International Journal of Agriculture and Crop Sciences.
Available online at www.ijagcs.com
IJACS/2013/6-12/794-807
ISSN 2227-670X ©2013 IJACS Journal

# The Effect of Liquid Detergent on Common Pistachio Psylla, Agonoscena Pistaciae, Soil and Plant

**B. Panahi*, M. Basirat and S. J. Hosseinifard**

Members of Scientific Board of Iran's Pistachio Research Institute, Rafsanjan, Iran

***Corresponding author email:*** bahman_2@yahoo.com

**ABSTRACT:** The common pistachio psylla, Agonoscena pistaciae (Homoptera: Psyllidae) is known as the key pest of pistachio trees in Iran. This study was carried out during three years to test the effect of dish washing detergent (Rika®) against this pest in a randomized complete block design with five treatments and four replicates. The treatments were including: 1- 3500ml dish washing detergent per 1000 liter water 2- 2000ml dish washing detergent per 1000 liter water 3- 1000ml dish washing detergent + 500ml pesticide (Amitraz) per 1000 liter water 4- 1500 ml pesticide (Amitraz) per 1000 liter water 5-water (control). Amitraz was used as a common insecticide in compare to different concentrations of dish washing detergent (Rika®). The results showed that the percentage of mortality of Amitraz treatment was higher than other treatments (1, 2, and 3) in 14th and 21st days after spraying, furthermore there were significant differences between Amitraz and other treatments. The side effect of this treatment on the parasitoid psyllaephagus pistaciae indicated that dish washing detergent on the susceptible and resistance stages of psyllaephagus were evaluated as harmless and slightly harmful group, respectively. In addition, Amitraz in two above mentioned stages of wasp were evaluated in slightly harmful group. The results the effects of different treatments on soil and pistachio plant indicated that dish washing detergent on Ec and pH of soil, mineral elements of leaf and different parts of fruit, relative water content and leaf chlorophyll were not significant. By the way, lapse of time in treated plants with dish washing detergent (Rika®) increase of Na, decrease of Fe in leaf and hull and decline in gas exchanges and photosynthesis were observed.

***Key words:*** Agonoscena pistaciae, liquid detergent, psyllaephagus pistaciae, leaf mineral nutrients, photosynthesis.

## INTRODUCTION

The common pistachio psylla, Agonoscena pistaciae (Homoptera: Psyllidae) is known as the main pest of pistachio trees in Iran which causes much damage to the pistachio orchards of the country every year. Due to its high reproduction ability and multiple generations, this pest reproduces a very large population one or more times in most years and causes a lot of damages to the trees and the yield. The pest sever outbreak, in addition to reducing the current year yield, results in abscission of next year flower buds, leaves abscission and tree weakness (Mehrnejad, 2003; Mehrnejad and Copland, 2006). Currently, chemical control is the most practical way for reducing the pest population density and preventing the related damage. Research programs are being conducted on other control methods including biological control, agricultural control and etc., but they require more time and research.

Several insecticides have been tested against common pistachio psylla, and various pesticides such as Amitraz, Hexaflumuron, Imidacloprid and Teflubenzuron are used against this pest. Due to multiple generation and high reproduction ability of this pest, and also due to unclear level of economic loss and indiscriminate spraying by the farmers, continuous use of these toxins during a several-year period causes resistance, destruction of the natural enemies of the pest, pests sever outbreak, and sometimes remaining of pesticides residues in the crop. Therefore, it is necessary to test newer compounds and investigate on the side effects of such compounds on beneficial insects. Then, if they are proved to be effective, these new compounds may be made available to gardeners so that they may use them alternatively for controlling the common pistachio psylla pest.

Effects of detergents on pests have been studied in several cases. As instances, Puri et al. (1994) have studied the effect of detergents on sweet potato whitefly and reported 97% to 99% mortality of this pest. Moore et al. (1979) recommended use of soaps in controlling pests of ornamental trees and indoor plants when complete

pest control is not aimed. Vavrina et al. (1995) used detergents to control greenhouse whitefly on tomato plant that caused reduced crop and delayed fruit ripening. Patruno et al. (1991) studied the effect of a commercial detergent named Last, which is used as an insecticide for controlling pear Psylla Pyri, on soil structure stability and on maintaining soil moisture at a field study in Italy. They came to this conclusion that this detergent, in compare to the control treatment, has no significant effect on soil structure. In vitro, soil was treated with detergent in low concentrations resulting in increased moisture maintenance in soil. However higher concentrations of the detergent (unapplied ratios) reduced soil moisture maintenance by 2 percent while improving soil stability.

Chemicals decomposition in nature depends on type and concentration of the chemical, environment temperature and pH (Proter, 2012). As a general rule, if an organic matter has a linear chain, it would be decomposed in a relatively short time and it is so-called biodegradable. Thus, soaps, alkylbenzene, linear sulfonates, alkin sulfates, alkan sulfonates, sulfated fatty alcohols, ether sulfates, sucrose esters, alcohol phosphates and fatty alkanolamide are often biodegradable (Davidson & Milwidsky, 1987).

The chemical under study in this research is a dish washing detergent liquid with the commercial brand of Rika® which is known as Light Duty Liquid Detergent (LDLD). This chemical is composed of different matters including: 1) Anionic surfactants that is alkyl benzene sodium sulfonate in this dish washing detergent in which the alkyl chain is linear (LABSNa), 2) non-anionic surfactant which plays the role of booster and stabilizer, 3) hydro trope (urea), 4) electrolyte (sodium chloride), 5) colour, 6) essence, 7) water. The main foam and cleanser matter is alkyl benzene sodium sulfonate. The objective of this research was to study the effect of dish washing liquid detergent (Rika®) on pistachio common psylla, and its side effects on two life stages of Psyllaephagus pistaciae, soil and plant.

## MATERIALS AND METHODS

### *A) Studying the effect of dish washing detergent (Rika®) on pistachio common psylla and beneficial insects:*

### *Studying the effect of dish washing detergent (Rika®) on pistachio common psylla*

The experiment of studying the effect of dish washing detergent on pistachio common psylla and comparing its effectiveness with Amitraz insecticide, which is currently used as an effective insecticide on pistachio common psylla pest in pistachio orchards, was carried out in three separate stages. The first, second and third stages of this experiment were carried out during years 2001, 2002 and 2003, respectively. A pistachio orchard which was severely infected by the psylla was chosen for conducting this experiment. This orchard was divided into four blocks any of which was separated to 5 parts (treatments). First, four blocks (I, II, III & IV) were selected randomly, and then treatments were determined randomly in any of these blocks and the design map was drawn.

This experiment was carried out in form of a randomized complete block design through treatments including 1) 3500ml dish washing detergent per 1000 litre water, 2) 2000ml dish washing detergent per 1000 litre water, 3) 1000ml dish washing detergent + 500ml pesticide (Amitraz) per 1000 litre water, 4) 1500 ml pesticide (Amitraz) per 1000 litre water, and 5) water (control) using small motorized sprayer and conventional nozzle in pistachio orchards. Samplings were conducted in five steps including one day before spraying, 2) two days after spraying, 3) seven days after spraying, 4) fourteen days after spraying, 5) twenty one days after spraying. In these samplings, 15 pistachio leaflets were picked from trees located at the central parts of the experiment blocks. The leaflets were picked randomly and from all sides and both upper and lower parts of the experimental trees. The leaflets picked at each experiment step, considering the related treatment and replicate were placed separately into plastic labelled covers. The samples were carried to the laboratory inside icebox containing ice. In the laboratory, number of psylla nymphs on the front and back of the leaflets were counted and inserted in especial tables. Meanwhile, in sampling one day before experiment, number of eggs on the front and back of the leaflets were counted and recorded. The mean population density of pest was then calculated at any experiment unit and pest mortality percentage for any of the insecticides was computed in every sampling step using Henderson- Tilton Formula. The related data were statistically analysed in form of randomized complete block design, and the averages were compared among treatments by Duncan's test at level of 5%.

### *First step experiment*

This experiment was carried out on 20/08/2001 at Naseriyeh station of Iran's Pistachio Research Institute located near Rafsanjan. The trees to be sprayed had been planted in rows and were almost 25 years old. Spraying was started at 7a.m. and continued up to 9.5a.m. Weather was calm (not windy) during the spraying. In sampling one day before spraying, mean infection at the block under test was determined to be 58.66 nymphs, and 15.15 eggs were counted on each leaflet.

### *Second step experiment*

This experiment was conducted on 04/08/2002 at Kaboutarkhan region of Rafsanjan. The experimental trees had been planted in rows and were almost 20 years old. Spraying was started at 7.5a.m., ended at 10a.m. Weather was

calm (not windy) during the spraying. In sampling one day before spraying, mean infection at the block under test was determined to be 53.17 nymphs, and 43.78 eggs were counted on each leaflet.

***Third step experiment***

This experiment was carried out on 26/07/2003 at Naseriyeh station of Iran's Pistachio Research Institute located near Rafsanjan. The trees to be sprayed had been planted in rows and were almost 25 years old. Spraying was started at 7a.m. and ended at 10.5a.m. Weather was calm (not windy) during the spraying. In sampling one day before spraying, mean infection at the block under test was determined to be 128.41 nymphs, and 24.67 eggs were counted on each leaflet.

***Studying the side effect of the experimental treatments on the beneficial insects***

***Studying the side effects on the adult insects of Psyllaephagus pistaciae (susceptible life stage) at the laboratory***

For conducting this part of the experiment, first the adult insects were gathered through the following procedure; a large number of pistachio leaves with mummified nymphs of psylla on them containing larvae and pupae of this wasp were collected from the orchards and kept under appropriate condition in glassware with lace, so that, having the adult insect of Psyllaephagus pistaciae, this wasp could be used daily for the experiments. This is done due to the requirement of exposing the adult wasps, which have been newly emerged from eggs, to the spraying surfaces and evaluating them. Accordingly, 20×20 cm glass plates were provided and two glass plates were considered for each treatment. Treatments included 1) 3500ml dish washing detergent per 1000 litre water, 2) 1000ml dish washing detergent + 500ml pesticide (Amitraz) per 1000 litre water, 3) 1500 ml pesticide (Amitraz) per 1000 litre water, and 4) water (control), and any of these treatments were provided by the amount of 1 litre. An amount of 0.8 ml. out of the provided treatments was placed on glass plates separately for each of the said treatments (Hassan, 1977). The toxic solution was then made completely spread on each glass plate. After the solution was dried, a box was placed at the top and bottom of the glass plate and a polyethylene frame with lace pores for air ventilation was prepared and installed at its middle. Following that, 20 adult insects (Psyllaephagus pistaciae) were entered the box infected by the insecticide so that these wasps could be exposed the toxic surfaces. After the experiment was started, numbers of live and dead wasps were counted at any treatment once every half hour and inserted in the related tables. This experiment was repeated in four replicates.

***Studying the side effects on the resistant life stage of Psyllaephagus pistaciae (larvae, pupae and insect inside the psylla mummified nymph)***

For conducting this experiment, a plot of pistachio orchard with very active parasitoid wasps was selected which had not been sprayed at least for one month and numerous mummified capsules of pistachio psylla could be easily observed on the leaflets. Then, the said plot was randomly divided into four smaller plots. These plots were sprayed with treatments of 1) 3500ml dish washing detergent per 1000 litre water, 2) 1000ml dish washing detergent + 500ml pesticide (Amitraz) per 1000 litre water, 3) 1500 ml pesticide (Amitraz) per 1000 litre water, and 4) water (control) using 100-liter motorized sprayer.

The next morning, sampling was done separately from the said treated leaflets. 100 parasitism mummified nymphs containing wasp pupae were collected from the sampled leaves of any treatment and placed separately within glass-wares and kept in appropriate condition. After one month, when all parasitoid wasps emerged out of mummified capsules, number of emerged wasps was counted and percentage of toxin's effect was calculated using Abbott's formula. This experiment was repeated in two replicates.

***Studying the effect of dish washing detergent (Rika®)) on some properties of soil and plant***

In order to investigate the effects of dish washing liquid on soil and pistachio plant, a plot of pistachio orchards of the Naseriyeh station of Iran's Pistachio Research Institute located near Rafsanjan, with similar cultivar and water, soil and nutrition conditions, was selected. This plot was divided into three blocks and on any of these blocks (replicates) four treatments were applied in form of randomized complete blocks design. Treatments included foliar application of:

A) 3500ml dish washing detergent per 1000 litre water
B) 1000ml dish washing detergent + 500ml pesticide (Amitraz) per 1000 litre water
C) 1500 ml pesticide (Amitraz) per 1000 litre water
D) Water as control

During the 3-year period of the experiment, these treatments were applied every year depending on the population density of pistachio common psylla and at least four times a year. Management operations including control of other pests, fertilization, pruning and irrigation were applied similarly on all experimental trees. Leaflet sampling was done in September every year on 5 experimental trees at each replicate. Leaflet samples were then extracted at the laboratory using Dry Ash method and by digestion with hydrochloric acid, and the elements concentration in the obtained extract was measured. Phosphorus by calorimetric method (yellow colour, vanadate

molybdate), potassium and sodium by flame photometry method, Calcium and magnesium by complexometric method, and iron, zinc, copper and manganese by atomic absorption method were measured.

The yields of the experimental trees related to different treatments, that any of them repeated in three replicates any of which in turn included 5 trees, were harvested in September every year and their properties, including the yield dry weight, percentage of blank nuts, percentage of split nuts and number of nuts per 100g were investigated and determined. Different fruit parts including hull, shell and kernel were separated and the minerals content as mentioned before for the case of leaflet were also measured in them. Furthermore, some important features such as rate of gas exchange, leaf chlorophyll, relative water content of leaf, amount of detergent residues in leaf and fruit, and percentage of flower buds abscission and leaves abscission were also measured at the end of the season. In this research a portable device for infrared gas analysis (IRGA) model LCA-4 made by ADC BioScientific Ltd., England, was used for measuring leaf photosynthesis. Amount of leaf chlorophyll in the experimental trees was determined based on the Method of Arnon (1949). The relative water content of leaves was calculated using Turner Method (1981). And finally, the amount of detergent residues in leaf and fruit was measured according to the National Standard 2288, "Characteristics and Testing Methods of Dish Washing Liquid Detergent".

It shall be noted that during the first years before conducting the research project, soil sampling was done by drilling profile in the research site, and, during the second and third years, sampling was done from two surface layers. all chemical and tissue characteristics of soil samples related to the first year were measured, and in the samples related to the second and third years, those properties with the possibility of being affected by the detergent, including EC and pH, and also the elements such as phosphorus and potassium which determining them was essential for removing nutrients deficiency, were measured. Different properties of soil were analysed according to the instruction of the Soil & Water Research Institute. The project data were statistically analysed by MSTAT-C & SAS software and the averages were compared with each other using Duncan's test. The statistical complex analysis on the three-year data of the project was performed.

## RESULTS AND DISCUSSION

### *A) Effect of dish washing detergent (Rika®) on common pistachio psylla and the beneficial insects*

#### *Effect of the experimental treatments on common pistachio phyla*

In studying the effect of the mentioned treatments on common pistachio psylla, and considering the surveys performed one day before the experiment and the days after the experiment which have been described in the Materials & Methods section, the mean number of live nymphs in each replicate was determined and the mortality percentage in any replicate of the treatments was then calculated. The calculated mortality percentage was statistically analysed in form of randomized complete blocks design and then means of mortality percentage were compared by Duncan's test in level 5%.

#### *First step experiment*

In order to study the results of this experiment, the average of counted number of live nymphs on the front and back of leaflets was calculated and then the mortality percentage in each replicate was determined using Henderson-Tilton formula. The calculated mortality percentage was then statistically analysed; results of variance analysis related to samplings performed 2, 7, 14 & 21 days after spraying are presented in table No.18. Means comparison in this experiment, in sampling done 2 days after spraying, indicated that, there is no significant difference between treatments 1, 3 & 4 (Amitraz pesticide) and these treatments were then classified in the same group; however, treatment 2, with lower mortality percentage, was placed in the second group (B) (table 1). In samplings performed 7, 14 & 21 days after spraying, a significant difference was observed between treatment 4 (Amitraz pesticide) and other treatments, and this treatment, with a higher mortality percentage, was classified in the first group (A) while other treatments (1, 2 & 3), were placed in the second group (B) showing lower mortality percentage (table 1).

#### *Second step experiment*

The mean number of live nymphs was calculated as well in order to study the results of this experiment, and then the mortality percentage in each replicate was determined using Henderson- Tilton formula. Results of variance analysis related to samplings performed 2, 7, 14 & 21 days after spraying are presented in table No.19. Means comparison in this experiment indicated that in sampling done 2 days after spraying there is no significant difference between treatments 1, 3 & 4 (Amitraz pesticide) and these treatments were then classified in the same group; however, treatment 2, with lower mortality percentage, was placed in the second group (B) (table 2). In sampling performed 7 days after spraying, treatments 3 and 4 were placed in the first group (A) and treatments 1 and 2 were classified in the next group (B) (table 2). In sampling 14 days after spraying, treatment 4 (Amitraz pesticide), showing higher mortality percentage, was classified in the first group (A), and treatments 3, 1 & 2, with lower mortality percentage, were placed in groups AB, BC & C respectively (table 2).

Table 1. Comparison of the means effect of treatments on the common pistachio psylla, Agonoscena pistaciae, in 2nd, 7th, 14th and 21st days after spraying in 2001.

| Number of Treatment | Treatment | 2 days after spraying | 7 days after spraying | 14 days after spraying | 21 days after spraying |
|---|---|---|---|---|---|
| 1 | 3500 ml dish washing detergent per 1000 liter water | 92.79 AB | 86.11B | 63.30B | 68.43 B |
| 2 | 2000 ml dish washing detergent per 1000 liter water | 87.69 B | 83.43 B | 72.54B | 65.87 B. |
| 3 | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water | 97.72 A | 88.27 B | 71.53 B | 71.43 B |
| 4 | 1500 ml insecticide (Amitraz) per 1000 liter water | 99.37 A | 98.83A | 94.73A | 88.51 A |

*: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

Table 2. Comparison of the means effect of treatments on the common pistachio psylla, Agonoscena pistaciae, in 2, 7, 14 and 21 days after spraying in 2002.

| Number of Treatment | Treatment | 2 days after spraying | 7 days after spraying | 14 days after spraying | 21 days after spraying |
|---|---|---|---|---|---|
| 1 | 3500 ml dish washing detergent per 1000 liter water | 76.12 AB | 71.52 B | 81.61 BC | 73.29 AB |
| 2 | 2000 ml dish washing detergent per 1000 liter water | 59.46 B | 65.56 B | 75.58 C | 55.18 B |
| 3 | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water | 95.74 A | 91.93 A | 89.06 AB | 63.35 B |
| 4 | 1500 ml insecticide (Amitraz) per 1000 liter water | 97.19 A | 95.98 A | 96.62 A | 83.15 A |

*: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

Table 3. Comparison of the means effect of treatments on the common pistachio psylla, Agonoscena pistaciae, in 2, 7, 14 and 21 days after spraying in 2003.

| Number of Treatment | Treatment | 2nd days after spraying | 7th days after spraying | 14th days after spraying | 21st days after spraying |
|---|---|---|---|---|---|
| 1 | 3500 ml dish washing detergent per 1000 liter water | 89.43 A | 95.65 A | 75.60 BC | 72.65 B |
| 2 | 2000 ml dish washing detergent per 1000 liter water | 93.14 A | 81.05 B | 61.35 C | 71.66 B |
| 3 | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water | 98.30 A | 97.10 A | 78.04 AB | 74.33 B |
| 4 | 1500 ml insecticide (Amitraz) per 1000 liter water | 99.00A | 98.82 A | 93.08 A | 90.92 A |

*: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

***Third step experiment***

The mean number of live nymphs was calculated as well in order to study the results of this experiment, and then the mortality percentage in each replicate was determined using Henderson-Tilton formula.

The calculated mortality percentage was then statistically analysed; results of variance analysis related to samplings performed 2, 7, 14 & 21 days after spraying are presented in table 20. Means comparison in this experiment, in sampling done on 2nd day after spraying, indicated that there was no significant difference between Amitraz treatment and other treatments, and these treatments were then classified in the same group (table 3). In sampling performed 7 days after spraying, no significant difference was observed among treatments 1, 3 and 4 (Amitraz pesticide) , yet treatment 2, with lower mortality percentage, was placed in the second group (B) (table 3). In sampling on the 14th day after spraying, treatment 4 (Amitraz pesticide), with higher mortality percentage, was

classified in the first group (A), and treatments 3, 1 & 2, with lower mortality percentage, were placed in groups AB, BC & C respectively. In sampling performed on 21st day after spraying, a significant difference was observed between treatment 4 (Amitraz) and other treatments, to the extent that treatment 4 (Amitraz pesticide), showing higher mortality percentage, was placed in the first group (A) and other treatments were classified in the second group (B) with lower mortality percentage.

***Complex analysis***

The complex analysis among treatments 1, 2, 3 & 4 in samplings performed 2, 7, 14 & 21 days after spraying was done for three replicates of the experiment (table 21). Means comparison revealed that, in sampling 2 & 7 days after spraying, there was no significant difference between treatments 3 and 4 (Amitraz pesticide) and these treatments were therefore classified in the first group (A), while treatments 1 & 2 were significantly different with treatment 4 (Amitraz pesticide) and thus were placed in the second group (B). in sampling 14 days after spraying , treatment 4 (Amitraz pesticide), showing a higher mortality percentage, was placed in the first group (A) and treatments 3, 1 & 2, with lower mortality percentage, were classified into groups B, BC & C respectively (table 4). Accordingly, on the 14th day after spraying, there was a significant difference between Amitraz treatment and the three other treatments and thus their effects on the pest were not similar. In sampling performed 21 days after spraying, a significant difference was observed between Amitraz treatment and other treatments leading to classification of Amitraz treatment, with higher mortality percentage, in the first group (A) while other treatments (1, 2 & 3) were placed in the second group (B) with lower mortality percentage (table 4). Results of complex variance analysis indicated that the year effect and the year effect × treatment in samplings done 2 and 7 days after spraying were significant, yet they revealed no significant difference on 14th day and 21st day after spraying.

Table 4. Comparison of the means effect of treatments on the common pistachio psylla, Agonoscena pistaciae, in 2, 7, 14 and 21 days after spraying base on complex analysis in 2001,2002 and 2003.

| Number of Treatment | Treatment | 2 days after spraying | 7 days after spraying | 14 days after spraying | 21 days after spraying |
|---|---|---|---|---|---|
| 1 | 3500 ml dish washing detergent per 1000 liter water | 86.12 B | 84.42 B | 73.5 BC | 71.45 B |
| 2 | 2000 ml dish washing detergent per 1000 liter water | 80.10 B | 76.68 C | 69.82 C | 64.24 B |
| 3 | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water | 97.25 A | 92.44 A | 79.54 B | 69.70 B |
| 4 | 1500 ml insecticide (Amitraz) per 1000 liter water | 98.52 A | 97.89 A | 94.83 A | 87.53A |

*: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

Table5. Percentage of mortality and effect of insecticides on adult insects (susceptible life stage) of the parasitoid psyllaephagus pistaciae base on LT50 in control.

| | 3500 ml dish washing detergent per 1000 liter water | | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water | | 1500 ml insecticide (Amitraz) per 1000 liter water | |
|---|---|---|---|---|---|---|
| | percentage of mortality | percentage of insecticide effect | percentage of mortality | percentage of insecticide effect | percentage of mortality | percentage of insecticide effect |
| Replicate1 | 54.55 | 9.1 | 56.25 | 12.5 | 78.95 | 57.9 |
| Replicate2 | 53.85 | 7.69 | 66.67 | 33.34 | 91.30 | 82.6 |
| Replicate3 | 52.94 | 5.88 | 56.25 | 12.5 | 73.68 | 47.37 |
| Replicate4 | 56.25 | 12.5 | 52.94 | 50.88 | 77.78 | 55.56 |
| mean | 54.40 | 8.8 | 58.03 | 16.06 | 80.43 | 60.86 |

Table 6. Standard of assessment to test the side effects of pesticides on natural enemies by the IOBC/WPRS of the sixth working group in laboratory.

| Title of group | Number of group | Percentage of insecticide effect on natural enemies |
|---|---|---|
| Harmless | 1 | <30% |
| Slightly Harmful | 2 | 30-79% |
| Moderately Harmful | 3 | 80-99% |
| Harmful | 4 | >99% |

***Side effects of the experimental treatments***

***Side effects of the treatments on adult insect (susceptible life stage) of Psyllaephagus pistaciae***

The mortality rate of adult insect of Psyllaephagus pistaciae under any of the treatments and also under the

control treatment during time was studied and the results were inserted in the related table. When 50 % of wasps were died, the wasps' mortality percentage in the experimental treatments was calculated (table 5). Then, the effect percentage of the toxin under any of the treatments was calculated using Schneider-Orelli formula (table 5). Considering the assessment standards of IOBC/ WPRS organization (table 6) and mean percentage of toxin effect in the experimental treatments (table 5), it can be concluded that treatment of 3500 ml dish washing detergent (Rika®) per 1000 litre water and treatment of 1000 ml dish washing detergent (Rika®) + 500 ml insecticide (Amitraz) per 1000 litre water are classified in the group of harmless toxins (group 1) in regard with their side effects on adult insect (susceptible life stage) of Psyllaephagus pistaciae. In addition, treatment of 1500 ml insecticide (Amitraz) per 1000 litre water was evaluated to be in the slightly harmful toxins group (group 2).

***effects of the treatments on the resistant life stage of Psyllaephagus pistaciae***

Psyllaephagus pistaciae wasps emerged out of 100 mummified nymphs of psylla were counted in the experimental and control treatments (table 7). Then, the effect percentage of the experimental toxins was calculated using Abbott's formula (table 7). According to the assessment standards of IOBC/WPRS organization (table 6) and mean percentage of toxins effect (table 7) it can be concluded that treatment of 3500 ml dish washing detergent (Rika®) per 1000 litre water and treatment of 1000 ml dish washing detergent (Rika®) + 500 ml insecticide (Amitraz) per 1000 litre water are classified in the group of slightly harmful toxins (group 2) in regard with their side effects on the resistant life stage of Psyllaephagus pistaciae (larvae and pupae of wasp within the mummified nymph of pistachio psylla); furthermore, treatment of 1500 ml insecticide (Amitraz) per 1000 litre water was evaluated to be in the same group (group 2) as well.

Table 7. Number of adults' emergence of the parasitoid psyllaephagus pistaciae form 1000 mummified psyllid, Agonoscena pistaciae, in treatment and percentage of insecticide effect on less susceptible life stage of the parasitoid psyllaephagus pistaciae (larvae and pupa of the parasitoid within mummified psyllid).

| | 3500 ml dish washing detergent per 1000 liter water | | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water | | 1500 ml insecticide (Amitraz) per 1000 liter water | | Control | |
|---|---|---|---|---|---|---|---|---|
| | Number of adults' emergence of the parasitoid | Percentage of insecticide effect | Number of adults' emergence of the parasitoid | Percentage of insecticide effect | Number of adults' emergence of the parasitoid | Percentage of insecticide effect | Number of adults' emergence of the parasitoid | Percentage of insecticide effect |
| Replicate1 | 5 | 73.68 | 5 | 73.68 | 9 | 52.63 | 19 | - |
| Replicate2 | 7 | 50 | 3 | 78.57 | 7 | 50 | 14 | - |
| Mean of percentage of insecticide effect | - | 61.84 | - | 76.13 | - | 51.32 | - | - |

***B) Effect of dish washing detergent (Rika®) on some properties of soil and plant***

***Effect of treatments on some properties of soil***

Soil properties were assessed before initiation of the experiment by drilling profile in the experimental plot and sampling the different separated horizons. Table 8 presents the said properties:

Table 8. Soil analysis results of experimental plot before initiation of experiment.

| Soil texture | Sand (%) | Silt (%) | Clay (%) | $CaCo_3$ (%) | Available phosphor ($mgKg^{-1}$) | Available potassium ($mgKg^{-1}$) | Sodium adsorption ratio (SAR) | Acidity of saturation paste (pH) | Electro conductivity of soil saturation paste (ECe) ($dSm^{-1}$) | Horizon Thickness (cm) | Horizon |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy Loam | 76.6 | 13.6 | 9.8 | 12.5 | 4.5 | 375 | 3.5 | 8.4 | 7.1 | 0-30 | Ap |
| Sandy | 93.6 | 5.4 | 1.0 | 10.0 | 5.7 | 300 | 3.1 | 7.7 | 5.4 | 30-60 | $C_1$ |
| Loamy Sand | 83.6 | 15.4 | 1.0 | 10.5 | - | - | 1.4 | 7.8 | 5.2 | 60-80 | $C_2$ |
| Sandy | 97.6 | 1.4 | 1.0 | 9.5 | - | - | 2.0 | 7.9 | 4.7 | 80-110 | $C_3$ |
| Sandy | 97.6 | 1.4 | 1.0 | 10.0 | - | - | 2.6 | 8.0 | 5.9 | 110-150 | $C_4$ |

Soil of the experimental plot was light-textured and phosphorous deficiency could be observed in the depth of root density (30- 60 cm). The electro conductivity of saturation extract of soil was almost similar and a little salty in all depths. The pH of the saturation paste was also high (especially in surface horizon). In the first year of

experiment, measures were taken to remove the phosphorous efficiency and, to some extent, potassium deficiency in the depth of root density.

Among the soil properties, the electro conductivity of saturation extract and acidity of saturation paste (ECe, pH) were assessed during the three-year period of the experiment due the possibility of being affected by the detergents. Detergents have active anionic matter which may be considered as a pollutant for the environment. This active anionic matter was measured at the end of the three years of experiment in the soil samples of different treatments in order to determine the effect of detergent in contaminating the soil. The results of soil analysis at depths of 0-30cm and 30-60cm in different treatments in regard with ECe, pH and active anionic matter have been presented in table 9. Complex analysis was done on the three-year results of the experiment in regard with ECe and pH factors. Active anionic matter was assessed at the end of the experiment. Results of means comparison are related to one series experiment.

Table 9. Effect of different treatments on some of soil properties.

| Active anionic matter (%) | Active anionic matter* (%) | Acidity of saturation paste (pH) | Acidity of saturation paste (pH) | Electro conductivity of soil saturation paste (ECe) ($dSm^{-1}$) | Electro conductivity of soil saturation paste (ECe) ($dSm^{-1}$) | Treatment |
|---|---|---|---|---|---|---|
| Cm 30-60 | Cm 0-30 | Cm 30-60 | Cm 0-30 | Cm 30-60 | Cm 0-30 | |
| 0.000 A | A 0.007 | A 7.6 | A 8.4 | A 5.2 | A** 6.9 | A |
| 0.000 A | A 0.005 | A 7.6 | A 8.3 | A 5.4 | A 7.0 | B |
| 0.000 A | A 0.004 | A 7.7 | A 8.2 | A 4.9 | A 7.0 | C |
| 0.000 A | A 0.004 | A 7.6 | A 8.3 | A 5.6 | A 7.1 | D |

*: Calculations were made in term of sulfonate benzene alkyl sodium molecular mass and its unit is %.
**: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

The results presented in table 9 indicate that the effects of different treatments on the electro conductivity of saturation extract (ECe) and acidity of saturation paste (pH) of soil were not statistically significant in level 5%. Difference observed in ECe in compare with the rate assessed before experiment initiation (table 8) is probably related to irrigation and sampling time. The important point is that there is no significant difference between the control treatment (D) and other treatments; therefore there would be no significant difference in regard with cations and anions soluble in soil as well and their results would not be presented. Regarding active anionic matter existence in detergent and in surface soil, it shall be said that treatment A (foliar application of 3500 ml dish washing detergent (Rika®) per 1000 litre water shows a higher amount in compare with other treatments (0.007 sodium salt LAB), yet the differences between treatments are not significant statistically in level 5%. The lowest levels in this regard were related to the control treatment and treatment C (foliar application of 1500 ml insecticide (Amitraz) per 1000 litre water.

It seemed that the detergent used in the experiment had no effect on the main chemical properties of soil in short time (experiment period), and active anionic matter in the detergent had no significant accumulation in the surface soil during this period.

***Effects of treatments on concentration of leaf nutrients***

Table 10 presents the results of analyzing the leaf samples in regard with concentration of nutrients including phosphorous, potassium, calcium, magnesium, iron, zinc, manganese and copper. These results are related to three years of experiment and complex statistical analysis has been done on them.

Table 10. Effect of different treatments on concentration of leaf nutrients.

| Cu µg/g DM | Mn µg/g DM | Zn µg/g DM | Fe µg/g DM | Na g/100g DM | Mg g/100g DM | Ca g/100g DM | K g/100g DM | P g/100g DM* | Treatment |
|---|---|---|---|---|---|---|---|---|---|
| A 5.4 | A 24.5 | A 5 | A 104 | A 0.35 | A 1.10 | A 1.7 | A 1.02 | A** 0.10 | A |
| A 5.4 | A 26.5 | A 7 | A 107 | A 0.28 | A 1.20 | A 1.8 | A 1.05 | A 0.11 | B |
| A 6.5 | A 26.9 | A 6 | A 120 | A 0.23 | A 1.05 | A 1.9 | A 1.03 | A 0.12 | C |
| A 7.1 | A 25.0 | A 7 | A 127 | A 0.21 | A 0.95 | A 1.9 | A 0.98 | A 0.11 | D |

*: Dry matter.
**: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

The results presented in table 10 indicate that none of the treatments had a significant effect in level 5% on concentration of leaf nutrients during the three-year period of the experiment. In regard with sodium, although no significant difference was observed, but sodium concentration was higher (0.35%) under treatment A, that is foliar application of 3500 ml dish washing detergent (Rika®) per 1000 litre water, in compare with other treatments. After treatment A in this regard comes treatment B, 1000 ml dish washing detergent (Rika®) + 500 ml insecticide (Amitraz) per 1000 litre water (under which sodium concentration is 0.28 %), and this is probably due to existence of sodium element in the detergent.

Treatments C And D are respectively foliar application of 1500 ml Amitraz pesticide per 1000 litre water

and the control treatment in which no detergent has been used. Under these treatments, iron concentration in leaf is similar, and is higher than treatments A and B in which detergent has been applied. Since iron is an essential element in photosynthesis and chlorophyll production in leaf, foliar application of detergent probably has led to relative reduction of photosynthesis in leaf and, following that, reduction of iron concentration (tables 10 & 16).
Considering the findings resulted from studying the effect of treatments on concentration of leaf nutrients during the three-year period of experiment, it can be said that application of detergents can lead to relative increase of sodium and relative reduction of iron in leaf, and continuous and long-term use of these detergent may have more adverse effect in regard with these elements.

***Effect of the treatments on concentration of nutrients in different parts of the fruit***
***Effect of the treatments on concentration of nutrients in pistachio hull***

Pistachio hull was analyzed in different treatments regarding the concentration of phosphorous, potassium, calcium, magnesium, sodium, iron, zinc, manganese and copper. Results of these analyses and complex statistical (three year) studies have been presented in table 11.

Table 11. Effect of different treatments on concentration of pistachio hull nutrients.

| Cu µg/g DM | Mn µg/g DM | Zn µg/g DM | Fe µg/g DM | Na g/100g DM | Mg g/100g DM | Ca g/100g DM | K g/100g DM | P g/100g DM* | Treatment |
|---|---|---|---|---|---|---|---|---|---|
| A 2.9 | A 24.5 | A 7.1 | A 108 | A 0.09 | A 0.27 | A 0.45 | A 6.0 | A** 0.12 | A |
| A 2.5 | A 23.2 | A 5.7 | A 117 | A 0.09 | A 0.31 | A 0.39 | A 5.8 | A 0.12 | B |
| A 2.6 | A 28.0 | A 5.9 | A 130 | A 0.06 | 0.30 A | A 0.44 | A 5.5 | A 0.12 | C |
| A 2.9 | A 25.1 | A 7.3 | A 134 | A 0.04 | A 0.28 | A 0.41 | A 5.3 | A 0.12 | D |

*: Dry matter.
**: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

As it can be seen in table 11, none of the treatments had significant effect in level 5% on concentration of nutrients in pistachio hull during the three years of experiment. However, just like the case with leaf, concentration of sodium element in treatments A and B is relatively higher than in the other two treatments, and, also, concentration of iron element in these two treatments is relatively lower than in treatments C and D. It seems that the same change trend with concentration of two sodium and iron elements in leaf appears in the case of pistachio hull as well, and it is affected by nutrients concentration in leaf.

***Effect of the treatments on concentration of nutrients in pistachio shell***

The above-mentioned nutrients were also measured in pistachio shell under experimental treatments, and the results were inserted in table 12. Effects of different treatments on concentration of nutrients in pistachio shell were not statistically significant in level 5%, and a trend similar to what was observed in the cases of leaf and hull was not observed in regard with sodium and iron. Concentrations of phosphorous and copper in pistachio shell were not high enough to be detected by measuring tools applied, and so they are marked with letters N. D. (not-detected) in the table.

Table 12. Effect of different treatments on concentration of pistachio shell nutrients.

| Cu µg/g DM | Mn µg/g DM | Zn µg/g DM | Fe µg/g DM | Na g/100g DM | Mg g/100g DM | Ca g/100g DM | K g/100g DM | P g/100g DM* | Treatment |
|---|---|---|---|---|---|---|---|---|---|
| ND | A 0.73 | A 3.8 | A 24 | A 0.007 | A 0.82 | A 0.16 | A** 0.1 | ND*** | A |
| ND | A 0.75 | A 3.4 | A 18 | A 0.007 | A 0.65 | A 0.14 | A 0.1 | ND | B |
| ND | A 0.72 | A 3.1 | A 21 | A 0.007 | A 0.83 | A 0.15 | A 0.1 | ND | C |
| ND | A 0.74 | A 3.2 | A 21 | A 0.007 | A 0.77 | A 0.15 | A 0.09 | ND | D |

*: Dry matter.
**: Means with similar letters in each column are not significantly different using Duncan test (α=5%).
***: Not Detected.

***Effect of the treatments on concentration of nutrients in pistachio kernel***

In order to determine the possible effect of different treatments on concentration of nutrients in pistachio kernel, the elements mentioned in the previous sections were also assessed in the edible part of the fruit, and results were presented in table 13. The statistical study of these results indicated no statistically significant difference in level 5% among means of different treatments obtained through complex analysis. The relative difference existed in pistachio hull and leaf in regard with sodium and iron was not observed in pistachio kernel, and thus kernel is similar to shell in this regard. Accordingly, regarding change in nutrients concentration, treatments caused relative changes only in concentration of sodium and iron elements in pistachio hull and leaf that this

difference is not significant statistically. However, it shall be considered that these findings have been resulted from a three-year experiment and that long-term application of detergent as pesticide may cause some changes in concentration of nutrients like sodium and iron especially in pistachio hull and leaf.

Table 13. Effect of different treatments on concentration of pistachio kernel nutrients.

| Cu µg/g DM | Mn µg/g DM | Zn µg/g DM | Fe µg/g DM | Na g/100g DM | Mg g/100g DM | Ca g/100g DM | K g/100g DM | P g/100g DM* | Treatment |
|---|---|---|---|---|---|---|---|---|---|
| ND*** | A 7.4 | A 31.5 | A 67 | A 0.01 | A 0.72 | A 0.86 | A 1.09 | A** 0.12 | A |
| ND | A 7.6 | A 28.5 | A 66 | A 0.01 | A 0.80 | A 0.80 | A 1.02 | A 0.14 | B |
| ND | A 7.5 | A 26.5 | A 73 | A 0.01 | 0.71 A | A 0.90 | A 1.01 | A 0.14 | C |
| ND | A 7.0 | A 31.8 | A 71 | A 0.01 | A 0.71 | A 0.95 | A 1.07 | A 0.13 | D |

*: Dry matter.

**: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

***: Not Detected.

***Effect of the treatments on some qualitative and quantitative characteristics of pistachio***

Table 14 presents the results of investigating the effect of different experimental treatments on some qualitative and quantitative characteristics of pistachio. Considering lack of a significant difference in concentration of nutrients in different parts of leaf and fruit after applying the experimental treatments, a similar trend is expected to be observed in the case with qualitative and quantitative characteristics. However, considering the pest control in treatments A, B and C, the yield dry weight and percentage of blank nuts under these treatments were relatively better than under the control treatment (D), yet this difference was not statistically significant in level 5%.

Table 14. Effect of different treatments on some quantitative and qualitative characteristics of pistachio.

| Number of Nuts per 100 g | Split Nuts (%) | Blank Nuts (%) | Yield Dry Weight (Kg)* | Treatment |
|---|---|---|---|---|
| 98 A | 81 A | 23 A | 6.2 A** | A |
| 95 A | 80.7 A | 22 A | 4.5 A | B |
| 92 A | 78.4 A | 19 A | 4.3 A | C |
| 90 A | 77.8 A | 25 A | 5.7 A | D |

*: Dry weight of yield (kg) was mean of 5-tree samples.

**: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

***Effect of the treatments on some physiologic properties of the experimental pistachio trees***

Tables 15, 16 & 17 present the findings resulted from studying the effects of different treatments on some physiologic properties of the experimental pistachio trees.

Table 15. Effect of different treatments on leaf relative water content percentage and leaf chlorophyll percentage.

| Total Leaf Chlorophyll (%) | Relative Water Content (%) | Treatment |
|---|---|---|
| 1.567 A | 79.87 A* | 3500 ml dish washing detergent per 1000 liter water (Treat A) |
| 1.700 A | 80.07 A | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water (Treat B) |
| 1.900 A | 80.80 A | 1500 ml insecticide (Amitraz) per 1000 liter water (Treat C) |
| 2.033 A | 81.17 A | Water (control) (Treat D) |

*: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

In compare with the control trees, reduction of leaf relative water content and leaf chlorophyll was observed in leaves of trees on which the experimental treatments had been applied, yet the difference between means was not meaningful in level 5% of Duncan's test.

Table 16. Photosynthesis rate (µmolCo2/$m^2$s) of pistachio experimental trees in 1st, 3rd, 5th and 7th days after different treatments application.

| Photosynthesis (7th day) | Photosynthesis (5th day) | Photosynthesis (3rd day) | Photosynthesis (1st day) | Treatment |
|---|---|---|---|---|
| 11.50 D | 13.90 C | 14.47 C | 14.70 B* | 3500 ml dish washing detergent per 1000 liter water (Treat A) |
| 13.47 C | 14.00 C | 14.73 BC | 14.80 B | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water (Treat B) |
| 14.60 B | 15.03 B | 15.30 B | 15.50 B | 1500 ml insecticide (Amitraz) per 1000 liter water (Treat C) |
| 16.27 A | 16.70 A | 17.07 A | 17.50 A | Water (control) (Treat D) |

*: Means with similar letters in each column are not significantly different using Duncan test (α=5%).

As it can be seen, rate of photosynthesis is reduced in the experimental trees over time. For instance, the trees treated by treatment A had the lowest rate of photosynthesis on the 7$^{th}$ day after treatments application, while in control trees the photosynthesis rate was higher in compare with other trees and this rate underwent no change over time.

Table 17. The content of active anionic substance in leaf and fruit of pistachio in percentage after different treatments application.

| Active anionic substance in fruit (%) | Active anionic substance in leaf (%) | Treatment |
|---|---|---|
| 0.278 A | 1.544 A* | 3500 ml dish washing detergent per 1000 liter water (Treat A) |
| 0.122 AB | 0.656 B | 1000 ml dish washing detergent + 500 ml insecticide (Amitraz) per 1000 liter water (Treat B) |
| 0.156 AB | 0.344 B | 1500 ml insecticide (Amitraz) per 1000 liter water (Treat C) |
| 0.089 B | 0.467 B | Water (control) (Treat D) |

*: Means with similar letters in each column are not significantly different using Duncan's test (α=5%).

These results are related to three years of experiment, and the complex statistical analysis has been performed on them. Comparison of leaf and fruit of the trees treated by the experimental treatments reveals that content of active anionic matter, which is considered to be an index for measuring the amount of detergent (Rika®) penetrated into leaf and fruit tissues, may be only observed in the trees treated with the treatment A, while its amount is not significant in other trees. In addition, comparison of leaf and fruit tissues shows that the amount of active anionic matter penetrated into the fruit tissue is lower in compare with the leaf tissue that this observation is probably due to existence of harder coating tissues in fruit in compare with in leaf.

In shall be mentioned that buds abscission percentage and leaves abscission percentage of the experimental trees were noted during the related season in every year of experiment, but since these percentages in all treatments were insignificant and incomparable, and thus the calculated data related to these characteristics were not mentioned in the results.

Table 18. ANOVA of treatments on the common pistachio psylla, Agonoscena pistaciae, in 2001 A) 2nd days after spraying B) 7th days after spraying C) 14th days after spraying D) 21st days after spraying.

A)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 228.96 | 76.32 | 2.3724 ns |
| Treatment | 3 | 333.059 | 11.03 | 3.4511 ns |
| Error | 9 | 289.526 | 32.17 | - |
| Total | 15 | 851.545 | - | - |

B)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 63.698 | 21.233 | 0.664 ns |
| Treatment | 3 | 546.229 | 182.076 | 5.6941* |
| Error | 9 | 287.789 | 31.976 | |
| Total | 15 | 897.713 | - | |

C)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 1549.353 | 516.451 | 7.5529** |
| Treatment | 3 | 2173.035 | 724.345 | 10.5933** |
| Error | 9 | 615.401 | 68.378 | - |
| Total | 15 | 4337.789 | - | - |

D)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 167.648 | 55.883 | 0.7696 ns |
| Treatment | 3 | 1254.021 | 418.007 | 5.7567* |
| Error | 9 | 653.516 | 72.613 | - |
| Total | 15 | 2075.185 | - | - |

ns: non-significant.
*: meaningful (α=5%).
**: meaningful (α=5%).

Table 19. ANOVA of treatments on the common pistachio psylla, Agonoscena pistaciae, in 2002 A) 2nd days after spraying B) 7th days after spraying C) 14th days after spraying D) 21st days after spraying.

A)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 462.798 | 154.266 | 0.7379 ns |
| Treatment | 3 | 3848.216 | 1282.739 | 6.1357* |
| Error | 9 | 1881.562 | 209.062 | |
| Total | 15 | 6192.576 | - | - |

B)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 164.426 | 54.809 | 0.5359 ns |
| Treatment | 3 | 2688.868 | 896.289 | 8.7631** |
| Error | 9 | 920.514 | 102.279 | - |
| Total | 15 | 3773.808 | - | |

C)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 761.892 | 253.964 | 4.2584* |
| Treatment | 3 | 998.658 | 332.886 | 5.5817* |
| Error | 9 | 536.749 | 59.639 | - |
| Total | 15 | 2297.299 | - | - |

D)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 1866.168 | 622.056 | 4.4602* |
| Treatment | 3 | 1764.833 | 588.278 | 4.218* |
| Error | 9 | 1255.202 | 139.467 | - |
| Total | 15 | 4886.203 | - | - |

ns: non-significant.
*: meaningful (α=5%).
**: meaningful (α=5%).

Table20. ANOVA of treatments of treatments on the common pistachio psylla, Agonoscena pistaciae, in 2003 A) 2nd days after spraying B) 7th days after spraying C) 14th days after spraying D) 21st days after spraying

A)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 122.185 | 40.728 | 0.8896 ns |
| Treatment | 3 | 245.237 | 81.746 | 1.7855 ns |
| Error | 9 | 412.042 | 45.782 | - |
| Total | 15 | 779.465 | - | - |

B)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 211.926 | 70.642 | 1.3504 ns |
| Treatment | 3 | 801.930 | 267.310 | 5.1101* |
| Error | 9 | 470.795 | 52.311 | - |
| Total | 15 | 1484.651 | - | - |

C)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 919.176 | 306.392 | 3.2578 ns |
| Treatment | 3 | 2026.374 | 675.458 | 7.182** |
| Error | 9 | 846.443 | 94.046 | - |
| Total | 15 | 3791.993 | - | - |

D)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Replication | 3 | 140.387 | 46.796 | 1.3147ns |
| Treatment | 3 | 991.483 | 330.494 | 9.2847** |
| Error | 9 | 320.359 | 35.595 | - |
| Total | 15 | 1452.228 | - | |

ns: non-significant.
*: meaningful (α=5%).
**: meaningful (α=5%)

Table21. ANOVA of treatments of treatments on the common pistachio psylla, Agonoscena pistaciae, in2001,2002 and 2003 A) 2nd days after spraying B) 7th days after spraying C) 14th days after spraying D) 21st days after spraying

A)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Year | 2 | 1684.022 | 842.011 | 9.3102** |
| Error | 9 | 813.959 | 90.44 | - |
| Treatment | 3 | 2847.742 | 949.247 | 9.9219** |
| Treatment × Year | 6 | 1578.704 | 263.117 | 2.7502* |
| Error | 27 | 2583.132 | 95.972 | |
| Total | 47 | 9507.559 | - | |

B)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Year | 2 | 1175.682 | 587.841 | 12.0135* |
| Error | 9 | 440.384 | 48.932 | - |
| Treatment | 3 | 3100.066 | 1033.355 | 16.6215** |
| Treatment × Year | 6 | 938.377 | 156.396 | 2.5156* |
| Error | 27 | 1678.584 | 62.170 | - |
| Total | 47 | 7333.093 | - | - |

C)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Year | 2 | 967.099 | 483.549 | 1.3503 ns |
| Error | 9 | 3223.005 | 358.112 | - |
| Treatment | 3 | 4377.027 | 1459.009 | 19.6613** |
| Treatment × Year | 6 | 831.89 | 138.648 | 1.8684ns |
| Error | 27 | 2003.594 | 74.207 | |
| Total | 47 | 11402.615 | - | |

D)

| Source of variation | Degree of freedom | Sum of squares | Mean squares | F - value |
|---|---|---|---|---|
| Year | 2 | 600.732 | 300.366 | 1.2433 ns |
| Error | 9 | 2174.287 | 241.587 | - |
| Treatment | 3 | 3609.919 | 1203.306 | 14.5796** |
| Treatment × Year | 6 | 399.552 | 66.592 | 0.8068ns |
| Error | 27 | 2228.403 | 82.533 | - |
| Total | 47 | 9012.894 | - | - |

ns: non-significant.
*: meaningful (α=5%).
**: meaningful (α=5%).

Comparing the means of the effect percentages of the experimental treatments on common pistachio psylla based on complex analysis during three experimental steps led to classification of samplings done on 2nd, 7th, 14th and 21st days after spraying by Amitraz treatment in the first group (A) with higher mortality percentage, and classification of the said samplings treated by two Rika® detergent treatments with concentrations of 3500 ml and 1000 ml per 1000 liter water in the second group (B). Accordingly, it can be claimed that the effect of dish washing detergent (Rika®) with two experimental concentrations on common pistachio psylla was lower in compare with insecticide (Amitraz). However, the effect percentages of Rika® dish washing detergent with concentration of 3500 ml per 100 liter water in samplings done on 2nd and 7th days after treatment were 86.12% and 84.42& respectively which were remarkable. Although the treatment of 1000 ml dish washing detergent (Rika®) + 500 ml insecticide (Amitraz) per 1000 litre water in samplings 2nd and 7th days after spraying was classified in the first group (A) with an effect similar to that of the insecticide (Amitraz), but in samplings 14th and 21st days after spraying this treatment was placed in the second group (B) having a lower effect on common pistachio psylla in compare with the insecticide (Amitraz). according to the results of complex analysis performed on these experiments, the mixed treatment of Rika® (1 per 1000) and Amitraz (0.5 per 1000) had an effect similar to that of Amitraz treatment up to 7 days after spraying, and also showed a relatively good mortality percentage on 14th day after spraying (79.54%). This treatment was also placed in the same group with Amitraz treatment (1.5 per 1000) in the second and third experimental steps. Thus, this mixture can be used for controlling common pistachio psylla in some cases but it must be considered that this mixture is less lasting than Amitraz treatment (1.5 per 1000).

Results of the experiments carried out on toxins' side effects in the experimental treatments indicated that side effects of treatment of 3500 ml dish washing detergent (Rika®) per 1000 litre water and mixed treatment of 1000 ml dish washing detergent (Rika®) + 500 ml insecticide (Amitraz) per 1000 litre water on the susceptible life stage of Psyllaephagus pistaciae (adult insect) were lower side effects of treatment of 1500 ml insecticide (Amitraz) per 1000 litre water. Thus these two treatments cause less mortality on the adult insect of this beneficial wasp. However the side effects of these two treatments on the resistant life stage of Psyllaephagus pistaciae (mummified nymphs of psylla) were similar to side effects of Amitraz treatment with concentration of 1500 ml per 1000 litre water.

The effects of different treatments on some properties of soil (pH and EC), concentration of nutrients in leaf and different parts of fruit, relative water content of leaf, and leaf chlorophyll content were not statistically significant. However, detergent application changed the amount of anionic matter in surface soil, leaf and fruit to some extent in compare with the control treatment. In addition, sodium and iron nutrients in pistachio hull and leaf were also affected by these treatments, as under treatments containing detergent, relatively increased sodium and relatively reduced iron in pistachio hull and leaf, and also reduced gas exchange and photosynthesis rates can be observed over time. Therefore, it can be concluded that detergent affects the concentration of iron in the plant and, as the results, affects the gas exchanges, and its possible harmful effects could also be studied in long term.

## REFERENCES

Davidson A, Milwidsky BM. 1987. Synthetic detergents. 7th Edition. Longman publication. PP. 336.

Hassan SA. 1977. Standardized a technique for testing side effects of pesticides on beneficial arthropods in laboratory. Journal of plant disease and protection 83(3): 158-163.

Mehrnejad MR, Copland MJW. 2006. Behavioral responses of the parasitoid Psyllaephagus pistaciae (Hymenoptera: Encyrtidae) to host plant volatiles and honeydew. Entomological Science 9: 31-37.

Mehrnejad MR. 2003. Pistachio psylla and other major psyllids of Iran.116pp. Agriculture Research and Education Organization. [In Persian].

Moore WS, Profita JC, Koeler CS. 1979 Soap for home landscape insect control. California insect control, California Agriculture 33(60): 13-14.

Patruno A, Cavazza L, Compagna C. 1991. Effect of a detergent-insecticide on some physical soil properties. Bolletion dell universita degli studi di bologna. 45: 39-46.

Proter MR. 2012. Handbook of surfactants. 2nd edition. Springer London. PP. 340.

Puri SN, Bhosle BB, Ilyas M, Butler GD, Henneberry TJ. 1994 Detergent and plant derived oils for control of the sweet potato whitefly cotton. Crop-protection 13(1): 45-48.

Vavrina CS, Stansly PA, Liu TX. 1995. Household detergent on tomato phytotoxicity and toxicity to silver leaf whitefly. HortScience 30(7): 1406-1409.