# *Tirathaba rufivena* (LEPIDOPTERA: PYRALIDAE) LARVAL POPULATION IN DİFFERENT FEMALE OIL PALM INFLORESCENCE PHENOLOGY

**Muhammad Idrus, S.*[1], Abu Hassan, A.[2], Abdul Hafiz, A. M.[2], Aiman Hanis, J.[3], Ting Chuan, S.[4], Cik Mohd Rizuan, Z. A.[1]**

[1]Department of Crop Protection , Felda Global Venture Research and Development Sdn Bhd. 26400, Pusat Penyelidikan Pertanian Tun Razak, Pahang, Malaysia

[2]School of Biological Sciences, Universiti Sains Malaysia, 11800, Gelugor, Penang.

[3]Dow Agrosciences (Malaysia) Sdn. Bhd., Level 6, CP Tower, Jalan 16/11, Pusat Dagang Section 16, 46350 Petaling Jaya, Selangor, Malaysia.

[4]Research and Development Department, Ta Ann Plantation Sdn Bhd. 96000, Sibu, Sarawak, Malaysia.

*Corresponding*: idrus.s@feldaglobal.com*

## ABSTRACT

Oil palm inflorescences are important diet for a certain pest known as the fruit bunch moth, *Tirathaba rufivena*. Currently, there was no study that stated which bunch or inflorescence stage that is preferred by *T. rufivena*. Therefore, the purpose of this study is to determine which oil palm bunch phenology had the highest *T. rufivena* population. Bunch from selected categories of oil palm bunch stage, *T. rufivena* frass condition and infestation level were counted, marked and harvested. Harvested bunch then were cut opened to collect and count the larvae. The results show that the young bunch with new frass and high infestation had the highest count of *T. rufivena* larvae (75.33 ± 12.98). Large numbers of *T. rufivena* larvae from all sizes were found in the young bunch with new frass and high infestation indicated an overlapping generation of *T. rufivena* within the same bunch. Collectively, these findings indicate that young bunch highly preferred by *T. rufivena* and any effective controlling need to initiate as early as at post anthesis of female inflorences stage.

**Keywords:** *Tirathaba*, pest, oil palm, phenology, inflorescence

## ABSTRAK

Pokok kelapa sawit adalah diet penting untuk perosak tertentu yang dikenali sebagai ulat tandan buah, *Tirathaba rufivena*. Pada masa ini, tiada kajian yang menyatakan peringkat tandan atau bunga yang manakah paling disukai oleh *T. rufivena*. Oleh itu, kajian ini dijalankan untuk menentukan fenologi tandan kelapa sawit yang mempunyai populasi *T. rufivena* tertinggi. Tandan kelapa sawit dari kategori terpilih yang merangkumi peringkat tandan, keadaan frass *T. rufivena* dan paras infestasi telah dihitung, ditandakan dan dituai. Buah yang dituai kemudian dibelah untuk mengumpul dan menghitung larva. Keputusan menunjukkan bahawa tandan muda dengan frass baru dan serangan tinggi mempunyai kiraan tertinggi larva *T. rufivena* (75.33 ± 12.98). Sebilangan besar larva *T. rufivena* dari semua saiz ditemui dalam tandan muda dengan frass baru dan serangan tinggi menunjukkan berlakunya generasi

bertindih *T. rufivena* dalam tandan yang sama. Secara kolektif, penemuan ini menunjukkan bahawa tandan muda sangat diutamakan oleh *T. rufivena* dan keperluan mengawal yang berkesan perlu dimulakan seawal peringkat tandan betina selepas berbunga.

**Kata kunci**: Tirathaba, perosak kelapa sawit, fenologi, perbungaan

## INTRODUCTION

Oil palm is a monocotyledon plant that has various phenology or growth stage as in other plants. Their phenology stage can be standardise by using Biologische Bundesantalt, Bundessortenamt und Chemische Industrie (BBCH) (Moreno & Romero 2015). Understanding the oil palm through BBCH scale give planter the ability to improve agronomic practices to apply inputs (manuring) and outputs (pollination and harvesting), applying preventive measures for pest and disease management (Salazar et al. 2006).

Oil palm inflorescences are important diet for a certain pest known as the fruit bunch moth, *Tirathaba rufivena*. This pest can cause loses up to 50 % in fresh fruit bunch (FFB) (Lim 2012; Patel et al. 2018). Their economy threshold level (ETL) was below 5 larvae per bunch. They had five instars and the total life cycle took only 28 – 34 days. Their larvae size can be from 0.50 mm to 15.00 mm (Riana 2000). Table 1 showed the details of *T. rufivena* life cycle by Riana (2000). Significantly, there is no study reported which bunch or inflorescence stage are preferred by this pest. The aim of the study was to determine which oil palm bunch phenology has the highest *T. rufivena* larval population. This information is crucial for the planter to focus on the bunch stage for preventive measures.

Table 1. Detail diagram of *T. rufivena* life cycle.

| Stage | Morphology | | | Activity | Development period (day) |
|---|---|---|---|---|---|
| | Measurement (mm) | Colour | Shape | | |
| **Egg** | 0.50 – 1.00 | White at first and orange during hatched | Round and scale | - | 3 – 4 |
| **Larvae** | | | | | |
| **Instar 1** | 1.00 – 2.00 | Brownish white | Hairless cruciform | Does not eat | 3 – 4 |
| **Instar 2** | 5.00 – 6.00 | Brown | Hairy cruciform | Eat | 4 – 5 |
| **Instar 3** | 9.00 – 10.00 | Brownish black | Hairy cruciform | Eat | 2 – 5 |
| **Instar 4** | 16.00 – 18.00 | Blackish brown | Hairy cruciform | Eat | 4 – 5 |
| **Instar 5** | 12.00 – 15.00 | Blackish brown dorsal with greyish brown ventral | Hairy cruciform | Does not eat | 1 |
| **Pupae** | 10.00 – 12.00 | Brown | Slightly oval | - | 7 – 8 |
| **Adult** | | | | | |
| **Male** | 11.00 – 12.00 | Blackish brown dorsal with greyish brown ventral | Triangular shape, slim abdomen, scale wings | Nocturnal | 3 – 4 |
| **Female** | 14.00 – 15.00 | Blackish brown dorsal with greyish brown ventral and orange striped abdomen | Triangular shape, broad abdomen, scale wings | Nocturnal | 3 – 4 |

Source: Rina (2000)

## MATERIALS AND METHODS

**Experiment Site**

The studies were conducted on oil palms between three to four years old with the height around 1.5 metre. The studies were done at site located around Igan in Sarawak, coordinate of 2°46'58.0"N 111°44'13.4"E. The study plot was determined based on the plantation layout which comprised of one field drain for every four rows of palms (one row: 15 palms).

**Experiment Methods**

The study was done to find which female oil palm inflorescence stages and *Tirathaba rufivena* damage symptoms had the highest *T. rufivena* larval population. The study had three assessments which were the female oil palm inflorescence stage, *T. rufivena* damage symptoms and *T. rufivena* larval population. The assessments divided into 21 different categories, each category had five bunches with a total of 105 bunches. Bunch that had meet the criteria of each category were assessed, marked and harvested. All bunches for this study had been taken from a 10 Ha plot that had high *T. rufivena* infestation. This study plot had 52.29 ± 2.47 of *T. rufivena* new infestation, indicated as high infestation based on Lim (2012) and Lim et al. (2012).

The assessment of female oil palm inflorescence stage was conducted by using the BBCH stage scale (Hormaza et al. 2012; Moreno & Romero 2015). From the BBCH stage scale, three stages of female oil palm inflorescence which were young (BBCH stage: 700 – 705), middle (BBCH stage: 707 – 709) and old (BBCH stage: 800 – 809) bunch were used for this study. The reason of using these three stages is because these stages were the common stages to show *Tirathaba* damage symptoms. Besides, these stages were important for fresh fruit bunch (FFB) yield. Male inflorescence data was not included because the lack of male inflorescence at the study site. This situation was also encountered by Mohamad et al. (2017) that stated their study site was lacked of suitable post-anthesis male inflorescence. Post-anthesis male inflorescence that was too old and already rot will cause inconsistent *T. rufivena* larvae count hence reducing the data accuracy.

The assessment of *T. rufivena* damage symptoms was differentiated into two, which were frass condition and infestation level. *Tirathaba rufivena* frass condition was categories into three which were no frass, new frass and old frass. For *T. rufivena* infestation level, the infestation were categories into four, which were no infestation, low infestation, medium infestation and high infestation.

The assessment of *T. rufivena* larval population was conducted by cutting open the bunch, counting and separating the size of *T. rufivena* larvae that had infested within the bunch. *Tirathaba rufivena* larvae had differentiated into small, medium and large sizes. All larvae were collected using forceps and were put on the sticky paper to ease the counting process.

All assessment were analyses by using data analysis software IBM SPSS ver. 22. All assessments were subjected to one-way analysis of variance (ANOVA). The differences between means for each data were separated using Tukey HSD test at P=0.05. Table 2 showed the details of each assessment and description for each categories. The category and description had been explained in details so that this assessment can be used by the planter in the future.

Table 2. Details of each assessment and description for *T. rufivena* larval population study.

| **Assessment variable** | | **Category** | **Description** |
|---|---|---|---|
| **Oil palm phenology** | Young bunch | BBCH scale: 700, 705 | • 2 months after anthesis<br>• Reach 50 % of final fruit size<br>• Fruit covered by bracts of floral whorl |
| | Middle bunch | BBCH scale: 707, 708, 709 | • 3- 4 months after anthesis<br>• Bunch and fruitlets reach their normal size<br>• Fruit shiny and black in colour |
| | Old bunch | BBCH scale: 800, 803, 805, 806, 807, 809 | • 5- 6 months after anthesis<br>• Colour change from black to orange-red |
| ***Tirathaba* damage symptoms** | Frass Condition | No frass (No infestation) | • Clean bunch without any frass<br>• Indicated no *Tirathaba* activity |
| | | New frass (New infestation) | • Reddish orange to reddish black color<br>• Sticky to touch<br>• Contain all *Tirathaba* instar<br>• Indicated active *Tirathaba* activity |
| | | Old frass (Old infestation) | • Black to grey color<br>• Powdery to touch<br>• Contain certain *Tirathaba* instar<br>• Indicated inactive *Tirathaba* activity |
| | Infestation level | Clean | • 0 % of *Tirathaba sp.* infestation |
| | | Low | • 10 to 25 % of *Tirathaba* infestation |
| | | Medium | • 25 to 50 % of *Tirathaba* infestation |
| | | High | • 50 and above % of *Tirathaba* infestation |
| ***Tirathaba* larval size** | Small | Instar 1 | • 0.1 – 0.5 cm |
| | Medium | Instar 2 | • 0.6 – 1.0 cm |
| | | Instar 3 | • 1.1 – 1.5 cm |
| | Large | Instar 4 | • 1.6 – 2.0 cm |
| | | Instar 5 | • 2.1 – 2.5 cm |

## RESULTS AND DISCUSSION

### Population of *Tirathaba rufivena* Larvae on Oil Palm Inflorescence

Young bunch with new frass and high infestation had the highest count of *Tirathaba rufivena* larval population with 75.33 ± 12.98 per bunch (Table 3). Young bunch was preferred by *T. rufivena* because this bunch had soft exocarp and mesocarp (Ming et al. 2016). The young fruitlets had smooth mesocarp without the formation of endosperm (Corley and Tinker 2008; Forero et al. 2012). During this period, the fruitlets were susceptible to infestation of *T. rufivena* larvae. *Tirathaba rufivena* heavy infestation during young bunch stage can lead to the abortive process of the bunch. The abortion of young bunch eventually reduced the FFB quantity.

New frass condition of *T. rufivena* had consistently shown higher larval count on all bunches phenology compared to old frass. This situation indicated that new frass represented the current *T. rufivena* larval population (Ming et al. 2016). *Tirathaba rufivena* high infestation had 3 – 15 times more larval count when compared with the low and medium infestation. This scenario indicated that *T. rufivena* larval population was directly proportional to the infestation level.

Large number of *T. rufivena* larvae from all sizes were found in the young bunch with new frass and high infestation. Notably this indicated that *T. rufivena* larval population were overlapping within the same bunch. Overlapping generation is where several generation of the same species live together (Varley et al. 1974). *Tirathaba rufivena* short life cycle of 28 – 34 days had contributed to the overlapping generation. Overlapping generation caused the bunch to be continuously infested by the *T. rufivena* larvae from several generations. This situation will increase the rotting process of young bunch. Figure 1 showed the young bunch rot after two months of heavy infestation by *T. rufivena.*

In order to improve the larvae count, the bunch cutting process needed to be taken gently to avoid from cutting or crushing the *T. rufivena* larvae that located inside the bunch. The rationale behind this circumstance is the larvae size can be from 0.5 mm (1$^{st}$ instar) to 15mm (5$^{th}$ instar) (Riana 2000).

Table 3. *Tirathaba rufivena* larval population on different bunch phenology and tirathaba symptoms.

| **Bunch phenology** | ***Tirathaba* symptoms** | | **Mean larvae size count per bunch** | | | |
|---|---|---|---|---|---|---|
| | **Frass condition** | **Infestation level** | **Small** | **Medium** | **Large** | **Total** |
| **Female young bunch** | No | No | 0.00 | 0.00 | 0.00 | 0.00 ± 0.00 a |
| | New | Low | 3.33 | 4.67 | 4.33 | 12.33 ± 2.40 ab |
| | | Medium | 6.00 | 14.00 | 24.33 | 44.33 ± 4.37 c |
| | | High | 11.67 | 29.00 | 34.67 | **75.33 ± 12.98 d** |
| | Old | Low | 2.00 | 1.33 | 0.33 | 3.67 ± 0.33 a |
| | | Medium | 0.33 | 1.67 | 2.00 | 4.00 ± 1.00 a |
| | | High | 6.33 | 2.00 | 2.67 | 11.00 ± 4.04 ab |
| **Female middle bunch** | No | No | 0.00 | 0.00 | 0.00 | 0.00 ± 0.00 a |
| | New | Low | 1.33 | 3.67 | 3.67 | 2.67 ± 2.67 a |
| | | Medium | 6.00 | 8.67 | 11.67 | 26.33 ± 1.45 bc |
| | | High | 1.67 | 21.67 | 21.67 | 45.00 ± 2.52 c |
| | Old | Low | 0.33 | 1.00 | 1.00 | 2.33 ± 0.67 a |
| | | Medium | 0.33 | 1.00 | 3.00 | 4.33 ± 0.67 a |
| | | High | 1.33 | 4.33 | 10.00 | 15.67 ± 3.18 ab |
| **Female old bunch** | No | No | 0.00 | 0.00 | 0.00 | 0.00 ± 0.00 a |
| | New | Low | 0.33 | 0.67 | 1.00 | 2.00 ± 1.15 a |
| | | Medium | 0.33 | 1.00 | 0.67 | 2.00 ± 1.00 a |
| | | High | 0.00 | 1.67 | 4.67 | 6.33 ± 6.33 a |
| | Old | Low | 0.00 | 0.00 | 1.00 | 1.00 ± 1.00 a |
| | | Medium | 0.00 | 1.67 | 3.00 | 4.67 ± 1.67 a |
| | | High | 0.33 | 1.33 | 6.67 | 8.33 ± 0.88 ab |

Means in column with different letters are significantly different at P < 0.05 (by Tukey HSD).


Figure 1. Young bunch with new frass and high infestation rot after two months.

Masijan et al. (2015) stated that the earliest infestation of *T. rufivena* was recorded at female pre-anthesis (BBCH stage: 601). During this stage, the fibrous woody structures of prophyll and peduncular bract that had protecting the inflorescence were torn out. It is possible to see the sex of the inflorescence during this stage (Forero et al. 2012). During this stage, the female pre-anthesis was susceptible to the pest infestation especially the fruit bunch moth, *T. rufivena* larvae.

Assessment of *T. rufivena* on other inflorescence stages had been done by Masijan et al. (2015). He had stated the importance of including the male inflorescence into *Tirathaba* management. In this study, the assessment for male post-anthesis was unable to conduct due to several factors such as limited count of male post-anthesis inflorescence in the field and inconsistency data assessment taken due to different male post-anthesis condition. Limited count of male inflorescence was affected by factors like high sex ratio of planting material, peat area that contained high organic matters and high water table in the field (Lim et al. 2012; Fadila et al. 2016). Male post-anthesis had different condition as it goes drier by ages. Other than that, male post-anthesis were also subjected to rotten, fungus infection, consumed by other pest and others.

## CONCLUSION

Young bunch with new frass and high infestation had the highest count of *Tirathaba rufivena* larval population. Meanwhile young bunch was preferred by *T. rufivena* because this bunch had soft exocarp and mesocarp. New frass represented the current *T. rufivena* larval population while the high infestation was directly proportional to the larval population. *Tirathaba rufivena* larval population were overlapping within the same bunch because of the short life cycle of 28 – 34 days. Consequently, young bunch rot after two months of heavy infestation by *T. rufivena*. Damage assessment should be focused on female young bunch because they had the consistency in terms of phenology stages, bunch condition and *Tirathaba* symptoms. Aside, female young bunch is important for FFB production.

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