STONE FRUIT TREE PESTS: (8) ALTERNATIVE MEANS OF CONTROL OF *SCOLYTUS AMYGDAL* BY HORTICULTURAL, MICROBIOLOGICAL, AND LOCAL CHEMICAL TREATMENTS IN APRICOT ORCHARDS IN EGYPT

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Abstract

Alternative means of control of *Scolytus amygdali* (Coleoptera: Scolytidae) in apricot orchards by horticultural, microbiological, and local chemical treatments were evaluated at Tokh district, Qalubia governorate during one and two successive years (1999/2000 and 2000/2001). The respective rates reductions of infestation with the following 12 treatments applied for one and two successive years were as follows: dormant pruning (33.33 increased to 41.76%), summer pruning (17.61 increased to 21.53%), dormant and summer pruning (45.30 increased to 55.30%), bacterial or fungal (5.74 or 8.31 increased to 8.81 or 11.91%), local painting or local spraying (58.36 or 66.57 increased to 64.76 or 75.04%), pruning together with bacterial or fungal (51.14 0r 52.23 increased to 57.75 or 60.52%), pruning and local painting or local spraying (77.74 or 83.98 increased to 84.34 or 90.70%) treatments.

INTRODUCTION

In Egypt, *Scolytus amygdali* (Coleoptera: Scolytidae) is a destructive pest in apricot orchards. Larvae bore their tunnels under the bark of the stem and branches, reducing the production, causing weakness and quick death of trees.

In spite of the high cost of chemical control with complete coverage spray with insecticides, the adverse affect on the biological control agents (parasites, predators, and pathogens), and pollution of the environment, recommendations for the control of the fruit tree borers' infestation in stone fruit orchards are still mainly directed towards the chemical control treatments.

Because apricot is a profitable crop, therefore plantations spread allover the new reclaimed lands in addition to old Delta lands. This study is a pioneer attempt to control the bark beetle *S. amygdali*, which is one of the apricot production-limiting factors.

The available literature in Egypt included studies on the biology of *S. amygdali* on peach trees (Tadros, 1994), monitored the population fluctuation in apricot orchards (Tadros and Abd-Allah, 1987, and Tadros, *et al.*, series no. 5, in press).

These studies are essential in determination of the proper timing of the pest control treatments. Previous trials to control *S. amygdali* in Egypt were lacking. However, abroad Ben-Yehuda and Mendel (1997) in Israel conducted chemical control experiments on *S. amygdali* and obtained satisfactory results. Ben Yehuda (2002) found that application of non-selective insecticides, burning of dead trees and pruning slash were environmentally unsafe and were often ineffective control.

The aim of the present investigation 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 *S. amygdali.*

MATERIALS AND METHODS

Experiments were carried out at Tokh district, Qalubia governorate, in an apricot orchard (10 feddans and 20 years old) highly infested with *S. amygdali.* Trials were extended during 2 successive years from October 1999 to December 2001. The following 12 treatments were evaluated using completely randomized design (50 trees each treatment and each tree was considered a replicate).

a. Horticultural treatments:

1. **Dormant pruning treatment:** During December of each year, the regular horticultural winter pruning was carried out including the infested branches and stubs (characterized with exit holes).
2. **Summer pruning treatment:** During July, the newly infested branches were pruned.
3. **Dormant and summer pruning treatments:** Treatments numbers 1 and 2 were applied together.

b. Microbiological treatments:

4. **Bacterial treatment:** Bactospeine F.C. (a.i. *Bacillus thuringiensis* (Berliner), 8500 International Units Ak / mg) at the rate of 200 cc/100 liters of water was locally sprayed on the stem, main branches and pruning sites 4 times each season (at monthly intervals on May, June, July and August) using knapsack sprayer.
5. **Fungal treatment:** Biofly F.C. (a.i., *Beauveria bassiana*, 3 x 10^7 spores / mg) at the rate of 400 cc/100 l. w. were locally sprayed on the stem, main branches and pruning sites 4 times each season (at monthly intervals on May, June, July and August) using knapsack sprayer.

c. Local chemical treatments:

6. **Local painting treatment:** Stemex insecticide (3% Anthracine + 18% Naphthalene) was used to paint the stem, main branches and infested sites 4 times each season at monthly intervals (May, June, July, and August). Painting

was practical using a brush.

7. **Local spraying treatment:** The MOA recommended Basudin (Diazinon) 60% EC and Cidial L (Phenthoate) 50% EC each at the rate of 300 cc/100 l. w. was sprayed alternatively 4 times each season at monthly intervals (May, June, July, and August). Spraying was practiced by a knapsack sprayer and mainly directed towards the stem, branches and infested sites.

d. Combined treatments:

8. **Pruning and bacterial treatment:** Treatment numbers 3, 4, and 5 were conducted together.
9. **Pruning and fungal treatments:** Treatments numbers 3, 4, and 6 were conducted together.
10. **Pruning and local painting treatments:** Treatments numbers 3, 4, and 7 were conducted together.
11. **Pruning and local spraying treatments:** Treatments numbers 3, 4, and 8 were carried out together.

e. Untreated:

12. **Check treatment:** Check trees were left untreated as control treatment.

f. Procedures of treatments: The previous 12 treatments were conducted from November 1999 to October 2000 season. During the 2nd season (November 2000 to October 2001), the same previous treatments were repeated on other trees in another nearby area of the same orchard with the same technique for confirmation. In the meantime, the same previous 12 treatments were carried out on the same past year trees to evaluate the cumulative effect of the two successive years (from November 1999 to October 2001). Treatments were evaluated by counting the newly emerged beetles indicated by the newly exit holes on one meter long branches scattered on each tree "replicate" during the following season. New exit holes were continuously counted and canceled by painting after each year treatment.

h. Evaluation of treatments: The efficiency of treatments was based on the percentage reduction of infestation (Henderson and Tilton, 1955), as follow:

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

Where, C: the mean number of new exit holes in untreated trees.

T: the mean number of new exit holes in treated trees.

Grouping of treatments was based on ANOVA test and "Least Significant Difference" (Snedecor and Cochran, 1990).

RESULTS AND DISCUSSION

Experiments were applied to evaluate the effect of different horticultural, microbiological, and local chemical treatments alone or in combination with each other's on the reduction of *S. amygdali* infestation. The direct effects of treatments were evaluated when applied for only one single year (1999–2000 or 2000-2001). The cumulative effects were also evaluated as well for two successive years (1999-2001).

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

a. Effect of horticultural treatments alone:

1. **Effect of dormant pruning:** Pruning treatment was of considerable value since the borer severely attacked the branches, which mainly included in the dormant pruning as well as the stem of trees. Thus, the reduction of infestation reached 32.85–33.67 % (mean, 33.33 %).
2. **Effect of summer pruning:** Because infestation with *S. amygdali* expanded all the year round, summer pruning of newly infested branches was of some value as the percentage reduction in the borer infestation ranged 15.22-19.26% (mean, 17.61%).
3. **Effect of dormant and summer pruning:** Remarkable degree of *S. amygdali* infestation was achieved when dormant and summer pruning treatments were applied together. The increased percentages reduction of the borer infestation ranged 44.93–45.56% (mean, 45.30%).

b. Effect of microbiological treatments:

4. **Effect of bacterial:** Bacterial treatment was relatively inactive in the field as the bacteria highly affected with the weather factors (especially higher temperature and hot wind) and the difficulty of these bacteria to reach the larvae inside their tunnels. Therefore, this treatment was less effective as the percentage reduction of infestation recorded only 5.31-6.03% (mean, 5.74%).
5. **Effect of fungal:** Although the effect of fungal treatment was rather higher than bacterial treatment, yet it was still of lower effect than other treatments. The percentage reduction in *S. amygdali* infestation reached 8.21-8.38% (mean, 8.31%).

c. Effect of local chemical treatments:

6. **Effect of local painting:** Local painting four times a year with "Stemex" insecticide on the stem and larger pruned areas reasonably increased the percentage reduction of *S. amygdali* infestation showing 55.07–60.64% (mean, 58.36%).
7. **Effect of local spraying:** Local spraying four times a year with insecticides to

the stem, bases of main branches and pruned stubs remarkably reduced *S. amygdali* infestation with 64.01-68.34% (mean, 66.57%). This treatment hindered the beetle settings, the beetle oviposition, hatching and larval entry inside the apricot wood.

d. Effect of combined treatments:

8. **Effect of pruning and bacterial:** Good results were obtained when dormant, summer pruning and bacterial treatments were all applied together in apricot orchards. The percentage reduction in *S. amygdali* infestation was 46.62-54.27% (mean, 51.14%). This result was mainly due to pruning treatment.
9. **Effect of pruning and fungal:** The effect of these treatments was also due to pruning rather than fungal treatment. The combined effect of dormant, summer pruning and fungal treatments resulted in 48.07-55.11% (mean, 52.23%).
10. **Effect of pruning and local painting:** Excellent results were achieved when these combined treatments were applied together showing 75.12–79.56% (mean, 77.74%) reductions of infestation. The effect was due to all the three treatments rather than one main treatment.
11. **Effect of pruning and local spraying:** In addition, excellent and satisfactory results were achieved when these combined treatments were applied together showing 79.47-87.10% (mean, 83.98%) reductions in infestation.

Table 1. Effect of one single year treatments on the percentage reduction in *Scolytus amygdali* infestation in apricot orchards at Qalubia governorate during 1999-2000 and 2000-2001 seasons.

Treatments	% reduction of infestation					
	1st year 1999-2000		2nd year 2000-2001		Mean	
	No. of exit holes	%	No. of exit holes	%	No. of exit holes	%
A: Horticultural Treatments:						
1. Dormant pruning	396	33.67	278	32.85	337.0	33.33
2. Summer pruning	482	19.26	351	15.22	416.5	17.61
3. Dormant & summer pruning	325	45.56	228	44.93	276.5	45.30
B: Microbiological Treatments:						
4. Bacterial	561	6.03	392	5.31	476.5	5.74
5. Fungal	547	8.38	380	8.21	463.5	8.31
C: Local Chemical Treatments:						
6. Local painting	235	60.64	186	55.07	210.5	58.36
7. Local spraying	189	68.24	149	64.01	169.0	66.57
D: Combined Treatments:						
8. Treatments, 3 + 4	273	54.27	221	46.62	247.0	51.14
9. Treatments, 3 + 5	268	55.11	215	48.07	241.5	52.23
10. Treatments, 3 + 6	122	79.56	103	75.12	112.5	77.74
11. Treatments, 3 + 7	77	87.10	85	79.47	81.0	83.98
E: Untreated Treatments:						
12. Check	597	--	414	--	505.5	--

B. Effect of two successive year treatments (Cumulative effect): Table (2)

a. Effect of horticultural treatments alone: Dormant pruning treatment alone in winter somewhat reduced *S. amygdali* infestation when applied for two successive years. This relatively low percentage reduction of infestation (41.76%) was because the larval infestation concentrated in the stem and main branches. However, continuous winter pruning effectively shared in reducing the borer infestation. Summer pruning had less effect (21.53%) on the reduction of infestation although it was repeated for two successive years. Summer pruning somewhat shared in the reduction of infestation and should be included in the integrated control program. Applying

dormant and summer pruning treatments together for two successive years effectively reduced infestation with 55.30%. This reasonable effect was mainly due to dormant pruning.

b. Effect of microbiological treatments: The pathogenic bacteria or fungus was relatively useless even when applied cumulatively for two successive years (8.81 and 11.91%, respectively).

c. Effect of local treatments: Local painting and local spraying 4 times a year was quite effective in the reduction of *S. amygdali* infestation especially when was applied for two successive years (64.76 and 75.04%, respectively).

d. Effect of combined treatments:

Applying dormant pruning, summer pruning microbiological, and/or local chemical treatments in different combinations resulted in adequate reduction in *S. amygdali* infestation especially when carried out year after another.

Winter and summer pruning and bacterial treatments showed 57.75% reduction of infestation when conducted for two successive years. Applying winter and summer pruning and fungal treatments for two successive years resulted in almost similar results (60.52%). Winter and summer pruning with local painting for two successive years almost doubled percentage reduction in the borer infestation (84.34%). Winter and summer pruning with local spraying for two successive years resulted in almost similar percentage reduction in the borer infestation (90.70%). These combined treatments would resulted in more reduction in *S. amygdali* infestation should they applied yearly.

Table 2. Effect of two successive year treatments on the percentage reduction in *Scolytus amygdali* infestation in apricot orchards at Qalubia governorate during the two successive seasons (1999-2001) and differences between one and two year's treatments.

Treatments	Two successive years		Differences between % reduction of infestation of 1 & 2 years
	No. of exit holes	% reduction of infestation	
A: Horticultural Treatments:			
1. Dormant pruning	357	41.76	8.43
2. Summer pruning	481	21.53	3.92
3. Dormant & summer pruning	274	55.30	10
B: Microbiological Treatments:			
4. Bacterial	559	8.81	3.07
5. Fungal	540	11.91	3.6
C: Local Chemical Treatments:			
6. Local painting	216	64.76	6.4
7. Local spraying	153	75.04	8.47
D: Combined Treatments:			
8. Treatments, 3 + 4	259	57.75	6.61
9. Treatments, 3 + 5	242	60.52	8.29
10. Treatments, 3 + 6	96	84.34	6.6
11. Treatments, 3 + 7	57	90.70	6.72
D: Untreated Treatments:			
12. Check	613	--	

C. Statistical analysis: Statistical analysis and grouping of the 12 treatments applied for one and two years concluded that there were significant differences between treatments and classified as: {insignificant differences between the same letters of grouping}

a. Superior group (80 – 100%):

1. Pruning and local spraying for two years (90.70%) A
2. Pruning and local painting for two years (84.34%) A
3. Pruning and local spraying painting for one year (83.98%) A

b. Sufficient group (60 – less than 80%):

1. Pruning and local painting for one year (77.74%) A
2. Local spraying for two years (75.04%) A
3. Local spraying for one year (66.57%) AB
4. Local painting for two years (64.76%) AB
5- Pruning and fungal for two years (60.52%) B

c. Moderate group (40 - less than 60%):

1. Local painting for one years (58.36%) B
2. Pruning + Bacterial for two years (57.75%) B
3. Dormant and summer pruning for two years (55.30%) B
5. Pruning + Fungal for one year (52.23%) B
5. Pruning + Bacterial for one year (51.14%) B
6. Dormant and summer pruning for one year (43.30%) BC
7. Dormant pruning for two years (41.76%) BC

d. Less group (20 - less than 40%):

1. Dormant pruning for one year (33.33%) C
2. Summer pruning for two years (21.53%) C

d. Least group (zero - 19%):

1. Summer pruning for one year (17.61%) CD
2. Fungal for two years (11.91%) CD
3. Bacterial for two years (8.81%) D
4. Fungal for one year (8.31%) D
5. Bacterial for one year (5.74%) D

DISCUSSION

From the foregoing results in Tables (1) and (2), it could be concluded that the direct effect of one single year treatments on *S. amygdali* infestation varied from one treatment to another. The cumulative effect of two successive year treatments concluded that the infestation could be highly reduced if these treatments repeated year after another. The effect of horticultural treatments alone (winter and summer pruning) approximated 45 and 55% reduction of infestation when applied for 1 and 2 years, respectively. However, the majority of the effect was due to dormant winter pruning (33 and 42%, respectively). Summer pruning was negligible (18 and 22%, respectively).

Microbiological treatments with bacteria or fungus showed very low effects (6 and 8% for one year, slightly increased to 9 and 12% for two years). This was owing to the phenomenon that the pest hide inside the tree wood under the bark in addition that the bacteria and fungus were highly affected with the weather factors in the field and failed to reach the larvae inside.

Local spraying and local painting were quite effective in the reduction of the borers' infestation (58 and 67%). The cumulative effect for two years increased the reduction of infestation to 65 and 75%, respectively.

Applying dormant pruning in winter with the summer pruning, worming together with pathogenic microbiological or local chemical treatments in different combinations

magnified the reduction of infestation and greatly magnified the reduction of infestation when applied for two successive years. Pruning and bacterial or fungal treatments reduced the infestation with about 51 or 52% for one year and 58 or 61% for two years. However, local painting or local spraying with pruning treatments greatly reduced the infestation with 78 or 84% for one year and 84 or 91% for two years, respectively.

Table (2) concluded that repeating the different treatments from one year to another was of great value in effective treatments, of less value in moderately effective treatments, but of no value in the least effective treatments.

Repeating winter and summer pruning together increased the reduction of infestation with 10%, (winter pruning only increased with 9% while summer pruning only increased with 4%). Repeating bacterial or fungal treatments increased the reduction of infestation with 3 or 4%. Repeating local spraying or painting treatments increased the reduction of infestation with 7-8%, respectively. Repeating the different combinations of pruning with microbiological treatments increased the reduction of infestation with 7-9% but with local chemical treatments increased with 6-7%.

It could be concluded that the low cost and environmentally safe treatments such as winter pruning increased the reduction of infestation and was of great value, and should be repeated each year. Repeating local spraying or painting treatments was also valuable, especially when applied after harvesting. Microbiological treatments should be excluded although they are environmentally safe.

The previous treatments on the control of *S. amygdali* are applied for the first time in apricot orchards in Egypt. However, Ben-Yehuda and Mendel (1997) in Israel found that foliar sprays with chemicals on *S. amygdali* and *S. mediterraneus* [*S. rugulosus*] resulted in satisfactory results. Ben Yehuda (2002) stated that applications of non-selective insecticides, burning of dead trees and pruning slash were environmentally unsafe and were often ineffective for *S. amygdali* control.

In China, Li *et al.* (1995) and Wang *et al.* (1998) stated that *S. seulensis* was a pest of stone fruits, causing 15-30% damage to apricot trees. They proposed enforcing quarantine and improving orchard management as control measures, while spraying insecticides resulted in >85% control.

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آفات أشجار الفاكهة ذات النواة الحجرية:

(٨) الطرق البديلة لمكافحة خنافس قلف الحلويات *Scolytus amygdali* باستخدام المعاملات البستانية والميكروبية والكيماوية الموضعية في حدائق المشمش في مصر

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تم تقييم فعالية بعض الطرق البديلة لمكافحة خنافس قلف الحلويات *Scolytus amygdali* في حدائق المشمش باستخدام المعاملات البستانية والكيماوية الموضعية في منطقة طوخ، محافظة القليوبية لمدة عام واحد وعامين متتاليين (١٩٩٩/٢٠٠٠،و ٢٠٠٠/٢٠٠١). بلغت معدلات تقليل الإصابة عند تطبيق المعاملات ألاثني عشر الآتية لمدة عام واحد وعامين متتاليين ما يلي، علي الترتيب: معاملات التقليم الشتوي (33.33% ازدادت إلي ٤١,٧٦%)، ومعاملات التقليم الصيفي (١٧,٦١% ازدادت إلي ٢١,٥٣%)، ومعاملات التقليم الشتوي والصيفي معا (45.30% ازدادت إلي ٥٥,٣٠%)، والمعاملات البكتيرية أوالفطرية (٥,٧٤-٨,٣١% ازدادت إلي ٨,٨١-١١,٩١%)، ومعاملات الدهان الموضعي أوالرش الموضعي (٥٨,٣٦-٦٦,٥٧% ازدادت إلي ٦٤,٧٦-٧٥,٠٤%)، ومعاملات التقليم مع البكتيرية أوالفطرية (٥١,١٤-٥٢,٢٣% ازدادت إلي ٥٧,٧٥-٦٠,٥٢%)، ومعاملات التقليم، مع الدهان الموضعي أوالرش الموضعي (٧٧,٧٤-٨٣,٩٨% ازدادت إلي ٨٤,٣٤-٩٠,٧٠%).