INTEGRATED MANAGEMENT OF *ZEUZERA PYRINA* L. IN POMEGRANATE ORCHARDS USING ENVIRONMENTALLY SAFE TREATMENTS

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Abstract

Alternative non-conventional and environmentally safe means (sex pheromone mass trapping, horticultural, mechanical, microbiological and local chemical treatments) for reduction *Zeuzera pyrina* L. infestation, were evaluated in infested pomegranate orchards during three successive years (2005, 2006, and 2007) at Wady El-Natroun district, Behera governorate.

Z. pyrina infestation was reduced by 59.78, 68.92 and 80.00% due to whole year pheromone treatment, 56.87, 80.15 and 88.21% due to pruning treatment, 36.76, 55.85 and 65.03% due to worming treatment, 7.92, 12.77 and 17.48% due to bacterial treatment, 6.23, 11.38 and 15.89% due to fungal treatment, 68.26, 79.69 and 84.23% due to whole year local spraying, 60.99, 75.38 and 81.99% due to whole year local painting, 83.52, 92.15 and 96.29% due to whole year complete coverage spraying, when applied for 1, 2, and 3-successive years, respectively. The respective combined treatments resulted in 71.41, 85.85 and 92.58% due to partial pheromone and pruning, 47.18, 62.00 and 74.30% due to partial pheromone and worming treatments, 31.72, 40.62 and 52.84% due to partial pheromone and bacterial treatment, 28.81, 38.77 and 51.52% due to partial pheromone and fungal treatment, 81.36, 92.46 and 96.03% due to partial pheromone and local spraying, 78.69, 91.38 and 94.44% due to partial pheromone and local painting and 65.38, 77.69, 83.97% due to partial pheromone and complete coverage spraying

INTRODUCTION

Pomegranate nowadays is an important exporting crop in Egypt. The cultivated area is yearly increasing in the old valley lands as well as in the new reclaimed lands. *Zeuzera pyrina* is a serious polyphagous pest in Egypt, attacking several fruit trees especially pomegranate, apple, pear and olive, in addition to some ornamental and wood tree species. Larvae bore tunnels inside the tree branches and stem, consume large amount of wood, causing weakness, reducing the production, and finally death of trees.

The use of insecticides for the protection of fruit trees from *Z. pyrina* infestation still the main tool of control (El-Sherif *et al*., 1985), and has been recently increased. However, Tadros *et al.* (1993) and (2006-b) obtained good control results of *Z. pyrina* by using horticultural, mechanical and chemical treatments in pear orchards. These are safe for the environment, and human and animal.

Moreover, promising results were achieved under field conditions by attraction of *Z. pyrina* using sex pheromone traps by Tadros and Voerman (1994) and Tadros *et al.* (2006-a) in Egypt, Vettori and Pasqualini (1997), in Israel, Natale and Pasqualini (1999), Pasqualini *et al.* (1999) in Italy, and Haniotakis *et al.* (1999) in the Netherlands. In addition, Shehata *et al.* (1995) in Egypt carried out microbiological control of *Z. pyrina* in pear orchards and obtained adequate results.

The main scope of this study is to prevent the yield losses due to the damage of this boring pest, eliminate the pesticide residues, prevent the outbreaks of secondary species, decrease the environmental pollution, magnify the role of the biological control agents (parasites, predators and pathogens) and obtain better production of decontamination of fruits through using non traditional approaches for controlling *Z. pyrina* in pomegranate orchards.

MATERIALS AND METHODS

Experiments on *Z. pyrina* were carried out during the activity seasons allover three successive years (2005, 2006 and 2007). Field trials were carried out in heavily infested pomegranate orchards (10 feddans, 12 years old) at Wady El-Natroun district, Behera governorate as follows:

1. Effect of one-year treatments

1.1. Whole year mass trapping with a pheromone treatment

According to Abdel-Azim (2005), locally made trap bottles were suspended on trees at 1.5 m above the ground at the rate of 1 trap per 5 trees. Each trap was baited with a polyethylene dispenser impregnated with a blend of *Z. pyrina* sex pheromone {1.5 mg active ingredient (a.i.) of E-2, Z-13-octadecadien-1-ol acetate (E Z 2, 13 -18: Ac) plus 0.08 mg a.i. of E-3, Z-13- octadecadien-1-ol acetate (E Z 3, 13 -18: Ac)}. Dispensers renewed at 6-week intervals, and the caught males were counted and removed weekly from May to November.

1.2. Partial season mass trapping with pheromone and pruning treatments Pruning described in item 1.9. was applied, followed by partial pheromone from early May to mid August (flowering and fruiting period).

1.3. Partial season mass trapping with pheromone and worming treatments Partial pheromone treatment during flowering and fruiting period were conducted simultaneously with worming treatment described in item 1.10.

1.4. Partial season mass trapping with pheromone and bacterial treatments Partial pheromone treatment during flowering and fruiting period were conducted simultaneously with bacterial treatment described in item 1.11.

1.5. Partial season mass trapping with pheromone and fungal treatments

Partial pheromone treatment during flowering and fruiting period were conducted simultaneously with fungal treatment described in item 1.12.

1.6. Partial season mass trapping with pheromone and complete coverage spraying treatments: Partial pheromone was conducted during flowering and fruiting period. After harvesting, two complete coverage sprays with Basudin (Diazinon) 60% E.C. and Cidial (Phenthoate) L 50% E.C. (300 cc/100 liters of water) were applied on September and October [these are the recommended insecticides by the MOA].

1.7. Partial season mass trapping with pheromone and partial local spraying treatments

Partial pheromone was conducted during flowering and fruiting period. After harvesting, two local spraying of the trunk and main branches with Basudin and Cidial (300 cc/100 liters of water) were applied on September and October.

1.8. Partial season mass trapping with pheromone and partial local painting treatments

Partial season pheromone treatment was conducted during flowering and fruiting period. After harvesting, two local painting of the tree trunk using Stemex (item 1.11.) were applied on September and October.

1.9. Pruning treatment

During the horticultural winter pruning in January 2005, 2006, and 2007, infested branches were pruned and immediately got rid of them.

1.10. Worming treatment Killing the larvae inside their tunnels using a wire was applied four times each season (during January, April, July, and October).

1.11. Bacterial treatment The commercial bacterial compound "Diple 2X" (a.i. *Bacillus thuringiensis* var. *kurstaki* (Berliner), 3200 International Units Ak / mg) at the rate of 200 cc per 100 liters of water was locally sprayed on the stem, main branches and pruning sites four times each season. A compressed air knapsack sprayer was used in spraying at monthly intervals on May, June, July and September.

1.12. Fungal treatment The commercial fungal compound "Biofly FC" (a.i., *Beauveria bassiana*, 3 x 10^7 spores / mg) at the rate of 400 cc per 100 liters of water were locally sprayed on the stem, main branches and pruning sites four times each season. A compressed air knapsack sprayer was used in spraying at monthly intervals on May, June, July and September.

1.13. Whole year complete coverage-spraying treatment The recommended four alternative sprays with Basudin and Cidial each at the rate of 300 cc /100 liters

water were applied. Before harvesting, two sprays were conducted on May and June, then after harvesting on September and October.

1.14. Whole year local spraying treatment The same insecticides, at the same dates and the number of applications as in complete coverage spray (item 1.13) were carried out but spraying was concentrated only on the trunk and main branches.

1.15. Whole year local painting treatment Local painting was concentrated only to the trunk using Stemex insecticide (3% Anthracine + 18% Naphthalene), using a brush, four times on the same dates of complete coverage spraying.

1.16. Untreated check Trees of this treatment did not receive any pheromone, horticultural, mechanical, microbiological or insecticidal treatments.

2. Effect of two and three successive years treatments

The same sixteen previously mentioned one - year treatments that applied during 2005 were repeated in other pomegranate orchards during 2006 and 2007 seasons to confirm the results for the 2^{nd} and 3^{rd} years. In addition, the same previously one-year treatments of 2005 were repeated in the same pomegranate orchard during 2006 and 2007 seasons to studying the effect of the cumulative effect of treatments for two and three successive years.

3. Statistical analysis

The experimental design was completely randomized at significance level 5% split design with 10 trees, each replicated 3 times (33 trees each treatment). Evaluation of the different treatments was carried out at the end of the year (during December) by counting the alive larvae in the treated and untreated pomegranate trees. Active holes with mass of sawdust indicate alive larvae (in case of uncertainty, branches were dissection). The efficiency of treatments was based on the percentage reduction of infestation according to the following formula (Henderson and Tilton, 1955):

% Reduction of infestation = [(C - T) / C] X 100

Where: C: Mean number of alive larvae in the untreated trees.

T: Mean number of alive larvae in the treated trees.

Analysis of variance (F test) and Least Significant Difference (LSD) (Snedecor and Cochran, 1990) were used for differentiation between treatments.

RESULTS AND DISCUSSION

The effect of mass trapping of *Z. pyrina* male moths with sex pheromone, horticultural, mechanical, microbiological and local chemical treatments on the reduction of infestation was studied in pomegranate orchards at Wady El-Natron district, Behera governorate during 1, 2 and 3 successive seasons (2005, 2006 and 2007). Data concluded the following results:

1. Effect of one single year treatments (direct effect): (Table, 1)

Statistical analysis of variance and LSD resulted in the following groups:

1.1. The superior group (70.00 – 100.00% reduction of infestation):

a) **Whole year complete coverage-spraying treatment** achieved a good percentage reduction of infestation averaged 83.52% (range, 81.55-84.67%).

b) **Partial mass trapping with pheromone then local spraying treatments** gave moderate percentage reduction of infestation, reached 81.36% (range, 80.35–82.54%).

c) **Partial mass trapping with pheromone then local painting treatments** led to a good reduction of infestation showing 78.69% (range, 78.07-79.30%).

d) **Partial mass trapping with pheromone and pruning treatments** together as an integrated environmentally safe pest control showed a good effect on the reduction of infestation reached 71.41% (range, 70.32-72.57%).

1.2. The moderate group (50.00 - 70.00% reduction of infestation)

a) **Whole year local spraying treatment** reduced infestation by 68.26% (range, 64.59-72.73%).

b) **Partial mass trapping with pheromone then complete coverage spraying treatments** after harvesting resulted in adequate control, showing 65.38% (range, 64.71-65.66%) reduction of infestation.

c) **Whole year local painting treatment** was of considerable value due to its efficient action as well as reducing insecticidal application. The percent reduction of infestation reached 60.99% (range, 57.24-65.34%).

d) **Whole year mass trapping with pheromone traps** allover the year reduced the borer infestation with 59.78% (range, 55.08-65.66%).

e) **Pruning treatment** in winter resulted in 56.87% (range, 53.12-59.36%) reduction in infestation.

1.3. The less effective group (25.00 - 50.00% reduction of infestation)

a) **Partial mass trapping with pheromone and worming treatments**

together as an integrated environmentally safe pest control showing 47.18% (range, 46.65-48.13%) reduction of infestation.

b) **Worming treatment** showed 36.76% reductions of infestation (range, 29.41-42.39%).

c) **Partial mass trapping with pheromone and Bacterial treatment** had slight effect may be because it was highly affected with the hot temperature and winds. Thus, the percentage reduction of infestation averaged 31.72% (range, 29.93-32.89%).

d) **Partial mass trapping with pheromone and Fungal treatment** was showed almost the same as bacterial treatment, yet it was still lower effect reached 28.81% (range, 27.43-30.42%) reduction of infestation.

Table 1. Effect of one single year treatments on the reduction of *Zeuzera pyrina* L. infestation in pomegranate orchards at Wady El-Natron district, Behera governorate during 2005, 2006 and 2007.

No	Treatments	Mean no. of alive larvae per tree (L/T) and percent reduction of infestation (%RI)								Group-ing
		2005		2006	2007			Mean		
		L/T	%RI	L/T	%RI	L/T	%RI	L/T	%RI	
1	Pheromone	١.٦٨	٥٥.٠٨	١.٧٢	٥٧.١١	١.٥٩	٦٥.٦٦	١.٦٦	٥٩.٧٨	b
2	Pruning	١.٥٢	٥٩.٣٦	١.٨٨	٥٣.١٢	١.٩٤	٥٨.١٠	١.٧٨	٥٦.٨٧	bc
3	Worming	٢.٦٤	٢٩.٤١	٢.٣١	٤٢.٣٩	٢.٨٧	٣٨.٠١	٢.٦١	٣٦.٧٦	cd
4	Bacteria	٣.٣٩	٩.٣٦	٣.٨٥	٣.٩٩	٤.١٦	١٠.١٥	٣.٨	٧.٩٢	e
5	Fungus	٣.٥٠	٦.٤٢	٣.٧٩	٥.٤٩	٤.٣٢	٦.٧٠	٣.٨٧	٦.٢٣	e
6	Local painting	١.٤٦	٦٠.٩٦	١.٣٩	٦٥.٣٤	١.٩٨	٥٧.٢٤	١.٦١	٦٠.٩٩	b
7	Local spraying	١.٠٢	٧٢.٧٣	١.٤٢	٦٤.٥٩	١.٥٠	٦٧.٦٠	١.٣١	٦٨.٢٦	b
8	Complete coverage spray	٠.٦٩	٨١.٥٥	٠.٦٣	٨٤.٢٩	٠.١١	٨٤.٦٧	٠.٦٨	٨٣.٥٢	a
9	Pheromone + Pruning	١.١١	٧٠.٣٢	١.١٠	٧٢.٥٧	١.٣٤	٧١.٠٦	١.١٨	٧١.٤١	ab
10	Pheromone + Worming	١.٩٤	٤٨.١٣	٢.١٣	٤٦.٨٨	٢.٤٧	٤٦.٦٥	٢.١٨	٤٧.١٨	c
11	Pheromone +Bacteria	٢.٥١	٣٢.٨٩	٢.٨١	٢٩.٩٣	٣.١٤	٣٢.١٨	٢.٨٢	٣١.٧٢	d
12	Pheromone +Fungus	٢.٦٨	٢٨.٣٤	٢.٧٩	٣٠.٤٢	٣.٣٦	٢٧.٤٣	٢.٩٤	٢٨.٨١	d
13	Pheromone + Local painting	٠.٨٢	٧٨.٠٧	٠.٨٣	٧٩.٣٠	٠.٩٨	٧٨.٨٩	٠.٨٨	٧٨.٦٩	ab
14	Pheromone+ Local spray	٠.٦٩	٨١.٥٥	٠.٧٠	٨٢.٥٤	٠.٩١	٨٠.٣٥	٠.٧٧	٨١.٣٦	a
15	Pheromone + Complete coverage spray	1.32	64.71	1.39	65.34	1.59	65.66	1.43	65.38	b
16	Untreated (check)	٣.٧٤	--	٤.٠١	--	٤.٦٣	--	٤.١٣	--	e

Values within a column followed by different letter are significantly different (P> 0.05), L.S.D. = 0.51
Duncan [1951 as described by Computer Mstat Program, 1987] multiple ranges test.

The least group (less than 25.00% reduction of infestation)

a) **Bacterial treatment** had very slight reduction of infestation (average, 7.92% and range, 3.99-10.15%).

b) **Fungal treatment** showed also the least effect reached 6.23% (range, 5.49-6.70%) reduction of infestation.

2. Effect of two successive years treatments (cumulative effect): Table (2)

Statistical analysis of variance and LSD resulted in the following groups:

2.1. The superior group (75.00 – 100.00% reduction of infestation)

a) **Partial mass trapping with pheromone then local spraying treatments** reduced infestation by 92.46% (ranged 92.11-92.92 %) after two successive years.

b) **Whole year complete coverage spraying treatments** reduced infestation by 92.15% (ranged 90.46-93.64%) after two successive years.

c) **Partial mass trapping with pheromone then local painting treatments** reduced infestation by 91.38% (ranged 91.33-91.61%) after two successive years.

d) **Partial mass trapping with pheromone and pruning treatments** reduced infestation by 85.85% (ranged 85.26-86.51%) after two successive years.

e) **Pruning treatment** reduced infestation by 80.15% (ranged 79.93-80.49%) after two successive years.

f) **Whole year local spraying treatments** reduced infestation by 79.69% (ranged 78.32-81.41%) after two successive years.

g) **Partial mass trapping with pheromone then complete coverage spraying treatments** reduced infestation by 77.69% (ranged 77.17-78.29%) after two successive years.

h) **Whole year local painting treatments** reduced infestation by 75.38% (ranged 74.71-76.15%) after two successive years.

2.2. The moderate group (50.00 – 75.00% reduction of infestation)

a) **Whole year mass trapping with pheromone treatment** reduced *Z. pyrina* infestation by 68.92% (ranged 68.26-69.65%) after two successive years.

b) **Partial mass trapping with pheromone and worming treatments** reduced infestation by 62.00% (ranged 61.42-62.66%) after two successive years.

c) **Worming treatment** reduced infestation by 55.85% (ranged 54.44-57.23%) after two successive years.

2.3. The less effective group (30.00 – 50.00% reduction of infestation):

a) **Partial mass trapping with pheromone and Bacterial treatment** reduced infestation by 40.62% (ranged 39.60-41.94%) after two successive years.

b) **Partial mass trapping with pheromone and Fungal treatment** reduced infestation by 38.77% (ranged 38.44-39.31%) after two successive years.

2.4. The least group (less than 30.00% reduction of infestation):

a) **Bacterial treatment** reduced infestation by 12.77% (ranged 12.14-13.49%) after two successive years.

b) **Fungal treatment** reduced infestation by 11.38% (ranged 11.02-11.71%) after two successive years.

3. Effect of three successive years treatments (cumulative effect): Table (2) Statistical analysis of variance and LSD resulted in the following groups:

3.1. The superior group (90.00 – 100.00% reduction of infestation):

a) **Whole year complete coverage spraying treatments** increased the reduction of infestation to 96.29% when repeated for three successive years.

b) **Partial mass trapping with pheromone then local spraying treatments** increased the reduction of infestation to 96.03% when repeated for three successive years.

c) **Partial mass trapping with pheromone then local painting treatments** increased the reduction of infestation to 94.44% when repeated for three successive years.

d) **Partial mass trapping with pheromone and pruning treatments** increased the reduction of infestation to 92.58% when repeated for three successive years.

3.2. The moderate group (75.00 – 90.00% reduction of infestation):

a) **Pruning treatment** increased the reduction of infestation to 88.21% when repeated for three successive years.

b) **Whole year local spraying treatments** increased the reduction of infestation to 84.23% when repeated for three successive years.

Table 2. Effect of two and three successive year's treatments on the reduction of *Zeuzera pyrina* L. infestation in pomegranate trees at Wady El-Natroun district, Behera governorate during one, two and three successive years (2005, 2006 and 2007).

No	Treatments	Mean no. of alive larvae per tree (L/T) and percent reduction of infestation (%RI)							
		2- successive years						3- years	
		2005/06		2006/07		Mean		Mean (2006/07)	
		L/T	%RI	L/T	%RI	L/T	%RI	L/T	%RI
1	Pheromone	1.94	68.26	2.10	69.65	2.02 bc	68.92	1.51 b	80.00
2	Pruning	1.22	79.93	1.35	80.49	1.29 ab	80.15	0.89 ab	88.21
3	Worming	2.77	54.44	2.96	57.23	2.87 c	55.85	2.64 c	65.03
4	Bacteria	5.26	13.49	6.08	12.14	5.67 e	12.77	6.23 e	17.48
5	Fungus	5.41	11.02	6.11	11.71	5.76 e	11.38	6.35 e	15.89
6	Local painting	1.45	79.15	1.75	74.71	1.60 b	75.38	1.36 b	81.99
7	Local spraying	1.13	81.41	1.50	78.32	1.32 ab	79.69	1.19 ab	84.23
8	Complete coverage spray	0.58	90.46	0.44	93.64	0.51 a	92.15	0.28 a	96.29
9	Pheromone + Pruning	0.82	86.51	1.02	85.26	0.92 ab	85.85	0.56 ab	92.58
10	Pheromone + Worming	2.27	62.66	2.67	61.42	2.47 c	62.00	1.94 bc	74.30
11	Pheromone +Bacteria	3.53	41.94	4.18	39.60	3.86	40.62	3.56 cd	52.84
12	Pheromone +Fungus	3.69	39.31	4.26	38.44	3.98 d	38.77	3.66 d	51.52
13	Pheromone + Local painting	0.51	91.61	0.60	91.33	0.56 a	91.38	0.42 ab	94.44
14	Pheromone + Local spray	0.48	92.11	0.49	92.92	0.49 a	92.46	0.30 a	96.03
15	Pheromone + Complete coverage spray	1.32	78.29	1.58	77.17	1.45 b	77.69	1.21 ab	83.97
16	Untreated (check)	6.08	--	6.92	--	6.50 e	--	7.55 f	--

Values within a column followed by different letter are significantly different (P> 0.05),
L.S.D. for 2 years = 0.83, and for 3 years = 0.95
Duncan [1951 as described by Computer Mstat Program, 1987] multiple ranges test.

c) **Partial mass trapping with pheromone then complete coverage spraying treatments** increased the reduction of infestation to 83.97% when repeated for three successive years.

d) **Whole year local painting treatments** increased the reduction of infestation to 81.99% when repeated for three successive years.

e) **Whole year mass trapping with pheromone treatment** increased the reduction of infestation to 80.00% when repeated for three successive years.

3.3. The less effective group (55.00 – 75.00% reduction of infestation):

a) **Partial mass trapping with pheromone and worming treatments** increased the reduction of infestation to 74.30% when repeated for three successive years.

b) **Worming treatment** increased the reduction of infestation to 65.03% when repeated for three successive years.

3.4. The least effective group (less than 55.00% reduction of infestation):

a) **Partial mass trapping with pheromone and Bacterial treatment** increased the reduction of infestation to 52.84% when repeated for three successive years.

b) **Partial mass trapping with pheromone and Fungal treatment** increased the reduction of infestation to 51.52% when repeated for three successive years.

c) **Bacterial treatment** increased the reduction of infestation to 17.48% when repeated for three successive years.

d) **Fungal treatment** increased the reduction of infestation to 15.89% when repeated for three successive years.

4. Conclusion and discussion

As shown in Tables (1 and 2), some environmentally safe means of control resulted in rather good reduction of *Zeuzera pyrina* infestation. Others resulted in relatively low reduction of infestation. However, repeating these treatments year after another on the same trees magnified the reduction of infestation. Satisfactory reduction of infestation were obtained by whole year treatment with pheromone (59.78, 68.92 and 80.00%), pruning (56.87, 80.15 and 88.21%), and worming (36.76, 55.85 and 65.03%), when applied for 1, 2, and 3 successive years respectively.

On the other hand, pheromone traps are costly, and to increase the efficiency of this treatment, other environmentally safe control treatments i. e. dormant pruning and worming were also applied in combination with mass pheromone attraction treatment.

Mass attraction treatment with pheromone was applied during the first half of the tree growth season (flowering and fruiting until harvesting). This period coincided with the first activity season of the pest, thus decreased the pest population, and resulted in adequate decrease in the target borer's infestation. Results of partial pheromone and pruning showing 71.41, 85.85 and 92.58% and partial pheromone and worming reached 47.18, 62.00 and 74.30% when applied for 1, 2, and 3 successive years, respectively.

On the contrary, bacterial and fungal treatments were ineffective. The respective results were 7.92, 12.77 and 17.48% for bacterial, and 6.23, 11.38 and 15.89% for fungal treatments. In an attempt to magnify their role, they were applied in combination with partial pheromone treatment. The respective results were 31.72, 40.62 and 52.84% for partial pheromone and bacterial, and 28.81, 38.77 and 51.52% for partial pheromone and fungal treatments.

Insecticide treatments, however, still the effective in controlling severe infestation of the target pest. The recommended complete coverage spraying resulted in 83.52, 92.15 and 96.29%, when applied for 1, 2, and 3-successive years, respectively. To eliminate the insecticidal hazards, spraying and painting insecticides were applied locally. The respective resulted were 68.26, 79.69 and 84.23% for whole year local spraying, and 60.99, 75.38 and 81.99% for whole year local painting,

The safe use of insecticides in IPM programs was superior in plant protection. Therefore, the use of pheromone mass trapping was carried out during the flowering, fruiting until harvesting which coincided with the first activity season of the pest. Insecticide application, however, were used after harvesting during the second half of the activity period of the pest. To increase the safety of insecticides used and eliminate the environmental pollution, insecticides were sprayed or painted locally to the trunk and the main branches of trees only to accommodate the 2^{nd} period of moths' activity season, while the 1^{st} period was checked by mass attraction with pheromone trap. Results of partial pheromone and local spraying were 81.36, 92.46 and 96.03%, partial pheromone and local painting were 78.69, 91.38 and 94.44%, and partial pheromone and complete coverage spraying were 65.38, 77.69, 83.97%, when applied for 1, 2, and 3 successive years respectively.

Local spraying and painting were easy to apply, reduce the quantity of insecticides used, and safe effort in addition to the reduction of crop pollution with insecticides.

The present results were in agreement with several researchers such as Tadros and Voerman (1994), in Egypt who stated that *Z. pyrina* successfully attracted to the sex pheromone. On the other hand, Tadros *et al.* (1993) evaluated the efficiency of pruning, worming, and complete coverage spraying treatments in the reduction of *Z.*

pyrina infestation, and obtained good results (16-81%). However, the present results disagree with Tadros *et al.* (1993) concerning worming which showed low reduction of infestation due to the difficulty of applying this treatment owing to the numerous spins and off springs around the pomegranate tree stem. Bacterial and fungal treatments were ineffective because they were highly affected with the hot temperature and winds.

Vettori and Pasqualini (1997), Natale and Pasqualini (1999), Pasqualini *et al.* (1999), in Italy evaluated the efficiency of mass capture using traps baited with synthetic pheromone in controlling *Z. pyrina*. The results were encouraging in the sense that there was a decrease in the capture rate of the pest over 3 years period, indicating a possible reduction in the levels of infestation.

Navon *et al.* (1997), in Israel studied the use of sex pheromone for trapping *Z. pyrina* using polyethylene funnel traps in apple and pear orchards. The highest catch was 4 males / trap/week.

Haniotakis *et al.* (1999), in the Netherlands concluded that the dispenser Z.p.-01607 was superior to all other types of prototype or commercial. He added that mass trapping at 10 traps/ ha was not effective.

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المكافحة المتكاملة لحفار ساق التفاح .L ***Zeuzera pyrina*** في حدائق الرمان بإستخدام المعاملات الآمنة بيئيا

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أصبح الرمان من المحاصيل التصديرية الهامة في مصر في الآونة الأخيرة، إلا أن حفار ساق التفاح .*Z. pyrina* L يسبب أضرارا اقتصادية في حدائق الرمان. وللحد من التلوث البيئي بالمبيدات تم تقييم فعالية بعض الطرق الآمنة لتقليل الإصابة بالحفار مثل اصطياد الفراشات بأعداد كبيرة باستخدام مصايد الفرمونات الجنسية، والمعاملات البستانية (التقليم)، والميكانيكية (قتل اليرقات داخل أنفاقها بالسلك)، والميكروبية (البكتيريا والفطريات الممرضة)، والمعاملات الكيماوية الموضعية (رش ودهان أماكن الإصابة فقط)، في منطقة وادي النطرون محافظة البحيرة خلال ثلاث سنوات متتالية (٢٠٠٥، ٢٠٠٦، ٢٠٠٧).

أظهرت النتائج ما يلي:

أدت المعاملة طوال العام بالفرمون فقط إلي تقليل الإصابة بنسبة 59.78 و 68.92 و 80.00%؛ وبالتقليم فقط إلي 56.87 و 80.15 و 88.21%؛ وبقتل اليرقات بالسلك فقط إلي 36.76 و 55.85 و 65.03%؛ وبالبكتيريا الممرضة فقط 7.92 و 12.77 و 17.48%؛ وبالفطريات الممرضة فقط 6.23 و 11.38 و 15.89%؛ وبالرش الموضعي فقط إلي 68.26 و 79.69 و 84.23%؛ وبالدهان الموضعي فقط إلي 60.99 و 75.38 و 81.99%؛ وبالرش الكلي فقط إلي 83.52 و 92.15 و 96.29%؛ في حين أدت المعاملة الجزئية بالفرمون مع التقليم إلي 71.41 و 85.85 و 92.58%؛ والمعاملة الجزئية بالفرمون مع قتل اليرقات بالسلك إلي 47.18 و 62.00 و 74.30%؛ والمعاملة الجزئية بالفرمون مع البكتيريا الممرضة إلي 31.72 و 40.62 و 52.84%؛ والمعاملة الجزئية بالفرمون مع الفطريات الممرضة إلي 28.81 و 38.77 و 51.52%؛ والمعاملة الجزئية بالفرمون مع الرش الموضعي إلي 81.36 و 92.46 و 96.03%؛ والمعاملة الجزئية بالفرمون مع الدهان الموضعي إلي 78.69، 91.38، 94.44%؛ والمعاملة الجزئية بالفرمون مع الرش الكلي إلي 65.38 و 77.69 و 83.97%؛ وذلك عندما أجريت المعاملات لمدة عام واحد، وعامين متتاليين، وثلاثة أعوام متتالية، علي الترتيب.