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Determination of Pest Insect Species at Pomegranate (*Punica granatum* L.) Orchards in Adıyaman and Siirt Provinces, Turkey

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ABSTRACT
This study was carried out in order to determine the insect pest species found at the orchards of Adıyaman and Siirt provinces. The studies were carried out in the Şirvan district of Siirt and Adıyaman's the Central, Kahta and Samsat districts, where pomegranate production is intensively carried out through the years of 2017 and 2018. Samplings was carried out at the pomegranate orchards at least two weeks interval between April and October. Visual control, knock and insect rearing methods were used to obtain the insect species. According to the results from the study; a total of 42 insect species were obtained from the orders of Orthoptera (1), Thysanoptera (9), Hemiptera (18), Coleoptera (8) Lepidoptera (4) and Diptera (2). Among the identified pest species, *Aphis punicae* Passerini (Hemiptera: Aphididae) and *Apomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae) were determined as the main pest species. *Dioryctria simplicella* Heinemann (Lepidoptera: Pyralidae), *Arcyophora dentula* Lederer (Lepidoptera: Nolidae), *Chrysobothris affinis* (F.), *Acmaeodera wethloi* Obenberger (Coleoptera: Buprestidae) and *Zaprionus indianus* (Gupta) (Diptera: Drosophilidae) were determined for the first time in Turkey's pomegranate production areas.

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Adıyaman ve Siirt İlleri Nar (*Punica granatum* L.) Bahçelerinde Belirlenen Zararlı Böcek Türleri

ÖZET
Bu çalışma, Adıyaman ve Siirt illeri nar üretim alanlarında bulunan zararlı böcek türlerinin belirlenmesi amacıyla yürütülmüştür. Çalışmalar nar üretiminin yoğun bir şekilde yapıldığı Siirt'in Şirvan ilçesi ile Adıyaman'ın Merkez, Kahta ve Samsat ilçelerinde 2017-2018 yıllarında yürütülmüştür. Örneklemeler, Nisan ayı ile ekim ayı arasında tüm örnekleme bölgelerine en az iki haftalık aralıklarla gidilerek gerçekleştirilmiştir. Böcek türlerininin elde edilmesinde gözle kontrol, darbe ve kültüre alma metotları kullanılmıştır. Bu çalışma sonucunda ; Orthoptera takımından 1, Thysanoptera takımından 9, Hemiptera takımından 18, Coleoptera takımından 8, Lepidoptera takımından 4 ve Diptera takımından 2 tür olmak üzere toplamda 42 zararlı böcek türü tespit edilmiştir. Tespit edilen zararlı türlerden, *Aphis punicae* Passerini (Hemiptera: Aphididae) ve *Apomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae) ana zararlı türler olarak belirlenmiştir. *Acmaeodera wethloi* Obenberger (Coleoptera: Buprestidae), *Chrysobothris affinis* (F.) (Coleoptera: Buprestidae), *Arcyophora dentula* Lederer (Lepidoptera: Nolidae), *Dioryctria simplicella* Heınemann (Lepidoptera: Pyralidae), ve *Zaprionus indianus* (Gupta) (Diptera: Drosophilidae) türleri ise Türkiye nar üretim alanlarında ilk kez tespit edilmiştir.

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INTRODUCTION

Although pomegranate is known as a fruit of tropical and subtropical climates, it can also be grown in warm and temperate climates. Pomegranate is consumed fresh as well as used in the food industry as fruit juice, jam and sauce. Due to the growing awareness of healthy nutrition in the world, pomegranate is a preferred fruit type due to its antioxidants, polyphenolic substances and vitamin C content (Zarei et al. 2011; Eyigün 2012).

Official statistics on pomegranate fruit kept regularly by the United Nations Food and Agriculture Organization (FAO) and EUROSTAT are not available. However, when the data of the prominent countries in pomegranate production are examined, it is seen that India, Iran, China and Turkey are the leading countries that produce the most pomegranate production. Besides, Turkey is the most important producer and exporter country in the Middle East after Iran (Kurt and Şahin 2013). According to TurkStat data, Turkey's pomegranate production amount reached 537 847 tons in 2018. 56.53% (304.045 tons) of this production is met in the Mediterranean Region, 30.9% (166.430 tons) in the Aegean Region and 10.69% (57.540 tons) in the Southeastern Anatolia Region. It is seen that among 58 pomegranate cultivation provinces in Turkey, Adıyaman province ranks 10th (10.295 tons) and Siirt province is in 11th (6.788 tons) in terms of production ammount (TurkStat, 2020).

The development of extensive pomegranate cultivation in the Southeastern Anatolia Region has not been followed up by adequate strategies of pest control, due to the lack of detailed available data about the pests. The pomegranate has many pest insects which are capable of causing serious crop loses if not well managed (Coccuza et al. 2016).

Pest insects which cause economic losses by inducing various damages on the root, stem, branch, shoot, leaf and flower parts of the plant constitute important problems in pomegranate production areas. In some studies, to determine the pest species in pomegranate production areas in Turkey was indicated that Carob moth [Apomyelois (=Ectomyelois) ceratonia (Zeller) (Lepidoptera: Pyralidae)], Mediterranean fruit fly [Ceratitis capitata (Wied.) (Diptera: Tephritidae)], Pomegranate aphid [Aphis punicae (Passerini) (Hemiptera: Aphididae)], Pomegranate whitefly [Siphoninus phillyreae (Haliday) (Hemiptera: Aleyrodidae)], Citrus mealybug [Planococcus citri (Risso) (Hemiptera: Pseudococcidae)] and Wood leopard moth [Zeuzera pyrina (L.) (Lepidoptera: Cossidae)] were important pest insects and they caused serious economic losses (Mart and Altın, 1992; Öztop et al., 2002; Öztürk et al., 2005; Öztop et al., 2010; Yıldırım and Başpınar, 2011; Mamay, 2021).

Although studies have been carried out to determine pest species in pomegranate areas of Diyarbakır and Şanlıurfa provinces in the Southeastern Anatolia Region (Mart and Altın, 1992; Mart and Kılınçer, 1993; Mamay and Ünlü, 2013; Mamay et al., 2014a, Mamay et al., 2014b; Mamay et al., 2016; Mamay, 2021), no studies have been carried out within the framework of determining entomological problems in Siirt and Adıyaman. In this paper, the results obtained on the pest species in the pomegranate areas of Adıyaman and Siirt, their distribution areas and types of damage were discussed.

MATERIAL and METHODS

The studies were conducted in the Şirvan district of Siirt, and in the Central, Kahta and Samsat districts of Adıyaman in the years of 2017 and 2018 . Sampling was carried out between April and October by visiting all sampling regions at least two weeks interval. The number of sampled trees was not less than 0.1% of the number of trees in study regions (Table 1). The number of trees sampled in the orchards was determined according to Lazarov and Grigorov (1961) (Table 2).

Table 1. Number of trees sampled in the regions
Çizelge 1. Survey alanlarında örneklenen ağaç sayısı

Province	District	Total number of trees	Number of trees sampled
Adıyaman	Central	262.600	1.341
	Kahta	371.000	1.590
	Samsat	80.100	617
Siirt	Şirvan	116.320	1.986

(TurkStat, 2020)

Rearing method

The rearing method was used to acquire adults of insects which were in the pre-mature life stages. , The insects in pre-mature life stages were placed in appropriate culture containers with the plant parts where they were found in. The samples were placed in a climatic chambers set at 26 ± 1°C temperature , 65 ± 5% humidity and 16: 8 h (light / dark) Photoperiod and nutritional supplements were made in the containers as needed.

Table 2. Number of trees sampled according to the total number of trees in the orchardes (Lazarov and Grigorov, 1961)

Çizelge 2. Bahçedeki toplam ağaç sayısına göre örneklenen ağaç sayıları (Lazarov and Grigorov, 1961)

Total number of trees in survey orchard	Number of trees sampled
1-20	All trees
21-70	10–30
71-150	31–40
151-500	41–80
501-1000	%15 of all trees
More than 1000	%5 of all trees

Samples were collected by visual control, knock and rearing methods.

Visual control method

Bud, flower, leaf, shoot, stem and fruit samples were examined visually from four directions of randomly selected trees in the orchards according to the phenology of the tree and the determined insects were taken with hand, forceps or mouth aspirator.

Knock method

The insects were made to fall into the Steiner funnel by striking one branch from each of the four sides of 25 randomly selected trees from each garden. Adult of insects fallen into the Steiner funnel were collected by using mouth aspirator, forceps and soft brush then transferred to killing bottles. The dead insects were placed in petri dishes with the necessary label information and brought to the laboratory for preparation and identification.

RESULTS and DISCUSSION

As a result of the surveys conducted in the pomegranate orchards of Adıyaman and Siirt provinces, 42 pest species belonging to 15 families from 6 orders were obtained. These species and their distribution areas are given in Table 3.

Orthoptera order

Uvarovistia satunini was determined from Tettgoniidae family. The pest was detected only in Şirvan district of Siirt. It was observed that adults and nymphs of the pest directly attacked the flowers and feed greedily. Although the pest has not been reported to cause harm to the pomegranate, İlçin (2015) stated some populations might occur to cause serious economic damages in many agricultural lands. In addition, it was stated that the pest species was detected in the provinces of Muş, Bingöl, Tunceli, Diyarbakır, Batman, Mardin moved as a herd and was harmful to cultivated plants (Doğan, 2014; İlçin, 2015, Ünal, 2018, İlçin et al., 2019)

Thysanoptera order

With this study, *Thrips tabaci*, *T. meridionalis*, *Frankliniella intonsa*, *F. occidentalis*, *Neohydathothrips gracilicornis* (Thripidae), *Haplothrips flavitibia*, *H. reuteri* (Phlaeothripidae), *Melanthrips pallidior* and *M. fuscus* (Aeolothripidae) species were determined from Thysanoptera order. The adults and nymphs of the obtained species were observed in the leaves and flowers of the pomegranate. In addition, when the flowers falling on the ground were examined, it was observed thrips species. Mart and Altın (1992), in line with the research findings, stated that thrips species were determined in flowers of pomegranate. Öztop et al (2002) detected *F. occidentalis* in flowers in pomegranate orchards in Antalya province. Wohlfarter et al (2011) determined thrips species belonging to the families Thripidae, Phlaeothripidae and Aeolothripidae on the leaves, young shoots and flowers in South American pomegranate plantations. Referring to Sheikh (2006), they reported that thrips caused loss of fruit quality due to the damage they cause on flowers.

Hemiptera order

Aphididae family

Two species, *Aphis punicae* and *Brachycaudus helichrysi*, were identified from the Aphididae family.

Brachycaudus helichrysi was seen only in an orchard in Şirvan district and it was not considered to be a significant pest for pomegranate. *Aphis punicae* was detected in all study areas and it was determined that the pest caused to damage with dense populations on leaves, shoots, flowers and fruits. The pest caused fumagine due to the honeydew which occur during feeding. It has been concluded that *A. punicae* is one of the most important pests of pomegranate due to its prevalence, density and the damages which causes on the vegetative and genetic parts of the pomegranate. Yıldırım and Başpınar (2011) was stated that *A. punicae* was a species rarely seen in terms of prevalence and density in Aydın Province, but in other studies conducted in the Mediterranean Region and Southeastern Anatolia, similar to the findings we obtained, was stated that *A. punicae* was one of the important pest species causing yield and quality loss (Mart and Altın, 1992; Öztop et al., 2002; Öztürk et al., 2005; Mamay 2015). In addition, it has been reported that *A. punicae* caused significant damage to pomegranate in Iran, India, Egypt, Japan, Korea, South Africa and many Mediterranean countries (Ananda et al. 2009; Wohlfarter et al. 2010; Balikai et al. 2011; Sugimato, 2011; Abd-Ella, 2015; Lee et al., 2015; Cocuzza, 2016).

Aleyrodidae family

Three species belonging to the family Aleyrodidae, *Dialeurolobus rhamni*, *D. pulcher* and *Siphoninus finitimus*, were identified.

Table 3. Pest species identified in pomegranate orchards in Adıyaman and Siirt province and their distribution areas in 2017-2018 years.

Çizelge 3. Adıyaman ve Siirt ili nar bahçelerinde 2017-2018 yıllarında saptanan zararlı türler ve yayılış alanları

Order	Family	Species	Adıyaman			Siirt
			Central	Kahta	Samsat	Şirvan
Orthoptera	Tettigoniidae	*Uvarovistia satunini* (Uvarov)	-	-	-	+
Thysanoptera	Aeolothripidae	*Melanthrips pallidior* Priesner	+	-	-	-
		Melanthrips fuscus (Sulzer)	-	-	+	-
	Phlaeothripidae	*Haplothrips flavitibia* Williams	+	+	+	+
		Haplothrips reuteri Karny	+	+	+	-
	Thripidae	*Thrips tabaci* Lindeman	+	+	-	-
		Thrips meridionalis Priesner	+	-	-	+
		Frankliniella intonsa (Trybom)	+	+	-	+
		Frankliniella occidentalis (Pergande)	+	+	+	+
		Neohydathothrips gracilicornis (Williams)	-	-	-	+
Hemiptera	Aleyrodidae	**Siphoninus finitimus* Silvestri	+	+	+	+
		Dialeurolobus rhamni Bink-M.	+	+	+	+
		Dialeurolobus pulcher Dantsig	+	+	+	+
	Aphididae	**Aphis punicae* Passerini	+	+	+	+
		Brachycaudus helichrysi (Kaltenbach)	-	-	-	+
	Cicadellidae	*Fieberiella gemelina* Dlabola	+	+	+	+
		Euscelis incisus (Kirschbaum)	+	+	+	+
		Asymmetrasca decedens (Paoli)	+	-	+	-
		Macrosteles quadripunctulatus (Kirschbaum)	+	-	-	-
		Anaceratagallia ribauti (Ossiannilsson)	-	-	-	+
		Eupelix cuspidata (F.)	-	+	-	-
		Peraglena nervosus	-	-	-	+
		Zyginidia pullula (Boheman)	-	+	-	-
		Aphrodes assimilis (Signoret)	-	-	-	+
		Circulifer haematoceps (Mulsant & Rey)	-	+	-	-
	Coccidae	*Coccus hesperidum* L.	+	+	+	+
		Parthenolecanium corni (Bouché)	-	-	+	+
	Pseudococcidae	**Planococcus ficus* (Signoret)	+	+	+	+
Coleoptera	Bostrychidae	*Schistocerus bimaculatus* (Olivier)	-	-	-	+
	Buprestidae	*Chrysobothris affinis* (F.)	-	-	+	-
		Acmaeodera (s.str.) *wethloi* Obenberger	-	-	-	+
	Nitidulidae	*Carpophilus nepos* Murray	+	+	+	+
		Carpophilus mutilates Erichson	+	+	-	+
		Carpophilus hemipterus (L.)	+	+	+	+
		Urophorus humeralis (F.)	+	+	+	+
		Carpophilus bifenestratus Murray	+	-	+	+
Lepidoptera	Erebidae	*Diysgonia algira* (L.)	+	+	+	+
	Nolidae	*Arcyophora dentula* Lederer	-	+	-	+
	Pyralidae	**Apomyelois ceratoniae* (Zeller)	+	+	+	+
		**Dioryctria simplicella* Heinemann	-	-	-	+
Diptera	Drosophilidae	*Drosophila melanogaster Meigen*	+	+	+	+
		Zaprionus indianus (Gupta)	-	-	+	+

(+): existent, (-): absent, (*): Economically important species

Species belonging to the genus *Dialeurolobus* were generally seen in the lower part of the leaves and rarely in the upper part of the leaf. It was observed that both species could not occur a population in the orchards and cause serious damage. Both species are known to exist in pomegranate areas in Turkey (Öztürk and Ulusoy, 2009). *S. finitimus* individuals were observed only on the lower surface of the leaves and could occur a dense population in some orchards where they were seen. Adults, larvae and pupae of the pest could cover almost completely under the leaf and cause fumagine as a result of intensive feeding. Therefore, *S. finitimus* was detected to be more important than other whitefly species. Öztürk et al. (2005) determined whitefly species as *Acaudaleyrodes rachipora*, *Aleurothrixus floccosus*, *Bemisia argentifolii*, *B. tabaci*, *D. pulcher* and *Siphoninus phillyreae* in the pomegranate areas of the Eastern Mediterranean Region and stated that *S. phillyreae* was among the important pests of pomegranate. Yıldırım and Başpınar (2011) stated that *S. phillyreae* was one of the rare species in their study on pomegranate orchards in Aydın province.

Coccidae family

Pharthenolecanium corni and *Coccus hesperidum* species were determined from Coccidae family. It was observed that *P. corni* was generally seen as one or two individuals on the shoots and branches, *C. hesperidum* was detected rarely on fruit as well as on shoots and branches. Therefore, both pests could not occur an intensive population in the orchards and did not cause an economic damage. Similar to the findings obtained, Öztop et al. (2002) stated that *C. hesperidum* was among the species detected at low density. In addition, it has been reported that *C. hesperidum* and *P. corni* were detected in some studies conducted in pomegranate areas in the USA, South Africa and Iran (Moghaddam, 2009; Caroll, 2010; Wohlfarter et al., 2010).

Pseudococcidae family

Planococcus ficus species was identified from Pseudococcidae family. It was observed that the pest fed on the fruit crown, at the bottom of the fruit stem and especially in the areas where the fruits touch each other, and caused softening and colour change on the plant parts. In addition, the pest caused fumagine on the fruits due to producing honeydew and decreased the market value of the fruit. It was observed that *P. ficus* was seen more intensely in orchards where pruning was not done well and fruits was not thinning. Although the pest was not very spread in the region, it was evaluated as one of the important pests of pomegranate, as it caused economic losses in the orchards where it was seen. It has been reported that *Planococcus* sp. and *Planococcus citri* species were determined in the pomegranate areas of Diyarbakır, Şanlıurfa, Antalya and eastern Mediterranean provinces and caused damage during the ripening period of the pomegranate (Mart and Altın, 1992; Öztop et al., 2002; Öztürk et al., 2005). In other studies, conducted in different parts of the world such as India, South Africa, Spain and Cyprus, it has been stated that *Planococcus* species cause damage to pomegranate and decrease the market value by affecting the quality of pomegranate in particular (Mani and Krishnamoorthy, 200; Wohlfarter et al., 2010; Bartual et al., 2011; Kahramanoğlu and Usanmaz, 2013; Suroshe et al., 2016).

Cicadellidae family

Fieberiella gemelina, *Euscelis incisus*, *Asymmetrasca decedens*, *Macrosteles quadripunctulatus*, *Anaceratagallia ribauti*, *Eupelix cuspidata*, *Peraglena nervosus*, *Zyginidia pullula*, *Aphrodes assimilis* and *Circulifer haemato* were identified from the Cicadellidae family. *F. gemelina* was found to be the most spread among these species. The species obtained could not occur dense populations (2-3 individual at most per 100 knock) and caused no significant damage in orchards. Başpınar and Yıldırım (2011) stated that *Fieberiella anategea* was among the common species in pomegranate orchards and they considered *F. anategea* as a possible vector species, since the *Fieberiella* genus contains vector species that carry many viral diseases. Başpınar et al. (2013) reported that they identified 19 Cicadellid species, including species identified in the study, such as *E. incisus*, *A. decedens*, *M. quadripunctulatus*, *Z. pullula* and *C. haematoceps* in pomegranate orchards.

Coleoptera order

Bostrychidae family

Schistocerus bimaculatus species was obtained from the Bostrychidae family. The pest was detected only in the Şirvan district of Siirt. It was determined that *S. bimaculatus* caused drying of the tree by opening galleries on the branches and trunk of the pomegranate. The pest was detected for the first time in the pomegranate areas of Turkey in Antalya, and it was reported that it could cause significant damages if a good pruning and control was not done (Öztop et al., 2002). Andreadis et al. (2006) reported that they detected *S. bimaculatus* in their study on pomegranate orchards in Greece, and that the control against the pest depends on preventive measures such as pruning before mating and egg laying.

Nitidulidae family

The species were identified as *Carpophilus nepos*, *C. mutilatus*, *C. hemipterus, C. bifenestratus* and *Urophorus humeralis*. The most spread species were *C. nepos* and *C. hemipterus*. It was determined that these species preferred to feed on fruits which be cracked, damaged by birds and primary insects such as carob moth, or mechanically injured. In addition, it was observed that fruits can be infected with saprophyte disease agents by Nitidulidae species and this fruits can be completely decayed. Similar to the findings we obtained, Öztop et al. (2002) reported that *Carpophilus* species were detected in pomegranate fruits contaminated with Mediterranean fruit fly and cracked fruits near harvest and *Carpophilus* species were secondary pests in pomegranates. Öztürk et al (2005) stated that Sap beetles fed on pomegranate fruits that are injured naturally, and they caused intense decaying and rotting in pomegranates with the effect of saprophyte fungi during feeding. Mifsud and Audisio (2008) reported that Nitidulidae species caused problems in Central and Southern Italy, especially in pomegranate, fig and peach farming, and Cocuzza et al (2016) reported that damages caused by *Carpophilus* species in Israel.

Buprestidae family

Two species, *Chrysobothris affinis* and *Acmaeodera wethloi* were obtained from the Buprestidae family.

Chrysobothris affinis was found only in the Samsat district of Adıyaman and caused drying on the trunk and thick branches of pomegranate. It was observed that the pest fed on wood tissue, opening galleries and causing spalling in the shells. Although *C. affinis* was determined on European beech, Birch tree, Cherry plum, Nectarine and Almond in different regions of Turkey (Ak, 1998; Tozlu and Özbek, 2000; Bolu and Özgen, 2011), no information was available that the pest caused damage at pomegranate orchard in Turkey. This study was the first to demonstrate that *C. affinis* causes damage at pomegranate plants.

Acmaeodera wethloi was detected in Şirvan district of Siirt. The pest detected only in one orchard was obtained by culturing the drying branches that were heavily attacked by *S. bimaculatus*. It was observed that *A. wethloi* was not a spread pest and did not cause a serious problem. Although the existence of the insect was previously known in Turkey (Ghahari et al., 2015 (referring to Volkovitsh, 2006; Bellamy, 2008), this study was first report about damage of *A. wethloi* on pomegranate plant.

Lepidoptera order

Pyralidae family

Two species, *Apomyelois ceratoniae* and *Dioryctria simplicella* were obtained from the Pyralidae family.

It was determined that *A. ceratoniae* laid eggs in the calix of fruits, hatching larvae entered inside the endocarp and caused to decaying of fruit. Considering both the prevalence and damage type of carob moth, it was the most important pest species identified in the pomegranate production areas of Adıyaman and Siirt provinces. In other studies, conducted in the Mediterranean, Aegean and Southeastern Anatolia regions where pomegranate cultivation is widespread in Turkey have been reported that *A. ceratoniae* is main or important pest species and causes serious damage (Mart and Altın 1992; Öztop et al.2002; Öztürk et al.2005; Yıldırım and Başpınar 2011). And these similar findings have been shared from many countries such as Iran, Iraq, Tunisia, Saudi Arabia (Al-Izzi et al.1985; Alrubeai 1987; Norouzi et al 2008, Elsayed and Bazaid 2011; Moawad et al 2011; Braham 2015; Nobakht et al.2015).

Another Lepidoptera species directly causing damage at the fruit was *D. simplicella*. The pest was detected only in Şirvan district of Siirt. Although the pest was observed to be harmful in the calyx of the pomegranate, it could penetrate the inner parts of the fruit (endocarp). Damage of *D. simplicella* in the calyx was quite similar to the Carob moth damage. As a result, although the spread of the pest was limited, it was considered to be one of the important pest species in terms of damage type. There wasn't any study related the damage of *D. simplicella* on pomegranate plants The study results could be accepted as a first report about damage of *D. simplicella* on pomegranate plants.

Erebidae family

Dysgonia algira, from the Erebidae family, was identified and found to cause damage by attacking the leaves. It was observed that the larvae started eating from the edges of the leaves and caused crescent-shaped holes, mature larvae combined leaves and became pupae in them. Öztop et al. (2002) reported that *D. algira* did not cause an intense damage in the orchards as parallel with the findings in this study. In Italy, Sannino et al. (1986) stated in their study on *D. algira* that the pest could consume all leaves in dense populations, leaving only shoots.

Nolidae family

Arcyophora dentula species from Nolidae family was determined. It was observed that the pest caused damage by feeding on leaves. The species detected in two orchards in Kahta and one orchard in Şirvan was among the rare pests and did not cause serious damage in the orchards. In Turkey, there is no record that *A. dentula* causes damage to the pomegranate or that the pomegranate is the host of the pest. However, in a study conducted in pomegranate production areas in India was stated that *A. dentula*

caused damage and could leave the plant almost without leaves in some orchards (Mukarjee, 1941).

Diptera Order

Drosophilidae family

Drosophila melanogaster and *Zaprionus indianus* species were recorded from the Drosophilidae family. It was determined that both species preferred fruits that be cracked, attacked by primary pests such as carob moth and became soft and rot, rather than solid fruits. In some studies, and EPPO reports, parallel to this findings, both species have been reported to be secondary pests on pomegranate (Joshi et al., 2014; Braham, 2015; Anonymous, 2016 a, Anonymous, 2016 b). In other studies, conducted in pomegranate areas of Turkey, belonging to the Drosophilidae family, *Drosophila* sp. and *Zaprionus tuberculatus* species have been reported (Öztürk et al., 2005; Kuyulu et al., 2019). Although *Z. indianus* has been detected in fruits such as persimmon, blackberry, fig, cherry, mulberry, peach and plum in Turkey (Özbek-Çatal et al., 2019), no information has been stated that it is detected in pomegranate.

CONCLUSION

In this study, 42 pest insect species belonging to 15 families from 6 orders were obtained from pomegranate orchards. *A. ceratoniae* and *A. punicae* species were the main pest species among the pest species. They were common in Adıyaman and Siirt provinces and could cause significant damages if they were' not controlled. Besides, *S. finitimus* and *P. ficus* species were determined as other important pest species on pomegranate. Although both pests were not very common in orchards, it was observed that they could create dense populations in orchards and caused economic losses. *D. Simplicella*, *A. dentula*, *C. affinis*, *A. wethloi* and *Z. indianus* species were determined for the first time in pomegranate production areas of Turkey. The results of this study are important for the determination of the insect fauna of pomegranate and for pomegranate integrated pest management (IPM) studies. In order to solve entomological problems in pomegranate orchards, it will be great benefit to carry out detailed studies on the bioecology and control of the main pest species.

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Contribution of the Authors as Summary

The contribution of the authors is equal

Statement of Conflict of Interest

Authors have declared no conflict of interest

REFERENCES

Abd-Ella AA 2015. Effect of several insecticides on pomegranate aphid, *Aphis punicae* (Passerini) (Homoptera: Aphididae) and its predators under field conditions. OEPP/EPPO Bulletin, 45 (1): 90–98.

Andreadis SS, Navrozidis EI and Katerinis S 2016. First record of the grape cane borer, *Amphicerus bimaculatus* (Olivier, 1790) (Coleoptera: Bostrichidae), on pomegranate in Greece. Turkish Journal of Zoology, 40: 286-289.

Anonymous 2016a. EPPO Alert List– *Zaprionus tuberculatus* (Diptera: Drosophilidae), https://www.eppo.int/ACTIVITIES/plant_quarantine/alert_list_insects/zaprionus_tuberculatus

Anonymous 2016b. EPPO Alert List – *Zaprionus indianus* (Diptera: Drosophilidae) African fig fly, https://www.eppo.int/ACTIVITIES/plant_quarantine/alert_list_insects/zaprionus_indianus

Ak K, Çam H 1998. Tokat İlinde Bulunan Buprestidae (Coleoptera) Türleri Üzerinde Faunistik Çalışmalar, Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi, 15 (1): 31-45.

Al-Izzi MAJ, Al-Maliky SK, Younis MA, Jabbo NF 1985. Bionomics of *Ectomyelois ceratoniae* (Zell.) (Lep.: Pyralidae) on pomegranate in Iraq. Environmental Entomology, 14 (2): 149–153.

Ananda H, Kotikal Y, Balikai RA 2009. Sucking insect and mite pests of pomegranate and their natural enemies. Karnataka Journal of Agricultural Sciences, 22 (4): 781-783.

Alrubeai HF 1987. Growtand development of Ectomyelois ceratonia (Lep.: Pyralidae) under laboratory mass rearing conditions. Journal of Stored Products Research, 23 (3): 133-135.

Balikai RA, Kotikal YK, Prassanna PM 2011. Status of Pomegranate Pests and Their Management Strategies in India. Acta Horticulturae, (890): 569-583.

Bartual J, Lozoya A, García J, Valdés G 2011. Efficacy and residues of selected insecticides for control of cotton aphid (*Aphis gossypii*) and mealybug (*Planococcus citri*) in pomegranates. II International Symposium on the Pomegranate, 19-21 October P. 107-111, Madrid, Spain

Başpınar H, Yıldırım EM, Xing J 2013. Determination and population fluctuations of Cicadellidae (Hemiptera: Cicadomorpha) species in pomegranate orchards in Aydin Province, Turkey, Turkish Journal of Entomology, 37 (1): 3-11.

Bolu H, Özgen İ 2011. On the Buprestidae (Coleoptera) Species of Almond Orchards in the Southeastern and Eastern Anatolia i n Turkey, Munis Entomology and Zoology Journal, 6 (2): 970-976

Braham M 2015. Insect larvae associated with dropped pomegranate fruits in an organic orchard in Tunisia. Journal on Entomology and Nematology, 7 (2): 5–10

Caroll D 2010. Pomegranate Pest Management in the San Joaquin Valley, http://ucanr.org/sites/ Pomegranates/ files/122812.pdf

Cocuzza GEM, Mazzee G, Russo A, Giudice VL, Bella S 2016. Pomegranate arthropod pests and their management in the Mediterranean area, Phytoparasitica, 44: 393–409

Doğan A 2014. Derik ve Kızıltepe (Mardin) Orthoptera (Insecta) Faunasının Belirlenmesi. Dicle Üniversitesi Fen Bilimleri Enstitüsü Biyoloji Anabilim Dalı,Yüksek Lisans, 65 sy.

Elsayed G, Bazaid SA 2011. Field investigation of pomegranate fruit worms in Taif and laboratory evaluation of Bacillus thuringiensis against *Ectomyelois ceratoniae*. Archives of Phytopathology and Plant Protection, 44 (1): 28-36.

Eyigün FŞ 2012. Hicaz Nar Çeşidine Ait Narlardan Elde Edilen Nar Ekşilerinin Özelliklerinin Belirlenmesi Üzerine Bir Araştırma. Çukurova Üniversitesi Fen Bilimleri Enstitüsü Gıda Mühendisliği Anabilim Dalı, Yüksek Lisans Tezi, 112 s.

Ghahari H, Volkovitsh M G, Bellamy C L, plazi 2015. An annotated catalogue of the Buprestidae of Iran (Coleoptera: Buprestoidea). Plazi.org taxonomic treatments database. Checklist dataset https://doi.org/10.11646/zootaxa.3984.1.1 accessed via GBIF.org on 2021-07-08.

İlçin M 2015. Batman İli Ekili alanlarda bulunan Orthoptera: Insecta Faunasının Araştırılması ve Tarım alanlarında Zarar oluşturabilecek Türlerin Belirlenmesi. Dicle Üniversitesi Fen Bilimleri Enstitüsü Biyoloji Anabilim Dalı, Doktora Tezi, 163 sy.

İlçin M, Satar A, Tusu S. 2019. Uvarovistia satunini Uvarov, 1934 (Tettigoniidae: Orthoptera) Türünün Sürü Oluşturma ve Zarar Durumunun Tespit Edilmesi Bingöl, Türkiye . Dicle Üniversitesi Fen Bilimleri Enstitüsü Dergisi 8 (2019): 69-76

Joshi NK, Biddinger DJ, Demchak K, Deppen A. 2014. First Report of Zaprionus indianus (Diptera: Drosophilidae) in Commercial Fruits and Vegetables in Pennsylvania. Journal of Insect Science, 14(1): 259

Kahramanoglu I, Usanmaz S 2013. Management strategies of fruit damaging pests of pomegranate Planococcus citri, Ceratitis capitata and Deudorix (Virachola) livia. African Journal of Agricultural Research, 8 (49): 6563–6568.

Lazarov A, Grigorov P 1961. Karantina na Rastenijata. Zemizdat, Sofia, 258 p

Kurt H, Şahin G 2013. Bir Ziraat Coğrafyası Çalışması: Türkiye'de Nar (*Punica granatum* L.) Tarımı, Marmara Coğrafya Dergisi, 27: 551-574.

Kuyulu A, Yücel S, Genç H 2019. Molecular identification of invasive Drosophilid *Zaprionus tuberculatus* Malloch (Diptera: Drosophilidae) in Çanakkale, Turkey. Turkish Journal of Zoology, 43 (5): 531-535.

Lee Y, Lee W, Kimc H, Lee S 2015. A new record of *Aphis punicae* Passerini, 1863 (Hemiptera: Aphididae) from Korea. Journal of Asia-Pacific Entomology, 18 (2015): 157–163.

Mamay M, Ünlü L 2013. Şanlıurfa ili nar bahçelerinde Harnup güvesi, *Apomyelois ceratoniae* Zell. (Lepidoptera: Pyralidae)'nin ergin popülasyon gelişimi ve zarar oranının belirlenmesi. Türkiye Entomoloji. Bülteni, 3 (3): 121-131.

Mamay M, Ünlü L, Yanık E, İkinci A 2014a. Şanlıurfa ilinde nar bahçelerinde Harnup güvesi *Apomyelois ceratoniae* Zell. (Lepidoptera: Pyralidae)'nin bulaşıklık ve yaygınlık durumu. Türkiye Entomoloji. Bülteni, 4 (1): 47-54.

Mamay M, Ikinci A, Ünlü L, Doğan E. 2014b.

Infestation rate and host preference of Carob moth [*Apomyelois (= Ectomyelois) ceratoniae* Zeller (Lepidoptera: Pyralidae)] on different pomegranate cultivars. Turkish Journal of Entomology, 38(1): 101-110.

Mamay M 2015. Nar Yaprakbiti [*Aphis punicae* Passerini (Hemiptera: Aphididae)] 'nin Şanlıurfa ili nar bahçelerindeki bulaşıklık haritası. Türkiye Entomoloji. Bülteni, 5 (3): 159-166.

Mamay M, Ünlü L, Yanık E, Doğramacı M, ….. İkinci A 2016. Efficacy of mating disruption technique against carob moth, *Apomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae) in pomegranate orchards in Southeast Turkey (Şanlıurfa). International Journal of Pest Management, 62(4), 295-299.

Mamay M 2021. The influence of calyx removal and fruit bagging on carob moth, *Ectomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae), infestation in pomegranate. Crop Protection, 147:105708. DOI: https://doi.org/10.1016/ j.cropro. 2021.105708.

Mani M, Krishnamoorthy A 2000. Biological suppression of mealybugs *Planococcus citri* (Risso) and *Planococcus lilacinus* (Ckll.) on pomegranate in India. Indian Journal of Plant Protection, 28 (2): 187-189.

Mart C, Altın M 1992. Güneydoğu Anadolu Bölgesi nar alanlarında belirlenen böcek ve akar türleri. Türkiye II. Entomoloji Kongresi Bildirileri 28-31 Ocak, S. 725- 735, Adana, Türkiye

Mart V, Kılınçer N 1993. Güneydoğu Anadolu Bölgesi narlarında zararlı Harnup güvesi, *Ectomyelois ceratoniae* (Zell.) (Lep.: Pyralidae)'nin populasyon değişimi ve döl sayısı. Türkiye Entomoloji Dergisi, 17 (4): 209-216.

Mifsud D, Audısio P 2008. The Kateretidae and Nitidulidae of the Maltese Archipelago (Coleoptera). Bulletin of the Entomological Society of Malta,1: 15-37

Moawad SS, Hassan SA, Al Barty AM 2011. Enumeration and estimation of insect attack fruits of some cultivars of Punica granatum. African Journal of Biotechnology, 10 (19): 3880–3887

Moghaddam M 2009. Insects of Iran, The List of Coccoidea in the Hayk Mirzayans insect Museum of Iranian Research Institute of Plant Protection. Iranian Research Institute of Plant Protection Insect Taxonomy Research Department, Pub. No. 16

Mukerjee T 1941. *Arcyophora dentula* Hamps., A new pest of pomegranate. Indian Journal of Entomology, 3 (2): 337

Nobakht Z, Karimzadeh J, Shakaram J, Jafari S 2015. Identification of parasitoids of *Apomyelois ceratoniae* (Zeller) (Lepidoptera, Pyralidae) on pomegranate in Isfahan province Journal of Entomology and Zoology Studies, 3 (1): 287-289

Norouzi A, Talebi AA, Fathipour Y 2008. Development and demographic parameters of the Carob moth *Apomyelois ceratoniae* on four diet regimes. Bulletin of Insectology, 61 (2): 291–297.

Özbek Çatal B, Çalışkan Keçe AF, Ulusoy MR. 2019. New invasive species in Turkey: *Zaprionus indianus* (Gupta) (Diptera: Drosophilidae). KSÜ Tarım ve Doğa Dergisi, 22 (Ek Sayı 1): 109-112

Öztop A, Kıvradım M, Tepe S 2002. Antalya ili nar üretim alanlarında bulunan zararlılar ile bunların parazitoidlerinin ve predatörlerinin belirlenmesi ve popülasyon değişiminin izlenmesi. T.C. Tarım ve Köy işleri Bak. Tarımsal Araştırmalar Genel Müdürlüğü, Ankara, Proje no: Bs-99-06-09-130, Sonuç Raporu (Yayımlanmamış), 16 sy.

Öztop A, Keçeci M, Kıvradım M 2010. Antalya ilinde nar zararlıları üzerinde araştırmalar: Gövde ve dallarda zarar yapanlar. Batı Akdeniz Tarımsal Araştırma Enstitüsü Derim Dergisi, 27 (1): 12-17.

Öztürk N, Ulusoy MR, Bayhan E 2005. Doğu Akdeniz Bölgesi nar alanlarında saptanan zararlılar ve doğal düşman türleri. Türkiye Entomoloji Dergisi, 29 (3): 225-235

Öztürk N, Ulusoy MR 2009. Pests and natural enemies determined in pomegranate orchards in Turkey. Acta Horticolturae, 818: 277–284.

Sannino L, Balbiani A, Parenzan P 1986. *Dysgonia algira* L. (Lepidoptera: Noctuidae - Catocalinae) dannosa a melograno (Punica Granatum L.). Entomologica, 21:127-139

Sugimoto S 2011. The taxonomic identity of *Aphis punicae* Shinji, 1922 (Hemiptera: Aphididae). Entomological Science, 14(1): 68–74.

Suroshe SS, Sharma J, Singh NV, Pal RK 2016. New report of insect pests and their natural enemies in pomegranate. Indian Journal of Horticulture, 73 (3): 445-448

Tozlu G, Özbek H 2000. Erzurum, Erzincan, Artvin ve Kars illeri Buprestidae (Coleoptera) Familyası Türleri Üzerinde Faunistik ve Taksonomik Çalışmalar II. Sphenopterinae, Chalcophorinae, Chrysobothrinae, Agrilinae, Cylindromorphinae ve Trachyinae. Türkiye Entomoloji Dergisi, 24 (Ek sayı): 79-103

TURKSTAT, 2020. https://biruni.tuik.gov.tr/medas/?kn =92&locale=tr

Ünal M 2018. Tettigoniinae (Orthoptera: Tettigoniidae) from Turkey with key to genera and descriptions of six new species, Zootaxa, 4432(1):1

Wohlfarter M, Giliomee JH, Venter E 2010. A Survey of the Arthropod Pests Associated with Commercial Pomegranates, *Punica granatum* (Lythraceae), in South Africa. African Entomology, 18 (1): 192-199.

Yıldırım EM, Başpınar H 2011. Aydın ili nar bahçelerinde saptanan zararlı ve predatör türler, yayılışı, zararlı türlerden önemlilerinin popülasyon değişimi ve zararı. Türkiye Entomoloji Bülteni, 1 (3): 169-179

Yıldırım EM, Başpınar H 2015. The Population Fluctuations of Carob Moth, Apomyelois ceratoniae (Zell.) (Lepidoptera: Pyralidae) and Honeydew Moth *Cryptoblabes gnidiella* Mill. (Lepidoptera: Pyralidae), and İnvestigaton on Their Damage and Natural Enemies on Pomegranate in West Aegean Region of Turkey. Agriculture & Food , 3 (1): 186-192.

Zarei M, Azizi M, Zeinolabedin BS 2011. Evaluation of Physicochemical Characteristics of Pomegranate (Punica granatum L.) Fruit during Ripening. Fruits, 66: 121-129.