EFFECT OF OIL PALM PLANTING MATERIALS, RAINFALL, NUMBER OF MALE INFLORESCENCE AND SPIKELET ON THE POPULATION ABUNDANCE OF OIL PALM POLLINATOR, *Elaeidobius kamerunicus* FAUST (COLEOPTERA: CURCULIONIDAE)

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ABSTRACT

Elaeidobius kamerunicus is the main insect pollinator of oil palm and was first introduced to Malaysia in the year of 1980s. This introduction had increased the oil palm yield production. However, the yield production has obviously declined lately. There are several factors that contributing to the declined and most said is because of the *E. kamerunicus* population itself. As such, a study to determine the population abundance of *E. kamerunicus* on different oil palm planting materials was done at Ladang FELDA in Jengka, Pahang, Malaysia from May 2016 to April 2017. A total of nine spikelets, three each from top, middle and bottom section of male inflorescence which were systematically selected prior to data collection, were cut off early in the morning and brought back to Centre for Insect Systematics, UKM for *E. kamerunicus* counts. The mean population abundance of *E. kamerunicus* per ha for both oil palm clones and D×P were 20463 ± 3528 and 11079 ± 2135 weevils per ha, respectively. Based on previous studies in Malaysia and elsewhere, the *E. kamerunicus* populations in this plantation are adequate to pollinate the female inflorescence. Oil palm clones has higher number of spikelet due to uniformity of the plantlets and the number of male inflorescence showed positively correlated with the population abundance of *E. kamerunicus* per ha, suggesting that these factors were favorable for *E. kamerunicus* activities. However, further study is needed to determine the relationship between *E. kamerunicus* population on different oil palm planting materials and the fruit set.

Keywords: Oil Palm, *Elaeidobius kamerunicus*, Planting Materials, Population Abundance, Coleoptera

ABSTRAK

Elaeidobius kamerunicus adalah serangga pendebunga utama kelapa sawit dan serangga ini mula diperkenalkan di Malaysia pada tahun 1980an. Pengenalan *E. kamerunicus* ini telah meningkatkan pengeluaran hasil kelapa sawit. Walau bagaimanapun, pengeluaran hasil sawit menurun sejak kebelakangan ini. Terdapat beberapa faktor yang menyumbang kepada penurunan ini dan faktor utama adalah kerana populasi kumbang pendebunga, *E. kamerunicus* itu sendiri. Oleh itu, satu kajian untuk menentukan kelimpahan populasi *E. kamerunicus* pada bahan tanaman kelapa sawit yang berbeza telah dilakukan di Ladang FELDA di Jengka, Pahang, Malaysia dari Mei 2016 hingga April 2017. Sejumlah sembilan spikelet, tiga masing-masing dari bahagian atas, tengah dan bawah bunga jantan kelapa sawit dipilih secara rawak sebelum pengumpulan data, dipotong pada awal pagi dan dibungkus dalam beg plastik kemudian dibawa ke Pusat Sistematik Serangga, UKM untuk proses pengiraan bilangan kumbang *E. kamerunicus* pada setiap spikelet. Purata bilangan *E. kamerunicus* per hektar bagi kedua-dua bahan tanaman sawit klon dan D×P masing-masing adalah 20463 ± 3528 dan 11079 ± 2135. Berdasarkan kajian terdahulu di Malaysia dan di tempat lain, populasi *E. kamerunicus* di ladang ini adalah mencukupi untuk mendebungakan bunga betina kelapa sawit. Kelapa sawit klon mempunyai jumlah spikelet yang lebih tinggi berbanding kelapa sawit D×P disebabkan oleh keseragaman tumbuhan dan jumlah bunga jantan kelapa sawit menunjukkan hubungan yang positif dengan kelimpahan populasi *E. kamerunicus* per ha. Hal ini menunjukkan bahawa faktor-faktor ini adalah baik untuk aktiviti pendebungaan *E. kamerunicus*. Walau bagaimanapun, kajian lanjut diperlukan untuk menentukan hubungan antara populasi *E. kamerunicus* pada bahan tanaman kelapa sawit yang berbeza dengan set buah.

Kata kunci: Kelapa Sawit, *Elaeidobius kamerunicus*, Bahan Tanaman, Kelimpahan Populasi, Coleoptera

INTRODUCTION

Oil palm, *Elaeis guineensis* which belongs to family Arecaceae is currently the world's main vegetable oil crop, characterized by a large productivity and a long life span. Thus, there is an urgent need to improve productivity due to increased global demands and challenges in production efforts. Current oil palm planting materials are produced through the hybridization of Dura × Pisifera (D×P) that extremely slow and costly, as the breeding cycle can take up to 10 years (Eng et al. 2007). This has brought about interest in vegetative propagation of oil palm. Since the introduction of oil palm tissue culture in the 1970s, this planting material has proven to be useful not only in producing uniform planting materials but also increased 30% of yield production (Kushairi et al. 2006). Even though there were several abnormalities (mantled fruits) observed in oil palm clones, the problems have been solved after several attempt and was renewed interest to proceed with large scale propagation of oil palm clones to increase productivity (Corley et al. 1986).

Elaeidobius kamerunicus Faust (Coleoptera: Curculionidae) is the most efficient insect pollinator species of oil palm because it is well adapted during wet season (Dhileepan 1994). According to Basri et al. (1983), this weevil carried more pollen grains than other insect pollinator species. *Elaeidobius kamerunicus* was first introduced to Malaysia from Cameroon, Africa in the year of 1980 at Mamol Estates, Kluang Johor and Pamol and Mamol estate, Sabah which had reduced 30% of cost production by manual pollination (Syed 1982) and had improved 43% kernel to bunch ratio (Dhileepan 1994). Besides that, the application of insecticides against *E. kamerunicus* also effect the number of population (Yusdayati et al. 2015). Furthermore, Basri et al. (1987) reported that higher fresh fruit bunch (FFB) were achieved after the implementation of this weevil.

Although, the oil palm tissue culture process is costly and high labor intensive yet increased the yield production at least by 20% compared to D×P. Besides that, the oil to bunch ratio of the clonal materials was 28.5% as compared to 21.2% of oil palm D×P material

(Kushairi et al. 2006). Thus, this study attempted to clarify the influence of different oil palm planting materials, number of male inflorescence and spikelet on the variation in population abundance of *E. kamerunicus.* The results from this study will be useful in future study to correlate it with the fresh fruit bunch (FFB), fruit to bunch ratio and the fruit set.

MATERIALS AND METHODS

Study Site

Study on the population abundance of oil palm pollinator, *E. kamerunicus* per ha on different oil palm planting materials was started from May 2016 to April 2017 at FELDA Agricultural Services Sdn. Bhd. (FASSB), Pusat Perkhidmatan Pertanian Tun Razak, Jengka, Pahang, Malaysia. The study was conducted in the crops area planted in 2012 which is 5 years old oil palm that covers two planting materials which are FELDA Clone and Standard Crosses (D×P).

Sampling Method

The number of *E. kamerunicus* on the male inflorescence for both oil palm clones and oil palm D×P were recorded once a month for a year from the oil palm trees that were stratifically selected prior to experiment. Each study area (plot) has four subplots and each subplot has 16 oil palm trees. There were 64 oil palm trees for each plot. Male inflorescences at anthesis stage were randomly selected every month for the study. A total of nine spikelets of anthesising male inflorescences (three each from top, middle and bottom, respectively) was randomly selected and gently cut off in the morning between 8.00 am and 9.00 am to avoid the active time of the weevil (easy to collect), bagged into plastic bags and the number of *E. kamerunicus* on each spikelet of male inflorescence was counted (Basri & Norman 1997).

Data Analysis

To represent the population abundance of *E. kamerunicus* or the number of weevil individual per ha, the population abundance (mean number) of weevil per ha was calculated as the total number of *E. kamerunicus* per spikelet × total number of spikelet per male inflorescence × total number of male inflorescence per plot / 64 oil palm trees (16 oil palm trees for each subplot) × 136 oil palms (Equivalent to 1 ha). Rainfall data was taken from monthly rainfall recorded in FELDA Agricultural Sdn. Bhd, Jengka Pahang, Malaysia but was shifted one month backward due to one month of the weevil life cycle (Tuo et al. 2011). The population abundance of *E. kamerunicus* (dependent variables) per month for both oil palm planting materials (independent variables) was analyzed by 2-way ANOVA. Correlation and regression analysis between the number of male inflorescence in affecting the population abundance of *E. kamerunicus* per ha were also done and all analysis were run on Minitab 16 software. The data were normalized by square root transformation before run the analysis.

RESULT AND DISCUSSION

The mean population abundance of *E. kamerunicus* (number of individual) per ha for oil palm clones was 20463 ± 3528 with the highest and lowest population abundance being 141431 and 9318 weevils per ha recorded on Jan 17 and Oct 16, respectively. As for oil palm D×P, the highest and lowest population abundance of *E. kamerunicus* per ha were recorded on Jan 17 and Aug 16 with 83676 and 6435 weevils per ha, respectively, with the mean population abundance of 11079 ± 2135 weevil per ha. Throughout a year period of observation, the population abundances of *E. kamerunicus* per ha for both oil palm planting materials were found to be highest on Jan 17 and lowest on Oct 16 (Figure 1). Furthermore, the population abundance of *E. kamerunicus* per ha recorded at Ladang FELDA in Jengka, Pahang for both oil palm planting materials showed adequate number of weevils to pollinate the female inflorescence per ha. This result was supported by Donough et al. (1996) who reported that the population abundance of *E. kamerunicus* per ha between 20 000 and 80 000 required to produced 55% of fruit set while Dhileepan (1994) recorded only 7000 weevils were needed to produced 60% of fruit set in India. However, Basri and Norman (1997) claimed that at a very low number of *E. kamerunicus* (4711) resulted in more than 60% of fruit set. These clearly shows that the population abundance of *E. kamerunicus* per ha at Ladang FELDA in Jengka, Pahang, Malaysia was more than enough to produce high percentage of fruit set as reported by Farid (pers. comm.) that the fruit to bunch ratio in this plantation achieved more than 60%.

Result of 2-way ANOVA showed that there was significant difference in population abundance of *E. kamerunicus* per ha among oil palm planting materials (oil palm clones and D×P) ($F = 4.67$, df = 1 & df error = 48, $P < 0.05$) and between months of sampling ($F = 2.01$, df = 11 & df error = 48, $P < 0.05$). However, there was no significant ($F = 0.32$, df = 11, df error = 48, $P < 0.05$) interaction between planting materials and months of sampling (Table 1). The mean population abundance of *E. kamerunicus* per ha was significantly higher on Dec 16 and Jan 17 than on other sampling months that were not differed significantly among them with mean population abundance of *E. kamerunicus* range between 4000 to 23000 weevils per ha. Throughout one-year period of sampling, the mean population abundance of *E. kamerunicus* per ha was highest on Jan 17 (37518 ± 15817) and lowest on Oct 16 (4647 ± 1879) (Figure 2). Additionally, the mean population abundance of *E. kamerunicus* per ha was significantly higher in oil palm clones (20463 ± 3528 weevils per ha) compared to oil palm D×P (11079 ± 2135 weevils per ha) (Figure 3). This could be due to the higher mean number of spikelet per bunch ($F = 5.00$, df = 1, $P < 0.05$) (Figure 4) thus higher amount of pollen load on the male inflorescence, which consequently increase the attraction of the weevil (Young 1982). Kushairi et al. (2006) reported that oil palm clones are clonal plantlets derived from selected ortets that have greater degree of uniformity, higher heritability and efficiency in oil palm production as well as other desirable traits. Additionally, oil palm clones produced seedlings from the best cross and this would be the main reason for the uniformity of the plantlets.

Besides that, the population abundance of *E. kamerunicus* per ha showed positive relationships with monthly rainfall for oil palm clones ($r = 0.408$, $F = 6.78$, $P < 0.05$) and oil palm D×P ($r = 0.419$, $F = 7.23$, $P < 0.05$) (Figure 5). According to Basri et al. (1987) and Dhileepan (1994), the wet season is more favorable for the breeding of *E. kamerunicus.* This is supported by Prasetyo et al. (2010) who stated that high rainfall has significant effect on the population and aggressiveness of *E. kamerunicus.* Syed (1982) and Dhileepan (1992) reported that in West Africa and India, very hot and dry weather may cause temporary decline in the weevil population. Similarly, Sugih et al. (1996) reported that very low rainfall was not suitable for the *E. kamerunicus* activity in Riau, Sumatra. Furthermore, the wet season could cause low fruit set because of pollen density on the body of weevil pollinators could be washed off due to rain as reported by Hardon and Turner (1967). In contrast, Rizuan et al. (2013) reported that dry season was more favorable for weevil populations on the male spikelet because there was no reduction in pollinating efficiency observed during dry season. These contrasting reports suggest more in depth studies are needed to be conducted to correlate multiple factors that maybe influencing the population abundance of *E. kamerunicus* and fruit set of oil palm.

The number of male inflorescence at anthesis stage per ha showed significant and positive correlations for both oil palm clones ($r = 0.750$, $F = 43.77$, $P < 0.05$) and D×P ($r = 0.672$, $F = 27.97$, $P < 0.05$) in affecting the population abundance of *E. kamerunicus* per ha (Figure 6). In this study, the population abundance of *E. kamerunicus* per ha increased with number of male inflorescence at anthesis stage per ha for both oil palm planting materials indicating that the population abundance of *E. kamerunicus* per ha depends on male inflorescence availability (Dhileepan, 1994) as a sources of food and breeding site of the *E. kamerunicus* (Eardley et al. 2006; Syed 1982).

CONCLUSION

Oil palm clones has higher population abundance (number of individual) of *E. kamerunicus* as compare to oil palm D×P and the number of male inflorescence and spikelet plays a major role in determination of the population abundance of *E. kamerunicus* per ha. Although it is clear that the wet season is more favorable for activities of *E. kamerunicus,* the rainfall was seldom recorded higher than 400 mm per year, which means that the negative effects of severely high rainfall towards *E. kamerunicus* population could not be observed. Further studies are needed to correlate the number of rainy days and pollen load per weevil with the population abundance of *E. kamerunicus*. Other factors like estragole content, soil and field management may also influence the population abundance of *E. kamerunicus* per ha. The results in this study could be useful in future study in order to correlate it with the fruit set and fresh fruit bunch (FFB).

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REFERENCES

Basri, M.W., Hassan, A. & Hitam, A.B. 1983. Current status of *Elaeidobius kamerunicus* Faust and its effects on the oil palm industry in Malaysia. *PORIM (Palm Oil Research Institute of Malaysia) Occasional Paper* 6: 1- 39.

Basri, M.W., Masijan, Z., Halim, A.H. & Tayeb, D.M. 1987. The population census and the pollinating efficiency of the weevil, *Elaeidobius kamerunicus* in Malaysia - A status report, 1983 - 1986. *Proceedings of the 1987 International Oil Palm/Palm Oil Conference*. *Progress and Prospect 23 June - 1 July 1987*, pp. 535-549.

Basri, M.W. & Norman, K.H. 1997. Role and effectiveness of *Elaeidobius kamerunicus*, *Thrips hawaiiensis* and *Pyroderces* sp. in pollination of mature oil palm in Peninsular Malaysia. *Elaeis 9*(1): 1-16.

Corley, R.H.V., Lee, C.H., Law, I.H. & Wong, C.Y. 1986. Abnormal flower development in oil palm clones. *Planter* 62: 233–240.

Dhileepan, K. 1992. Pollen carrying capacity, pollen load and pollen transfering ability of the oil palm pollinating weevil, *Elaeidobius kamerunicus* Faust in India. *Oleagineux 47*(2): 55-61.

Dhileepan, K. 1994. Variation in populations of the introduced pollinating weevil (*Elaeidobius kamerunicus*) (Coleoptera: Curculionidae) and its impact on fruitset of oil palm (*Elaeis guineensis*) in India. *Bulletin of Entomological Research* 84: 477-485.

Donough, C.R, Chrew, K.W. & Law, I.H. 1996. Effect of fruit Set on OER and KER: Results from studies at Pamol Estates (Sabah) Sdn. Bhd. *Planter* 72: 203 – 219.

Eardley, C., Roth, D., Clarke, J.B.S. & Gemmill, B. 2006. *Pollinators and Pollination: A Resource Book for Policy and Practice*. South Africa: African Pollinator Initiative (API).

Eng, T.L., Halimah, A., Soo, H.B., Elyana, M.S., Chi, Y.A.T., Leslie, C.L.O., Suan, C.C. Abdul, R.R., Kiew, L.W. & Rajinder, S. 2007. Oil palm (*Elaeis guineensis* Jacq.) tissue culture ESTs: Identifying genes associated with collagenesis and embryogenesis. *BioMedical Central Plant Biology* 8:62.

Hardon, J.J., & Turner, P.D. 1967. Observations on natural pollination in commercial plantings of oil palm, (*Elaeis guineensis*) in Malaya. *Experimental Agriculture* 3: 105-116.

Kushairi, A.T., Zamzuri, A.H., Ong-abdullah, I., Rohani, M., Samsul, K.O., Ooi, R.S., Ravigadevi, E.S. & Basri, M.W. 2006. Current Status of Oil Palm Tissue Culture in Malaysia. In: Ahmad Kushairi; Ravigadevi Sambanthamurthi; Melina Ong Abdullah & Chan Kwong Choong (Eds.). *Proceeding Clonal & Quality Replanting Material*, pp. 3-14. Bangi: Malaysian Palm Oil Board.

Prasetyo, A.E., Supriyanto, E., Susanto, A. & Purba, A.R. 2010. Population dynamics of *Elaeidobius kamerunicus* Faust, a case study on upland oil palm plantation. *Proceeding of the International Oil Palm Conference*, pp. 103-113.

Rizuan, Z.A., Hisham, N.H. & Shamsudin, A. 2013. Role of pollinating weevil (*Elaeidobius kamerunicus*), seasonal effect and its relation to fruit set in oil palm area of FELDA. *Proceeding of PIPOC 2013 International Palm Oil Congress*, pp. 19-21.

Sugih, W., Setyobudi, H., Achmad, F. & Thiagarajan. 1996. Influence of rainfall, palm age and assisted pollination on oil palm fruitset in Riau, Indonesia. *Proceeding of the International Palm Oil Congress: Competitiveness for the 21st Century,* pp. 207-220.

Syed, R.A. 1982. Insect pollination of oil palm, feasibility of introducing *Elaeidobius* spp. into Malaysia. The Oil Palm in the Eighties. A report of the Proceedings of the International Conference on Oil palm in Agriculture in the Eighties, pp. Vol (1): 263-289.

Tuo, Y., Koua, H.K. & Hala, N. 2011. Biology of *Elaeidobius kamerunicus* and *Elaeidobius plagiatus* (Coleoptera:Curculionidae) main pollinators of oil palm in West Africa. *European Journal of Scientific Research* 49(3): 426-423.

Young, A.M. 1982. *Population Biology of Tropical Insect*. New York: Springer.

Yusdayati, R., & Hamid, N.H. 2015. Effect of several insecticides against oil palm pollinator's weevil against oil palm pollinatir's weevil, *Elaeidobius kamerunicus* (Coleoptera: Curculionidae). *Serangga* 20(2): 27-35.

APPENDICES

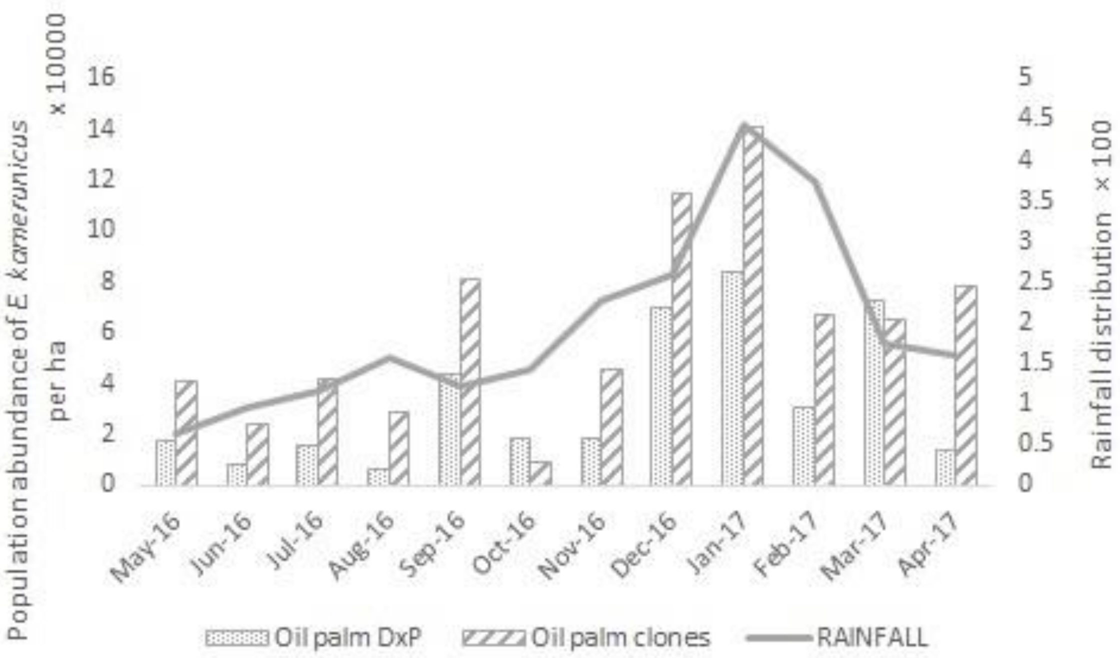

Figure 1 Population abundance (number of individual) of *E. kamerunicus* per ha for 12 months of sampling period in both oil palm clones and oil palm D×P (Rainfall was shifted one month backward)

Table 1 Result of two-way ANOVA between months of sampling and among oil palm planting materials in affecting the population abundance of *E. kamerunicus* per ha.

Parameter	Population abundance of *E. kamerunicus* perha			
	df	**ss**	**F**	**P**
Oil palm planting materials	1	23647	4.67	P < 0.05
Months of sampling	11	111788	2.01	P < 0.05
Months of sampling × Oil palm planting materials	11	17701	0.32	P > 0.05

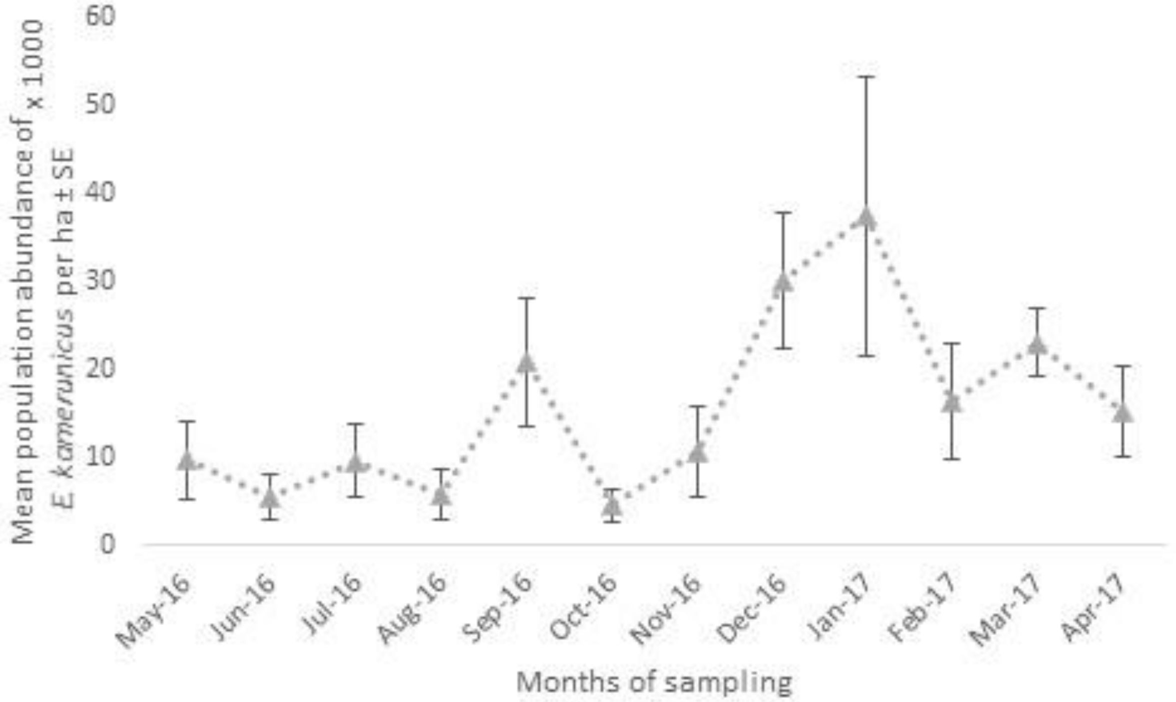

Figure 2 Mean population abundance of *E. kamerunicus* per ha ± SE between months of sampling from May 16 to Apr 17.

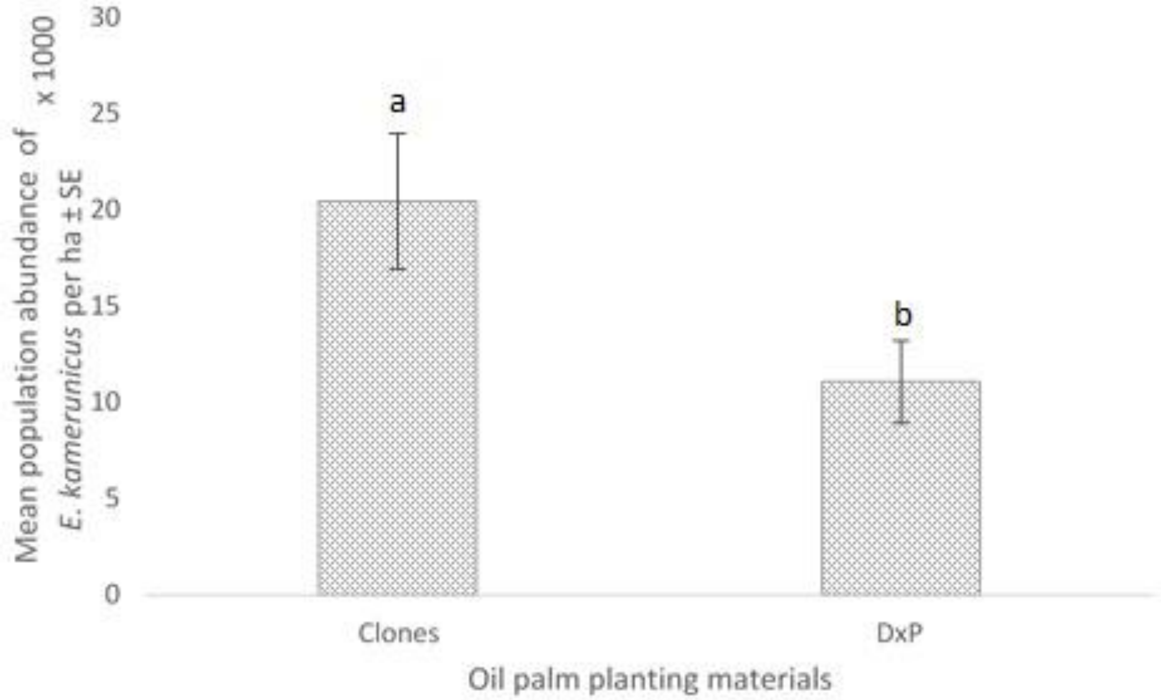

Figure 3 Mean population abundance of *E. kamerunicus* per ha ± SE between oil palm planting materials (Clones and D×P)

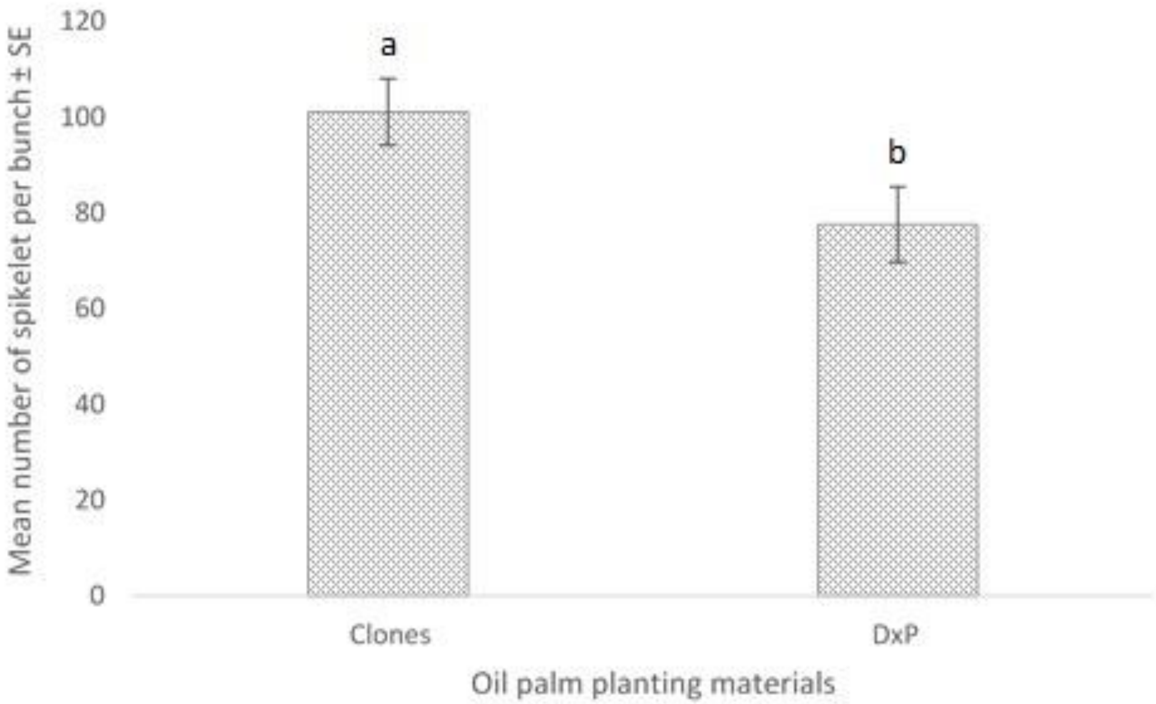

Figure 4 Mean number of spikelet per bunch ± SE between oil palm planting materials (Clones and D×P).

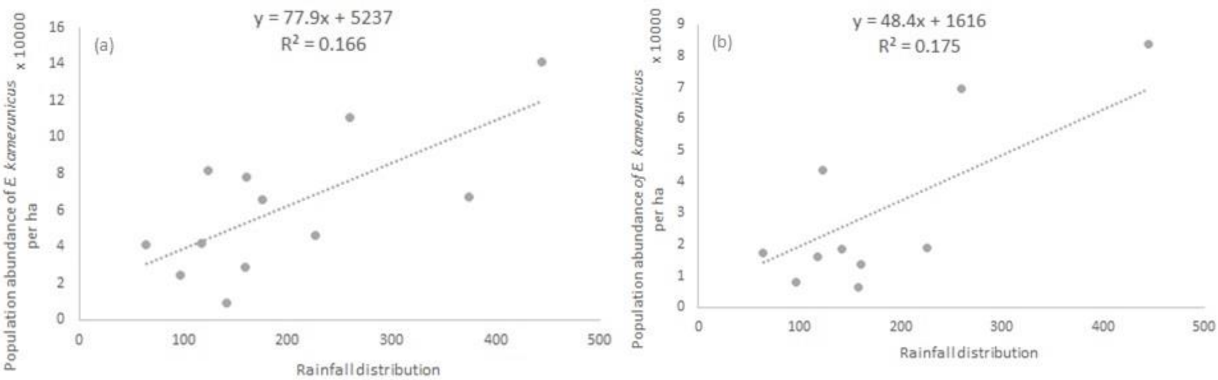

Figure 5 Correlation between rainfall distribution and the population abundance of *E. kamerunicus* per ha for oil palm clones (a) and D×P (b).

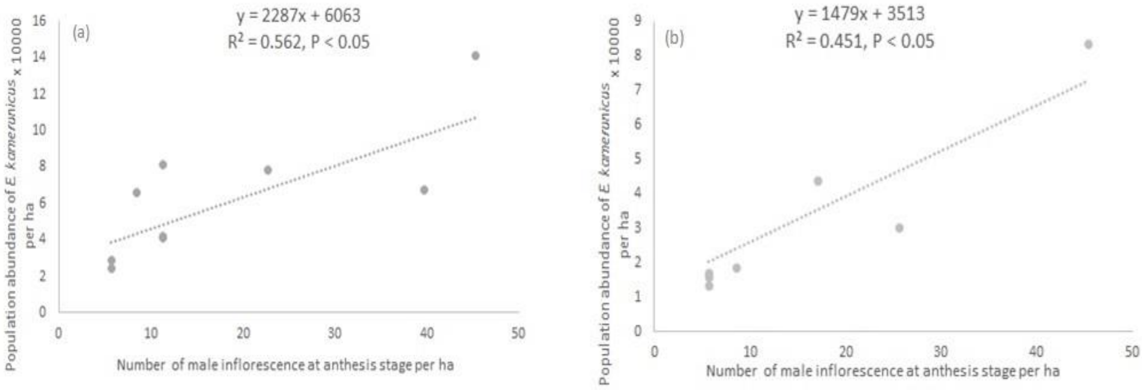

Figure 6 Correlation between the number of male inflorescence at anthesis stage per ha and the population abundance (number of individuals) of *E. kamerunicus* per ha for oil palm clones (a) and D×P (b).