure 1. Although the 2016 planting year recorded more anthesising male inflorescences per plot, the much larger spikelet number in the 2013 planting year suggests that inflorescence size and resource availability should be considered alongside the number of anthesising male flowers when interpreting pollinator carrying capacity.

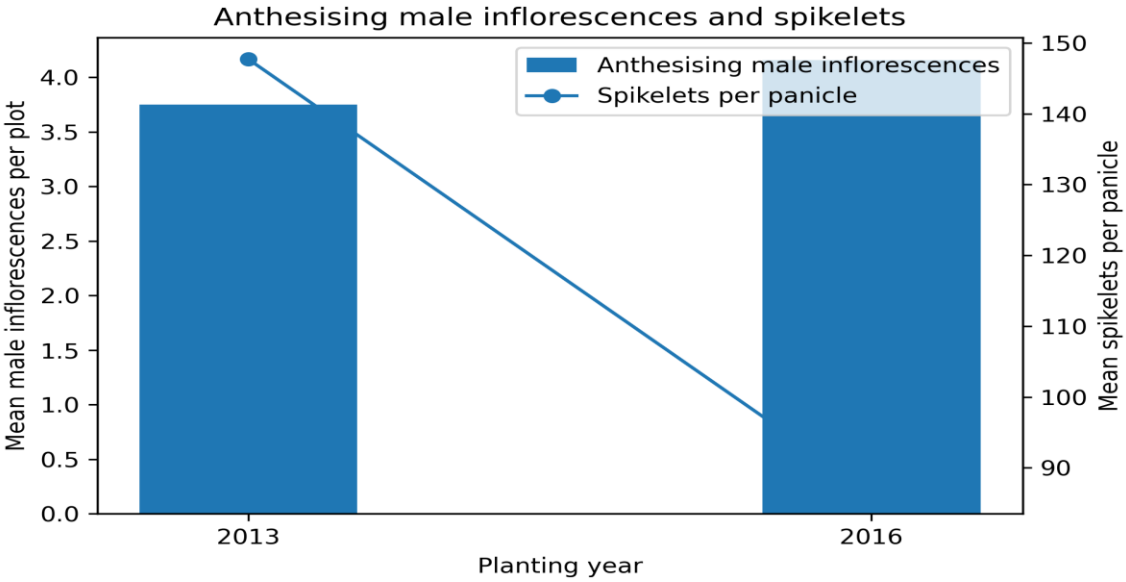

Figure 1. Mean anthesising male inflorescences and spikelets per panicle by planting year.

3.2 Estimated Population of E. Kamerunicus Per Hectare

Table 2. Estimated E. kamerunicus population by planting year

Planting year	n	Total population ha-1 (mean ± SD)	Males ha-1 (mean ± SD)	Females ha-1 (mean ± SD)
2013	16	29,017.69 ± 4,122.71	7,699.81 ± 1,547.30	21,317.88 ± 3,534.12
2016	51	19,098.41 ± 1,983.36	4,984.57 ± 934.60	14,113.84 ± 1,489.63

Based on Table 2, the estimated E. kamerunicus population was significantly higher in the 2013 planting year than in the 2016 planting year. The 2013 planting year recorded a mean population of 29,017.69 ± 4,122.71 adults ha-1, whereas the 2016 planting year recorded 19,098.41 ± 1,983.36 adults ha-1 ($p < 0.001$). The maximum population observed in the 2013 planting year was 35,804 adults ha-1, while the maximum in the 2016 planting year was 23,268 adults ha-1. Male and female populations were also higher in the 2013 planting year ($p < 0.001$).

The higher weevil population in the 2013 planting year can be explained by the larger number of spikelets per male inflorescence. Since E. kamerunicus uses anthesising male inflorescences as feeding and reproductive sites, a larger male inflorescence may support a larger adult weevil population. This agrees with Siswanto and Soetopo (2020) who found that older oil palms were associated with increased E. kamerunicus populations on male inflorescences. Similarly, Prabowo et al. (2021) reported significant variation in E. kamerunicus population density among oil palm planting materials and found that population density was related to male inflorescence characteristics during anthesis.

The mean population in the 2016 planting year was slightly below the practical threshold of approximately 20,000 individuals ha-1 cited in Indonesian oil palm pollination studies (Kahono et al., 2012). This condition may indicate a potential pollination risk if it persists during periods of high female flower receptivity. The relationship between pollinator population and fruit-set performance has also been demonstrated in oil palm, where pollinator density is positively related to fruit-set and fruit-to-bunch characteristics (Cascante-Marín et al., 2025). Therefore, the 2016 planting year requires closer monitoring to ensure that E. kamerunicus availability is sufficient when female inflorescences reach anthesis.

Figure 2 shows the mean total, male, and female populations by planting year. The dashed horizontal line represents the 20,000 adults ha-1 reference threshold. The 2013 planting year was above this threshold, while the 2016 planting year was slightly below it.

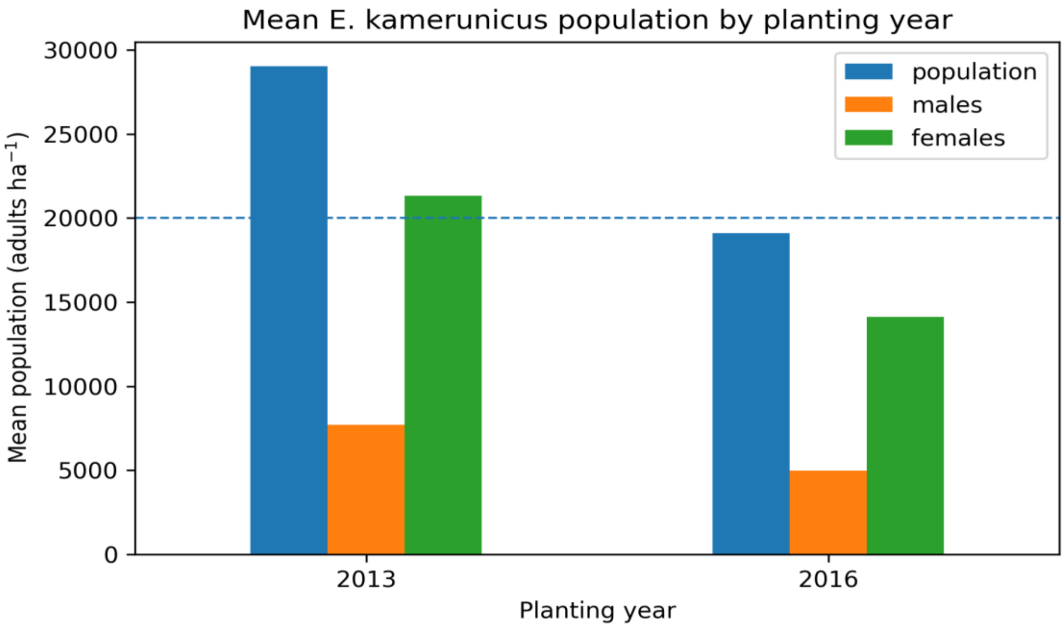

Figure 2. Mean E. kamerunicus population by planting year. Dashed line indicates 20,000 adults ha-1 reference threshold.

3.3 Sex Ratio of E. Kamerunicus

Table 3. Percentage of male and female E. kamerunicus by planting year

Planting year	n	Male (%) mean ± SD	Female (%) mean ± SD
2013	16	26.62 ± 4.21	73.38 ± 4.21
2016	51	26.02 ± 3.51	73.98 ± 3.51

Based on Table 3, the sex ratio of E. kamerunicus was female-biased in both planting years. In the 2013 planting year, females represented 73.38 ± 4.21% of the total population, while males represented 26.62 ± 4.21%. In the 2016 planting year, females represented 73.98 ± 3.51%, while males represented 26.02 ± 3.51%. The difference in male and female percentages between the two planting years was not statistically significant ($p = 0.609$), indicating that the overall sex-ratio structure was relatively similar between planting years despite the difference in total population size.

A female-biased population structure has also been reported by Yue et al. (2015), who observed that the sex ratio of E. kamerunicus on oil palm inflorescences tended to be biased toward females. Swaray et al. (2021) also reported a higher female population than male population across oil palm hybrids on peat soil. Muhammad et al. (2023) Biologically, the dominance of female adults may support future population maintenance because females determine egg production. However, this interpretation should be made cautiously because population growth also depends on the availability of anthesising male inflorescences, pollen resources, larval survival, microclimate, predation, parasitism, and pesticide exposure.

Thus, although both planting years had a favourable female-biased sex ratio, the lower total population in the 2016 planting year suggests that sex ratio alone is not sufficient to assess pollination adequacy. Plantation management should monitor both the total number of E. kamerunicus adults and the availability of anthesising male inflorescences.

3.4 Implications for Fruit Set and Plantation Management

Based on the findings, the 2016 planting year should not be interpreted as having a poor pollination condition solely because its population was slightly below the reference threshold. Rather, it should be considered a block requiring intensified monitoring, especially when many female inflorescences enter the receptive phase. Management actions may include routine monitoring of anthesising male inflorescences, minimizing insecticide disturbance during pollinator-active periods, and ensuring that male-flower availability is sufficient to sustain E. kamerunicus populations. Future studies should integrate direct fruit-set measurements, bunch weight, microclimatic records, pesticide-use history, and block-level management data. Such integration would allow a stronger test of whether the observed differences in spikelet availability and pollinator population translate into yield consequences.

4. Conclusion

The results of this study indicate that the 2016 growing season had a slightly higher number of flowering male inflorescences per observation plot, while the 2013 growing season had a significantly higher number of grains per panicle and an estimated significantly higher population of E. kamerunicus. The average population in the 2013 planting year reached 29,017.69 adult individuals ha^{-1}, while the 2016 planting year averaged 19,098.41 adult individuals ha^{-1} and was slightly below the commonly used minimum threshold of approximately 20,000 adult individuals ha^{-1}. The sex ratio was female-biased in both planting years, with no significant difference between them. Analytically, these results indicate that the carrying capacity of flowering male inflorescences, represented by the number of anthers, is more informative than the number of male inflorescences alone for explaining the abundance of E. kamerunicus. Practically, the 2016 planting block requires stricter monitoring and management of pollinators to reduce the risk of inadequate pollination. Further research should evaluate fruit set, cluster weight, microclimate, and management factors to determine whether the observed population differences impact pollination success and yield.

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