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The Effectiveness of *Elaeidobius kamerunicus* to the Fruit Set of Oil Palm

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ABSTRACT
The pollinating of oil palm is cross pollination. The important insect that play an important role is *Elaeidobius kamerunicus* (*EK*). The superior DP hybrid with high sex ratio in young plants resulted in a lack of pollen.The *Hatch and Carry* technique is used to increase *EK* populations. This research aimed to determine the effectiveness of *EK* with Hatch and Carry technique on the fruit set level. The *EK* population increased the fruit set from 69% to 80%; *Hatch and Carry* techniques are effective on plantations dominated with young plant, and this technique can increase productivity by 5 – 16%.

Introduction

Oil palm (*Elaeis guineensis* Jacq) is a plantation commodity that plays an important role in the Indonesian economy. The area of oil palm plantations in 2015 is 10.9 million ha with production of 29.3 million tons of CPO [2].

Palm oil production is determined by the success of pollinating. Palm oil is a monoecious tree, but due to the male and female inflorescence anthesis at different times, the nature of the pollination is cross-linked and requires pollination agents [3, 11].

The varieties grown in the plantations are hybrids of Dura x Pisifera. The breeding results of some seed producers (Indonesian Oil Palm Research Institute, Socfindo, Sumbio) dominated by female inflorescence, minimal male inflorescence, the sex ratio of young plants is too high (80-95%) resulting in lack of pollen sources [8].

The success of pollination (fruit set) is influenced by the availability of pollen, wind speed, rainfall conditions, and pollinator insects activity.The widely used pollinating insects are *Elaeidobiu kamerunicus* (*EK*) from Cameroon and started to introduce in Indonesia around 1983 [4]. The *EK* is monophagic, its food source is only from oil palm flower, making it very suitable as a pollinating agent in oil palm plant. Successfully pollinated flowers will develop well, have a thick mesocarp, while the unpollinated fruit is small, has no endosperm and is called parthenocarpic fruit. A good fruit set level is more than 70%, the higher the fruitset value the larger, heavier, and higher CPO contain in the fruit bunches [8]. This condition can be achieved with the requirement of minimum 3 bunches male inflorescence / ha, *EK* population more than 20.000 weevils / ha, and rainfall in ideal condition that is 250 mm / month.

Considering the importance of *EK* in the pollination process, some State plantation or Private plantations increase *EK* populations by *Hatch and Carry* techniques, as an alternative / substitute for Assisted Pollination because this technique requires a considerable amount of labor.

This research aimed to determine the effectiveness of *EK* in general condition (usual) and with "*Hatch and Carry*" technique to the success of fruitset and palm oil productivity

Materials and Methods

1. Time and Place

The research was conducted in 4 estates Kebun Lama and Aek Kulim (April-June 2014); Sawit Langkat and Marihat (May to June 2016), North Sumatera Province, Indonesia.

Table 1. Oil Palm Planting Years Composition at Research Sites (ha).

Group	Range (year)	Kebun Lama	Aek Kulim	Sawit Langkat	Marihat
Old	>20	84	-	-	392
Adult	15-20	568	-	-	-
Teen	9-14	64	259	257	121
Young	3-8	-	91	492	340
Total		721	350	749	853

The rainfall conditions in the research sites are shown in Figure 1.

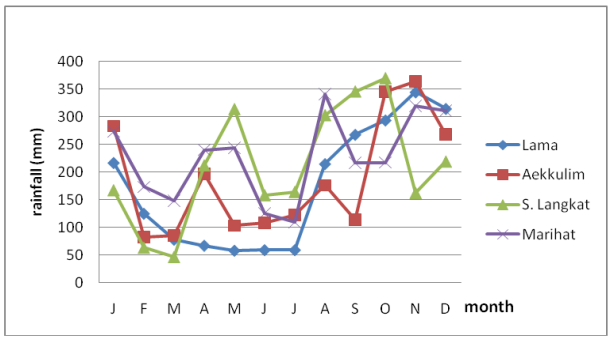

Figure 1. The average rainfall in research sites.

2. Materials and Equipment

The materials used are Fresh Fruit Bunches, male inflorescence, pollen, *Hatch and Carry* boxes. The equipment used is egrek (palm harvester) to harvest the FFB, machetes, scales, pollen sprayer. (Figure 2).

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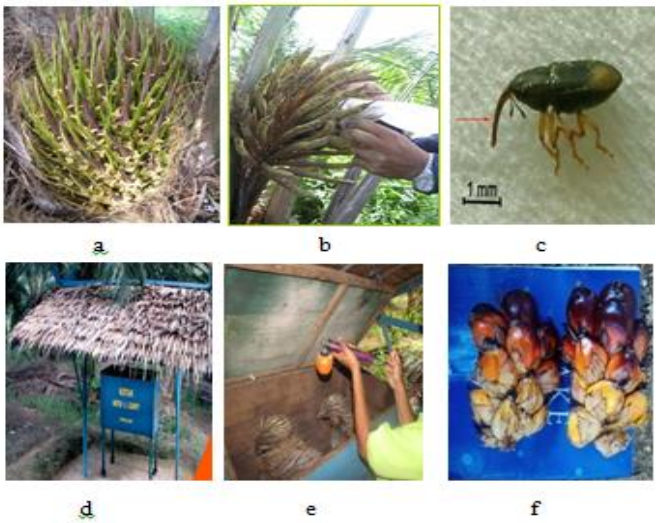


Figure 2. a. Female Inflorescence, b. Male Inflorescence, c. *Elaeidobius kamerunicus* weevil, d. *Hatch and Carry* box, e. Spraying pollen, f. Fruitset calculation.

3. Research Methods

The research used descriptive design with primary data of *EK* and fruit set level observation, secondary data i.e. bunch weight and fresh fruit bunch productivity.

4. Research Procedure

a. Block Samples, placement of sample blocks focused on young plants

b. *EK* population:

– 2 Samples of male inflorescence in 1 ha by bloom conditions ≤50% and ≥50%.

– Capturing the *EK* from 3 spikelets with plastic bag and the spikelet then cut.

– Incorporated a cotton swab dipped with Ethyl acetate into the plastic bag so that the *EK* fainted then *Elaeidobiuskamerunicus* was calculated.

– Calculation, population / ha = average number in 3 spikelets x number of spikelet x number of male inflorescence in 1 ha.

c. Fruit set:

– Fresh fruit bunches (FFB) samples are harvested, cut into pieces and separated the spikelet, normal fruit and parthenocarpy fruit are calculated.

– **Fruit set value =** $\frac{\text{The fruit}}{\text{Fruit+parthenocarpy}}$ **x 100%**

– Another way is by weighing between the weight of bunches and fruit.

d. *Hatch and Carry* Technique

The implementation stages of *Hatch and Carry* are as follows;

– The box 120 cm x 60 cm x 100 cm (Figure 1), 1 box for one oil palm plantation block of 15-20 ha and given a shade.

– The taking of male flower inflorescence 4-6 days through anthesis (containing egg and pupa of *EK*) is put into the box, stem damped, left ± 8 days.

– On the 8th day the egg has become a beetle / imago and ready to fly.

– Before the box is opened, it is sprayed with pure pollen (specially prepared from adult plant blocks) so that when *EK* flies on its body already carries pollen.

e. Evaluation

Evaluate the effectiveness of oil palm pollinant insects (*EK*) under common block conditions and *Hatch and Carry* technique.

Results and Discussion

1. Effectiveness *Elaeidobius kamerunicus* under Common Condition

Observations were made in April and May 2014 at Kebun Lama, PTPN I on plants planted in 2005

Table 2. Observation results of male inflorescence and population of *Elaeidobius kamerunicus.*

14-Apr	Block	MI	M*EK*	F*EK*	Total
	64	3	6.53	15.075	21.605
			30%	70%	
	74	2	5.47	13.238	18.708
			29%	71%	
14-May	64	4	6.17	14.839	21.009
			29%	71%	
	74	3	4.65	12.95	17.6
			26%	74%	

Description : MI : Male Inflorescence, *E K*: *Elaeidobius kamerunicus*, M*EK* : Males, FEK : Females

The population per hectare of *EK* on block 64 in April and May 2014 amounted to>20,000 weevils and in block 74 less than 20,000 weevils.The population in May declined compared to April 2014.The population dynamics of *Elaeidobius kamerunicus* is influenced by rainfall conditions. The number of female weevils varies between 70-74% compared to the 26-30% male weevils, which means reproductive opportunities of *Elaeidobius kamerunicus* can be well sustained. The uniqueness of *Elaeidobius kamerunicus* is the life cycle of the male weevils only 46 days but the female weevils is able to live longer that is 65 days [9, 13]. The largest number of *EK*s is commonly found in male inflorescence on the 3rd day of anthesis.Other factors that can reduce is the presence of other insect pests, beetles, ants and rat pests.In Indonesia there are also pollinator insects; *Thripshawaiiensis*, but due to its less effective then *Elaedobius kamerunicus* was imported to achieve production targets [9].

The number / population of *Elaeidobius kamerunicus* will affect the fruit set level of the next 6 months due to the time taken from pollination until the FFB matured and harvested is 6 months.In rainfall conditions>250 mm, *EK* breeding will be good but its aggressiveness is better in relatively dry months. The rainfall pattern in Kebun Lama, PTPN I shows the occurrence of dry months between March and July and this is one of the causes of declining *EK* population of 2.3% in blocks of 64 and 7% in block 74. However, the problem that occurs in areas with high rainfall throughout the year is wet pollen which cannot be flown by wind or pollinating insects [1].

The composition of plants at Kebun Lama has 84 Ha of old plants aged ≥20 years.In old plants there is a balance on the number of male and female inflorescence (sex ratio 50%). Generally in 1 year, there are 6 female inflorescence and 6 male inflorescence. The amount of pollen from the male inflorescence can be spread through the wind and the *EK* is able to develop well. Thus, the composition of the planting year is important to note that in the area of young plants can obtain additional pollen from old plants that are flown by wind or carried by the *EK*.

2. Fruit set

Observation of the fruit set level in Kebun Lama with the following results.

Table 3. Fruit Set Level Data at Kebun Lama, PTPN I.

Block	BW	Section	Fruit Part		
	(Kg)	Outer	NF	PF	FS%
64	10		416	14	97
74	9		430	42	91
		Middle			
64	10		268	67	81
74	9		313	91	79
		Inner			
64	10		289	178	75
74	9		126	255	51
64	Total		973	258	80
74			869	387	69

Description : BW (bunch weight), NF (Normal fruit), PF (Parthenocarpy), FS (Fruitset).

The average fruit set on block 64 is 80% and in block 74 is 69%. Comparison of yields on outer fruits is the best (91-97%) and the lowest is in inner fruits 75% in blocks 64 and 51% in block 74 caused by dense flower arrangements resulting in difficulty of pollen entry to the pistil [13]. that in recent years a decrease in Malaysia production was also caused by a decrease in fruitset level. According to [8] the good thing in *EK* is to breed well naturally, its flying power is far enough and can reach the female flowers located on the inner bunch.Although without the *Hatch and Carry* technique in Kebun Lama, blocks with more *EK* populations capable of producing a good fruit set level of 80%, an increase of 11% [12]. In West Africa the increase in fruit set level by *Hatch and Carry* technique can reach 36% [7].

The observations made [5] in smallholdings plantation, normal fruit are around 64.4% and partenocarpy / unfertilized fruit is 35.1%.

3. The Result of Fresh Fruit Bunches

The observation on Bunch Weight (BW) and Fresh Fruit Bunches (FFB) productivity in Kebun Lama are shown in Tabel 4.

Table 4. Bunch Weight and Productivity in Kebun Lama.

Year	Ages	BW (Kg)				FFB (Ton/ha)			
		Block 64	%	Block 74	%	Block 64	%	Block 74	%
2009	4	4,3	100	3,7	86	3,7	100	2,7	73
2010	5	5,5	100	53	96	6,0	100	3,0	50
2011	6	7,8	100	7,9	101	14,2	100	12,4	87
2012	7	10,4	100	9,7	93	21,	100	20,6	96
2013	8	11,6	100	10,5	91	20,	100	18,0	87
Average		7,9	100	7,4	94	13,	100	11,3	86

Description : Block 64 as a standard comparation with the index 100%

In block 64 which has a population of *EK*>20,000 head / ha is able to result heavier bunch weight compared to block 74.Observations until 2013 showed the average value in Block 64 was 7.92 kg (100%) and block 74 was 7.40 kg (94%). Productivity in block 64 is also 14% higher. Advantages are obtained on blocks that naturally have a population of *EK*>20,000 weevils i.e. in blocks 64 that are closer to the old plant than block 74.

Effectiveness of *EK* with *Hatch and Carry*

Aek Kulim Estate

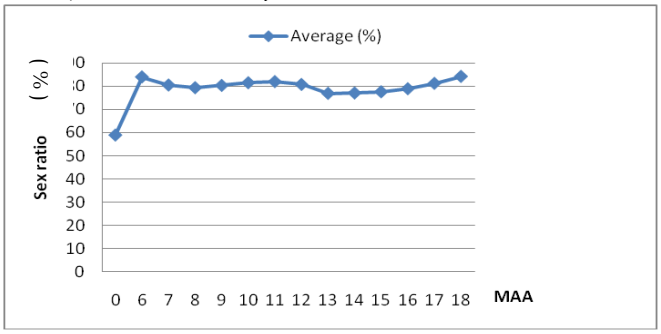
Based on the composition of the 350 ha plant area are young plants and teen (planting years 2008, 2009 and 2010).Planting materials / varieties used are Lame and Yangambi from Socfin Indonesia. Sex ratio observation in plants for the 2008 planting year is shown in Table 5.

Table 5. Sex Ratio of Oil Palm Plant 2008.

Year	Ages (year)	Male Inflorescence	Female Inflorescence	Total	Sex Ratio (%)
2012	4	3,21	20,80	24,00	87
2013	5	2,47	22,23	24,00	93

Based on the table the sex ratio is high (dominant female flower), so the company carries out the *Hatch and Carry* technique started in June 2012. A very large number of female inflorescence and little male inflorescence is a negative impact of plant breeding success that aims to produce high productivity of FFB [8]

The number of boxes placed in the 2008, 2009, 2010 planting year of 350,24 ha is 27 with an average of 1 box for 13 ha (standard 15-20 ha**).**



Description: MAA (Month After Application) *Hatch & Carry*

Figure 3. Observations of Fruit Set Level at Aek Kulim Estate.

At the beginning of the application the level of the fruit set was 58.87%.The results of *Elaeidobius kamerunicus* effectiveness were calculated 6 months after application (December 2012). The fruit set level continues to improve until December 2013 observations. Rainfall data at Aek Kulim shows the occurrence of dry months (<100mm) in February and March which will affect the next 6 month fruit set level i.e. the July to October fruit sets slightly decreased to 76.87% - 78.86% and returned to >80% in November and December 2013. In plantations where there is only young and teen plant, *Hatch and Carry* techniques are able to increase the fruit set by 17-26%.

Langkat and Marihat Oil Palm Plantation - PTPN IV

The observed population of *Elaeidobius kamerunicus* is shown in Table 6.

Table 6. Population of *Elaeidobius kamerunicus* Weevils (September 2014).

No	Estate	Treatment	Date Application (2014)	MI/Ha	*EK* Population	%
1	Langkat	-HC	March	4	16.112	100
		+HC	March	4	20.608	128
2	Marihat	- HC	March-June	2	17.716	100
		+HC	March-June	3	17.640	100

Description: MAA (Month After Application), Without HC as astandard comparison, the index 100%, MI (Male Inflorescence)

The *EK* population in Langkat Estate Plantation on the 10 L Block (-HC) is 16,112 which means less than the pollination requirement. This can be due to Langkat Estate does not have any grown or old plant, so the supply of pollen as a source of *EK* food and breeding site is limited.With the *Hatch and Carry* application in the 6 month period has been able to increase the *EK* population to 20,608 (28% increase).

The *EK* population in Marihat shows more number than in Langkat, but *Hatch and Carry* technique has no effect on increasing *EK* population.With a various plant composition at Marihat Estate, the male flower stock is well suited for *EK* breeding.In relation to the importance of *EK* role, things that can decrease the population should be prevented such as the presence of rat pests, other predators and excessive application of insecticides in the control of oil palm leaf-eating caterpillars [4]. In plantations with a composition of years or a good age group, the *Hatch and Carry* technique is ineffective or unnecessary. The productivity observations are shown in Table 7.

Table 7. Evaluation of Productivity at Langkat and Marihat Estate.

No	Estate	Year	-HC		+HC	
			FFB (Ton/ha)	%	FFB (Ton/ha)	%
1	Langkat	2014	8,65	100	9,05	105
		2015	13,65	100	15,09	116
2	Marihat	2014	13,94	100	14,10	101
		2015	20,75	100	21,76	105

Description: Standard Comparison Without HC is indexed 100%

Productivity by *Hatch and Carry* technique at Langkat increases in 2014 and 2015 respectively 5% and 16% and in Marihat is 1% and 5%.The *Hatch and Carry* technique is more effective on plantations with less plant variations in plant age or dominant young plants. Generally, the productivity in Marihat's plantation with the High Land Suitability class (S1) is higher than in the Langkat plantation with the S2 land suitability class.

Conclusion

1. EK populations affect the increase of fruit set level.
2. The Hatch *and Carry* technique is effective on plantations dominated by young and teen plants, and is ineffective (not necessary) if the plantation has an adult or old plant.
3. Increased productivity with *Hatch and Carry* techniques can reach 16%.

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