Türk. entomol. derg., 2013, 37 (1): 3-11
ISSN 1010-6960

Orijinal araştırma (Original article)

Determination and population fluctuations of Cicadellidae (Hemiptera: Cicadomorpha) species in pomegranate orchards in Aydin Province, Turkey[1]

Nar bahçelerindeki Cicadellidae (Hemiptera: Cicadomorpha) türleri ve popülasyon dalgalanmaları

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Summary

Many Cicadellidae (Hemiptera: Cicadomorpha) species may reach high populations in fruit orchards. Cicadellids can cause damage not only by sucking plant sap, but also by transmitting detrimental plant pathogens, which may become more important in many cases. It was aimed to determine Cicadellidae species and population fluctuations of common species in pomegranate orchards in Aydın (Nazilli, Karacasu) province in Turkey. Studies were conducted in two pomegranate orchards through 2009-2010. Samplings were done with two yellow sticky traps and by sweep net with 100-sweep-collection on weeds in each orchard. Additionally, cicadellids were collected by shaking one branch of each tree and 20 trees in total in each orchard. Cicadellidae species and their populations were therefore investigated both on trees and weeds in orchards. As a result, 19 cicadellid species were found in orchards. Of these species, *Docotettix cornutus* Ribaut, *Fieberiella anategea* Meyer-Arndt, *Asymmetrasca decedens* (Paoli)+*Empoasca decipiens* Paoli and *Zyginidia pullula* (Boheman) were common on the trees and *A. decedens* (Paoli)+*E. decipiens* Paoli, *Cicadulina bipunctella* (Matsumura), *Macrosteles quadripunctulatus* (Kirschbaum) were common on the weeds in the orchards. *Fieberiella anategea* and *D. cornutus* populations reached high levels in July-November on yellow sticky traps in 2009, but remain low during 2010. *Asymmetresca decedens* + *E. decipiens* populations reached high levels in May-June and October in 2009 and 2010. On the other hand, *Z. pullula* population stayed at a very low level in the years 2009 and 2010.

Key words: Pomegranate, Cicadellidae, leafhopper

Özet

Cicadellidae (Hemiptera: Cicadomorpha) familyası türleri birçok meyve bahçelerinde yüksek popülasyon oluştururlar. Bitki dokularını sokup emerek yaptıkları doğrudan zararların yanı sıra, birçok meyve hastalığı etmenini taşıyarak yaptıkları dolaylı zararlar bazı durumlarda daha çok önem kazanır. Bu çalışmada Aydın (Nazilli, Karacasu) ili nar bahçelerinde Cicadellidae türlerinin saptanması ve önemlilerinin popülasyon dalgalanmalarının araştırılması amaçlanmıştır. Çalışmalar iki farklı nar bahçesinde 2009-2010 yıllarında yürütülmüştür. Örneklemelerde her bir bahçede iki adet sarı yapışkan tuzak ağaçlara asılmış ve bunun yanısıra yabancı otlardan da her bir bahçede 100 atraplık toplama gerçekleştirilmiştir. Ayrıca, her bir bahçede 20 ağacın birer dalına 3 kere vurularak Japon şemsiyesine düşen cicadellidler de toplanmıştır. Böylece hem ağaçlarda ve hem de bahçe içerisindeki yabancı otlarda mevcut Cicadellidae türleri ve bunların popülasyonları saptanmıştır. Çalışma sonunda bahçelerde toplam 19 Cicadellidae türü saptanmış olup, bunlardan *Docotettix cornutus* Ribaut, *Fieberiella anategea* Meyer-Arndt, *Asymmetrasca decedens* (Paoli)+*Empoasca decipiens* Paoli, *Zyginidia pullula* (Boheman) ağaçlarda, *A. decedens* (Paoli)+*E. decipiens* Paoli, *Cicadulina bipunctella* (Matsumura), *Macrosteles quadripunctulatus* (Kirschbaum) ise yabancı otlarda en yaygın saptanan türler olmuştur. *Fieberiella anategea* ve *D. cornutus* popülasyonu 2009 yılında temmuz-kasım ayları arasında ağaçlardaki sarı yapışkan tuzaklarda yüksek seyretmiş, ancak 2010 yılında yıl boyunca düşük bulunmuştur. *Asymmetresca decedens* + *E. decipiens* popülasyonu ise her iki yılda da mayıs-haziran ve kasım aylarında yüksek düzeylere ulaşmıştır. *Zyginidia pullula* popülasyonu her iki yılda da düşük düzeylerde seyretmiştir.

Anahtar sözcükler: Nar, Cicadellidae, yaprakpireleri

[1] This study was presented as a poster presentation at the IV. Plant Protection Congress of Turkey, 28-30 June 2011, Kahramanmaraş, Turkey

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Alınış (Received): 30.04.2012 Kabul ediliş (Accepted): 16.07.2012

Introduction

Pomegranate is being grown widely in Anatolia, one of the nativelands for pomegranate, and is among the pomegranate exporters in the world (Özgüven & Yılmaz, 2000). Pomegranate is consumed not only as fresh table fruit, but also for pomegranate juice which has antioxidant activity, so it is becoming more popular worldwide. Many pest species have been determined in pomegranate orchards (Mart & Altın, 1992; Mani & Krishnamoorthy, 2000; Elsayed & Bazaid, 2001; Juan et al., 2004; Öztürk et al., 2005; Mozaffarian et al., 2007; Giliomee & Millar, 2009; Öztürk et al., 2009; Öztop et al., 2010; Wohlfarter et al., 2010; Yıldırım & Başpınar, 2011). However, few papers are available on the cicadellids in pomegranate orchards of the world. Öztürk et al. (2005) reported *Asymmetrasca decedens* (Paoli, 1932), *Empoasca decipiens* Paoli, 1930 (Hemiptera: Cicadellidae) among other pests in pomegranate.

Cicadellidae is a very large family, approximately 22,000 species described for the entire world and comprises many destructive species as plant pests (Dietrich, 2004). The damage caused by members of the family consists not only sucking excessive amounts of sap from plants, but also mainly by vectoring virus and bacteria from plant to plant, which results in heavy quantity and quality losses in fruit production worldwide. It was therefore aimed to determine the cicadellid species in pomegranate orchards in Aydın province in Turkey and to investigate population fluctuations of abundant species in this study.

Materials and Methods

Studies were conducted in two pomegranate orchards, located in Karacasu and Nazilli counties in Aydın Province through 2009-2010. The orchard in Karacasu, which consisted of the İzmir variety (local variety), was 1 ha and 20 years old. The other orchard in Nazilli, which contained the Hecaz variety, was 3 ha and 10 years old. Samplings for monitoring the populations were taken with two yellow traps in each orchard; they were coated with tanglefoot sticky material on both sides, and were hung on the trees. Traps were changed and captured specimens counted in the laboratory every two weeks during the vegetative period. Samples on the traps were removed with a needle for identification and transferred to petri dish containing acetone to remove sticky tanglefoot from the insect body for easier identification.

To determine the cicadellids on weeds in each orchard, collections were conducted with a sweep net and a 100-sweep-collection. Because *E. decipiens* and *A. decedens* are indistinguishable with regard to external characters (Başpınar, 1994), 100 male genitalia were prepared from collections on different dates and the proportions of both species were determined. However, the populations of both species are treated as *E. decipiens* + *A. decedens* in the figures. Additionally, cicadellids were collected by shaking one branch of each tree and 20 trees in total in each orchard. Cicadellids that dropped on the sheet under the shaken branch were collected with a sucking tube and brought to laboratory for identification. Identification of cicadellids, except *Fieberiella anategea* Meyer-Arndt 1991, was done by the first author by examining the male genitalia. Species identification was made according to Oman (1949).

Results and Discussion

As a result of the study, 19 cicadellid species were found in pomegranate orchards. Of these species, *Docotettix cornutus* Ribaut, 1948, *Fieberiella anategea* Meyer-Arndt, 1991, *Asymmetrasca decedens* (Paoli, 1932), *Empoasca decipiens* Paoli,1930, *Zyginidia pullula* (Boheman, 1845) were common on the trees and *A. decedens*, *E. decipiens*, *Z. pullula*, *Cicadulina bipunctella* (Matsumura, 1908) and *Macrosteles quadripunctulatus* (Kirschbaum, 1868) were common species on the weeds in the orchards. Table 1 shows that 13 and 14 Cicadellidae species collected on trees and on weeds, respectively. *E. decipiens*, *A. decedens*, *Z. pullula*, *C. bipunctella*, *M. quadripunctulatus*, *Recilia schimidtgeni* (Wagner, 1939), *Thamnotettix zelleri* (Kirschbaum, 1868) and *Euscelis incisus* (Kirschbaum, 1858) were collected on both the trees and weeds.

Arboridia adanae (Dlabola, 1957)*, Circulifer haematoceps* (Mulsant & Rey, 1855)*, D. cornutus, F. anategea* and *Euscelidius mundus* (Haupt, 1927) were found only on the traps on the pomegranate trees. *Docotettix cornutus* and *F. anategea* were the only two cicadellids that dropped on the sheet by shaking the branches. On the other hand, *Anaceratagallia laevis* (Ribaut, 1935)*, Balclutha hebe* (Kirkaldy, 1906)*, Balclutha punctata* (Fabricius, 1775)*, Aconurella prolixa* (Lethierry, 1885)*, Exitianus capicola* (Stal, 1855) and *Psammotettix striatus* (Linnaeus, 1758) were collected by sweeping net only on the weeds. During the collections, *Portulaca oleracea* L., *Amaranthus* spp., *Cyperus rotundus* L., *Tribulus terrestris* L., *Chenopodium album* L., *Seteria verticillata* (L.), *Sorghum halepense* (L.), *Solanum nigrum* L., *Digitaria sanguinalis* L.and *Cynodon dactylon* (L.) were common summer weeds in orchards. However, summer weeds were not widespread in orchards due to drip irrigation systems and tillage. It seems that may be the reason that leafhoppers are not able to reproduce continuously and to reach high populations on weeds in orchards. For this reason, the proportion of cicadellid species was evaluated on weeds, instead of their population fluctuations (Table 2).

Table 1. Cicadellidae (Hemiptera) species found in pomegranate orchards in 2009-2010

Species	Sticky traps on trees	Sweep net on weeds	Shaking the branches
Megophthalminae			
Anaceratagallia laevis (Ribaut)	-	+	-
Typhlocybinae			-
Empoasca decipiens Paoli	+	+	-
Asymmetrasca decedens (Paoli)	+	+	-
Arboridia adanae (Dlabola)	+	-	-
Zyginidia pullula (Boheman)	+	+	-
Deltocephalinae			
Circulifer haematoceps (Mulsant & Rey)	+	-	-
Cicadulina bipunctella (Matsumura)	+	+	-
Macrosteles quadripunctulatus (Kirschbaum)	+	+	
Balclutha hebe (Kirkaldy)	-	+	-
Balclutha punctata (Fabricius)	-	+	-
Maiestas schmidtgeni (Wagner)	+	+	-
Docotettix cornutus Ribaut	+	_	+
Fieberiella anategea Meyer-Arndt	+	-	+
Aconurella prolixa (Lethierry)	-	+	-
Thamnotettix zelleri (Kirschbaum)	+	+	-
Exitianus capicola (Stal)	-	+	-
Euscelidius mundus (Haupt)	+	-	-
Euscelis incisus Kirschbaum	+	+	-
Psammotettix striatus (L.)	-	+	-

Table 2. Incidence of cicadellid species in the total collection by sweep net on weeds in pomegranate orchards

	Incidence (%)		
Cicadellid Species	2009	2010	Average
Empoasca decipiens + *Asymmetrasca decedens*	42.79	41.81	42.30
Zyginidia pullula	22.00	18.03	20.01
Cicadulina bipunctella	20.17	21.31	20.74
Macrosteles quadripunctulatus	11.98	13.11	12.55
Others	3.06	5.74	4.40
Total	100.00	100.00	100.00

The incidence of common species on the weeds was determined at the end of season (Table 2). The most common species were *E. decipiens* + *A. decedens* with 42.79 and 41.81 % in 2009 and 2010, respectively. The proportions of *E. decipiens* + *A. decedens* populations were 54.29 and 52.94 % for *E. decipiens* and 45.71 and 47.06 % for *A. decedens* in 2009 and 2010, respectively. *Zyginidia pullula* constituted 22.00 %, followed by *C. bipunctella* with 20.17 %, in 2009. However, in 2010, *C. bipunctella* was more common at 21.31 % than *Z. Pullula* which dropped to 18.03 %. *Macrosteles quadripunctulatus* and other species were in minor in both years.

Population fluctuations

Empoasca decipiens, *A. decedens, Z. pullula, D. cornutus* and *F. anategea* were monitored regularly only on the traps, since they represented continuous populations on the trees. The population levels for all cicadellids on the traps were lower in 2010 than 2009. Growers applied broad spectrum insecticides regularly during the growing season in 2010 because of the high value of pomegranates produced in 2009. It is supposed that the regular sprayings resulted in very low populations of cicadellids in the orchards in 2010 when compared to 2009.

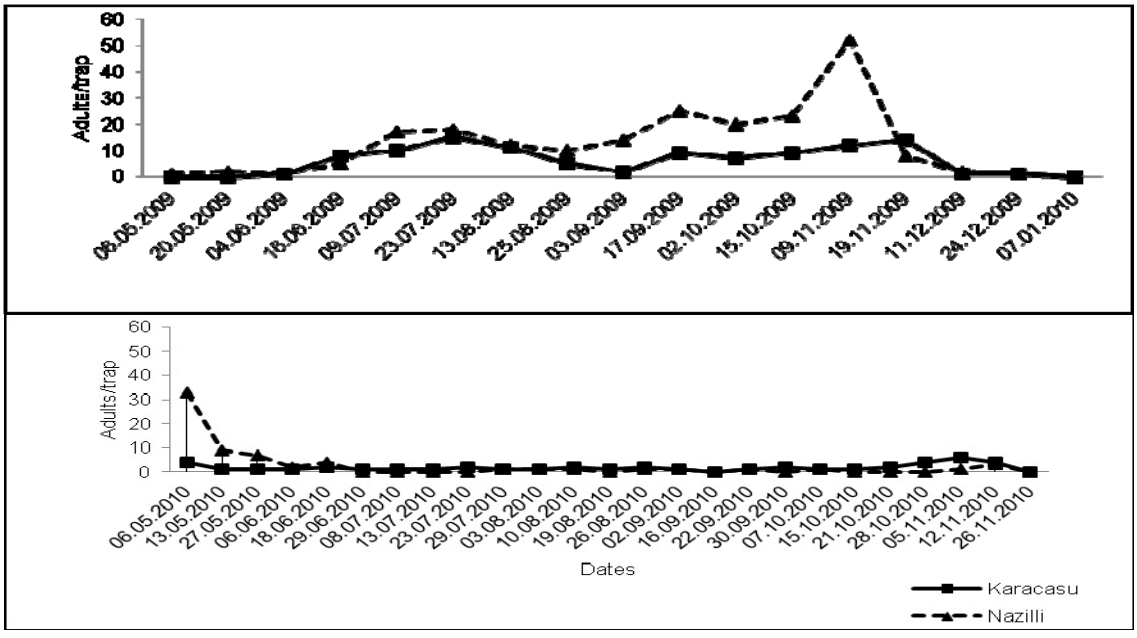

Figure 1. Population fluctuations of *Fieberiella anategea* on yellow sticky traps on pomegranate trees in Karacasu and Nazilli counties in 2009 and 2010.

Fieberiella anategea nymphs were observed during both winter and early spring (March) on the weeds, namely, *Cardaria draba* (L.), *Raphanus raphanistrum* L. and *Silybum marianum* L. At the beginning of May in both 2009 and 2010, *F. anategea* adults appeared on the traps in the orchards (Fig 1). It was an indication that *F. anategea* nymphs began to mature to the adult stage in April. The nymphs occurred again in July-August and the population of *F. anategea* peaked in July, October and November in Nazilli county in 2009. There was no distinct peak in Karacasu county, but the population was abundant in the same months as in Nazilli county in 2009. The population had already started to build up in April both in Nazilli and Karacasu counties in 2010. However, its numbers decreased sharply in May and continued at very low levels until the end of the season, and the adults disappeared by winter.

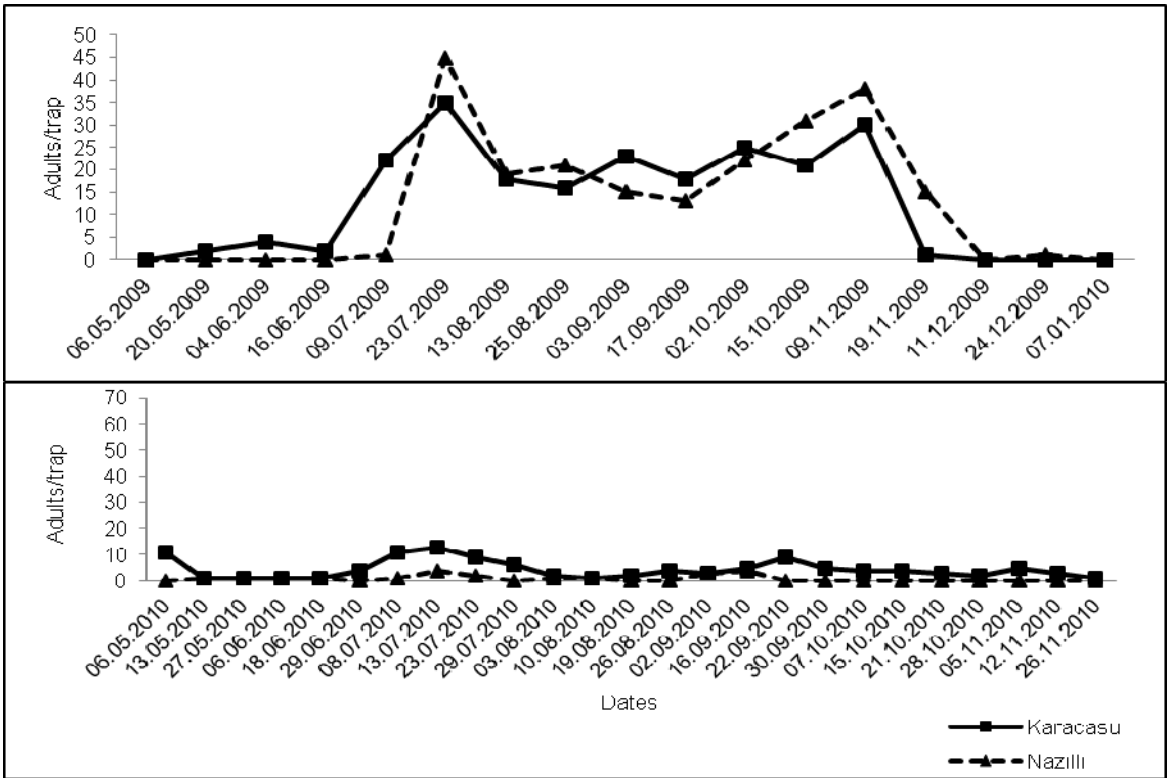

Figure 2. Population fluctuations of *Docotettix cornutus* on yellow sticky traps on pomegranate trees in Karacasu and Nazilli counties in 2009 and 2010.

Docotettix cornutus adults were observed first in the beginning of May and it started to build up its population (Fig 2). The population had peaked in July and November both in Karacasu and Nazilli counties in 2009. *Docotettix cornutus* occurred at low levels both in Karacasu and Nazilli counties in 2010. There were two small peaks in Karacasu county in July and September, while there was no distinct increase in Nazilli county. The population increase seemed to be occur in the same period in both years.

Asymmetrasca decedens+Empoasca decipiens adults were observed almost all year round in the orchards. They started to build up higher populatios at the beginning of May (Fig 3). Their numbers were highest in May-June and October- November in both Karacasu and Nazilli counties in 2009 and 2010. They occurred at very low levels during summer and fall, between the two peaks. As a result, it indicates that *A. decedens* and *E. decipiens* do not breed on pomegranate, but feed temporarily in spring, and seek refuge on the trees, which serve as shelter, in late fall. The proportions of *E. decipiens+A. decedens* populations were 59.35 and 53.96 % for *A. decedens* and 40.65 and 46.04 % for *E. decipiens* on the traps in 2009 and 2010, respectively.

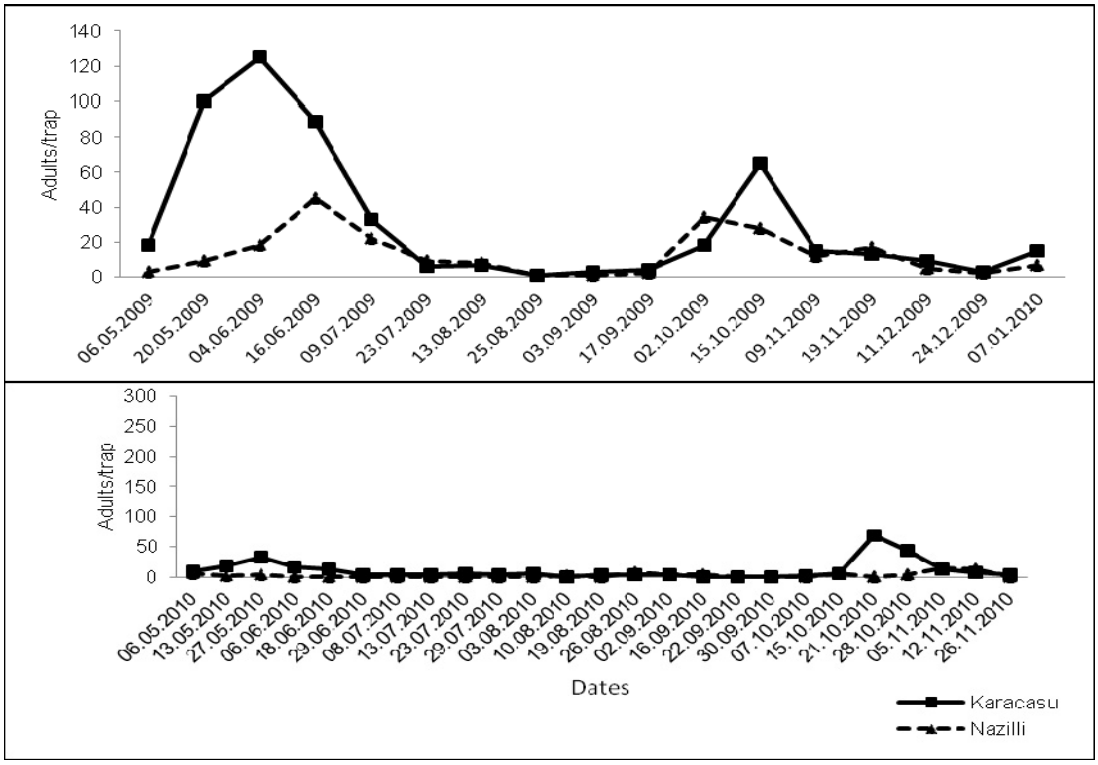

Figure 3. Population fluctuations of *Asymmetrasca decedens+Empoasca decipiens* on yellow sticky traps on pomegranate trees in Karacasu and Nazilli counties in 2009 and 2010.

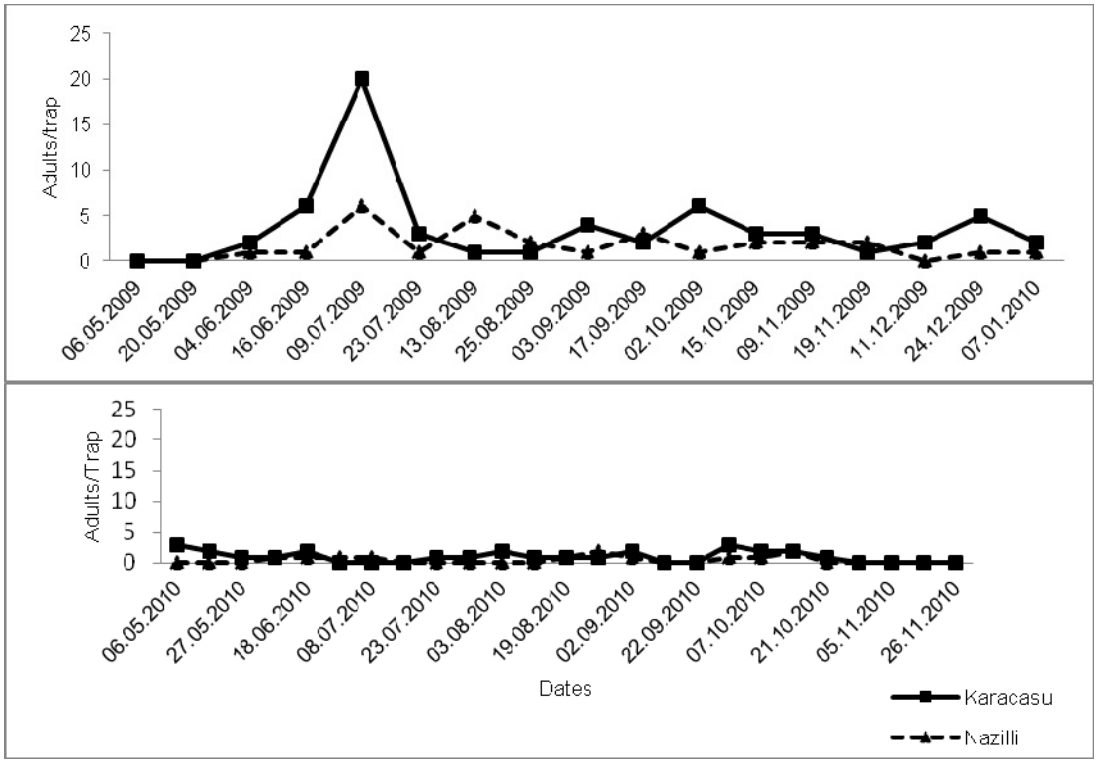

Figure 4. Population fluctuations of *Zyginidia pullula* on yellow sticky traps on pomegranate trees in Karacasu and Nazilli counties in 2009 and 2010.

Zyginidia pullula adults were observed on the traps in May in two trial orchards. Its population peaked in July in Karacasu county in 2009, but stayed at low levels at other times in two orchards (Fig 4). There were no adults of *Z. pullula* observed during the winter period in orchards. It seems that *Z. pullula* visits trees occasionally and is caught on the traps by chance.

The other species that were found on the traps and on the weeds never built continuous populations. During collections by shaking trees, *F. anategea* and *D. cornutus* dropped on the collecting sheet. Their populations occurred from May to December, which parallelled their occurence on the traps.

The summer weeds in pomegranate orchards are common and occur in other fruit orchards where congeneric cicadellids are collected. Başpınar & Uygun (1994) reported that similar cicadellids were collected on summer weeds in citrus orchards. The population levels of the cicadellids on weeds depends on the weed density and permanency in orchards. Drip irrigation systems and tillage of soil between the trees in pomegranate orchards resulted in reduction in weed density. For that reason, the population of cicadellids on weeds never reaches high levels. The cicadellids captured on traps on the pomegranate trees were mostly congeneric with the species collected on the weeds in the orchards. However, *C. haematoceps* and *E. mundus* were collected very rarely and only on sticky traps on the trees in this study, but they were reported also on weeds (Young & Frazier, 1954; Lodos & Kalkandelen, 1985; Başpınar & Uygun, 1991; Başpınar & Uygun, 1992). It seems that they might be attracted to traps by chance while they are flying.

Fieberiella anategea and *D. cornutus* were the most abundant and permanent species on sticky traps on the trees. They were also collected directly by shaking the trees, which was an indication that they were feeding on the trees. Additionally, *F. anategea* nymphs were also collected both on sticky traps and on the collecting sheet after shaking the branches, which means that they not only feed, but also breed on pomegranate trees. *Fieberiella anategea* was originally described in western Turkey and the Aegean Islands in Greece, and its paratypes were reported on *Castanea* sp., *Rubus fructicosus* L., *Vitis vinifera* L., *Cistus salviifolius* L., *Onobrychis* sp., *Quercus* sp. and *Olea* sp. in Turkey (Meyer-Arndt, 1991).

The other leafhoppers which were collected on sticky traps were never collected by shaking the trees, which might indicate that they had not stayed for a long period on the trees, but had been attracted during ashort visit.

The other cicadellid feeding on the trees, *D. cornutus,* has been reported on *Olea europaea* L. and *Lygustrum* sp. (Lodos & Kalkandelen, 1986). There were no nymphs of *D. cornutus* collected during sampling on pomegranate trees. *Olea europaea* is very common in the Aegean Region of Turkey, especially in Aydın province where the study was conducted; almost all pomegranate orchards more or less neighbour olive orchards. As a result, it might be deduced that *D. cornutus* occurs not only in olive orchards, but also in pomegranate orchards which are near olives.

Cicadellids are not key pests in pomegranate orchards in Turkey. Adult movement enables them to distribute over wide areas. Their populations are affected by many other factors, including many different hosts, not only weeds in orchards, but also in other orchards such as olive, peach and plum. Direct damage by cicadellids by sucking sap of the pomegranate seemed to be negligible. However, some of the cicadellids transmit many important plant diseases causing economically significant losses in the production. So, cicadellids can fly long distance (Taylor and Reling, 1986) and spread plant diseases a long distance by their flight activity (Mello et al., 2009).

Fieberiella anategea and *D. cornutus* were determined to be feeding on pomegranate trees for the first time in this study. However, there is not any record of the transmission of any plant disease by these cicadellids in pomegranate orchards so far. But, the genus *Fieberiella* could be a potential vector group in plant disease transmission, because it includes a vector species, *Fieberiella florii* (Stal, 1864), which

transmits many plant diseases. Krczal et al. (1989) and Tedeschi & Alma (2006) reported that *F. flori* is a vector of apple proliferation agent. Nielson (1975) stated that *F. flori* is a vector of the western strain of North American aster yellows virus, western X-disease virus of peach, and eastern X-disease virus of peach. Meyer-Arndt (1991) reported that interspecific similarity and intraspecific variation in the male genitalia has led to confusion over the identity and distribution of several species. Additionally, the fact that *F. anategea* was determined to be breeding on pomegranate is an indication that this cicadellid should be taken into consideration as a potential pest in future. *Fieberiella anategea* and other *Fieberiella* species may occur in mixed populations and *F. anategea* might have been involved in transmission of the aforementioned plant pathogens.

Acnowledgement

The authors thank to Dr. Alberto ALMA (Di. Va. P.R.A.Entomologia e Zoologia applicate all'Ambiente, via Leonardo da Vinci 44 10095 Grugliasco (Torino), Italy) and Dr. Özhan BOZ (Adnan Menderes University, Agricultural Faculty, Department of Plant Protection, Herbology Laboratory, Aydın, Turkey) for the identification of *Fieberiella anategea* Meyer-Arndt and the weeds in pomegranate orchards, respectively.

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