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**MONITORING STUDIES OF THE RED PALM WEEVIL *RHYNCHOPHORUS  
FERRUGINEUS* USING PHEROMONE TRAPS IN PALM TREE ORCHARDS**

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**SUMMARY**

Monitoring studies were conducted at Amria district (Alexandria governorate) during the two successive seasons 2007 – 2008 and 2008 – 2009 using pheromone traps (Ferrolure + 700 mg). Weevils of *R. ferrugineus* were found to be existed in pheromone traps all year round on the course of two successive seasons 2007 – 2008 and 2008 – 2009. Two flight peaks were recorded during both years of study, the 1<sup>st</sup> peak was recorded in the 1<sup>st</sup> half of September (mean number 0.13 weevil / trap), the 2<sup>nd</sup> peak occurred in the 2<sup>nd</sup> half of March (mean number 0.19 weevil / trap) during 2007 – 2008 seasons. In 2008 – 2009 seasons, there were also two recorded peaks, the 1<sup>st</sup> peak was recorded two weeks earlier than 2007 – 2008 seasons (in the 2<sup>nd</sup> half of August, mean number 0.15 / trap), the 2<sup>nd</sup> peak was recorded also two weeks earlier than the foregoing seasons (in the 1<sup>st</sup> half of March, mean number 0.21 weevils / trap). The effect of weather factors upon weevils' density population was studied.

Key words: Red palm Weevil, pheromone, traps, food baits, ecology.

**RÉSUMÉ**

Des études de suivi ont été menées dans le district d'Amria (gouvernorat d'Alexandrie) au cours des deux saisons successives de 2007 - 2008 et 2008 - 2009 à l'aide de pièges à phéromones (Ferrolure+ 700 mg). Les charançons *R. ferrugineus* ont été trouvés dans les pièges à phéromone toute l'année au cours des deux saisons successives 2007 - 2008 et 2008 - 2009. Deux pics de vol ont été enregistrés au cours des deux années d'étude, le 1<sup>er</sup> pic a été enregistré dans la première quinzaine de septembre (nombre moyen : 0,13 charançon / piège), le second pic a été noté dans la deuxième quinzaine de mars (nombre moyen de 0,19 charançon / piège) au cours de la saison 2007-2008. En 2008 - 2009, il y avait également deux pics enregistrés, le premier deux semaines plus tôt qu'en 2007 - 2008 (deuxième quinzaine d'août, avec un nombre moyen de 0,15/piège), le second également deux semaines plus tôt que la saison précédente (première quinzaine de mars, avec un nombre moyen de 0,21 charançon/piège). L'effet des facteurs météorologiques sur la densité de population des charançons a été étudié.

Mots-clés : Charançon rouge du palmier, phéromone, pièges, appâts alimentaires, écologie.

## **INTRODUCTION**

Red palm weevil, *Rhynchophorus ferrugineus* Oliv. is the most destructive and notorious pest of palm trees in Egypt. The damage is entirely done by the grubs which feed on the tissues in the trunks and also in the "core" of the crown. The grubs bore into the tissues, feed internally and ultimately kill the palm tree. In severe infestations all stages of the pest could be found inside the palm trunk.

Males of RPW produce an aggregation pheromone that attract both males and females weevils, and was first identified and synthesized by Hallett et al. (1993). Moreover, several trap designs were described that would attract and capture adults of *R. ferrugineus*. As a result, pheromone traps have been widely used in controlling RPW as a main component of integrated pest management regime (El-Ezaby et al., 1998; Abdallah and Al-Khatri, 2000). Aggregation pheromone have been reported as an effective tool for monitoring and trapping RPW in the field (Gunnawardena and Badarage, 1995; El-Garhy, 1996; El-Ezaby et al., 1998). The present work is a trial to use pheromone traps as a monitor for weevils' population density on the course of two successive years, as well as studying the effect of weather factors on adult weevils' activity.

## **MATERIAL AND METHODS**

### **Seasonal abundance**

Monitoring studies of the curculionid weevils *R. ferrugineus* were carried out in date palm orchard located at Amria district, Alexandria governorate. Studies were conducted during two successive years using pheromone traps from the first of May 2007 until the end of April 2009.

An orchard of about 3 feddan (1 feddan = 0.42 ha) with infested date palm trees was chosen for the study. Pheromone traps were made as described by Abraham et al. (1998) and Muthiah et al. (2002), using 10-L plastic bucket with lids. Four windows (1.5 x 5 cm) were made equidistantly at the top of the bucket just below the upper rim, the pheromone lure was hung on the inner side of the lid using a metal wire. To provide better grip for the attracted weevils, jute cloth was stuck on the outer side of the bucket. Traps were hung on tree trunk at height of 1 meter using rubber bands with at least 50 m between each trap (2 traps/feddan) and they were inspected half monthly to count numbers of attracted weevils, at the same time traps were cleaned by washing and replacing the old food bait with fresh ones, in addition, to replace aggregation pheromone lure each month before running out. The aggregation pheromone lure used was Ferrolure+ 700 mg (4-methyl-5-nonanol "9 parts" 4-methyl-5-nonanone "1part", greater than 95% chemical purity, releasing rate 3-10 mg/day) produced by ChemTica International).

### **Progress of infestation**

The "actual data" of the seasonal abundance recorded at half-monthly intervals per trap were accumulated "cumulative effect" during the two successive seasons 2007-2008 and 2008-2009. The accumulated number for the two years together represented the total number of weevils per trap. The presented figure indicated the period of the seasonal cycle of weevils' activity. Progress of infestation also indicated the rate of infestation increase of weevils' year after another.

### **Effect of weather factors on the activity of red palm weevil**

The main weather factor; the day mean temperature (DMT) and the day mean relative humidity (DMRH) were considered. Necessary weather data were obtained from the Central Meteorology, ARC, MOA, Giza. Population data of weevils and the meteorological data, both at half-monthly intervals, were presented in Tables.

To smooth down the population data to an almost normal form, three reading running means were worked out according to the formula " 2 multiplied by the second number + (the first

number + the third number / 4". The relationship between the weather factors and weevils population during both years of study was investigated.

To determine the direct effect of each weather factor on weevils' activity, population counts were plotted against the corresponding weather data. The simple correlation coefficient "r" for the relationship between each weather factor and weevils' population was then worked out (Snedecor and Cochran, 1990).

## RESULT

### Seasonal abundance

The seasonal abundance of *R. ferrugineus* in palm tree orchard at Alexandria governorate during 2007 – 2008 and 2008 - 2009 were tabulated in Tables (I and II) and graphically illustrated in Figure (1). These Tables and Figure revealed that weevils were attracted to pheromones traps all year round from the 1<sup>st</sup> half of May 2007 until the end of April 2009.

In 2007 – 2008 seasons (Table I), weevils started to be attracted to pheromone traps from the 1<sup>st</sup> half of May 2007 in few numbers (Mean number 0.02 weevils / trap), weevils activity fluctuated during the next weeks until recording the 1<sup>st</sup> peak of flight during the 1<sup>st</sup> half of September (Mean number 0.13 weevils / trap), then, continue fluctuation irregularly to record the 2<sup>nd</sup> peak in the 2<sup>nd</sup> half of March (Mean number 0.19 weevils / trap).

The grand total number of attracted weevils was 1.29 with grand mean 0.05 during 2007 – 2008 seasons (from 1<sup>st</sup> half of May 2007 until 2<sup>nd</sup> half of April 2008).

In 2008 – 2009 seasons (Table II), weevils were attracted to pheromone traps from the 1<sup>st</sup> half of May 2008 (mean number 0.02 weevils / trap), then, and during the next weeks showed a smooth fluctuation in population density to record the 1<sup>st</sup> peak of flight in the 2<sup>nd</sup> half of August (Mean 0.15 weevils / trap). Moreover, a drastic fluctuation was shown during the period from the 1<sup>st</sup> half of September until the 1<sup>st</sup> half of March whereas the 2<sup>nd</sup> peak was recorded (Mean number 0.21 weevils / trap).

The grand total number of attracted weevils was 1.34 with grand mean 0.06 during 2008 – 2009 seasons (from the 1<sup>st</sup> half of May 2008 until the 2<sup>nd</sup> half of April 2009).

### Progress of infestation

Cumulative numbers of attracted weevils during the 2 years of study (from the 1<sup>st</sup> half of May 2007 until the 2<sup>nd</sup> half of April 2009) presented in Tables (I and II) and Figure (1) indicated that the seasonal cycle of *R. ferrugineus* in date palm orchards at Alexandria governorate was 24 months of weevils activity. Infestation with the red palm weevil increased during only one year (from 1.29 to 2.63 weevils / trap / year).

### Effect of temperature and relative humidity on weevils' activity

The simple correlation and regression coefficients for the relationship between the mean numbers of *R. ferrugineus* weevils population per one trap in date palm orchards at Alexandria governorate and the corresponding day mean temperatures and day mean relative humidity calculated during the 2 years of study (from the 1<sup>st</sup> half of May 2007 until the 2<sup>nd</sup> half of April 2009) of weevils activity was presented in Tables (I and II). Statistical analysis (Table III) revealed that the fluctuation in *R. ferrugineus* weevils population was highly significant and positively correlated with the day mean temperature ("r" = 0.692 and 0.643). On the other hand, day mean relative humidity showed insignificant correlation ("r" = 0.121 and 0.051) in both years of study.

## **DISCUSSION**

### **Seasonal abundance**

Adult weevils were seen all over the year months, strong reduction of adult activity occurs in winter as consequence of the low temperatures recorded in this season. A long period of time is required by the weevils to increase its populations, which reach damaging levels near the end of summer in August and September.

These results are in agreement with those obtained by Conti *et al* (2008), but they concluded that pheromone traps were not always effective in monitoring the insect population dynamics, they added that, in some cases, pheromone traps failed to detect RPW adults before damage occurred to the palms.

### **Progress of infestation**

Infestation with the red palm weevil increased during only one year (from 1.29 to 2.63 weevils / trap / year). This serious parameter imposed the need of controlling the pest year after another. It was noticed that adult capture was not always in synchrony with the expression of symptoms of infestation by the palms, except, in two occasions, in September 2007 and 2008.

### **Effect of temperature and relative humidity on weevils' activity**

Fluctuation in *R. ferrugineus* weevils population was highly significant and positively correlated with the day mean temperature. El-Ezaby (1998), stated that during the winter the adult weevils are very active and increased in number under the weather conditions of U.A.E. during 1995 and 1996 seasons. Also, Conti *et al.* (2008), found that, in Sicily, the cold temperature during winter and spring time had an adverse effect on biological activity of the insect and prevent further spreading of the infestation. Wattanapongsiri (1966) proved *that R. ferrugineus* can breed in a wide range of climates, and this is largely because the larvae feed protected within their host palms.

**Table I:** Mean number of adult weevils of *R. ferrugineus* in pheromone traps at Amria region (Alexandria governorate) from first of May 2007 until end of April 2008 together with the corresponding weather factors.

Nombre moyen d'adultes de *R. ferrugineus* dans les pièges à phéromones dans la région d'Amria (gouvernorat d'Alexandrie) du 1<sup>er</sup> mai 2007 jusqu'à la fin de l'année 2008 avec les facteurs météorologiques correspondants.

Date of inspection		Mean number of adult weevils/trap			Mean temp. °C	Mean R.H.%
		actual	smoothed	cumulative		
May	1→15/2007	0,02	0,18	0,02	22,7	71
	16→31/2007	0,03	0,02	0,05	24,4	70
June	1→15/2007	0,01	0,02	0,06	26,1	78
	16→30/2007	0,04	0,04	0,10	27,0	77
July	1→15/2007	0,06	0,05	0,16	28,6	70
	16→31/2007	0,03	0,04	0,19	29,2	75
Aug.	1→15/2007	0,05	0,05	0,24	29,1	77
	16→30/2007	0,07	0,08	0,31	29,3	78
Sep.	1→15/2007	0,13	0,10	0,44	28,2	77
	16→31/2007	0,08	0,08	0,53	27,6	74
Oct.	1→15/2007	0,03	0,04	0,56	26,2	74
	16→30/2007	0,02	0,02	0,58	23,2	66
Nov.	1→15/2007	0,02	0,02	0,60	23,0	75
	16→30/2007	0,04	0,03	0,64	20,7	73
Dec.	1→15/2007	0,03	0,04	0,67	19,7	71
	16→31/2007	0,04	0,03	0,71	16,3	62
Jan.	1→15/2008	0,02	0,03	0,73	14,9	57
	16→31/2008	0,03	0,03	0,76	15,6	65
Feb.	1→15/2008	0,02	0,03	0,78	15,8	49
	16→28/2008	0,05	0,05	0,83	16,3	53
Mar.	1→15/2008	0,07	0,10	0,90	17,4	59
	16→31/2008	0,19	0,30	1,09	22,0	63
April	1→15/2008	0,11	0,13	1,20	20,7	68
	16→30/2008	0,09	0,07	1,29	16,3	63
Grand total		1,29				
Grand mean		0,05				

**Table II:** Mean number of adult weevils of *R. ferrugineus* in pheromone traps at Amria region (Alexandria governorate) from first of May 2008 until end of April 2009 altogether with the corresponding weather factors.

Nombre moyen d'adultes de *R. ferrugineus* dans les pièges à phéromones dans la région d'Amria (gouvernorat d'Alexandrie) du 1<sup>er</sup> mai 2008 jusqu'à la fin avril 2009 avec les facteurs météorologiques correspondants.

Date of inspection		Mean number of adult weevils/trap			Mean temp. C	Mean R.H.%
		actual	smoothed	cumulative		
May	1→15/2007	0,02	0,18	0,02	22,7	71
	16→31/2007	0,03	0,02	0,05	24,4	70
June	1→15/2007	0,01	0,02	0,06	26,1	78
	16→30/2007	0,04	0,04	0,10	27,0	77
July	1→15/2007	0,06	0,05	0,16	28,6	70
	16→31/2007	0,03	0,04	0,19	29,2	75
Aug.	1→15/2007	0,05	0,05	0,24	29,1	77
	16→30/2007	0,07	0,08	0,31	29,3	78
Sep.	1→15/2007	0,13	0,10	0,44	28,2	77
	16→31/2007	0,08	0,08	0,53	27,6	74
Oct.	1→15/2007	0,03	0,04	0,56	26,2	74
	16→30/2007	0,02	0,02	0,58	23,2	66
Nov.	1→15/2007	0,02	0,02	0,60	23,0	75
	16→30/2007	0,04	0,03	0,64	20,7	73
Dec.	1→15/2007	0,03	0,04	0,67	19,7	71
	16→31/2007	0,04	0,03	0,71	16,3	62
Jan.	1→15/2008	0,02	0,03	0,73	14,9	57
	16→31/2008	0,03	0,03	0,76	15,6	65
Feb.	1→15/2008	0,02	0,03	0,78	15,8	49
	16→28/2008	0,05	0,05	0,83	16,3	53
Mar.	1→15/2008	0,07	0,10	0,90	17,4	59
	16→31/2008	0,19	0,30	1,09	22,0	63
April	1→15/2008	0,11	0,13	1,20	20,7	68
	16→30/2008	0,09	0,07	1,29	16,3	63
Grand total		1,29				
Grand mean		0,05				

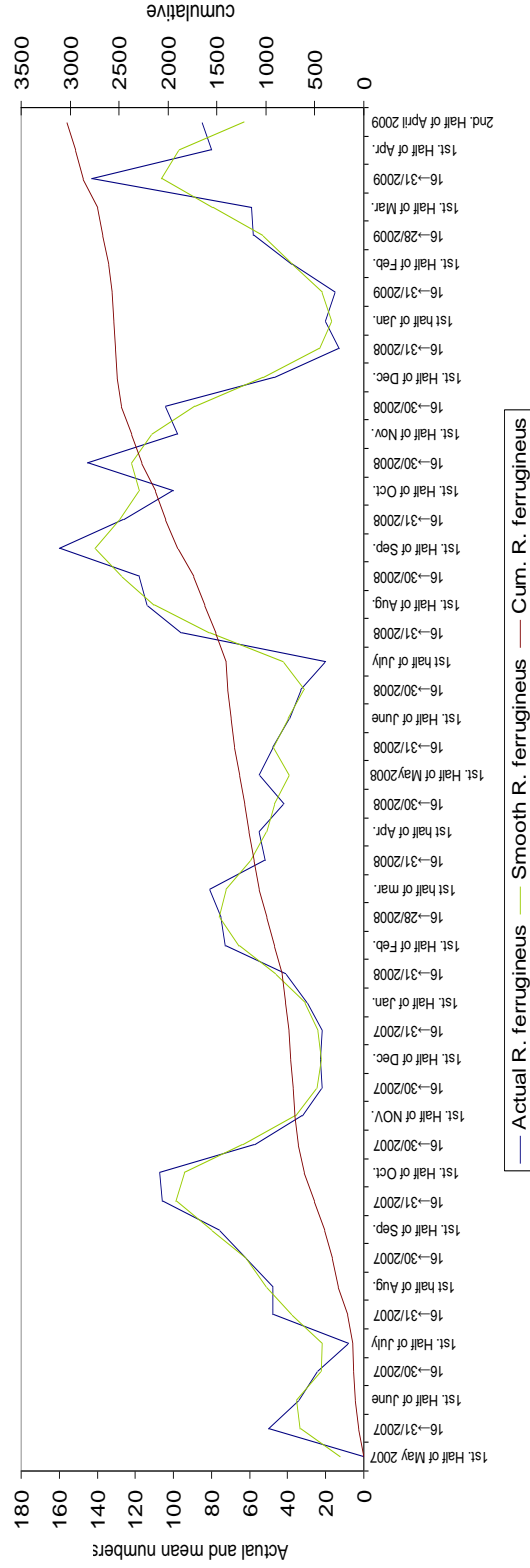
**Table III:** The correlation "r" and regression "b" coefficients (Linear model) between the mean numbers of *R. ferrugineus* weevils population in palm trees orchards and the corresponding day mean temperature (DMT) and day mean relative humidity (DMRH) calculated during 2007 - 2008 and 2008 - 2009 seasons of weevils activity.

Coefficients de corrélation "r" et de régression "b" entre le nombre moyen de *R. ferrugineus* dans les vergers de palmiers, et les températures et humidités relatives journalières moyennes calculée pendant les périodes d'activité des saisons 2007-2008 et 2008-2009.

Season	Period		Weather Factor	Simple correlation "r"	Regression coefficient "b"
	From	To			
2007 – 2008 n = 12	1 <sup>st</sup> half of	2 <sup>nd</sup> half of	DMT	0.692	0.00
	May	April	DMRH	0.121	0.145
2008 – 2009 n = 12	1 <sup>st</sup> half of	2 <sup>nd</sup> half of	DMT	0.743	0.01
	May	April	DMRH	0.051	0.33

**Fig 1: Mean numbers of adult weevils of *R. ferrugineus* in pheromone traps at Amria district (Alexandria governorate) from 1st. half of May 2007 until end of April 2009.**

**Le nombre moyen de charançons adultes de *R. ferrugineus* dans les pièges à Amria district (gouvernorat d' Alexandrie) du 1<sup>er</sup> semestre de Mai 2007 jusqu'à la fin du Avril 2009.**





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