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Integrated pest management for the Control of Red Palm Weevil

(*Rhynchophorus ferrugineus oliv*) in
the eastern region, Al Ain, UAE.

Abstract

Biological and ecological studies showed that Red Palm Weevil (*Rhynchophorus ferruginous* Oliver), has three and a half generations per year, with an average of 111.1 days/generation, while the average age of male and female was 82.4 and 92.6 days, respectively. Female lays an average of 155.8 eggs/generation. Three larval stages developed within an average of 73 days to the pupal stage, which emerged as adults after 24.2 days.

Database studies showed no significant difference in susceptibility of different date palm Cultivars to Red Palm Weevil infestation, while Cultivars at the age of 6-10 years were infested up to 64.78% level, which was significantly more as

compared to any other age. Moreover, infestation in the first meter up the stem was 98.01% which was significantly more than infestation at any other height. One insecticide spraying at the peak population (March-April) resulted in good weevil control, while insecticide injection significantly reduced infestation in the farms by 98.25%. Similarly, use of aggregation pheromone traps during the season gave high weevil catch resulting in significant infestation reduction by up to 63.5%.

So Integrated Pest Management Program (IPM) for the control of Red Palm Weevil using insecticide spraying and injection, plus aggregation pheromones, was

adopted in the Agriculture Department resulting in infestation reduction to 0.4% in all the farms.

Introduction

Red Palm Weevil (*Rhynchophorus ferrugineus* Oliv. Fam: Curculionidae, Sup. Fam. Curculioiwidea, Order: Coleoptera) is a serious pest attacking different species of palm trees e.g. date palm, coconut palm and royal palm. Lever (1969) advocated that the origin of the Weevil is Tropical Africa, although Abraham (1975) claimed its origin is India. The pest was reported in Asia, Australia, Philippines and Thailand in 1962 (Mathen, 1962 & Wygner, 1962), and in 1963 Iraq (Abdo Rubo, 1963). Later the weevil was recorded in India, Sri Lanka, Indonesia, Burma, Punjab and Pakistan (Lakshmanan, 1972 & Muthuraman, 1984). In the United Arab Emirates, the pest was first reported in the Northern Emirates in 1985, and later it spreaded in all the Emirates. (Fig. No. 1).

Symptoms:

The first symptoms appear as yellowing and drying of the leaves, which in some cases spread up to the growing tip. In cases of sever infestation white-yellowish secretion with nasty smell oozes from the area of infestation on the stem. Later the secretion becomes red in colour. In rare cases, especially in young seedlings, infestation is reported below soil level penetrating up the stem. In very sever cases the palm tree collapses and dies.

Most of the palm trees at the age-group of 6-10 years are most susceptible as compared to any other ages. In spite of this, infestation has been reported in old trees. Infestation reported in the first meter of the stem was higher than in any height. (Fig. No. 1).

Symptoms of infestation are put on different Categories according to the external and internal symptoms on the leaves. Severity of infestation is evaluated on a scale with 0 indicating

no infestation; with increase of severity up to scale 5 where the palm tree collapses and dies due to very sever infestation. (Table No. 2).

Life cycle of the weevil:

The Life Cycle of the Weevil was studied in our laboratory in

sugar cane and date palm tissue. Three and a half generations of the weevil developed during on year. The life span of the first generation was 76-125 days, with an average of 100.5 days, while the second generation range was 66-144 days with average of 105 days, and the third generation span was 89.5-166 days, with an average of 127.8 days. Our studies showed that the life span of the male and female varied from one generation

to another. The life span for the male and female in the first generation was 90.7 and 111.7 days, respectively, while in the third generation the life span was 66.6 and 67.6 days for male and female, respectively.

The female is attracted by the smell after Taktteeb to the palm tree. It laid its eggs in the soft tissues to which they are attached by sticky gummy secretion.



Fig. No.1: World-wide distribution of Red Palm Weevil.

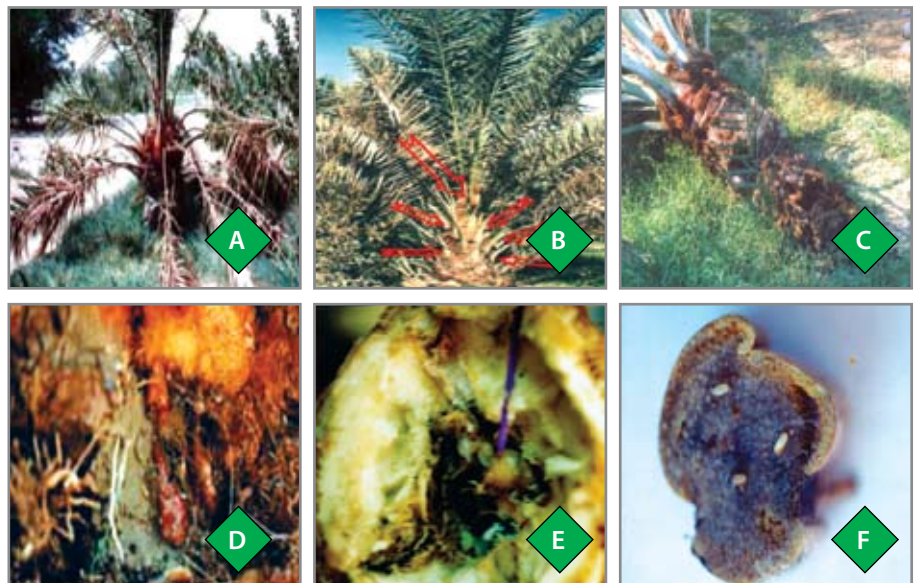


Fig. No. 2: Infestation Symptoms.

- (A): Drying of the Leaves.
- (B): Symptoms on young Date Palm Tree.
- (C): Dead Date Palm Tree due to Severe Infestation.
- (D): Secretion Oozing from Infested Stem.
- (E): Larvae in the stem.
- (F): Eggs in sugar cane.

Severity Scale	Description of Symptoms	Category
0	No external symptoms after Takreeb.	One.
1	Dryness of leaves from 3 rd row, some stages of Weevil may be observed.	Two.
2	After Takreeb different stages of the Larvae are observed, with 1-5 pupae, with damage internal tissues of the stem. Yellowish secretion is observed from the infested stem.	Three.
3	Sever internal damage of the stem with many and larvae pupae are observed. Leaves up to the 3 rd . row turn yellowish, which may extend to the upper leaves and the heart of the stem.	Four.
4	Dryness of the heart with sever internal damage of the stem, with all stages of the Weevil present. Yellowish secretion with nasty smell is observed from the infested stem.	Five.
5	Collapse and death of the date palm tree	Six.

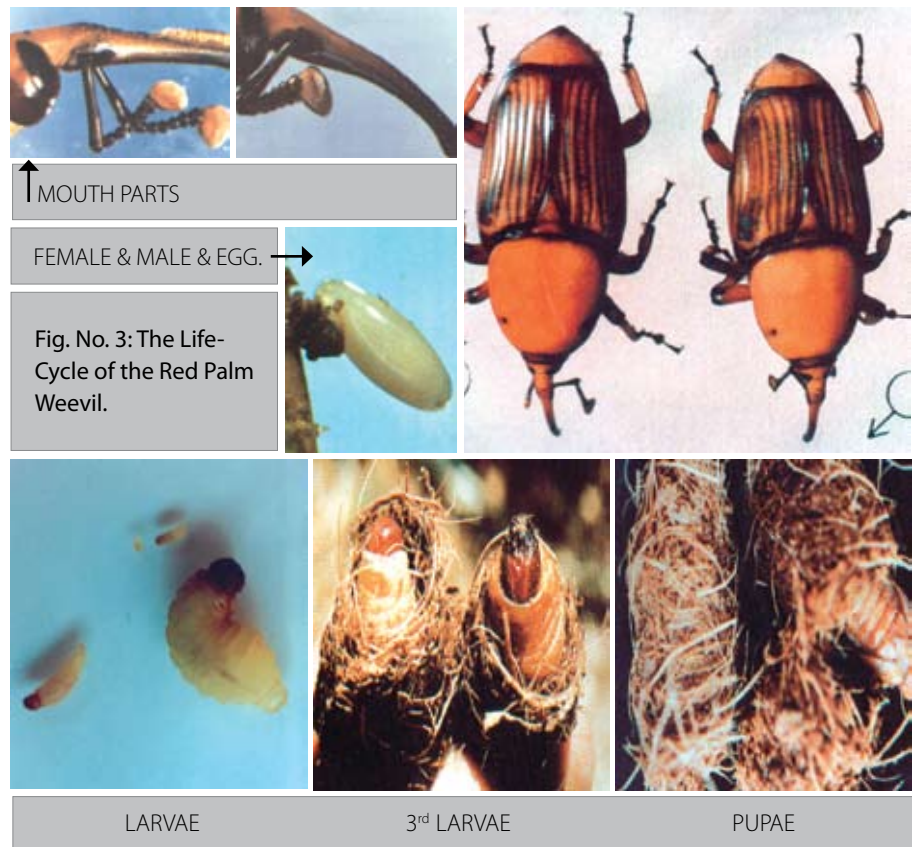


Table No. 1: Description of Infestation according to the Category and Severity of Infestation.

In the laboratory the number of eggs laid varied from one generation to another. The average eggs laid were 288.3, 107 and 77.2 eggs/female in the first, second and third generation, respectively. The size of the egg was 2.2 mm long and 1 mm wide. It was found that the temperature of 40% was fatal for the eggs.

After 3-4 days the eggs hatched to the first larva which was 4.5-5 cm long. It was fat, with round ends, strong mouth parts and with no legs. Its color was white after hatching and after each moulting, then changing to brownish-red after the second and third larval stage. The larvae are the most destructive stage of the weevil as they penetrate deep in the stem causing a lot of internal damage. When the infestation is severe the whole palm collapses and dies. So means of control were directed towards the larvae.

After 4-5 months the larvae came outside the stem changing to the pupae, and 20-25 days later pupae changed to the adults. After mating the females lay the eggs which hatch to complete the life cycle. (Fig. No. 3).



(a):- Database survey.

Introduction:

The Department of Agriculture & Livestock, Al Ain, with the Faculty of Agricultural Sciences, United Arab Emirates University, UAE, drew a Joint Project with Sultan Qabous University and Ministry of Agriculture, Sultanate of Oman, for the control of Red Palm Weevil (*Rhynchophorus ferrugineus* Oliver) in both Countries in 1996.

Database Survey was set up to provide information about the susceptibility of different date palm Cultivars to infestation, place of infestation on the stem, most susceptible age-group of the date palm, and finally the effect of insecticide injection on the control of the infestation.

Evaluation of the Database information collected will enable us to formulate an Integrated Pest Management Program (IPM) for the control of Red Palm Weevil infestation.

The Team of the Department of Agriculture & Livestock, Al Ain, UAE surveyed 7707 and 9476 farms during seasons 1997/98 and 1998/99, respectively. The Farms are distributed in 34 Extension Centers located in Al Ain, Northern, Southern & Western Regions. In each Center, there are 100-1100 farms, each with 200-1500 date palm trees. The Survey covered about 1,325,574 trees with over 60 different known Cultivars.

Materials & methods:

(1):- Susceptibility of Date Palm Cultivars to Infestation:

From the survey of about 1,325,574 date palms trees, 71975 Cultivars were identified from which 1670 were found infested. Infested date palms were grouped according to their known Cultivars.

(2):- Effect of Age-Group on Infestation:

From 9476 farms surveyed, 629 Cultivars were found infested. Infested date palms were grouped according to the age-group

of 1-5, 6-10, 11-15, 16-20 and over 20 years of age.

(3):- Place of Infestation on Date Palm Stem:

From a total of 1,325,574 date palms in the farms, 2092 were reported infested. Infested date palm trees were grouped according to the place of infestation on the stem at the height of 0-25, 26-50, 51-100, 101-200, and 201-300, and over 300 cm.

(4):- Effect of Insecticide Injection on the Infestation:

During the Survey of 1,325,574 date palms, 2054 were found infested which were injected with concentrated insecticides to control infestation. Insecticides used were Carbosulfan 25% EC (Marshal), Phenthoate 11% +Dimethoate 41% EC (Rogodial), Dimethoate 18%+Endosulfan 40% EC (Rolfan) and Aluminum phosphide 56-57% Tablets (Phostoxin tablets).

VAAdults, pupae and larvae in the infested stem tissues were removed. Holes were made by chisel 10 cm. above and around the infested area. The number of holes made depended on the size of the stem and the severity of infestation. The angle and depth of the holes were decided according to the size of the stem and the location of infestation. Concentrated insecticide was injected by syringes in the holes at the dose of 5, 10, 15 or 20 ml per date palm tree depending on the number of holes made.

(Table No. 2). The holes were closed by mud and covered by plastic sheets to prevent evaporation of the insecticide injected and to trap any emerging adults or larvae from the treated stem. Soil was heaped around the stem up to the height of 10 cm or more to induce new roots development to make the tree stronger against falling.

Crop Protection Extension Officers did all the insecticide injection operations in the farms, and also demonstrated to the farmers how to do injection without damaging the palm trees.

No insecticide injection was carried out when date fruits were approaching maturity, otherwise all the date fruits were removed before injection. It is worth mentioning that laboratory analysis of fruits collected at different intervals after insecticide injection, showed no insecticide residues.

After 3-4 weeks the plastic sheets were removed and the numbers of reinvested date palms trees were calculated.

Results:

(1):- Response of Date Palm Cultivars to Infestation:

Cultivar Khasab, Khineze, Lolo, Gabri and Helali were more susceptible to infestation as compared to Fard, Khalas, Rezez, Buman, Negal, Bagl and Barhi, although differences were not significant. It is worth mentioning that Fuhoul were also infested. So farmers are advised to grow Cultivars with good quality and high yields. (Table No. 3, & Fig. No. 4).

(2):- Effect of Age-Group on Infestation:

Percentage infestation was 12.78% at the age of 1-5 years, increasing to a maximum of 64.78% at the age of 6-10 years, which was significantly more as compared to any other age-group. Then the infestation decreased gradually to 17.12, 3.28, and 1.28% at the age of 11-15, 16-20 and over 20 years, respectively.

(Table No. 4, & Fig. 5).

So farmers are advised to pay more attention to young palms up to the age of 10 years by removing old dry branches of and look carefully for early infestation for immediate control.

(3):- Place of Infestation on the Stem of Date Palm Tree:

Infestation at the height of 0-25, 26-50 and 51-100 cm. were 40.9, 36.8 and 20.4%, respectively. Total percentage of infestation at the height of 0-100 cm was 98.1%, which was significantly more as compared to infestation at any other height.

Infestation recorded at the heights of 1-2, 2-3 meters, or more, were 1.7, 0.2, and 0.0%, respectively. (Table No. 5, & Fig. No. 6.).

Maximum infestation at the height of up to one meter may be due to the fact that the Weevils are known to fly very low, mostly not more than one meter high. At this height, low temperatures and high humidities are most indecisive for insect mating, eggs lying and hatching. Larvae are known to be the most destructive stage in the life cycle of the Weevil as they are mainly responsible for infestation. Hard and sharp mouthparts of the larvae make it easy for them to penetrate deep into the heart of the stem through any holes causing a lot of internal damage to the stem.

(4):- Effect of Insecticide Injection on Infestation:

The numbers of reinvested palm trees after insecticide injection were 36, with the percentage of reinfestation of 1.75%. So results showed that insecticide infection successfully controlled infestation up to 98.25% level. (Table No. 6, & Fig. 7).

Conclusion:

Different Cultivars grown showed varying degrees of susceptibility to infestation, though not significant. So farmers may grow good quality and high yielding Cultivars.

Significantly severe infestation (98.1%) was recorded at the height of 0-100 cm. up the stem. So farmers are advised to clear all dead branches at this height and look carefully for the infestation for early treatment.

Date palms at the age of 6-10 years were severely infested at 64.78% infestation level, which was significantly more than infestation occurring at any other age. It is recommended that farmers should pay more attention to palm trees at this age, especially removal of old dry branches, and to look carefully for any infestation for early treatment.

Insecticide injection significantly controlled infestation by up to 98.25% level. So it is adopted in the Agriculture Department & Livestock as a major part in the Integrated Pest Management Program (IPM).



Group	Date Palm Diameter (cm.)	Insecticide Dose Per Date Palm (ml.). (MI).	No. of Holes/ Palm	Hole Angle(Degree).	Chiesl Depth (cm.).
1	Less than 1	5	1	30	3 - 5
2	1.5	10	2	45	5 -10
3	1.5 - 2	15	2 - 3	60	10 -15
4	More than 2	20	3 - 4	60	20



Table No. 2: Angle, Depth of Number of Hole per Palm Tree, and Dose of Insecticide Injected. Efficiency of the insecticide on controlling infestation was evaluated after 30 days.

Cultivars		Regions				Total	% Infestation
		West	Al Ain	North	South		
Fard	INF*	45	24	42	35	146	1.6
Khalas	INF.	149	49	49	67	332	1.8
Khesab	INF.	29	23	30	8	90	3.0
khenaze	INF.	100	24	64	41	229	3.0
Buman	INF.	48	22	28	26	124	2.7
Negal	INF.	97	13	52	17	179	2.3
Lolo	INF.	59	2	39	7	107	3.2
Gesh	INF.	21	16	11	22	70	2.0
Gabre	INF.	27	12	30	1	70	3.3
Helale	INF.	20	8	24	4	56	3.4
Mesle	INF.	5	4	7	0	16	2.8
Rezez	INF.	21	1	3	0	25	1.6
Barhe	INF.	7	3	6	2	18	1.4
Bagl	INF.	64	13	56	0	133	2.2
Fuhoul	INF.	47	4	17	7	75	2.7
LSD							NS

Table No. 3: Susceptibility of Date Palm Cultivars to Red Palm Weevil Infestation. Department of Agriculture & Livestock, Al Ain.

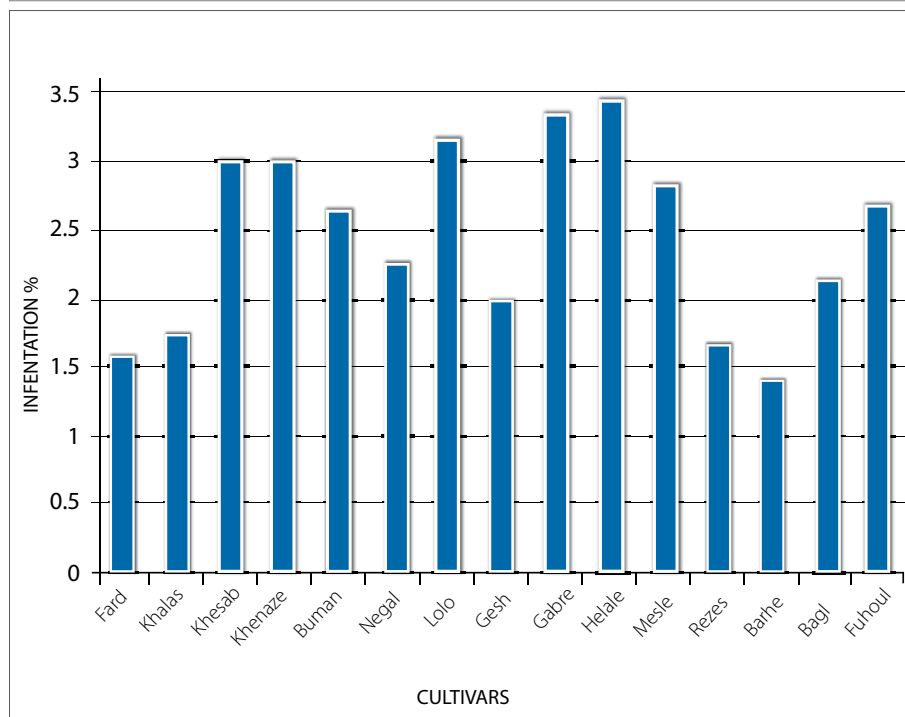


Fig. No. 4: Susceptibility of Different Date Palm Cultivars to Red Palm Weevil Infestation.



Region	Center	Total No. of Date Palms	INF*	No. of Infested Date Palms					Total Infest. Dtae Palms
				Age (Years)					
				0-5	6-10	11-15	16-20	>20	
Western	Saad South	14881	INF.	48	244	37	1	0	330
			%INF	14.55	73.94	11.21	0.30	0.00	
Al Ain	Qattara	4175	INF.	6	38	15	0	0	59
			%INF	10.17	64.40	25.42	0.00	0.00	
Northern	Hayer	5968	INF.	31	123	8	0	0	162
			%INF	16.14	75.92	4.94	0	0	
Southern	Wagon	4200	INF.	8	35	21	10	4	78
			%INF	10.26	44.48	26.92	12.82	5.13	
% Infestation (Average Mean)				12.78	64.78	17.12	3.28	1.28	
LSD At 5% Level								14.88	

Table No. 4: Evaluation of Red Palm Weevil Infestation according to Date Palm Age-Groups. Department of Agriculture & Livestock, Al Ain. INF*=No. of infested Date Palms. % INF*=Percent infested Date Palms.

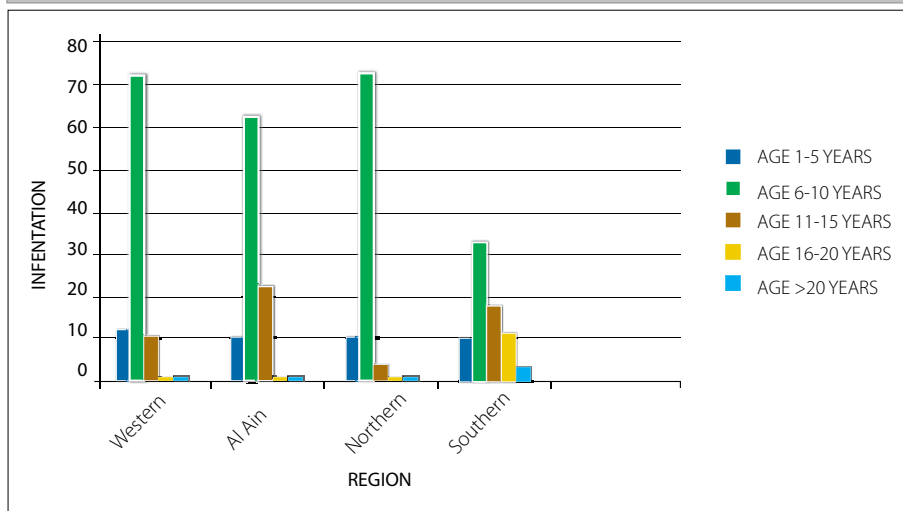


Fig. No. 5: Evaluation of Red Palm Weevil Infestation According to Date Palm Age-groups.

Stem Height (cm.).	Number of Infested Date Palms In The Regions.				Total Number Of Infested Date Palms	% Infestation
	West	Al Ain	North	South		
0-25	589	80	78	109	856	40.9%
26-50	302	125	172	171	770	36.8%
51-100	127	28	233	38	426	20.4%
(0-100)						(98.1%)
101-200	12	2	21	1	36	1.7%
201-300	4	0	0	0	4	0.2%
Over 300	0	0	0	0	0	0.0%
Number of Infested Date Palms	1034	235	504	319	2092	
Total No. of Date Palms	355861	330948	330989	307776	1325574	

Table No. 5: Place of Red Palm Weevil Infestation on the Stem of the Date Palm Tree. Department of Agriculture & Livestock, Al Ain.

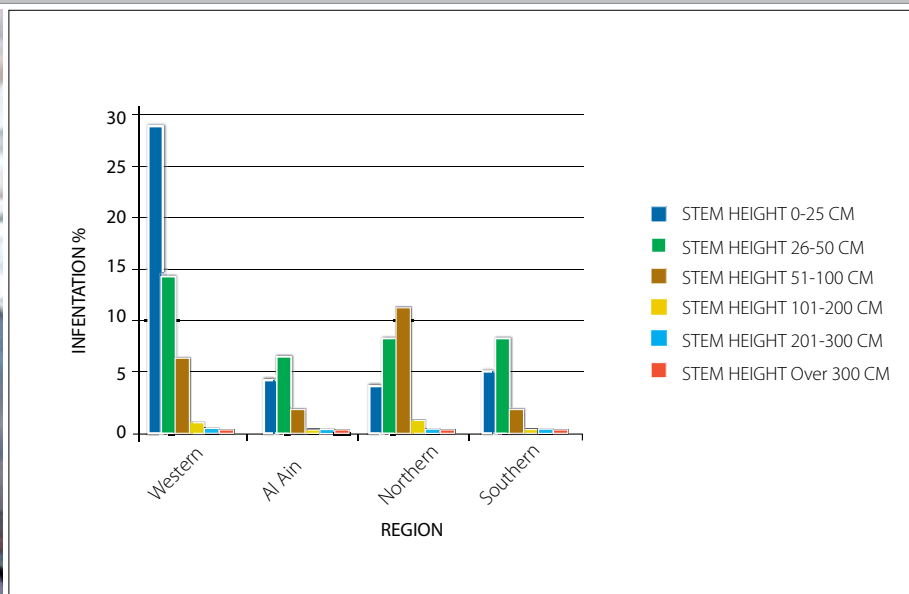


Fig. No. 5: Evaluation of Red Palm Weevil Infestation According to Date Palm Age-groups.

Treatments	Regions				Total
	West	Al Ain	North	South	
Total Number of Date Palm Trees	355,861	330,948	330,989	307,776	1,325,574
Total Number of Injected Palm Trees	1020	231	481	322	2054
Number of Reinvested Palm Trees.	12	8	12	4	36
Percentage Reinfestation.	1.18	3.46	2.49	1.24	1.75%
Percentage Infestation Control.					98.25%

Table No. 6: Effect of Insecticide Injection on Infestation. Department of Agriculture, & Livestock, Al Ain.

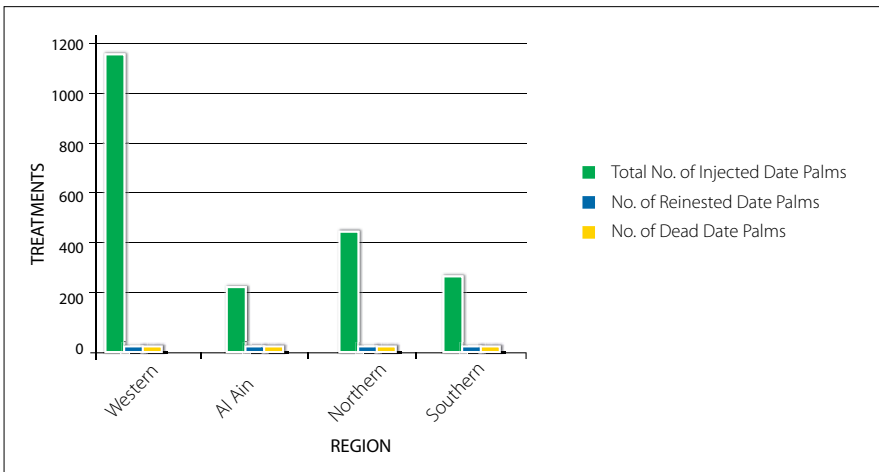
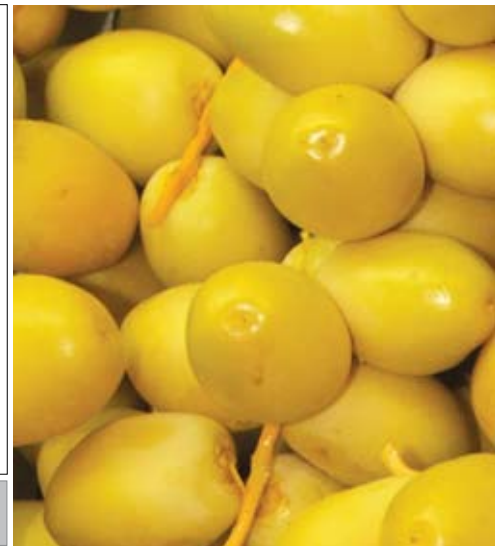


Fig. No. 7: Effect of Insecticide Injection on Red Palm Weevil Infestation.



(b):- Insecticide Injection.

(1):- Laboratory experiments:

Materials & Methods:

The mortality of the new hatching and one-month old larvae, pupae and adults was evaluated in the laboratory using Rolfan (Dimethoate 40% + Endosulfan 18% EC.) and Marshal (Carbosulfan 25%EC.), Primicid (Pirimphos ethyle 50% EC.), and Super Acid (METHIDATHION 40% EC.) insecticides.

1:- *Young larvae*: Larvae were fed in sugar cane tissues dipped for 30 seconds in diluted insecticides. For the control, larvae were fed on sugar cane tissues soaked in water only. Four replicates of

each treatment were made. Mortality was evaluated after 24 hours.

2:- *One-month old larvae*: One-month old larvae were embedded inside the tissue of young date palm free of infestation. The tissue was then treated with diluted insecticide, while the control was soaked in water only. Dead larvae were counted 7 days later.

3:- *Pupae*: Pupae of the same age-group were dipped for 30 seconds in the diluted insecticide, while in the control pupae were dipped in pure water only. After all pupae in the control emerged, the dead pupae dipped in the insecticides were counted.

4:- *Adults*: Males and females adults of the same age-group were embedded in date palm tissue treated with diluted insecticides. Cotton soaked with nutrients for adults' feeding was added. In the control, palm tissue was soaked with water only. Dead adults were counted within a period of 1-12 days.

Results:

The Insecticides tested gave 99, 97, 80 and 84% kill of young larvae, one-month old larvae, pupae and adults, respectively. Insecticides varied on their effect on the different stages of the weevil as they gave average percent kill of 99, 98, 93, 87 and

83% by Rolfan, Primicid, Rogadial, Marshal and Super Acid, respectively.(Table No. 7).

(2):- Field experiments:

1:- Small Scale Survey:-

Injection of the same Insecticides were evaluated for the control Red Palm Weevil infestation in the field, in season 1994/95, 1995/96 and 1996/97.

The Survey was carried in the four Regions (Al Ain, Northern, Southern and Western) covering 24 Extension Centers with 6177 Farms with a total of 1,108,723 date palm trees. The numbers of infested farms, as well as the number of infested and injected date palm trees were recorded during the three seasons.

Adults, pupae and larvae in the infested stem tissues were removed. Holes were made by chisel 10 cm. above and around the infested area. The number of holes made depended on the size of the stem and the severity of infestation. The angle and depth of the holes were decided according to the size of the stem and the location of infestation. Concentrated insecticide was injected by syringes in

the holes at the dose of 5, 10, 15 or 20 ml per date palm tree depending on the holes made. The holes were closed by mud and covered by plastic sheets to prevent evaporation of the insecticide injected and to trap any emerging adults or larvae from the treated stem. Soil was heaped around the stem up to the height of 10 cm or more to induce new roots development to make the tree stronger against falling (Table No.2, Fig No. 8).

Crop Protection Extension Officers did all the insecticide injection operation in the farms and also demonstrated to the farmers how to do it without damaging the palm trees.

No insecticide injection was carried out when date fruits were approaching maturity, otherwise all the date fruits were removed before injection. It is worth mentioning that laboratory analysis of fruits collected at different intervals after insecticide injection, showed no insecticide residues.

After 3-4 weeks the plastic sheets were removed and the numbers of reinvested

date palms trees were calculated.

Results:

The averages percentages of infested farms were 24.7, 28.2 and 21.9% in season 94/95, 95/96 and 96/97, respectively. On the other hand, the averages percentages of infested and injected palm trees decreased from 1.3% to 0.9% and to 0.7% in season 94/95, 95/96 and 1996/97, respectively.

So it is clear that insecticide injection resulted in continuous reduction of the number of infested farms, as well as the number of infested date palm trees during the three seasons. (Table No. 8).

2):- Large Scale Field Survey:

The large scale survey started in season 1991/92 up to season 1998/99. All the farms in the 34 Extension Centers, with a total of 1,632,659 date palm trees (season 1998/99) were surveyed whereby all infested trees were injected by insecticide.

Results:

Maximum numbers of infested and injected palm trees were (39865) in the Western Region, while the least (4497) in the Southern Region.

The maximum numbers of infested and injected palm trees were 14,723 and 11,944 in Seasons 1994/95 and 1995/96, with percent infestation 1.33% and 1.08%, respectively. This high infestation was recorded before using segregation pheromone traps in the farms as part of the Integrated Pest Management.

Due to the adoption of insecticide injection as part of the Integrated Pest Management Program, infestation in the farms was reduced to 0.69, 0.50 and 0.38%, in season 1996/97, 97/98 and 1998/99, respectively. (Table No. 9).

Our research program for the control of Red Palm Weevil is continuous. The number of safe insecticides used now for the control of the infestation reached nine insecticides. (Table No. 10).

Insecticides	Dose m/l	% Kill				% Average
		Young Larvae	1-Month-Old Larvae	Pupae	Adults	
Rolfan	2	100	97	100	100	99
Primicid	2.5	100	100	90	100	98
Rogadial	2	100	100	70	100	93
Marshal	3	100	87	80	80	87
Super Acid	2	95	100	60	40	84
AVERAGE		99	97	80	84	
Control	Water	00	00	00		

Table No. 7: Evaluation of Insecticides on Different Stages of Red Palm Weevil. (Laboratory Expt. 1993/94)

Table No. 8: Percent Infestation of Red Palm Weevil in the Field. (Small Scale Field Expt. 1994/95-96/97) (*) = Extension Centers.

Regions	No. of Farms	Percentage Infestation			No. of Palm Trees	% Infested Palm Trees		
		94/95	95/96	96/97		94/95	95/96	96/97
Al Ain (4)*	517	18.8	19.1	19.7	246032	2.6	0.8	0.3
Western (11)*	2327	36.6	44.3	31.1	538618	1.2	1.4	1.1
Northern (5)*	938	18.7	17.2	15.9	166640	0.5	0.5	0.5
Southern (4)*	848	24.5	32.1	20.7	128868	0.7	0.8	1.1
Total (24)*	-	98.6	112.7	87.4	1080158	5.0	3.5	4.0
Average %	-	24.7	28.2	21.9	-	1.3	0.9	0.7

Table No. 9: Number of Injected Palm Trees and Percentage of Infestation in different Seasons. (Field Survey: 9991/92 up to 1998/99).

Region	Total Number of Injected Palm Trees									
	SEASON									
	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	Total	Ave
Al Ain	1	45	559	6471	1992	856	686	466	11076	1.04
West	4069	4858	3570	6108	8115	4995	4861	3289	39865	3.75
North	1	1077	337	1156	906	910	793	1372	6552	0.62
South	0	2	133	988	931	892	546	1995	4497	0.42
Total	4071	5982	4599	14723	11944	7653	6886	6132	61990	
Total No Palm Trees	601950	742481	815565	1108732	1108723	1108723	1379503	1632659		
% Infestation	0.68	0.81	0.56	1.33	1.08	0.69	0.50	0.38		

Table No. 10: Insecticides Used For Injection & Spraying For The Control of Red Palm Weevils

Common Name	Trade Name	Concen. %	Form	Manufacture Company
DIMETHOATE 11% + PHENTHOATE 41%	Rogodial.	52%	EC.	Isagro, Italy.
CARBOSULFAN	Marshal.	25%	EC.	F.M.C., USA.
BENFURACARB	Oncol.	20%	EC.	Otuska, Japan.
FIPRONIL	Regent.	5% & 20%	SC.	Rhone Poulenc, France.
TRIAZOPHOS	Hostathion	40%	EC.	AgrEvo., Germany.
PIRIMIPHOS-METHYL	Actillic.	50%	EC.	Zenica Agrochimic, England.
CHLORPYRIPHOS 27.8 % + DIMETHOATE 22.2 %	Salut.	50%	EC.	Basef., Germany.
PHENTHOATE 42 g/l + MINERAL OIL 710 g/l	Cidial Oil.	5%	EC.	Isagro, Italy.
ALUMINUM PHOSPHIDE	Phostoxin.	56%	FUMIGA TABLET	Detia Degesch, Germany.

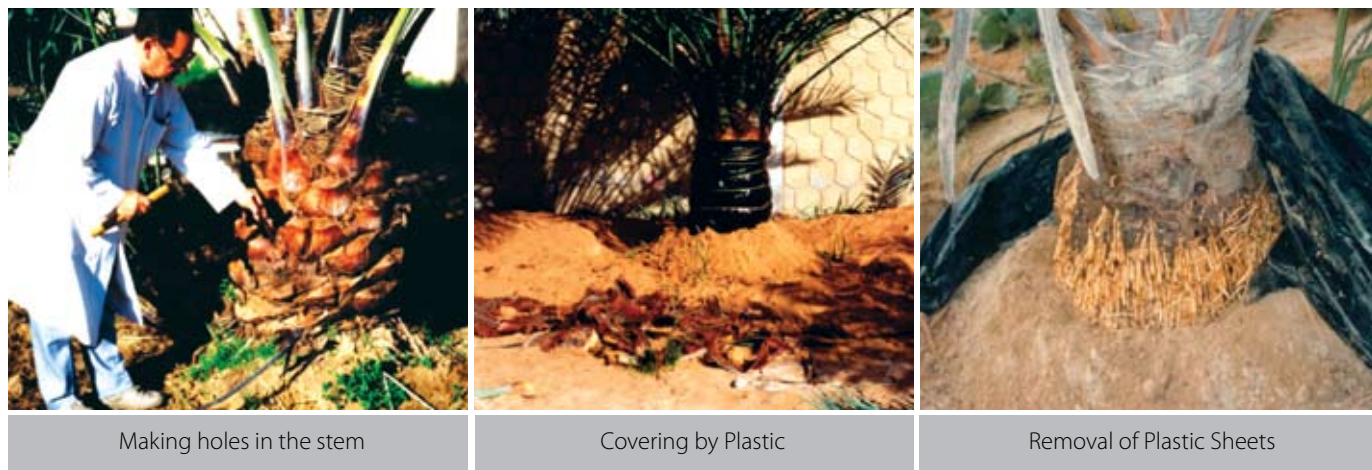


Fig. No. 8: Insecticide Injection Operation.

(C):AGGREGATION PHEROMONES.

Aggregation Pheromones have been reported as effective tools for monitoring and trapping Red Palm Weevil in the field (Lepasme, 1974; Nirula, 1956; Wygner, 1962; Mathen, 1967; Frohich 1970; Lakshmanan, 1972; Roa, 1973; Dean, 1976; ElHideri, 1980; Sharif, 1982; Gunnawardena & Bandarge, 1995a; 1995b; Elgarhy, 1996 and El Ezaby, 1997).

Aggregation Pheromones Traps were used for the catch of adult weevils before they mate and lay eggs.

(1):- *Small Scale Survey*: An Aggregation Pheromone from Costa Rica under trade name; Ferrolure + , with chemical name: 4-methyl-5- nonanol (9 parts)+ 4-methyl-5 - nonanone (1 part) + Synergist , 95% purity, weight 700 mg., was evaluated for Red Palm Weevil catch in the field.

Trap consists of 10 liter-size plastic bucket with a cover, with four 2.5x6 cm openings for the entrance of the attracted adults. The bucket was rough from the outside to allow the weevils to crawl up easily to the openings. The pheromone lures were hanged from underneath the bucket cover. Soft date fruits mixed with granular insecticide were put at lower part of the

bucket as baits. Traps were put in all the Farms at the rate of one trap/100 palm trees, with a minimum of 2/Farm. (Table No. 11. & Fig. No.)

In eight Extension Centers, 93 farms with severe Red Palm Weevil infestation were selected. In each farm 5 traps were hanged 50 cm up the palm tree stem, or burried in the soil to a depth of 10 cm and 5 meters away from the palm trees. Baits were changed every 15 days, while the Pheromone lures and catches were done every month over a period of twelve months in season 1995/96.

Results:

In all the Extension Centers the number of weevil trapped increased in February and March reaching maximum catch in April, and then decreased to the least number in October. The average catch for all the Centers showed the same trend, being 1.5, 4.2 and 9.2 adult/trap for February, March and April. (Table No. 12). The adult weevils are very active during these months due to high humidity and low temperatures. So it is very important that aggregation pheromone traps should be put before and during these months, as part of the Integrated Pest Management Program.

(2):- *Large Scale Survey*: A total of 18,644 aggregation pheromone traps were put

in the 7,012 farms with a total of 1,597,266 date palm trees. The numbers of trapped weevils were recorded from July 1999 up to June 2000, using a total of 225,728 pheromone sachets.

Results:

A total of 149,893 adult weevils were trapped. Evaluation of infestation during this period showed that Pheromone Traps used, gave a significant reduction in infestation during the season. If the female/male ratio is 2:1, it means that 103,258 females were trapped during the season. If we assume that only 100 eggs hatched, this means that about 1, 3 millions larvae were controlled before causing any infestation.

Maximum catches were 18,955, 19,016, 14,834, 16,103 and 20,654 weevils in July, August, September, October and November, respectively. Catches were 7,067 and 8,065 in January and February, respectively. Then the number of catches increased to 16,734 and 15,535 adults in March and April, respectively. The catches were reduced to the lowest numbers 6,314 and 2,265 in May and June, respectively. (Table No. 13).

So Pheromone Traps are extensively used in all the farms in our efforts to control the infestation, with one insecticide spraying.

(3): Correlation between the use of Pheromone Traps and Infestation:

In eight Extension Centers farms with severe infestation were selected. Pheromone Traps were put in 50% of the farms, while in the other half no traps were put. Total weevil catches was recorded, as well as the number of infested date palm trees in all the farms.

Results:

Infestation was reduced by 63.5% when Pheromone Traps were used, as compared to 35.8% reduction in farms with no Pheromone Traps. This clearly showed the role of Pheromone Traps in reducing infestation in the field (Table No. 14)

Trade Name.	Active Ingredient	Concntration	Manufacture Co.
Drexel, D 264 14 G.	Diazinon.	14%	Drexel Chem. Co., USA.
Basudin.	Diazinon.	10%	Syngenta, Spain.
Diazinon.	Diazinon.	10%	Agropharm, UK.
Marshal.	Carbosulfan.	5%	FMC, USA.
Furidan.	Carbofuran.	5%	FMC, USA.
Prizonon.	Diazinon.	2.5%	Probelet SA, Spain.

Table No. 11: Granular Insecticides used with Baits in Pheromone Traps in the Field.



Fig. No.9: Preparation of the Pheromone Traps.

Table No.12: Total Number of Weevil Catch by Aggregation Pheromone. (Season:- 1996)

Month	Abu Samara	Al Ain	Qattara	Sulimat West	Saad West	Saad South	Fagah	Wagan East	Month Average
Jan.	39	18	28	25	99	88	10	12	0.7
Feb.	165	37	9	114	190	100	64	34	1.5
Mar.	338	117	46	212	658	217	278	77	4.2
Apr.	947	328	145	708	1004	621	368	159	9.2
May.	111	148	22	27	326	90	61	7	1.7
Jun.	65	109	9	43	183	112	73	11	1.3
Jul.	12	219	22	16	171	115	73	18	1.4
Aug.	77	184	22	7	159	68	72	10	1.3
Sep.	72	132	8	16	89	83	19	34	1.0
Oct.	26	35	17	34	93	66	13	6	0.6
Nov.	70	56	16	77	268	120	53	22	1.5
Dec.	56	26	12	43	143	84	16	9	0.8

Table No. 13: Total number of Weevil catch by Aggregation Pheromone. Season: 1999/2000

REGION	DATE & TOTAL NUMBER OF CATCH												TOTAL
	7/99	8/99	9/99	10/99	11/99	12/99	1/20	2/20	3/20	4/20	5/20	6/20	
Al Ain	2667	2192	1440	1973	1477	687	575	636	1589	1241	157	350	14984
West	9503	10010	7791	8408	14154	5538	4200	4336	8267	8891	2942	890	84930
North	3049	3783	3913	4002	3840	2482	1640	1836	4179	2641	1749	435	33549
South	3736	3031	1690	1720	1183	637	652	1257	2699	2762	1466	590	21423
Total	18955	19019	14834	16103	20654	9344	7067	8065	16734	15535	6314	2265	154886

Centers	Total Catch	Number of Infested Palm Trees (With Pheromone)		Number of Infested Palm Trees (Without Pheromone)	
		1995/96	1996/97	1995/96	1996/97
Abu Samara	1,987	66	97	109	114
Al Ain	1,409	694	116	433	69
Qattara	356	5	8	161	209
Sulimat West	1,322	61	48	273	116
Saad West	3,383	164	41	289	117
Saad South	1,764	63	82	59	139
Fagah	1,100	52	16	7	9
Wagan	399	17	2	56	118
Total	11,711	1,122	410	1,387	891
% Infestation Reduction.		63.5		35.8	

Table No.14: Percentages of Infested Palm Trees with or without Aggregation Pheromone Traps. Season:-1995/96 & 1996/1997.

INTEGRATED PEST MANAGEMENT PROGRAM (IPM).

CONCLUSION

- ▶ Sex Aggregation Pheromones Traps are put in all the farms for the catch of adult weevils before they mate and lay eggs. Pheromone traps used, gave a significant reduction in infestation during the season.
- ▶ During the period November up to April low temperatures and high humidity are favorable conditions for adults mating and eggs laying. So during this period ONE insecticide spraying is applied in all the farms for the control of adults that escaped being trapped by Pheromone Traps.
- ▶ In case of any infestation occurring after the use of pheromone traps and insecticide spraying, insecticide injection is practiced for the immediate control of infestation.
- ▶ Adoption of this IPM program annually in all the farms in the Department Agriculture & Livestock resulted in the reduction of infestation to about 0.40% only.

