

ALTERNATIVE MEANS OF CONTROL OF *ZEUZERA PYRINA* BY MASS TRAPPING WITH SEX PHEROMONE, HORTICULTURAL, MECHANICAL AND LOCAL CHEMICAL TREATMENTS

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Abstract

Alternative means of control (sex pheromone mass trapping, horticultural, mechanical, and local chemical treatments) were evaluated at Nubaria district, Behera governorate during 1, 2, and 3 successive years (2000, 2001, and/or 2002) against *Zeuzera pyrina*.

The rate of reduction of *Z. pyrina* with whole year pheromone treatment revealed 62.27, 71.50 and 82.39%, pruning treatment 19.93, 23.20 and 30.49%, worming treatment 40.07, 53.25 and 61.55%, whole year local painting 80.90, 88.65 and 94.46%, whole year local spraying 58.50, 68.60 and 71.45%, whole year complete coverage spraying 82.83, 92.75 and 97.92%, partial pheromone and pruning 69.40, 80.05 and 86.55%, partial pheromone and worming treatments 86.47, 94.25 and 98.48%, partial pheromone and local painting 79.80, 87.45 and 95.27%, partial pheromone and local spraying 70.27, 95.65 and 98.86%, partial pheromone and complete coverage spraying 86.03, 95.65 and 98.86%, when applied for 1, 2, and 3 successive years, respectively.

INTRODUCTION

In Egypt, *Zeuzera pyrina* is a serious polyphagous pest attacking several fruit trees specially apple, pear olive, pomegranate as well as some ornamental and wood tree. Larvae bore tunnels inside the tree stem and branches and consume large amount of wood, reducing the production, causing weakness and finally death of trees.

The use of insecticides for the protection of fruit trees from borers' infestation was the main tool of control and has been recently increased. Therefore, for environmental, human and animal safety during consumption, alternative methods must be concerned.

Tadros and Voerman (1994) in Egypt, Castellari (1986), Pasqualini *et al.* (1992), Vettori and Pasqualini (1997), Navon *et al.* (1997) in Israel, Natale and Pasqualini (1999), Pasqualini *et al.* (1999) in Italy, and Haniotakis *et al.* (1999), in the Netherlands obtained promising results by field attracting of *Z. pyrina* using sex pheromone traps.

The main scope of this study was to prevent the yield losses due to 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 and obtain better production of decontamination of fruits through using non traditional approaches for controlling *Z. pyrina*.

MATERIALS AND METHODS

Experiments on *Z. pyrina* were conducted during the whole season of moths' activity seasons of 2000, 2001 and 2002. Field trials were carried out in heavily infested apple orchards at Nubaria district, Behera governorate.

1. Effect of one-year treatments:

1.1. Whole year mass trapping with a pheromone treatment: Locally made 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 April to October.

1.2. Partial season mass attracting with pheromone and pruning treatments: Pruning described in item 1.7. was applied, followed by partial pheromone from early April to mid July (flowering and fruiting period until last harvesting).

1.3. Partial season mass attracting with pheromone and worming treatments: Partial pheromone treatment during flowering and fruiting period were conducted simultaneously with worming treatment described in item 1.8.

1.4. Partial season mass attracting 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 August and September [these are the recommended insecticides by the MOA].

1.5. Partial season mass attracting 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 August and September.

1.6. Partial season mass attracting 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 August and September.

1.7. Pruning treatment: During the horticultural winter pruning in December 1999, 2000, and 2001, infested branches were pruned and immediately got rid of them.

1.8. Worming treatment: Killing the larvae inside their tunnels using a wire was applied four times each season (during December, May, July, and September).

1.9. 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 April and May, then after harvesting on August and September.

1.10. Whole year local spraying treatment: The same insecticides, at the same dates and the number of applications as in complete coverage spray (item 1.9) were carried out but spraying was concentrated only on the trunk and main branches.

1.11. 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.

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

2. Effect of two and three successive years treatments:

The same twelve previously mentioned one - year treatments that applied during 1999/2000 were repeated in other apple orchards during 2000/01 and 2001/02 seasons to confirm the results for the 2nd and 3rd years. In addition, the same previously one-year treatments of 1999/2000 were repeated in the same apple orchard during 2000/01 and 2001/02 seasons to studying the effect of the cumulative effect of two and three successive years.

3. Statistical analysis:

The experimental design was completely randomized (Duncan's multiple range test} at significance level 5% split design with 25 trees each split replicated 3 times. 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 trees. The percentage reduction of infestation was calculated according to the following formula:

$$\% \text{ Reduction of infestation} = [(C - T) / C] \times 100$$

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 LSD were used for differentiation between treatments.

RESULTS AND DISCUSSION

The effect of mass attraction of *Z. pyrina* male moths with sex pheromone, horticultural, mechanical, and local chemical treatments on the reduction of infestation was studied in apple orchards at Nubaria district, Behera governorate during 1, 2 and 3 successive seasons (1999/2000 to 2001/02). 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 (71.00 – 100.00% reduction of infestation):

- a) **Partial mass attraction with pheromone and worming treatments** together as an integrated environmentally safe pest control gave satisfactory effect (a mean of 86.47% and ranged 85.2-87.9%) on the reduction of infestation.
- b) **Partial mass attraction with pheromone then complete coverage spraying treatments** after harvesting resulted in excellent control, showing 86.03% (ranged 84.2-88.5%) reduction of infestation.
- c) **Whole year complete coverage-spraying treatment** achieved a good percentage reduction of infestation reached 82.83% (ranged 80.5-84.6%).
- d) **Whole year local painting treatment** was of great value due to its efficient action as well as reducing insecticidal application. The percent reduction of infestation reached 80.90% (ranged 79.8-81.8%).
- e) **Partial mass attraction with pheromone then local painting treatments** led to a good reduction of infestation showing 79.80% (ranged 78.7-81.3%).

1.2. The moderate group (51.00 - 70.00% reduction of infestation):

- a) **Partial mass attraction with pheromone then local spraying treatments** gave moderate percentage reduction of infestation, averaged 70.27% (ranged 68.1–71.4%).

Table 1. Effect of one single year treatments on the reduction of *Z. pyrina* infestation in apple orchards at Nubaria, Behera governorate during 1999/2000, 2000/01 and 2001/02

Treatment	Mean no. of alive larvae per tree (L/T) and percent reduction of infestation (%RI)								Group- ing
	1999/2000		2000/01		2001/02		Mean		
	L/T	%RI	L/T	%RI	L/T	%RI	L/T	%RI	
Pheromone only	2.12	61.8	2.23	66.0	3.08	59.0	2.48	62.27	c
Pheromone + Pruning	1.88	66.1	1.68	74.4	2.43	67.7	2.00	69.40	bc
Pheromone + Worming	0.76	86.3	0.97	85.2	0.91	87.9	0.88	86.47	a
Pheromone + Complete coverage spray	0.64	88.5	0.96	85.4	1.19	84.2	0.93	86.03	ab
Pheromone + Local spray	1.77	68.1	1.87	71.4	2.16	71.3	1.93	70.27	abc
Pheromone + Local painting	1.04	81.3	1.40	78.7	1.55	79.4	1.33	79.80	ab
Pruning only	4.20	24.3	5.31	19.1	6.29	16.4	5.27	19.93	e
Worming only	3.24	41.6	3.71	43.4	4.87	35.2	3.94	40.07	d
Complete coverage spray only	1.08	80.5	1.01	84.6	1.25	83.4	1.11	82.83	ab
Local spraying only	2.20	60.4	2.56	61.0	3.45	54.1	2.74	58.50	c
Local painting only	1.01	81.8	1.24	81.1	1.52	79.8	1.26	80.90	ab
Untreated (check)	5.55	--	6.56	--	7.52	--	6.54	--	f

b) **Partial mass attraction with pheromone and pruning treatments** together as an integrated environmentally safe pest control showed a very good effect on the reduction of infestation reached 69.40% (ranged 66.1-74.4%).

c) **Whole year mass attraction with pheromone traps** allover the year reduced the borer infestation with 62.27% (ranged 59.0-66.0%).

d) **Whole year local spraying treatment** reduced infestation by 58.50% (range, 54.1-61.0%). This treatment was easy to apply, reduce the quantity of insecticides used, and safe effort in addition to the reduction of crop pollution with insecticides.

1.3. The less effective group (31.00 - 50.00% reduction of infestation):

Worming treatment showed 40.07% reductions of infestation (ranged 35.2-43.4%).

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

Pruning treatment in winter resulted in 19.93% (ranged 16.4-24.3%) reduction in infestation. The low reduction of infestation was due to the concentration of larvae in the stem and main branches that were not included in pruning percentage.

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 (81.00 – 100.00% reduction of infestation):

- a) **Partial mass attraction with pheromone then complete coverage spraying treatments** reduced infestation by 95.65% (ranged 95.60-95.70%). Repeating these treatments for the second year increased the reduction of infestation by 3.62%.
- b) **Partial mass attraction with pheromone and worming treatments** reduced infestation by 94.25% (ranged 93.70-94.80%). Repeating these treatments for the second year increased the reduction of infestation by 4.23%.
- c) **Whole year complete coverage spraying treatments** reduced infestation by 92.75% (ranged 92.3–93.2%). Repeating these treatments for the second year increased the reduction of infestation by 5.17%.
- d) **Whole year local painting treatments** reduced infestation by 88.65% (ranged 88.3–89.0%). Repeating these treatments for the second year increased the reduction of infestation by 5.81%.
- e) **Partial mass attraction with pheromone then local painting treatments** reduced infestation by 87.45% (ranged 86.40–88.50%). Repeating these treatments for the second year increased the reduction of infestation by 7.65%.

2.2. The moderate group (61.00 – 80.00% reduction of infestation):

- a) **Partial mass attraction with pheromone and pruning treatments** reduced infestation by 80.05% (ranged 79.60-80.5%). Repeating these treatments for the second year increased the reduction of infestation by 6.50%.
- b) **Partial mass attraction with pheromone then local spraying treatments** reduced infestation by 79.40% (ranged 77.9–80.90 %). Repeating these treatments for the second year increased the reduction of infestation by 9.13%.
- c) **Whole year mass attraction with pheromone treatment** reduced *Z. pyrina* infestation by 71.50% (ranged 70.30-72.70%). Repeating this treatment for the second year increased the reduction of infestation by 9.23%.
- d) **Whole year local spraying treatments** reduced infestation by 68.60% (ranged 68.50–68.70%). Repeating these treatments for the second year increased the reduction of infestation by 2.85%.

2.3. The less effective group (41.00 – 60.00% reduction of infestation):

Worming treatment reduced infestation by 53.25% (ranged 52.6–53.9%). Repeating these treatments for the second year increased the reduction of infestation by 8.30%.

2.4. The least group (less than 40.00% reduction of infestation):

Pruning treatment reduced infestation by 23.20% (ranged 21.9-24.5%). Repeating these treatments for the second year increased the reduction of infestation by 3.27%.

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 (91.00 – 100.00% reduction of infestation):

a) **Partial mass attraction with pheromone then complete coverage spraying treatments** reduced infestation by 98.86%. Repeating these treatments increased the reduction of infestation by 9.62%. The total reduction for 3 years reached 12.83%.

b) **Partial mass attraction with pheromone and worming treatments** reduced infestation by 98.48%. Repeating these treatments increased the reduction of infestation by 7.78%. The total reduction for 3 years reached 12.01%.

c) **Whole year complete coverage spraying treatments** reduced infestation by 97.92%. Repeating these treatments increased the reduction of infestation by 9.92%. The total reduction for 3 years reached 15.09%.

d) **Partial mass attraction with pheromone then local painting treatments** reduced infestation by 95.27%. Repeating these treatments increased the reduction of infestation by 7.82%. The total reduction for 3 years reached 15.47%.

e) **Whole year local painting treatments** reduced infestation by 94.46%. Repeating these treatments increased the reduction of infestation by 7.75%. The total reduction for 3 years reached 13.56%.

3.2. The moderate group (71.00 – 90.00% reduction of infestation):

a) **Partial mass attraction with pheromone then local spraying treatments** reduced infestation by 89.77%. Repeating these treatments increased the reduction of infestation by 10.37%. The total reduction for 3 years reached 19.50%.

b) **Partial mass attraction with pheromone and pruning treatments** reduced infestation by 86.55%. Repeating these treatments increased the reduction of infestation by 10.65%. The total reduction for 3 years reached 17.15%.

c) **Whole year mass attraction with pheromone treatment** reduced infestation by 82.39%. Repeating this treatment increased the reduction of infestation by 10.89%. The total reduction for 3 years reached 20.12%.

d) **Whole year local spraying treatments** reduced infestation by 71.45%. Repeating these treatments increased the reduction of infestation by 10.10%. The total reduction for 3 years reached 12.95%.

Table 2. Effect of two and three successive years treatments on the reduction of *Z. pyrina* infestation in apple orchards at Nubaria, Behera governorate during 1999/2001 and 2000/2002.

Treatment	Mean no. of alive larvae per tree (L/T) and percent reduction of infestation (%RI)							
	2- successive years						3- years	
	1999/01		2000/02		Mean		Mean (1999/03)	
	L/T	%RI	L/T	%RI	L/T	%RI	L/T	%RI
Pheromone only	1.75	70.3	2.08	72.7	1.92bc	71.50	1.24ab	82.39
Pheromone + Pruning	1.15	80.5	1.56	79.6	1.36abc	80.05	0.95ab	86.55
Pheromone + Worming	0.31	94.8	0.48	93.7	0.40a	94.25	0.11a	98.48
Pheromone + Complete coverage spray	0.25	95.7	0.33	95.6	0.29a	95.65	0.08a	98.86
Pheromone + Local spray	1.31	77.9	1.45	80.9	1.38abc	79.40	0.72ab	89.77
Pheromone + Local painting	0.68	88.5	1.04	86.4	0.86ab	87.45	0.33ab	95.27
Pruning only	4.61	21.9	5.76	24.5	5.19e	23.20	4.89c	30.49
Worming only	2.80	52.6	3.52	53.9	3.16d	53.25	2.71b	61.55
Complete coverage spray only	0.40	93.2	0.59	92.3	0.50a	92.75	0.15a	97.92
Local spraying only	1.85	68.7	2.40	68.5	2.13cd	68.60	2.01ab	71.45
Local painting only	0.65	89.0	0.89	88.3	0.77ab	88.65	0.39ab	94.46
Untreated (check)	5.91	--	7.63	--	6.77f	--	7.04d	

3.3. The less effective group (51.00 – 70.00% reduction of infestation):

Worming treatments reduced infestation by 61.55%. Repeating these treatments increased the reduction of infestation by 13.18%. The total reduction for 3 years reached 21.48%.

3.4. The least effective group (less than 50.00% reduction of infestation):

Pruning treatments reduced infestation by 30.49%. Repeating these treatments increased the reduction of infestation by 7.29%. The total reduction for 3 years reached 10.56%.

4. Conclusion and discussion:

As shown in Table (3), the environmentally safe means of control mostly resulted in relatively low reduction of *Z. pyrina* infestation, however, applying the treatments yearly on the same trees magnified the reduction of infestation. Results of whole year pheromone were 62.27, 71.50, and 82.39%, worming revealed 40.07, 53.25, and 61.55%, pruning gave 19.93, 23.20, and 30.49% when applied for 1, 2, and 3 successive years respectively.

As 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 worming showing 86.47, 94.25, and 98.48% and partial pheromone and pruning reached 69.40, 80.05, and 86.55% statistically ranked first when applied for 1, 2, and 3 successive years respectively (Table 3).

From the statistical point of view (Table 3), insecticide treatments, however, considered effective in IPM programs was superior and obligatory used in plant protection especially in controlling severe infestation of the target pest. 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

Table 3. Grouping of different treatments applied to control *Z. pyrina* larvae on apple trees during one, two and three successive years (1999/2000, 2000/2001 and 2001/2002).

Treatment	% Reduction of infestation (RI)					
	One year		Two years		Three years	
	% RI	RO	% RI	RO	% RI	RO
Pheromone only	62.27	c	71.50	bc	82.39	ab
Pheromone + Pruning	69.40	bc	80.05	abc	86.55	ab
Pheromone + Worming	86.47	a	94.25	a	98.48	a
Pheromone + Complete coverage spray	86.03	ab	95.65	a	98.86	a
Pheromone + Local spray	70.27	abc	79.40	abc	89.77	ab
Pheromone + Local painting	79.80	ab	87.45	ab	95.27	ab
Pruning only	19.93	e	23.20	e	30.49	c
Worming only	40.07	d	53.25	d	61.55	b
Complete coverage spray only	82.83	ab	92.75	a	97.92	a
Local spraying only	58.50	c	68.60	cd	71.45	ab
Local painting only	80.90	ab	88.65	ab	94.46	ab
RO = Ranked order						

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 2nd period of moths' activity season, while the 1st period was checked by mass attraction with pheromone trap. Results of partial pheromone and local painting were 79.80, 87.45, and 95.27%, and partial pheromone and local spraying were 70.27, 79.40, and 89.77% when applied for 1, 2, and 3 successive years respectively. Moreover, the effects of applying partial pheromone was applied during the 1st activity season of the pest then the recommended complete coverage spraying of insecticides during the 2nd activity season. The respective results were 86.03, 95.65, and 98.86% when applied for 1, 2, and 3 successive years.

Application of whole year local painting and local spraying was effective as well as environmentally safe and of low cost. The respective results were 80.90, 88.65, and 94.46%, and 58.50, 68.60, and 71.45% when applied for 1, 2, and 3 successive years (Table 3).

The present results were in agreement with several researches such as Tadros and Voerman (1994), in Egypt who stated that *Z. pyrina* successfully attracted to the sex pheromone E-2,Z-13-octadecadin-1-ol acetate and E-3,Z-13-octadecadin-1-ol acetate imported from the Netherlands. 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%).

Castellari (1986), Pasqualini *et al.* (1992), 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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الطرق البديلة لمكافحة حفار ساق التفاح *Zeuzera Pyrina*

باستخدام المعاملات بالمصائد الفرمونية الجنسية والمعاملات البستانية والميكانيكية
والكيماوية الموضعية

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يسبب حفار ساق التفاح أضراراً اقتصادية في حدائق التفاح في مصر. وللحد من التلوث البيئي بالمبيدات تم تقييم فعالية بعض الطرق البديلة مثل جذب الحفار بأعداد كبيرة باستخدام الفرمونات، والمعاملات البستانية والميكانيكية والكيماوية الموضعية في منطقة النوبارية محافظة البحيرة خلال ثلاث سنوات متتالية (٢٠٠٠، ٢٠٠١، ٢٠٠٢).

أظهرت النتائج ما يلي:

أدت المعاملة طوال العام بالفرمون فقط إلى تقليل الإصابة بنسبة ٦٢,٢٧، ٧١,٥٠، ٨٢,٣٩% وبالتقليم فقط إلى ١٩,٩٣، ٢٣,٢٠، ٣٠,٤٩% ويقتل اليرقات بالسلك فقط إلى ٤٠,٠٧، ٥٣,٢٥، ٦١,٥٥% وبالدهان الموضعي فقط إلى ٨٠,٩٠، ٨٨,٦٥، ٩٤,٤٦% وبالرش الموضعي فقط إلى ٥٨,٥٠، ٦٨,٦٠، ٧١,٤٥%؛ وبالرش الكلي فقط إلى ٨٢,٨٣، ٩٢,٧٥، ٩٧,٩٢% في حين أدت المعاملة الجزئية بالفرمون مع التقليم إلى ٦٩,٤٠، ٨٠,٠٥، ٨٦,٥٥% والمعاملة الجزئية بالفرمون مع قتل اليرقات بالسلك إلى ٨٦,٤٧، ٩٤,٢٥، ٩٨,٤٨% والمعاملة الجزئية بالفرمون مع الدهان الموضعي إلى ٧٩,٨٠، ٨٧,٤٥، ٩٥,٢٧% والمعاملة الجزئية بالفرمون مع الرش الموضعي إلى ٧٠,٢٧، ٩٥,٦٥، ٩٨,٨٦% والمعاملة الجزئية بالفرمون مع الرش الكلي إلى ٨٦,٠٣، ٩٥,٦٥، ٩٨,٨٦% وذلك عندما أجريت المعاملات لمدة ثلاث سنوات متتالية، علي الترتيب.