



# Determination of leafhopper (Hem.: Cicadellidae) species and population dynamics of important species in second crop maize in Şırnak province, Türkiye

## Şırnak ili ikinci ürün mısır alanlarındaki yaprakpisesi (Hem.: Cicadellidae) türlerinin belirlenmesi ve önemli türlerin populasyon değişimleri

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### ABSTRACT

The Cicadellidae family, belonging to the Hemiptera order, holds great significance among the various species of sucking insects that infest crop plants. The family members not only cause direct damage to the infested plants but also serve as vectors for viruses and other similar diseases. This study was conducted to determine the species belonging to Cicadellidae family and their population fluctuations in second-crop maize Şırnak province in 2020. The samplings were done at three different phenological periods of maize plants (vegetative, reproductive, and maturity stages). The population dynamics of commonly observed species were recorded using yellow sticky traps in three fields. The studies were initiated at the 2-4 leaf stage of maize the traps were monitored at weekly intervals till the crop maturity. A total of 13 species, i.e., *Anaceratagallia ribauti* (Ossiannilsson, 1938), *Batracomorphus irroratus* (Lewis, 1834), *Empoasca decipiens* Paoli, 1930, *Euscelis lineolatus* Brullé, 1832, *Exitianus fasciolatus* (Melichar, 1911), *Goniognathus (Epistagma) guttulinervis* (Kirschbaum, 1868), *Mogangella straminea* Diabola, 1957, *Neoliturus fenestratus* (Herrich-Schäffer, 1834), *Neoliturus opacipennis* (Lethierry, 1876), *Orosius orientalis* (Matsumura, 1914), *Psammotettix striatus* (Linnaeus, 1758), *Plathymetopius chloroticus* Putton, 1877, *Zyginidia sohrab* Zachvatkin, 1947 were identified from the study areas. *Plathymetopius chloroticus* was the first record of the Cicadellidae fauna of Türkiye. The most common species were *Empoasca decipiens* (%70), *Zyginidia sohrab* (27%) and *Psammotettix striatus* (3%) respectively. *E. decipiens* was recorded from 2-4 leaf stage of second crop maize in Şırnak province, The three common species were observed in fields from the 2-4 leaf stage, reaching their maximum level during the generative stage of the maize plants, and declining in population density during the maturation stage. Population density of *E. decipiens* reached the highest level (764 individuals per trap/week) during generative period of maize. It is recommended to use cultural control, in second crop maize fields where there are high population densities of species observed in the study area.

**Key Words:** Corn, First record, Population density, *Empoasca decipiens*, *Zyginidia sohrab*

### ÖZ

Bitki zararlısı emici böcek türleri arasında Cicadellidae familyası (Hemiptera) bitkilere verdikleri doğrudan zararın yanında virüs ve benzeri hastalıklara vektörlük etmelerinden dolayı oldukça önemli bir familyadır. Bu çalışma, Şırnak ilindeki ikinci ürün mısır ekiliş alanlarındaki Cicadellidae familyasına ait türler ile yaygın ve yoğun bulunan türlerin

populasyon değişimlerini izlemek amacıyla 2020 yılında yapılmıştır. Çalışmalar Silopi ve Cizre ilçelerinde mısırın üç farklı fenolojik döneminde (vejetatif gelişme, generatif ve olgunluk) örneklemeler yapılarak yürütülmüştür. Yaygın türlerin populasyon değişimleri üç farklı yerde, sarı yapışkan tuzakların mısırın 2-4 yapraklı döneminden itibaren asılarak bitkilerin olgunlaşma dönemine kadar haftalık olarak takip edilmesiyle gerçekleştirilmiştir. Şırnak ili ikinci ürün mısır alanlarında Cicadellidae familyasına bağlı toplam 13 tür kaydedilmiştir. Bu türlerin, *Anaceratagallia ribauti* (Ossiannilsson, 1938), *Batracomorphus irroratus* (Lewis, 1834), *Empoasca decipiens* (Paoli, 1930), *Euscelis lineolatus* (Brullé, 1832), *Exitianus fasciolatus* (Melichar, 1911), *Goniognathus guttulinervis* (Kirschbaum, 1868), *Mogangella straminea* (Dlabola, 1957), *Neoliturus fenestratus*, *Neoliturus opacipennis*, *Orosius orientalis* (Matsumura, 1914), *Psammotettix striatus* (Linnaeus, 1758), *Plathymetopius chloroticus*, *Zyginidia sohrab* (Zachvatkin, 1947) olduğu belirlenmiştir. Bu türler içinde en yaygın ve yoğun olan türlerin sırasıyla *E. decipiens* (%70), *Z. sohrab* (%27) ve *P. striatus* (%3) olduğu kaydedilmiştir. *Plathymetopius chloroticus*'un Türkiye cicadellid faunası için ilk kayıt olmuştur. Yaygın olan üç türün mısır bitkisinin 2-4 yapraklı döneminden itibaren görüldüğü, popülasyonlarının mısır bitkisinin generatif döneminde maksimum seviyeye ulaştığı ve olgunlaşma döneminde yoğunluklarının düştüğü görülmüştür. *Empoasca decipiens*'in mısırın generatif döneminde 764 birey (tuzak/hafta) olan en yüksek seviyeye ulaştığı belirlenmiştir. Şırnak ili ikinci ürün mısır ekim alanlarında popülasyonun yoğun olduğu yerlerde bu zararlıya karşı dikkatli olunması ve zararlı popülasyonunu azaltıcı kültürel önlemlere önem verilmesi gerektiği düşünülmektedir.

**Anahtar Kelimeler:** Mısır, ilk kayıt, populasyon yoğunluğu, *Empoasca decipiens*, *Zyginidia sohrab*

## Introduction

Maize, (*Zea mays* L.), holds significant importance across diverse industries and serves as a crucial resource for both human and animal consumption. There are several pest species that result in substantial economic losses in agricultural produce apart from phytopathogens, including fungi, bacteria, viruses, and phytoplasmas, which exert detrimental effects on various plants globally (Pimentel, 1976; Walker, 1983; Oliveira et. al 2014). Various detrimental insect species are observed during different phenological stages of maize, which exert adverse impacts on yield components, leading to direct and indirect yield and economic losses (Şimşek, 1982; Gözüaçık, 2009; 2016). One of the harmful insects in corn plants is leafhoppers (Mutlu and Sertkaya, 2015). Leafhoppers are small insects belonging to the family Cicadellidae in Hemiptera order. They are commonly found in various habitats, including orchards, agricultural fields, forests, and grasslands. Leafhoppers are known for their ability to jump and distinctive wing structure (Kalkandelen, 1974a).

While it is easy to notice the damage caused by insects with chewing mouthparts, it is more challenging to identify the damage caused by Cicadellidae species with piercing-sucking mouthparts as they feed on some plant parts.

Cicadellidae species, which can be both monophagous or polyphagous, are known to cause damage to a wide range of plants (maize, cotton, tomato, pepper, etc.) (Lodos, 1986; Nault and Ammar, 1989). They also act as vectors of plant virus diseases (Nault and Ammar, 1989). They release toxic substances into the plant's system, clogging the xylem and phloem vessels and hindering the transport of nutrients. The females of certain species can cause damage to tissues when depositing eggs on the plant's young growth organs and shoots. Additionally, some species are responsible for the secretion of honeydew, a sugary substance known as "fumagine," which can further affect plant health. (Oman, 1949; Kalkandelen, 1974a; Lodos, 1982a, Nault and Ammar, 1989; Mutlu and Sertkaya, 2016a).

Maize is cultivated as both first and second crop in several provinces of southeastern Anatolia Türkiye, including Şırnak. The district with the largest maize cultivated area is Silopi, followed by İdil and Cizre. Beytüşşebap also has some cultivation, although to a lesser extent. Silopi ranks first in terms of production quantity, followed by Cizre, İdil, and Beytüşşebap districts.

Despite the knowledge of many harmful insect species feeding on maize in the southeastern Anatolia, research on the presence of Cicadellidae family among these pests is limited. (Şimşek,

1982; Mutlu et al., 2008a). Seven species belonging to the Cicadellidae family have been identified in sorghum and maize fields in the southeastern and Eastern Anatolia regions, and it has been reported that four of these species are potential harmful pests (Şimşek, 1982).

A total of 20 species of Cicadellidae have been identified in second-crop maize from Diyarbakır province and its districts of which *Z. Sohrab Zatchvakin*, *Empoasca decipiens* Paoli, and *Asymmetrasca decedens* (Paoli) have been reported as the most abundant and widespread species (Mutlu et al., 2008b).

Cicadellidae species in second-crop maize have been rarely identified in Şırnak province; therefore, this determined the occurrence of these species in the province. The primary objective of the study was to identify the species belonging to Cicadellidae family in the second-crop maize cultivation areas of Şırnak province and determine which of the identified species are widespread and abundant.

## Materials and Methods

### Materials

The main materials used in the study consisted of the second-crop maize cultivation, leafhopper

species, yellow sticky traps (20×25 cm), iron rods, binocular microscope, standard sweep-net, Petri dishes, Eppendorf tubes (2 mm), drying paper, transparent polyethylene bags, magnifying glass, ice container, sable brushes, culture containers, and other necessary equipment.

### Methods

#### *Determining the distribution and densities of leafhopper species*

For the determination of species belonging to the Cicadellidae family, yellow sticky traps and sweep-net methods were used in the second-crop maize production areas in Silopi and Cizre districts during 2020. The samplings were conducted in seven fields in Silopi and four fields in Cizre districts (Table 1). A total 33 observations were conducted, starting from the phenological stage when maize plants had 2-4 leaves until the maturity stages. These observations covered the vegetative growth stages (early, mid, and late whorl stages), reproductive stages (tassel and ear development), and maturity stages of the plants. The leafhoppers species were identified by Prof. Dr. Ünal Zeybekoğlu from the Department of Biology, Faculty of Arts and Sciences, Ondokuz Mayıs University.

Table 1. The sampled fields and cultivated areas of second crop maize in Şırnak province during 2020

Districts	Total Cultivated Area (da.)	Sampled Maize Fields	Coordinates
Cizre	1.262	Yalıntepe-1	37° 17' 00" N, 42° 03' 25" E
		Yalıntepe-2	37° 16' 30" N, 42° 03' 19" E
		Güçlü-1	37° 16' 55" N, 42° 05' 59" E
		Güçlü-2	37° 17' 23" N, 42° 05' 50" E
Silopi	10.790	Bostancı-1	37° 10' 25" N, 42° 20' 44" E
		Bostancı-2	37° 10' 51" N, 42° 21' 59" E
		Başköy	37° 09' 35" N, 42° 29' 48" E
		Kavaközü	37° 13' 22" N, 42° 21' 00" E
		Ceylanköy	37° 15' 50" N, 42° 22' 18" E
		Üçağaç	37° 27' 87" N, 42° 37' 31" E
		Pınarönü	37° 28' 00" N, 42° 34' 39" E
İdil	1.801	-	-
Beytüşşebap	8	-	-
Total	13.861	11	-

The collected samples were placed in polyethylene bags with drying paper inside to prevent moisture, and labels containing information such as the collection location, date,

and phenological stage of the plant were attached to the bags. The bags were then brought to the laboratory using ice containers to maintain their freshness. The samples obtained from the yellow

sticky traps were collected in Eppendorf tubes containing alcohol. Labels with information such as the collection location, date, and phenological stage of the plant were attached to the tubes.

#### Population dynamics of important leafhopper species

Yellow sticky traps were used to determine the population dynamics of the most common and abundant species of Cicadellidae in the study area. The study was carried out in three fields, with one maize field in Cizre district and two in Silopi district. The studies started from the 2-4

leaf stage of the maize plant and continued until harvest. Yellow sticky traps were placed in each field at three different points, with a minimum distance of 25 meters between them. The traps were positioned upright on adjustable iron rods, set at a height near the height of the plant, and placed on the ground (Mutlu et al., 2008a; Mutlu and Sertkaya, 2015). The traps were subjected to a weekly change, during which the leafhopper species in each trap were carefully counted.

The information regarding the maize fields where population dynamics were monitored are provided in Table 2.

Table 2. Information about the fields where population monitoring was conducted using yellow sticky traps in second crop maize Şırnak province during 2020

Districts	Location	Coordinates	Field Size (da)	Variety	Planting Date	Harvest Date
Silopi	Başköy	37° 09' 35" N 42° 29' 48" E	150	Dekalb	04.07.2020	19.11.2020
	Kavaközü	37° 13' 22" N 42° 21' 00" E	90	Polen	05.07.2020	20.11.2020
Cizre	Güçlü	37° 17' 23" N 42° 05' 50" E	150	Polen	01.07.2020	15.11.2020

The morphological differentiation of adult individuals on the front and back surfaces of the yellow sticky traps was performed using a hand magnifier or a binocular microscope. The numbers of individuals belonging to each species were recorded separately. The average number of adult individuals on three traps for each field was calculated, and weekly population values for each

field were determined.

## Results and Discussion

### Distribution and Densities of Leafhopper Species

The identified leafhopper species in the second-crop maize fields of Şırnak province are listed in Table 3.

Table 3. The species of the family Cicadellidae, Delphacidae and Cixiidae identified in the second crop maize cultivation areas in Şırnak province during 2020

Order	Family	Subfamily	Species
Hemiptera	Cicadellidae	Agallinae	<i>Anaceratagallia ribauti</i> (Ossiannilsson, 1938)
		Deltocephalinae	<i>Euscelis lineolatus</i> (Brullé, 1832)
			<i>Exitianus fasciolatus</i> (Melichar, 1911)
			<i>Psammotettix striatus</i> (Linnaeus, 1758)
			<i>Plathymetopius chloroticus</i>
			<i>Neoliturus fenestratus</i> ((Herrich-Schäffer, 1834)
			<i>Neoliturus opacipennis</i> (Lethierry, 1876)
			<i>Mogangella straminea</i> (Dlabola, 1957)
		<i>Orosius orientalis</i> (Matsumura, 1914)	
		Euscelinae	<i>Goniognathus guttulinervis</i> (Kirschbaum, 1868)
		Typhlocybinae	<i>Empoasca decipiens</i> (Paoli, 1930)
			<i>Zyginidia sohrab</i> (Zachvatkin, 1947)
		lassinae	<i>Batracomorphus irroratus</i> (Lewis, 1834)
Delphacidae	<i>Sogatella vibix</i> (Haupt, 1927)		
	<i>Laodephax striatellus</i> (Fallén, 1826)		
Cixiidae	<i>Setapius barajus</i> Dlab.		
	<i>S. lindbergi</i> (Dlabalo, 1957)		
	<i>Reptalus panzeri</i> (Löw, 1883)		

A total of 13 species belonging to Cicadellidae family (Hemiptera order and Cicadomorpha suborder) were identified in the second-crop maize fields of Şırnak province. Among these species, one belonged to the subfamily Agalinae, eight belonged to Deltocephalinae subfamily, one belonged to Euscelinae subfamily, two belonged to Typhlocybinae subfamily, and one belonged to Lassinae subfamily. During the survey conducted in the fields, it was noted that *E. decipiens*, *Z.*

*sohrab*, and *P. striatus* were the most common and abundant species compared to other leafhopper species. In addition to the Cicadellidae family, two species belonging to the Delphacidae family (Fulgoromorpha suborder) and three species belonging to Cixiidae family were also identified.

The data regarding the occurrence rates of the identified widespread and abundant species are provided in Figure 1.

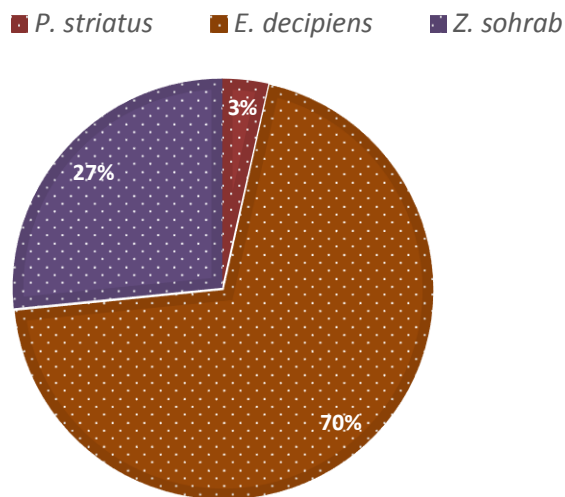


Figure 1. The population ratios of important Cicadellidae species detected using yellow sticky traps in second crop maize.

*Empoasca decipiens* was the dominant species 70% (6663 adult) occurrence rate, followed by *Z. sohrab* as the second most abundant species with 27% occurrence rate (2532 adult), and *P. striatus* with a very low occurrence rate of 3% (333 adult) (Figure 1.).

#### Subfamily: Agallinae

*Anaceratagallia ribauti* (Ossiannilsson, 1938)

#### General distribution

Sweden, Poland, Yugoslavia, Austria, France, Bulgaria, Albania, Belgium, the Netherlands, Czechoslovakia, Finland, Iran, Greece, the United Kingdom, Switzerland, Portugal, the Soviet Union, and Germany. (Dlabola, 1981).

#### Distribution in Türkiye

Diyarbakır, Ağrı, Osmaniye, Adana, Muğla, Ordu, Ankara, Bitlis, Çanakkale, Samsun, Eskişehir, Mersin, Erzurum, İstanbul, İçel, İzmir, Konya, Malatya, Nevşehir, Hatay, Elazığ, Kırklareli,

Manisa, Bilecik, Mardin, Siirt, Urfa, Yozgat and Zonguldak (Lodos and Kalkandelen, 1981; Önder et al., 2011; Akmeşe and Sertkaya, 2021).

#### Host plants

According to the study conducted by Önder et al. (2011), this species has been identified in grasslands and steppes, as well as in some agricultural fields and weeds such as *Medicago sativa*, *Sinapis* sp., *Gossypium* sp., *Sesamum indicum*, and certain *Euphorbia* plants. The researchers stated that this species is a rare and economically unimportant species that feeds on plant materials in shrublands, grasslands, and agricultural areas.

#### Examined material

On August 3, 2020, a total of 1 adult (♂) was determined in second crop maize in Silopi (Kavaközü) district.

*Subfamily: Deltocephalinae*

*Euscelis lineolatus* (Brulle, 1832)

*General distribution*

The species has been reported in Albania, Azerbaijan, Germany, Greece, Bulgaria, Uzbekistan, Algeria, France, Morocco, the Netherlands, Spain, Switzerland, Italy, Iran, Ireland, the Canary Islands, Portugal, Hungary, Sicily, Sardinia, Türkiye, Tunisia, Jordan, and Yugoslavia (Demir, 2008; Önder et al., 2011)

*Distribution in Türkiye*

Artvin, Balıkesir, İstanbul, Kırklareli, Konya, İzmir, Kırşehir, Kırıkkale, Manisa, Malatya, Bursa, Niğde, Ankara, Osmaniye (Kadirli), Trabzon, Samsun and Uşak (Akmeşe and Sertkaya, 2021; Demir, 2008; Önder et al., 2011).

*Host plants*

It has been reported that the species has been identified in grasslands, shrublands, and agricultural areas (Önder et al., 2011).

*Examined material*

On July 28, 2020, a total of 1 adult (♂) was detected in the second-crop maize fields of Cizre (Yalıntepe) district in Şırnak province.

*Exitianus fasciolatus* (Melichar, 1911)

*General distribution*

The species has been reported in Afghanistan, Libya, Tunisia, Egypt, Iran, the Soviet Union, Türkiye, the Canary Islands, Italy, the Madeira Islands, Algeria, Jordan (Ethiopian Region), and Israel (Linnavuori, 1962).

*Distribution in Türkiye*

Adana, Gaziantep (Dlabola, 1957a, 1971a), Diyarbakır, İzmir, Nevşehir, Bitlis, Maraş, Niğde, Gaziantep, Sakarya, Konya, Mardin, Urfa (Lodos and Kalkandelen, 1986), Adana (Balcalı) (Başpınar and Uygun, 1992c), Hatay (Kaya and Başpınar, 2019).

*Host plants*

No information has been found in the

literature regarding the host plants of this species.

*Examined material*

In the survey conducted in the second-crop maize fields of Cizre (Yalıntepe) district in Şırnak province, a total of 1 adult (♂) was detected on July 28, 2020.

*Mogangella straminea* Dlabola, 1957

*General distribution*

This species has been reported in Kazakhstan, Moldova, and Ukraine., Türkiye (Lodos and Kalkandelen, 1987a).

*Distribution in Türkiye*

Dlabola (1957b) identified this species based on specimens collected from Ankara (Mogan Lake). Kalkandelen (1974a) reported it from Eymir Lake, which is very close to Mogan Lake in Ankara.

*Host plants*

Emelyanov (1964) states that this species is found in various weed species. Lodos and Kalkandelen (1987a) reported its presence in grass plants.

*Examined material*

Material examined: A total of 1 adult individual (♂) was detected on November 9, 2020, in the fields where sampling was conducted in the second-crop maize in Cizre (Güçlü) district.

*Nealiturus fenestratus* (Herrich-Schäffer, 1834)

*General distribution*

This species has been reported in the Canary Islands, Greece, Romania, Switzerland, Germany, Israel, Serbia, Türkiye, Austria, Tunisia, Libya, Belgium, Algeria, China, Mongolia, Denmark, France, Egypt, Portugal, Iraq, Poland, Bulgaria, Italy, Afghanistan, the Netherlands, Iran, the Czech Republic, Albania, Russia, Cyprus, Hungary, Syria, and Spain (Lodos and Kalkandelen, 1985a).

#### *Distribution in Türkiye*

Van, Kayseri, Bolu, Siirt, Ankara, Diyarbakır, Erzurum, Çorum, Sivas, Kars, Adana, Erzincan, Mersin, İzmir, Muş, Edirne, Bitlis, Mardin, Konya, Tokat, Nevşehir, Osmaniye, Şanlıurfa and Ağrı, (Dlabola, 1957b, 1971a, 1981; Kalkandelen, 1974a, b; Giray, 1980; Lodos and Kalkandelen, 1985a; Özbek et al., 1987; Başpınar and Uygun, 1991b; Yıldırım and Özbek, 1991; Güçlü and Özbek, 1994a; Mutlu, 2008b; Akmeşe ve Sertkaya, 2021).

#### *Host plants*

It has been stated that this species is found in *Phaseolus vulgaris*, *Beta vulgaris* var. *rapa*, *Trifolium* spp., *Hypericum* sp., *Carthamus tinctorius*, *Solanum tuberosum*, *Artemisia* sp., *Chrysanthemum segetum*, *Trifolium repens*, *Medicago sativa*, *Helichrysum arenarium*, *Chenopodium* spp., *Tamarix* sp., and *Pimpinella anisum* plants (Ribaut, 1952; Giray, 1980; Özbek et al., 1987; Yıldırım and Özbek, 1991; Başpınar and Uygun, 1991b; Güçlü and Özbek, 1994a).

#### *Material examined*

Şırnak (Cizre-Güçlü, 31.08.2020-1). A total of 1 adult (♂) was detected in second crop maize

*Nealiturus (Circulifer) opacipennis* (Lethierry, 1876)

#### *General distribution*

Geranium, Hungary, Iran, Poland, Canary Islands, Cyprus, Madeira Island, Spain, Italy, Egypt, Mongolia, Germany, France, Afghanistan, Russia, Türkiye, Austria, Czech Republic, Sicily, Slovakia, Syria, Yugoslavia, Algeria, Tunisia, Jordan, Greece, Lebanon, Romania, and Morocco (Önder et al., 2011).

#### *Distribution in Türkiye*

Mersin (Silifke, Tarsus, Taşucu), Adana (Karataş, Kozan, İmamoğlu Seyhan, Tuzla, Yumurtalık), Antalya (Alanya, Manavgat), Ereğli (Konya plain, 1000 m), Osmaniye (Kadirli, Sumbas), Hatay (Kumlu, Reyhanlı) (Başpınar et al., 1993; Akmeşe and Sertkaya, 2021).

#### *Host plants*

Lodos and Kalkandelen (1985a) reported finding the species on *Beta vulgaris rapa*, *Chenopodium* sp., *Gossypium* sp., and *M. sativa* L. Başpınar and Uygun (1991b) reported finding it on *Amaranthus* sp., *Brassica napus* (turnip), *Chenopodium* sp., *Cyperus rotundus*, *Portulaca oleracea*, *Prosopis stephaniana*, *Raphanus raphanistrum*, *S. halepense*, and spinach plants.

#### *Material examined*

Şırnak (Cizre-Güçlü, 28.07.2020-1, Silopi-Kavaközü, 07.09.2020-1). A total of 2 adult (♂) were detected.

*Orosius orientalis* (Matsumura, 1914)

#### *General distribution*

The species is found in Uganda, India, Israel, Egypt, Taiwan, Türkiye, Iraq, Morocco, Iran, Palestine, Madeira Islands, Pakistan, Japan, and throughout the Oriental Region, as stated by Dlabola (1971a, 1981).

#### *Distribution in Türkiye*

Urfa, İzmir, Adana, Mersin, Hatay, Diyarbakır, Nevşehir, and Muğla (Dlabola 1957b, 1981; Giray 1980; Lodos and Kalkandelen, 1985a; Mutlu, 2008b).

#### *Host plants*

They reported finding the species on *Raphanus sativus*, *Nicotiana tabacum*, *R. raphanistrum*, *M. sativa*, *Beta vulgaris*, *Solanum lycopersicum*, *Crotalaria juncea*, *Brassica campestris vartoria*, *Chicorium intybus*, *S. indicum*, *P. oleracea*, *Gossypium* sp., *Sesamum orientale*, *Vigna mungo*, *Amaranthus* sp., and *Mentha piperita* plants (Giray, 1980; Lodos and Kalkandelen, 1985a; Başpınar and Uygun, 1991b).

#### *Material examined*

Şırnak (Silopi-Başköy, 20.07.2020-1). A total of 1 adult (♂) was determined in second crop maize.

*Psammotettix striatus* (Linnaeus, 1758)

#### *General distribution*

It is reported to be quite common in the

Paleartic and Nearctic regions (Kalkandelen, 1974a; Lodos, 1986; Lodos and Kalkandelen, 1987b).

#### *Distribution in Türkiye*

Hatay, Mersin, Sakarya, Konya, Erzurum, Adıyaman, Diyarbakır, Bitlis, Muş, Amasya, Mersin, Şanlıurfa, Bolu, Çorum, Elazığ, Manisa, Kayseri, Ankara, Malatya, Bingöl, Siirt, Osmaniye, Adana, Nevşehir, and Aydın (Dlabola, 1957b; Kalkandelen, 1974a; Şimşek, 1982; Lodos, 1986; Özbek, 1986; Lodos and Kalkandelen, 1987b; Özbek et al., 1987; Başpınar and Uygun, 1990; Yıldırım and Özbek, 1991; Başpınar and Öncüer, 2000; Tezcan et al., 2003; Mutlu et al., 2008b; Akmeşe and Sertkaya, 2021; Atmaca et al., 2021).

#### *Host plants*

It has been found on *Z. mays*, *S. tuberosum*, *Vicia sativa*, *Origanum* spp., *M. sativa*, *T. repens*, *M. piperita*, *Onobrychis sativa*, *N. tabacum*, *Gossypium hirsutum*, *Oryza sativa*, *Cucurbita pepo*, and *Triticum aestivum* plants (Lodos, 1981; Ribaut, 1952; Lodos, 1986; Özbek, 1986; Özbek et al., 1987; Lodos and Kalkandelen, 1987b; Başpınar and Uygun, 1990; Başpınar and Öncüer, 2000; Tezcan et al., 2003).

#### *Material examined*

It was found throughout the vegetation period in the second-crop maize fields where the studies were conducted in 2020. A total of 125 adult individuals were found in second crop maize.

#### *Subfamily: Euscelinae*

*Goniognathus guttulinervis* (Kirschbaum, 1868)

#### *General distribution*

Greece, Armenia, Italy (including Sicily and Sardinia), France, Afghanistan, Southern Russia, Georgia, Saudi Arabia, Azerbaijan, Algeria, Uzbekistan, Portugal, Syria, China (Xinjiang), Morocco, Iraq, Iran, Jordan, Kazakhstan, Israel, Ukraine, Hungary, Canary Islands, Egypt, Tunisia, North Africa, Spain and Lebanon (Nast, 1972).

#### *Distribution in Türkiye*

Diyarbakır, Antalya (Akkaya and Uygun, 1996; Demir, 2004; Mutlu et al., 2008b).

#### *Host plants*

Shrubby plants, vineyards, and vegetable fields (Akkaya and Uygun, 1996; Bosco, 2004; Demir, 2004).

#### *Material examined*

A total of 1 adult (♂) was determined from the fields in Silopi (Başköy) district where the studies were conducted on September 7, 2020.

#### *Subfamily: Iassinæ*

*Batracomorphus irroratus* Lewis, 1834

#### *General distribution*

Denmark, Albania, Afghanistan, Bulgaria, Belgium, China, Czechoslovakia, Greece, England, Germany, Hungary, Italy, Mongolia, Türkiye, Switzerland, USSR, Yugoslavia, France, and Austria (Lodos and Kalkandelen, 1982).

#### *Distribution in Türkiye*

Dlabola (1957b, 1981) reported its presence in Nevşehir (Ürgüp), Adana (Gavur Dağı), Erzurum (Kandilli 1720 m), Bolu (Gerede-Bolu Mountains 1200 m), Sivas (Gürün), and Ankara.

#### *Host plants*

According to Ribaut (1952), this species feeds on *Helianthum vulgare*, while Emelyanov (1964) mentioned *Astragalus arbuscula*, *Kochia prostrata*, and *Camphorosma monsplicum* as its host plants.

#### *Material examined*

A total of 1 adult (♂) was determined from the fields in Silopi (Kavaközü) district where the studies were conducted on August 3, 2020.

#### *Subfamily: Typhlocybinae*

*Empoasca decipiens* Paoli, 1930

#### *General distribution*

According to Lodos and Kalkandelen (1983), the distribution of this species includes Italy,



Morocco, Tunisia, Türkiye, Jordan, Switzerland, Netherlands, Poland, Iran, Lebanon, Greece, Spain, Germany, Cyprus, Israel, Libya, Russia, Iraq, France, Egypt, Afghanistan, Austria, Bulgaria, Pakistan, Czech Republic, Romania, and England (Lindberg, 1948; Dlabola, 1971b).

#### *Distribution in Türkiye*

It has been reported in Osmaniye, Diyarbakır, Şanlıurfa, Denizli, Eskişehir, Hatay, Kahramanmaraş, Adana, Mersin, Muğla, Antalya, Balıkesir, Çanakkale, Aydın, Manisa, Erzurum, and İzmir (Dlabola, 1957b; Bennett and Tanrıseven, 1957; Bozkurt, 1970; Süzer, 1980; Özbek et al., 1987; Başpınar and Uygun, 1991b; Yıldırım and Özbek, 1991; Güçlü and Özbek, 1994b; Başpınar and Öncüer, 2000; Mutlu et al., 2008b; Akmeşe and Sertkaya, 2021; Atmaca et al., 2021). Besides, Lodos and Kalkandelen (1983) stated that it is present in all regions of Türkiye except for the Black Sea region.

#### *Host plants*

It has been found on *G. hirsutum*, *Citrullus lanatus*, *Chenopodium* sp., *Juglans* spp., *Citrus* spp., *Mercurialis* sp., *Vicia* sp., *Cyperus* sp., *Granium* sp., *Malva* sp., *Datura* sp., *Xanthium* sp., *Sonchus* sp., *S. tuberosum*, *P. oleracea*, *Prunus domestica*, *Beta vulgaris*, *B. vulgaris* var. *rapa*, *Capsicum* spp., *Cucurbita moschata*, *C. pepo*, *Glycine max*, *Helianthus annuus*, *Daucus* sp., *Olea europaea*, *S. indicum*, *S. lycopersicum*, *Solanum melongena*, *Lactuca aculeata*, *Solanum nigrum*, *Malus domestica*, *C. arvensis*, *Allium* sp., *Hibiscus esculentus*, *Avena* sp., *Castanea* spp., *Cynodon dactylon*, *Ficus carica*, *M. sativa*, *Glycyrrhiza glabra*, *Setaria glauca*, *M. piperita*, *Crataegus oxyacantha*, *N. tabacum*, *Prunus persica*, *Petroselinum sativum*, *Cucumis sativus*, *P. vulgaris*, *Cannabis sativa*, *R. sativus*, *P. anisum*, *T. repens*, *Vicia faba*, *R. raphanistrum*, *Ricinus communis*, *P. stephaniana*, *Vitis vinifera*, *Amaranthus* sp., *Prunus amygdalus*, *O. sativa*, *S. halepense*, *Prunus avium*, *Spinacia oleracea*, *V. sativa*, *Pisum sativum*, *Vigna unguiculata*, *Prunus armeniaca*, *Polygonum aviculare* and *Z. mays*

(Avidov and Harpaz, 1969; Bozkurt, 1970; Lodos and Kalkandelen, 1983; Giray, 1980; Süzer, 1980; Zümreoğlu, 1980; Zümreoğlu and Akbulut, 1984; Özbek et al., 1987; Başpınar and Uygun, 1991a; Yıldırım and Özbek, 1991; Güçlü and Özbek, 1994b; Başpınar and Öncüer, 2000; Mutlu, 2008b).

#### *Material examined*

A total of 15 adult (5 ♂, 10 ♀) were found in the second crop maize fields during the survey studies in 2020.

#### *Zyginidia sohrab* Zachvatkin, 1947

#### *General distribution*

Iran, Croatia, Israel, Jordan, Syria, Afghanistan, Russia, Cyprus, Uzbekistan, Africa, and Lebanon are among the countries where *Z. sohrab* is found (Nast, 1972; Lodos and Kalkandelen, 1984).

#### *Distribution in Türkiye*

It has been reported in the Southeastern and Eastern Anatolia regions, including Şanlıurfa, Bingöl, Hakkâri, Kars, Elazığ, Gaziantep, Malatya, Siirt, Diyarbakır, Adıyaman, Van, Bitlis, as well as in Istanbul, Düzce, Kocaeli, Adana, Osmaniye, Hatay, and Mersin (Şimşek, 1982; Lodos and Kalkandelen, 1984; Lodos and Kalkandelen, 1985a; Alaoğlu et al., 2007; Mutlu et al., 2008b; Kılıç and Sertkaya, 2019; Akmeşe and Sertkaya, 2021; Atmaca et al., 2021).

#### *Host plants*

It has been found on *Panicum miliaceum*, *R. sativus*, *Arachis hypogaea*, *V. vinifera*, *Citrullus vulgaris*, *Z. mays*, *Lactuca sativa*, *H. esculentus*, *G. hirsutum*, *Dactylis glomerata*, *Sorghum vulgare*, *Brassica oleracea*, *Gossypium herbaceum*, *Beta vulgaris*, *M. sativa*, *P. persica*, Cucurbitaceae, and other wild and cultivated plants (Lodos, 1982a; Şimşek, 1982; Lodos and Kalkandelen, 1984; Lodos and Kalkandelen, 1985a).

#### *Material examined*

In the second crop maize fields sampled in 2020, *Z. sohrab* was found throughout the

vegetation period, and a total of 58 adult individuals were collected.

In this study, 13 species belonging to Cicadellidae were identified in the second crop maize fields of Şırnak province. Among the identified species, it was determined that *E. decipiens*, *Z. sohrab*, and *P. striatus* were the most common and abundant species. In contrast to this study, Alaoğlu et al. (2007) reported that *Z. sohrab* had a very high occurrence rate (%99.5) in maize fields in Konya, followed by *E. decipiens* with a very low occurrence rate (%0.4), while *Psammotettix* sp. did not reach a significant level. Yılmaz et al. (2007) recorded 17 species in maize areas of Manisa, İzmir, and Aydın provinces, among which *Z. pullula* and *A. decedens* were the most abundant and widespread species. Similarly, a total of 20 species were determined on second crop maize in Diyarbakır province, and the most common and abundant species were *Z. sohrab*, *E. decipiens*, *A. decedens*, and *P. striatus* (Mutlu, 2008a). However, in this study, *E. decipiens* was determined as the dominant species, while *Z. sohrab* was dominant in Diyarbakır province. In the Eastern Mediterranean region, 32 species of Cicadellidae were identified in both main and second crop maize, with *C. bipunctella* accounting for 61% of the species, followed by *A. decedens* & *E. decipiens* with 24%, and *Z. sohrab* with 12% (Akmeşe and Sertkaya, 2021). Kaya and Başpınar (2019) recorded a total of 30 species belonging to the Cicadellidae family and revealed that *C. bipunctella*, *Z. pullula*, *B. punctata*, and *P. provincialis* were the most prevalent among them in Hatay province.

In this study, *E. decipiens* was determined as the dominant species with a prevalence rate of 70%. This result differs from findings obtained in other regions of Türkiye. In the Central Anatolia region, *Z. sohrab* was found with a rate of 99.5% (Alaoğlu et al., 2007), in the Southeast Anatolia region, it was above 94% (Mutlu and Sertkaya, 2015), and in the Aegean region, *Z. pullula* was identified as the most common species (Yılmaz et al., 2007; 2009). In the Mediterranean region, *C. bipunctella* accounted for 61% of the species

(Akmeşe and Sertkaya, 2021). In contrast to the aforementioned studies, *Z. sohrab* was determined to have a prevalence rate of 27% in this study. It is believed that with the expansion of main and second crop maize cultivation areas in the future and the increasing density of narrow-leaves weeds both inside and outside the fields, this species has a high potential to become the dominant species.

As evident from the above-mentioned studies, it can be said that the species richness and abundance of leafhoppers vary according to the ecological conditions of the region and the type of crop being cultivated. In maize cultivation areas in Türkiye, *Zyginida* spp. was the most abundant species, except in the Mediterranean region. Although in small numbers, *A. decedens* has been identified in both main and second crop maize in other regions. In Şırnak province, *A. decedens* was not recorded, while *E. decipiens* was the most prevalent species. This was an interesting result obtained in the study. The reason for *E. decipiens* being the most abundant species is thought to be the presence of weeds in the field and its edges, where this pest is found and feeds intensively. In fact, Mutlu et al. (2008a) stated that in second crop maize, the presence of rough cocklebur significantly increased the abundance of *E. decipiens*.

The present investigation revealed a lower number of species in comparison to other studies carried out in diverse geographical regions. This could be attributed to the recent cultivation of maize in Şırnak province on limited areas. Therefore, the differences in species diversity, occurrence rates, prevalence, and abundance among regions or provinces are thought to be influenced by weed density, cropping pattern, pest control practices, and climatic conditions (temperature and humidity). This hypothesis was supported by the findings of Mutlu et al. (2008a), who reported that weed species and density were among the most important factors contributing to the species and population density of leafhoppers.

The current investigation has successfully

documented the initial occurrence of *Plathymetopius chloroticus*, a species that is uncommon in Türkiye. No prior documentation of this species in Türkiye was found through a comprehensive review of literature. Nonetheless, Mutlu (2008b) has identified a *Plathymetopius rostratus* species within the Ergani district of Diyarbakır province, specifically

in second-crop maize.

*Population dynamics of important leafhopper species in second crop maize*

Population dynamics of *Empoasca decipiens* in the second crop maize fields has been shown in Figure 2.

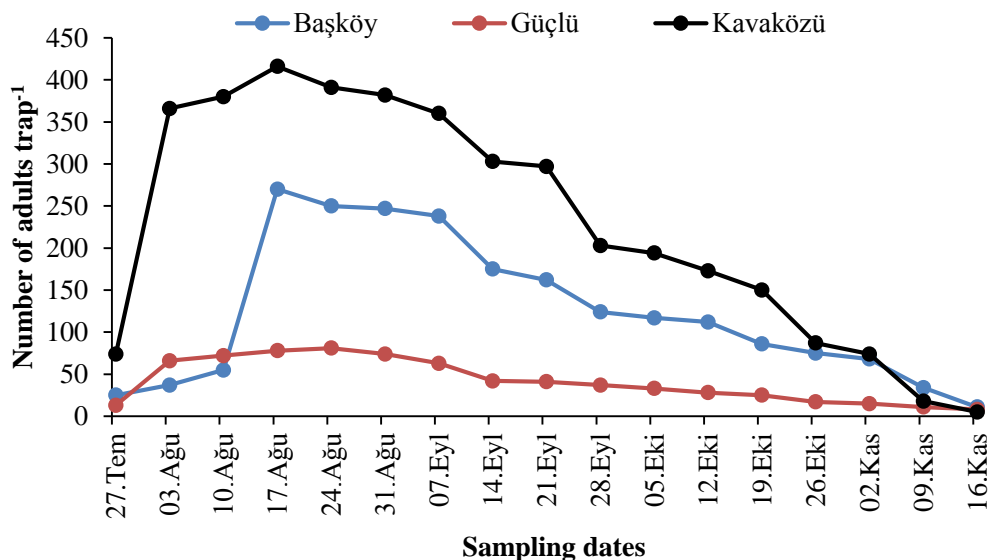


Figure 2. Population dynamics of *Empoasca decipiens* in the second crop maize fields of Şırnak province during 2020

It has been determined that *E. decipiens* is present in the fields where the second-crop maize was studied throughout the vegetation period. The population of *E. decipiens* starts to increase from the 2-4 leaf stage of the maize plant and reaches its peak in mid-August (during the

generative phase of maize). However, during the maturation period, the population starts to decline (Figure 2).

Population dynamics of *Zyginidia sohrab* in the second crop maize fields has been shown in Figure 3.

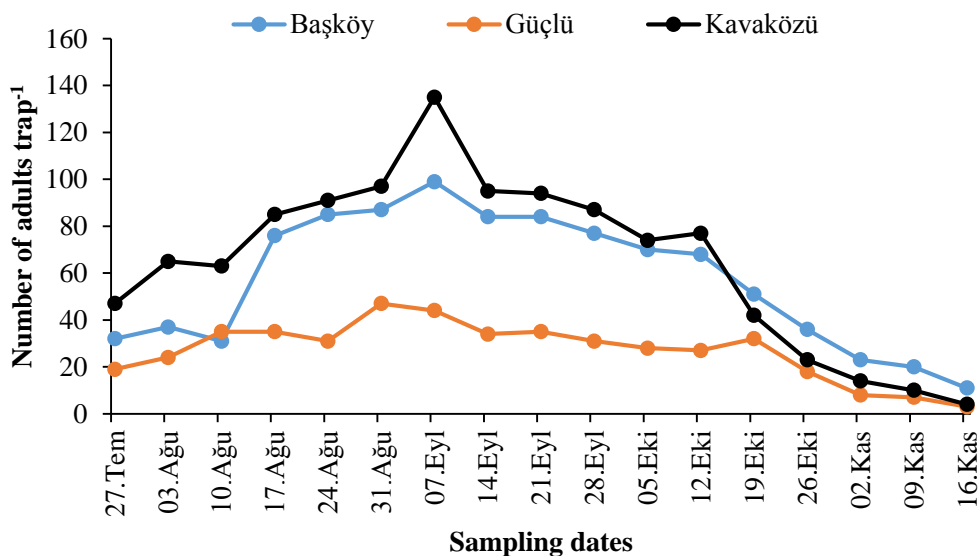


Figure 3. Population dynamics of *Zyginidia sohrab* in second crop maize fields of Şırnak province during 2020

It has been determined that *Z. sohrab*, was present in the fields where the second-crop maize was studied throughout the vegetation period. The population of *Z. sohrab* started to increase from the 2-4 leaf stage of the maize plant and reached to peak in the first week of September

(during the maturation phase of maize). After this period, the population started to decline (Figure 3).

Population dynamics of *Psammotettix striatus* in the second crop maize fields has been shown in Figure 4.

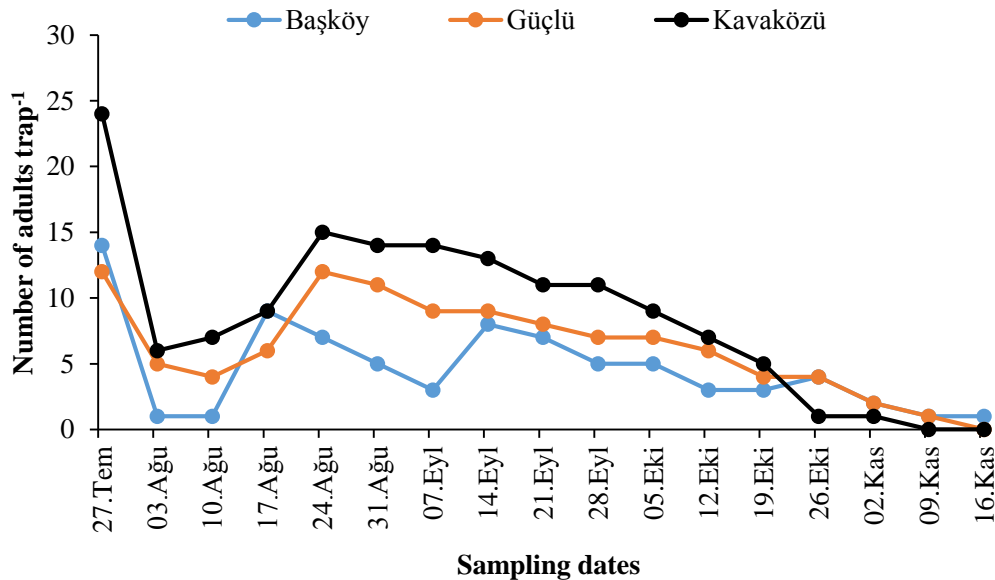


Figure 4. Population dynamics of *Psammotettix striatus* in second crop maize fields in Şırnak province during 2020

It has been determined that *P. striatus* was present in the fields where the second-crop maize was studied throughout the vegetation period. The population of *Psammotettix striatus*, which was initially observed in high numbers during the 2-4 leaf stage of the maize plant, remained relatively stable. However, after the first week of September, the population started to decline and reached its minimum level during the harvest period (Figure 4).

In this study, high populations of all three species were initially observed in yellow sticky traps. Particularly, it is believed that *E. decipiens* and *P. striatus* migrated from neighboring cotton fields to the maize fields where the study was conducted. Mutlu et al. (2008a) has previously mentioned that *P. striatus* spreads from cotton fields to second-crop maize plants in Diyarbakır, causing damage. Additionally, Göçmen et al. (1996) have confirmed that *P. striatus* individuals feed on cotton plants. Furthermore, Mutlu et al. (2008a) has noted that individuals of this species transition to the second-crop maize fields

neighboring cotton fields where the study was conducted.

Similarly, the high population of *Z. sohrab* in yellow sticky traps during the first week is believed to be influenced by its migration from the main crop maize fields neighboring the study area. The population of *E. decipiens* reached its peak during the generative stage of maize. This is thought to be due to the high density of weeds in the field and along its edges, as well as the frequent irrigation during the generative stage, which keeps the leaves fresh and moist, positively affecting the reproductive capacity of this species. With the onset of maturity, as temperatures decrease, and irrigation is discontinued leading to a decrease in the population density of these species. Similarly, Mutlu and Sertkaya (2015) reported that in second-crop maize, the population of *Z. sohrab* starts to increase from the 2-4 leaf stage and reaches its maximum level during the maturation period. Daily meteorological data wasn't collected in the current study. Previous research has indicated

that climate conditions, including temperature and humidity, have a favorable influence on leafhoppers increased reproduction capability in second crop maize in Diyarbakır province. Due to the similarity in temperature and precipitation patterns between the study area and Diyarbakır province, it is believed that these factors will have a positive effect on leafhopper population in second crop maize in Şırnak province.

## Conclusions

Different Cicadellidae species were identified from the second crop maize fields and population dynamics of important species were determined. A total of 13 species were recorded, including eight species from the subfamily Deltocephalinae, two species from Typhlocybinae, one species from Agallinae, one species from Euscelinae, and one species from Iassinae. In addition to the Cicadellidae family, two species from the family Delphacidae and three species from the family Cixiidae were also identified. Among the identified leafhopper species, the most abundant and widespread species were *E. decipiens*, *Z. sohrab*, and *P. striatus* with population proportions of 70%, 27%, and 3%, respectively. *E. decipiens* and *Z. sohrab* were observed in the maize fields throughout the vegetation period of the second-crop maize, and their population densities were found to peak during the generative stage of maize. Furthermore, the presence of *P. chloroticus* was recorded for the first time in this study in Türkiye.

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**Conflict of Interest:** The authors declare that there is no conflict of interest regarding the subject of this study.

**Author Contributions:** The experiment was designed by Çetin Mutlu, the setup and fieldwork were conducted by Ayşe Baran Yazıcı, and the identification of leafhopper species was carried out by Ünal Zeybekoğlu.

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