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Foliar Applications with Plant-Derived Extracts Control Pistachio Psyllid, *Agonoscena pistaciae*

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Abstract

Citrus and palm trees' extracts, commercially formulated as ProAlexin PNS™ and Agrispray™, were studied against the pistachio psyllid, *Agonoscena pistaciae,* in field conditions. Generally, foliage spraying application against the pistachio psyllid may cause severe reduction on the honeybee forager population, which visits infested trees to collect honeydew. ProAlexin™ products have the same formulation with Provigoro 14 WA Bee Care®, a natural water acidifier, which not only has negative action on the honeybees, but also shows disinfectant action against *Nosema* spp. The scope of the present study was to determine any effect of ProAlexin products on the reduction of the population of the pistachio psyllid, *Agonoscena pistaciae*. Experiments were performed at the orchard of the A.U.A., with two mixtures sprayed on psyllid infested pistachio trees, the first with ProAlexin PNS™ and Agrispray™ and the second only with Agrispray™. They were both applied with the addition of APG25™ non-ionic surfactant. Results showed that mortality on the trees treated with ProAlexin PNS™ + Agrispray™ mixture and Agrispray™ was significantly higher compared with the control. This could be explained due to the phytoalexins that these products elicit, which are part of the plant mechanism against insect herbivores. These products are potentially promising methods to be used in sustainable agriculture approaches against the pistachio psyllid and they should be tested for their effects on the biological control agents of this pest. Beyond this, the results of this study encourage to test their effects on other pests of pistachio and other tree species.

Keywords

Pistacia vera, Pistachio Psyllid, *Agonoscena pistaciae,* Control, Honeydew, Honeybees

1. Introduction

Honeydew is a sugar-rich sticky liquid, secreted by insects feed on plant sap. Many piercing-sucking, sap-feeding insects, except for tapping into the phloem of plants, where water transports sugars and other nutrients around the plant, have a filter chamber, a bypass of part of the midgut, to allow excess fluid to be quickly passed through the system. Some nutrients are absorbed, but not all; so insects with a filter chamber tend to excrete copious amounts of fluid, still containing a good deal of sugars and amino acids, but especially sugars. This sugar-laden sticky secretion is called honeydew [1]. Honeydew is an excellent food resource for many insects, such as honeybee, *Apis mellifera* L. Honeybees collect the honeydew from the living parts of the plants, transform it by combining it with specific substances of their bodies and then deposit, dehydrate, store and leave it in honeycombs to ripen and mature [2].

The pistachio psyllid, *Agonoscena pistaciae* Burckhardt and Lauterer (Hemiptera: Psyllidae) is a key pest of the pistachio trees throughout the pistachio-producing regions in the world [3]. Both the nymphs and adults suck sap from the leaves and produce large amounts of honeydew (**Figure 1**). Direct feeding causes reduced plant vigor, defoliation, stunting, poor yield and bud drop [4]. Chemical control is a common method in the management of this pest. The control of this pest has been based on insecticides with no attention either to the pest density and economic damage, or to their effect on the beneficial and productive insects (biological control agents, pollinators) [5]. Thus, foliage spraying application against the pistachio psyllid may cause severe reduction on the honeybee forager population, which visits (**Figure 2**), or flies to the trees to collect honeydew.

From the above, it is well understandable that the effective treatment of the pistachio psyllid and other honeydew-producing insects, as well, with insecticides that do not harm bees, is very important for bee keeping and also for the balance of the eco-system.

ProAlexin™ Nutrient Synergist and Agrispray™ (Phyto Innovative Products Ltd, Middlesbrough, UK) are mixtures of citrus and palm ingredients (citrus extract, demineralised water, citric acid, glycerine and palm oil extract), rich in flavonoids and ascorbic acid. These elements show synergistic effects, allowing the plant to suppress pathogenic attack naturally and preserve the flavor of vegetables and fruits. Flavonoids and ascorbic acid are extremely powerful elicitors of phytoalexins, as well as stabilizers towards oxidisable substances present in fruit and vegetables. ProAlexin™ and Agrispray™ have the same formulation with Provigoro 14 WA Bee Care®, a natural water acidifier, which not only does it have negative action on the honeybees, but it shows disinfectant action against *Nosema* spp [6].

The scope of the present study is to determine any effects of ProAlexin™ and Agrispray™ mixtures on the reduction of the population of the pistachio psyllid, *A. pistaciae*.

Figure 1. *Agonoscena pistaciae* nymph feeding on leaf.

Figure 2. Forager honeybee collecting honeydew from pistachio tree infested by *Agonoscena pistaciae.*

2. Materials and Methods

Experiments were performed at the orchard of the A.U.A in October 2013, a period when pistachio psyllid was in abundance. A mixture of ProAlexin PNS™ (5 ml/L) and Agrispray™ (3 ml/L) was sprayed twice on psyllid infested pistachio trees, with the addition of APG25™, a non-ionic surfactant (1 ml/L). Sprayings were performed to 25-years-old "Aeginis" pistachio (*Pistacia vera*) trees (n = 3) at the rates indicated, with untreated trees serving as controls. The trees had

never been treated with systemic insecticides and the last treatment with contact insecticides was >1 year prior to the present treatment. Two sprayings were performed in total, on October the 5th and 10th in 2013.

One day after the last spraying, the trees were sampled in order to obtain five leaves from each of the three trees of each treatment (45 leaves in total) and psyllid nymphs were counted under a binocular stereomicroscope. They were counted as dead when no sign of movement was observed. The percentage of psyllid mortality was counted as the ratio of the dead psyllids over the total of the psyllid individuals. Data were arcsine transformed to ensure normality, linearity and homoscedasticity and then subjected to one-way analysis of variance. Differences between treatment means were tested for significance ($P < 0.05$) with Student's *t*-test [7].

3. Results

Results on the psyllid mortality showed significant difference between the treated trees and the control ($t = 10.39$, $P < 0.0001$). The mortality on the trees treated with ProAlexin PNS™ + Agrispray™ mixture was significantly higher compared with the control (**Figure 3**). A variety of psyllid nymphal instars were found dead on the treated pistachio leaves, in which mortality was 93.05% ± 3.18%, significantly higher compared with the control (20.67% ± 5.86%). It has to be mentioned that the psyllid nymphs were counted as dead when no sign of movement was observed.

4. Discussion

Undoubtedly, the psyllid populations on trees reduce the pistachio nuts production significantly [3]. Therefore, in order to make the cultivation profitable, a psyllid management program should be developed, which could include the use of insecticides. The use of broad-spectrum synthetic insecticides is damaging to the balance between the psyllids and the beneficial insects, especially when applied later in the season, than in pre-blossom [8]. Non-residual contact insecticides and certain short-residual products have the least adverse effect on natural enemy populations and pollinators, as well. In many areas, the honeybees forage

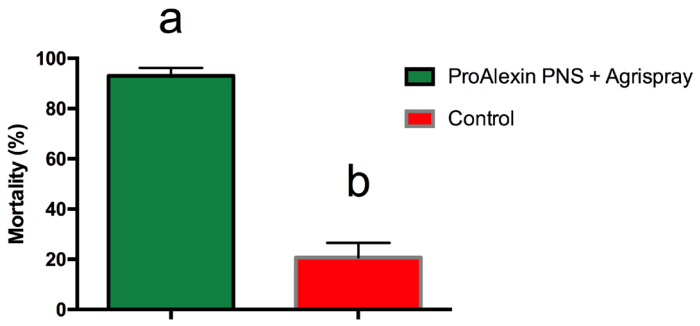

Figure 3. Percent mortality (mean ± s.e.) of pistachio psyllid, *Agonoscena pistaciae,* after foliar applications with plant-derived extracts. (Columns without common letters have significant difference, $P < 0.05$).

on both flowers and honeydew excreted by the insects living on the tree, such as the psyllids [9].

ProAlexin PNS™ + Agrispray™ mixture and Agrispray™ applied to the plant surface have lethal effect against the pistachio psyllid, *Agonoscena pistaciae* Burckhardt & Lauterer (Hemiptera: Psyllidae). These products are designed to elicit phytoalexins, which are part of the plant mechanism against insect herbivores [10] [11] [12]. Moreover, other ingredients of ProAlexin PNS™ and Agrispray™, like citrus and palm oil extracts, are rich in flavonoids, which are also of high importance for the defence of the plant against insect pests [10] [13] [14] [15]. The results of the present study have shown that psyllid mortality on ProAlexin PNS™ + Agrispray™ reached 93%, whilst respective mortality for the control was 21%.

Some synthetic insecticides are known to have low toxicity on honey bees. Spirotetramat is a new systemic and persistent foliar insecticide with low basic risk for the forager honey bees, based on acute oral and contact experiments [16]. Nevertheless, there is still a risk of mortality for the adults and pupae, substantial agitation of brood development, and early brood termination at less than maximum application rate [17].

In conclusion, the present study has shown that ProAlexin PNS™ and Agrispray™ mixture has clearly had adverse effects on pistachio psyllid, by increasing the nymphal mortality when sprayed on pistachio, in field conditions. Since the same formulation, in different commercial name (Provigoro 14 WA Bee Care®), has already been registered for beekeeping use as water acidifier, these products are a very promising solution for the pistachio psyllid control, without harming the forager bees. Moreover, these products are potentially promising methods to be used in sustainable agriculture approaches against the pistachio psyllid and they should be tested for their effects on the biological control agents of this pest. Last but not least, the results of this study have encouraged us to test their effects on other pests of pistachio and different tree species.

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