Evaluation of The effect of diatomaceous earth and Two compounds derived from chinaberry tree (Melia Azedarach) extract on mortality of nymphs and spawning rate of common pistachio psyllid Agonoscena pistaciae Burkhardt & Lauterer (Hem.: Psyllidae) under field conditions

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Abstract

Introduction: Common pistachio psyllid Agonoscena pistaciae Burkhardt & Lauterer *(*Hem.*:* Psyllidae) is one of the main pests of pistachio trees in Iran. Given the risks of excessive use of chemical pesticides, it seems that one of the methods to minimize pesticide pollution is to use plant and mineral compounds.

Materials and methods: In this research, the mineral composition of diatomaceous earth and the formulated compounds of chinaberry tree (Melia Azedarach) plant extract (A: chinaberry extract + soap and B: chinaberry extract + potassium silicate) were used to investigate the mortality of nymphs and spawning rate.

Results: Investigating the results indicated that the leaves treated with chinaberry extract + soap with a concentration of 3000 mg/liter following 5 and 10 days and the combination of chinaberry extract + soap (3000 mg/liter) and diatomaceous earth (10000 mg) ¬g/liter) following 5 days were reported to have the highest mortality of nymphs and the lowest spawning rate compared to the control group. Moreover, the results have indicated that the spawning rate of the leaves treated with the combination of chinaberry extract + potassium silicate and the combination of chinaberry extract + soap and diatomaceous earth after 15 days is not significantly different compared to that of the control.

Conclusion: Given the favorable effect of the chinaberry + soap and the combination of chinaberry extract + soap and diatomaceous earth in reducing the number of nymphs and the spawning rate, it seems that spraying pistachio trees with these compounds can properly control the psyllid population.

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1. Introduction

Common pistachio psyllid (Agonoscena pistaciae Burckhat & Lauterer) is known as a one of the main pests of pistachio trees in Iran. Spread and damage of common pistachio psyllid as a serious pest is one of the main worries of pistachio orchard owners every year. This pest is spread in all pistachio farming fields of Iran [1]. Fully-grown insects are so powerful in reproduction. Products are taking a lot of damages because of this pest. Pistachio's kernel growth and filling period, from mid-June to mid-August, is the most sensitive time for the pistachio plant to prevent the damage of this pest. If the conditions are suitable for increasing the pest population growth in this time period, the plant and its crop will suffer heavy damage [2].

This pest is so sensitive to pistachio orchard owners and they are constantly attempting to control it by using pesticides; they spray pistachio trees 8 times a year in order to control the pest damage. This leads to an increase in the consumption of pesticides and environmental pollution. Thus, the outbreak and spread of this pest necessitates a review of chemical to decrease the pesticides consumption amount. To control this pest, low-risk substances can be used with predetermined concentration and time of use [3].

Today, extensive research is being conducted in order to use new compounds that have fewer environmental risks to control pistachio psyllid. One of these solutions is using mineral and plant pesticides. The controlling ability of all kinds of plant diseases, pests, failure to create resistance to pests and plant diseases, the lack of toxicity for mammals, the stimulation of immunity of plant and the environmental pollution prevention, the abundance of rich mineral resources and the possibility of accessing a large amount of mineral compounds are among the significant points of producing and manufacturing mineral insecticides. Depending on the elements kind and their structure, mineral pesticides are considered as natural substances, which are classified in the group of low-risk compounds or substances with a low danger index for humans. Some pesticides such as sulfur and diatomaceous earth have been registered as natural pesticides [4].

Compounds such as diatomaceous earth and chinaberry plant extract have been used in this research; they have got pesticidal properties that confirmed in different researches.

Diatomaceous earth is very fine particles extracted from diatom fossils, which are effective on many pests, including sucking insects, with high mobility [5, 6]. Diatoms are very small single cells that are generally found in aquatic or wet environments and have a significant amount of silica in their structure. By creating scratches in the cuticle of the insect's body surface, diatomaceous earth dehydrates insects and kills them [5].

Panahandeh and Ahmadi [6] investigated the effects of pesticidal compounds of fertilizers of mineral origin, diatomaceous earth and also different additives on the population density of nymphs aged 1 to 4, the spawning rate of adult insects and also the hatching of pistachio psyllid eggs. The treatments related to the evaluation of diatomaceous earth, materials (gelatin, wood cement, eremurus, potassium silicate and dipotassium phosphate) were used as additives to diatomaceous earth. The results of their study indicated that the diatomaceous earth along with

various additives are able to reduce the growth index of the pest population.

Aziz et al. [7], in a study that investigated the effects of diatomaceous earth on Sitophilus granarius, reported that 14 days after using diatomaceous earth, the highest adult mortality reached 98%.

The chinaberry Melia belongs to the Meliaceae family in Iran and has two species of chinaberry Melia azedarach L. or neem M. indica (Adr.). According to many studies, the fruit and leaf extracts of this plant have medicinal properties and antiviral and microbial activity, and also have ovicidal and larvicidal effects in insects [8].

Contact toxicity of fruit powder extracts using 96% ethanol, chinaberry (Melia azedarach), neem (Azadirachta indica) and two commercial formulations of neem (Neemarin and Neem oil) on nymphs of the first and fifth instars of pistachio psyllid in laboratory conditions was examined by Iranmanesh et al. The results of their study indicated that chinaberry also has insecticidal potential like neem on common pistachio psyllid [9].

The common pistachio psyllid control has been mainly conducted by using chemical insecticide compounds, and numerous pesticides have been officially tested so far on this pest in recent years. Given the resistance in this pest, effectiveness of various insecticides have lost one after the other [10]. As pistachio psyllid is one of the main pistachio pests and there is no existing compounds to control it, there is an urgent need to find new compounds. Although most of the pistachio orchards are infected with this pest and if one orchard is sprayed, the infection will occur again in the neighboring orchards. If a compound can prevent this pest from respawning in the orchard, it can be so effective to controlling the next generation of this pest. According to these reasons, in the present research, diatomaceous earth and chinaberry plant extract and their compound were used to control the spawning and hatching rates of common pistachio psyllid.

2. Materials and methods

The effect of different treatments on the mortality rate of pistachio psyllid

Specifications of the experiment site

The experiments were conducted in Rafsanjan (a village called Kabutar Khan) with geographic coordinates 30°17'15.7"N 56°28'19.3"E in Kerman Province.

Characteristics of the orchard and the type of pistachio trees

In this study, the orchards that were selected had uniform conditions in terms of horticultural operations and in terms of psyllid nymph population, they were at the threshold of economic loss (7.7-30.7 nymphs per leaflet [11]. The orchards were sprayed. The experiments were conducted on 25-to-30-year-old adult pistachio trees.

Orchard experiment: the effect of pesticide compounds on the mortality of A. pistaciae eggs and nymphs

The compounds of diatomaceous earth and formulated chinaberry extract (chinaberry + soap and chinaberry + potassium silicate, prepared in the poison and fertilizer production technology unit of Shahid Bahonar University of Kerman) were tested. Spraying was conducted using diatomaceous earth powder with a

concentration of 10000 mg/liter, chinaberry + soap 3000, chinaberry + potassium silicate 3000, chinaberry + soap 3000 with diatomaceous earth 10000 mg/liter by manual sprinkler (GM313 model) using a normal nozzle with uniform circular spraying at five to seven in the morning. Water was used as the control. An orchard with a suitable amount of psyllid contamination (on average 30.7-7.7 nymphs per leaflet of the Fandoghi cultivar) was selected. This experiment was conducted in the form of a randomized complete block design with four replications. Two trees were selected for each replication and their leaves were marked with colored ribbons in 4 geographical directions and in the middle. For sampling, 5 leaves having 3-5 leaflets were selected from each tree and one leaflet was randomly selected and counted compared to the control. The leaves were selected in such a way that there are at least 4 leaves at the bottom of the next year's cluster. Sampling was conducted 5, 10, and 15 days after treatment [12] and the eggs number and nymphs on and under each leaf was counted and recorded in the laboratory using SaIran binoculars.

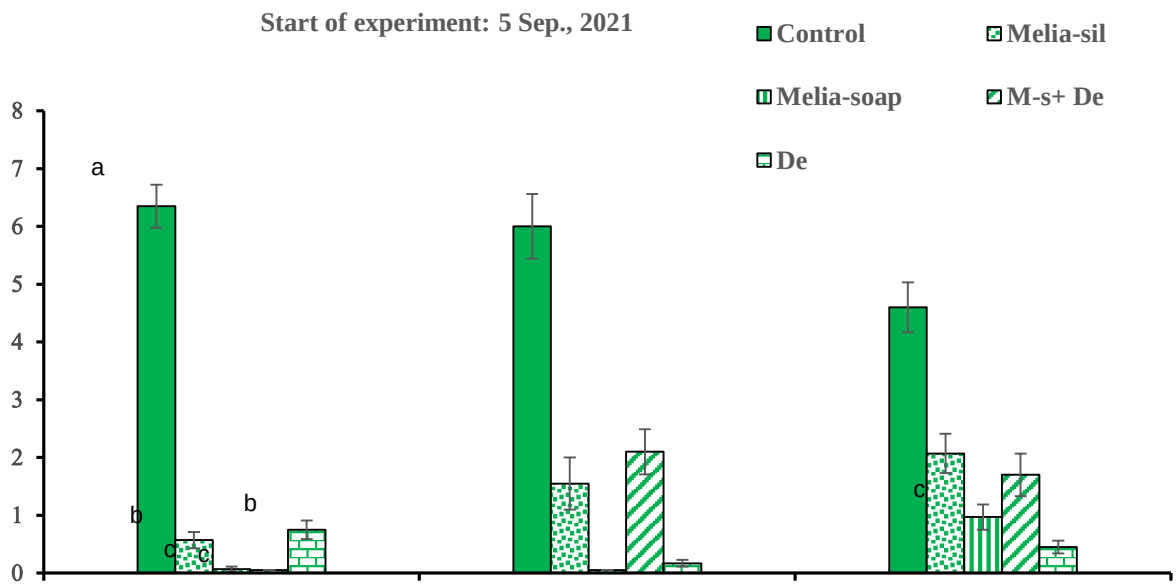
Data analysis

In order to verify the basic assumptions, the data were first tested using Bartlett's Test in terms of homogeneity of variance and normal distribution [13]. Data analysis was conducted by Statplus 2007 professional. After calculating the means and standard error, the means were compared using Fisher's LSD test ($P<0.05$).

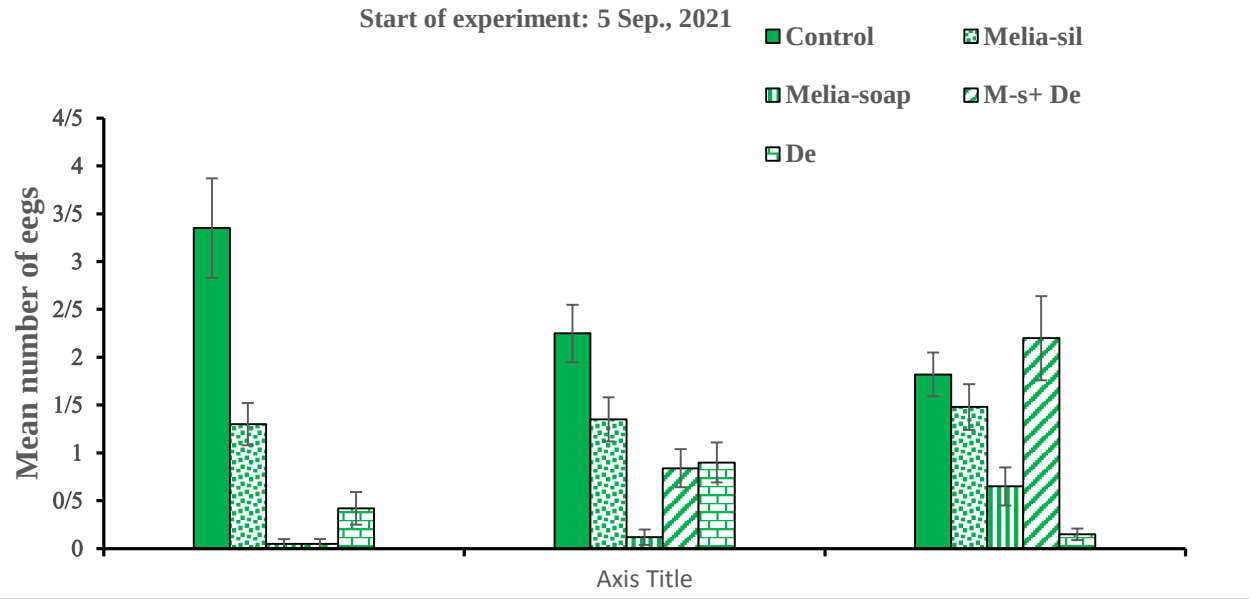
3. Results

The effect of different treatments of the compounds of chinaberry extract + potassium silicate (Melia + sil), the compound of chinaberry extract + soap (Melia + soap), compound of chinaberry extract + soap + diatomaceous earth (M-s + de) and diatomaceous earth (De), on the mortality rate of common pistachio psyllid nymphs following 5, 10 and 15 days.

The results indicated that the effect of different treatments on the mortality of nymphs at different times was significant compared to the control (Figure 1).



Treatment



Treatment

The results indicate that the highest mortality of common pistachio psyllid nymphs on each leaf is related to the treatment of the compound of chinaberry extract + soap with a concentration of 3000 mg/liter following 5 and 10 days (P≥ 0.000, dft,e = 4, 5, F=185.73) and the treatment of the compound of chinaberry extract + soap (3000 mg/liter) and diatomaceous earth (10000 mg/liter) following 5 days. Moreover, no significant difference was observed between the treatment of the compound of chinaberry extract + soap and diatomaceous earth and the compound of chinaberry extract + potassium silicate, the compound of chinaberry extract + soap and diatomaceous earth following 15 days (P = 0.000, dft,e = 4, 5, F=24.80).

The effect of different treatments of the compound of chinaberry extract + potassium silicate (Melia + sil), compound of chinaberry extract + soap (Melia + soap), compound of chinaberry extract + potassium silicate + diatomaceous earth (M-s + de) and diatomaceous earth (De), following of 5, 10 and 15 days on the spawning rate of common pistachio psyllid

The results have indicated that the effect of different treatments on the reduction of spawning rate at different times was significant compared to the control (Figure 1). The results of different treatments on the spawning rate showed that the spawning rate on the leaves treated with the compound of chinaberry extract + potassium silicate and the compound of chinaberry extract +soap and diatomaceous earth after 15 days compared to the control doesn't has a statistically significant difference (P ≤ 0.001, dft,e= 4, 5, F=27.35). However, the leaves treated with the compound of chinaberry extract + soap and the compound of chinaberry extract + soap and diatomaceous earth following 5 days

reported to have the lowest spawning rate compared to the control (Figure 2) (P≤0.000, dft,e=4, 5, F=26.81).

4. Discussion

One of the main challenges for nature and humans is using environmentally friendly pesticides , and the use of integrated pest management including biological control and natural pesticides are very diverse [14, 15, 16, 17]. Given the mortality results of the nymphs, one of the compounds that had the highest mortality rate was the treatment of the chinaberry extract + soap compound with a concentration of 3000 mg/liter and the compound of chinaberry + soap and diatomaceous earth following 10 days. The results of this study are in line with those of Alizadeh et al. (2018); they have reported that the azadirachtin plant extract has a mortality of up to 80%, yet this mortality decreases over time [18]. Chinaberry is rich in limonoids, and its pesticidal properties and power to control pests have been proven in several studies. The results of the study conducted by Iranmanesh et al. have confirmed the results of this study. It was attempted to investigate and compare the contact toxicity of chinaberry extract (Melia azedarach), neem (Azadirachta indica) and two commercial formulations of neem (Neem Oil and Neemarin) on nymphs of the first and fifth instars of common pistachio psyllid in laboratory conditions. The results of their study showed that chinaberry also has pesticidal potential on pest nymphs [9].

The decrease in the effect of chinaberry formulated compounds was observed after 10 and 15 days in this study. These results are in line with those of the study conducted by Alizadeh et al. (18). They have investigated the effect of three concentrations of azadirachtin, Thymol soap, spirodiclofen and spinosad on the pistachio psyllid nymph population. The results of their studsy showed that Thymol was more effective than other pesticides to controlling common pistachio psyllid and it reduces the population of pistachio psyllium nymphs by about 90%. However, after 21 days, the effect of azadirachtin gradually decreased. It can be explained by the lack of durability of azadirachtin extract in environmental conditions. Based on the studies conducted by other researchers in this field, it has been determined that the extract of azadirachtin gradually decomposes in the ultraviolet rays of sunlight and loses its effectiveness [19].

The combined treatment of chinaberry extract + soap and diatomaceous earth following 10 days also showed the greatest rate of reduction; this is in line with the results of the study conducted by Panahandeh [20] reporting that different treatments of mineral compounds including californium solution, potassium silicate, potassium nitrate, diatomaceous earth and potassium sulfate along with various additives are able to reduce the population growth index of pistachio psyllid nymphs.

Another study in line with our study shows the effects of diatomaceous earth and NeemAzal on peach aphid, Myzus persicae (Sulzer). Their results indicated that the greatest effects of reducing the pest population were related to the treatment (Diatomaceous earth + NeemAzal), which is probably due to the longer shelf life and also the sticking of diatomaceous earth their mortality [21].

The leaves treated with the compound of chinaberry + soap and the compound of chinaberry extract + potassium silicate and diatom had the lowest spawning rate after 5 days compared to the control. Qharegozlo [22] investigated the effects of removing pesticides such as (spirotetramat, imidacloprid, permethrin and chlorpyrifos), oil essences (mint, fennel, artemisia), plant resins (Asafoetida, cypress, eldar pine), Alcohols (ethyl alcohol, methyl alcohol, isopropyl alcohol) and petroleum derivatives (gasoline, kerosene) on pistachio psyllid spawning rate. According to this study, Asafoetida resin had significantly reduced the population of psyllium eggs. Moreover, Panahandeh [20] have reported that potassium silicate combind with CADENCE GOLD (an additive composition containing three compounds of humectant, non-ionic surfactant and wetting agents) can significantly reduce the spawning rate of pistachio psyllid. In another study, Hassanzadeh et al. [23] have reported that given the inhibitive effect of high kaolin mineral composition, spraying pistachio trees with processed kaolin (Sepidan 95% ®WP) with a concentration of 5% can successfully prevent the spawning of pistachio psyllid and as thus prevent the contamination of pistachio trees. Moreover, the effect of different concentrations of mineral compounds on the rate of spawning of pistachio psyllid is quite evident in the study conducted by Baghodrat et al. [24]; in the treatment of zeolite , feldspar , sulfur and wollastonite,, the spawning rate decreased as the concentration increased.

The results of different treatments on the spawning rate have indicated that there was not a significant difference between spawning rate of the leaves treated with the compound of chinaberry extract + potassium silicate and the compound of chinaberry extract + soap and diatomaceous earth following 15 days compared to the control group. This reduction is due to the decomposition of plant compounds against ultraviolet rays. But diatomaceous earth had the greatest effect in this period of time; this is in line with the results of the research conducted by Hassanzadeh et al. [23]. They have reported that the leaves treated with kaolin after 21 days have the greatest reduction in spawning compared to acetamiprid.

5. Conclusion

Due to environmental hazards, synthetic and chemical pesticides excessive use can reduce the health level of consumers and ultimately that of the whole society. Moreover, it causes the destruction of natural enemies and the emergence of pest resistance to pesticides. Be chemical. In the studies conducted over the recent years, the significant effect of plant and mineral compounds on pest control has been reported. In this research, it was attempted to investigate the insecticidal effects of plant and mineral compounds on common pistachio psyllid. This pest is one of the main pests of pistachio in Iran, especially in Kerman Province. The results indicated that plant compounds of chinaberry + soap and chinaberry extract + soap and diatomaceous earth are able to significantly reduce the amount of common psyllid nymphs. Moreover, the effect of different treatments on the reduction of spawning rate at different times was significant compared to that of the control. In this regard, it is recommended that more researches be conducted in order to determine the effect of these mineral and plant compounds on pests. It is also suggested that further and more detailed studies be conducted on the compounds effect in the presence of additives on

the most important natural enemies of common pistachio psyllid.

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Conflicts of Interest:

The authors declare no conflict of interest.

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