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A Study on Barn Owl Population (*Tyto alba* var. *javanica*) in Reducing Rat Attacks and Parthenocarpy in Oil Palm Fresh Fruit Bunches

Kadarwati Budihardjo[1], Herry Wirianata[1] and Septa Primananda[2]
1) Magister of Plantation Management, Institut Pertanian Stiper (INSTIPER), Yogyakarta, Indonesia
2) EMU R&D, Wilmar International Plantation, Central Borneo, Indonesia
Corresponding Author, E-mail: kadarwati_yk@yahoo.co.id
Phone: + 62 812-8891-2224

Abstract

In mature oil palms, rat attacks fruit bunches, causing significantly reduction in the potential yield and the quality of oil palm fruit bunches. Rat is also known to consume the post anthesis male flowers which act as the breeding sites for the eggs and larvae of *Elaeidobius kamerunicus* pollinator beetle. Indirectly, the pollinator beetle population can be reduced in high rat infestation area, affecting the pollination and increasing the percentage of parthenocarpic fruit bunches. The barn owl (*Tyto alba* var. *javanica*) is a rat biological control agent in the oil palm plantations. The study conducted at PT. Mustika Sembuluh in Central Borneo shows that barn owl (*T. alba*) population is significantly correlated with both rat attacks and parthenocarpic percentage of oil palm fruit bunches in oil palm plantation.

Keywords: Rat attacks, Male flower, Parthenocarpic, *Tyto alba*, PFB.

INTRODUCTION

The concept of Integrated Pest Management (IPM) is a concept of pest control using a combination of approaches to control various potential pests that can threaten agricultural products. This includes natural pest population control with a series of technical supports such as: farming methods, specific diseases, pests, variety of crops resistant to pests, sterile insects, trapping compounds, parasites and predator growth stimulations, or the use of chemical pesticides if necessary (Kusnaedi, 2005). Biological control by using predators, peresitoids and pathogen insects have been implemented in pest control for a long time. According to Purnomo (2010), there are 3 basic approaches in biological control, that is conservation and enhancement of natural enemies, additional of natural enemies, and introduction of natural enemies.

One of the major pests of oil palm that may cause attacks to plants or crops is rat. During the immeture phase (TBM), rat causes attacks by eating the stem of palm up to its growing point. In the newly developed oil palm plantation areas, the death of new plants caused by rat attacks can reach up to 20 - 30%. Rat attacks during Mature phase (TM) is damaging by eating the Oil Palm Fruit Bunches (TBS), therefore the potential yield and the quality of TBS decreased significantly (Sipayung *et al*., 1996).

The results of research conducted by Indonesian Oil Palm Research Institute (IOPRI) show that a Malayan field rat (*Rattus tiomanicus*) can consume the flesh of the oil palm fruit (*mesocarp*) around 5.94–13.70 grams per day and bring 30-40 times of the consumed kernel to its nest. Rat population in oil palm plantations ranges from 183-537 rats per hectare, and fluctuates very little (persistent). Thus, the average loss of Crude Palm Oil (CPO) is around 827.96–962.38 kg/hectare/year, and this does not include the lost kernel brought by rat into its nest. In addition, damaged fruit bunches caused by rats become oxidized and contribute to the increase of FFA (*Free Fatty Acid*) on palm oil production (Sipayung *et al*., 1996).

Picture 1. Damaged fruit bunches by rats (left) and parthenocarpic fruit bunches (middle and right) in the oil palm tree (Source: Prasetyo, 2012).

Rat attacks may also affect the pollinator beetle of oil palm (*Elaei dobius kamerunikus*) because rat eats male flower. It will interfere with the reproduction of *E. kamerunikus* since the pollinator beetle breeds by depositing its larvae in the anthesised male flowers. Indirectly, rat attacks reduce pollinator beetle population, this results in the increasing percentage of parthenocarpic incidence cause to the lack of pollination in regions with high rat attacks. Based on a research in the West Africa, fruit maturation process varies in the average of 162–171 days. In Indonesia, it also varies in the average of 173 days after anthesis (Turner, 2003). Therefore, the insufficient population of *E. kamerunicus* may affect the pollination process and it will be visible from the low *fruit set* on mature fruit bunches of the oil palm tree 6 months there after.

PT. Mustika Sembuluh (MS) is one of the Private Large-Scale Plantations (PBS) in Central Borneo which has replaced the use of rat bait by implementing the predatory owl *T. alba* breeding to biologically control rat population in 3 Estates (MS-1, MS-2, MS-3) of the plantation since 2014. *T. alba* is introduced to a cage in the field (gupon) from the breeding facility. Now, it continues to be developed in MS-1, MS-2 & MS-3 Estates based on the addition of the SOP of Agronomy No. 11 of 2014 on *T. alba* breeding. In the early stages of gupon development, the cage is expected to be located in population ratio of 1 gupon per 50 hectares and gradually increased to a ratio of 1 gupon per 20–30 hectare (Primananda and Sukarman, 2014).

T. alba is a type of owl that is potential and effective in controlling rats biologically. The characteristics and morphology of *T. alba* are:
99% of its food is mice/rats. Life cycle, it spawns 4 to 11 eggs on an average of twice a year, Both eyes are located at the front of the face and it has a sharp hearing, Have strong legs and sharp nails, Have a strong and wide beak, so that it can swallow a rat.

Picture 2. Male and female *T. alba* owls in its breeding cage

A female bird begins to spawn at the age of 8 months with the number of eggs around 12-14 eggs per year, depending on the availability of food. The spawning period ranges between 1-3 times in a year, but generally it happens two times a year. The egg color is dirty white, each weighs ± 20 grams. Based on the observations in the gupon, the average number of eggs is about 5 (five) eggs with the average hatching rate of 53%. The egg will hatch after the incubation period about 28 days and it will hatch in sequence according to the order of eggs produced. Rat control by using rat poison (*rat bait*) can be combined with *T. alba* breeding, but only rat poison of the first generation of anticoagulant (AG I) like warfarin and coumatetralyl are recommended. Meanwhile, the second generation of anticoagulant (AG II) like brodifacoum may lead to the death of the owl (secondary predator).

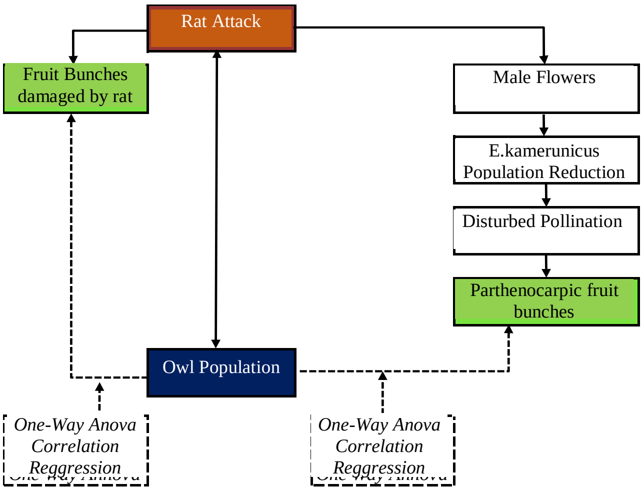
Picture 3. The documentation of monitoring results in the field of PT. MS; (a.) Eggs and rats hunted by the owl (brooder) in the gupon, (b.) The brooder incubates the eggs in the gupon, (c.) The brooder and its owlets of 1–1.5 months in the gupon, (d.) Owl flies from gupon while it was being recorded.

T. alba management as the biological control of rat in the three Estates (MS-1, MS-2 and MS-3) is still on the development stage with a diverse population level of *T. alba* owl in all three Estates. The populations of owl and gupon are recorded monthly based on the SOPs in order to control the rat attack biologically. This study aims to determine the significant effect of the spread of *T. alba* population in relation to the decreasing of the percentage of rat attacks and the percentage of parthenocarpic fruit bunches of TBS at PT. MS. This research provides quantitative information on the influence of implementation of *T. alba* management on the percentage decrease of rat attacks and parthenocarpic. In addition, it functions as a reference in the implementation of rat control by using *T. alba* predator in oil palm plantations.

MATERIAL AND METHODS

This research was conducted for 21 months (January 2016 - September 2017) at PT. MS, East Kotawaringin Regency, Central Borneo Province. The secondary data were as follows:
Monthly census data of *T. alba* population at PT. MS (estate 1, 2 and 3) from January 2016 to December 2017, FFB grading (sorting) data of TBS delivery from PT. MS (Estate 1, 2 and 3) at the PT. MS (Mill 1 and 2) Palm Oil Mills from January

2016 to December 2017, *Area statement* data and maps of PT. MS (estate 1, 2 and 3) from January 2016 to December 2017.



Picture 4. Flowchart of analysis research

Research method of the study is descriptive research method (Budihardjo K, 2003). The dependent variable of the study is the percentage of rat attacks and parthenocarpic on TBS, while the independent variable is the spread of *T. alba* population. The research analysis is described in figure 4 above.

RESULTS AND DISCUSSION

Study of *Tyto alba* Population against Rat Attacks

The correlation analysis shows that the relationship between *T. alba* population and rat attack rate is quite strong with a correlation value of 0.551. The t test results show the significant effect with the t count value of 5.516 ≥ 1.999 (t table) which means that *T. alba* population can control rat attack rate in Oil Palm Plantations. The *Anova* analysis results show an F count of 26.6 ≥ f table of 3.14, which means that the rat attack rate in the three Estates is significantly different.

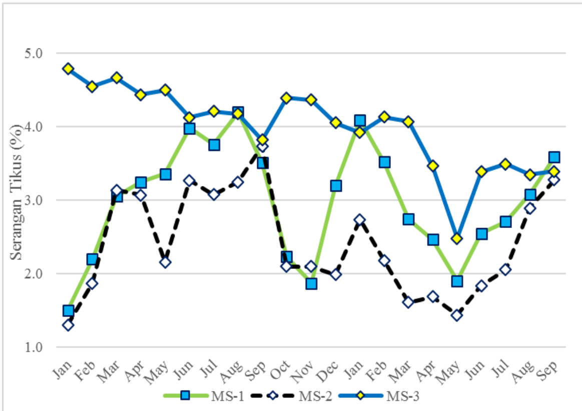
Table 1. Rat Attacks Rate in the Estate

Estate	Average Ratio of Hectare to Owl Population	Research Variables Rat Attack Rate (%)	Quadratic Transformation
MS-1	50 hectares/pair	2.99 [a]	109.45 [a]
MS-2	86 hectares/pair	2.41 [a]	52.17 [a]
MS-3	407 hectares/pair	3.99 [b]	279.40 [b]

Description: the number in a column followed by the same small letter shows that it is not significantly different in the *Scheffe* post hoc test at 5%.

The post hoc test results (Table 1) show that rat attack rate in MS-1 and MS-2 (50 hectares/pair and 86 hectares/pair) is not significantly different, whereas MS-3 (407 hectares/pair) shows a higher rat attack rate and it is significantly different from MS-1 and MS-2.

The research by Thohari of the *Southeast Asian Regional Centre for Tropical Biology* (SEAMEO BIOTROP), Bogor, West Java, mentioned that a pair of *T. Alba* in a cage can prey on 3.650 rats in a year, so a pair of owls can prey on an average of 10 rats per day. An adult *T. alba* in a 4 m x 4 m x 5 m cage can consume up to 5 (five) *Rattus tiomanicus* rats and kill up to 9 (nine) rats per night, although it does not consume the entire body of the rat. In other words, *T. alba* has a greater predatory power compared its consuming power.



Picture 5. Rat attacks rate in PT. MS on January 2016 – September 2017.

Figure 5 above shows that the larger coverage area in MS-3 causes a lot of rats, which cannot be controlled by *T. alba*. It is caused by the imbalance between the hunting ability per day with the number of rats per coverage area (too broad). In accordance with the post hoc test results, rat attack rate in MS-1 and MS-2 are not significantly different because the spread of *T. alba* population does not differ much, while in MS-3, the spread of the population is not in line with the recommendations. So, it can be seen that the rat attack rate in MS-3 is higher than those in MS-1 and MS-2 from January 2016 to September 2017.

Influence of *Tyto alba* Population on Parthenocarpic Fruit Bunches Percentage

The correlation analysis results show that the relationship between *T. alba* population and parthenocarpic formation percentage is quite strong with a correlation value of 0.818. The t test shows a t value of 8.81 ≥ t table of 1.999. It means that the variable of *T. alba* population has a significant effect on parthenocarpic. The *Anova* analysis results show an F count of 58.5 ≥ f table of 3.22, which means that the parthenocarpic formation percentage in the three Estates is significantly different.

Table 2. Parthenocarpic fruit bunches percentage in Each Estate

Estate	Average Ratio of Hectare to Owl Population	Research Variables	Root Transformation
		Parthenocarpic Formation (%)	
MS-1	50 hectares/pair	0.23 [a]	0.84 [a]
MS-2	86 hectares/pair	0.96 [a]	1.19 [a]
MS-3	407 hectares/pair	2.38 [b]	1.70 [b]

Description: the number in a column followed by the same small letter shows that it is not significantly different in the *Scheffe* post hoc test at 5%.

The post hoc test results (Table 2) show that parthenocarpic fruit bunches percentage in MS-1 and MS-2 (50 hectares/pair and 86 hectares/pair) is not significantly different, whereas MS-3 (407 hectares/pair) shows a higher parthenocarpic fruit bunches percentage and it is significantly different from MS-1 and MS-2.

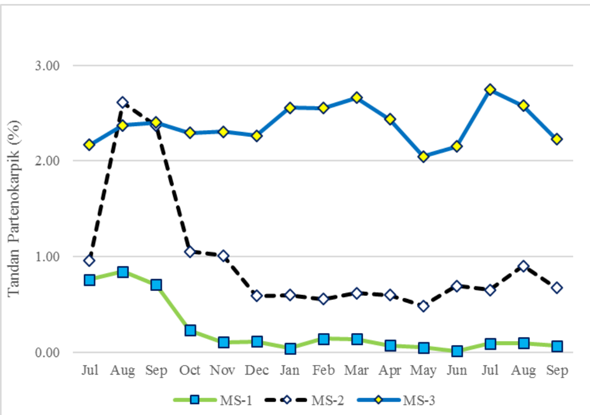


Figure 6. Parthenocarpic fruit bunches percentage in PT.MS on January 2016 – September 2017.

Based on the figure above, *T. alba* owl population in MS-1 shows a lower and more stable parthenocarpic fruit bunches percentage compared to MS-2, although the post hoc test results are not significantly different. The higher the *T. alba* population in the field, the coverage area controlled by *T. alba* will become narrower and suitable for their hunting proless. Consequently, it will lead to the rat population reduction in the field. One of the causes of parthenocarpic fruit bunches is that rats eat the male flowers and reduced the weevil pollinators as a result.

Observations in the field show that rat eats male flowers of oil palm with a lot of eggs, larvae and pupae of *E. kamerunicus* weevil that serves as the pollinator insect in PT. MS. This causes reduction in the population of *E. kamerunicus* weevil as the main pollinator weevil that carries pollen to the female flowers of oil palm. Consequently, it interferes the intensity of pollination in the field.

Figure 7. Male flowers of oil palm (a) male flowers after anthesis, (b) male flowers after anthesis eaten by rat, (c) and (d) eggs and larvae of *E. kamerunicus* in male flowers (Source: Prasetyo *et al*., 2012).

This research is in accordance with the research by (Syed 1982; Sipayung *et al*., 1987; Poinar, 2002; in Prasetyo, 2012) which stated that *E. kamerunicus* population may decrease because of rat that eats the eggs, larvae, pupae, and imago. (Sipayung *et al*., 1987 in Prasetyo, 2012). It is proven by the findings of various insects and small animals, including bug pincher (*Chelisoches morris*), snail (*Parmorian pupillaris*) and weaver ant (*Ocophylla smaragdina*). Larvae and pupae of *E. kamerunicus* is second in number after bug pincher in the rat stomach. Rat likes to eat the larvae and pupae of *E. kamerunicus* as the source of additional protein in order to grow healthy and live longer (Hutauruk *et al*., 1985 in Prasetyo, 2012). On the other hand, male flowers in a good condition are needed to provide a sufficient amount of food for the *E. kamerunicus* larvae and they consume the base of the male flowers filament (Howard *et al*. 2001; Susanto *et al*. 2007).

The results of research conducted by Indonesian Oil Palm Research Institute (IOPRI) in Central Borneo show that in reaching the value of good fruit set of oil palm above 75%, it requires pollinator weevil population above 144,000 of *E. kamerunicus* per hectare with the availability of anthesis male flowers at least 9 flowers per hectare (Prasetyo *et al*., 2012). A good oil palm fruit set is above 75% (Susanto *et al*., 2007). After the female flowers are pollinated during anthesis, they will become kernels which are generally in the range of 600–2000 kernels with fruit set percentage in the range of 40–60% (Pahan, 2006). Pollination performed by *E. kamerunicus* weevil increase the production of oil palm from 44% to 75% (Hutahuruk *et al*., in Sholehana, 2010). In addition, Ponnamma (1999) reported that *E. kamerunicus* can increase the value of fruit set from 36.9% to 78.3%. This value can be achieved with the presence of *E. kamerunicus* weevil population of at least around 20,000 per hectare.

Figure 8. Male and female *E. kamerunicus*, pollinator insect of oil palm (Source: Walker, 2011)

According to Syed and Shalleh (1987 in Prasetyo *et al*., 2012), it takes about 1,500 *E. kamerunicus* weevil per bunch to pollinate receptive female flowers for minimum pollination (50% fruit formation) in fruit bunches. Arif (2009) adds that if *E. kamerunicus* population is less than 700 weevil per anthesis female flower bunch, the fruit set will be low. As an illustration, if there are 100,000 flowers in one male flower bunch, then the number of *E. kamerunicus* larvae which can propagate in the flower bunch can reach up to 20,000 larvae (Syed, 1982; Eardley *et al*., 2006 in Prasetyo *et. al*., 2012). If there is a rat attack with the attacks level of 20% on male flower bunches, then the potential *E. kamerunicus* population will be decreased by 4,000 weevil/male flower.

CONCLUSION AND SUGGESTIONS

Conclusion

The conclusion of the study results is as follows:
The increase of *Tyto alba* var. *javanica* population has a significant effect on rat attacks and parthenocarpic percentages decrease on TBS at PT. MS, The average ratio of hectare to owl population in MS-1 Estate (50 hectares/pair) and MS-2 Estate (86 hectares/pair) shows that the rat attacks rate is not significantly different. The MS-3 Estate (407 hectares/pair) shows a higher rat attacks rate and it is significantly different from that of MS-1 and MS-2 Estates, The parthenocarpic fruit bunches percentage in MS-1 Estate (50 hectares/pair) is lower and more stable than in MS-2 Estate (86 hectares/pair) although it does not show a significant difference. The MS-3 Estate (407 hectares/pair) shows a higher parthenocarpic fruit bunches percentage and it is significantly different from MS-1 and MS-2 Estates.

Suggestions

Further study is suggested concerning on the influence of the spread of *T. alba E. kamerunicus* pollinator weevil population in Oil Palm Plantations that has not been studied. This Study is beneficial as a reference in the development of *T. alba* as a biological control and a part of the Integrated Pest Management concept in Oil Palm Plantations.

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