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Distribution, host plants and natural enemies of *Aleyrodes proletella* L. (Hemiptera: Aleyrodidae) on collard (*Brassica oleracea* L. var. *acephala*) in Düzce province of Turkey

Düzce ilinde karayaprak lahanasında (*Brassica oleracea* L. var. *acephala*) zararlı *Aleyrodes proletella* L. (Hemiptera: Aleyrodidae)'nın yayılışı, konukçuları ve doğal düşmanları

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ABSTRACT

This study was carried out on distribution, density, host plant, and natural enemies affecting its population fluctuation of *Aleyrodes proletella* L. (Hemiptera: Aleyrodidae) on collard during the years of 2016-2017 in Düzce province in Western Black Sea Region. *Aleyrodes proletella* was widespread in all districts of Düzce province and the infestation rate was 84.3%. The highest infestation rates were determined in Akçakoca (97.8%), Yığılca (93.3%), Gümüşova (88.9%), Kaynaşlı (84.4%), Cumayeri (82.2%), Gölyaka (80%), Çilimli (75.6%) and Central (75%) districts, respectively. Hosts of *A. proletella* except collard was determined that white cabbage (*Brassica oleracea* L. var. *capitata*) and *Lapsana communis* L. subsp. *intermedia* (Bieb.) Hayek plant which is called as common nippleworth belonging to the Asteraceae (Capparales) family. Parasitoid of *A. proletella* was detected as *Encarsia tricolor* Förster (Hymenoptera: Aphelinidae), and predators of *A. proletella* were found as *Clitostethus arcuatus* Rossi (Coleoptera: Coccinellidae) and *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae).

INTRODUCTION

Vegetables in the Brassicaceae (Capparales) family are rich in terms of nutrients and phytochemicals (glucosinolate, isothiocyanate, indole compounds), and provides normal levels of cholesterol and blood sugar levels in the human body. They also have protective effects against bone resorption, heart disease, and cancer. Due to these properties, the importance of healthy nutrition is understood better every day as a result of researches (Vural et al. 2000). Collard (*Brassica oleracea* L. var. a*cephala*) is one of the oldest forms of the family Brassicaceae (Nieuwhof 1969) and it's indispensable for healthy nutrition for many years due to its rich nutritional values (Günay 1984).

Western Black Sea Region is one of the important regions

in Turkey in terms of winter vegetable production. Among the cultivated winter vegetables, collard is one of the most valuable vegetables for the region and approximately 53.000 da areas were cultivated in 2017 and 66.000 tons were harvested (TUIK 2018). In the region, 8.401 da parts corresponding to roughly 15% of the cultivated areas are located. Collard plant was grown in the 1.389 da area in Düzce province and 2.020 tons of products were obtained (TUİK 2018).

Aleyrodes proletella is among the pests which are very difficult to control for farmers. The pest can give a large number of progenies, have a wide host range and improve resistance to insecticides in a short time (Byrne and Bellows 1991, Springate 2016). Besides, this pest is seen in the temperate regions of the world (De Barro and Carver 1997) and causes damage by sucking phloem sap directly, which affects cabbage growth and yield. Indirect damage caused by honeydew excretion contaminated with wax deposition and remains of dead whitefly bodies. It is very important because this provides the substrate for sooty mod fungi and a sticky layer on the plant surface (Ramsey and Ellis 1996). *Aleyrodes proletella* has not been determined as a virus vector (Springate and Colvin 2012). Recently, *A. proletella* has developed into one of the most important Brassica pests in vegetable production in Europe, especially in Germany (Saucke et al. 2011, Springate and Colvin 2012).

The origin of *A. proletella* called as cabbage whitefly is the European continent. It is one of the main pests damaging members of the Brassicaceae family in Turkey and European countries (De Barro and Carver 1997, Evans 2008, Martin et al. 2000, Mound and Halsey 1978, Springate 2016, Ulusoy and Vatansever 1997).

In previous studies in Turkey, it was determined that *A. proletella* was distributed in Central and North Anatolian Regions (Alkan 1961). Ulusoy and Vatansever (1997) reported that *A. proletella* was detected on cabbage, cauliflower, and red cabbage for the first time in the Eastern Mediterranean Region and their populations were not at a significant level and suppressed by natural enemies which exist in nature. Also, it has been noted that cabbage whitefly is found in Eastern Mediterranean (Içel, Hatay, Adana) and Western Mediterranean (Antalya, Burdur, Isparta), Aegean (Muğla, Aydın), Marmara (Balıkesir, Bursa), Central (Konya, Karaman, Aksaray, Niğde, Kayseri, Sivas) and Eastern Anatolian Regions (Malatya) (Ulusoy 2001). Finally, *A. proletella* was determined in Uşak, Manisa, Izmir (Ulusoy et al. 2012a), Bartın and Kastamonu provinces (Ulusoy et al. 2012b). Only detection studies have been done related to *A. proletella* until now, but there is not any study about damage levels, prevalence, and parasitism rate in Turkey.

The study aimed to reveal distribution, hosts and natural enemies affecting population fluctuation of *A. proletella*. Also, this study will contribute to creating a management program against *A. proletella* causing economic losses in Düzce province in the Western Black Sea Region.

MATERIALS AND METHODS

This study was conducted in the 2016 and 2017 agricultural growing season in Düzce province of Turkey. The samples were periodically collected every 15 days in the collard areas and its around other plants for the determined hosts and natural enemies of the *A. proletella*. The geographical information about sample sites was given in Table 1.

The survey was conducted in July-August determining for distribution areas of *A. proletella* that density of *A. proletella* populations was highly seen (Koca et al. 2017). Sample areas where the distribution studies of *A. proletella* were given Table 2. Eggs, larvae, pupae and pupae molts of the pest were searched for all the leaves of 15 plants in each field. When a biological period of the pest is found on one leaf of a plant, the field is considered as infecting with whitefly. According to the infestation in the surveyed fields, the infestation rates (%) of each district were determined.

Besides, heavily infected leaves with the whiteflies were collected from collard fields and they were brought to the laboratory in the icebox. Since the whiteflies were diagnosed from the pupae, the individuals of the pest in the pupae period were removed from the leaves with a fine tip brush and taken into the 70% alcohol. Preparations of samples

Table 1. The geographical information of the sample areas where the studies of *Aleyrodes proletella* L. are periodically conducted

District	Location	Altitude	Coordinates
Merkez	Aziziye	145 m	40° 50’ 39.767174” N / 31° 7’ 44.929873” E
Merkez	Ağa	143 m	40° 50’ 41.398276” N / 31° 7’ 41.400622” E
Çilimli	Mahirağa	160 m	40° 52’ 47.002000” N / 31° 3’ 1.136904” E
Çilimli	Topçular	148 m	40° 52’ 26.779871” N / 31° 3’ 4.386132” E

Table 2. The geographical information of the sample areas where the distribution studies of *Aleyrodes proletella* L.

District	Location	Altitude (m)	Coordinates
Merkez	Aziziye	145	40° 50' 39.767174" N / 31° 7' 44.929873" E
Merkez	Ağa	143	40° 50' 41.398276" N / 31° 7' 41.400622" E
Merkez	Mergiç	139	40° 50' 41.368704" N / 31° 7' 7.309679" E
Merkez	Gökçe	178	40° 49' 12.900415" N / 31° 12' 16.092856" E
Gölyaka	Kültür	145	40° 46' 57.048859" N / 30° 59' 44.612925" E
Gölyaka	Yeşil	129	40° 46' 32.335354" N / 30° 59' 26.950981" E
Gölyaka	Yeşilova	144	40° 46' 25.084941" N / 30° 58' 9.176810" E
Gümüşova	Çaybükü	126	40° 51' 28.993069" N / 30° 58' 28.855943" E
Gümüşova	Selamlar	120	40° 51' 31.870845" N / 30° 57' 42.512501" E
Gümüşova	Kültür	157	40° 51' 55.575326" N / 30° 56' 34.972433" E
Cumayeri	Orta	117	40° 52' 24.280337" N / 30° 56' 43.740339" E
Cumayeri	Yeniyaka	114	40° 52' 57.400254" N / 30° 57' 27.104618" E
Cumayeri	Aşağı Avlayan	159	40° 53' 13.504572" N / 30° 58' 30.058712" E
Çilimli	Mahirağa	160	40° 52' 47.002000" N / 31° 3' 1.136904" E
Çilimli	Topçular	148	40° 52' 26.779871" N / 31° 3' 4.386132" E
Çilimli	Yukarı Karaköy	138	40° 52' 50.046643" N / 31° 0' 20.910253" E
Kaynaşlı	Şimşir	242	40° 46' 41.137056" N / 31° 16' 30.478622" E
Kaynaşlı	Merkez	298	40° 46' 14.91188" N / 31° 19' 9.995560" E
Kaynaşlı	Sarıçökek	289	40° 46' 35.086546" N / 31° 19' 3.543271" E
Yığılca	Dutlar	291	40° 56' 41.737601" N / 31° 20' 36.343914" E
Yığılca	Hoşafoğlu	312	40° 56' 26.343448" N / 31° 22' 46.815747" E
Yığılca	Orhangazi	312	40° 57' 43.832919" N / 31° 26' 31.271681" E
Akçakoca	Ayaz	26	41° 5' 22.661951" N / 31° 8' 21.650823" E
Akçakoca	Yeni	34	41° 4' 59.933752" N / 31° 7' 27.119167" E
Akçakoca	Dadalı	124	41° 3' 42.474908" N / 31° 11' 2.874786" E

stored in alcohol were carried out according to Bink (1979), Düzgüneş (1980) and Martin (1987). The larvae and pupae of the whiteflies on the leaf samples were counted with a stereoscopic microscope as parasitized or non-parasitized. The leaves were taken into the parasitoid boxes after the counts of the leaf samples were completed.

To determine the predators fed on the whiteflies, the plants infected with whiteflies were firstly examined by the visual inspection method after waiting for a few minutes around the plants. The adults of the predators which observed to be fed on whiteflies were collected. After that, the leaves were removed from the other pests and the immature periods of the predators were taken into the culture boxes with their prey in the laboratory.

RESULTS AND DISCUSSION

The host diversity of *A. proletella* comprised three species in Düzce province. These species were determined as *Brassica oleracea* var. *capitata*, *Brassica oleracea* var. *acephala* (Brassicaceae) and *Lapsana communis* subsp. *intermedia* (Asteraceae).

Mound and Halsey (1978) reported that hosts of *A. proletella* were found as *Impatiens parviflora*, *Bongardia chrysogonum*, *Codonopsis clematidae*, *Ostrowskia magnifica*,

Acanthocephalus benthamianus, *Cephalorrhynchus* sp., *Inula* sp., *Steptorhamphus crambifolium*, *Cichorium* sp., *Lactuca muralis*, *L. triangulata*, *Lapsana communis*, *Mutisia acutifolium*, *Prenanthes purpurea*, *Sonchus arvensis*, *S. oleraceus*, *Sonchus* sp., *Taraxacum officinale*, *Brassica balearica*, *B. cretica*, *B. incana*, *B. macrocarpa*, *B. robertiana*, *B. tinei*, *B. olaeracea*, *Cheiranthus* sp., *Lepidium latiolum*, *Euphorbia peplus*, *Quercus robur*, *Vicia faba*, *Chelidonium majus*, *Aquilegia montana*, *A. lactiflora*, *Thalictrum minus*, *Linaria* sp., *Petroselinum* sp. and *Laser trilobus.*

Brassica oleracea, *Sonchus* sp., *Lactuca serriola*, *Euphorbia* sp., *E. peplus*, and *Cichorum intby* were identified as hosts of *A. proletella* in Turkey (Alkan 1961, Ulusoy 2001, Ulusoy and Vatansever 1997).

In Düzce province, the farmers start to plant the collard seedlings at the beginning of May and begin to harvest the leaves from June. The harvest finishes with the cooling of the weather in October. However, many farmers continue to collect leaves of collard in winter because of withstanding to winter conditions of these plants. In such cases, the cabbage whitefly can hibernate on collard. These plants are removed at the beginning of the spring season, especially at the end of March-beginning of April, and new collard seedlings were planted at the beginning of May depending on the climatic conditions. In this period of soil preparation in the fields, it was found that the adults of *A. proletella* migrated to *Lapsana communis* plants around the collard fields and created a population on these weeds.

Related to *A. proletella* in the past years in Turkey had only detection studies, which it is reported in many provinces in the Middle, North, and Eastern Anatolia, Mediterranean, Aegean, Marmara and Black Sea Regions (Alkan 1961, Ulusoy 2001, Ulusoy and Vatansever 1997, Ulusoy et al. 2012a, Ulusoy et al. 2012b, Ülgentürk and Ulusoy 1999). However, studies were not conducted to determine the distribution and density of the pests in these provinces. In this study, *A. proletella* was detected in Düzce province in the Western Black Sea Region and determined the infestation rates of whiteflies in all districts.

Table 3 showed that *A. proletella* was spread throughout in whole of Düzce province and the infestation rate of whitefly was 84.3%. *Aleyrodes proletella* has the highest infestation rate in Akçakoca with 97.8% followed by Yığılca with 93.3%. On the contrary, the least infestation rates were determined in Central with 75% and Çilimli with 75.6%.

The natural enemies of cabbage whitefly were found in this study. *Encarsia tricolor* Forster (Hymenoptera: Aphelinidae) known as a larval parasitoid of whiteflies was identified as the natural enemies of *A. proletella* in the collard areas. The morphological identification of *E. tricolor* was performed by Dr. Andrew POLASZEK (International Institute of Entomology, The Natural History Museum, London, UK). The distribution areas of this parasitoid have been reported as Belgium, Canary Islands, Czech Republic, France, Germany, Greece, Hungary, Italy, the Netherlands, Portugal, Russia, Serbia, Spain, Sweden, Ukraine, United States of America and the United Kingdom in the world (Anonymous 2017). In our country, this parasitoid was firstly identified by Ulusoy (1999) on the *Aleyrodes lonicerae* (Walker) fed on *Sonchus* spp. in the Mediterranean Region. In this study, the parasitoid *E. tricolor* was detected on *A. proletella* fed on *Brassica oleracea* var. *acephala*. When the previous studies were examined on the activities of *Encarsia* species, it was seen that 70-80% of *A. proletella* was parasitized by *E. inaron*, 45-60% of *Trialeurodes vaporariorum* Westwood (Hemiptera: Aleyrodidae) was parasitized by *Encarsia* spp. (Ulusoy and Vatansever 1997). Further, in a conducted study in California by Dreistadt and Flint (1995), it was reported that the amount of *Siphoninus phillyreae* Haliday (Hemiptera: Aleyrodidae) on the leaves was 98% before *E. inaron* was placed in the area. After that, when the parasitoids placement in the area, the density of whiteflies decreased to less than 1%. Koca et al. (2018) found that the natural parasitism rate of *E. tricolor* on *A. proletella* reached up to 80%. Lodos (1986) reported that there was no need to use chemicals in control of *A. proletella* and these parasitoids kept to the pests under the control. Similarly, Manzari et al. (2002) referred that *Encarsia* genus has been very effective in biological control, especially on whiteflies.

Clitostethus arcuatus Rossi (Coleoptera: Coccinellidae) and *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae) were determined as the predators of *A. proletella* on collard in this study. The distribution areas of *C. arcuatus* have been reported as Albania, Austria, Belgium, Bosnia and Herzegovina, England, Bulgaria, Canary Islands, Croatia, Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, San Marino, Sicily, Slovakia, Russia, Spain, Switzerland, the Netherlands, Ukraine and Yugoslavia in the world (Fauna Europaea 2017). It was reported that this predator species is located in the Eastern Mediterranean Region, Mediterranean Region and Eastern Anatolia Region in our country (Gözüaçık et al. 2012, Soylu 1980, Soylu and Ürel 1977). Both larvae and adults of *C. arcuatus* are fed on larvae and pupae of whiteflies. *Paratetranychus citri*, *Brevipalpus levisi*, *Dialeurodes citri*, *A. proletella*, *Aleurothrixus floccosus*, *A. racgiphora*, *A. floccosus*, *A. lonicera*, *Bemicia tabaci*, *B. hancocki*, *Parabemisia myricae*, *Paraleyrodes minei*, *Siphoninus phillyrae*, and *Trialeurodes*

Table 3. Infestation rates of *Aleyrodes proletella* L. on collard in Düzce province, Turkey in 2017

District	Location	Number of Plant Checked	Infected Plant	Infestation Rate (%)	Average Infestation Rate (%)
Merkez	Aziziye	15	6	40%	75%
Merkez	Ağa	15	15	100%	
Merkez	Mergiç	15	12	80%	
Merkez	Gökçe	15	12	80%	
Gölyaka	Kültür	15	11	73.3%	80%
Gölyaka	Yeşil	15	14	93.3%	
Gölyaka	Yeşilova	15	11	73.3%	
Gümüşova	Çaybükü	15	13	86.7%	88.9%
Gümüşova	Selamlar	15	12	80%	
Gümüşova	Kültür	15	15	100%	
Cumayeri	Orta	15	12	80%	82.2%
Cumayeri	Yeniyaka	15	11	73.3%	
Cumayeri	Aşağı Avlayan	15	14	93.3%	
Çilimli	Mahirağa	15	12	80%	75.6%
Çilimli	Topçular	15	10	66.7%	
Çilimli	Yukarı Karaköy	15	12	80%	
Kaynaşlı	Şimşir	15	12	80%	84.4%
Kaynaşlı	Merkez	15	12	80%	
Kaynaşlı	Sarıçökek	15	14	93.3%	
Yığılca	Dutlar	15	14	93.3%	93.3%
Yığılca	Hoşafoğlu	15	13	86.7%	
Yığılca	Orhangazi	15	15	100%	
Akçakoca	Ayaz	15	15	100%	97.8%
Akçakoca	Yeni	15	15	100%	
Akçakoca	Dadalı	15	14	93.3%	
TOTAL		375	316		84.3%

vaporariorum have been reported as hosts of this predator (Soylu and Ürel 1977, Ulusoy and Ülgentürk 2003, Ulusoy and Vatansever 1997). Regarding the efficacy of predator, Bathon and Pietrzik (1986) reported that *C. arcuatus* was able to consume roughly 550 *A. proletella* eggs during larval development and it was an effective predator of *A. proletella*. *Chrysoperla carnea* has been reported to be a polyphagous predator fed with aphids, whiteflies, armored scale insects, some lepidopterous eggs and larvae, thrips, psyllids, chrysomelid larvae and some mite species (Kaya and Öncüer 1988). *Chrysoperla* Staeinman species are widely seen in different agro-ecosystems in many parts of the world (Ridgway and Jones 1968, Stark and Whitford 1987). It was reported that this predator insect is fed on *Acaudaleyrodes citri*, *A. rachiphora*, *Aleurobolus olivinus*, *Aleurothrixus floccosus*, *A. lonicerae*, *A. proletella*, *B. tabaci*, *Dialeurolobus pulcher*, *Dialeurodes citri*, *S. phillyreae*, *T. vaporariorum*, *Parabemisia myricae*, and *Paraleyrodes minei* (Telli and Yiğit 2012, Ulusoy and Ülgentürk 2003, Ulusoy et al. 1996, Zia et al. 2008).

As a result of the study; considering today's agricultural conditions, organic agriculture is becoming increasingly important and preferred. So, it should be avoided as much as possible from chemical treatments in terms of damages to humans and the environment in which vegetables consumed directly in leaves such as collards. For this reason, native natural enemies must be supported to achieve the natural balance already existing in nature. Although *A. proletella* may be a potential pest for the collards, the plants should be inspected at certain intervals from the beginning of the cultivation period. To reduce the populations of this potential pest, it is thought that the support of natural enemies will suppress the pest, as well as preserving the natural balance. If chemical control is needed, it must be considered that an appropriate decision should be made for the application of the pesticides according to the situation of natural enemies and the harvest period of the plants. Also, it is predicted that the pest population will have a significant decrease in the next growing season with the control against *Lapsana communis*, which is a weed host of cabbage whitefly, at the end of the growing season of the collard.

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ÖZET

Batı Karadeniz Bölgesi'nde yer alan Düzce ilinde karayaprak lahanası üzerinde 2016-2017 yıllarında yürütülen bu çalışmada *Aleyrodes proletella* L. (Hemiptera: Aleyrodidae)'nın yayılış alanları, yoğunlukları, konukçuları ve popülasyonlarına etki eden doğal düşmanları ortaya konulmuştur. Bu amaçla Düzce ilinin tüm ilçelerinde belirlenen karayaprak lahanası alanlarından belirli tarihlerde örneklemeler yapılmıştır. Çalışma sonucunda *A. proletella*'nın Düzce ilinin tüm ilçelerinde yaygınlık gösterdiği belirlenmiş olup, Düzce ilinin bulaşıklık oranı %84.3'tür. İlçeler bazında ise en yüksek bulaşıklık oranına göre Akçakoca (%97.8), Yığılca (%93.3), Gümüşova (%88.9), Kaynaşlı (%84.4), Cumayeri (%82.2), Gölyaka (%80), Çilimli (%75.6) ve Merkez (%75) şeklinde sıralandığı tespit edilmiştir. *Aleyrodes proletella*'nın karayaprak lahanası dışındaki konukçuları olarak ise beyaz lahana (*Brassica oleracea* L. var. *capitata*) ve Asteraceae (Capparales) familyasına bağlı tavşan salatası, şebrek ve meme otu gibi isimlerle bilinen *Lapsana communis* L. subsp. *intermedia* (Bieb.) Hayek bitkisi olduğu belirlenmiştir. *Aleyrodes proletella*'nın doğal düşmanları olarak parazitoit *Encarsia tricolor* Förster (Hymenoptera: Aphelinidae), predatörler ise *Clitostethus arcuatus* Rossi (Coleoptera: Coccinellidae) ve *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae) olarak tespit edilmiştir.

Anahtar kelimeler: *Aleyrodes proletella,* doğal düşman, Düzce, konukçu, lahana beyazsineği, yayılış

REFERENCES

Alkan B., 1961. Murgul Bölgesi ziraat nebatlarında zarar yapan hayvan ve böcek nevileri üzerinde incelemeler. Ankara Üniversitesi Ziraat Fakültesi Yıllığı, 3, 271-285.

Anonymous 2017. Natural History Museum, http://www.nhm.ac.uk (Accessed date: 11.11.2017).

Bathon H., Pietrzik J., 1986. Zur Nahrungsaufnahme des Bogen-Marienkäfers, *Clitostethus arcuatus* (Rossi) (Col., Coccinellidae), einem Vertilger der Kohlmottenlaus, *Aleurodes proletella* Linné (Hom., Aleurodidae). Journal of Applied Entomology, 102 (1-5), 312-326.

Bink F.A., 1979. Methods for mounting Aleyrodidae specimens. Entomologische Berichten, 39, 158-160.

Byrne D.N., Bellows T.S., 1991. Whitefly biology. Annual Review of Entomology, 34, 431-457.

De Barro P.J., Carver M., 1997. Cabbage whitefly, *Aleyrodes proletella* (L.) (Hemiptera: Aleyrodidae), newly discovered in Australia. Australian Journal of Entomology, 36, 255-256.

Dreistadt S.H., Flint M.L., 1995. Ash whitefly (Homoptera: Aleyrodidae) overwintering and biological control by *Encarsia inaron* (Hymenoptera: Aphelinidae) in Northern California. Environmental Entomology, 24 (2), 459-464.

Düzgüneş Z., 1980. Küçük arthropodların toplanması, saklanması ve mikroskobik preparatlarının hazırlanması. T.C. Gıda Tarım ve Hayvancılık Bakanlığı, Zirai Mücadele ve Zirai Karantina Genel Müdürlüğü, Ankara, 77 s.

Evans G.A., 2008. The whiteflies (Hemiptera: Aleyrodidae) of the world and their host plants and natural enemies. http://keys.lucidcentral.org/keys/v3/whitefly/PDF_PwP%20ETC/world-whitefly-catalog-Evans.pdf (Accessed date: 05.11.2019).

Fauna Europaea, 2017. http://www.fauna-eu.org (Accessed

date: 01.11.2017).

Gözüaçık C., Yiğit A., Uygun N., 2012. Güneydoğu Anadolu Bölgesi'nde farklı habitatlarda bulunan Coccinellidae (Coleoptera) türleri. Türkiye Biyolojik Mücadele Dergisi, 3 (1), 69-88.

Günay A., 1984. Özel sebze yetiştiriciliği. Cilt 3, Çağ Matbaası, Ankara, 312 s.

Kaya Ü., Öncüer C., 1988. Laboratuvarda üretilen *Chrysoperla carnea* (Steph) (Neuroptera: Chrysopidae)'nın biyolojisine farklı iki besinin etkisi üzerinde bir araştırma. Türkiye Entomoloji Dergisi, 12 (3), 151-159.

Koca A.S., Kütük H., İmren M., 2017. Population dynamics of cabbage whitefly in Düzce province of Turkey. International Conference on Agriculture, Forest, Food Science and Technologies, 15-17 May 2017, Cappadocia, Turkey, 257 p.

Koca A.S., İmren M., Kütük H., 2018. Parasitism of cabbage whitefly, *Aleyrodes proletella* L. in Düzce province, Turkey. International Agriculture Congress, 3-6 May 2018, Komrat-Gagauzya, Moldova, 99 p.

Lodos N., 1986. Türkiye Entomolojisi (Genel, Uygulamalı ve Faunistik). Ege Üniversitesi Ziraat Fakültesi, Yayın No: 429, 569 s.

Manzari S., Polaszek A., Belshaw R., Quicke D.L.J., 2002. Morphometric and molecular analysis of the *Encarsia inaron* species-group (Hymenoptera: Aphelinidae), parasitoids of whiteflies (Hemiptera: Aleyrodidae). Bulletin of Entomological Research, 92, 165-175.

Martin J.H., 1987. An identification guide to common whitefly pest species of the world (Homoptera: Aleyrodidae). Tropical Pest Management, 23 (4), 298-322.

Martin J.H., Mifsud D., Rapisarda C., 2000. The whiteflies (Hemiptera: Aleyrodidae) of Europe and the Mediterranean basin. Bulletin of Entomological Research, 90 (5), 407-448.

Mound L.A., Halsey S.H., 1978. Whitefly of the world. A systematic catologue of the Aleyrodidae (Homoptera) with host plant and natural enemy data. British Museum and John Willy and Sons., Chichester-Newyork-Brisbane-Toronto, 340 p.

Nieuwhof M., 1969. Cole crops. Leonard Hill, London, 353 p.

Ramsey A.D., Ellis P.R., 1996. Resistance in wild *Brassicas* to the cabbage whitefly *Aleyrodes proletella*. Acta Horticulturae, 407, 507-514.

Ridgway R.L., Jones S.L., 1968. Field cage-releases of *Chrysopa carnea* for supression of population of the bollworm and the tobacco budworm on cotton. Journal of Economic Entomology, 61 (4), 892-897.

Saucke H., Schultz B., Wedemeyer R., Liebig N., Zimmermann O., Katz P., 2011. Biotechnische regulierung der kohlmottenschildlaus in kohlgemuse–sachstand und perspektiven. Ges Pflanzen, 63, 183-189.

Soylu O.Z., 1980. Akdeniz Bölgesi turunçgillerinde zararlı olan turunçgil beyazsineği, *Dialeurodes citri* (Ashmead)'nin biyolojisi ve mücadelesi üzerinde araştırmalar. Bitki Koruma Bülteni, 20 (1-4), 36-53.

Soylu O.Z., Ürel N., 1977. Güney Anadolu Bölgesi turunçgillerinde zararlı böceklerin parazit ve predatörlerinin tespiti üzerinde araştırmalar. Bitki Koruma Bülteni, 17 (2-4), 77-112.

Springate S., 2016. The cabbage whitefly, *Aleyrodes proletella*: causes of outbreaks and potential solutions, PhD Thesis, University of Greenwich, UK, 382 pp.

Springate S., Colvin J., 2012. Pyrethroid insecticide resistance in British populations of the cabbage whitefly, *Aleyrodes proletella*. Pest Management Science, 68, 260-267.

Stark S.B., Whitford F., 1987. Functional response of *Chrysopa carnea* (Neuroptera: Chrysopidae) larvae feeding on *Heliothis virescens* (Lep.: Noctuidae) eggs on cotton in field cages. Entomophaga, 12 (5), 521-527.

Telli Ö., Yiğit A., 2012. Hatay ili turunçgillerinde zararlı turunçgil pamuklu beyazsineği, *Aleurothrixus floccosus* (Maskell) ve turunçgil ipek beyazsineği, *Paraleyrodes minei* Laccarino (Hemiptera: Aleyrodidae)'nin doğal düşmanları. Türkiye Entomoloji Dergisi, 36 (1), 147-154.

TUIK 2018. Türkiye istatistik kurumu, http://www.tuik.gov.tr (Accessed date: 15.06.2018).

Ulusoy M.R., Uygun N., Kersting U., Karaca İ., Satar S., 1996. Present status of citrus whiteflies (Homoptera: Aleyrodidae) in Turkey and their control. Journal of Plant Diseases and Protection, 103 (4), 397-402.

Ulusoy M.R., Vatansever G., 1997. Doğu Akdeniz Bölgesi sebze alanlarında iki yeni beyazsinek türü: *Aleyrodes proletella* L. ve *Trialeurodes vaporariorum* Westwood (Homoptera: Aleyrodidae). Çukurova Üniversitesi Ziraat Fakültesi Dergisi, 12 (3), 59-68.

Ulusoy M.R., 1999. Akdeniz Bölgesi beyazsinek (Homoptera: Aleyrodidae) türleri üzerinde tespit edilen Aphelinidae (Hymenoptera: Chalcidoidea) türleri. Türkiye Entomoloji Dergisi, ISSN 1010-6960, 23 (4), 251-258.

Ulusoy M.R., 2001. Türkiye beyazsinek faunası, Baki Kitabevi, ISBN: 975-7024-14-7, Yayın No: 022, Adana, 99 s.

Ulusoy M.R., Ülgentürk S., 2003. The natural enemies of whiteflies (Hemiptera: Aleyrodidae) in Southern Anatolia. Zoology in the Middle East, 28 (1), 119-124, DOI: 10.1080/09397140.2003.10637961.

Ulusoy M.R., Karut K., Çalışkan A.F., 2012a. Ege Bölgesi Aleyrodidae türleri üzerine faunistik çalışmalar. Türkiye Entomoloji Bülteni, 2 (4), 251-262.

Ulusoy M.R., Karut K., Özdemir I., Ülgentürk S., Kaydan M.B., 2012b. Bartın ve Kastamonu illeri Aleyrodidae türleri üzerinde faunistik çalışmalar. Türkiye Entomoloji Dergisi, 36 (3), 363-376.

Ülgentürk S., Ulusoy M.R., 1999. Ankara ilinde bulunan beyazsinek türleri. Türkiye Entomoloji Dergisi, 23 (4), 259-268.

Vural H., Eşiyok D., Duman İ., 2000. Kültür sebzeleri (Sebze yetiştirme). Ege Üniversitesi Basımevi, Bornova, İzmir, 440 p.

Zia K., Hafeez F., Khan R.R., Arshad M., Ullah U.N., 2008. Effectiveness of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) on the population of *Bemisia tabaci* (Genn.) (Homoptera: Aleyrodidae) in different cotton genotypes. Journal of Agriculture and Social Sciences, 4, 112–116.

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