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V. SUMMARY

Larvae of woodborers excavate and pupate inside the tree wood, thus the available insecticides do not reach them to check their ravages, making the search for alternate control strategies mandatory. The present study dealt with the mass attraction of adult borers by pheromone, light, and semiochemicals attractants alone or in combination with other environmentally safe horticultural practices in fruit orchards.

Field trials on ***Z. pyrina*, *S. myopaeformis*, *Sc. amygdali*** and ***Ph. scarabaeoides*** were conducted along the 7 successive year's activity seasons from 1996 until 2002 in heavily infested apple, pear, apricot and / or olive orchards at Qalubia, North Sinai, Fayoum and / or Behera governorates of Egypt.

1. Trap design experiments:

Several pheromone trap designs have been developed for monitoring and control by mass trapping of boring pest populations.

The first step was to point out the most effective, applicable and economic trap shape, size, height, colour and distances. Trials were conducted in infested pear and apple orchards located at Qalubia governorate for ***Z. pyrina*** and ***S. myopaeformis*** moths, respectively, during the activity seasons of 1996 to 2000.

1.1. Trap shape:

Considering the economic and applicable aspects, the relative effectiveness of 8 commercially locally made and imported traps were evaluated in trapping ***Z. pyrina*** and ***S. myopaeformis*** moths. These shapes were:

1- Large empty opaque ice cream cups, 2- Empty transparent mineral water or carbonated water bottles, 3- Empty opaque petroleum oil

or vegetable oil bottles, 4- Empty opaque petroleum oil buckets, 5- Locally made cardboard pyramid sticky traps, 6- Locally made funnel traps, 7- The recommended imported pyramid sticky traps and 8- The recommended imported funnel traps.

Results indicated that, transparent carbonated water bottle was the preferred and best trap shape for ***Z. pyrina*** and ***S. myopaeformis*** under the Egyptian conditions. It was less expensive, easier to construct, use, store and transport, required less preparation and handling time in the field and had large capacity available for capturing mass numbers of males.

1.2. Trap size:

Four sizes (0.5, 1, 1.5 and 2 liters) of transparent carbonated water bottle traps were evaluated for their efficiency in trapping ***Z. pyrina*** and ***S. myopaeformis*** male moths.

From the statistical (trap catches was proportional to trap size), economical and applicable points of view, 2 liters transparent carbonated water bottles were the most efficient trap size.

1.3. Trap height:

Transparent carbonated water bottles with 2 liters size were evaluated in trapping ***Z. pyrina*** and ***S. myopaeformis*** male moths at 6 different heights (on the ground 0, 0.5, 1, 1.5, 2 and 2.5 meters above the ground level).

It could be recommended that the optimum trap height for ***Z. pyrina*** in pear orchards was 1.5 meters above the ground but 2.5 meters above the ground in case of ***S. myopaeformis*** in apple orchards.

1.4. Trap color:

The efficiency of 7 trap colors (yellow, red, white, blue, green, black and transparent) in capturing ***Z. pyrina*** and/or ***S. myopaeformis*** males was evaluated.

From the statistical points of view yellow trap was the best trap colour, but from economical and applicable point of view transparent trap was most suitable and of equal effect in capturing ***Z. pyrina*** and ***S. myopaeformis*** males.

1.5. Trap distance (numbers of traps per feddan):

Tests to determine the minimum number of traps per feddan (168, 42, 18 and 10 traps), traps were distributed at 5, 10, 15 and 20 meters apart.

From the statistical, economical and applicable points of view, the maximum trapping distance for trapping ***Z. pyrina*** and ***S. myopaeformis*** was 20 meters apart.

From all the previous results, and considering the economical and applicable aspects, the transparent carbonated water bottle traps, of 2 liters size, that were suspended on trees at 1.5 - 2.5 meters above the ground and placed at 20 meters between trees, were the optimum trap design for trapping ***Z. pyrina*** and ***S. myopaeformis***.

2. Light trap experiments:

Four locally made light-traps were set, 3 meters high, at Qalubia governorate in an almost isolated apple orchard (2 traps) and pear orchard (2 traps). During ***Z. pyrina*** 1998 activity season, the lamps of the traps were operated automatically every night from sunset and switched off at sunrise using photoelectric cell.

At the same time 12 delta sticky traps loaded with ***Z. pyrina*** sex pheromone were applied in another 2 apple and pear orchards. Traps were suspended on the tree branches at the rate of 1 trap per feddan from April to Novamber 1998 and the trapped males were collected and counted weekly. In the meantime, the pupal skin count technique was applied in the 2 apple and pear orchards. The old empty pupal skins were counted, and removed weekly.

Evaluation of light trap catches was carried out in comparison with catches of pheromone trap and pupal skin count techniques which applied, at the same time, in separat apple and pear orchards.

Monitoring ***Z. pyrina*** using sex pheromone catches coincide with the traditional pupal skin count technique in date of starting emergence, peaks and date of cesing emergence but differ from that in the light trap catches.

It could be concluded that light trap catches were considered of no value if compared with pupal skin counts as the total number of moths per season in light trap placed in 9 feddans was 173 and 176 moths compared with 1728 and 1240 moths, in only 200 trees (one feddan), of apple and pear, receptively. In the mean time, the total number of male moths caught in light trap from 9 feddans was 111 and 107 males compared with 309 and 312 males, caught in pheromone trap placed in only one feddan.

Considering the area of influence, the relative percentage of moths caught in light trap (in 9 feddans) compared with pupal skin counts were 1% & 4% and 1% & 3% for apple and pear, receptively, when compared with pheromonal traps.

According to the previous results, the weekly catches of light traps as well as those of other two techniques used, indicated that, it could not relay upon light traps in mass attracting in any IPM programs of ***Z. pyrina*** either in apple or pear orchards.

Trapping other fruit tree borers (non target pests) in apple and pear orchards:

Although there were severe infestation with fruit tree borers other than ***Z. pyrina*** in the experimental apple and pear orchards, yet light traps did not trap ***S. myopaeformis***; ***Sc. amygdali*** or ***Chlorophorus varius*** (the main serious apple and pear wood tree borers' species) except some individuals accidentally.

3. Attracting Scolytidae experiments:

3.1. Attracting *Ph. scarabaeoides* 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.

3.1.1. Evaluation of some semiochemical attractants:

Thirteen semiochemical attractants as well as water (as check) treatments were evaluated for their efficiency in attracting ***Ph. scarabaeoides*** in an olive orchard at North Sinai governorate during 1999 season of beetles' activity.

The semiochemicals were; 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 and/or distilled water.

Results showed that ethylene was significantly the most effective semiochemical in attracting ***Ph. scoreboards*** in olive orchard.

3.1.2. The relative attractancy of bottle traps and plant traps:

Owing to the superiority of ethylene in attracting ***Ph. scoreboards*** in olive orchards, the following treatments were evaluated for their attractancy during 2000 season at Fayoum governorate, - traps provided with ethylene, - recently cut logs of olive branches, placed beside the tree trunk, - recently cut olive branches in bundles suspended on trees and - standing trees painted with ethylene on the stem. Each treatment was randomly distributed on trees in each of the 4 cardinal directions (north, east, south and west).

Data indicated that vial traps baited with ethylene, caught significantly the maximum numbers of ***Ph. scarabaeoides*** beetles, representing 37.16% of the total trapped beetles. Each trap caught 116 - 214 beetles, with an average of 177.25 beetles. Plant traps of olive logs painted with ethylene caught also large numbers of ***Ph. scarabaeoides*** beetles, representing 32.81% of the total trapped beetles. Each tree log trap caught 109-193 beetles, with an average of 156.5 beetles. 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 on the trunk, representing 19.84 and 10.19% of the total trapped beetles, respectively. Each trap caught an average of 94.63 and 48.63 beetles, respectively. However, these averages significantly differed from each other.

3.1.3. Trapping *Ph. Scarabaeoides* beetles from different directions:

The north direction attracted almost one third of ***Ph. scarabaeoides*** beetles (31.08%) in infested olive trees. The average number was 296.50 beetles. Moderate number of beetles (average, 238.50 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 and 201.75 beetles) with respective percentages of 22.77% and 21.15% of beetles.

Accordingly, the northwestern direction was preferred for ***Ph. scarabaeoides*** beetles infestation.

3.1.4. Evaluation of semiochemical traps as a mean of control:

An attempt, to use bottle traps and plant traps as a mean of controlling ***Ph. scarabaeoides*** in an olive orchard, was applied during 2000 / 2001 located at Fayoum governorate.

Winter pruned logs were painted with ethylene and placed beside olive trees in the extreme peripheral of the orchard from the north, east, south and west at the rate of one log per tree. Logs were regularly painted alternatively with insecticides (Cidial L 50%, Basudin 60% and Metazon 60%) each at the rate of 300 cc 100 liters_water.

Results clarified that, in the treated olive orchard, the percentage 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.

The average degree of infestation decreased from 6.6 active holes per branch before treatment to 1.1 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 active holes per branch before treatment to 20.0 active holes 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.

3.2. Attracting *Sc. amygdali* in apricot orchards:

The field response of ***Sc. amygdale*** to some semiochemicals was evaluated during 1998, in an infested apricot orchard, at Qalubia governorate. The semiochemicals used were; butyl acetate, isopentyle acetate, amyl acetate, isobutyl acetate, and Nu-Lure Insect bait. Black, green and transparent traps were evaluated, at the same time, for their efficiency in trapping ***Sc. amygdali***. Traps were suspended from late April until late July 1998.

Data indicated that isobutyl acetate was the most effective material in attracting ***Sc. amygdali*** beetles where the total attracted number was 361 beetles with an average of 27.77 beetles. Isopentlyl acetate and butyle acetate were of low attractancy effect showing the respective total numbers of 187 and 177 beetles with the averages of 14.38 and 13.62 beetles. The least attraction effect was with amyl acetate recording 40 beetles with an average of 3.08 beetles. Traps baited with Nu-Lure insect bait recorded negligible effect as much as untreated traps, reporting 13 and 12 beetles with averages of 1.00 and 0.92 beetles, respectively.

3.2.2. Effect of trap color:

Black colour trap was the most attractive of ***Sc. amygdali*** beetles, with all tested semiochemical attractants in apricot orchards during 1998. The total number was 430 beetles with an average number of 33.08 beetles. Transparent traps showed the least attractancy effect where the total number was 143 beetles with an average number of 11.00 beetles. However, green traps were almost least attractive to ***Sc. amygdali*** beetles that the total number was 217 beetles with an average number of 16.69.

Accordingly, it could be relay upon black color trap in attracting ***Sc. amygdali***. However, more modification in other trap colors and designs should be continued to increase the efficiency of traps.

It could be concluded that the most effective tested semiochemicals was isobutyl acetate baited in black painted traps.

4. Prediction of *Z. pyrina* and *S. myopaeformis* moth's activity based on pheromone trapping and degree-day accumulations:

In an attempt to determine the correlations between climatic factor(s) and moths activity as well as use the day-degree method for predicting the peak emergence period of ***Z. pyrina*** and ***S. myopaeformis*** adult moths in pear and apple orchards i.e. to asses prediction formula through which population fluctuation could be expected, the simple correlation coefficient (r) for the relationship between 6 main weather factors; daily maximum, minimum and mean temperature and daily maximum, minimum and mean relative humidity and the population fluctuation of ***Z. pyrina*** and ***S. myopaeformis*** was quantitatively calculated during 6 successive years (from 1997 to 2002) in pear and apple orchards at Qalubia governorate.

Squared partial regression coefficients (R-square) of the single factors, daily maximum temperature (X_1) and daily minimum temperature (X_2), daily maximum relative humidity (H_1) and daily minimum relative humidity (H_2) as well as other different statistical models of combined temperature {(X_1X_2), ($X_1X_1^2$), ($X_2X_2^2$), ($X_1X_2^2$), ($X_1^2X_2$), ($X_1^2X_2^2$) and ($X_1X_2X_1^2X_2^2$)} on ***Z. pyrina*** and ***S. myopaeformis*** population fluctuation were assessed. Assessment was conducted for each single year from 1997 to 2002 and, at the same time, for the mean of the 6 years together for each considered pest.

The ideal statistical model was chosen, for each considered insect borer, to calculate the predicted population values (Y`) and, at the same time, the effective weather factor(s) on the rate of population during 1997-2002 were used to set prediction of its expected population in the same year(s). Prediction calculations were based on the linear regression formula described by Bishop, (1969): $\mathbf{Y' = a + b1X1 + b2X2 ... bjXj}$

where:- **Y'** = predicted population of a particular insect, **a** = constant (calculated for every mathematical relationship between a certain weather factor and a particular insect population during a specific activity period), **b** = slope for the independent variable X and **X** = independent variable (weather factor).

The half-monthly predicted values which assessed according to the selected statistical model and according to Bishop prediction formula were plotted, for each year, against the corresponding actual (observed) population values of ***Z. pyrina*** and ***S. myopaeformis*** obtained from pheromone trap catches for the same year from 1997 to 2002 as well as the mean of the 6 years (1997-2002).

To verify the validity and reliability of predicated (calculated) population for a certain year, the statistical difference between them was calculated by χ^2 test. Insignificant χ^2 values confirmed the reality of predictions and significant χ^2 values assured the incorrectness of these prediction.

4.1. Prediction of *Z. pyrina* moths activity based on pheromone trapping and degree-day accumulations:

Results indicated that the R-square values of the 6 weather factors and their combinations indicated that, daily maximum temperature and daily minimum temperature were the most significant factors affecting the rate of moth's emergence and that R-square values of each single daily maximum (X_1) and minimum temperature (X_2) and daily maximum relative humidity (H_1) and minimum relative humidity (H_2) separately were significantly varied in their effect on ***Z. pyrina*** population fluctuation. R-square values of temperature were 0.627 to 0.855 for (X_1) and 0.637 to 0.965 for (X_2) while those of relative humidity were 0.015 to 0.693 for (H_1) and 0.002 to 0.611 for (H_2).

Accordingly, the R-square values of the two single factors of relative humidity (H_1 and H_2) were excluded from the results and were not included in selection of suitable statistical models used.

Although the statistical combined model $X_1X_2X_1^2X_2^2$ which had the largest R-square values and used in assessing the prediction formula to gave good fitness between predicted and observed values, yet it must recognize that the effective weather factor in case of ***Z. pyrina*** was the daily minimum temperature X_2 and was a better predictor of insect activity rather than X_1 (maximum temperature).

Generally, results indicated that the smoothed observed population in the combined 1997-2002 and single years 2002, 2000 and 1997 was almost the same as the predicted population with very small differences during all the activity season of ***Z. pyrina*** moths. On the same side, the smoothed observed population and the predicted population of 1999 was also the same all the activity season except during the 1st and 2nd half of August. On the other side, during 1998 and 2001, obvious differences between the smoothed observed population and the predicted population were noticed.

Tabulated Chi square (χ^2) values at 0.05 and 0.01 significant levels were satisfied, showing that the calculated values of Chi test were highly significant as the total (χ^2) values, at 0.01 level, were 0.581, 2.285, 0.378, 0.509, 3.651, 1.249 and 0.649 for 1997, 1998, 1999, 2000, 2001, 2002 and 1997-2002, respectively.

Accordingly, it could be relay on the prediction formula for predicting the peak emergence period of ***Z. pyrina*** adults in pear orchards at any time during the activity season better than the use of calendar dates

4.2. Prediction of *S. myopaeformis* population fluctuation in apple orchards:

Results indicated that R-square values of each single daily maximum (X_1) and minimum temperature (X_2) and daily maximum relative humidity (H_1) and minimum relative humidity (H_2) were separately significantly varied in their effect on ***S. myopaeformis*** population fluctuation. R-square values of temperature were 0.461 to 0.958 for (X_1) and 0.607 to 0.904 for (X_2) while those of relative humidity were 0.002 to 0.936 for (H_1) and 0.078 to 0.968 for (H_2). Accordingly, the R-square values of the two single factors of relative humidity (H_1 and H_2) were excluded from the results and were not included in selection of suitable statistical models used.

Although the statistical combined model $X_1X_2X_1^2X_2^2$ used in assessing the prediction formula, yet it must recognize that, in case of ***S. myopaeformis***, the effective weather factor was the daily maximum temperature (X_1) rather than minimum temperature (X_2)(effective weather factor in ***Z. pyrina***).

Results presented clearly indicated that in case of ***S. myopaeformis***, there were some degrees of correlation between the predicted and observed data in some years of the study. These degrees varied between very close correlation in only one year (2000), close correlation in some years (2001 and 2002), moderate correlation in the combined study of 1997/2002 together and very poor correlation in 1999 separate year.

Other factors, as the nutrition status of trees, the horticultural practices which may accelerate or delay the tree activity, ..etc. gave the interpretation that there were poor correlation in most of years of study and played an important role in predicting the population activity of ***S. myopaeformis***.

According to graphs and statistical analysis (χ^2 test) which magnified the differences between the observed and predicted population it could be concluded that it could not relay on temperature and relative humidity only in case of ***S. myopaeformis*** to predict the population activity in the following seasons.

5. Mass attracting experiments:

Mass attracting of ***Z. pyrina*** and ***S. myopaeformis*** were applied with sex pheromones. Trials were conducted in infested pear and apple orchards at Behera governorate during 3 successive years from December 1999 to December 2002 seasons of each pest activity. The following 12 treatments were evaluated:

Effect of one – single, two and three year treatments:

Experiments were carried out during the whole season of moths' activity of ***Z. pyrina*** and ***S. myopaeformis*** during 2000, 2001 and 2002 as one - year treatments, then were replicated in another apple orchards in 2001 and 2002 seasons for confirmation for the 2^{nd} and 3^{ed} years. In addition, the same previously one-year treatments of 1999/2000 were replicated in the same apple orchards for studying the effect of the cumulative effect of 2 and 3 successive years in 2000/2001 and 2001/2002 seasons.

5.1. Mass attracting with a whole year pheromone treatment alone:

Locally made 2 liters size dry transparent carbonated water bottles were suspended on apple trees, 1.5 or 2.5 meters 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*** or ***S. myopaeformis*** sex pheromone.

Results indicated that mass attracting with whole year pheromone treatment reduced the infestation with 62.27 for ***Z. pyrina*** and 66.40%, for ***S. myopaeformis***.

Two and three successive years of application increased the reduction of infestation with 71.50 and 82.39% for ***Z. pyrina*** and 72.15 and 83.34% for ***S. myopaeformis***.

5.2. Partial season pheromone and pruning treatments:

Pheromone treatment was applied partially after winter pruning during the early season (flowering and fruiting period) from early moth emergence until harvesting. This partial season pheromone and pruning treatments resulted in 69.40 and 53.97% reduction of ***Z. pyrina*** and ***S. myopaeformis*** infestation, respectively.

Two and three successive years of application increased the reduction of infestation with 80.05 and 86.55% for ***Z. pyrina*** and 58.85 and 62.91% for ***S. myopaeformis***.

5.3. Partial season pheromone and worming treatments:

The partial pheromone treatment was conducted simultaneously with worming treatment which resulted in reduction of infestation equal 84.47 and 63.47% in ***Z. pyrina*** and ***S. myopaeformis***, respectively.

Two and three successive years of application increased the reduction of infestation with 94.25 and 98.48% for ***Z. pyrina*** and 69.20 and 78.51% for ***S. myopaeformis***.

5.4. Partial season pheromone and complete coverage treatments:

The partial pheromone treatment was conducted simultaneously with 2 complete coverage sprays during the rest of moths activity season in July to October after harvesting on early August and early September. Basudin (Diazinon) 60% E.C. and Cidial (phenthoate) L 50% E.C. each at the rate of 300 cc /100 liters of water were alternatively used. These treatments reduced ***Z. pyrina*** and ***S. myopaeformis*** infestation with 86.03 and 80.40%, respectively.

Two and three successive years of application increased the reduction of infestation with 95.65 and 98.86% for ***Z. pyrina*** and 85.25 and 94.39% for ***S. myopaeformis***.

5.5. Partial season pheromone and partial local spraying treatments:

The partial pheromone treatment was conducted and followed by 2 local spraying of the trunk and main branches of trees simultaneously after harvesting on early August and early September. Basudin and Cidial at the rate of 300 cc /100 liters of water were alternatively used. These treatments reduced ***Z. pyrina*** and ***S. myopaeformis*** infestation with 70.27 and 66.73%, respectively.

Two and three successive years of application increased the reduction of infestation with 79.40 and 89.77% for ***Z. pyrina*** and 73.30 and 81.62% for ***S. myopaeformis***.

5.6. Partial season pheromone and partial local painting treatments:

The partial pheromone treatment was conducted and followed by 2 local painting of the trunk and main branches of trees simultaneously after harvesting on early August and early September. Stemex insecticide (18% Anthracine + 3% Naphthalene) was used using a painting brush. These treatments reduced ***Z. pyrina*** and ***S. myopaeformis*** infestation with 79.80 and 73.47%, respectively.

Two and three successive years of application increased the reduction of infestation with 87.45 and 95.27% for ***Z. pyrina*** and 80.95 and 89.17% for ***S. myopaeformis***.

5.7. Pruning treatment:

During December pruning (winter pruning) of infested branches with ***Z. pyrina*** and ***S. myopaeformis*** was conducted in apple orchards. Pruning treatment resulted in 19.93 and 12.47% reduction of ***Z. pyrina*** and ***S. myopaeformis*** infestation, respectively.

Two and three successive years of applications increased the reduction of infestation with 23.20 and 30.49% for ***Z. pyrina*** and 20.40 and 29.87% for ***S. myopaeformis***.

5.8. Warming treatment:

Worming treatment (killing ***Z. Pyrina*** larvae using a flexible wire and scrapping ***S. myopaeformis*** larvae using plastic brush and a piece of palm raffia) was applied 4 times during December, May, July, and September. Worming treatment resulted in 40.07 and 27.53% reduction of ***Z. pyrina*** and ***S. myopaeformis*** infestation, respectively.

Two and three successive years of application increased the reduction of infestation with 53.25 and 61.55% for ***Z. pyrina*** and 35.50 and 42.64% for ***S. myopaeformis***.

5.9. Whole year complete coverage spraying treatment:

The recommended 4 sprays with Basudin and Cidial each at the rate of 300 cc /100 liters water were applied alternatively as 2 or 3 sprays at least one month before harvesting and 2 or 1 sprays were applied immediately after harvesting for ***Z. Pyrina*** and ***S. myopaeformis***, respectively. This treatment reduced the infestation of ***Z. pyrina*** and ***S. myopaeformis*** with 82.83 and 81.07%, respectively.

Two and three successive years of application increased the reduction of infestation with 92.75 and 97.92% for ***Z. pyrina*** and 92.65 and 98.00% for ***S. myopaeformis***.

5.10. Whole year local spraying treatment:

In this treatment the same insecticides, dates and times of application as in complete coverage spray were carried out except spraying was concentrated on the trunk and main branches. Local spraying treatment resulted in 58.50 and 62.60% reduction of ***Z. pyrina*** and ***S. myopaeformis*** infestation, respectively.

Two and three successive years of application increased the reduction of infestation with 68.60 and 71.45% for ***Z. pyrina*** and 73.00 and 85.62% for ***S. myopaeformis***.

5.11. Whole year local painting treatment:

Local painting with Stemex insecticide was concentrated only to the trunk using a painting brush, 4 times on the same dates of complete coverage spraying treatment. Local painting treatment resulted in 80.90 and 70.90% reduction of ***Z. pyrina*** and ***S. myopaeformis*** infestation, respectively.

Two and three successive years of application increased the reduction of infestation with 88.65 and 94.46% for ***Z. pyrina*** and 75.00 and 96.28% for ***S. myopaeformis***.