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Study on Field Evolution of Citrus Mealybug (*Planococcus citri* Risso) (Hemiptera: Pseudococcidae) Management in Finike County of Antalya, Turkey

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ABSTRACT

This study was conducted to evaluate efficiency of biological and chemical control methods against citrus mealybug, *Planococcus citri* Risso (Hemiptera:Pseudococcidae), caused important economic losses in the east Mediterranean region of Turkey. It was investigated at 23 different citrus orchards in Finike county of Antalya in 2011. Chloropyrifos-ethyl, spirotetramat, summer oil and biological control agents (*Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae) and *Leptomastix dactylopii* How. (Hymenoptera: Encyrtidae) were applied under grower conditions against mealybug. Percent infestation rate of mealybug was determined on random samples of 5 fruits per tree, examining presence or absence of mealybug, i.e. totally 150 fruits per orchard. Biological control agents were sampled by a strike technique. The mealybug density differences among the applied methods were analyzed to compare the average mealybug infestation rate in insecticide and biological control applied orchards, and it was different insignificantly. While the lowest infestation rate was at summer oil (% 5.91); spirotetramat (% 6.88), chloropyriphos-ethyl (%7.69) and biological control (% 8.66) followed it. The highest average number of natural enemies for each treatment was determined as 20.57 individuals, of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), *C. montrouzieri,* and *Scymnus* spp. in orchards biological control application used, followed by summer oil sprayed orchards as 4.25 individuals, of *C. carnea* and *Scymnus* spp., and spirotetramat sprayed orchards as 2.67 individuals per orchard, of *C. carnea* and *Scymnus* spp. It is determined that summer oil and spirotetramat are compatible with natural enemies. However, chorpyrifos-ethyl was incompatible, due to side effects on natural enemies. Because of possibility of phytoxicity effect of summer oil in hot weather condition; spirotetramat has a chance in IPM application for managing citrus mealybug.

Key words: Citrus mealybug, *Cryptolaemus montrouzieri*, *Leptomastix dactylopii*, summer oil, spirotetramat, chlorpyrifos-ethyl.

INTRODUCTION

Citrus production is restricted by many pests and diseases in Turkey. Citrus mealybug, *Planococcus citri* Risso (Hemiptera: Pseudococcidae) is one of the main

pests affecting all citrus varieties in Turkey. As a main pest, the citrus mealybug infests a total of approximately 100 000 ha of citrus on the East and West Mediterranean coasts of Turkey. Citrus rust mite (*Phyllocoptruta oleivora* (Ashmead); Acari: Eriophyidae) and California red scale (*Aonidiella aurantii* (Maskell); Hemiptera: Diaspididae) are also considered as key pests which are suppressed by a specific acaricide and summer oil applications, respectively on citrus orchards in Turkey (Uygun, 2001; Erkılıç and Demirbaş, 2007). Citrus mealybug has a soft, oval, flat body covered by powdery wax and body margin has long waxy filaments around the body in numbering 18 pairs with a white wax that extends into spines along the body margin (McKenzie, 1967). During the winter, the mealybugs occupy cracks and cavities in the trunks of citrus trees in adult female or egg stages. In early spring (at the end of April or beginning of May depending on temperature) they emerge from these hibernating sites. Three to six overlapping generations occur in a year, but only one cycle (Spring-Summer) is of major concern to citrus growers, with peak infestations occurring at the beginning of June in the Mediterranean region of Turkey (Uygun *et al*., 2010)

Citrus mealybug extracts the juices from the plant and also produce honeydew on foliage and fruits with subsequent development of sooty molds. Furthermore, it may cluster around the fruit's pedicel and cause young fruits to drop in early spring (Jeppson, 1989).

Conservation of natural enemies is the first step in citrus mealybug control. However, natural biological control does not always suppress the pest population sufficiently to keep it under the economically damaging level. Nonetheless, releases of exotic natural enemies, *C. montrouzieri* and *L. dactylopii* have provided effective control without needing to use of insecticides. The critical period for controlling the mealybug population is from mid-May through the summer. To avoid missing the beginning of the buildup of the pest population, a summer oil application during winter months and releases of *C. montrouzieri* and/or *L. dactylopii* at the beginning of the infestation as well as ant control, are important practices in orchards where the citrus mealybug has been a problem in previous years ((Öztop *et al*., 2011).

The officially recommended release rate is 10 *L. dactylopii* adults per tree, as with 5 *C. montrouzieri* adults, in old orchards and grapefruit plantations the numbers need to be doubled, and in heavy infestations more than double the number may be needed (Erkılıç and Demirbaş, 2007). Both of *C. montrouzieri* and *L. dactylopii* are exotic, and cannot survive the Mediterranean winters and thus needs to be released again each spring growing season (Yiğit and Canhilal, 1998; Karacaoglu and Yarpuzlu, 2013).

Growers usually spray registered (spirotetramat, summer oil) and unregistered (chlopyriphos-ethyl) active ingredients and release the exotic natural enemies to control the Citrus mealybug populations. Repeated applications of the pesticides might be necessary when one application is inadequate to control of the pest.

This study was conducted to evaluate the effect of some insecticides and release of the exotic natural enemies on citrus mealybug control under growers' conditions in Finike (Antalya) in Turkey

MATERIAL AND METHODS

Treatments were established in 23 around fifteen year old “finike” orange orchards (Table 1). Exotic natural enemies (*C. montrouzieri* and *L. dactylopii*) were released to control mealybug (10 *L. dactylopii* adults, with 5 *C. montrouzieri* adults per tree), and summer oil had been used at winter term in 7 of the citrus orchard designated as Biological Control “BC”. In “BC” orchards 6, summer oil was sprayed by backpack sprayer during winter months.

Table 1. Experimental designed areas, application methods and dates.

OrchardS	Treatments	Location	Treatment Date		Orchards	Treatments	Location	Treatment Date
1	BIOLOGICAL CONTROL (BC) (Release rate; 5 predator and 10 parasitoid per tree)	Kıllıoğlu	12.05.2011		1	SPIROTETRAMAT (ST)	Sahilkent -1	15.05.2011
2		Sapaca/ SahilKent	10.06.2011		2		Kıllıorman	30.05.2011
3		Dalkavak-1	25.05.2011		3		Sahilkent-2	20.04.2011
4		Dalkavak-2	20.05.2011		4		Sahilkent-3	20.04.2011
5		Dalkavak-3	10.05.2011		5		Sahilkent-4	01.05.2011
6		Demirağaç	25.05.2011		6		Sahilkent-5	01.05.2011
1	CHLORPYRIFOS ETHYL (CE)	Tekke/Bölücek	20.05.2011		7		Çavdır	15.05.2011
2		Hasyurt	15.05.2011		1	SUMMER OIL (SO)	Hortum	09.06.2011
3		Turunçova-1	10.05.2011		2		Zengeder	25.05.2011
4		Turunçova-2	01.06.2011		3		Tekke	20.05.2011
5		Turunçova-3	01.06.2011		4		Turunçova	15.05.2011
6		Turunçova-4	01.06.2011					

The remaining 6 citrus orchards were sprayed with chlorpyrifos-ethyl (250ml/hl of 480 EC) designated as Chlorpyrifos Ethyl “CE”. In “CE” orchard 2, chlorpyrifos-ethyl was sprayed two times and additionally buprefozin (50ml/hl of 400 SC) was sprayed on May 10. In “CE” orchard 1, apart from chlorpyrifos-ethyl, summer oil and spirotetramat were applied, respectively at the beginning of March and June 20.

Other remaining 6 and 4 orchards were sprayed with spirotetramat (100 ml/hl of 100 SC) and summer oil (1250 ml/hl of 850 EC), respectively. They were designated as Spirotetramat “ST” and Summer Oil “SO”, respectively. In “ST” orchards 1 and 4, spirotetramat was applied by backpack sprayers.

Firstly, 30 trees were selected from each citrus orchard. Percent infestation rate of mealybug was determined on random samples of 5 fruits per tree, totally 150 fruits per orchard. The fruit samples were selected from four directions and inside of trees. The fruits were examined just visually in orchards for presence or absence of mealybug, even there was one mealybug on fruit accepted as infested fruit. Thus percent infestation rate was calculated. The percent infestation of mealybug differences among the applied methods were analyzed using the analysis of variance (ANOVA) procedure to compare the average mealybug infestation rate in insecticide and biological control

applied orchards. Furthermore, to observe any side effects of insecticides on natural enemies, numbers of insect predators were estimated from each orchard by strike technique (Steiner, 1962; Horsburg and Asquith, 1968). A total of 100 strikes (one or two strikes per randomly selected tree) were made in each orchard. All active stages of predators that fell on collapsible tray were recorded.

RESULTS

The mealybug infestation rate (%) in natural enemies release and insecticides applied orchards is shown in Fig. 1. Biological control applied orchards (BC); data from biological control applied orchards showed that mealybug infestation rate was low in “BC” orchards 2, 3, 4, 5 and 7. However, it was high in “BC” orchards 1 and 6 on which mealybug was controlled by natural enemies (Fig. 1).

Chlorpyrifos-ethyl applied orchards (CE); mealybug infestation rate was low in “CE” orchards 1, 2 and 4. However, it was high in “CE” orchards 3, 5 and 6 (Fig . 1).

Spirotetramat applied orchards (ST); mealybug infestation rate was higher than acceptable level (5-10 %) in “ST” orchards 1 and 4 (Fig. 1).

Summer oil applied orchards (SO); mealybug infestation rate was only high in “SO” orchard 4 (Fig. 1). Because of unusual care during application.

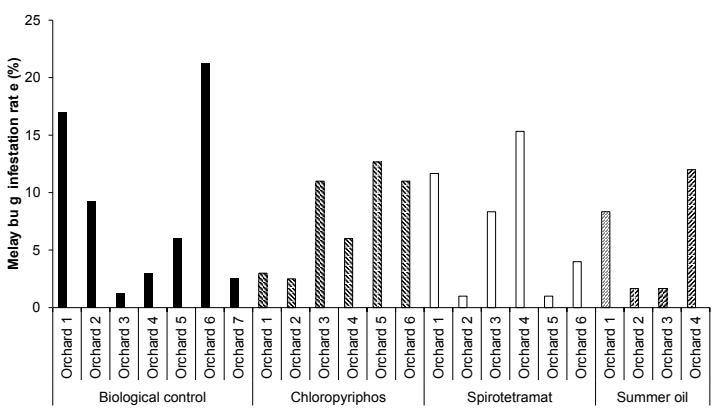

Fig. 1. Infeastation rate (%) of *Planococcus citri* at different citrus orchards.

The percent infestation of mealybug was different insignificantly (F=0.196; df=3, 19; P=0.898). While the lowest infestation value was at summer oil (% 5.91); spirotetramat (% 6.88), chloropyriphos-ethyl (%7.69) and biological control (% 8.66) followed it (Fig. 2).

In this experiment, the determined insect predators were Green lacewing (*C. carnea*), and coccinelids (*C. montrouzieri* and *Scymnus* spp). *C. carnea* is the most frequently obtained predator. Number of total collected insect predators was the highest at biological control applied orchards. Summer oil and spirotetramat applied orchards has similar numbers of insect predators. Data from chorpyrifos-ethyl applied orchards was zero (Fig. 3).

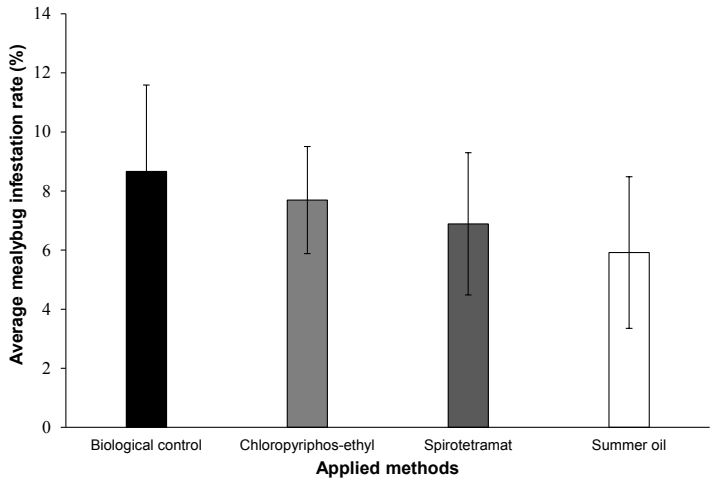

Fig. 2. Average mealybug infestation rate at different control methods.

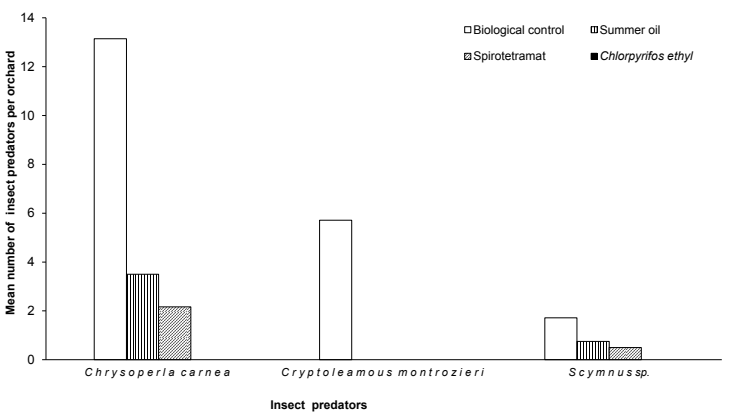

Fig. 3. Species and number of insect predators in insecticide and biological control applied orchards.

DISCUSSION

Our results show that there were not any significant differences among tested control methods against mealybug in citrus orchards. Biological control of mealybug in “BC” orchard 1 was unsuccessful, because *C. montrouzieri* and *L.dactylopii* were released on May 12, probably it was late. Erkilic and Demirbas (2007) suggested that, early spring releases of parasitoids are very important in orchards where citrus mealybugs were a problem in the previous year. In “BC” orchard 6, coverage achievements were inadequate, because summer oil was sprayed by backpack sprayer during winter months. Carman, (1989) suggested that backpack sprayers cannot achieve thorough coverage of trees. Hand-gun sprayers can be useful in

targeting individually infested trees, and can deliver high volumes at high pressures which will help maximize control.

Either single spirotetramat or chlorpyrifos-ethyl spraying against mealybug did not reduce citrus mealybug numbers below an average of 5-10 percent infestation rate that is a desirable result of mealybug control in some of the citrus orchards in this experiment. Kerns *et al*., (2002) suggested that chemical control of citrus mealybug can be extremely difficult and the success of a chemical control depends on the correct application of the needed pesticides at proper time. However, no single treatment may offer acceptable control of mealybug; follow-up applications are often necessary. Control is most easily achieved if applications are started during the initial infestation of the fruit, and when the first instar crawlers are prevalent. On the other hand, treatment effectiveness of pesticides is significantly determined by achieving completeness of coverage, because citrus mealybug presents all citrus surfaces. Carman (1989) suggested that coverage achievements by hand-gun sprayers are mostly adequate if usual care is taken in making the application.

Use of selective insecticides for citrus mealybug control will often prevent problems with mealybug by preserving natural enemies (Öztop *et al*., 2011). Number of total determined insect predators in summer oil and spirotetramat applied orchards showed that these insecticides are compatible with the natural enemies. In this respect, chorpyrifos-ethyl was incompatible.

CONCLUSION

Biological control is a promising solution for both pest problems in agriculture and environmental protection of natural ecosystems worldwide. Biological control practices should be the cornerstone of citrus IPM programme. Increasing efforts towards biological control implementations is limited by growers' knowledge. Therefore, training of growers is a priority for making the application of biological control more widespread in citrus growing areas of Turkey. Successfully managing and maintaining biological control of citrus pests requires the presence of someone responsible with more than a rudimentary knowledge of crop protection. On the other hand, new chemical management tactics should be studied especially compatible insecticides with natural enemies has to be improved. It is seen that spirotetramat has a chance in IPM programmes for managing citrus mealybug.

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