Journal of Oil Palm Research Vol. 26 (3) September 2014 p. 195-202

Elaeidobius kamerunicus: APPLICATION OF HATCH AND CARRY TECHNIQUE FOR INCREASING OIL PALM FRUIT SET

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ABSTRACT

The population of Elaeidobius kamerunicus *Faust and its aggressiveness have been on a decline in Indonesia in recent years. This situation has affected the oil palm fruit set. Hatch and carry technique was developed to solve this problem. Larvae and pupae of* E. kamerunicus *present in post anthesis male inflorescences were allowed to hatch in boxes. The hatched adults were sprayed with high viability (≥ 60%) pollens and then released in targeted oil palm plantation. After two months, the population of* E. kamerunicus *in the male inflorescences increased from 2571 weevils per hectare to 51 908 weevils per hectare. The frequency of visits by* E. kamerunicus *to anthesising female inflorencences also increased from 32 weevils per bunch to 604 weevils per bunch. As a result, the fruit set of oil palm up to a distance of 200 m from the hatch and carry boxes increased between 15.04% to 21.05%.*

Keywords: *Elaeidobius kamerunicus*, hatch and carry, pollen, fruit set, oil palm.

Date received: 31 October 2013; **Sent for revision:** 19 December 2013; **Received in final form:** 12 January 2014; **Accepted:** 19 March 2014.

INTRODUCTION

In 1983, the African pollinating weevil, *Elaeidobius kamerunicus* Faust was introduced to Indonesia from Malaysia (Susanto *et al.,* 2007). This insect species improved the oil palm pollination with 26% increase in fruit set and 60% increase in yield (Lubis and Sipayung, 1986). This introduction has significantly contributed to the oil palm industry in Indonesia and has greatly reduced the need for assisted pollination (Lubis and Sipayung, 1987; Susanto *et al*., 2007; Purba *et al*., 2010).

During the early years of introduction, the population of *E. kamerunicus* increased rapidly. Six months after release in North Sumatra, the population reached 57 807 weevils per hectare at 10 male inflorescences per hectare (Hutauruk and Sudharto, 1984). For the last 30 years, the population of *E. kamerunicus* has grown steadily recording high density in oil palm plantations in Indonesia, not only in Sumatra, but also in Kalimantan, Java, Celebes and Papua. Generally, oil palm fruit set value has reached more than 75% through the involvement of this pollinator (Purba *et al.,* 2010; 2011).

Recently, oil palm fruit set in several areas has been reported to achieve only 10% or below. This problem had to be solved by the reintroduction of assisted pollination (Prasetyo *et al*., 2012; Prasetyo, 2013). The low fruit set value indicated that pollination by *E. kamerunicus* has not been optimal due to the low population of the weevil. The main cause of the declining population was predation by rats, which preyed on eggs, larvae, pupae and imago of *E. kamerunicus*. This is followed by other predators such as ants, spiders, mites and

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nematodes (Syed, 1982; Sipayung *et al.*, 1987; Poinar *et al.*, 2002; Aisagbonhi *et al.*, 2004; Krantz and Poinar, 2004). Improper application of insecticides has also contributed to a reduction of *E. kamerunicus* population by 10%-20% in the field (Hutauruk *et al.*, 1985; Purba *et al.*, 2012). Ahmad *et al.* (2012) also reported that cypermethrin was toxic to *E. kamerunicus* whereas *Bacillus thuringiensis* was not toxic to this weevil. Planting of high yielding oil palm planting materials has also affected the populations of *E. kamerunicus*. Such planting materials produce abundant numbers of female inflorescences but with few male inflorescences (Purba *et al.*, 2009; Prasetyo *et al.*, 2012). Optimal number of male inflorescences is important because they not only serve as sources of food but also as the breeding sites for *E. kamerunicus* (Syed, 1982; Eardley *et al.*, 2006). High rainfall also significantly affects the population and aggressiveness of *E. kamerunicus* (Prasetyo *et al.*, 2010).

The correlation between population of *E. kamerunicus* and the fruit set value revealed the need to increase the population density of this weevil. Hatch and carry technique is one method whereby *E. kamerunicus* can be introduced to new areas to help increase the population of the weevil. In principle, this technique involves collection of post anthesis male inflorescences containing larvae and pupae of *E. kamerunicus.* These inflorescences are then placed in specially designed boxes where the larvae and pupae are allowed to hatch. The hatched adult weevils are sprayed with high viability ($\geq$ 60%) pollen and then released into the targeted oil palm plantation. This study aims to find the fruit set values of oil palms at different distances from the hatch and carry boxes. The right density of these boxes could then be determined.

MATERIALS AND METHODS

The study (hatch and carry technique) was undertaken in PT Binanga Mandala plantation, Labuhan Batu Selatan, North Sumatra, from September 2012 to May 2013. The 700 ha of mature, three to four years of palms of La Me progeny was the focus of application. Due to the necessity of high viability pure pollens for the technique, the preparation were carried out in the Plant Protection Laboratory of the Indonesian Oil Palm Research Institute (IOPRI).

Pre Observation

Initial observations were conducted before the application of hatch and carry technique. These observations covered fruit set analysis, number of anthesising male inflorescences per hectare, and *E. kamerunicus* population. These observations were needed to determine the proper locations for placement of hatch and carry boxes.

Analysis of Oil Palm Fruit Set

Oil palm fruit set was analysed using the method described by Susanto *et al*. (2007). Twenty spikelets were taken from each fruit bunch sample; half from the base and half from the top of the bunch. The number of developed fruit and the parthenocarpic fruits were determined from each spikelet (*Figure 1*). The oil palm fruit set value was calculated using the formula:

$$\text{Fruit set value} = \frac{\text{Number of developed fruits}}{\text{Number of developed fruits} + \text{parthenocarpic fruits}} \times 100\%$$

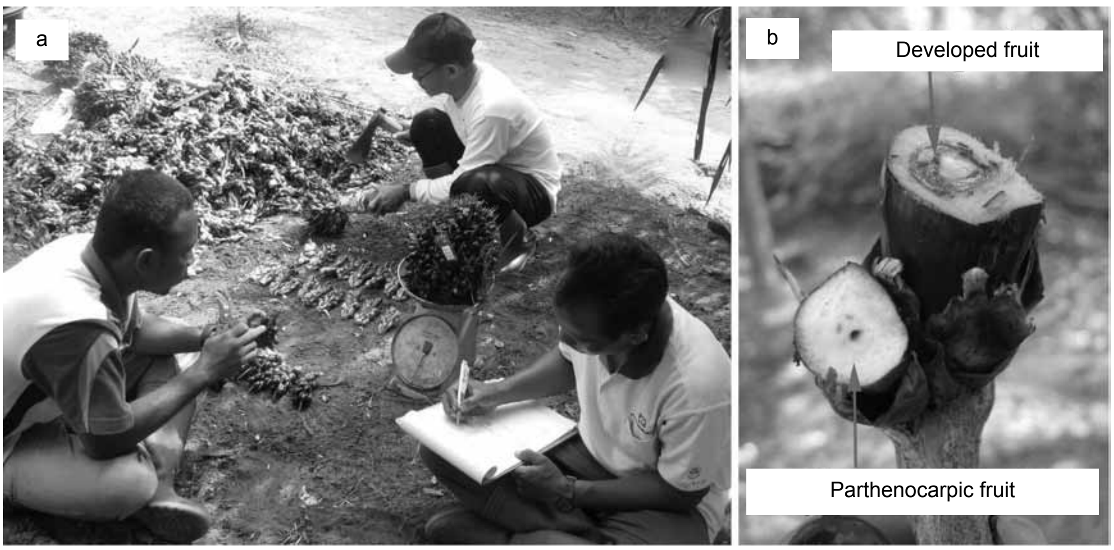

Figure 1. Analysis of oil palm fruit set: (a) counting the developed fruit percentage from 20 spikelets samples, (b) determining the developed and parthenocarpic fruit.

Observation of Anthesising Males

A total of 143 palms were systematically selected in each block for anthesising male inflorescences count. The anthesising males were divided into two groups based on the percentage of anthesis: 25% - 50% and > 50% (*Figure* 2).

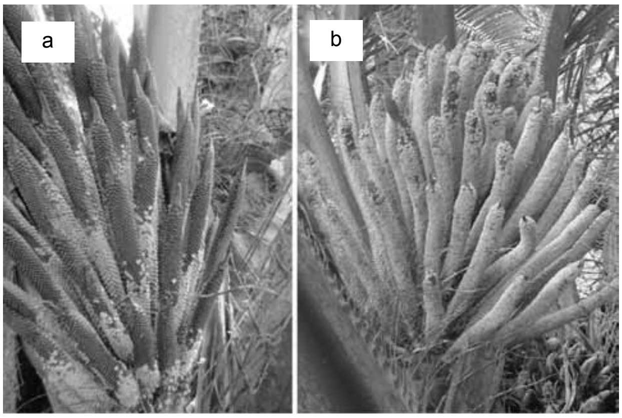

Figure 2. Percentage of anthesising males: (a) 25% - 50%, (b) 75% - 100%.

***Elaeidobius kamerunicus* Population**

From each anthesising male sample, the total number of spikelets was determined by counting. Three spikelets near the end of the inflorescence were then selected for *E. kamerunicus* weevils counting. Selected spikelets were covered with transparent plastic and cotton balls dampened with 1 ml ethyl acetate were put inside the plastic cover to inactivate the weevils trapped inside. The spikelet bases were cut and the inactive weevils were then collected and counted. The average number of weevils in those selected spikelets was assumed as the average weevil population per spikelet. The number of weevils per inflorescence was then calculated by multiplying the average weevil per spikelet with the total spikelets in each anthesising male sample. The population of *E. kamerunicus* weevils per hectare was calculated from the total number of weevils in the anthesising male samples of 143 palms. These observations were conducted at 09:00 to 11:00 am (Susanto *et al*., 2007). The number of *E. kamerunicus* weevils visiting the anthesising female infloresences was also counted every two months. Yellow sticky traps were installed on the anthesising female infloresences at palms in rows 5, 15, 25 and 35 from each block. The yellow sticky traps, 2 cm x 30 cm, that looped around the upper side of infloresence trapped the weevils that come visiting.

Hatch and Carry Application

The hatch and carry technique used in this study consisted of two steps. The first step involved the hatching in boxes of larvae and pupae of *E. kamerunicus* present on the male inflorescences (Prasetyo and Susanto, 2012) (*Figure* 3). The second step was the release of *E. kamerunicus* to the field. In each hatch and carry box, 60 cm x 60 cm x 120 cm, six of four to five days post anthesis male inflorescences were put inside; *E. kamerunicus* adult weevils would later emerge from these inflorescences. Since one life cycle would take 9-12 days to complete, the inflorescences were replaced every 9-12 days. To determine the number of *E. kamerunicus* hatched, five male inflorescences were removed to count the weevil numbers daily. Before release, the weevils were sprayed with 1 g of high viability pure pollens. High viability pollens were obtained based on pollen viability test conducted by germinating oil palm pollens in liquid media containing 8% sucrose and 15 mg of H_3BO_3 (Lubis, 1993). Pollens with percentage of germination ≥ 60% represented the high viability pollen and used for the hatch and carry technique.

Figure 3. Design and placement of hatch and carry box with six post anthesis male inflorescences inside.

The pollen is considered germinated when the pollen tube has reached equal length or more to the length of pollen diameter.

Four hatch and carry boxes were installed in the trial location. The fruit set values of oil palms in five different distances from each box were analysed. The palms selected for the analysis were 10 m, 100 m, 200 m, 300 m, and the 400 m away from the boxes, as illustrated in *Figure 4*. Five fruit bunch samples were taken from palms selected for fruit set analysis. The oil palm fruit bunches from the assisted pollination treatment was used as the positive control (Susanto *et al.*, 2007).

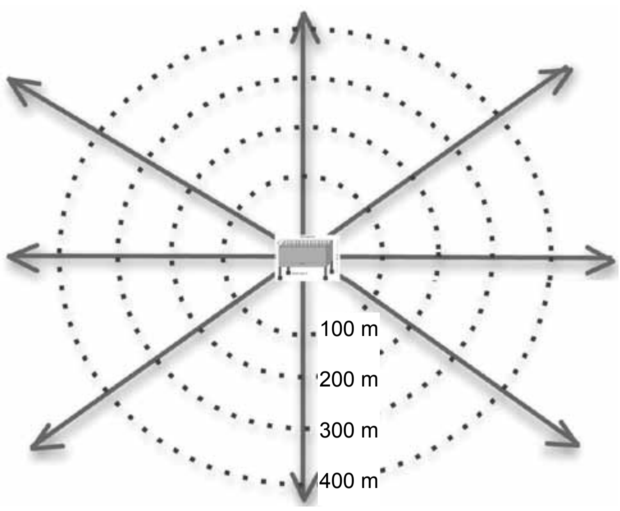

Figure 4. Diagram of hatch and carry box installation with palms at five different distances for fruit set analysis.

As the observation in pre-application, parameters used after the application of hatch and carry technique also covered fruit set analysis, the number of anthesising males per hectare, and *E. kamerunicus* population. The weevil population was counted every two months starting from the beginning of the application.

RESULTS AND DISCUSSION

Elaeidobius kamerunicus and Oil Palm Pollen Condition

The most important criteria to be assured before applying the hatch and carry technique is the quality of the *E. kamerunicus* hatched out from the male inflorescences and the pollens used to spray the weevils. As shown in *Figure 5,* this experiment indicated that the male inflorescences selected were appropriate and rich with *E. kamerunicus* population.

Development of *E. kamerunicus,* as revealed in *Figure 5,* started on the seventh day after the male inflorescence had anthesised. Syed (1982) reported that larval development into pupae took a minimum of five days, and that of pupae to adult weevils took at least two days. Slightly different results were reported by Kurniawan (2010) in his study conducted in West Java and Central Kalimantan. He found that it took at least six days from larvae to pupae, and three days to change the pupae to adult weevils. Tuo *et al*. (2011) also observed similar cycle in West Africa. They reported that it needed three

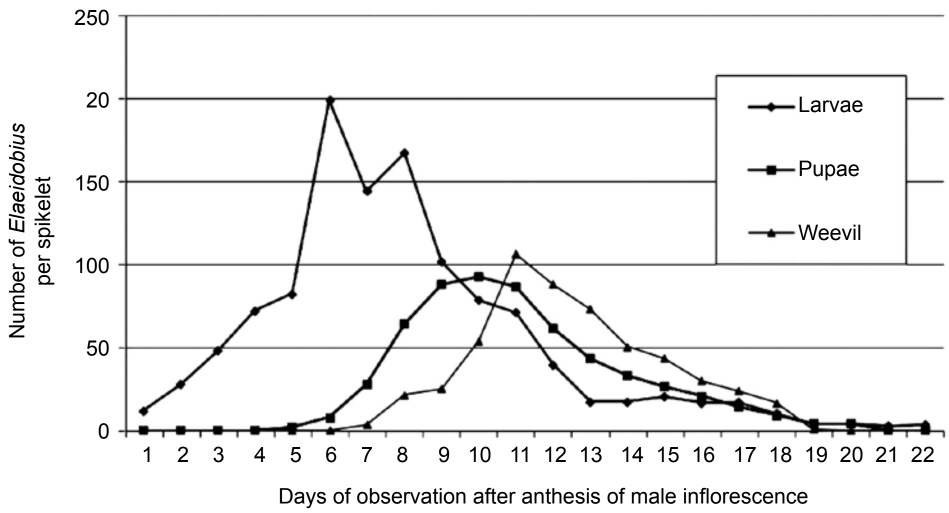

Figure 5. Graph revealing the mean of larvae, pupae, and Elaeidobius kamerunicus *number in male inflorescence after anthesis on a daily basis.*

days and four days for larvae to pupae and pupae to adult weevils respectively.

On average, the total number of adult weevils was 536 per spikelet (*Figure 5*). The male inflorescences were obtained from 10-year old palms with the average of 148 spikelets per male inflorescence giving an average of 79 328 weevils per male inflorescence. With six male inflorescences in each box, the number of *E. kamerunicus* would reach 475 968.

Oil palm pollens used were also collected from 10-year old plants. Pollen viability test showed 89% germination on pollens stored for two weeks in a freezer at -20°C. The pollen viability decreased to 62% during six months storage before being applied to *E. kamerunicus* (*Figure 6*). When bottles containing pollens were kept in silica gel, pollen viability reached 74.87% after six months (Widiastuti and Palupi, 2008).

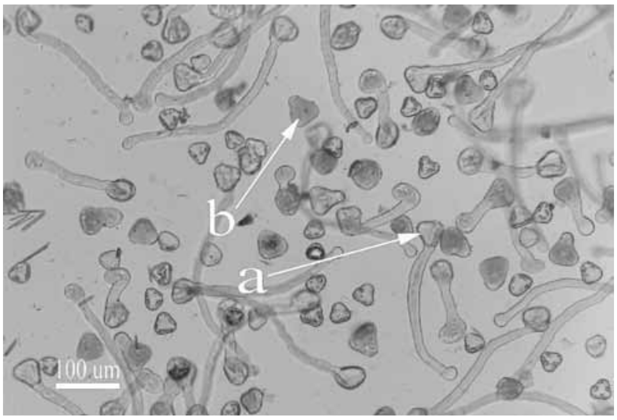

Figure 6. Pollen viability test under a light microscope with 200X magnification (pollens incubated at 40°C for 2 hr): (a) germinated, (b) dead pollen.

Development of *Elaeidobius kamerunicus* Population

Before the hatch and carry technique was applied, there were only 2571 *E. kamerunicus* on the male flowers at anthesis per hectare with the average number of anthesising males at two inflorescences per 3 ha. Two months after release, the weevil population increased rapidly to 51 908 weevils per hectare giving a 20-fold increase. The average number of anthesising males was 1 inflorescence per hectare. This high number of *E. kamerunicus* on the anthesisising male inflorescences is depicted in *Figure 7a*. The weevil population kept on increasing continuously while the number of anthesising male inflorescences only increased 1.5 times compared to pre-observation period. *Figure 7b* shows *E. kamerunicus* weevils covering almost the entire anthesising male inflorescence.

The observations made four and six months after release indicated a lower increase in the weevil population compared to the first two months (*Figure 7a*). As stages in the life cycle of *E. kamerunicus;* starting from eggs, larvae to pupae were fully spent on post anthesis male inflorescences (Syed, 1980; Hutauruk *et al.*, 1982), the small increase on the number of male inflorescences might lead to a limited breeding site for the weevils. This may explain the lower increase in population. The increase in population of *E. kamerunicus* was more likely due to the continuous release of weevils from the breeding boxes.

A similar phenomenon appeared when trapped *E. kamerunicus* on yellow sticky traps attached to the anthesising female inflorescences were examined.

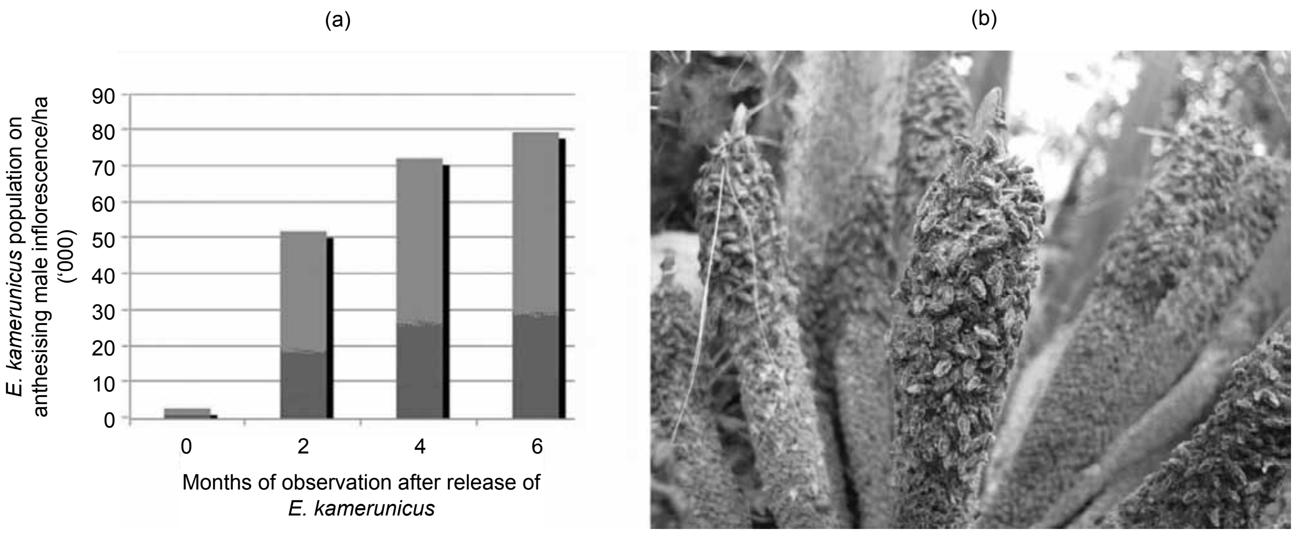

Figure 7. Elaeidobius kamerunicus *population on anthesising males after release: (a) graph of* E. kamerunicus *population growth at two-month basis, (b) picture of the weevil population (two months after release).*

On average, 604 weevils were trapped, giving about 18-fold increase in population two months after release (*Figure 8*). This frequent visit to the anthesising female flowers by weevils previously sprayed with viable pollens was responsible for the increase in pollination and fruit set.

Oil Palm Fruit Set Increase

The fruit set analysis showed no difference among oil palm fruit set at 10 m, 100 m, and 200 m away from the installed boxes. The difference in fruit set was observed in palms at distances of 300 m and 400 m from the box (*Table 1*). Our observation also indicated that the fruit set in palms 200 m away from the box showed similar value with the ones receiving assisted pollination. Since the initial fruit set value before the release of *E. kamerunicus* was 67.56%, there was an increase of between 15.04% to 21.05% in the fruit set after the weevil release. Based on this observation, the ideal distance between the hatch and carry boxes is at 400 m or about one to two boxes per block of about 25 ha. Nevertheless, as shown in *Table 1*, the mean fruit set in all distances six months before release and during the duration of release was increased from 37.67% to 67.56%.

As shown in *Table 1*, the fruit set value in the oil palms 400 m away from the box declined by about 5.34% from the mean fruit set value at the start of the hatch and carry application. This decline was predicted to be contributed by rainfall, temperature and relative humidity during the flower pollination (Broekmans, 1957; Corley and Tinker, 2003). Turner and Gilbanks (1982) suggested that the optimum temperature for pollination of oil palm should be 22°C-33°C with the average fruit set of over 70%. Other studies indicated that at 27°C -29°C, assisted pollination with pollen viability of above 80% would

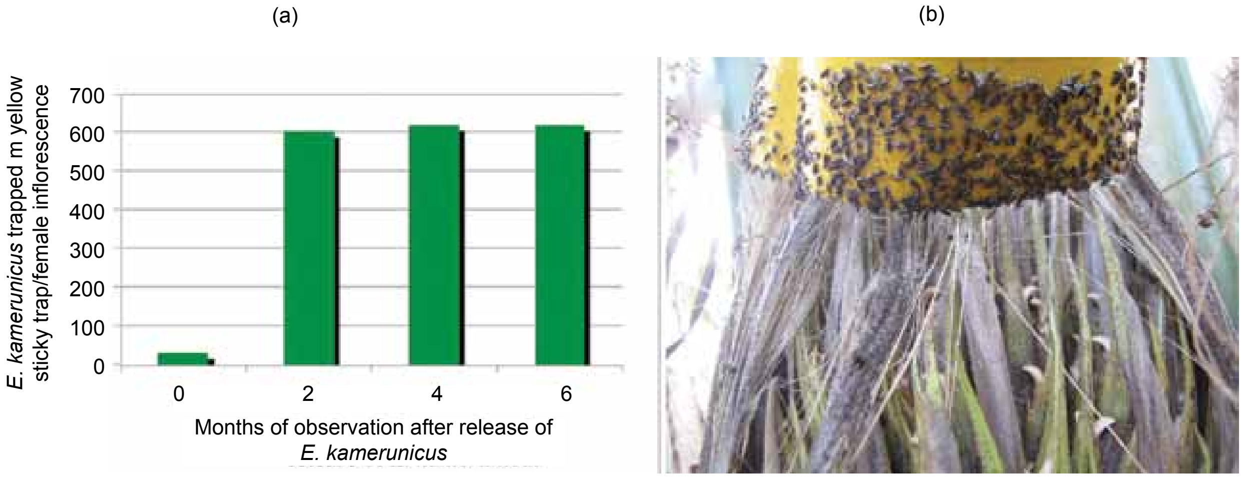

Figure 8. Elaeidobius kamerunicus *weevils trapped on yellow sticky trap attached to the anthesising female: (a) chart showing the number of* E. kamerunicus *trapped at two monthly observation, (b) picture of trapped weevils on yellow sticky trap.*

TABLE 1. RESULTS OF PERCENTAGE FRUIT SET AND OIL PALM BUNCH WEIGHT AT FIVE DIFFERENT DISTANCES FROM THE HATCH AND CARRY BOX

Distance between palm samples and hatch and carry box (m)	Mean of fruit set value (%)			Mean of bunch weight (kg), four months after hatch and carry application
	Six months before hatch and carry application	During hatch and carry application	Four months after hatch and carry application	
10	-	67.29a	88.61a	7.11 ab
100	-	64.85a	87.38a	7.59a
200	-	65.29a	82.50a	6.44ab
300	-	69.91a	67.58b	6.16ab
400	-	67.77a	62.22b	5.21b
Assisted pollination	-	70.23a	84.50a	7.16ab
Mean	37.67	67.56	-	-

Note: The same letter in the same column does not show the real difference by Duncan test at 95% significance level.

result in fruit set of 71% (Widiastuti and Palupi, 2008). As revealed in *Table 1*, the fruit set increased between 20.28% to 20.39% on 10 m to 200 m distances compared to 400 m from the box. Furthermore, the increase number of the weevil population led to competition for nutrients and space among them. This condition would affect the placement of pollen head the right position on the flower pistil (Prasetyo, 2013).

The improved oil palm fruit set would correspondingly increase the average weight of fresh fruit bunches. *Figure 9* shows that the longer the distance was between the palm and the hatch and carry box, the smaller was the size of the bunches. The difference between the average weights of oil palm bunches at the distance of 400 m and 100 m from the hatchery box was 2.38 kg per bunch.

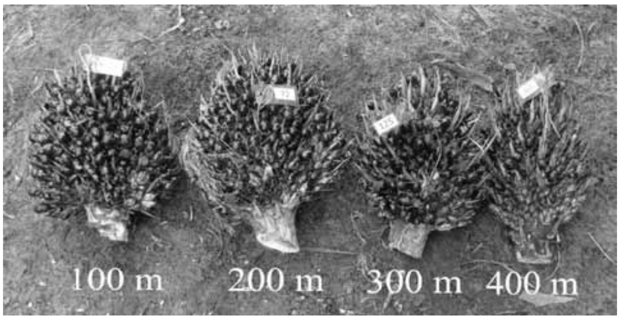

Figure 9. Comparison of fresh fruit bunches at different distances from the hatch and carry box.

CONCLUSION

Two months after the application of the hatch and carry technique, the six bunches of post anthesis male inflorescence from 10-year old palms could increase the *E. kamerunicus* population from 2571 to 51 908 per hectare. With such a population density, *E. kamerunicus* could play a better role as the pollinators with 18 times more frequent visits to the anthesising female inflorescences. With over 60% pollen viability, the increase in population of *E. kamerunicus* with the hatch and carry technique has improved the fruit set by 15.04% - 21.05% for oil palm at a distance of 200 m from the hatch and carry box. We conclude that one to two boxes for every 25 ha of oil palm areas will be the most effective placement density to help improve the weevil population and hence fruit set.

ACKNOWLEDGEMENT

The authors would like to thank the management of PT Binanga Mandala, North Sumatra for permission and assistance to this study. We hope this study contributes important information for oil palm field management.

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