THE EFFECT OF RELATIVE HUMIDITY AND CULTURAL PRACTICES ON *Tirathaba rufivena* (WALKER, 1861) (LEPIDOPTERA: PYRALIDAE) POPULATION IN OIL PALM PLANTATION

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ABSTRACT

Tirathaba rufivena is one of major insect pests of oil palm industry in Sarawak especially oil palm planted at peat soil. It causes significant losses to Fresh Fruit Bunch (FFB) yield of oil palm if it reaches outbreak level. Therefore, there was a concern over the population of *T. rufivena* and its relationship with relative humidity (RH). A case study was carried out to identify the effects of relative humidity on the population of *T. rufivena*. This study was conducted at Saribas Estate 1, Pusa, Betong District in Sarawak within eight weeks by using Complete Randomised Design (CRD) with two treatments (maintenance and less maintenance area) and six replications. Light traps fitted with 18w bulb were used to collect the *T. rufivena* population while digital psychrometer XINTEST Model HT-86 was used to record RH level. The result showed the highest mean number of infested bunches was found at less maintenance area (n=6, M=15, SD=13.78) than maintenance area (n=6, M=13, SD=10.62), t (10) = -0.28, p =0.78. Furthermore, a simple correlation analysis was carried out and the result revealed that there was a weak, positive correlation between a number of *T. rufivena* and relative humidity in the maintenance area, r = .24, n = 48, p = 0.11 while, in less maintenance area, there was a medium positive interaction between population of *T. rufivena* and relative humidity, r = .40, n = 48, p = 0.01. The results indicated that, implementation of cultural practice in maintenance area and census as an early detection of the infestation level method helps in reducing the pest outbreak. Therefore, a comprehensive data collection is needed especially on the depth of peat soil in the area with the highest infestation level of *T. rufivena* to give more comprehensive information on the ecological aspect this insect pest.

Keywords: Oil palm, Pyralidae, *Tirathaba rufivena*, relative humidity, peat soil

ABSTRAK

Tirathaba rufivena merupakan salah satu daripada serangga perosak utama di dalam industri kelapa sawit di Sarawak terutamanya kelapa sawit yang ditanam di tanah gambut. Ia menyebabkan kerugian besar kepada hasil Tandan Buah Segar (FFB) kelapa sawit sekiranya mencapai tahap letusan perosak. Oleh itu, terdapat kebimbangan terhadap populasi *T. rufivena* dan hubungannya dengan kelembapan relatif (RH). Satu kajian telah dijalankan untuk mengenal pasti kesan kelembapan relatif terhadap kadar populasi *T. rufivena*. Kajian ini dijalankan di Ladang Saribas 1, Pusa, Daerah Betong di Sarawak selama lapan minggu dengan menggunakan kaedah rekabentuk rawak lengkap (CRD) di antara dua rawatan (penyelenggaraan dan kurang penyelenggaraan) dengan enam replikasi. Perangkap cahaya yang dipasang dengan mentol berkuasa 18w digunakan untuk memerangkap *T. rufivena* manakala psikrometer digital XINTEST Model HT-86 digunakan untuk merekod peratusan RH. Hasil kajian menunjukkan bahawa purata terbanyak bilangan tandan yang diserang adalah pada kawasan kurang penyelenggaraan (n = 6, M = 15, SD = 13.78) berbanding dengan kawasan penyelenggaraan (n = 6, M = 13, SD = 10.62) = -0.28, p = 0.78. Selain itu, satu analisis hubungkait dilakukan dan hasilnya menunjukkan terdapat hubungkait yang lemah dan positif antara populasi *T. rufivena* dan kelembapanrelatif di kawasan penyelenggaraan, r = .24, n = 48, p = 0.11 sementara, di kawasan kurang penyelenggaraan, sederhana dan positif antara populasi *T. rufivena* dan kelembapanrelatif, r = .40, n = 48, p = 0.01. Hasil kajian ini menunjukkan bahawa, pelaksanaan amalan penyelanggaraan dan bancian awal sebagai kaedah pengesanan tahap serangan dapat membantu dalam mengurangkan letusan perosak. Maka dengan itu, pengumpulan data yang menyeluruh diperlukan terutamanya pada kedalaman tanah gambut di kawasan dengan paras serangan tertinggi *T. rufivena* untuk memberikan lebih banyak maklumat mengenai aspek ekologi serangga persosak ini.

Kata kunci: Kelapa sawit, Pyralidae, *Tirathaba rufivena*, kelembapan relatif, tanah gambut

INTRODUCTION

There are 2.37 million hectares of peat soil in Malaysia with 810,000 hectares are in Peninsular Malaysia, 86,000 hectares in Sabah and 1.47 million hectares in Sarawak respectively (Melling et al. 2008). By 2013, data recorded by Malaysian Palm Oil Board (MPOB) showed that total oil palm planted area in Sarawak is estimated to be 1,263,391 hectares with an annual production of 18.63 tonnes per hectare of fresh fruit bunch (FFB) (MPOB 2015). However, localised losses attribute to a number of insect pests can be substantial if high pest populations or outbreaks occur persistently. The major insect pest attacks are bagworms (Lepidoptera: Psychidae), nettle caterpillars (Lepidoptera: Limacodidae), rhinoceros beetle (Coleoptera: Dynastidae) and bunch moths (Lepidoptera: Pyralidae) (Darus & Wahid 2000). Highest infestation of *T. rufivena* was reported in oil palm planted on peat soil areas especially in Mukah, Sibu, and Miri in Sarawak (Masijan et al. 2015).

Several methods have been proposed in controlling *T. rufivena* in oil palm either using chemical, biological control or combination of both methods. A preliminary study was done by Zhong et al. (2016) found the potential predator (*Chelisoches morio* (Fabricius) (Dermaptera: Chelisochidae) on controlling *T. rufivena*. In addition, Masijan et al. (2017) compared the effectiveness of chemical insecticides namely cypermethrin and chlorantriniliprole and biocontrol product (commercial *Bacillus thuringiensis* (Bt.) and MPOB Bt. in young oil palm and the result showed chlorantriniliprole was found to be the most effective control agent. However, these current practices give a significant financial burden to the company due to improper dosage and over application of insecticides. Furthermore, this will give some bad effect to non-target insect such as the pollinating weevil, *Elaeidobius kamerunicus*, beneficial insect such as parasitoids and predators that could also become detrimental to the environment (Masijan et al. 2015). Resistant development on *T. rufivena* against pesticides also could happen and make the control strategies become worse.

Therefore, it is important to study the ecological aspect of *T. rufivena* to analyse the effect between pest and its abiotic factor. Thus, with the combination of chemical control and cultural management practices (regular census, removing female inflorescences and sanitation practices) through manipulation of the environment the level of pest infestation is expected to decrease, and the application of pesticides will reduce. Data on the environment is important as one of tools to predict the seasonal variability of pest infestation so that proper control actions can be made to control the adult from offspring for the next season to prevent the outbreaks of *T. rufivena* and further economic losses. As one of the pest management strategies, therefore, this study is important to determine the impact of an abiotic factor (relative humidity) on the population abundance of *T. rufivena* in two different levels of areas in oil palm plantation.

MATERIALS AND METHODS

Study Area

A field experiment was conducted in mature area oil palm plantation (four years old) at Saribas Estate 1 at Block B25, Pusa, Betong district, Sarawak, Malaysia. The plot was in the triangle system with 8.75m distance in between palms. Oil palm planting materials used in this study was from the hybridization of Dura × Pisifera (D×P).

Sampling Method

The light trap's design was based on the method described by Salim et al. (2007) with some modifications incorporated that is suitable for oil palm plantation. The complete sets of traps were placed in the field with a height of 150 cm from the ground. Six light traps had been set up within 2.16 hectares' area with a ratio of one light trap per 0.36 hectare in Complete Randomised Design (CRD) for two treatments (maintenance and less maintenance area) with different percentage of RH. Maintenance areas referred to areas that were properly managed with pruning, spraying, and weeding activities. In contrast, less maintenance areas were referred to areas with fewer or lack of the entire programs. Three light traps were permanently placed in the maintenance area and another three were placed randomly in the area of less maintenance. The light traps activated in two (2) consecutive days every week (Friday until Saturday) at 1800 hours to 0600 hours (12 hours). Data for maximum, minimum and current RH were recorded using Digital Psychrometer, XINTEST model HT-86. Meanwhile, daily rainfall was recorded by using a rain gauge and all the data were recorded at the beginning and the end of the sampling session during the light traps' installation.

In addition, the census was done in the same area of light trap devices were installed in order to investigate the number of palm attacks by larvae stage of bunch moth. The total number of oil palm affected by bunch moth were counted and recorded in the census form according to Masijan et al. (2015).

Data Collection and Analysis

The number of *T. rufivena* in the light trap was counted and recorded weekly for two months in two consecutive days (Friday and Saturday) from February until March 2015. Two months before the experiment was conducted and during eight weeks of the experiment period, there were no pesticides applied in order to provide the natural ambience in the sample plot. Besides, the maximum, minimum and current RH, temperature, and rainfall on the collection days also recorded. The statistical analysis of all observation was subjected to independent samples *t*-test to compare the mean scores of two different treatments by using the Statistical Package for the Social Sciences (SPSS) software version 20. The significance threshold was assumed at *p*=0.05. To assess the infestation level of *T. rufivena* between two levels of areas, mean comparison based on, the population of *T. rufivena* and relative humidity were regressed. The correlation coefficient between the population of *T. rufivena* and relative humidity were assessed using Pearson correlations and differences between means were separated using Tukey HSD's Multiple Range Test *p*<0.05. In order to compare the strength of the correlation coefficients for a population of *T. rufivena* and relative humidity affect in maintenance and less maintenance separately, the correlation value (r) were converted to *z* values using Fisher's r-to-*z* transformation followed Pallant, (2013) as shown in the equation below:

$$Z_{obs} = \frac{z_1 - z_2}{\sqrt{\frac{1}{N_1 - 3} + \frac{1}{N_2 - 3}}}$$

RESULTS AND DISCUSSIONS

The data (Figure 1 and Figure 2) revealed the mean number of *T. rufivena* attacked in oil palm plantation. An independent-samples *t*-test was conducted to compare the number of *T. rufivena* attacked in maintenance and less maintenance area. There was significant difference in number of *T. rufivena* attacked in maintenance (M = 0.67, SD = 0.95) and less maintenance, M = 1.15, SD = 1.22; t (94) = -2.14, *p*= .04 (two-tailed). During the sampling period, the highest population of *T. rufivena* (3.00±0.63) was found at less maintenance area with a maximum relative humidity at 93.39±1.32 % and temperature of 24.60±2.32 °C. While in maintenance area the highest population recorded on February, 22 with number of *T. rufivena* 2.00±1.26, maximum relative humidity at 93.22±1.42 %. This may be due to short life cycle of *T. rufivena*. It takes around 28 to 39 days from eggs to adults (Corbett, 1930; Ibrahim, 2012). As shown in Figure 3, on March 9, 2015 *T. rufivena* was at the larvae stage. Therefore, around February 21, until March 1, the adult female were in phase to lay up eggs of its life cycle for 10 days. After that, eggs takes 4 to 6 days to hatched, 14 to 21 days in larvae and 10 to 12 days of pupae before become an adult (Ibrahim, 2012). Thefore the result showed highest population *T. rufivena* on February 22 until March 1, 2015 on both areas.

This finding was similar with Hafizal & Idris (2014) where it was found that population abundance of planthopper and leaf hopper were not significantly affected by temperature and relative humidity during rice growth period. However, Zulfiqar et al. (2010) stated that the population of insect pests (leaf hoper) increases with decreases in relative humidity. This probability may due to differences in light source used during the collection of oil palm bunch moth. Ramamurthy et al. (2010) in his field observation on the efficiency of three different light sources (lumen 2700, black or ultra violet-A 400-315 nm and ultra violet-C 280-100nm) in monitoring insect diversity found the mercury light trap showed the maximum ability for trapping of the lepidopteran.

Another factor that should be taken into consideration in the population abundance of bunch moth in oil palm plantation was the programmes and activities involved in less maintenance area. Only two-month period is given in preparing the less maintenance areas to be skipped from the schedule from pruning, spraying and weeding activities. This might affect the results because some of pesticides and herbicides application may takes time to break down and stay longer (persists) in the environment. Based on Muhamad et al. (2013) study showed that herbicide diuron half-life when applied with recommended dosage takes 22.35 - 49.5 days to break down in oil palm plantation.

Basic climate parameters such as relative humidity and temperature may have a significant impact on the abundance of insect pest in oil palm plantation. It may either promote insect population growth or cause population decline. With the warm and dry weather in Sarawak, Malaysia throughout of the month March until September one can expect insect activity to be increased in number. As a cold-blooded organism, change in humidity and temperature may influenced their life cycle period, migration patterns, insect susceptibility to insecticides, change in host-pest interaction growth and behavior by affecting the insect's ability to regulate water loss. Most insect remain active at a range of 15°C to 32°C (David & Shankar 2011). Low humidity is often detrimental to insect development, but most insects found in desert crops have adapted physiological and behavioral mechanisms to prevent dehydration (Palumbo 2011). Godfray (1985) stated that, the ambient temperatures and relative humidity for *T. rufivena* were 25-28°C and 70-90% respectively.

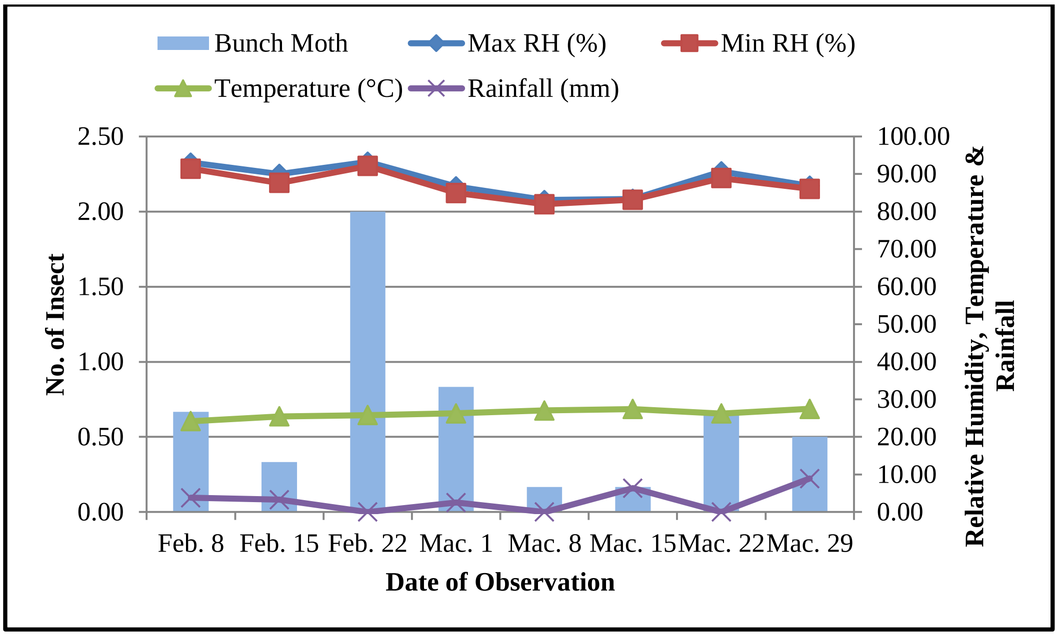

Figure 1. Mean of a number of *T. rufivena* attack oil palm fruits bunches and relative humidity, temperature, and rainfall recorded during the period in maintenance areas.

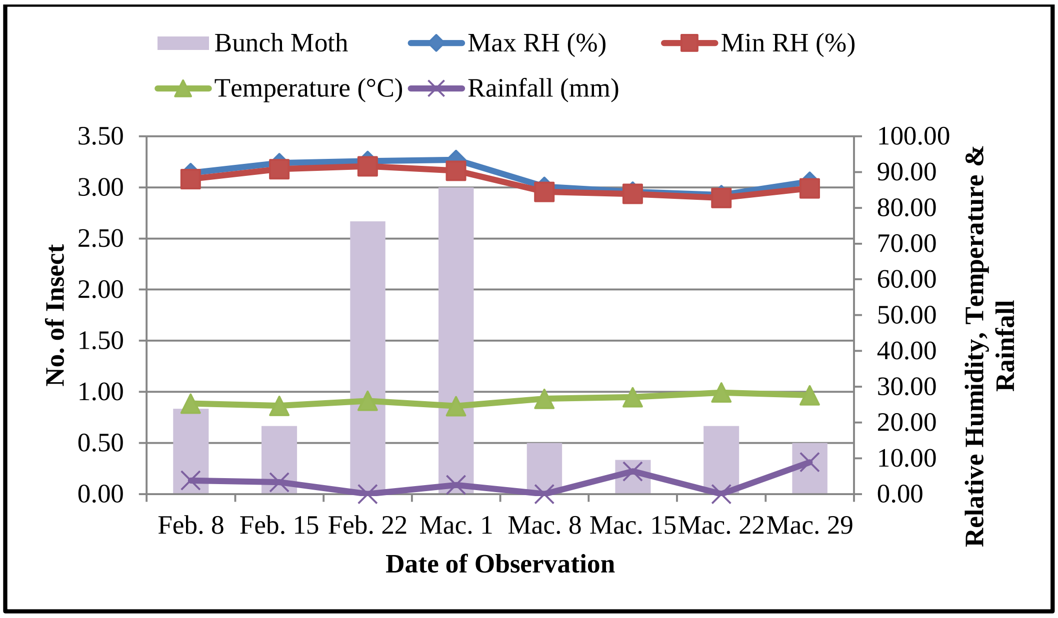

Figure 2. Mean of a number of *T. rufivena* attack oil palm fruits bunches and relative humidity, temperature, and rainfall recorded during the period in less maintenance areas.

Figure 3. *T. rufivena* larvae on oil palm fruit bunch at Saribas Estate, Sarawak. March 9, 2015

In addition, the data collected from the census on mature bunches revealed there was no statistically significant difference between maintenance and less maintenance area as shown in Figure 4, the highest mean number of infested bunches was found at less maintenance area (n=6, M=15, SD=13.78) than maintenance area (n=6, M=13, SD=10.62), t (10) =-0.28, p=0.78 with 95% confident that the true difference between these means is CI=-17.83, 13.83). There are several factors including the availability of food and shelter influenced the difference in a total number of *T. rufivena* at maintenance less maintenance area. This is because, at the less maintenance area, the shrubs will be as an alternative host place for *T. rufivena*. Riyanto et al. (2011) stated that many predatory insects are affected by an area with lots of vegetation such as shrubs and bogs that many plants. The effect of cultural practices done in maintenance areas showed reduction in palm affected by *T. rufivena*. This is because of the implementation of cultural practice programs such as removing the female inflorescences (disbudding, ablation, castration, deflowering), sanitation practice (removing rotten bunches) consistently, along with census as early detection and visual observation on fresh damage would be expected to improve the efficiency of spraying insecticides.

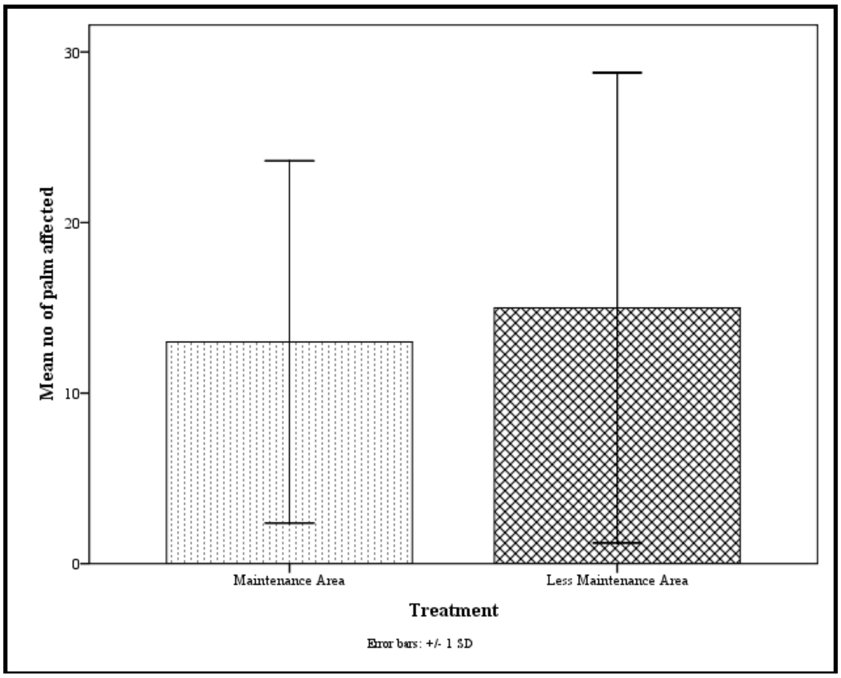

Figure 4. Mean of palm oil affected by *T. rufivena.*

A Pearson product moment correlation coefficient was computed to assess the relationship between the two levels of the area (maintenance and less maintenance), the population of *T. rufivena*, relative humidity, rainfall and temperature in oil palm plantation (Table 1). The variable was interpreted followed Cohen (1988) guideline. There was a weak, positive correlation between a number of *T. rufivena* and relative humidity in the maintenance area, r = .24, n = 48, p = 0.11 which indicates an increase in the rate of relative humidity might correlate positively with the number abundance of bunch moth. Meanwhile, in less maintenance area, there was a medium positive correlation between population of *T. rufivena* and relative humidity, r = .40, n = 48, p = 0.01.

Table 1. Pearson correlation (r) between the population of *T. rufivena*, relative humidity, rainfall and temperature among two different areas (maintenance area and less maintenance area) in oil palm plantation (n=48)

Variable		The population of *T. rufivena*	Relative Humidity	Rainfall	Temperature
Maintenance Area	The population of *T. rufivena*	1			
	Relative Humidity	0.235	1		
	Rainfall	-0.208	-0.13	1	
	Temperature	-0.198	-.825**	0.245	1
Less Maintenance Area	The population of *T. rufivena*	1			
	Relative Humidity	.399**	1		
	Rainfall	-0.133	-0.138	1	
	Temperature	-.290*	-.728**	. 0.184	1

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

The correlation between population *T. rufivena* and RH affect in maintenance area was r = .24, while in less maintenance area it was slightly higher, r = .40. The correlation value (r) from Table 1 was converted to z value. The result calculated for Z (observed) value of -0.85, that is between the boundaries (±1.96), there is a no statistically significant difference in the strength of the correlation between RH and population of *T. rufivena* in maintenance and less maintenance areas. The present study might differ from previous study by Zafar et al. (2013) who stated that population of *H. armigera* on sunflower showed significant and positive correlation r-value of 0.514** with maximum temperature. Another study by Darwish et al. (2015) stated that eggs stage of almond moth stage was the most sensitive stage to high temperatures followed by pupae, and late larval instars. Meanwhile, Anjali et al. (2012) also concluded that the seasonal population of insect pest is greatly influenced by abiotic factors. However, this result was not reflecting the actual data because there is a limitation on the period of study. There is a time limitation, where the study only covered for eight weeks only. Besides, the life cycle of *T. rufivena* from eggs to adult is around 30 days (eggs 4 days, larvae 16 days and pupae 10 days) (Masijan et al., 2015). Due to short life cycle, this may affect the result of present study which focusing the adult stage of *T. rufivena*. Further research is needed to prolong the period of study for a better understanding and comprehensive data on the ecological aspects *T. rufivena* infestation in oil palm planted in peat soil.

CONCLUSION

Based on the results, the population of *T. rufivena* was a significantly affected by the different level of areas applied (maintenance and less maintenance areas). Furthermore, the relationship between RH and *T. rufivena* also showed weak and positive correlation on oil palm plantation. Thus, it can be concluded that the cultural practice and combination with result from census gave a positive effect in controlling the infestation of bunch moth and would ensure better management of pest management for sustainable and long-term control of pest in oil palm plantation.

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