

Ecological studies and evaluation of some aggregation pheromone types with measuring the potential of female reproductive system in red palm weevil, *Rhynchophorus ferrugineus* (Olivier).

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Abstract: The red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera:Curculionidae) (Oliv.) is the most serious and destructive insect pest for date palm trees. The relative weevil-attracting potential of the aggregation pheromones procured from different countries and used in trapping the red palm weevil, *R. ferrugineus* Olivier, was evaluated in date plantations of Ismailia Governorate, Egypt. Results of this study indicated that high release rate pheromone obtained from Chemtica Natural, Costa Rica type pheromone was more attractive than France and Spain types pheromone. Moreover, ecological studies have clearly showed that the adult stage of red palm weevil, *R. ferrugineus* has two peaks of swarming activity on date palm trees throughout the year, one of them during October 2011 whereas, the other during March 2012. Results also, appeared that the female captured contains numbers of eggs not laid. The mean number of egg per female attractive and newly female were 220.2 and 261.8 eggs, respectively. No significant differences were found between numbers of eggs for the newly female and the female attractive.

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1. Introduction

The date palm, *Phoenix dactylifera* L. (Palmeae) is the most common and widely cultivated in the arid regions of the Middle East and North Africa. In many areas, date palm fruit has provided the stable carbohydrate food of local people since long time age. The total number of date palm trees recorded in the ancient life reached about 109 millions which yielded 4.2 million metric tons. Arab countries however, contain 78.3% of the total world date palm trees which demonstrate 75% of the production. Based on the Agricultural statistics issued by Ministry of Agriculture and Land Reclamation (2002), the number of female date palm trees revealed about ten millions planted in 70132 Feddan. The total production/ton at 2001 reached about 1.113.270 metric ton (estimated yield/tree = 108.83 kg) harbored 26.5% of the world production (Abdel-Megeed *et al.*, 2004). Recently date palm insect pests in general and the red palm weevil (RPW), *R. ferrugineus* (Coleoptera: Curculionidae) in particular are widely accepted as being the most destructive factors of date, coconut and oil palms throughout South and Southeast Asia (Wattanapongsiri, 1966). Nowadays, the date palm crop in Eastern Arab countries is under threat. Red palm weevil was probably introduced to the Middle East on infested ornamental palm from India or Pakistan. This insect was firstly discovered attacking palm in the Arabian peninsula especially United Arab

Emirates in 1986 and progressively spread to Gulf states and crossed the red sea into North Africa as the latest record since 1992 in Egypt. It is found over a wide geographical area in Asia, involving many different Agro ecosystems. In United Arab Emirates, Abbas *et al.* (2006) used the aggregation pheromone traps to investigate the population density of *R. ferrugineus* infesting date palm. In Egypt, Zayed (2008) evaluated the efficiency of some food baits compared to chemical attractors for management of red palm weevil by pheromone/food-based trap system throughout the year, and determined the best efficient food bait during the subsequent annual season. The related species is highly polyphagous with a number of known hosts exceeding more than ten different palm species (Murphy and Briscoe, 1999). The wide uncontrolled translocation of offshoots is considered the main factor governing the spatial distribution pattern of red palm weevil. The larval and adult stages of this insect feed within tunnels inside the trunk of palms and this behavior frequently damage the infested trees. In infested plantations, yield has been dropped from 4.2 to 0.3 metric ton/Feddan (Gush, 1997). The present work was undertaken for evaluation of different types of aggregation pheromones, determination of seasonal abundance of RPW adults and comparing the number of eggs laid by both attracted females and newly females.

2. MATERIALS AND METHODS

Three aggregation pheromone traps were evaluated for RPW catch in the field at Qassasin, Ismailia Governorate, Egypt during August 2011-July 2012. The commercial pheromones with different release rate were tested; the first one from France, Qaluibe company, the second one from Costa Rica Chemtica company and the third one from Spain, Sedq Espana. The components of the pheromone are 4-methyl 1-5-nonanol (9 parts) + 4-methyl nonanone (1 part) – purity 99.9% + 0.1% colorant and 0.1% antioxidant. The experiments were carried out at Yousry El-Sebay Laboratory of red palm weevil at Qassasin, Ismailia Governorate.

Trap design and related compounds:

Bucket design traps were used in the present study. The traps were inserted slightly in the soil surface. A number of round holes were made to allow adult weevils to enter inside the trap safely and easy. The used traps commonly consists of plastic bucket (9 liter in size). The bucket was punctured around its wall with 4 holes each of 2-5 cm diameter at 15cm from the bottom. Selected Kairomone was used as a synergist to activate the potent ability of releasing ethyl acetate blooms. Ethyl acetate bags were hanged from the underside surface of the trap top releasing chemicals through a fine plastic tube (as 100 and 128 mg/d). Liquid soap was mixed with trap water used in the inside bucket trap. Number of collected weevils caught in the pheromone traps was weekly counted, sexed, and grouped into date record contains two weekly figures.

Evaluation of different pheromone types:

The Three commercial pheromones were tested in the form of recommend bucket traps and distributed uniformly in the selected severely infested area. Each pheromone traps were replicated five times and field evaluation was carried out during March 2011 till April 2011. The data recorded were kept in the experimental date palm field area.

Seasonal abundance and population trends of *R. ferrugineus*:

To estimate the seasonal abundance of *R. ferrugineus*, ten traps of Costa Rica pheromone were distributed in the experimental orchard, each trap has a distance 150 meter approximately from the other. The field trials were carried out during one successive date palm growing season from August 2011 until July 2012.

Comparative study on the number of eggs laid by captured and newly females:

Thirty females and males captured in traps and thirty newly females and males collection cocoon in

palm infestation paired (♂ and ♀), placed in separate cups and provided with palm slices of date palm wood until egg lying. Daily number of laid eggs was recorded and oviposition period was counted per each female.

Anatomical study of female reproductive system:

Twenty females in each pheromone trap were dissected monthly during season 2011-2012. The dissected female was drowned using drowning eye piece under stereomicroscope and the number of mature eggs in calyx and immature eggs in ovarioles were counted Figures (2-4).

Statistical analysis:

All the obtained results were statistically analyzed using the computer program SAS (SAS 1985).

3. RESULTS AND DISCUSSION

3.1. Evaluation of different pheromone types.

Data recorded in Table (1) show a comparison between different types of aggregation pheromones. The adults were significantly attractive with Costa Rica aggregation pheromone compared to Spain pheromone. A slight significant attraction was recorded by France pheromone. The mean number of attractive adults with Costa Rica, France and Spain pheromone was 82.25, 55, 38.125, respectively.

Table 1. Effect of aggregation pheromones on the number of attracted adult *R. ferrugineus*

Month/Week	Number of attracted adult <i>R. ferrugineus</i>		
	Costa Rica	France	Spain
March			
Week1	78	24	30
Week2	102	67	34
Week3	121	89	55
Week4	119	103	50
April			
Week1	78	27	36
Week2	84	79	56
Week3	66	44	39
Week4	34	7	5
Mean	82.25 a	55ab	38.125b

L.SD.05 =28.7

3.2. Seasonal abundance and population trends of *R. ferrugineus*

The data recorded in Table (2) and graphically illustrated in Figure (1) showed that the numbers of red palm weevil were changed from month to month

during the tested period from August 2011 to July 2012. The number of captured adults increased gradually and reached their peak in October 2011 (112 individual/trap) then they decreased gradually once again till January. The number of captured adults of red palm weevils increased and reached the maximum peak again in March 2012 with a total number of 158 adults, followed by decline in the total number to 44 adults in July 2012. Data obtained proved that the reliable number of captured red palm weevil occurred during two periods which extended from March to May and from September to November. While, there was scarcely distributed individuals during the other months. The highest level of occurrence expressed as adults caught in aggregating pheromone traps during early spring months. These results in general agree with the findings of Abbas (2000 and 2005). In Egypt, El Sebay (2003) and El Sebay *et al.*, (2010) estimated four overlapping generations of red palm weevil adults per year and recorded two peaks during March and November. In Saudi Arabia, Vidyasager *et al.*, (2000) found that, the peak of the red palm weevil adult populations trapped was immediately after winter season during the months of April and May. A much smaller second peak was observed during October and November months just before winter. (Gunawardena and Bandarage, 1995 and El Garhy, 1996). Other previous studies reported

maximum catches in March and April (Hallet *et al.*,1993, El Ezaby *et al.*,1998, Muralidharan *et al.*, 2000 and Oehlschlager,2004). In the present study, occurrence of females in traps was higher than males all over the year and the percentage of captured males was lower than that of female weevils. These results are in agreement with Al-Saoud(2004) and Zayed (2008).

Table 2. Monthly total numbers of *R. ferrugineus* adults (males and females) caught by pheromone traps.

Month	No of male	No of Female	Total
August 2011	15	34	49
September	32	55	87
October	40	72	112
November	29	52	81
December	9	21	30
January 2012	5	11	16
February	19	33	52
March	56	102	158
April	31	45	76
May	19	56	75
June	21	33	54
July 2012	14	30	44
Total	290	544	834
Mean \pm S.E	24.2	45.3	69.5

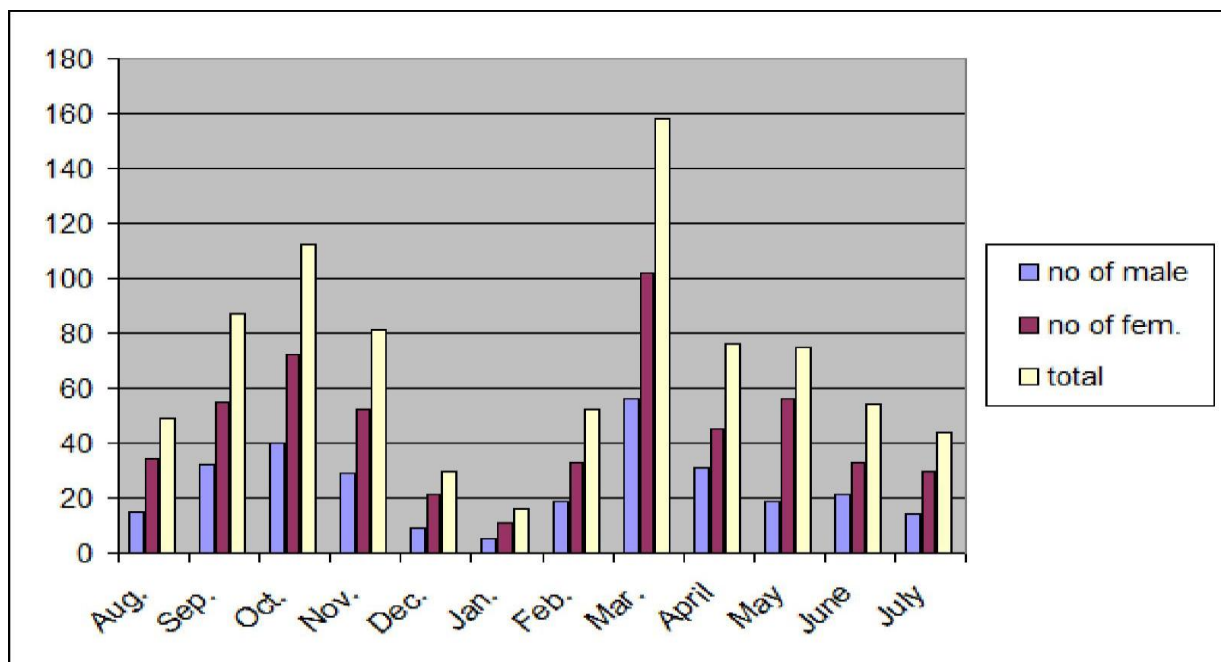


Figure 1. Monthly abundance of *R. ferrugineus* adult stage (males and females) caught by pheromone traps.

3.3. Number of eggs laid by captured and newly females:

Data presented in Table (3) demonstrate that, the lowest mean number of eggs (220.2 eggs/female) was recorded in female captured during 56.8 days. On the other hand, the highest mean number (261.8 eggs /female) was recorded in newly female during 76.4 days. No significant differences were found between number of eggs in newly female and female attractive but there was a significant difference between number of days life in newly females newly and attracted females.

Abraham *et al.* (2001) found that the average life of female captured was three months and the number of eggs laid was 320 eggs.

On the other hand, the present results appeared that, the females captured contain eggs not laid. Similar results were obtained by Abbas (2005).

Table 3. Number of eggs and duration days of females captured and newly females

Replicate	female		newly female	
	Mean number of egg	Life female days	Mean number of egg	Life female days
1	189	40	250	67
2	230	65	267	78
3	167	48	190	88
4	235	60	312	70
5	280	71	290	79
Mean	220.2a	56.8a	261.8a	76.4b

L.SD.05 =45.18 number of eggs

L.SD.05 =15.57 Life female days

3.4. Anatomical structure of the reproductive system of captured females

Monthly, twenty females were selected randomly from each trap and dissected after capturing to remove the reproductive system and count the number of both eggs in calyx (mature eggs) and in ovarioles (immature eggs) as shown in Figures (2-4). The data in Table (4) showed the oogenesis potential of captured females by estimating the total number of two types of eggs (immature and mature eggs). The maximum number of eggs was recorded during August, October 2011 and March 2012 and it was 72, 60 and 78 respectively.

Table 4. Numbers of mature and immature eggs found in dissected females captured in aggregation pheromone traps of *R. ferrugineus*

	No of eggs		
	Mature /calyx	Immature /ovariols	Total
August 2011	12	48	60
September	8	36	44
October	18	60	78
November	12	44	56
December	8	36	44
January 2012	6	40	46
February	16	32	48
March	20	52	72
April	12	44	56
May	16	40	56
June	12	44	56
July 2012	14	36	50

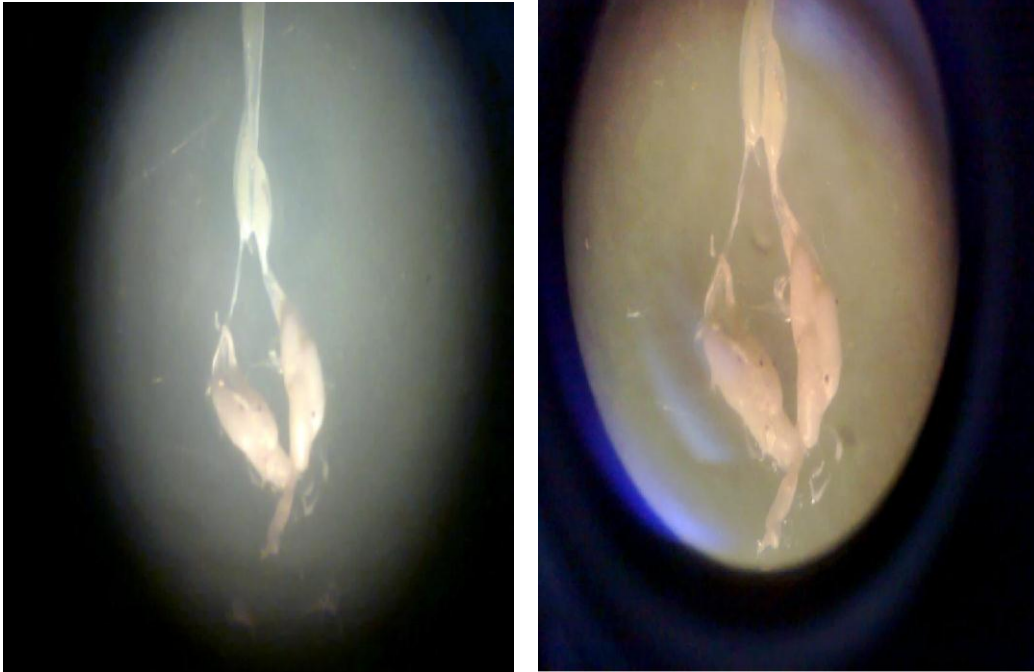


Figure 2. Eggs in calyx of *R. ferrugineus*



Figure 3. Immature eggs in ovarioles of female *R. ferrugineus*



Figure 4. Reproductive system of female *R. ferrugineus*

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