

Impact of Mass Pheromone Trapping on Red Palm Weevil: Adult Population and Infestation Level in Date Palm Gardens of Saudi Arabia

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The red palm weevil, Rhynchophorus ferrugineus Oliv. is a serious pest of date palm in all the Gulf countries. One of the important components of integrated management of the pest is the use of pheromone-based trapping system. After standardising the method of trapping with aggregation pheromone, 4-methyl-5-nonanol (Ferrolure) and/or 4-methyl-5-nonanol + 4-methyl-5-nonanone (9:1) (Ferrolure+), mass-trapping system was adopted for the entire Qatif region in the Eastern Province of Saudi Arabia. A total of 2 252 pheromone traps were used in the mass trapping system. From an initial capital level of 4.12 weevils per trap per week in 1994, the adult population was reduced to 2.02 weevils per trap per week at the end of 1997. A grand total of 794 657 weevils were trapped since the inception of the mass-trapping programme. The peak adult population 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 the onset of winter. When the weather parameters were correlated with the weevil catch in different months, it was found that there was a drop in capture rate of weevils at the beginning of winter season. After the integration of mass pheromone trapping-system into the control programme, there was a significant reduction in the infestation level of the pest.

Keywords: Pheromone traps, red palm weevil, *Rhynchophorus ferrugineus*, date palm, ferrolure, 4-methyl-5-nonanol.

The red palm weevil, *Rhynchophorus ferrugineus* Oliv. (Coleoptera: Curculionidae) is a major pest of date palm in all the countries of Arabian peninsula, besides, other Middle East countries (Abraham & Vidyasagar, 1992; Bokhari & Abuzuhira, 1992). After the first report of this pest in Saudi Arabia in 1987, infestations spread to several regions within a short period. For controlling red palm weevil several kinds of control methods were described (Nirula, 1956; Morin *et al.*, 1986; Vidyasagar & Bhat, 1991). The pest in the Kingdom of Saudi Arabia (KSA) was initially managed by adopting chemical control methods alone.

However, the results were not very encouraging as the pest infestation continued to increase and spread to newer areas. Hence, attempts were made to introduce food baits as a component in the control strategy (Abraham & Vidyasagar, 1992). During the same period, research was pursued for the isolation and identification of male aggregation pheromones of different species of red palm weevil. Although, the male aggregation pheromone in *R. palmarum* was first established by RoCHAT *et al.*, (1991), further studies were conducted by Oehlschlager *et al.*, (1992). A pheromone-based trapping system for trapping adult *R. palmarum* (L.) for

management of red ring disease in commercial oil palm plantations of Costa Rica was developed (Chinchilla *et al.*, 1993). Later on Hallett *et al.*, (1993a), established the presence of pheromone and isolated and synthesised the male aggregation pheromones of *R. ferrugineus* Oliv. These researchers also reported that a blend of 4-methyl-5-nonanol and 4-methyl-5-nonanone (9:1) was very effective in the trapping of *R. ferrugineus* adults. A few field tests were conducted on the trapping methods of adult *R. ferrugineus* in UAE and Indonesia (Hallett *et al.*, 1993b). After extensive field-testing an efficient mass trapping system for capturing red palm weevil adults in KSA was developed (Abozuhairah *et al.*, 1996).

The objective of the present study is to investigate the influence of mass trapping of adult weevils with pheromone trapping system on the population of the weevil in the field. It is also envisaged to investigate the impact of mass trapping on the overall infestation level in the region. An attempt was made to see the relationship between weather parameters and capture rate of weevils.

MATERIALS AND METHODS

The study was undertaken in Al Qatif region near Dammam in the Eastern Province of Saudi Arabia. The region is a traditional date palm growing area with about 3 055 gardens and 464 785 palms under survey. The spacing of date palms was not uniform in all gardens and many farmers practised intercropping with a variety of crops like citrus, figs, vegetables *etc.* The study area was spread over an area of about 60-70 km long and 10-15 km wide.

The mass pheromone trapping of weevils was started in the month of August 1994 in Al Qatif region. Based on the field experiments conducted, the standard Saudi bucket trap (5L

capacity plastic bucket covered with date palm leaf sheath and four windows) was selected for mass pheromone trapping (Abozuhairah *et al.*, 1996). The traps were baited either with 4-methyl-5-nonanol (Ferrolure) or 4-methyl-5-nonanol + 4-methyl-5-nonanone (9:1 ratio) (Ferrolure+) lures in sachets or bubble formulation, supplied by Chem Tica, Costa Rica. The traps were strapped to the palms at a height of 1.3 to 1.5 m from ground level. Only small bits of date stem (~750 g) were used as food bait and carbaryl 0.3 per cent solution was used to kill the attracted weevils. The traps were set up at 1 trap per hectare in all cultivated gardens. However, in gardens with wide spacing, plastic houses, intercrops *etc.*, the traps were kept at the rate of one trap for every 250 palms. As there were many neglected gardens in Al Qatif regions, the traps were located in cultivated gardens in such a way, that these neglected gardens were on the periphery of traps. The food and pesticide solution was replaced every week in summer and once in two weeks during winter, after recording the weevil catches. The pheromone traps were checked at regular intervals and were replaced with new ones when exhausted. The data on the weevil catch was recorded area wise and compiled on a weekly basis.

Weather data on the maximum and minimum temperature and relative humidity was collected from the Meteorological station located inside Agricultural Improvement Scheme, Al Qatif. This data was provided by the Agricultural Research Center. In the present study an attempt has also been made to correlate the weevil capture data with the weather parameters during the year 1995.

RESULTS AND DISCUSSION

The *Table 1* shows the area wise distribution

TABLE 1
DISTRIBUTION OF PHEROMONE TRAPS IN DIFFERENT AREAS IN 1997

Area	No. of gardens	Type of lure		Total traps
		4-methyl-5-nonanol + 4-methyl-5-nonanone (9:1)		
Abuman	121	169		169
Al Jesh	112	154		154
Area no. 3	69	117		117
Awamiya	120	200		200
Ayashi	63	83		83
Dammam	48	103		103
Jerrodiya	116	130		130
Owjam	71	110		110
Qhudeh	128	150		150
Qhwaldia	83	132		132
Safwa	108	165		165
Saihat	109	164		164
Tarut	127	156		156
Tobi 2	86	121		121
Um Al Hamam	110	115		115
Um Musahik	122	183		183
Grand total	1 593	2 252		2 252

of traps in Al Qatif during 1997. There were a total of 1 593 date palm gardens under survey in the area. A total of 2 252 traps were distributed in all these gardens. The highest number of 200 traps was placed in Awamiya area, followed by Um Musahik with 183 traps. During 1994, two batches of lures were used in the months of August and December and another batch was used in May 1995. Based on the infestation and the weevil catch in a garden more new traps were added later on. All pheromone sachets of 4-methyl-5-nonanol were substituted with 4-methyl-5-nonanol + 4-methyl-5-nonanone (9:1) from the month of September 1997. Thereafter, the trapping was continued with 4-methyl-5-nonanol + 4-methyl-5-nonanone (9:1) lures only. The lures were changed in the months of April, July, September and November in 1997. In all 9 348 lures were

used for the trapping programme in 1997. Out of them, 2 394 4-methyl-5-nonanol and 6 954 4-methyl-5-nonanol + 4-methyl-5-nonanone (9:1) sachets were distributed in various areas.

In the integrated management of *R. ferrugineus* in coconut gardens of India, coconut log traps treated with coconut toddy + yeast + acetic acid were found to be effective (Kurian *et al.*, 1984). An important pest of coconut and other palms in the America through direct attack and as a vector of the red ring nematode is American palm weevil, *R. palmarum* (Griffith, 1987). Accumulated losses due to red ring disease associated with little leaf syndrome can reach 15 per cent or more in commercial plantations in Costa Rica (Chinchilla *et al.*, 1993). Traps baited with 2-methyl-5 (E)-hepten-4-ol were used for capturing American palm weevil. Mass

trapping within 5 500 ha of oil palm plantation using 19L bucket, 9L and 5L containers and hollow system traps interchangeably since these were equally effective (Oehlschlager *et al.*, 1993). When four types of traps *viz.* bucket traps, bucket traps with leaf sheath covering, basin traps and pit traps, were tested in the field, it was found that the bucket trap with leaf sheath covering gave the optimum adult weevil catch (Vidyasagar, 1995; Abozuhairah *et al.*, 1996). An important factor to be kept in mind was the relative convenience of servicing the traps during summer months. On this count the bucket trap with leaf sheath covering was much better than other kinds of traps tested.

From the previous field experiments it was known that 4-methyl-5-nonanol and 4-methyl-5-nonanone (9:1) lures were superior to 4-methyl-5-nonanol lures (Vidyasagar, 1995). However, there was no significant difference in the weevil catch between 4-methyl-5-nonanol + 4-methyl-5-nonanone and 4-methyl-5-nonanol after the start of mass trapping. Hence, the data collected from traps baited with these two types of lures was not separately presented.

In *Figure 1*, the weevils captured in different months by pheromone traps in 1994, 1995, 1996 and 1997 is presented. The highest catch of weevils was recorded in the months of April and May. This was mainly due to the emergence of a new brood of weevils after the winter season, besides, the increased activity of adults upon the arrival of warmer climate. A total of 111 399 weevils were trapped in four months of 1994, whereas, in 1995 and 1996 the total number of weevils captured was 264 747 and 198 247 respectively which was increased to 220 264 during 1997. From the very start of the mass trapping programme up to the end of December 1997 a grand total of 794 657 weevils were captured in Al Qatif region.

In *Table 2*, data on the weevil catch in different areas is presented. The highest catch of weevils 78 548 was recorded by Tarut area followed by Awamiya, Um Musahik and Al Joch areas. The data was compiled to see the cumulative catch in different areas. Chinchilla *et al.*, (1993) and Oehlschlager *et al.*, (1995) conducted several experiments on *R. palmarum*

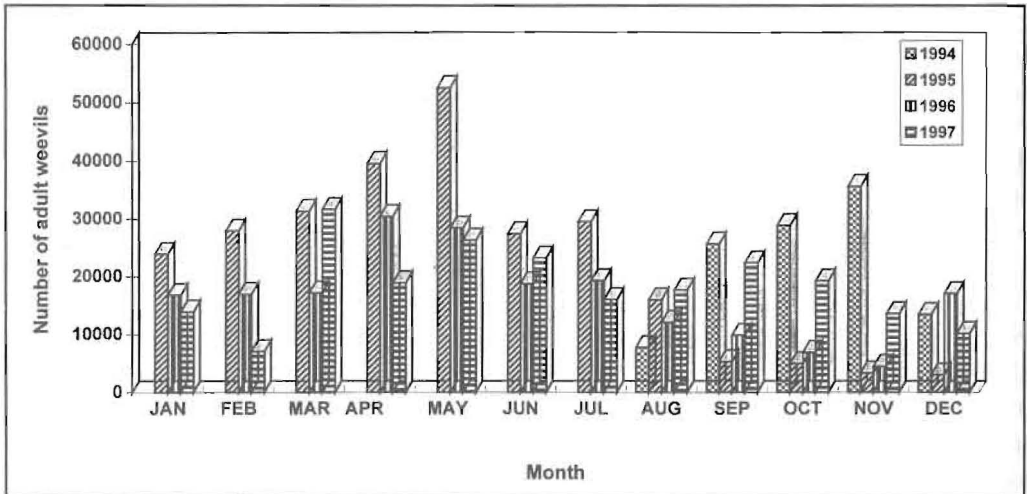


Figure 1. Number of red palm weevil adults trapped in different months

TABLE 2

WEEVILS CAPTURED BY PHEROMONE TRAPS IN DIFFERENT AREAS OF QATIF REGION
FROM AUGUST 1994 TO DECEMBER 1997

Area	Weevils trapped			Cumulative total
	1994 & 1995	1996	1997	
Abuman	22 217	12 886	19 462	54 565
Al Jesh	25 211	15 676	20 583	61 470
Area no. 3	13 393	10 019	13 362	36 774
Awamiya	38 003	15 185	13 622	66 810
Ayashi	14 625	6 410	6 289	27 324
Dammam	8 793	7 585	7 526	23 904
Jerrodiya	29 274	12 501	12 287	54 062
Owjam	16 946	11 534	12 498	40 978
Qhudeh	28 624	13 437	16 925	58 986
Qhwalidia	22 554	9 869	11 719	44 142
Safwa	26 373	13 339	13 166	52 878
Saihat	20 536	14 757	15 413	50 706
Tarut	41 137	17 939	19 472	78 548
Tobi 2	16 460	12 810	10 610	39 880
Um Al Hamam	22 436	8 080	7 353	37 869
Um Musahik	29 564	16 220	19 977	65 761
Total	376 146	198 247	220 264	794 657

and estimated the weevil population to be 57 weevils per hectare at the beginning of the mass trapping. However, their estimations did not hold good as they captured about 61 000 weevils in about one year from a specific areas instead of the estimated 1 700 weevils. The reason given by them was the immigration of weevils from adjoining stands. In the present study the density of traps was kept more or less the same and all cultivated gardens in the Qatif region were covered under mass trapping. The increase in the number of traps over a four-year period was necessitated due to increase in the number of newly planted gardens.

The *Figure 2* shows the average number of weevils captured per trap per week in different months. The highest average capture rate of 4.12 weevils per trap per week was

recorded during 1994, which was reduced to 4.0 weevils per trap per week during 1995. There was further decline in the number of weevils with average catches of 2.23 and 2.02 weevils per trap per week during 1996 and 1997 respectively. The highest catch of about 32 weevils per trap per month was recorded in April 1995. This average is quite high compared to the capture rates observed in Costa Rica. Due to this high number of weevils resident in the gardens, the density of traps has to be maintained at the same level even after four years of trapping. By adopting mass trapping the infestation levels were brought down substantially (Vidyasagar, 1998).

An attempt has been made to correlate the weevil catch with weather data such as temperature and humidity observed during

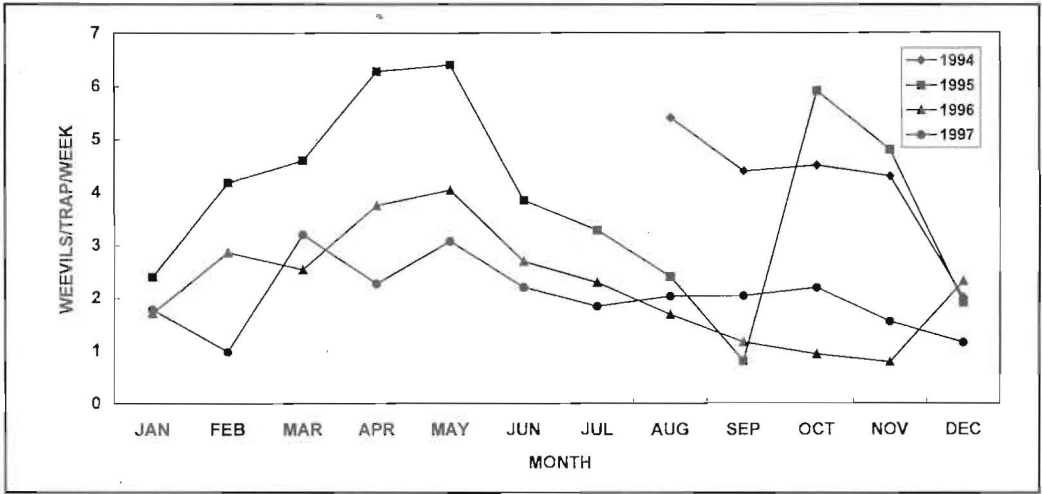


Figure 2. Average number of red palm weevil adults trapped every week in different months

1995. The average number of weevils per trap per week in different months is shown in *Figure 3a* and the data on maximum, minimum temperature and relative humidity is presented in *Figure 3b*. In the months of winter that was from January to February 1995, there was a drop in the number of weevils trapped per week. From the middle of February when the temperatures started rising there was more catch. As the mean temperature *i.e.*, maximum and minimum, started rising from middle of February the average weekly weevil catch also increased. The peak capture rate was recorded in May when the maximum temperature was above 35°C. In the subsequent months there was a decline in the number of trapped weevils, although temperature was high. This may be due to the removal of a large population in the months of April and May. In December 1995 again the average weevil catch fell considerably, although, old lures were replaced with new lures. Due to the higher release rate and also increased activity of adult weevils there was an increase in the weevil catch in summer months. In Costa Rica survey trapping in the

oil palm plantations using palm stem traps without pheromone revealed that the population of *R. palmarum* declined at the onset of the rainy season in May-June and thereafter climbed by a factor of 3 to peak in the dry season in February to March (Morales & Chinchilla, 1990). The same trend was noticed, when pheromone baited trapping was done in about 50 ha area with internal and perimeter traps, where weevil capture rates declined through December and then increased between December and February (Chinchilla *et al.*, 1993).

Vidyasagar *et al.*, (1999) have studied the life cycle of the pest in the laboratory and reported that the development of larvae is arrested during winter months. This may be one of the reasons for lower catches during winter months. The relationship between the lower catches in winter months and higher catches in summer months was holding good in subsequent years as well. In 1997 also the capture rate increased as soon as the temperatures increased.

At the start of the trapping programme, the

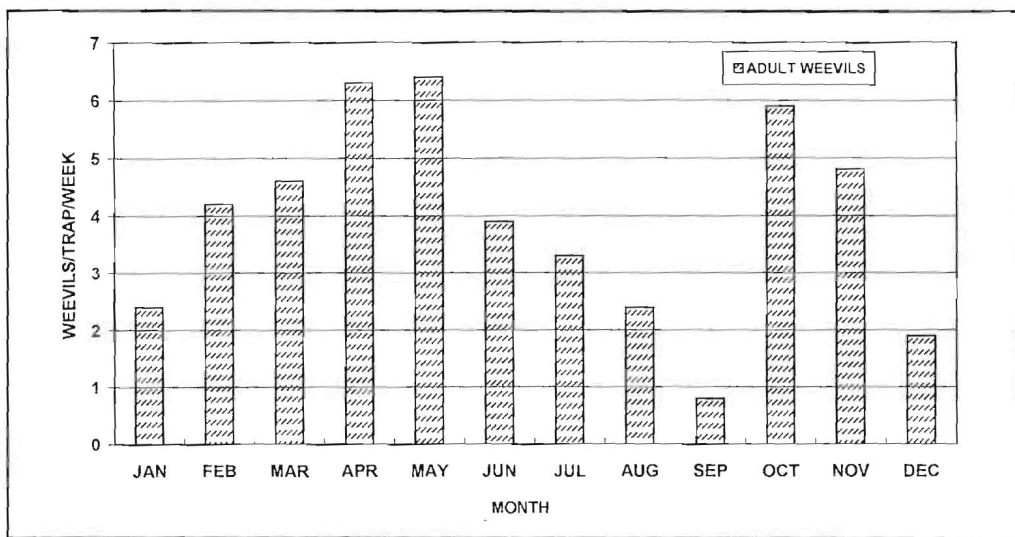


Figure 3a. Average number of red palm weevils captured in different months

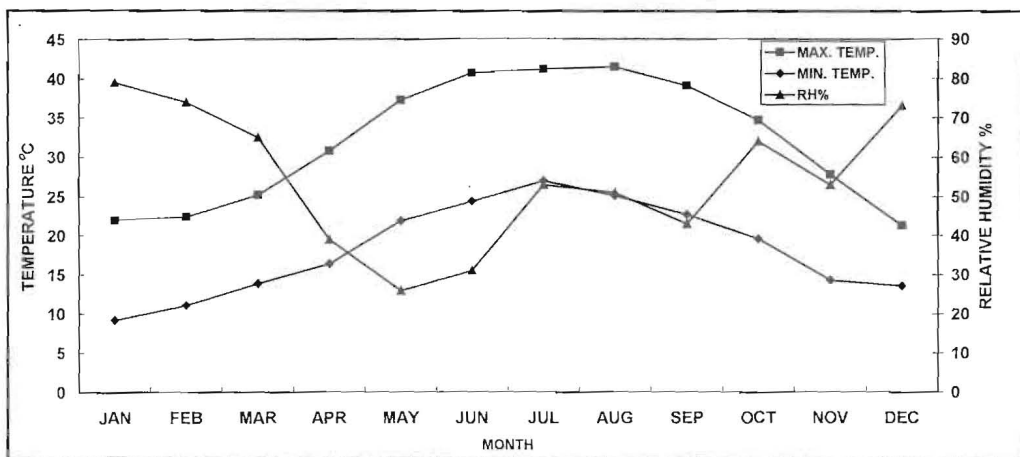


Figure 3b. Average maximum and minimum temperature and relative humidity in Al Qatif

infestation level in this region was 6.6 per cent of all the surveyed gardens. In subsequent years the infestation has declined to 4.0 and 2.3 per cent levels. In almost all areas where more than 50 000 weevils were captured, the level of infestation showed a steady decline from 1993 to 1995 (Table 3). However, this was the cumulative effect of all the control measures used besides, mass trapping (Vidyasagar,

1998).

From the above account it is concluded that the population of the weevils, in the most severely affected Al Qatif region of Saudi Arabia has been reduced substantially due to the mass trapping with pheromone-based traps. As a consequence of the lower weevil populations, there has been a reduction in the infestation level also over the last three years.

TABLE 3
PER CENT OF RED PALM WEEVIL INFESTED PALMS IN SOME AREAS FROM 1993 TO 1995

Area	% infested palms		
	1993	1994	1995
Abuman	7.10	5.50	3.40
Al Jesh	5.70	4.00	2.20
Awamiya	8.90	4.50	2.00
Jerrodiya	4.40	1.90	1.60
Qhudeh	6.90	3.30	1.60
Safwa	4.30	2.50	0.90
Saihat	5.00	3.40	5.50
Tarut	8.10	3.70	1.00
Um Musahik	5.00	7.40	4.50

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