RED PALM WEEVIL

A STRATEGY TO MANAGE RED PALM WEEVIL *Rhynchophorus ferrugineus* OLIV. ON DATE PALM *Phoenix dactylifera* L. - ITS SUCCESSFUL IMPLEMENTATION IN AL-HASSA, KINGDOM OF SAUDI ARABIA

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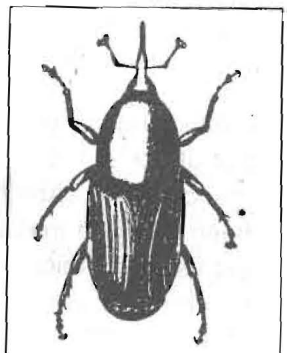
ABSTRACT

The date palm, *Phoenix dactylifera* L. is the most important fruit crop cultivated in the Kingdom of Saudi Arabia since pre-historic times. The dreaded pest of palm, *viz.* the red palm weevil, *Rhynchophorus ferrugineus* Oliv. has attained a key pest status since the early nineties after first being reported in Saudi Arabia during the mid-eighties. The concealed nature of the pest makes detection of infested palms difficult. Also, the hardy nature of the crop, coupled with the high breeding potential of the pest together with unique agroclimatic conditions of Saudi Arabia make palm weevil management a challenging task. This article highlights the successful implementation of an Integrated Pest Management (IPM) strategy adopted in Saudi Arabia, from 1994 to 1997 emphasising the role of trapping the pest using food-baited pheromone traps along with other IPM tactics which led to the ultimate suppression of the pest.



Rhynchophorus ferrugineus

KEY WORDS: Date palm, weevil control.

INTRODUCTION

Since ancient times, date palm, *Phoenix dactylifera* L. is closely associated with the life of the people in the Kingdom of Saudi Arabia. It is the oldest fruit tree in the Arabian Peninsula and has been of great significance to Saudi Arabia for the past 7000 years (Thomson, 1949). With over 13 million date palms, Saudi Arabia is considered to be one of the world's leading date producing countries, with an annual production of 0.5 million tonnes.

The crop was relatively free of any major insect pest problem, until the mid eighties when the dreaded pest of palms, *viz.*, the red palm weevil, *Rhynchophorus ferrugineus* Oliv. (Coleoptera: Curculionidae) was first reported from Al-Qateef, an oasis township in the Eastern province of Saudi Arabia (Abozuhairah *et al.*, 1996). From Al-Qateef, the pest spread throughout the country.

The agroclimatic conditions prevailing in Saudi Arabia, together with the unique morphology of the crop have offered the pest an ideal ecological niche. Further, movement of offshoots as planting material had assisted in the rapid spread of the pest in a short span of about a decade (Abraham *et al.*, 1998). Red palm weevil is now a key pest of date palm in Saudi Arabia and other Middle-Eastern countries.

The pest is a concealed tissue borer and if timely curative measures are not adopted, larval feeding often leads to the death of the palm.

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Table 1

Weevils trapped and catch per pheromone trap, during the first phase of the trapping programme (Jan to June, 1994)

Area	Weevil trap catch							No. of traps	Catch/ trap
	Jan	Feb	Mar	Apr	May	Jun	Total		
Holailah-I & II	0	1	8	9	40	12	70	15	4.67
Holailah-III	0	0	0	0	7	1	8	3	2.67
Baniman	0	0	0	3	11	1	15	6	2.50
Kadoud	0	0	2	14	14	11	41	8	5.13
Oaba-I & II	0	0	0	16	21	6	46	7	6.57
Sultana	8	0	0	0	0	0	8	3	2.67
Suhemia	0	0	1	6	16	2	25	4	6.25
Aboshabal-I & II	0	1	5	15	13	5	39	7	5.57
Sudan	0	0	0	0	1	1	2	2	1.00
Shuaiby	0	0	1	2	1	0	4	1	4.00
Ashura	0	0	0	6	7	0	13	2	6.50
Majas	0	0	0	0	0	0	0	1	0.00
Al-Guaibahl	0	0	0	0	0	0	0	1	0.00
Batalyah-I, II & III	0	0	10	21	19	7	57	9	6.33
Total	8	2	27	92	150	49	328	69	4.75

However, taking up curative measures in the early stage of attack is not possible, as it is difficult to detect such palms (Abraham *et al.*, 1998). It has also been reported that initial attempts to control the pest using chemical control methods in Saudi Arabia were not very successful (Bokhari and Abozuhairah, 1992).

Red palm weevil has been successfully managed on coconut in India, using an Integrated Pest Management (IPM) programme (Abraham and Kurian, 1975 and Abraham *et al.*, 1989). To tackle the challenging problem of palm weevil on date palm an IPM strategy was developed based on past experience of managing weevil populations on coconut in India (Abraham *et al.*, 1998). The strategy as recommended by Abraham *et al.* (1989) had been implemented in Al-Hassa, the prestigious date growing Centre in the Kingdom of Saudi Arabia since 1994. This study pertains to the implementation of the IPM strategy from 1994 to 1997, and the successful management of weevil population on date palm in Al-Hassa during this period.

MATERIAL AND METHODS

An IPM programme modeled on the lines of managing palm weevil on coconut in India, was implemented in the date plantations of Al-Hassa in Saudi Arabia for the first time during 1994. Al-Hassa is the most prestigious date palm growing

Table 2

Area-wise weevil catch in Al-Hassa from mid-1994 to 1997

Sr. No.	Area	Number of weevils captured				
		1994	1995	1996	1997	Total
1	Kadoud	87	229	278	170	764
2	Baniman	86	363	490	324	1263
3	Holailah-I	107	306	132	72	617
4	Holailah-II	125	269	147	109	650
5	Holailah-III	50	254	190	142	636
6	Sultana	0	4	1	5	10
7	Oaba-I	40	110	125	43	318
8	Oaba-II	71	255	319	263	908
9	Batalyah-I	18	45	87	190	340
10	Batalyah-II	92	247	298	366	1033
11	Batalyah-III	330	475	554	402	1761
12	Ashura	646	953	631	181	2411
13	Aboshabal-I	33	80	61	46	220
14	Aboshabal-II	140	234	142	172	688
15	Suhemia	150	345	285	214	994
16	Sudan	60	157	209	46	472
17	Shuaiby	170	251	353	301	1075
18	Jubail	X	318	509	203	1030
19	Ain Mansour	X	41	187	298	256
20	Al-Shubail	X	187	367	133	687
	Total	2205	5123	5365	3680	16373
B.	Monitors					
1	Al-Guaibah	1	28	9	5	43
2	Majas	0	0	1	2	3
3	North	33	115	83	55	286
4	East	7	22	26	31	86
5	City	11	20	49	33	113
	Total	52	185	168	126	531
	Grand Total (A+B)	2257	5308	5533	3806	16904

X = Area not trapped.

Centre in the Kingdom of Saudi Arabia with an estimated population of three million palms. The IPM strategy as proposed by Abraham *et al.* (1989) formed the methodology of this study. The major components of the IPM programme implemented in the field between 1994 and 1997 were as follows.

(i) Surveillance (ii) trapping adult weevil population using pheromone (Ferrugineol) lures (iii) examination of palms to locate infestations (iv) elimination of hidden breeding sites (v) clearing off neglected gardens (vi) crop and field sanitation (vii) preventive chemical treatments (viii) curative chemical treatments (ix) imposing quarantine regulations and (x) training and extension.

Of the above IPM components, work done in relation to surveillance, trapping the weevil and examining palms to locate infestations are presented in detail. These three strategies had a direct impact on the overall management of the

Table 3

Weevil catch per trap in different operational areas of Al-Hassa, from mid-1994 to Dec. 1997

Sr. No.	Area	Weevil catch/trap 1994	1995	1996	1997
1	Kadoud	(44) 1.98	(93) 2.46	(93) 2.99	(93) 1.87
2	Baniman	(30) 2.87	(126) 2.88	(126) 3.89	(55) 2.09
3	Holailah-I	(40) 2.78	(103) 2.97	(103) 1.28	(103) 0.70
4	Holailah-II	(34) 3.68	(89) 3.02	(89) 1.65	(99) 1.10
5	Holailah-III	(89) 0.56	(159) 1.60	(159) 1.19	(159) 0.89
6	Sultana	(10) 0.00	(10) 0.40	(10) 0.10	(21) 0.24
7	Oaba-I	(61) 0.65	(61) 1.80	(61) 2.05	(61) 0.70
8	Oaba-II	(66) 1.08	(120) 2.13	(120) 2.66	(156) 1.69
9	Batalyah-I	(45) 0.40	(73) 0.62	(73) 1.19	(73) 2.60
10	Batalyah-II	(55) 1.68	(199) 1.24	(200) 1.49	(200) 1.83
11	Batalyah-III	(88) 3.75	(171) 2.78	(177) 3.13	(177) 2.27
12	Ashura	(103) 6.27	(192) 4.96	(192) 3.29	(196) 0.92
13	Aboshabal-I	(28) 1.18	(48) 1.67	(48) 1.27	(48) 0.96
14	Aboshabal-II	(24) 5.82	(46) 5.09	(46) 3.09	(46) 3.74
15	Suhemia	(39) 3.85	(152) 2.27	(152) 1.88	(181) 1.18
16	Sudah	(27) 2.23	(86) 1.83	(86) 2.43	(86) 0.53
17	Shuaiby	(119) 1.43	(189) 1.32	(189) 1.87	(189) 1.59
18	Jubail	X	(206) 1.54	(2.06) 2.47	(206) 0.99
19	Ain Mansour	X	(90) 0.46	(90) 2.08	(179) 1.66
20	Al-Shubah	X	(127) 1.47	(127) 2.89	(185) 0.72
Average catch/trap		(902) 2.55	(2340) 2.19	(2347) 2.29	(2613) 1.41
B.	Monitors				
1	Al-Guaibah	(25) 0.04	(27) 1.03	(32) 0.28	(32) 0.16
2	Majas	(5) 0.00	(5) 0.00	(5) 0.20	(5) 0.40
3	North	(81) 0.41	(59) 1.95	(99) 0.84	(99) 0.56
4	East	(66) 0.11	(86) 0.26	(100) 0.26	(107) 0.29
5	City	(54) 0.22	(51) 0.39	(51) 0.96	(51) 0.65
Average catch/trap		(231) 0.19	(228) 0.81	(287) 0.59	(294) 0.40
Av. catch/trap (A+B)		(1133) 1.99	(2568) 2.07	(2634) 2.10	(2907) 1.31

Figures in parentheses are number of traps. X = Areas not trapped.

pest. Other components of the strategy although playing their own role in the management of the weevil, were supplementary in nature.

1. Surveillance:

An initial assessment on the magnitude of the problem in Al-Hassa was made by undertaking a surveillance programme to monitor the activity of the pest, using pheromone traps (monitors) between January to mid-June, 1994. During this period, 69 monitors were set up in 14 areas. If a given monitor trapped no weevils for two or three weeks, then the trap was shifted to different gardens within the area. Besides this, a study of the daily infestation reports helped to gauge the seriousness of the problem in a given area. Based on this initial assessment a decision was taken on the future line of action pertaining to the mass trapping of the pest.

2. Trapping the weevil using pheromone traps:

In coconut, floating weevil populations have been successfully trapped and destroyed using different attractants (Maharaj, 1973; Kurian, 1979; Kurian, 1984). Later Hallett *et al.* (1993) synthesised the male produced aggregation pheromone "Ferrugineol" (4-Methyl-5 nonanol) for *R. ferrugineus*. Since 1994, "Ferrolure" the commercial formulation of Ferrugineol has been used along with a food bait (date palm stem bits/ dates) in 5 litre plastic buckets containing insecticide, to attract and kill weevil populations attacking date palm in Saudi Arabia (Anonymous, 1994).

In Al-Hassa pheromone traps were used to (i) mass trap the weevil in pest infested areas and (ii) monitor weevil activity in traditionally uninfested areas.

2.1 Setting of traps in the field:

Al-Hassa has an extensive irrigation system, comprising open feeder canals. The length of these canals varies. However, the distance between two consecutive lateral canals is 160 metres. These canals were used as markers to fix the position of every trap in the field.

Under the Mass Trapping Programme (MTP), traps were hung at a height of 1.5 m from the ground on old palms, initially at every 200 m along the length of irrigation canals. Subsequently, the trap density was increased by introducing an additional trap between two traps, thus reducing the distance between two traps to 100 metres. This progressive increase in the trap density ensured wider coverage of the area with the available men and material. The position of each trap was plotted on the field map of the operational area. Similarly, field maps depicting the position of every trap were prepared for all the operational areas.

In the monitor areas, traps were set 1 km apart as recommended by Oehlschlager (1994). In the vast stretches of the monitor areas it was often difficult to locate infestations on the basis of weevil captures by pheromone traps. Hence, if a particular monitor recorded consistent weevil captures for two to three weeks, then four to five additional traps (indicators) were set 200 m around this monitor. Thus, the checking teams got closer to the source of infestation, making the task

Table 4

Number of traps that captured weevils in the mass trapped areas from 1994 to 1997

Sr. No.	Area	No. of traps that captured weevils				% trap that captured weevils				Average
		1994	1995	1996	1997	1994	1995	1996	1997	
1	Kadoud	30 (44)	63 (93)	79 (93)	72 (93)	68.18	67.74	84.95	77.42	74.57
2	Baniman	28 (30)	95 (126)	103 (126)	107 (155)	93.33	75.40	81.75	69.03	79.88
3	Holailah-I	28 (40)	80 (103)	61 (103)	31 (103)	70.00	77.67	59.22	30.10	59.25
4	Holailah-II	31 (34)	66 (89)	49 (89)	54 (99)	91.18	74.16	55.06	54.55	68.74
5	Holailah-III	34 (89)	84 (159)	77 (159)	64 (159)	38.20	52.82	48.43	40.25	44.93
6	Sultana	0 (10)	3 (10)	1 (10)	5 (21)	0.00	30.00	10.00	23.81	15.95
7	Oaba-I	21 (61)	41 (61)	44 (61)	23 (61)	33.42	67.21	12.13	37.70	37.87
8	Oaba-II	34 (66)	83 (120)	73 (120)	100 (156)	51.52	69.17	60.83	64.10	61.41
9	Batalyah-I	16 (45)	35 (73)	43 (73)	63 (73)	35.56	47.95	58.90	86.30	57.18
10	Batalyah-II	30 (55)	99 (199)	114 (200)	150 (200)	54.55	49.75	57.00	75.00	59.08
11	Batalyah-III	77 (88)	140 (171)	154 (177)	139 (177)	85.23	89.87	87.01	78.53	85.16
12	Ashura	103 (103)	175 (192)	176 (192)	89 (196)	100.0	71.15	91.67	45.41	77.06
13	Aboshabal-I	12 (28)	28 (48)	32 (48)	22 (48)	42.86	58.33	66.67	45.83	53.42
14	Aboshabal-II	23 (24)	44 (46)	41 (46)	41 (46)	95.83	95.65	89.13	89.13	92.44
15	Suhemia	30 (39)	96 (152)	111 (152)	107 (181)	76.92	63.16	73.03	59.12	68.06
16	Sudah	20 (27)	60 (86)	65 (86)	33 (86)	74.07	69.77	75.58	38.37	64.45
17	Shuaiby	70 (119)	98 (189)	116 (189)	128 (189)	58.82	51.85	61.38	77.72	59.94
18	Jubail	X	127 (206)	154 (206)	99 (206)	X	61.65	74.76	48.05	61.49
19	Ain Mansour	X	26 (90)	64 (90)	134 (179)	X	28.89	71.11	74.86	58.29
20	Al-Shubah	X	83 (127)	99 (127)	65 (185)	X	65.35	77.95	35.14	59.48
	Total	587 (902)	1526 (2340)	1656 (2347)	1526 (2613)	65.08	65.21	70.56	58.40	64.81

Figures in parentheses are number of traps.

of locating infestations in the vast stretches of monitor areas easy. If by the addition of indicators, the infestation was not detected and the situation worsened, then the area was mass trapped.

By the end of 1997, thre were 2907 traps in the field. Of these, 2613 served under the MTP while 294 functioned as monitors. All traps were serviced (cleaning, change of food/insecticide and recording number of weevils captured) once a week. At the end of every week, data on weevil captures was compiled trapwise for all the operational areas. This gave a clear picture on the activity of the pest, enabling the staff of the checking teams to concentrate their efforts where the pest was most active.

The MTP commenced from mid-June 1994. Although 17 operational areas were identified for the MTP on the basis of weevil captures during

Table 5

Number of infested palms located in Al-Hassa between October, 1992 to December, 1997

Months	No. of infested palms located						Total	Average
	1992	1993	1994	1995	1996	1997		
January		7	19	134	85	116	361	72.20
February		3	21	96	40	57	217	43.40
March		1	6	66	76	60	209	41.80
April		2	13	69	63	39	186	37.20
May		0	13	69	125	98	305	61.00
June		11	35	113	220	114	493	98.60
July		34	95	167	181	176	653	130.60
August		57	131	220	227	206	841	168.20
September		23	148	211	258	247	887	177.40
October	46	22	177	271	302	247	1065	177.50
November	56	43	255	235	260	272	1121	186.83
December	30	17	124	120	160	153	604	100.67
Total	132	220	1037	1771	1997	1785	6942	
Eradicated	36	80	327	542	445	345	1775	
% Eradicated	37.50	35.71	31.53	30.60	22.28	19.33	25.57	

the first phase, three more areas, *viz.*, two in the North and one in the East of Al-Hassa were added to the MTP during 1995. Thus, by the end of 1995 there were 20 operational areas under the MTP, with an approximate palm population of 0.7 million, spread over cultivated area of about 40 sq. kms. Besides this, five operational areas continued to be under monitor traps. Although under MTP there were 902 traps in the field at the end of 1994, the trap number was gradually increased to 2613 by December 1997. Most traps were set in the field by the end of 1995.

3. Examining palms to locate infestations:

Examining palms to locate infestations formed an important component of the IPM strategy. Early detection of infested palms ensured quick curative treatment and also arrested the spread of the pest. Special teams (checking teams) were deployed for examining date gardens to locate red weevil infestation. The efficiency of these teams was enhanced by utilizing the pheromone trap reports, i.e., if a particular trap caught weevils during the current week, then the gardens surrounding this trap were examined during the following week. The symptoms of palm weevil infestation in date palm, categorised by Abraham *et al.* (1998) assisted the checking teams to detect infestations. Most of the symptoms were noticed through visual observations. However, the typical fermented odour associated with the ooze/fresh frass of the infested palm and the sound produced by feeding larvae, also enabled the checking teams to detect infestations.

It was seen by the middle of 1995, that in heavily infested gardens, the pest reoccurred after some time. In order to break the cycle of the pest in such gardens and those lying in their surroundings, the concept of follow-up examination of palms was introduced, wherein such hot spots were re-examined three to four times, at an interval of two to three months. Each follow-up checking was followed by a round of prophylactic insecticidal spray.

The impact on the IPM strategy adopted on the management of weevil populations in date plantations of Al-Hassa is assessed on the basis of (i) the number of weevil trapped and (ii) infestations located between 1994 to 1997. Results pertaining to these aspects of the strategy are presented below.

RESULTS AND DISCUSSION

In a pest management programme, it is essential to assess the effect of the strategy adopted to suppress the pest. Results pertaining to the work done on trapping the weevil and locating infestations in Al-Hassa, from 1994 to 1997 are discussed below.

A. The pheromone trapping programme

1. First phase (surveillance)

During this phase of the pheromone trapping programme, between January to mid-June 1994, a total of 69 monitors were set up in different areas of Al-Hassa. A total of 328 weevils were captured during this period with an average catch per trap of 4.75 weevils (Table 1). Also, the highest weevil catch per trap was from Al Oaba-I and II, followed by Ashura and Suhemia. There were no weevil captures from Majas and Guaibah. Based on these initial weevil captures, the second phase of the trapping programme was initiated wherein 17 operational areas were identified as pest infested and put under the MTP.

2. Second phase (Mass trapping the weevil)

2.1 Areas wise weevil captures

Table 2 shows that between mid-1994 to December, 1997 a total of 16,904 weevils were

captured in Al-Hassa using pheromone traps of which 16,373 were captured under MTP, while 531 were trapped in the monitor areas. Table 2 also reveals that in the mass trapped areas, the highest number of weevils were captured from Ashura (2411), followed by Batalyah-III (1761) and Baniman (1263). Similarly, from Table 2 it is seen that during the same period a total of 531 weevils were captured from the monitor areas, with the highest number of weevils captured from the Northern villages.

A year-wise analysis of the situation shows that weevil captures were almost the same during 1995 and 1996, while during 1997 there was an appreciable decrease in the number of weevils trapped (Table 2). This shows that it took two years for the IPM strategy to stabilize the situation, which resulted in the decline in the number of weevils trapped during the third year.

It is relevant to point out that it took two years of trapping *R. palmarum*, with pheromone traps, to obtain more than 90 per cent reduction in weevil captures in oil palm plantations of Costa Rica (Oehlschlager, 1995).

The total weevil catch in different operational areas, does not clearly depict the severity of the problem, as the size of different areas was not uniform. Consequently, the number of traps in different operational areas varied. A more accurate assessment of the situation was, therefore, made by studying the weevil catch per trap (Table 3).

It can be seen from Table 3, that the overall weevil catch per trap reduced from 1.99 weevils during 1994 to 1.31 in 1997. Similarly, the catch per trap in the mass trapped areas was reduced from 2.55 in 1994 to 1.41 in 1997.

In the monitor areas, the weevil catch per trap significantly increased from 0.19 during 1994 to 0.81 in 1995. However, when three areas as mentioned before were brought under MTP during 1995, there was a fall in catch per trap in the monitor areas, which decreased from 0.81 in 1995 to 0.40 in 1997.

The above presentation, thus, indicates that the weevil had been successfully suppressed in the mass trapped areas and its spread curtailed in the monitor areas.

2.2 Trap wise weevil captures

Another factor that was considered to study the suppression of weevil population was to analyse the total number of traps that recorded weevil captures between 1994 and 1997. It is seen from Table 4 that in the mass trapped areas on an average 64.81 per cent of the traps captured weevils at least once from 1994 to 1997. Further, a look at the per cent traps recording weevil captures every year, showed that for 1994, 1995 and 1996, 65 to 70 per cent of the traps recorded weevil captures at least once, suggesting that the weevil population was suppressed between this period. During 1997 however, only 58.48 per cent of the trap recorded weevil captures, indicating an overall reduction in population level. Thus, once again it can be seen that it took just over two years of trapping the weevil with pheromone traps, together with the other components of the IPM programme to obtain an appreciable decline in the population levels of the pest.

Treatment of infested palms and removal of palms beyond recovery also played an important role in the suppressing/checking the spread of the pest.

B. Examination of gardens and infestation reports

As mentioned earlier, examination of gardens to locate infested palms formed the basic component of the IPM strategy adopted to combat the pest. Initially gardens were examined irrespective of the presence of the pest. However, from the middle of 1995 when over two-thirds of the pheromone traps were set in the field, examination of gardens to locate infestations was done on the basis of the weekly pheromone report. It was seen that the best possibility of recording infested palms was by examining gardens lying within 50 metres radius of a trap that registered weevil captures during the previous week. A study conducted on this aspect showed that nearly 80

per cent of the infestations were reported from within 50 m radius of an allotted trap.

The ultimate success or failure of any IPM programme can be assessed by damage caused by the pest and the ability to minimise crop losses.

From Table 5 it is evident that between late 1992 when the weevil was first detected in Al-Hassa to the end on 1997 only 6942 infestations were reported. It is relevant to point out that this is a significant achievement, considering that in a much smaller operational area with a lesser palm population of Al-Qateef another oasis township in the Eastern Province of Saudi Arabia, at the end of five years during 1992, the annual infestation shot up to 6 per cent with nearly 20,000 infestations per annum (Anonymous, 1998). On the contrary, at Al-Hassa infestation levels were maintained well below the per cent level. This suggests the success of the IPM strategy adopted in controlling the pest at Al-Hassa.

From Table 5 it is also seen that 352 infestations were detected between late 1992 and December, 1993. Given the high breeding potential of the pest (Nirula, 1956), it was logical to conclude that there lay hidden many infestations in the field. Later, as a result of an intensive examination campaign a total of 1037 infestations were detected during 1994. Further, upto 1996 there was a marginal annual increase in the number of infestations reported. However, during 1997 infestation levels dropped as compared to the previous year of 1996, thus proving the success of the IPM strategy adopted to combat the pest.

It is also seen from Table 5 that the per cent eradicated palms steadily decreased from 37.5 per cent during 1992 to 19.33 per cent in 1997. This is a significant achievement as the checking teams were able to detect infestations in the early stage of attack, thereby reducing the spread of the weevil and ensuring early treatment and recovery of infested palms.

By the middle of 1995 it was observed that infestations reoccurred in and around heavily infested gardens. This was probably due to the aggregated spatial distribution of the pest. The population of *R. palmarum* has also been reported to be highly aggregated (Oehlschlager *et al.*, 1995). Due to this tendency, the pest reoccurs in certain pockets (Hot spots), specially where heavily infested gardens harbour adult weevils. Repeated examination of palms lying in heavily infested gardens and its surrounding, ensured the 'Hot spots' becoming free of the pest. During 1996 and 1997, a total of 511 gardens were examined under the follow-up examination programme. Of the gardens examined, 16.24 per cent were infested. It is therefore recommended to make the 'Hot spots' free of the pest by conducting repeated examination of the palms in such hot spots, which can be followed by preventive insecticidal sprays.

Besides the above components of the IPM programme adopted in Al-Hassa to combat the pest, elimination of alternate breeding sites was carried out throughout the period of this study. It was seen that 34.05 per cent of beheaded/cut palms were infested and formed a major alternate breeding site of the pest in date plantations.

Similarly, to eliminate the possibility of the pest developing in abandoned gardens the Ministry of Agriculture and Water, Kingdom of Saudi Arabia arranged to remove 90,517 palms from neglected gardens in Al-Hassa between 1995 to 1997, thereby eliminating the possibility of the pest breeding in the neglected gardens.

Preventive chemical sprays were carried out by soaking palms with insecticides using the special spray lance as recommended by Abraham and Vidyasagar, 1992. In all, just over a million palms were soaked with insecticide (chlorpyriphos, endosulfan, methidathion 0.1%) between 1994 to 1997.

Further, restrictions imposed on the movement of planting material in Al-Hassa, ensuring the transport of only pest free (certified) off shoots and the frequent training of farmers through regular farmers meets on palm weevil and its management played an important role in combating the pest.

Thus from the results presented above it is clear that the IPM strategy adopted to combat the pest

successfully suppressed the weevil population on date palm in Al-Hassa, the addition of a good biocontrol agent in this strategy will go a long way in further strengthening the programme.

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