

The Effect of Hatch and Carry Distance of *Elaeidobius Kamerunicus* on Fruit Set and Bunch Weight of Oil Palm (*Elaeis guineensis* Jacq.)

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Article History: Received: 06 January 26,, Final Revision: 16 January 26, Accepted: 26 January 26, Online Publication: 30 January 26

ABSTRACT

Hatch and carry is a breeding and distribution system for the primary pollinator of the oil palm, *Elaeidobius kamerunicus*. Information on the optimal distance for the Hatch and Carry application on pollination success and bunch productivity is still limited. This study aims to determine the effective distance of Hatch and Carry on fruit set and bunch weight in oil palm. The study used a quantitative method with a Completely Randomized Design (CRD), including Hatch and Carry distance treatments at radii of 10 m, 100 m, 200 m, 300 m, and 400 m, as well as assisted pollination techniques as a comparison. Data on fruit set and bunch weight were analyzed using analysis of variance (ANOVA) at the 95% confidence level, followed by the Duncan Multiple Range Test (DMRT). The results showed that the highest fruit set was observed at 10–200 m and was not significantly different, but decreased significantly at 300 m and 400 m. The same pattern also occurred for bunch weight, with the highest value at 100 m. The assisted pollination technique produces fruit set equivalent to the effective Hatch and Carry distance of 10–200 m. This study concluded that the effective distribution range of *E. kamerunicus* is within a radius of 200–300 m; thus, Hatch and Carry technology has the potential to be an efficient alternative for increasing oil palm productivity.

Keywords: Hatch and Carry, *Elaeidobius Kamerunicus*, Fruit Set, Bunch Weight, Oil Palm

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is a strategic plantation commodity whose productivity is primarily determined by the success of the female flower pollination process. In oil palm plantations, the main pollinating insect is the beetle *Elaeidobius kamerunicus*, which naturally increases fruit set and bunch weight [1]. However,

under certain conditions, such as low pollinator populations or uneven distribution, pollination effectiveness can decrease. Therefore, Hatch and Carry technology was developed to increase the population and distribution of *E. kamerunicus* in plantation areas [2]. Although this technology has been implemented, the effective distance of beetle

distribution on oil palm productivity remains to be scientifically studied.

Effective pollination has been shown to correlate directly with increased fruit set and oil palm bunch production. The presence of *Elaeidobius kamerunicus* has been reported to significantly increase fruit set compared to natural pollination without the assistance of primary pollinating insects [3], [4]. However, several studies have shown that the natural distribution of pollinating beetles is often uneven due to factors such as distance, environmental conditions, and the availability of male flowers [5]. Hatch and Carry technology has been applied as a practical solution to increase pollinating beetle populations in the field [6]. However, quantitative studies on the effectiveness of Hatch and Carry distance on oil palm productivity are still relatively limited and show varying results.

Effective pollination has been shown to correlate directly with increased fruit set and oil palm bunch production [7], [8]. The presence of *Elaeidobius kamerunicus* has been reported to significantly increase fruit set compared to natural pollination without the assistance of primary pollinating insects [3], [9]. However, several studies have shown that the natural distribution of pollinating beetles is often uneven due to factors such as distance, environmental conditions, and the availability of male flowers [10]. Hatch and Carry technology has been applied as a practical solution to increase pollinating beetle populations in the field [6]. However, quantitative studies on the effectiveness of the Hatch and Carry distance on oil

palm productivity are still relatively limited.

The main problem with the application of Hatch and Carry technology is the lack of an optimal distance standard that guarantees maximum, efficient pollination effectiveness. Beetle distribution distances that are too close can increase operational costs, while distances that are too far can reduce pollination success. Therefore, this study is important for answering the question of the extent of the effective range of *E. kamerunicus* from the Hatch and Carry point to the level of fruit set and the weight of oil palm bunches. This study hypothesizes that there is an optimal Hatch and Carry distance that yields the highest fruit set and bunch weight compared to longer distances. This study has scientific and practical significance in the development of insect-based oil palm pollination technology. Therefore, this study aims to determine the effective Hatch and Carry distance for fruit set and the weight of oil palm bunches. Scientifically, this study provides quantitative data on the relationships between Hatch and Carry distances and the value of fruit set and the weight of oil palm bunches. Technically, the results of this study can serve as a basis for determining the optimal distribution distance of *E. kamerunicus* in plantations. In addition, this study supports more efficient and sustainable management of oil palm plantations by optimizing the role of natural pollinators. Using an experimental approach and statistical analysis, this research is expected to provide technical recommendations for optimal Hatch and Carry distances.

MATERIALS AND METHODS

Data analysis model

This study used a quantitative approach with a Completely Randomized Design (CRD). The treatments tested consisted of the Hatch and Carry distances of *Elaeidobius cameranicus* from the oil palm tree, namely 10 m, 100 m, 200 m, 300 m, and 400 m, as well as assisted pollination as a control. A data analysis model was used to evaluate the effect of Hatch and Carry distances on fruit set

value and oil palm bunch weight.

Research Variable

The independent variables in this study were the Hatch and Carry distance of *Elaeidobius cameranicus*, while the dependent variables included fruit set (%) and bunch weight (kg). Fruit set was assessed as the percentage of established fruit relative to the number of pollinated female

flowers, and bunch weight was measured at harvest using a digital scale in kilograms (kg).

Research Procedure

The study began with selecting the Hatch and Carry placement location. Next, *Elaeidobius camericus* beetles were prepared and treated with pollen spray. The beetles were then released at the Hatch and Carry point. As a comparison, assisted pollination was performed at other locations with direct pollen spraying. Fruit set was observed after fruit formation, and bunch weight was measured at harvest time. All observation data

were recorded and summarized. Six months after the hatch-and-carry placement, observations were made of oil palm FFB yield within radii of 10 m, 100 m, 200 m, 300 m, and 400 m.

Data Analysis

Fruit set and bunch weight data were analyzed using analysis of variance (ANOVA) based on a Completely Randomized Design (CRD) at a 95% confidence level. If the analysis results showed significant differences, testing was continued with the Duncan Multiple Range Test (DMRT) to determine differences between treatments.

RESULTS AND DISCUSSION

Based on the data analysis, data on fruitset formation and the weight of fresh oil palm fruit

bunches were obtained. The results of the data analysis can be seen in Table 1.

Table 1. Fruitset formation and weight of oil palm bunches with hatch and carry distances

Distance from the hatch and carry box	Average fruit set value (%)	Average bunch weight (kg)
10 m	88.61 a	7.11 ab
100 m	87.38 a	7.59 a
200 m	82.50 a	6.44 ab
300 m	67.58 b	6.16 ab
400 m	62.22 b	5.21 b
<i>Assisted pollination</i>	84.50 a	7.16 ab

Note: The same letters in the same column do not indicate a significant difference based on Duncan's test at a significance level of 95%.

Based on Table 1, the Hatch & Carry distance treatment of *Elaeidobius camericus* significantly affected the formation of fruit set and the weight of oil palm bunches. The highest fruit set values were obtained at distances of 10 m (88.61%), 100 m (87.38%), and 200 m (82.50%), which were not significantly different from the assisted pollination treatment (84.50%), indicating that the release of pollinating beetles at these distances was still effective in supporting the pollination process. Conversely, fruit set decreased significantly at distances of 300 m (67.58%) and 400 m (62.22%), indicating the limited distribution range of beetles from the Hatch & Carry box. A similar pattern also occurred in bunch weight, with the highest weight (7.59 kg) at 100 m and the lowest (5.21 kg) at 400 m. Hatch & Carry treatment

with the release of pollen beetles at a distance of 100 m produced the best combination with a fruit set value of 87.38% and a bunch weight of 7.59 kg.

A Hatch & Carry distance of 100 m provided the best combination of fruit set and bunch weight, with a fruit set value of 87.38% and a bunch weight of 7.59 kg, higher than other distances. This indicates that this distance is within the effective dispersal and foraging range of *E. kamerunicus*, resulting in optimal contact with female flowers. At distances of 10 m to 200 m, fruit set was not significantly different from assisted pollination, indicating that insect pollination still performed well within this radius. Conversely, distances of 300 m and 400 m showed significant decreases in fruit set and bunch weight, indicating limited beetle mobility to reach flowers. This pattern is consistent

with the principle of insect pollination, which is strongly influenced by the distance between the pollinator source and the target flower [11], [12]. Overall, a distance of 100 m was found to be optimal, providing a balance between insect dispersal labor and high production yields.

Several studies have shown that the effectiveness of insect pollination is influenced by the distance to the pollinator, with consequences for fruit set and crop yield. For example, research by Rahimi and Jung [13] showed that the distance between the pollinator source and the target flower significantly influences the effectiveness of insect pollination in agricultural environments. Furthermore, Mohd-Azlan et al. [14] found that the ability of pollinators to reach female flowers decreases with increasing distance between the pollinator source and the flower. The proximity of pollinators to natural habitats can increase their abundance and diversity, such as the beetle *Elaeidobius kamerunicus*, which is crucial for effective pollination [3], [15]. In other crops, proximity to pollinator habitats, such as forests and grasslands, increases crop productivity [16]. Therefore, effective distance-based pollinator management is an efficient agronomic approach to support the productivity of flowering plants. Therefore, the optimal distance of 100 m found in this study is consistent with the general principles of insect pollination in tropical agricultural environments.

However, several studies have shown that insect pollination effectiveness is also influenced by other variables, such as microclimate conditions and vegetation structure, which can weaken the direct relationship between distance and yield [17], [18], [19]. Furthermore, herbicide use in

agricultural practices can influence *E. kamerunicus* population numbers [17]. Some studies even suggest that assisted pollination remains advantageous under conditions of low pollinator populations, as manual control can ensure direct pollen contact. Furthermore, plant genetic variation has been reported to influence flower maturity and receptivity, thereby varying fruitset responses across varieties [20]. These arguments suggest that although distance is an essential factor, its influence cannot be separated from other biotic and abiotic conditions.

This study contributes novelty by empirically determining the effective Hatch & Carry distance based on quantitative data on fruit set and bunch weight, a previously undiscussed topic in the oil palm literature, particularly in the context of *E. kamerunicus* pollinator distribution. Maintaining natural habitats and floral resources in agricultural landscapes can support pollinator diversity and movement, ultimately benefiting crop yields [21], [22]. This study fills a knowledge gap on the spatial effects of pollinator distribution on tropical crop yields and provides practical guidelines for oil palm plantation management. This approach offers new insights into integrating natural pollination technologies to improve production efficiency. The study's contribution lies in enhancing practical understanding of how *E. kamerunicus* release spacing affects oil palm productivity. These findings provide effective agronomic solutions to address productivity challenges and serve as a reference for formulating technical recommendations in the field. Conceptually, this study extends the knowledge framework for effective distance-based pollination management in tropical commodities, providing a basis for further research.

CONCLUSION

This study shows that the Hatch & Carry distance of *Elaeidobius cameranicus* affects fruit set formation and oil palm bunch weight. The treatment of releasing pollen beetles at a distance of 10–200 m resulted in relatively high fruit set and bunch weight values and was not significantly different from the assisted pollination technique.

However, a significant decrease occurred at distances of 300 m and 400 m. The best combination was obtained at a distance of 100 m, with a fruitset value of 87.38% and a bunch weight of 7.59 kg. The results of this study confirm that the Hatch & Carry technology, at an optimal distance of 100 m, is an effective and efficient

alternative for pollination to increase oil palm productivity sustainably. This study was limited to one location and one observation season, so variations in agroclimatic conditions and plantation management were not fully represented.

Further research is recommended to test the Hatch & Carry distance under various environmental conditions and plant ages, and to integrate economic analysis to strengthen the technology's application at the plantation level.

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