The Effects of Citral Soap and Citral Activator of Nonionic Surfactants on Spirotetramat Insecticide against *Agonoscena pistaciae* in Rafsanjan

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Abstract

Introduction: *Agonoscena pistaciae* is a major pest of pistachio orchards that reduces the crop quality and quantity. Hence, to control this pest, gardeners use different insecticides every year.

Materials and Methods: In this study, the lethal effects of spirotetramat with some non-ionic surfactants, including the citral soap and the citral activator at the concentrations of 120, 180, and 240ppm of the soap, and at the concentrations of 500, 1000, and 2000ppm of the activatoras well as their effects on *A. pistaciae* samples taken on days 1, 3, 7, 14, and 21 after spraying, were studied.

Results: The effects of each treatment, using the Henderson-Tilton's formula, showed that the number of nymphs decreased in different treatments on days 1 and 7 after spraying, and the results of different concentrations showed that with an increase in the concentration, the rate of mortality increased; with the greatest effect exerted by the concentration of 240ppm of the citral soap, after one week.

Conclusions: According to the preliminary results obtained from this section, it can be concluded that the citral soap can be a good choice for the pistachio pest control in pistachio gardens, due to its favorable effects on pistachio seedlings and its satisfactory performance in combination with spirotetramat in producing a healthy product, reducing consumption costs, reducing environmental hazards, exerting impacts on natural enemies, and minimizing the use of chemical pesticides.

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1. Introduction

Pistachios (Pistacia vera L) are from among the major horticultural products and the third most important export product of Iran. Due to their excellent quality, pistachios are of high significance among agricultural products, in the countries producing them and are quite desirable. Since Iran's pistachios are of particular importance for the country's exportation and are highly valuable products, more efforts must be made to maintain its global position [1]. According to the latest FAO statistics in 2012, the production of pistachios has increased in the world in recent years, with Iran, the United States, Turkey, China, and Syria currently being the largest producers of pistachios in the world, having the vastest areas of cultivated gardens. Considering the importance of this product, extensive research has been conducted on the ways of reducing pest infestation and major diseases [2]. From among the major factors that reduce the production of pistachios in Iran's pistachio gardens, one can allude to the role of various pests whose contribution to the reduction of the final production is much more than other living factors. From among various ticks and insects that damage pistachios, the dried mildew or the common pistachio psyllid (CPP), *Agonoscena pistaciae* Burckhardt and Lauterer (Hem. Psyllidae), is the major pest of pistachio trees distributed in all pistachio production regions of Iran. The CPP population is increasing in many countries, including Iran, Turkey, Iraq, Armenia, and Turkmenian, as well as Mediterranean regions, such as Syria and Greece [3]. This insect is currently the major pest of pistachio gardens and crops in Iran. The direct feeding of the adults and nymphs by sucking the leaf sap reduces plant Growth and causes defoliation, stunting, the falling of fruit buds, and the low crop yield [4]. For this reason, pistachio gardeners are highly sensitive to this type of pest and constantly try to control it by pesticides. This condition leads to the more use of pesticides and the resulting environmental contamination due to the expansion and outbreak of this pest. Hence, the use of chemicals used in producing pesticides is required to be controlled. To control this type of pest, different pesticides with additives effective in the proper acidity of water, including surfactant scan be used. Surfactants are surface active agents that reduce the surface tension of water [5]. By reducing the surface tension of water, the amount of pesticides applied increases and the plant's surface or soil becomes wetter. These materials also play a crucial role in diminishing droplets (the dynamic surface tension) and are often referred to as wetting agents. Hydrogen acidity above 7 causes some pesticides to be hydrolyzed and consequently reduces heir effects [6]. These changes usually occur due to the disintegration of the molecules that form the smaller molecules of pesticides and their combination with more molecules of water. The major attributes of storing and maintaining a toxin droplet in plants is their being hard to get wet and the dynamic pull of the toxin droplet. But regarding toxicity, or absorption of methyl glucose, the importance of the dynamic drag of the surface as the length of the chain of ethoxylate surfactant suggests that surfactants act in ways other than facilitating and contributing to the preservation and survival of the toxin [7]. The term surfactant is derived from the term "surfactant agents" (surface active agents) to

describe an organic substance with specific properties and structures. Surfactants are organic compounds that change the surface properties of a liquid, when added to it at low concentrations. The overall structure of a surfactant consists of hydrophilic and hydrophobic parts. Therefore, surface active agents are the substances that tend to collapse at the surface, after dissolving in water. Adding these materials to water reduces the surface tension of water. Surfactants have a hydrophilic group called "head" and a hydrophobic chain called "tail" [8].

Surface active agents can be classified according to their structures into the categories of anionic, cationic, non-ionic, and ionic. In appropriate changes in the pH of the solvent hydrolyze the pesticide and then reduce its effects. Such changes are usually caused by the breakdown of the pesticide molecules into smaller molecules and their combination with more molecules of water. Pesticides are often subjected to alkaline hydrolysis, in which pH values greater than 7 lead to the chemical decomposition of the main pesticide components. The alkaline water breaks down the pesticide particles, so unwanted reactions occur. The newly created compounds may not contain suitable insecticides and mites, so the effects of the spraying process decrease. However, some pesticides may undergo acidic hydrolysis, where pH value is less than 7 [9]. In general, insecticides are more sensitive to alkaline hydrolysis than fungicides and growth regulators. Besides, insecticides within the chemical grade of organophosphate, pyrethroid, and carbamate are more sensitive to alkaline hydrolysis. In addition, the proper range for most insecticides and mites is between 5 and 7 [10]. In this study, the effects of the spirotetramat pesticide in combination with some nonionic surfactants of the citral soap and the citral activator as well as their effects on pistachio psyllium were studied.

2. Materials and Methods

2.1. The geographical location

The location of the study is Rafsanjan, one of the major pistachio areas in Iran and the world. For experiment purposes, apistachio garden was selected with all issues related to the principles of gardening, including having the same kind of pistachios, as well as the same methods of fertilization, spraying, and irrigation. The garden rows were classified according to a completely randomized block design, with three replications, and with each replication consisted of 15 blocked treatments.

2.2. The pesticide type used

The spirotetramat insecticide (MUVENTO) acts through gastrointestinal absorption with 10%SC formulation from the circular catenol group and the tetromic acid class that disrupt the production of fat. Spirotetramat has strong effects on suction pests and has a bi-directional movement (phloem and xylem). It is effective in a wide range of suction pests and is useful in the context of the pre-harvest interval for products to be exported. The pre-harvest interval in vegetables, summer vegetables, sour lemons, and sweet lemons is just one day. It is also seven days in garden products and 21 days in soybeans. It has a high quality and affects pests three to seven days after application. In Iran, to fight common pests in pistachio [11]. This pesticide was used by the 10%SC formulation made by Bayer of Germany at the recommended dose of 0.5% per thousand for this experiment.

2.3. The non-ionic surfactant (active on the surface)

The non-ionic surfactants of the citral plant soap (the triple plant growth enhancer) containing 4.5% iron, 4.5% manganese, 5.5% manganese, and the citral actuator produced by Kia Sam Karmania Co., at the consumption dose of 0.5% per thousand, were used for spraying.

2.4. Desert experiments

Five trees are randomly selected and marked one day before spraying within the rows. Ten leaves of trees are separated and sampled in three replicates Next, in the laboratory, pistachio psylla eggs and nymphs were counted at both upper and lower parts of the leaves [12].

2.5. Spraying

At this stage, the concentrations of water acidity were considered to be including acidity 4, acidity 6, and acidity 8. The recommended concentrations of the pesticide and the surfactant were then mixed thoroughly into the acidity listed separately on the sprayer tank (1000 liters). During each replicate (block), the treatments were randomly sprayed on trees. In this experiment, a non-ionic surfactant was applied to the control treatment. In other treatments, the pesticide spraying task was carried out with non-ionic surfactants under three different acidity conditions. It should be noted that after spraying each treatment in three replays, the reservoir and spray devices were washed with water.

2.6. Sampling after the spraying task

The sampling of different treatments was carried out on days 1, 3, 7, 14, and 21 after the spraying task, with the samples transferred to the laboratory and the number of dead nymphs on the leaves counted.

2.7. Data analysis

According to the sampling done on the day before and after spraying and taking the control sample, the percentage of each treatment and mean comparisons were calculated using the Henderson-Tilton's formula, in the form of a randomized complete block design according to the Duncan's multiple range test and SPSS software, and the charts were drawn using SigmaPlot10.0 and Microsoft Excel.

Where,

Efficiency percentage= 100 × (1- (Ta × Cb) / (Ca × Tb),

Tb, Ta= The contamination rate in sprayed plots before and after poison application, and Cb, Ca= The infection rate in the control treatment before and after sampling;

3. Results

Considering that the study was carried out over two consecutive years, the crops of the year (2016-20017) showed positive results. The results of the spraying performed, the sampling and counting of the pest population done for each sample at different times, and the data recorded showed that the number of pests per unit area decreased significantly; this decrease in the pest population indicates the effects of the surfactants used in combination with the pesticide.

3.1. The effects of the citral activator spray

The effects of different concentrations of the activator on different days after being sprayed on *Agonoscena pistaciae* nymphs were investigated. The results of the analysis of variance and statistical calculations for the three concentrations showed that there was a significant difference among the three concentrations and the effects of the concentrations on different days after spraying ($F=100.61$, $df=14.30$, and $P<0.001$).

There was a significant difference between the concentrations of 500 and 1000mg/L on days 1 and 3, and also between 1000 and 2000 mg/L on days 1, 3, and 7 after spraying. The concentrations of 500 and 2000 mg/L also showed significant differences on all days, except day 21. The results of the effects of the concentrations on different days after spraying showed that the effect of the concentration of 500 mg/L was not significant on the decrease in the number of nymphs on days 1 and 3, after spraying. Concentrations of 1000 and 2000 mg/L showed similar results. Besides, all three concentrations had the greatest effects on the decrease in the number of pistachio nymphs on days 1 and 3 after spraying, and the trend of the effects was descending after one week. The results of different concentrations of the soap showed that with an increase in the concentrations, the mortality rate increased as well (Fig. 1).

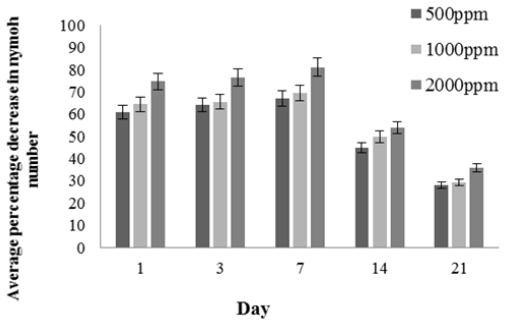

Fig.1. The average percentage reduction in the number of *Agonoscena pistaciae* nymphs on different days after spraying the citral activator

3.2. The effects of the citral spray

The effects of different concentrations of the citral soap on different days after being sprayed on *Agonoscena pistaciae* nymphs were investigated. The results of the analysis of variance and statistical calculations of the three concentrations showed that there was a significant difference among the three concentrations and the effect of each concentration on different days after being sprayed ($F=14.27$, $df= 14.30$, $P<0.001$).

According to the results, treatments of 120 and 180 mg/L were not significantly different on any days after spraying. Differences between the treatments of 180 and 240 mg/L were observed only on days 7 and 14 after spraying. Treatments of 120 and 240 mg/L were significantly different on all days after spraying. The results of the effects of the concentrations on different days after spraying showed that the effects of the treatment of 120 mg/L on the decrease in the number of nymphs on days 1 and 3 after spraying were not significantly different. Likewise, the results of the effects of the concentrations on different days after spraying showed that the effects of the treatment of 120 mg/Lon the decrease in the number of nymphs on days 1 and 3 after spraying were not significantly different. However, there was a significant difference among days 7, 14, and 21 after spraying, and the treatments of 180 and 240 mg/L had the same effects. Besides, all the three concentrations had the greatest effect on the decrease in the number of nymphs on days 1 to 7 after spraying. The results of different concentrations of pesticides showed that with an increase in the concentration, the mortality rate increased as well (Fig. 2).

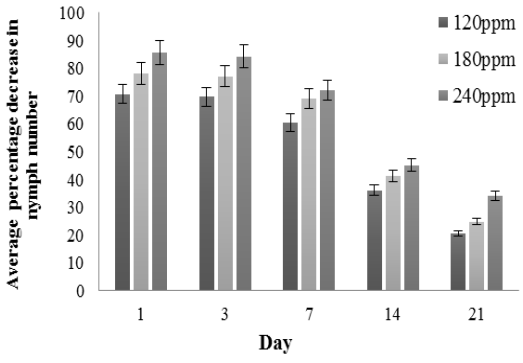

Fig.2. The average percentage reduction in the number of *Agonoscena pistaciae* nymphs on different days after spraying citral

4. Discussion

The common pistachio psyllid (CPP), *Agonoscena pistaciae* Burckhardt and Lauterer (Hem: Psyllidae), is the major pest of pistachio trees distributed in all pistachio production regions of Iran [2]. The extensive use of insecticides to control pests has led to the widespread development of different insecticide resistance mechanisms in pests. Soaps have physical effects on insects by causing rapid death through interfering with their respiratory system and damaging their external skeletal system. As a result, it could be expected that the effect of the soap would increase with an increase in its concentration; the same is true regarding its effects over a week after use rather than a few days. In a study on the effects of Palizin and Tondexir soaps on the nymphs of *A. pistaciae*, similar results were obtained. The results demonstrated that the number of nymphs decreased in Palizin and Tondexir treatments on days 1 to 7 after spraying, and it increased later [13].

5. Conclusions

Therefore, according to the preliminary results obtained, it can be concluded that due to the favorable effect of the citral soap on pistachio psyllium and its good performance in combination with the spirotitramat pesticide, it can be regarded as a suitable choice for controlling pistachio psyllium in pistachio gardens to produce healthy products, decrease consumption costs, reduce environmental hazards, affect natural enemies, and minimize the use of chemical pesticides.

Conflict of interest

The authors declare no conflict of interest.

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