

Pest and Natural Enemy Fauna in Organic Citrus Production in the Eastern Mediterranean Region of Turkey

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Abstract

This study was carried out in two orchards in the eastern Mediterranean region of Turkey, the Mars Seedless Grapefruit Orchard in Dörtüyl/Hatay and the Valencia Orange Orchard in Erdemli/Mersin. Organic farming methods were used in both orchards and the organic produce certified by the internationally recognised EKOTAR-Turkey. Citrus pests and their natural enemies were monitored by eye and stroke methods during 2004 and 2005. Infected plant material was brought to the laboratory to obtain the adult parasitoids and predators. Fifteen pest species belonging to different taxonomic groups (1 from Acarina, 1 from Thysanoptera, 1 from Hemiptera, 10 from Homoptera, 1 from Diptera and 1 from Lepidoptera) were identified and 34 beneficial species were found associated with these pests. Among the 14 species identified in the orchards, 3 species were economically important and considered to be key pests. In this paper, citrus production pests and their natural enemies were identified and control strategies in accordance with organic farming practices were reported.

Key Words: Citrus, Organic farming, Pest, Parasitoid, Predator.

INTRODUCTION

The citrus growing areas in Turkey are located in the Mediterranean, Aegean and the Black sea regions, with the Mediterranean area being the most important with about 75% of the production concentrated in this region. These areas have considerably enlarged within the last few years and further future expansion is expected.

Turkish citrus production has been managed commercially since the 1940s and has operated in harmony with the environment for many years. During the growing season, various pest, disease and weed problems occur, sometimes reaching worrisome levels. Different control methods can maintain the pest population below the economic threshold. Intensive use of pesticides poses a threat to both human and animal health, and to the environment. With the resurgence of secondary pests and the development of resistance, alternative pest control methods are being sought.

Considerable research has been done over the past 30 years on integrated pest management, yielding important advances for the citrus industry in Turkey. Many of these improvements have been incorporated into the strategies for organic farming. For example, biological control is an important integral part of the organic process. In Turkey, successful citrus pest containment relies largely on biological control and summer oil applications. In this paper, citrus pests and their natural enemies within 2 organic orchards were studied.

MATERIALS AND METHODS

The study was conducted in two different orchards in the eastern Mediterranean region. One was a 36 years old Mars Seedless Grapefruit Orchard in Dörtüyl/Hatay containing 336 trees. The orchard plot was within a 100

ha citrus plantation containing different citrus species. All plots were flood irrigated. The second plot was a 39 years old Valencia Orange Orchard with 410 trees in Erdemli/Mersin. This orchard was also flood irrigated. Soil and leaf samples were taken for analysis and the plant breeding applications were carried out in accordance with organic farming methods.

Pest and natural enemy species were monitored by visual check [minimum 100 plant material (bud, leaf, shoot and fruit)] and stroke methods (minimum 100 strokes) [1]. Pests which multiplied were controlled to within manageable thresholds. When their economic threshold level was reached, organic farming methods were utilised i.e. manipulating the density of their natural enemies.

RESULTS

In total, fifteen pest species belonging to different taxonomic groups, Acarina, Thysanoptera, Hemiptera, Homoptera, Diptera and Lepidoptera, were found within the study sites. Thirty-four beneficial species were found associated with these pests: 16 from Coccinellidae; 1 each from Cybocephalidae (Coleoptera), Chrysopidae (Neuroptera), Coniopterygidae (Neuroptera) and Thripidae (Thysanoptera); 5 from Eulophidae (Hymenoptera); 3 each from Encyritidae and Aphelinidae, 2 from Anthocoridae (Hemiptera) and a general predator from Dermaptera (*Forficula* sp.).

Citrus Pests and Their Natural Enemies in Dörtüyl/Hatay

The citrus pests present in the Mars Seedless Grapefruit Orchard in Dörtüyl/Hatay in 2004 and 2005 are given in Table 1. Thirty-two beneficial species were

found associated with these pests (Table 2). Among the pest species, 2 were of economic importance, while the

others were considered to have potential economic importance.

Table 1. Citrus pests in Dörtöyl/Hatay in 2004-2005.

Order Famil	y	Species
Acarina	Tetranychidae	<i>Panonychus citri</i>
Homoptera	Pseudococcidae	<i>Planococcus citri</i>
	Aleyrodidae	<i>Aleurothrix floccosus</i>
	"	<i>Dialeurodes citri</i>
	Coccidae	<i>Ceroplastes floridensis</i>
	"	<i>Coccus hesperidum</i>
	Cicadellidae	<i>Empoasca decipiens</i> <i>Asymetrasca decedens</i>
	Diaspididae	<i>Aonidiella aurantii</i>
	Margarodidae	<i>Icerya purchasi</i>
	Aphididae	<i>Aphis</i> spp.
Diptera	Tephritidae	<i>Ceratitis capitata</i>
Lepidoptera	Gracillariidae	<i>Phyllocnistis citrella</i>

During both years, the economically important pests were the citrus red mite, *Panonychus citri* (McGreg.) (Acarina: Tetranychidae) and the citrus mealy bug, *Planococcus citri* Risso (Homoptera: Pseudococcidae). *Panonychus citri* had 8 species of natural enemies of which *Stethorus gilvifrons* Mulsant (Coleoptera: Coccinellidae) and *Orius minutus* (L.) (Hemiptera: Anthocoridae) were the most important. When the mite population developed over the economic threshold, sulphur application was recommended. The other important pest, *Planococcus citri*, had 9 native natural enemies, of which *Chilocorus*

bipustulatus (L.), *Exochomus quadripustulatus* (L.) (Coccinellidae) and *Anagyrus pseudococci* (Girault) (Encyrtidae) were the most important. Because the mealy bug population developed over the economic threshold, more effective natural enemies, *Cryptolaemus montrouzieri* Muls. (Coccinellidae) and *Leptomastix dactylopii* How. (Encyrtidae) were released. Commercial use of these natural enemies is possible due to their mass rearing and transportation by a private company.

Table 2. Citrus pests and their natural enemies in Dörtöyl/Hatay in 2004 and 2005.

Pests	Natural enemies	
Acarina		
<i>Panonychus citri</i> (McGregor)	<i>Orius minutus</i> (L.)	Hem.
	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Conwentzia</i> spp.	"
	<i>Stethorus gilvifrons</i> (Mulsant)	Col.
	<i>Scymnus levallanti</i> Mulsant	"
	<i>Pharoscymnus pharoides</i> Marseul	"
	<i>Clitostethus arcuatus</i> (Rossi)	"
	<i>Cybocephalus fodori minor</i> E.-Y.	"
Homoptera		
<i>Aonidiella aurantii</i> Maskell	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Scymnus rubromaculatus</i> (Goeze)	"
	<i>Scymnus</i> spp.	"
	<i>Pharoscymnus pharoides</i> Marseul	"
	<i>Cybocephalus fodori minor</i> E.-Y.	"
	<i>Aphytis melinus</i> DeBach	Hym.
	<i>Comperiella bifasciata</i> Howard	"
<i>Coccus hesperidum</i> L.	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Exochomus quadripustulatus</i> (L.)	"
<i>Ceroplastes floridensis</i> Comstock	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Scymnus</i> spp.	"
<i>Icerya purchasi</i> Maskell	<i>Rodolia cardinalis</i> (Mulsant)	Col.
	<i>Chrysoperla carnea</i> (Stephens)	Neu.
<i>Planococcus citri</i> (Risso)	<i>Chrysoperla carnea</i> (Stephens)	Neu.

	<i>Orius minutus</i> (L.)	Hem.
	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Exochomus quadripustulatus</i> (L.)	“
	<i>Cryptolaemus montrouzieri</i> Mulsant	“
	<i>Scymnus levaillanti</i> Mulsant	“
	<i>S. subvillosus</i> (Goeze)	“
	<i>S. rubromaculatus</i> (Goeze)	“
	<i>Cybocephalus fodori minor</i> E.-Y.	“
	<i>Leptomastix dactylopii</i> How.	Hym.
	<i>Anagyrus pseudococci</i> (Girault)	“
<i>Dialeurodes citri</i> (Ashmead)	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Conwentzia</i> spp.	“
	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Exochomus quadripustulatus</i> (L.)	“
	<i>Clitostethus arcuatus</i> (Rossi)	“
	<i>Adonia variegata</i> (Goeze)	“
	<i>Stethorus gilvifrons</i> (Mulsant)	“
	<i>Serangium parcesetosum</i> Sicard	“
	<i>Encarsia lahorensis</i> (Howard)	Hym.
<i>Aleurothrixus floccosus</i> (Maskell)	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Clitostethus arcuatus</i> (Rossi)	Col.
	<i>Serangium parcesetosum</i> Sicard	“
	<i>Cryptolaemus montrouzieri</i> Mulsant	“
	<i>Chilocorus bipustulatus</i> (L.)	“
	<i>Cales noacki</i> Howard	Hym.
<i>Aphis</i> spp.	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Exochomus quadripustulatus</i> (L.)	Col.
	<i>Coccinella septempunctata</i> (L.)	“
	<i>C. undecimpunctata</i> (L.)	“
	<i>Scymnus syriacus</i> Marseul	“
	<i>S. subvillosus</i> (Goeze)	“
	<i>S. apetzi</i> Mulsant	“
	<i>S. levaillanti</i> Mulsant	“
	<i>S. rubromaculatus</i> (Goeze)	“
	<i>Pharoscymnus pharoides</i> Marseul	“
<i>Asymmetrasca decedens</i> (Paoli)		
<i>Empoasca decipiens</i> Paoli		
Lepidoptera		
<i>Phyllocnistis citrella</i> Stainton	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Scymnus</i> spp.	Col.
	<i>Synharmonia conglabata</i> (L.)	“
	<i>Cirrospilus</i> sp. nr. <i>lyncus</i> (Walker)	Hym.
	<i>Cirrospilus</i> spp.	“
	<i>Citrostichus phyllocnistoides</i> (Naryanan)	“
	<i>Neochrysocharis</i> sp.	“

Diptera

Ceratitidis capitata (Wiedemann)

Most of the pests belong to the order Homoptera and have an abundance of natural enemies. *Aleurothrixus floccosus* Mask. (Aleyrodidae) was associated with 6 different species of natural enemies; *Dialeurodes citri* (Ashmead) (Aleyrodidae) with 9 natural enemies; *Aphis* spp. with 10 natural enemies; *Aonidiella aurantii* Maskell (Hom.: Diaspididae) with 7 natural enemies; *Coccus hesperidum* L., *Ceroplastes floridensis* (Comstock) (Coccidae) and *Icerya purchasi* Maskell (Margarodidae) with 2 natural enemies. No natural enemies of the leafhoppers were observed. The only member from Lepidoptera found in the orchard was the

citrus leaf miner, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae). It was associated with 7 different species of natural enemies of which *Chrysoperla carnea* Steph. (Neuroptera: Chrysopidae) was the most important predator and *Cirrospilus* sp. nr. *lyncus* (Walker) and *Citrostichus phyllocnistoides* (Narayanan) (Eulophidae) the most important parasitoids. The Mediterranean fruit fly, *Ceratitidis capitata* (Wiedemann) (Tephritidae) was the only Dipteran pest found in the orchard. Although one of the world's most destructive fruit pests, it did not cause serious damage. No natural enemies of this pest were found in the orchard. The only remedy recommended for this pest is bait spraying which is acceptable within IPM strategies. The local citrus plots were bait sprayed and it is thought that this

protected the test plot. *Forficula* sp. was recorded as a general predator in the orchard.

The citrus pests detected in the Valencia Orange orchard in Erdemli/Mersin in 2004 and 2005 are shown in Table 3.

Citrus Pests and Their Natural Enemies in Erdemli/Mersin

Table 3. Citrus pests in Erdemli/Mersin in 2004 and 2005.

Order	Family	Species
Homoptera	Pseudococcidae	<i>Planococcus citri</i>
	Coccidae	<i>Ceroplastes floridensis</i>
	"	<i>Coccus hesperidum</i>
	Diaspididae	<i>Aonidiella aurantii</i>
	Aleyrodidae	<i>Aleurothrixus floccosus</i>
	"	<i>Dialeurodes citri</i>
	Cicadellidae	<i>Empoasca decipiens</i> <i>Asymmetresca decedens</i>
	Aphididae	<i>Aphis</i> spp.
Thysanoptera	Thripidae	<i>Thrips</i> spp.
Lepidoptera	Gracillariidae	<i>Phyllocnistis citrella</i>
Hemiptera	Miridae	<i>Dionconotus cruentatus</i>

Besides the 12 pest species found in this orchard, 24 beneficial species associated with these pests were observed (Table 4). Among the pest species, *P. citri* and *C. floridensis* in 2004 and only *C. floridensis* in 2005 were of economic importance, while the others were considered to be of potential economic importance. In 2004, the mealy bug population developed over the economic threshold, so

biological control by releasing natural enemies was recommended. In the second year, the native natural enemies controlled the pest and there was no need for further release. *C. floridensis* was the major problem in the orchard. Its natural enemies had not been able to keep it at low level so a summer oil application was recommended.

Table 4. Citrus pests and their natural enemies in Erdemli/Mersin in 2004-2005.

Pests	Natural enemies	
Homoptera <i>Aonidiella aurantii</i> Maskell	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Scymnus rubromaculatus</i> (Goeze)	"
	<i>Scymnus</i> spp.	"
	<i>Pharoscyrnus pharoides</i> Marseul	"
	<i>Cybocephalus fodori minor</i> E.-Y.	"
	<i>Aphytis melinus</i> DeBach	Hym.
<i>Coccus hesperidum</i> L.	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Exochomus quadripustulatus</i> (L.)	"
	<i>Coccinella septempunctata</i> L.	"
	<i>Forficula</i> sp.	Derm.
<i>Ceroplastes floridensis</i> Comstock	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Scymnus</i> sp.	"
<i>Planococcus citri</i> (Risso)	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Orius minutus</i> (L.)	Hem.
	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Exochomus quadripustulatus</i> (L.)	"
	<i>Cryptolaemus montrouzieri</i> Mulsant	"
	<i>Scymnus levaillanti</i> Mulsant	"
	<i>S. rubromaculatus</i> (Goeze)	"
	<i>Scymnus</i> spp.	"
	<i>Leptomastix dactylopii</i> How.	Hym.
<i>Anagyrus pseudococci</i> (Girault)	"	
<i>Dialeurodes citri</i> (Ashmead)	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Conwentzia</i> sp.	"
	<i>Chilocorus bipustulatus</i> (L.)	Col.
	<i>Exochomus quadripustulatus</i> (L.)	"
	<i>Adonia variegata</i> (Goeze)	"

<i>Aleurothrixus floccosus</i> (Maskell)	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Cryptolaemus montrouzieri</i> Mulsant	“
	<i>Chilocorus bipustulatus</i> (L.)	“
	<i>Cales noacki</i> Howard	Hym.
<i>Aphis</i> spp.	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Exochomus quadripustulatus</i> (L.)	Col.
	<i>Coccinella septempunctata</i> (L.)	“
	<i>Scymnus levaillanti</i> Mulsant	“
	<i>S. rubromaculatus</i> (Goeze)	“
	<i>Scymnus</i> spp.	“
	<i>Pharoscymsus pharoides</i> Marseul	“
<i>Asymmetrasca decedens</i> (Paoli)		
<i>Empoasca decipiens</i> Paoli		
Lepidoptera		
<i>Phyllocnistis citrella</i> Stainton	<i>Chrysoperla carnea</i> (Stephens)	Neu.
	<i>Scymnus</i> spp.	Col.
	<i>Synharmonia conglabata</i> (L.)	“
	<i>Cirrospilus</i> sp. nr. <i>lyncus</i> (Walker)	Hym.
	<i>Cirrospilus</i> spp.	“
	<i>Citrostichus phyllocnistoides</i> (Narayanan)	“
	<i>Ratzeburgiola incomplita</i> Boucek	“
Thysanoptera		
<i>Thrips</i> sp.	<i>Scolothrips</i> sp.	Thy.
Hemiptera		
<i>Dionconotus cruentatus</i> Brulle		

In comparison with Hatay orchard, neither mite species nor *I. purchasi* were observed. However, *Thrips* spp. from Thysanoptera order and *Dionconotus cruentatus* Brulle (Miridae) from the Hemiptera order were found. *Scolothrips* sp. was identified as the predator of *Thrips* spp. As in Hatay, most of the other pests in the Erdemli/Mersin plot belonged to the Homoptera order and had many natural enemies. As in Dörtyol, *A. aurantii* was identified as a potential economically important pest. Six species of natural enemies were associated with *A. aurantii*, the most important being, *Chilocorus bipustulatus* L. (Col.: Coccinellidae), *Cybocephalus fodori minor* E. Y. (Col.: Cybocephalidae) and *Aphytis melinus* DeBach (Hym.: Aphelinidae). Two whitefly species were identified in this orchard: *D. citri* and *A. floccosus*. *D. citri* was introduced into Turkish citrus ecosystems in 1965 [2] and *A. floccosus* in 1994 [3]. Their efficient natural enemies were also observed in the orchard: *Serangium parcesetosum* Sicard (Coccinellidae) for *D. citri* and *Cales noacki* Howard (Hymenoptera: Aphelinidae) for *A. floccosus*. The *Aphis* spp. pest was associated with 7 different species of natural enemies and *I. purchasi* with 2. The citrus leaf miner, *P. citrella* was within all the citrus orchards, and was particularly damaging in nurseries and young plantations. In this plot, it was associated with 7 different species of natural enemies, the most common ones being: *C. carnea*, *Cirrospilus* sp. nr. *lyncus* (Walker), *C. phyllocnistoides* (Narayanan) and *Ratzeburgiola incomplita* Boucek (Eulophidae).

DISCUSSION

Although organic citrus growing is currently represented by a very small portion of Turkey's citrus plantations, it is predicted that interest will lead to future enlargement. In fact, several citrus growers have entered organic farming in recent years in the eastern Mediterranean region. In organic

farming, aside from other problems, citrus growers are faced with a broad assortment of insects and mites. IPM has become a factor in dealing with insect and mite problems, specifically pest identification, managing thresholds, risk assessment and control strategies. The use of natural enemies, summer oil and natural insecticide applications are essential to keep insect populations below the economic threshold.

Numerous surveys of citrus orchards in Turkey reveal up to 89 pest species in Turkey [4-12]. In this study, 11 pest species in Hatay and 12 species in Mersin were detected. Thirty-two beneficial species in Hatay and 24 in Mersin were found associated with these pests. Among the pest species, only 3 were of economic importance, while the others were considered to be potential importance.

P. citri has become a problem in citrus orchards in recent years. Although 25 native natural enemies of the pest are recorded [10] that can, in general, reduce *P. citri* populations substantially, in orchards where broad-spectrum pesticides are used and proper culture practices not followed, the pest becomes economically important. In Dörtyol, the pests had been controlled by IPM methods for about 10 years. It is thought that the mealy bug problem in this orchard is due to the citrus variety. The *P. citri* population differs within citrus varieties. There is no problem in growing lemons, oranges and mandarins if biological control is applied on time. But with grapefruit, the shape formation of the fruits, the age of the plant and the planting density all affect the pest population. Therefore, surveys in the grapefruit orchards must start from May and natural enemies must be released on time. It is thought that in grapefruit orchards when the natural balance is established, native natural enemies will be sufficient to control the pest.

C. floridensis is an occasional pest in some citrus orchards. Seven natural enemies in Turkish citrus orchards [12] have been recorded. In Erdemli, *C. floridensis* was the major problem within the orchard before the study started. Its natural enemies had not been able to keep the pest population at a low level. Summer oil application directed against the first and second larval stages was recommended.

Nine mite species have been identified in citrus orchards in Turkey. The *Panonychus citri* mite causes damage to citrus and has 12 natural enemies [11] within Turkey. In Dörtyol, 8 natural enemies were found associated with the mite.

As a general opinion, pests don't cause serious problems when tree health is carefully maintained and when natural enemies are present. With enhancement and conservation of these enemies, it is possible to control citrus pests successfully. Certain oil sprays are available to contain the insects and mites on a temporary basis. In established groves, where the natural balance is not completely destroyed, insect and mite damage may not be significant because of the natural biological control.

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