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The Potential of Ethyl Acetate As Substitute Attractant for Red Palm Weevil, *Rhynchophorus* spp. (Coleoptera: Curculionidae)

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Abstract: Red palm weevils (RPW), *Rhynchophorus vulneratus* and *R. ferrugineus* (Coleoptera: Curculionidae) have been reported as main pests of coconut in Malaysia. These pests are currently managed using integrated control approaches and one of them is by using pheromone traps. Ethyl acetate (EtAc) has the potential to increase the efficiency of the pheromone traps and need to be further evaluated. A study was conducted on coconut plantation areas in Mersing, Johor to evaluate the effectiveness of EtAc in attracting RPW. A total of 20 traps from five treatments were set up from the beginning of March 2017 until early of July 2017. Results showed that the treatments with the combination of pheromone lure and EtAc (T1 and T2) can increase the number of captured weevils into the traps ($F=3.9$, $df=4$, $p=0.01$). Addition of food bait also help in increasing the effectiveness of the trap. The results also showed that the red palm weevil population in Mersing area was low as not many beetles were caught in the traps throughout the study period. Due to the high volatility of EtAc, its dispenser need to be improved so that the semiochemical can be sustained longer to prolong the attractant effect. EtAc can play an important role in the RPW baited pheromone traps that is suited with hot and humid climatic conditions of Malaysia.

Keywords: Coconut pests, Rhynchophorous, pheromone trapping, ethyl acetate, attractant

1. Introduction

Red palm weevils, *Rhynchophorus vulneratus* and *R. ferrugineus* (Coleoptera: Curculionidae) have been reported as main pests of coconut in Malaysia. Both species are capable of causing serious damage to

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coconut and several types of palms such as date palms and few ornamental palms. According to Department of Agriculture Malaysia, more than 500 ha of coconut trees especially in Terengganu and Kedah have so far been destroyed because of these beetles (Anon., 2013). Currently, red palm weevils (RPW) can be managed using integrated control approaches. One of them is by using the pheromone traps. Trapping adult weevils with pheromone trapping method has been widely practised all over the world in surveillance or mass trapping programs (Oehlschlager, 2006; Faleiro, 2006) including Malaysia (Sivapragasam *et al*., 2010; Wahizatul *et al*., 2014). The effectiveness of pheromone traps are influenced by several factors such as weather, trap placement (Hallet *et al*., 1999; Faleiro, 2005), and colour of the trap (Hallet *et al*. 1999). There are also few studies that recommend combination of pheromone and food-based baits to increase catches (Nair *et al*., 2000; Faleiro, 2006). Ethyl acetate (EtAc), a semiochemical also found can attract more adult weevils when used together with pheromone or food bait (Al-Saoud, 2009; Guarino *et al*., 2010). At present, the application of EtAc method is still new in Malaysia.

The purpose of this study is therefore to evaluate the effectiveness of EtAc in attracting RPW in coconut plantation so that a better management and control recommendation can be developed in order to eradicate the pest.

2. Methodology

Study sites

The study was conducted at three selected coconut plantation areas in Mersing, Johor. The areas are Jalan Air Papan (N 2°30’7’’, E 103°49’22”) (Figure 1), Kampung Tanjung Genting (N 2°29’27’’, E 103°48’57”) (Figure 2) and Kampung Tenglu Laut (N 2°28’25’’, E 103°49’26”) (Figure 3). Each location contained more than 30 trees and were approximately 1 ha in size.

Figure 1. Location for replicate 1 and 2

Figure 2. Location for replicate 3

Figure 3. Location for replicate 4

Trap design and treatments

The pheromone traps were fabricated using 5-L polyethylene terephthalate containers with four 4-cm diameter round windows cut 6 cm below the upper rim of the container. The distance between each window and the bottom of the container was 16 cm. The outer surface of each trap was wrapped up with rough sack cloth so that the weevils can climb into the traps more easily. The container was covered with a lid and at the underside of it had a small knob to which a wire was fixed to hold the commercial pheromone lure, the ethyl acetate (EtAc) dispenser and plastic of dried food bait. Each trap contained the following materials: (1) Dispenser of the commercial male RPW aggregation pheromone (Ferrolure +) containing 700 mg of the active ingredient 4-methyl-5-nonanol (90%) + 4-methyl-5-nonanone (10%) at >98% purity manufactured by Chemtica International S. A. Costa Rica, (2) 50 ml of EtAc at 100% purity soaked with cotton wool and placed in zipped plastic bag that act as dispenser, (3) two pieces of dried date fruit (approximately 50 gm) and (4) about 500 ml of water mixed with detergent to killed the trapped weevils. The five treatments are described as follows: (T1) Pheromone lure + EtAc + date fruit. (T2) Pheromone lure + EtAc. (T3) EtAc only. (T4) EtAc + date fruit and (T5) Pheromone lure only.

Pheromone lure, date fruits and EtAc were replaced every two months. Water in the traps also was replenished regularly to maintain the trap hygiene and to keep sufficient moisture. Captured weevils were removed at weekly intervals and the number of females and males as well as species type were recorded in each treatment. The traps were rotated within the area of sampling in each location after taking weekly

data in order to avoid trap placement or spot effect due to the aggregated behaviour of the RPW. The maintenance of the traps was done weekly.

Experimental design and trap installation

The experimental was a randomized complete block design with five treatments and four replicates (four coconut areas – Two from Jalan Air Papan and one each from Kampung Tanjung Genting and Kampung Tenglu Laut). The distance between traps in each area was 50 m and each traps were fixed at the coconut trunk and set 2-m from the ground level. The trap was tied with a steel wire to the coconut tree to prevent it from being overturned by wind or animals. A total of 20 traps were installed for a trapping period from the beginning of March 2017 until early of July 2017. Monthly record of the number of weevils caught in the traps was maintained throughout the study period to see the population fluctuation and the activity of the weevils during different months as well as to compare the efficacy of the treatments.

Statistical analysis

The data were analysed by mean of analysis of variance (ANOVA) and the means were compared by carrying out the Duncan Multiple Range 5% Test. Before the analysis, the number of captured beetles were transformed by sqrt (x) using the formula $\sqrt{x} + 0.5$ to normalize the data. Data were analysed using the Statistical Analysis System version 9.1.3 (SAS Institute, 2003).

3. Results and Discussion

The results from Figure 4 and Figure 5 reveal that the red palm weevil population in Mersing area was low as not many beetles were caught in the traps throughout the study period (from 10th March until 6th July 2017). The highest catch for *R. vulneratus* (RV) was recorded in June (five beetles) and for *R. ferrugineus* (RF) was in March (six beetles). The total number of RV caught for the whole duration of the study was 13 with a sex ratio of (male: female) of 1:0.86. As for RF, the sex ratio was 1:1.4 and the total number of beetle caught from 20 traps was 12. This sex ratio was similar to previous studies conducted by Sivapragasam *et al*. (2010) and Wahizatul *et al*. (2014). The ratio between RV and RF species also was similar (13:12) and not significant (F=0.5, df=1, p=0.78) (Table 1). By looking at Figure 4 and 5, it can be concluded that the number of beetle trapped per day was generally less than one which showed that the study area had a low population of this coconut pest.

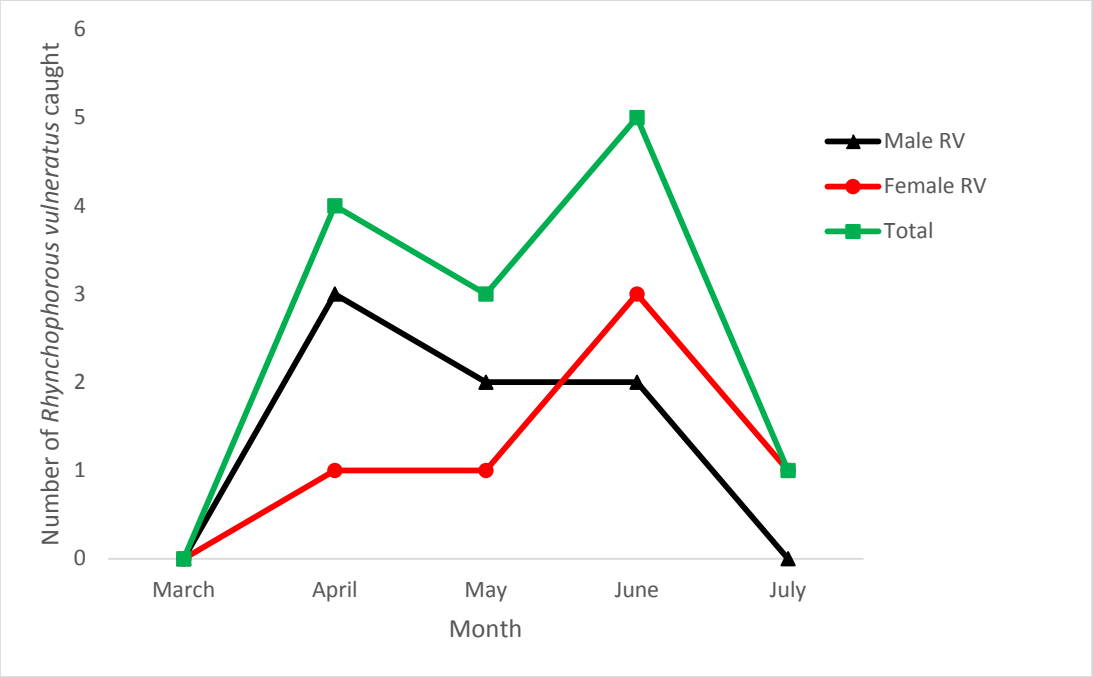

Figure 3. Number of *Rhynchophorous vulneratus* caught from the beginning of March 2017 until early of July 2017

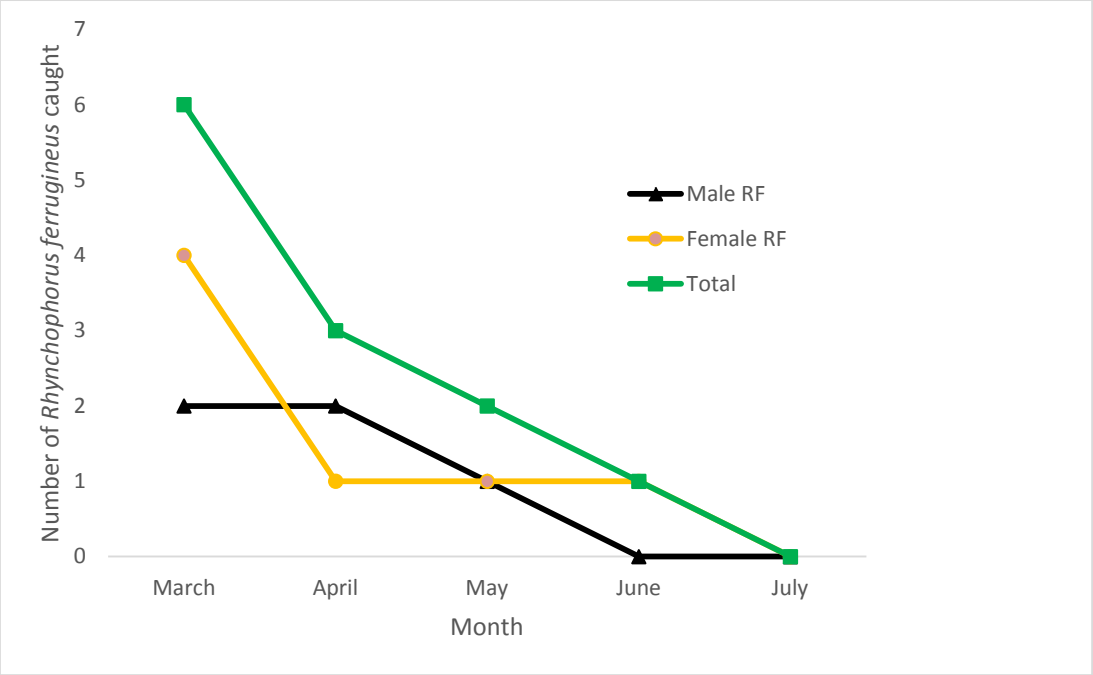

Figure 4. Number of *Rhynchophorous ferrugineus* caught from the beginning of March 2017 until early of July 2017

Table 1. Effect of ethyl acetate (EtAc) on the number of red palm weevil caught in traps

	Mean Number		
Treatment	**Male**	**Female**	**Male + Female**
T1	1.1198 a	1.0940 a	1.3891 a
T2	0.9660 a	0.8810 a	1.1198 ab
T3	0.7070 c	0.7718 a	0.7718 b
T4	0.7070 d	0.7070 a	0.7070 b
T5	0.7718 cb	0.7718 a	0.8365 b
Species			
RV	0.88 a	0.85 a	0.98 a
RF	0.82 a	0.84 a	0.95 a

Means with same letters in the same column are not significantly

different at DMRT ($\alpha = 0.05$)

*Data were transformed to $\sqrt{(x + 0.5)}$ prior to analysis

A total 7, 4, 1, 0, and 1 RV species were caught in traps with pheromone lure + EtAc + date fruit (T1), pheromone lure + EtAc (T2), EtAc only (T3), EtAc + date fruit (T4) and pheromone lure only (T5) respectively (Figure 6). The trapping trend also was similar for RF species (Figure 7) where T1 recorded the highest catches. For both *Rhynchophorous* species, T3 and T4 recorded the lowest number throughout the study period. From Figure 6, more males RV were caught in the traps compared to females. As for the RF, more females were recorded than males as shown in Figure 7.

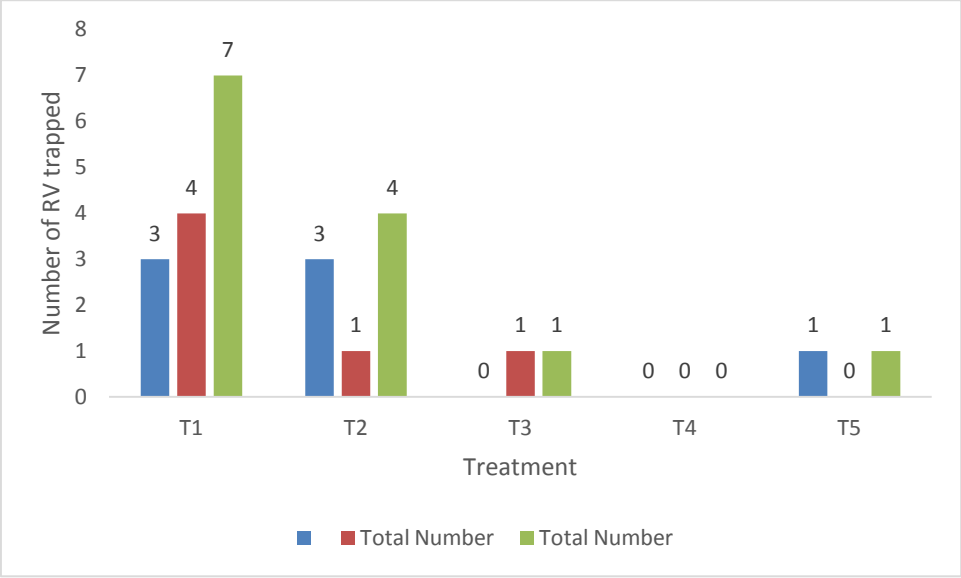

Figure 5. Number of *Rhynchophorous vulneratus* caught in all treatments

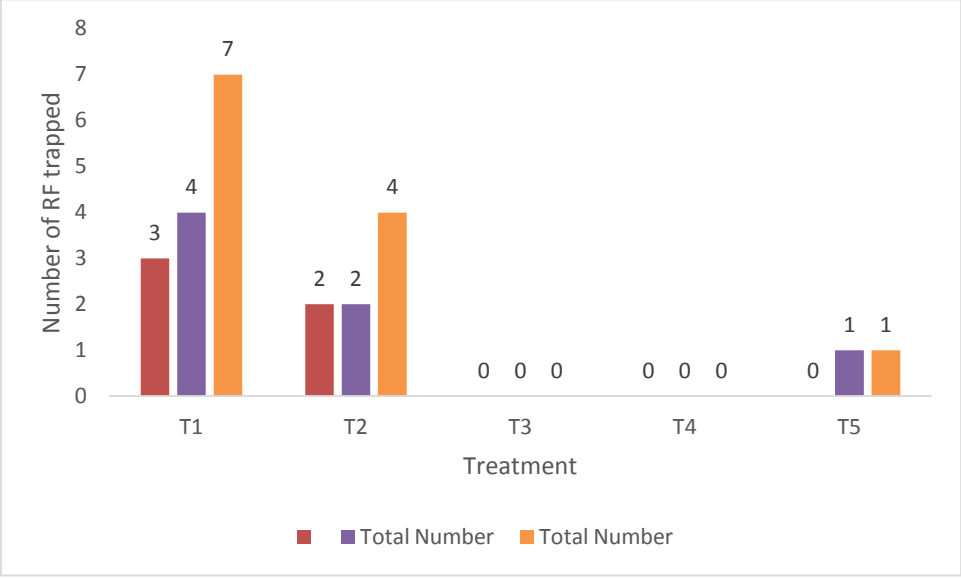

Figure 6. Number of *Rhynchophorous ferrugineus* caught in all treatments

Results in Table 1 reveal that there were significant differences between the mean of male RPW captured in traps housed with the combination of pheromone lure and EtAc ($F=4.95$, $df=4$, $p<0.004$). There were no significant differences for the females ($F=1.54$, $df=4$, $p=0.22$). If both numbers of male and female weevil combined, the statistical analysis indicate that there was a significant difference as well ($F=3.9$, $df=4$, $p=0.01$). T1 and T2 were superior to the other three treatments. The combination of pheromone lure and EtAc increased the number of captured weevils in both treatments. Adding food bait to the trap also help in increasing the effectiveness of the trap. According to Guarino *et al*. (2010), trap catches can be enhanced by adding synergistic palm volatiles into the pheromone trap. He also mentioned that combination of EtAc and palm-based food baits can be effective. This was also proven by Al-Saoud (2013). From this study, it was shown that EtAc alone is not sufficiently strong to attract the weevils into the trap. Combination of EtAc with 50 g of dried date fruits was also observed to be not good enough to be an efficient attractant. This could be due to the fact that small amount of the dates (50 g only) were used and they were dried and not fermented. Al-Saoud (2014) tested several weight category of fermented date fruits ranging from 150 – 350 g in his study and found out that 350 g was the best. In this experiment, dried date fruits were used to ease maintenance and for long lasting so that it will not be changed regularly as compared to other food baits such as sugarcanes or pineapples although these type of food bait was proven effective (Sivapragasam *et al*. 2010; Wahizatul *et al*., 2014).

Aside from that, location of this study which was near coastal might be the factor why the numbers of RPW recorded were low in this study. According to Mr. Zazali Chik from Department of Agriculture (DOA) Terengganu, the wind breeze from the beach can interrupt the pheromone lure in the traps which eventually resulting in low catches (Zazali, C. 2018, personal communication, 20 February). Moreover, DOA Johor had reported that Mersing district in Johor only recorded 12 RV and 12 RF from three sampling locations that covers 59.1 ha (unpublished data) which indicates that Mersing area has low population of the pest.

Further research or field evaluation are needed before more conclusive interpretation can be made on the suitability of the use of EtAc as a substitute attractant for RPW. However, this semiochemical could play an important role in the RPW baited pheromone traps when combined with RPW pheromone, food baits and water (Faleiro, 2005; Oehlschlager, 2005; Al-Saoud, 2014). Al-Saoud (2013) had tested a commercially available EtAc, known as Weevil Magnet™ which is not available in Malaysia. Accessibility of this product by farmers in Malaysia maybe a problem and therefore it is important that a simple and farmer-friendly technique be developed using EtAc. For this study, 50 ml of EtAc liquid at 100%

purity was soaked with cotton wool and placed in zipped plastic bag that act as dispenser (Figure 8). This technique had some problems where the EtAc cannot retain long enough as it highly volatile. A new method of slow-released EtAc packaging need to be developed so that the semiochemical can be sustained for a longer period of time to be effective as an attractant.

Figure 7. Ethyl acetate soaked in cotton wool and place in zipped plastic bag as dispenser

4. Conclusions

Based on this study, it is suggested that EtAc has the potential to enhance the efficiency of the mass-trapping programme of RPW in Malaysia. However, with the hot and humid climatic condition throughout the year, the slow-release of EtAc through proper packaging and the maintenance of the trap including the preservation of the food baits are really important to guarantee the success of the trapping. More research need to be carried out to increase the effectiveness of the trapping mechanism to control the RPW pest.

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