



# Status of Pest, *Oryctes rhinoceros* and Its Natural Enemies in the Independent Smallholder Treated with Different Insecticides

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**Abstract:** A field study was carried out at Tangkak, Malaysia regarding *Oryctes rhinoceros*'s infestation and its natural enemies after being treated with selected pesticides from January until October 2017. The objective of this study to examine the effect of different insecticides usages with the presences of *Oryctes rhinoceros* including untreated area and population of *Oryctes*'s natural enemy in the oil palm areas of smallholders. Three treatments with four replicates were applied in the selected oil palm area, namely Cypermethrin, Carbofuran and Untreated (without chemical). Twelve smallholders with three different insecticides used were chosen randomly and twelve samples were taken as replicates. Effects of the beetles' population over the chemical's treatments were analyzed using analysis of variance (ANOVA) (SPSS - version 23). The results dramatically revealed that the least presence of *Oryctes rhinoceros* was detected at Untreated area with total mean of 0.21, followed by Carbofuran with total mean of 2.63 and Cypermethrin with 3.12. The result of this study indicated that *Oryctes rhinoceros* in Tangkak, Johor has developed resistance to the insecticides used by the growers due to high frequency of similar type of chemical. These insecticides had no significant effect towards the natural enemy found in oil palm area in Tangkak which is *Platymeris laevicollis*. These natural enemies also showed no relationship directly with the presences of *Oryctes rhinoceros* due to low diversity of plant species or particularly lack of shelter.

**Keywords:** Insecticides, *Oryctes Rhinoceros*, *Platymeris Laevicollis*

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## 1. Introduction

Oil palm (*Elaeis guineensis*) is commonly as an estate crop and major crops for Malaysia. This crop usually being grown in a large scale estate around 3000 to 5000 hectares. It is known to be originated from the West of Africa. Oil palm is usually being planted in area with rainy tropical lowland. In order to produce a high quality of oil palm fruits, it needs to meet specific requirements such as a suitable temperature, deep soil and also suitable moisture throughout the year. In addition, the yield of the oil palm is not only can be affected

by the temperature and the soil moisture, it is also affected by the presence of the pest and diseases.

Oil palm has a high risk to be infected with one common pest which is *Oryctes rhinoceros* [1]. *Oryctes rhinoceros* is commonly known as 'kumbang badak' or rhinoceros beetle in Malaysia. Rhinoceros beetle can be reduced using several methods such as chemical, cultural, biological control and others. One of the effective ways is by applying chemical pesticides. Ahmad [2] stated that the application of insecticides towards the palms gives a significant result in term of controlling the beetles' population and the damage

when compared to the untreated trees. There are a few chemicals that are normally being used in the plantations in Malaysia such as the Cypermethrin, Carbofuran, naphthalene balls and others.

Apart from that, natural enemies also can be used to combat at pests like *Oryctes rhinoceros*. Vast benefits have been reported when natural enemies are introduced into the fields. Use of 'natural enemies' ensures the safety of the growers compared to the usage of insecticides that are hazardous to the operators. Natural enemies also can help to increase the ecosystems' biodiversity and also help in reducing insecticides residues [3]. There are twenty-eight species of natural enemies that have been recorded to be effectively suppress the attack from *Oryctes rhinoceros*. They are from Carabids (*Itanus sp.*, *O. punctatosulcatus*, *Omphra atrata*, *Oxylobus alveolatus* Chaud), Histerids (*Hister sp.*, *H. (Santalus) parallelus* Redt.) and *Reduviid (Sirthenca sp.)* [4].

## 2. Materials and Methods

### 2.1. Location and Duration of Study

This study was carried out in Tangkak, Johor, Malaysia for ten months starting from January until December of 2017.

### 2.2. Field Experiment Design

Research area were designed in Complete Randomize Design (CRD). This study was conducted using two different insecticides which are cypermethrin and carbofuran. Control plots of smallholders' oil palm fields is also included. A total of twelve smallholders with three different insecticides applications had been chosen in this study. Thus, a total of twelve samples were taken as replications in this study. Each pheromone trap and yellow sticky trap was placed in each smallholder with two different chemical usage including control. The presences of both populations of natural enemies and *Oryctes rhinoceros* were observed along the sampling period.

The *Oryctes rhinoceros* collected were kept in vials while the natural enemies were kept properly and were brought back for further counting, classification and identification process at the Laboratory of Entomology, Faculty of Plantation and Agrotechnology in Universiti Teknologi MARA (UiTM) Jasin, Melaka.

## 3. Data Analysis

This research is primarily to determine the effectiveness of two selected insecticides against rhinoceros beetles. Effects of the beetles' population over the treatments was analyzed using analysis of variance (ANOVA) of Statistical Package for Social Science (SPSS - version 23). Besides, to study the data regarding the natural enemies' population over the treatments, one-way analysis of variance (ANOVA) of Statistical Package for Social Science (SPSS - version 23) also was used.

To determine the relationship between both populations

and the presences of natural enemies and *Oryctes rhinoceros*, correlation analysis of Statistical Package for Social Science (SPSS - version 23) were used.

## 4. Results

### 4.1. Effect of Selected Insecticide Against *Oryctes Rhinoceros* Population in Tangkak

The mean numbers of rhinoceros beetles captured were recorded monthly for ten consecutive months. Figure 1 shows that the two selected insecticides including control showed a high significant difference ( $F = 27.424$ ;  $df = 2$ ;  $P < 0.01$ ) in mean number of rhinoceros beetles' population. The mean population of rhinoceros beetles applied with cypermethrin has the highest mean with 3.12, followed by application by carbofuran with mean of 2.63 and the lowest mean of beetles' population was recorded by Untreated with 0.21.

The total mean numbers for the *Oryctes rhinoceros* population for ten consecutive months were clarified in the Figure 2 below. As revealed by Figure 2, application of cypermethrin was mostly fluctuated from the early until at the end of sampling time. From the first sampling until the second sampling in two weeks' time, the mean number for *Oryctes rhinoceros* declined and it was constant until 15<sup>th</sup> February. For a month starting from 15<sup>th</sup> February, the population of the *Oryctes rhinoceros* rose and dropped down to 4.5 before it rose back to the highest mean number of *Oryctes rhinoceros* which was at 6.75 on 15<sup>th</sup> April 2017. Conclusively, the mean population of these beetles was found to be inconsistent within the range of 0.75 and 6.25.

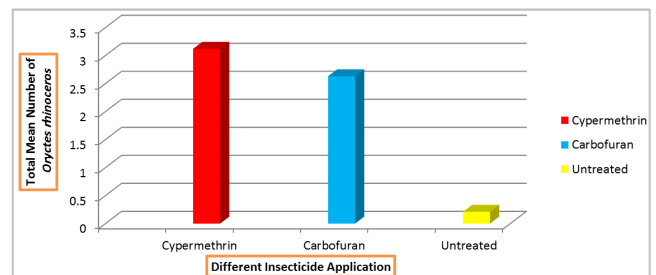


Figure 1. Total mean number of *Oryctes rhinoceros* with different insecticide application.

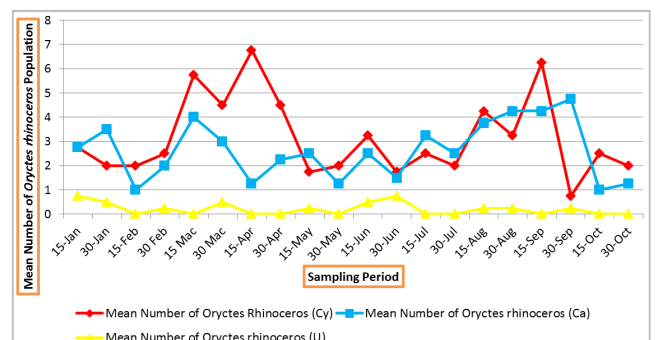


Figure 2. The Mean Number of *Oryctes rhinoceros* Population Dynamic Based on Insecticide.

As for the application with carbofuran, the result was moderately fluctuated. The mean number of *Oryctes rhinoceros* were varied where the population fluctuated which the populations went up and down along the sampling period. The highest mean number was recorded at 15<sup>th</sup> September at 4.75 and the lowest was both of 15<sup>th</sup> February and 15<sup>th</sup> October 2017 which was at 1.0.

Surprisingly, the mean number of *Oryctes rhinoceros* without any insecticide application (untreated) had been steadily low from the start until the end within the sampling period. The highest mean recorded for untreated is 0.75 and the lowest is zero (0), which really proves that areas without any insecticide application showed the lowest number of *Oryctes rhinoceros* captured in the pheromone trap.

#### 4.2. Effect of Selected Insecticide Against Natural Enemies (*Platyeris Laevicollis*) in Oil Palm in Tangkak and Its Relationship with *Oryctes Rhinoceros*

The total mean population of *Platyeris laevicollis* was found to be the highest (0.15) with Carbofuran application in oil palm areas, followed by untreated field (0.14) and 0.13 as the lowest for Cypermethrin application.

Figure 3 revealed no significant difference between these two parameters showed ( $F = 0.081$ ;  $df = 2$ ;  $P > 0.05$ ) in mean number of *Platyeris laevicollis*.

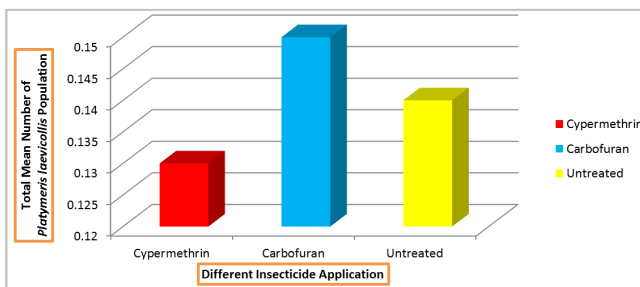


Figure 3. Total Mean Number of *Platyeris laevicollis* with Different Insecticide Application In Oil Palm Areas.

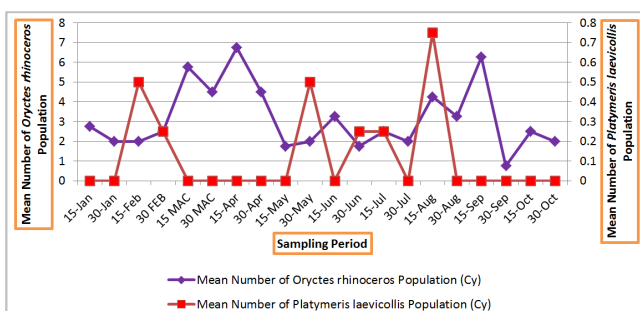


Figure 4. Relationship Between *Oryctes rhinoceros* and *Platyeris laevicollis* at Cypermethrin Usage.

In addition, as revealed in Figure 4, there was no relationship ( $r = -0.013$ ,  $P > 0.05$ ) between the presences of *Oryctes rhinoceros* and *Platyeris laevicollis* within Cypermethrin usage.

It was observed that along the sampling period, the population of the beetle was high and the natural enemy was

not present which explained the natural enemy didn't give any effect towards the beetles' population. This could be clearer seen where there was no *Platyeris laevicollis* captured for four months, two months between May and August and another two months between the months of August until October, but the presence of the *Oryctes rhinoceros* kept being fluctuated.

This was also clearly shown in Figure 5 and Figure 6 where the presence of *Oryctes rhinoceros* and *Platyeris laevicollis* populations did not influence the presence of *Oryctes rhinoceros* in the field with Carbofuran and Untreated field.

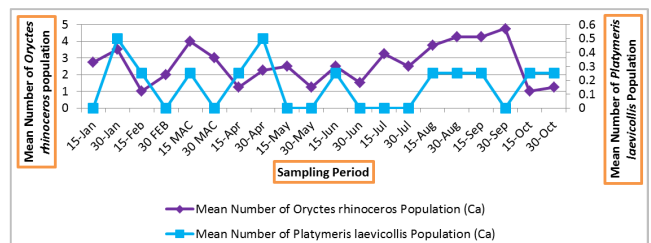


Figure 5. Relationship Between *Oryctes rhinoceros* and *Platyeris laevicollis* at Carbofuran Usage.

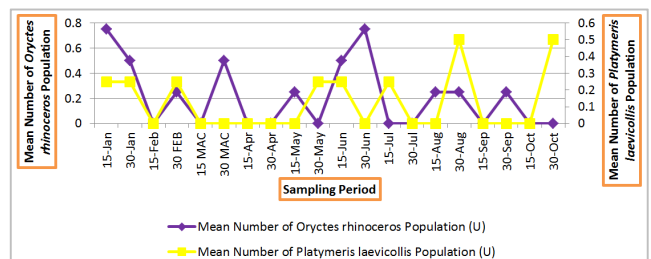


Figure 6. Relationship Between *Oryctes rhinoceros* and *Platyeris laevicollis* at Untreated Field.

## 5. Discussions

It was clearly shown that the population of *Oryctes rhinoceros* was stable and consistently low at untreated (control) area compared to the areas applied with Cypermethrin and Carbofuran. Both *Oryctes rhinoceros* populations at Cypermethrin and Carbofuran areas were greatly fluctuated during the ten months of sampling period. This probably caused by the *Oryctes rhinoceros* had been resistance to those two insecticides. Repeated use of the same class and mode of action of the insecticides may cause the pests to develop faster than it should be [5, 6, 22].

Besides, several classes have been reported to be detectable by insects such as carbamates, organophosphates and pyrethroids. During the presences of these insecticides, the insects just simply stop their feeding diets, find a protection by going down to the underside of the sprayed crops or just simply move away from the sprayed areas. Insects also developed penetration resistance. Penetration resistance occurred when insects have developed barriers at their outer cuticles. These barriers will decelerate the absorption rate on insecticides hence reduced the effects

towards the insects. Commonly, there are three main factors that help to develop the pests' resistance towards the insecticides which are genetic, biological and operational factors [6].

A study done by Szczepaniec *et al.* [7] found that insecticides under the class of neonicotinoid had altered and disrupted the plants' defense systems and lead to lower down the ability of the plants to be resistance to the herbivores attacks. It was proven that by applying the neonicotinoid, the spider mites populations and abundances were increased greatly from 30% to 100% in the greenhouse and it was getting worse in the field experiment where the populations were getting higher up to 200% when the plants are treated with neonicotinoid. Neonicotinoid was proven to have a very significant relationship with the spider mites' growth population rates. When cotton crops were applied with neonicotinoid, the spider mites' rate of growth population increase up to 27%, but significantly elevated to 100% for corns and tomatoes. In addition, neonicotinoid also can impede and convulse the plants' phytohormone like jasmonic acid (JA), 12-oxo-phytodienoic acid (OPDA), salicylic acid (SA) and abscisic acid (ABA). These phytohormones are needed as they are vital to help the plants to be anti-herbivores [8]. Then, it is believed that this is also of the reason why the Untreated area are constantly low compared to the treated areas as these insecticides are believed to reduce the oil palm's defense system other than due to the resistance cause.

Findings from this study also shown that the natural enemies were low in both areas with and without insecticide application. Therefore, the presence of *Oryctes rhinoceros* in the field is probably because of the environment itself that do not support the enhancement and the effectiveness of the natural enemies to stay. Availability of a suitable landscape is crucial for shaping the community of natural enemies [9]. Thies *et al.* [10] claimed that a complex landscape can help to improve giving a better support for natural enemies' population to expand. Increasing the diversity and manipulating the environment can be done by increasing the vegetational diversity [4]. Monoculture is proven to be more susceptible and has less tolerance to pests outbreaks compared to the polycultures. Other than polycultures and intercropping, semi natural habitats can also be considered to be a more stable environment for natural enemies. Field margins and hedgerows are examples of semi-natural habitats. Semi natural habitats are reported to consist more beneficial than harmful living organisms [11, 23].

Moreover, to encourage the survival of natural enemies, shelters must also be provided. A shelter is provided for the purpose to avoid the disturbance from hazardous environment such as heavy rain, heat, windy days and cold periods. Cover crops act as a shelter and also can help in providing the floral resource to the beneficial insects [12]. Furthermore, another method that can be used in encouraging the populations of natural enemies is by introducing the herbivore-induced plant volatiles (HIPVs) into the field. Damage done to the plants by herbivores will induce the

plants to release cues to the natural enemies in term of volatiles mixtures, aromatic compounds and also terpenes [13]. Natural enemies will make use of the cues released from the plants to detect any presence of the hosts or the preys. Rodriguez-sauna *et al.* [14] professes that the HIPVs provided the most reliable and detectable signals to the natural enemies. HIPVs releases the volatile blends as it responses to the herbivores attacks. According to Mafei [15] and Arimura *et al.* [16], the plants and herbivores' conditions, species involved and the stage of development are the keys in varying the HIPVs chemicals productions.

On top of that, another alternative in reducing bad impacts towards the population of natural enemies following the IPM's strategy is by using selective insecticides. Growers must have a complete information on insecticides usage so that they can use the chemicals judiciously and trying to make them understand that the best way in controlling the pests are through the use of maximum natural enemies in the fields and it is completed with the usage of insecticides when it is only necessary [17]. Selective insecticides have three categories of selectivity which are ecological, physiological and behavioral.

Besides, there are some cultural practices that can boost the natural enemies' availability. Tillage activity is one of the major factors which can give impact to the organisms' interactions at different trophic level [18]. Roughly, tillage makes the environment more stable and encourages species' divergence. Natural enemies can be affected by the numbers of tillage done and the methods used to do the tillage. Numbers of tillage has a negative relationship with the availability of natural enemies. More natural enemies will be reproduced when little tillage is done. As expressed by Ferguson *et al.* [19], post-harvest tillage will reduce parasitoids' emergence in the soil. Nevertheless, this relationship will vary depending to the ecological characteristics.

On top of that, fertilization also plays a vital role in enhancing the natural enemies. A study done by Safraz *et al.* [20] noted that parasitoids of *Plutella xylostella* (Diamond Back Moth) was more effective when sufficient supply of mineral nutrients [21] are given. As an addition, growers also must take note on their dates of harvesting and seeding as it also might contribute an effect to the populations of both, pests and natural enemies.

## 6. Conclusions

The result of this study can be concluded as significant findings as *Oryctes rhinoceros* in Tangkak, Johor has developed resistance to the insecticides used by the growers and low activity of natural enemies. There are two insecticides that have been studied in this research which were Pyrethroids (Cypermethrin) and Carbamate (Carbofuran). Throughout the ten months of sampling periods, it can be observed that the numbers of *Oryctes rhinoceros* caught were significantly high in mean numbers in the insecticides-applied areas compared to the untreated

areas. Furthermore, the results obtained showed that there were no effect of insecticides to the natural enemies and these natural enemies have no relation to the *Oryctes rhinoceros* presence in the oil palm. Secondly, natural enemies are absent in the fields because the insecticides used by the growers have killed the natural enemies thus resulting in no correlation between the natural enemies and the *Oryctes rhinoceros*.

## 7. Recommendations

This study found that there was continuously and too frequent chemical usage in the oil palm by growers caused bad effect and difficult to control *Oryctes rhinoceros* population and there were no natural enemies captured because low diversity in term of plant species such as no presence of shelter for the natural enemies to protect themselves. Therefore, this study suggested that high consideration on the chemicals types used and frequency of application should be carried out by growers. There was also suggested that the beneficial plants should be planted to increase the population of natural enemies to suppress *Oryctes rhinoceros* in oil palm area.

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