EVALUATION OF SOME SEMIOCHEMICALS AND PLANT TRAPS AS AN ALTERNATIVE MEAN OF CONTROL OF *PHLOEOTRIBUS SCARABAEOIDES* IN OLIVE ORCHARDS IN EGYPT

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Abstract

In Egypt, the olive shot hole bark beetle *Phloeotribus scarabaeoides* (Bern.) (Coleoptera: Scolytidae) is a serious pest in olive orchards. Attracting *Ph. scarabaeoides* with semiochemicals and plant traps were conducted in olive orchards at North Sinai and Fayoum governorates during 1999, 2000 and 2001 activity seasons.

1. Thirteen semiochemical attractants (ethyl alcohol, methyl alcohol, ethyl methyl alcohol at the rate of 50:50, ethyl methyl alcohol at the rate of 75:25, ethyl methyl alcohol at the rate of 25:75, ethylene, chlorobenzyle alcohol, butyl acetate, isopropyl acetate, acetaldehyde, amyl acetate, isopentyle acetate, Nu-Lure insect bait) as well as water (as check) were evaluated for their efficiency in attracting *Ph. scarabaeoides*. Ethylene was significantly the most effective attractant semiochemical (224 beetles) compared with the others (0-58.5 beetles).

2. Owing to the superiority of ethylene, the four treatments (ethylene traps in bottles, painting with ethylene the logs of olive branches placed beside the tree trunk, suspending bundles of 5 olive branches, and standing trees) were evaluated for their attractancy from the north, east, south and west. Data indicated that ethylene traps was significantly superior (37.16%) followed by log traps (32.81%), cuttings (19.84%) and standing olive trees (10.19%).

3. Almost 31.08, 25.00, 22.77, and 21.15% of beetles were attracted from the north, west east and south directions, respectively. Accordingly, the northwestern direction was preferred for *Ph. scarabaeoides* beetles infestation.

4. Bottle traps of ethylene and plant traps were evaluated as an alternative mean of controlling *Ph. scarabaeoides* in an olive orchard. Winter pruned logs were painted with ethylene and were painted alternatively with Cidial L 50%, Basudin 60% or Metazon 60% each at the rate of 300 cc 100 l. w. In the treated orchard, the percentage of infested trees decreased from 16% before treatment to 2% after treatment, resulting in 87.50% reduction of infestation. On the contrary, in the untreated orchard, the rate of infestation increased from 14% before treatment to 23 % after treatment. Thus, the trapping treatment resulted in 91.30% reduction of infestation. The active holes per branch decreased from 6.6 before treatment to 1.1 after treatment, resulting in 83.33% reduction of infestation in the treated olive orchards. In the untreated orchard, active holes per branch increased from 6.1 before treatment to 20.0 after treatment. Thus, the trapping treatment resulted in 94.50% reduction in the degree of infestation in the treated olive orchard compared with untreated one.

INTRODUCTION

In Egypt, olive orchards severely attacked with *Phloeotribus scarabaeoides* (Bern.), where larvae of the pest excavate and pupate inside the tree. Thus the available control measures are hardly reach them. The present study dealt with semiochemicals attractants alone or in combination with other environmentally safe horticultural practices in fruit orchards as alternative control strategy.

Researches in this respect are scant. However some attempts to verified the effect of some semiochemicals attractants such as ethylene-baited trees in the integrated management of *Ph. scarabaeoides* in olive orchards were carried out by Girgis (1987), Gonzalez and Campos (1995), Campos and Pena (1995), Gonzalez and Campos (1996), Campos and Pena (1997), Pena *et al.* (1998a) and Pena *et al.* (1998b).

The present investigation is an attempt to evaluate the effect of some semiochemicals attractants and plant traps as an alternative mean of integrated *Ph. scarabaeoides* control in olive orchards. This study aimed at elimination of insecticides used, 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.

MATERIALS AND METHODS

Attracting experiments of *Ph. scarabaeoides* with some semiochemicals and plant traps were conducted in olive orchards at North Sinai and/or Fayoum governorates during 1999, 2000 and 2001 activity seasons.

1. Evaluation of some semiochemical attractants

The following 13 semiochemical attractants as well as water (as check) treatments were evaluated for their efficiency in attracting *Ph. scarabaeoides* in an olive orchard (five feddans) at El-Sheikh Zoeied district, North Sinai governorate during 1999 season of beetles activity (from early April to mid May).

Small cylindrical vials (7.5 cm long and 2.5 cm diameter) containing pieces of cotton or minute chips of olive bark, saturated with each of the 14 treatments. The vials were perforated with eight needle size holes, at the upper third, to allow steady release and evaporation of the semiochemicals used. Vials were hanged in the middle upper third inside two liters empty black painted carbonated water bottles using a wire. Bottles had three windows to allow released vapours outside and serve as entrances to the attracted beetles inside. Bottles were provided with ca. 500 cc of water mixed with few drops of liquid soap to minimize the water surface tension.

Bottle traps were randomly suspended on tree branches at ca. 1.5 m high above the ground with five replicates for each treatment. Saturation of vials was repeated twice at 3 week intervals. The tested 13 treatments (semiochemicals) beside water as control were:

1- Ethyl alcohol (C_2H_5OH), 98%.
2- Methyl alcohol (CH_3OH), 99.9%.
3- Ethyl: methyl alcohol (at the ratio of 50 : 50).
4- Ethyl: methyl alcohol (at the ratio of 75 : 25).
5- Ethyl: methyl alcohol (at the ratio of 25 : 75).
6- Ethylene ($H_2C=CH_2$), 99.5%.
7- Chlorobenzyle alcohol ($ClC_6H_4CH_2OH$), 98%.
8- Butyl acetate (CH_3CO_2 CH $(CH_3)_2$ 99%.
9- Isopropyl acetate (CH_3CO_2CH (CH_3)), 98%.
10- Acetaldehyde (CH_3CHO), 99%.
11- Amyl acetate (CH_3CO_2 (CH_2) $4CH_3$), 99%.
12- Isopentyle acetate (CH3CO2CH2CH2CH (CH3)2), 98%.
13- Nu-Lure Insect baits (corn gluten meal, hydrolyzed).
14- Distilled water, (H_2O) as check control.

2. The relative attraction of ethylene bottle and plant traps

Owing to the superiority of ethylene in attracting *Ph. scoreboards* in olive orchards, the following four treatments were evaluated to compare their attractancy, during June/ July 2000, at Fayoum governorate (Abshaway district):

1. The same previously mentioned trap provided with chips ethylene bottles.
2. Recently cut logs of olive branches, ca. 1 m long and 3-4 cm thick. Logs were placed beside the tree trunk.
3. Recently cut olive branches, ca. 30 cm long and 1 cm thick, in a bundle of 5 branches each. Each bundle was suspended inside each tree and fixed to tree branches at ca. 1.5 m high above grounds.
4. Standing alive trees as traps (check control).

Treatments numbers (2) and (3) were painted completely with ethylene (absolute 95%), while treatment number (4) was partialy painted on the stem (a circle area of about 25 cm long).

Two replicates of each treatment was randomly distributed on trees in each of the four cardinal directions (north, east, south and west). Thus, eight replicates of each cardinal directions / treatment were used.

3. Control studies using ethylene attractants

In an attempt to control *Ph. scarabaeoides* in olive orchards using semiochemical attractants, plant and bottle traps were used during 2000 / 2001 season in two feddans area located at Ibshaway district, Fayoum governorate.

During pruning season in early winter (December 2000), pruned logs ca. 1 m long and 3-4 cm thick were chosen. Starting from February 2001, logs were placed beside the trees in the extreme peripheral of the orchard from the north, east, south and west direction at the rate of one log per tree. Logs were regularly painted with an aqueous solution of ethylene at monthly intervals, alternatively with insecticides (Cidial L 50%, Basudin 60% and Metazon 60% each at the rate of 300 cc per 100 liters water). Spraying insecticides was directed to pruned logs only to prevent the spread of infestation from these logs to the standing trees (not as insecticidal control in this program). During July to November 2001, the infested logs (from February to June) were removed and burned.

From February to November 2001, bottle traps were suspended in 1 feddan of the orchard at the rate of 1 trap per 5 olive trees, as in the previously mentioned technique. Attracting vials were renewed at monthly intervals, and inspection was carried out weekly.

Evaluation of this treatment was conducted by counting the rate and degree of *Ph. scarabaeoides* infestation in the treated orchard and in another untreated adjacent orchard of almost the same area, age, and same infestation level. Evaluation was carried out before the experiment during February and at the end of the beetle's activity season in November.

RESULTS AND DISCUSSION

Attraction experiments on *Ph. scarabaeoides* beetles with some semiochemicals and plant traps were conducted in olive orchards at North Sinai and or Fayoum governorates during 1999, 2000 and 2001 seasons.

1. The relative efficiency of semiochemical attractants

Table (1) showed the relative attraction of *Ph. scarabaeoides* beetles to 13 semiochemicals in addition to the distilled water in an infested olive orchard. Data indicated that among the 14 treatments, only ethylene was the most significantly effective semiochemical in attracting the beetles. The mean numbers of beetles per trap containing vials with cotton and olive ships were 181 and 267 beetles, respectively, with an average 224 beetles.

Intermediate catches were also obtained from 2 semiochemicals, ethyl alcohol (average, 58.5 beetles) and ethyl: methyl alcohol mixture (75:25) (average, 51 beetles).

Attracting effects were less with the semiochemicals, ethyl: methyl alcohol mixture (50:50) (average, 38.5 beetles), and isopentyle acetate (average, 35 beetles)

The response of *Ph. scarabaeoides* beetles to some of the other semiochemical attractants did not significantly differ from that of water showing average 0 – 24.5 beetles per trap, that the water, Nu Lure Insect Bait, amyl acetate, butyl acetate, chlorobenzle alcohol, acetaldehyde, methyl alcohol, isopropyl acetate and ethyl: methyl alcohol mixture (25:75) were the least

Generally, traps with vials containing plant chips saturated with semiochemical attractants were stable and attracted more beetles (total, 533 beetles) than traps with vials containing cotton pieces only (total, 408 beetles). It was obvious that in case of the plant chips, the chips impregnated and saturated with the chemical substance and released, at steady state, took longer time.

2. Comparative effectiveness of ethylene bottle and plant traps

According to the superiority of vial traps containing chips, it was baited with aqueous solution of 95% ethylene and evaluated for their efficiency in attraction of *Ph. scarabaeoides* beetles compared with plant traps (logs, cuttings and standing trees) painted during June/July 2000.

Data in Table (2) indicated that vial traps baited with ethylene caught significantly the maximum numbers of *Ph. scarabaeoides* beetles during 1.5 months, representing 37.16% of the total trapped beetles. Each trap caught 116 - 214 beetles, with an average of 177.25 ± 32.7 beetles during the same period.

Plant traps of olive logs painted with ethylene caught also large numbers of *Ph. scarabaeoides* beetles during 1.5 months, representing 32.81% of the total trapped beetles. Each tree log trap caught 109 - 193 beetles, with an average of 156.5 ± 27.5 beetles during the same period. Olive logs insignificantly varied from vial traps but significantly differed from cuttings and standing olive tree traps.

The lowest numbers of beetles were caught in traps of cuttings or standing olive trees baited with ethylene in a restricted particular area of the tree trunk during 1.5 months, representing 19.84 and 10.19% of the total trapped beetles, respectively. Each trap caught an average of 94.63 ± 27.3 (range, 54 - 135) and 48.63 ±17.4 (range, 29 – 81) beetles, respectively, during the same period. However, these averages significantly differed from each other.

Table 1. Effect of some semiochemicals in attracting *Ph. scarabaeoides* beetles in olive orchards at North Sinai governorate during 1999

No	Semiochemical Treatments	Mean no. of beetles per trap		Average	Grouping
		Vial with cotton	Vial with chips		
1	Ethyl alcohol	51	66	58.5	b
2	Methyl alcohol	13	11	12	ef
3	Ethyl: methyl alcohol mixture (50 : 50)	37	40	38.5	bcd
4	Ethyl: methyl alcohol mixture (75 : 25)	40	62	51	bc
5	Ethyl: methyl alcohol mixture (25 : 75)	26	23	24.5	de
6	Ethylene	181	267	224	a
7	Chlorobenzyle alcohol	0	4	2	ef
8	Butyl acetate	1	3	2	ef
9	Isopropyl acetate	17	19	18	def
10	Isopentyle acetate	39	31	35	cd
11	Amyl acetate	0	1	0.5	f
12	Nu-Lure Insect Bait	0	0	0	f
13	Acetaldehyde	3	6	4.5	ef
14	Distilled water	0	0	0	f
	Total	408	533	470.5	

chemical attractants (averages, 0, 0, 0.5, 2, 2, 4.5, 12, 18 and 24.5 beetles, respectively).

Table 2. Effect of ethylene attractant in vial and plant traps as well as the direction of Ph. Scarabaeoides infestation in olive orchards at Fayoum governorate during June / July 2000.

No.	Direction of traps	Mean no. of beetles per trap							
		Vial traps		Plant traps					
				Logs		Cuttings		Standing trees	
1	North	196	410	181	374	135	262	59	140
2		214		193		127		81	
3	East	152	346	134	243	102	188	32	92
4		194		109		86		60	
5	South	116	289	145	306	92	146	29	66
6		173		161		54		37	
7	West	208	373	177	329	67	161	43	91
8		165		152		94		48	
Total		1418		1252		757		389	
Percentage		37.16%		32.81%		19.84%		10.19%	
Average		177.25 ±32.7		156.50 ±27.5		94.63 ±27.3		48.63 ±17.4	
		a		a		b		c	

3. Trapping *Ph. Scarabaeoides* beetles from different directions

The north direction attracted almost one third of *Ph. scarabaeoides* beetles (31.08%) in infested olive orchard. The average number was 296.50 ± 121.9 beetles. Moderate number of beetles (average, 238.50 ± 134.2 beetles), representing 25.00%, was attracted from the west direction. East and south directions attracted the least numbers of beetles (the respective averages, 217.25 ± 106.1 and 201.75 ± 115.5 beetles) with respective percentages of 22.77 and 21.15% of beetles (Tables 2 and 3).

Accordingly, the northwestern direction was preferred for *Ph. scarabaeoides* beetles infestation. Thus, traps should be placed in this direction.

Table 3. Effect of direction on the attraction of Ph. scarabaeoides in an infested olive orchard at Fayoum governorate during June / July 2000.

Direction of traps	North	East	South	West
Total number of beetles	1186	869	807	954
Average	296.50 ±121.9	217.25 ±106.1	201.75 ±115.5	238.50 ±134.2
Percentage	31.08%	22.77%	21.15%	25.00%

4. Evaluation of semiochemical traps as a mean of control

According to the results of the previous experiments, traps and logs baited with ethylene were efficient in attracting *Ph. scarabaeoides* beetles compared with other plant traps (cuttings and standing trees). Thus, they were evaluated as an alternative mean of the pest control in olive orchards.

Data in Table (4) proved that, in the treated olive orchard, the percentage number of infested trees decreased from 16% before treatment to 2% after treatment, resulting in 87.50% reduction of *Ph. Scarabaeoides* infestation. On the contrary, in the untreated olive orchard, the rate of infestation increased from 14% before treatment to 23% after treatment. Thus, the trapping treatment resulted in 91.30% reduction of infestation in the treated olive orchard compared with untreated one at the end of the season (November).

The average degree of infestation decreased from 6.6 ± 3.5 (range, 1–13) active holes per branch of 1 meter long before treatment to 1.1 ± 1.1 (range, 1–3) active holes after treatment, resulting in 83.33% reduction of *Ph. scarabaeoides* infestation in the treated olive orchards.

On the other side, in the untreated olive orchard, the rate of infestation increased from an average of 6.1 ± 3.7 (range, 0–12) active holes per branch of 1 meter long before treatment to 20.0 ± 11.4 (range, 1–36) active holes after treatment.

Table 4. The percentage reduction of both rate and degree of Ph. scarabaeoides infestation in olive orchards at Fayoum governorate during 2001 season.

Infestation	Rate of infestation (%)		Degree of infestation	
	Treated	Untreated	Treated	Untreated
Before treatment	16	14	6.6 ± 3.5 (1-13)	6.1 ± 3.7 (0-12)
After treatment	2	23	1.1 ± 1.1 (1-3)	20.0 ± 11.4 (1-36)
% reduction of infestation	87.50 *		83.33 *	
		91.30 **		94.50 **

Where:

* = % reduction of infestation compared with before treatment.

** = % reduction of infestation compared with untreated.

Thus, the trapping treatment resulted in 94.50% reduction in the degree of infestation in the treated olive orchard compared with untreated one at the end of the same season (November).

The recent results are in agreement with the results obtained in Spain by Gonzalez and Campos (1995), who verified the effect of ethylene-baited trees in the integrated management of *Ph. scarabaeoides*. In addition, Campos and Pena (1995) found that concentrations of ethylene play an important role in the primary attraction of *Ph. scarabaeoides* to their host. Gonzalez and Campos (1996), stated that ethylene treatment aided the location of the olive wood by the flying beetles, and the attack density was significantly greater in the treated wood at the end of the experiment. Pena *et al.* (1998b), found that spraying olive logs with ethrel (a formulation that releases ethylene) was the most effective treatment to attract *Ph. scarabaeoides* and Pena *et al.* (1998a) stated that the best results were obtained when using plastic dispensers with holes in their upper surface containing an aqueous solution of ethrel. They also found that the addition of different plant materials to these dispensers triggered the release of ethylene.

At the same time, it seemed, that the current results agree with Campos and Pena (1997), in Spain, who carried out control experiment of *Ph. scarabaeoides* by treating cut olive logs with methoxychlor at 0.1%. Treatments eliminated part of the pest population and affected the fecundity of exposed females without affecting natural enemies (parasitoids). The combination of methoxychlor with an attractant, ethylene, did not change the attractively of the latter.

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تقييم فعالية بعض الجاذبات من أشباه الكيماويات والمصائد النباتية كأحد الطرق البديلة لمكافحة خنافس قلف الزيتون ***Phloeotribus scarabaeoides*** في حدائق الزيتون في مصر

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تعتبر خنافس قلف الزيتون من الآفات شديدة الخطورة في حدائق الزيتون في مصر. أجريت تجارب جذب خنافس قلف الزيتون باستخدام الجاذبات من أشباه الكيماويات والمصايد النباتية في حدائق الزيتون في محافظيى شمال سيناء أوالفيوم خلال موسم نشاط الخنافس لأعوام ١٩٩٩ و٢٠٠٠ و٢٠٠١.

أ- تم تقييم فعالية ١٣ من أشباه الكيماويات (كحول إيثيلى، وكحول ميثيلى، وكحول إيثيلى: ميثيلى بنسبة ٥٠:٥٠، وكحول إيثيلى: ميثيلى بنسبة ٢٥:٧٥، وكحول إيثيلي: ميثيلي بنسبة ٧٥:٢٥، والإيثيلين، وكحول الكلوروبنزايل، وأسيتات البيوتايل، وأسيتات الأيزوبروبايل، والأسيتالدهيد، وأسيتات الأميل، وأسيتات الأيزوبنتايل، وجاذب الحشرات نيو لور) بالإضافة إلى الماء المقطر (كمقارنة). تم تعليق أنابيب مشبعة بأشباه الكيماوية المختلفة في مصايد على الأفرع على ارتفاع ١,٥ متر. دلت النتائج على تفوق مادة الإيثيلين في جذب خنافس قلف الزيتون (٢٢٤ خنفساء) بصورة معنوية عن باقي المواد الأخرى (صفر – ٥٨,٥ خنفساء).

بـ- نظرا لتفوق مادة الإيثيلين، فقد تم تقييم ٤ معاملات (١- مصايدالإيثيلين في زجاجات المياه، ٢- قطع كبيرة من أخشاب الزيتون توضع بجوار جذوع الأشجار، ٣- حزم من ٥ أفرع زيتون تعلق علي الأشجار، ٤- ودهان مناطق علي جذوع الأشجار القائمة بالإيثيلين فقط) في قدرتها النسبية على جذب الخنافس من الاتجاهات الأربعة (شمال وشرق وجنوب وغرب). دلت النتائج على تفوق مصايد الإيثيلين (٣٧,١٦%)، يليها مصايد القطع الكبيرة من أخشاب الزيتون بدون فرق معنويا (٣٢,٨١%). جاءت مصايد الأفرع النباتية والمناطق المدهونة على الأشجار القائمة في المرتبة الأخيرة (١٩,٨٤ و ١٠,١٩%،على الترتيب).

جـ- بلغت نسبة اصطياد الخنافس ٣١,١، ٢٥، ٢٢,٨، ٢١,٢% من اتجاه الشمال الشرق والغرب والجنوب، على الترتيب. وبذلك يكون اتجاه الشمال الغربي هو الاتجاه المفضل لخنافس قلف الزيتون.

د- تم تقييم استخدام مصايد من مادة الإيثيلين كجاذب من أشباه الكيماويات والمصايد النباتية كوسيلة بديلة لمكافحة خنافس قلف الزيتون في حدائق الزيتون. تم دهان أفرع التقليم الشتوي بمحلول الإيثيلين ثم وضعها بجوار الأشجار في المحيط الخارجي للحديقة في الاتجاهات الأربعة بمعدل قطعة واحدة لكل شجرة ثم دهان الأفرع بانتظام مرة كل شهر بالتبادل بمبيدات السيديال ٥٠% أوالباسودين ٦٠% أو الميتازون ٦٠% بمعدل ٣٠٠ سم٣ لكل ١٠٠ لتر ماء. أسفرت النتائج عن تقليل الإصابة

في الحدائق المعاملة من ١٦% قبل المعاملة إلى ٢% بعد المعاملة أي بنسبة خفض ٨٧,٥٠%، وعلى العكس من ذلك فإن الحدائق غير معاملة ارتفعت فيها نسبة الإصابة من ١٤% في بداية التجربة إلى ٢٣% في نهايتها أي أنه بالمقارنة بالأشجار المعاملة تصل نسبة الخفض ٩١,٣٠%. ومن جهة أخرى انخفض متوسط عدد الثقوب في الأفرع المعاملة من ٦,٦ إلى ١,١ ثقب نشط في الحديقة المعاملة بنسبة خفض في الإصابة ٨٣,٣٣% بينما في الحدائق غير المعاملة ارتفع متوسط عدد الثقوب في الفرع من ٦,١ إلى ٢٠,٠ ثقب نشط وبمقارنة الحديقة المعاملة بالحديقة الغير معاملة تصل نسبة الخفض في الإصابة ٩٤,٥٠%.