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Original article

Lygus species (Hemiptera: Miridae), their distribution, and population dynamics in cotton production areas in Diyarbakır province, Türkiye

Diyarbakır ili pamuk alanlarındaki *Lygus* (Hemiptera: Miridae) türleri, yayılış alanları ve popülasyon gelişimi

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ABSTRACT

Many insect pests infest cotton (*Gossypium hirsutum* L.) crop, resulting in significant economic losses. The tarnished plant bugs (*Lygus* species) greatly damage the cotton crop during all growth stages. This study determined Lygus species infesting cotton in Diyarbakır province, their distribution, and population dynamics during 2020 and 2021. *Lygus* species samples were collected from 244 fields in 7 districts of the province by using either D-vac or sweep net based on the phenological period of cotton. Population dynamics of the species were monitored weekly by using sweep net and D-vac from two fields situated in the Sur (Gencan village) and Çınar (Şükürlü village) districts of the province during both years. Two species including *Lygus gemellatus* (Herrich-Schäffer) and *L. pratensis* (Linnaeus) were identified during the study. *Lygus gemellatus* was the most common and abundant species observed in 91.2% and 74.7% of the surveyed fields during 2020 and 2021, respectively. The species were recorded at the end of May (before flowering) during both years, and their populations increased afterward. The peak population of both species was observed during the boll maturation period. The D-vac trapped a statistically higher number of *Lygus* bugs than the sweep net at Gencan ($p < 0.05$), while both methods trapped statistically similar numbers of bugs at Şükürlü. It is concluded that the population density of both species can change from year to year depending on biotic and abiotic factors. It is suggested that survey studies must be conducted at the start of a vegetative period of cotton to monitor these species.

INTRODUCTION

Cotton (*Gossypium hirsitum* L.) is used in a variety of industries, principally the textile industry. It is also utilized as a raw material for the paper and cellulose industries, as well as in the furniture and healthcare sectors in Türkiye worldwide (Egbuta et al. 2017). Because of its variety of uses, it is a significant product from the perspective of strategy.

China (25%), USA (20%), India (16%), Pakistan (9%), Brazil (5%), Türkiye (4%), and Uzbekistan (4%) are the seven producers of cotton worldwide (Deguine et al. 2008). Türkiye is also rated sixth with 2.250.000 tons of cotton produced (TUIK 2021). In Türkiye, the Southeastern Anatolia Region produces 39.6% of cotton. Şanlurfa province leads the way in terms of production in this area with 892.906 tons, followed by Diyarbakır province in second with 309.229 tons (TUIK 2021).

Cotton, like many other crops, is susceptible to damage from a wide range of biotic and abiotic conditions that reduce production and quality. Particularly influential are pests and diseases (Kranthi et al. 2002, Matthews 1989, Özgür et al. 2019, ZMTT 2008). The important pests reported in cotton cultivation are *Helicoverpa armigera* (Hübner 1908) (cotton bollworm), and *Earias insulana* Boisd. (spiny bollworm), *Pectinophora gossypiella* (Saunders, 1844) (pink bollworm), *Spodoptera littoralis* (Boisduval, 1833) (cotton leafworm), *Tetranychus urticae* Koch, 1836 (two-spotted spider mite), *Lygus* spp. (tarnished plant bugs), *Thrips tabaci* Lindeman, 1889 (thrips), *Bemicia tabaci* Genn. (whitefly), *Empoasca decipiens* Paoli, 1930, *Asymmetrasca decedens* (Paoli, 1932) (leafhoppers) and *Aphis gossypii* Glover (cotton aphid) (ZMTT 2008). One of the notable challenges encountered in cotton production is the presence of *Lygus* spp., a pest species belonging to the Miridae family (Mccoll et al. 2011, Özgür et al. 2019, Ugine 2012, Wood et al. 2016, 2017, ZMTT 2008). The members of the Miridae insect family are called the tarnished plant bug (*Lygus* spp.) (George et al. 2021, Gore et al. 2012, Scales and Furr 1968). These insects are regarded as a pest in agriculture because it consumes a wide range of plants, including crops, and can seriously harm crops in both their nymph and adult stages (Layton 2000, Mccoll et al. 2011, Özgür et al. 2019, Wheeler 2001, ZMMT 2008).

Tarnished plant bugs are classified as piercing-sucking insects, as they employ their elongated mouthparts to puncture plant tissues and withdraw sap. These organisms consume a variety of plant components, such as buds, flowers, and developing fruits. The act of feeding by certain organisms can result in various detrimental effects on plant tissues, including distortion, discoloration, and abortion. These consequences ultimately contribute to a decrease in both crop yield and lint quality of cotton (Musser et al. 2009, Ugine 2012, Wood et al. 2016, 2017, ZMTT 2008).

Some researches have been conducted on Miridade family in Türkiye (Ateş 2018, Çerçi et al. 2021, Demirel 2009, Efil and İlkan 2003, Fent 2011, Kıyak and Ersoy 2022, Önder et al. 2006, Özgür et al. 2019, Tepecik and Dursun 2020, Yazıcı and Yıldırım 2018). However, there is not sufficient research on the cotton fields of Diyarbakır province. The research conducted in Şanlıurfa province has exclusively identified *Creontiades pallidus* Rambur as the only species of interest. It has been reported that this particular species is responsible for inducing substantial economic losses in cotton production (Efil and İlkan 2003). The objective of this study was to acquire noteworthy findings about the harmful species within the Miridae family, including their prevalence, abundance, seasonal population dynamics, and their association with the phenology of cotton plants in the cotton cultivation regions of Diyarbakır province. The objective was to enhance comprehension of these pests and offer valuable perspectives for their efficient control.

MATERIALS AND METHODS

The studies were conducted in Kayapınar, Çınar, Sur, Bismil, Bağlar, Yenişehir, and Ergani districts of Diyarbakır province, where cotton production is mostly produced (Figure 1). It has been observed that the most common cotton varieties are 455May, DP499, Golden West Esperia, Orion, and Lazer in these districts' cotton-growing areas.

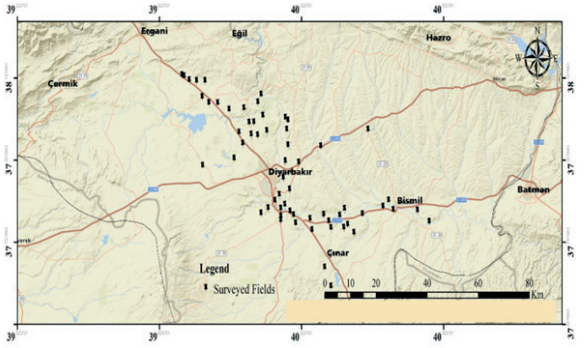

Figure 1. Distribution of the surveyed fields in Diyarbakır province to determine the infestation of *Lygus* species

Determination of Miridae species in cotton fields of Diyarbakır province

The research was conducted in Bağlar, Bismil, Çınar, Ergani, Kayapınar, Sur and Yenişehir the districts of Diyarbakır province in the years 2020 and 2021 (Table 1). For the survey studies, a modified "Husqvarna 132HBV" type vacuum insect collector called D-vac and a standard sweep-net was used to collect insects during the vegetative growth stages of cotton. The collected insects were placed in transparent plastic bags of 5 liters and transported to the laboratory. After being placed in a killing bottle containing ethyl acetate, adult individuals of Lygus species were separated under a stereo binocular microscope. The identification of the species belonging to the Miridae family was conducted by Prof. Dr. İnanç ÖZGEN (Fırat University, Faculty of Bioengineering, Department of Biomolecular Engineering, Elazığ, Türkiye).

Table 1. The distribution of surveyed cotton fields to determine Lygus species in Diyarbakır province

Surveyed Districts	Surveyed the number of cotton fields	
	2020	2021
Kayapınar	6	6
Ergani	6	6
Bağlar	4	4
Bismil	18	18
Çınar	28	28
Yenişehir	32	32
Sur	28	28
Total	122	122

The population dynamics of Lygus species in cotton fields

Population dynamics studies were carried out in the Sur and Çınar districts throughout 2020-2021. The research encompassed a total of four different fields, with two fields being investigated in each district. Sweep-net was employed to monitor the population dynamics of *Lygus* species in 2021. A total of 50 sweep nets were taken along the cotton rows on each occasion to collect adult individuals (ZMTT 2008). Sweep net and D-vac sampling techniques were used in the second-year study to evaluate their performance in obtaining Lygus species through the sampling technique. During the sampling procedure utilizing the D-vac method, Lygus species were acquired by employing the vacuum technique to extract them from the cotton plants. This process was conducted for 60 seconds at each of the six different points within the field, resulting in an overall sampling time of 6 minutes (Mutlu et al. 2008). The collected samples were transported to the laboratory and placed in a freezer to kill insects. Following this, the aforementioned insect samples were carefully transferred into appropriate plastic containers, and subsequently, the Lygus species were meticulously isolated and quantified.

Relationships between cotton phenology and damage caused by Lygus species

The research was carried out in 2022, focusing on the phenology of the cotton plant across three distinct stages: basic development, flowering, and maturation periods. The data collection involved employing a direct visual counting method. Sampling was conducted on 100 cotton plants, and the plants were randomly selected from various locations within the field. The sampling was carried out once a week, starting from the 3-5 leaf stage of cotton until the boll maturation stage. The direct counting method was employed for data collection. During the assessment, a comprehensive examination was conducted on the bolls of every cotton plant. The objective was to identify and record the black spots resulting from the feeding activities of Lygus species within the bolls. The percentage of damaged bolls was determined by comparing the number of damaged bolls to the total number of bolls counted.

RESULTS

Determination of Miridae species in cotton fields of Diyarbakır province

During two years, surveys were conducted in the cotton fields of the study area, resulting in the determination of two species belonging to the Miridae family: *Lygus gemellatus* (Herrich-Schäffer, 1835) and *L. pratensis* (Linnaeus) were recorded (Figure 2). Table 2 presents the data about the specific locations where the species under consideration were observed.

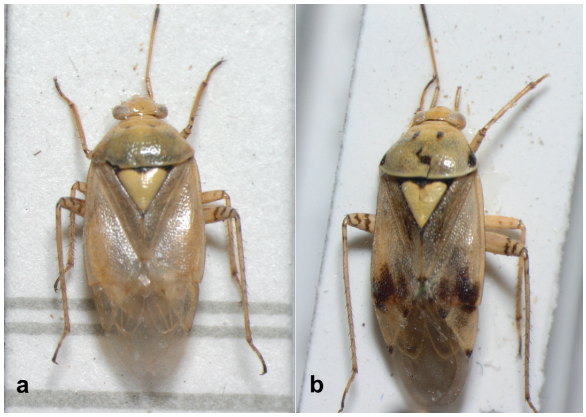

Figure 2. The tarnished plant bugs, *Lygus gemellatus* (a), *Lygus pratensis* (b) identified in the study

Table 2. *Lygus* species observed in cotton fields in Diyarbakır province

	Lygus gemellatus		*Lygus pratensis*	
Districts	2020	2021	2020	2021
Bağlar	-	-	-	-
Bismil	9	4	1	-
Çınar	23	22	5	7
Ergani	-	-	-	-
Kayapınar	-	-	-	-
Sur	85	125	6	38
Yenişehir	39	17	4	10
Total	166	168	16	57

Lygus species were not identified in the cotton fields of the Bağlar, Ergani, and Kayapınar districts in either of the two years (Table 2). The data acquired showed that *L. gemellatus* was the most common and abundant species in the cotton

production areas, accounting for 91% in 2021 and 75% in 2022. Besides, *L. gemellatus* was found to be most prevalent among the surveyed districts in the cotton fields of the Sur district.

The population dynamics of Lygus species in cotton fields

The data regarding the population dynamics of *Lygus* spp. in Diyarbakır province for the years 2020-2021 are presented in Figure 3 and Figure 4.The research started on May 22, 2020, in the cotton fields located in the Gencan and Şükürlü locations. The initial observation of *Lygus* species occurred in the Gencan of Sur district during the middle of June, before the onset of cotton flowering. On June 26, 2020, a total of 10 individuals were captured per sweep-net. On July 24, 2020, there was an observed increase in the count of individuals/ sweep-net, specifically during the cotton flowering period. The quantification of adult/sweep-net during the cotton maturation phase yielded a count of 8 on August 7, 2020, and a count of 4 on September 18, 2020. Following this point, a decline in the population of pests was observed. The presence of pests was detected in the village of Şükürlü, located in the Çınar district, during the initial week of July. This occurrence coincided with the flowering phase of the cotton crop, where a count of 3 adults per sweep-net was recorded. Following a particular period, there were variations observed in the population dynamics. Specifically, during the maturation phase on August 21, 2020, the population reached its peak count of 8 adults per sweep-net. In both study sites (Figure 3), it was observed that the population of Lygus spp. demonstrated a notable increase, particularly during the squaring and boll developmental stages of cotton.

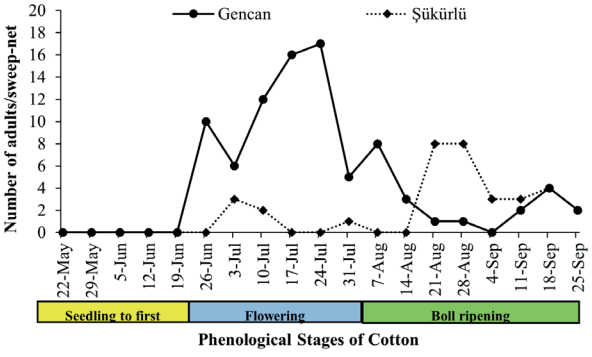

Figure 3. The population dynamics of *Lygus* spp. in cotton planted in Diyarbakır province during 2020

The study's second year started on May 22, 2021, at the Gencan and Şükürlü sites. *Lygus* species were observed in Gencan during the initial week of June. The population in the specified location was recorded as 2 adults per sweep-net on June 19, 2021, 5 adults per sweep-net on July 17, 2021, and 7 adults per sweep-net on August 7, 2021. The population had its lowest level during the period of cotton maturation, which typically occurs in late August. In the Şükürlü field, Lygus species were observed during the early week of June. The pest population observed in the present field showed a notable decrease in comparison to the population recorded in the Gencan field. In the Şükürlü region, the presence of one adult per sweep net was recorded on two separate occasions: August 7, 2021, and August 21, 2021 (Figure 4).

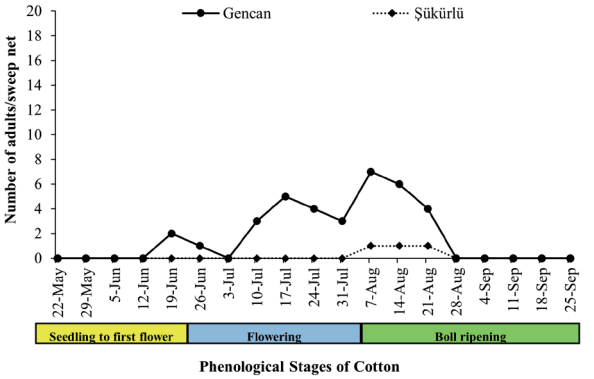

Figure 4. The population dynamics of *Lygus* spp. in cotton planted in Diyarbakır province during 2021

A comparative analysis of two distinct sampling methods was conducted on the cotton field situated in the Gencan location during the year 2021. Adult *Lygus* individuals were initially observed during the third week of May, coinciding with the vegetative growth stage of cotton, as illustrated in Figure 5. On May 29, a sampling procedure utilizing the D-vac method resulted in the acquisition of 57 adult individuals. Conversely, the sweep-net method resulted in the capture of 17 adult *Lygus* specimens. The population showed a decline in both methods; however, a subsequent increase was observed during the flowering and squaring stages of cotton. Notably, the D-vac method resulted in a total of 15 adult individuals. During the period of maturation, the population declined to its minimum level using both methods (Figure 5).

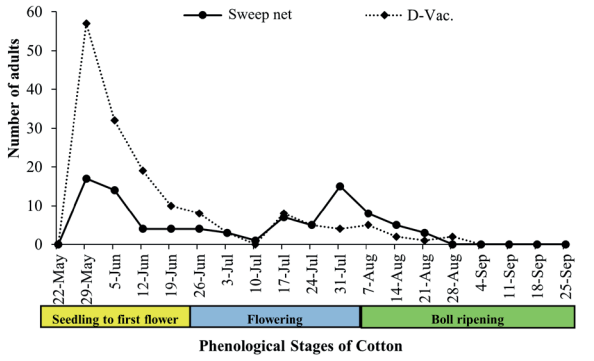

Figure 5. Population dynamics of *Lygus* species determined by Sweep-net and D-vac methods in Gencan during 2021

In another sampling conducted in the cotton field of Şükürlü, the first adult *Lygus* was determined in the last week of May (during the vegetative growth stage of cotton) (Figure 6). The same number of adult *Lygus* (7 individuals) were collected using both sampling techniques. The population in this field fluctuated during the blossoming and squaring seasons, although more adult *Lygus* were collected using the D-vac method than with the sweep-net technique. The population in both ways reached its lowest point in the maturation period.

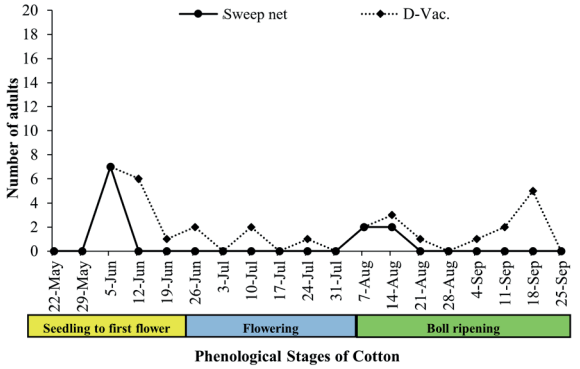

Figure 6. Population dynamics of *Lygus* species determined by Sweep-net and D-vac methods in Şükürlü during 2021

In the Gencan location field, the sweep-net method resulted in a capture rate of 36.5% (average 4.7 adult), whereas the D-vac the method resulted in a capture rate of 63.5% (average 8.2 adults). There was a significant capture in terms of D-vac sampling (t (19)= 3.865, p= 0.001) compared to the sweep net in the Gencan field. Similarly, in the Şükürlü location, the proportion of individuals captured using the sweep-net method was found to be 25.0% (average 0.58 adult), whereas the D-vac the method provided a high capture rate of 75.0% (average of 1.73 adults) (Figure 7). However, despite there was no statistically significant difference between the two methods (t (19)= 1.505, p= 0.150) at the Şükürlü location, relatively more *Lygus* spp. were obtained with D-vac.

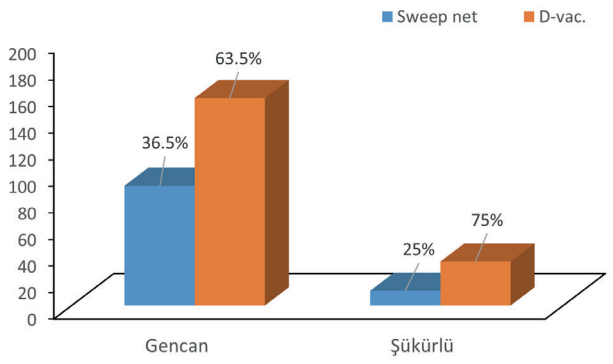

Figure 7. The relative proportion of Lygus species trapped by sweep net and D-vac sampling methods in Diyarbakır province during 2021

Relationships between cotton phenology and damage caused by Lygus species

Observations were carried out in the Gencan and Şükürlü districts during the period that extended from the final week of May to the initial week of October in both 2020 and 2021. The objective of these observations was to determine the relationship between *Lygus* species and cotton phenology, specifically about the extent of damage caused.

Damage to newly grown cotton bolls began in both districts during the early week of July, coinciding with the generative stage. The Gencan location exhibited the greatest number of damaged bolls during the middle of September (September 18, 2020), with a total of 180 infested bolls (Figure 8). Likewise, the Şükürlü location showed the greatest number of damaged bolls, precisely 84 infested bolls, on September 11, 2020 (Figure 8).

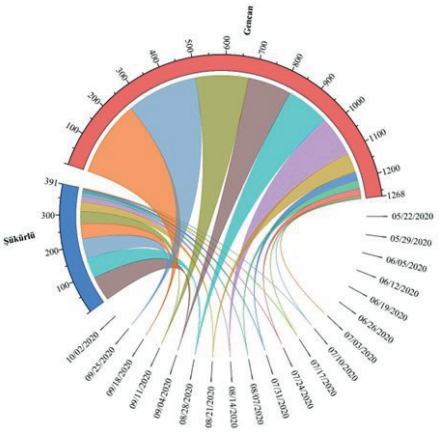

Figure 8. The number of damaged bolls due to *Lygus* spp. in Gencan and Şükürlü during 2020

In the second year of the study, which was the year 2021, the first boll damage was observed starting from the last week of June, which coincides with the beginning of the flowering period. After this period, an increase in the number of infested bolls was noticed, and it was determined that the highest number of damaged bolls occurred at the end of August and the beginning of September (during the maturation period). The highest boll damage was recorded in the Gencan field during the first week of September (September 4, 2021), with 378 infested bolls, while in the Şükürlü location, 410 infested bolls were identified at the end of August (August 28, 2021). The number of damaged bolls in the cotton plant was determined for both years (Figure 9). Consequently, it was determined that *Lygus* species cause damage to cotton plants during the squaring and boll-forming stages, with the most significant damage observed during the boll stage.

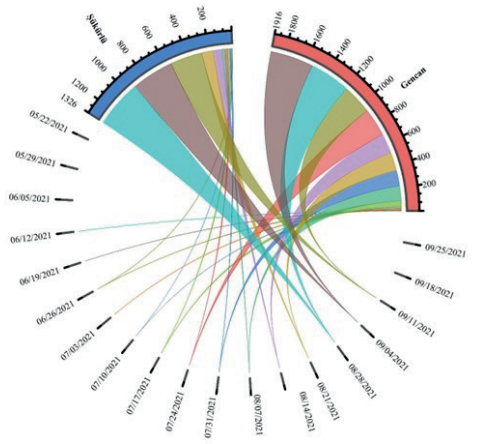

Figure 9. The number of damaged bolls due to *Lygus* spp. in Gencan and Şükürlü during 2021

Figure 8 displays the data about the quantity of bolls affected by *Lygus* species in four distinct cotton fields in Diyarbakır. In the first year of the study (2020), 20.000 bolls from 100 cotton plants in the field at Gencan were examined. Out of these, 1.268 were determined to be damaged and recorded as infested by *Lygus* species, while the remaining 18.732 were thought to be undamaged. As a result, 6.3% of the Gencan field's bolls were infested compared to those that were not affected. Similarly, in the field at Şükürlü, 100 plants totaled 15.500 bolls, of which 15.110 were found to be undamaged and 390 to be infested. 2.5% of the bolls in this field were determined to be damaged.

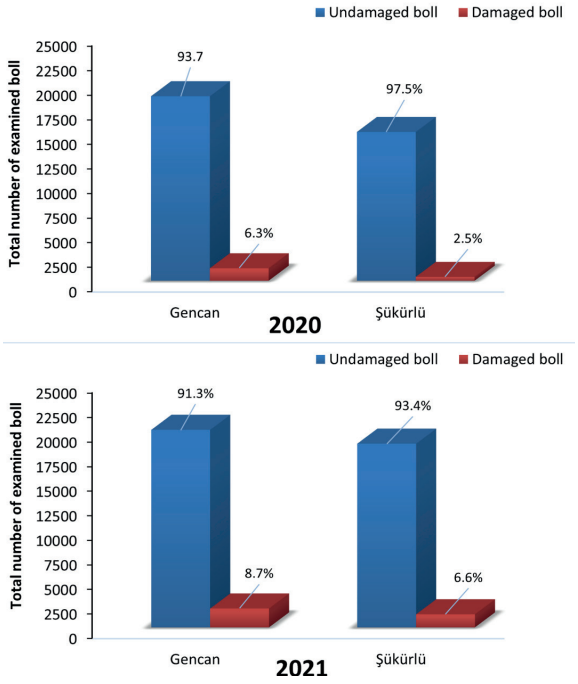

Figure 10. The number of damaged and undamaged bolls, and damage ratios caused by *Lygus* spp. in Gencan and Şükürlü locations

During the second year of the study, in the year 2021, a comprehensive examination of 22.000 bolls was conducted in the field at Gencan. Out of this total, 1.916 bolls were recorded as infested, while the remaining 20.084 bolls were identified as undamaged. Hence, the proportion of infested bolls to undamaged bolls in the Gencan was calculated to be 8.7%. In the Şükürlü cotton field, where the research was conducted, a comprehensive count of 20.000 bolls was conducted. Out of these, 18.674 bolls were found to be undamaged, while 1.326 bolls were identified as infested. The study determined that the proportion of bolls damaged by *Lygus* species in Şükürlü Village was 6.6% (Figure 10).

DISCUSSION

Over two years of surveys conducted in cotton cultivation areas in Diyarbakır province, two *Lygus species, L. gemellatus and L. pratensis*, were determined. Several studies have been conducted on tarnished plant bugs, including those found on cotton and other field crops In Turkiye (Arı 1999, Demirel 2009, Önder et al. 2006, Özgür et al. 2019, Yıldırım 2020). In these studies including cotton and other field crops *L. rugulipennis, L. lineolaris, L. borealis, L. elisus, L. hesperus, L. italicus, L. kalmi, A. linealatus, L. lucorum, C. pallidus, E. gemellatus, E. pratensis* and *A. lucorum* were determined. Besides, Wood et al. (2016, 2017) stated that *L. lineolaris* is a significant pest in cotton fields in the central United States.

According to several studies focusing on the cotton plant, it has been observed that the species C. pallidus is found in cotton fields located in Şanlıurfa province. Conversely, in the cotton cultivation areas of Hatay's Amik plain and Aydın province, the species *L. gemellatus, L. pratensis* and *C. pallidus* have been identified (Ateş 2018, Demirel 2022, Efil and İlkan 2003). In addition to *C. pallidus*, the species *L. italicus* has also been identified in the cotton fields located in Adana province. The findings of this study indicate that the species observed are consistent with those previously identified in various regions of Türkiye, thereby providing support for the assertion that *L. gemellatus* and *L. pratensis* are the most prevalent and abundant species in cotton fields. According to a study conducted by Efil and İlkan (2003), C. pallidus has been observed as a prevalent species in the cotton cultivation areas of Şanlıurfa province. In the present study, despite the carrying out of surveys over two years, the identification of the species *C. pallidus* could not be identified in Diyarbakır province.

In contrast to the findings of the present study, previous research conducted in Aydın province has reported a notably low occurrence of *E. gemellatus* and *E. pratensis,* with *C. pallidus* identified as the most prevalent and abundant species (Ateş 2018). It is widely acknowledged

that species within the Miridae family, specifically *Lygus* bugs, are subject to significant effects from abiotic factors, resulting in fluctuations in their population densities across different years and seasons. The population dynamics of these insects are affected by abiotic factors, including temperature, humidity, precipitation, irrigation, and other environmental conditions (Adams et al. 2013, Asiimwe et al. 2014, Harper et al. 1993, Lu et al. 2014, Schotzko and O'Keeffe 1986). In this research, *C. pallidus* was not determined despite the sampling of 244 cotton fields over two consecutive years. Hence, it can be concluded that *C. pallidus* does not exhibit any population within the ecological conditions of Diyarbakır. Therefore, it is recommended that comprehensive investigations be undertaken to investigate the occurrence of the aforementioned *Lygus* species in cotton fields within the Şanlıurfa province.

Both harmful *Lygus* species were observed before the flowering period of cotton, and after this period, their population density began to increase. During the squaring and boll formation period (July and August), it reached its peak. In the cotton fields of Aydın province, it has been determined that Miridae species pass from clover to cotton areas starting from the formation of cotton bolls and the highest population density on cotton occurs in August and September when the bolls are present (Ateş 2018). It has been also recorded that *C. pallidus* is observed during the flowering period of cotton and its density significantly increases during the boll formation period in Şanlıurfa province (Efil and Bayram 2009). This study's findings are supported by the fact that in the cotton fields of the Çukurova region, both *C. pallidus* and *L. italicus* show an increase in density from mid-July and reach their peak levels starting from August. Consequently, it can be stated that mirid species, in general, start increasing their population densities in cotton fields from the generative period onward and are considered harmful. The study also revealed that *L. gemellatus* demonstrates a high population density during the cotton boll period, whereas *L. pratensis* exhibits its highest population density during the boll maturation period.

The efficacy of sweep-net and D-vac methods in capturing adult *Lygus* individuals were evaluated, particularly during phenological periods characterized by the highest numerical intensity of harmful density. The D-vac method provided greater numbers of individuals in studies conducted to assess the population densities of both *Lygus* species. The population density of the pest in the Sur district was determined to be 36.5% through the utilization of the sweep-net method, whereas the D-vac method yielded a population density of 63.5%. In the Çınar district, it was observed that the rates obtained through the sweep-net method were 25%, while the rates obtained through the D-vac method was 75%. Based on the data acquired from both sampling locations, it has been concluded that the D-vac method exhibits higher effectiveness in capturing *Lygus* species in comparison to the sweep-net method. Nevertheless, an investigation carried out in Aydın province revealed that the sweep-net method provided the most favorable outcomes, exhibiting the highest capture rate among the various methods employed (Ateş 2018). According to Schotzko and O'Keefe (1986), they obtained approximately the same number of individuals while sampling *Lygus* hesperus Knight species from lentils using the D-vac and sweep net methods. However, they obtained a lower number of *L. hesperus* nymphs with the sweep net method. Harper et al (1993) reported that differences between sweep net and D-vac insect population estimates varied over sampling dates and years and were dependent on the insect species, their developmental stages, and abiotic factors. Buffington and Redak (1998) found a significantly higher number of Miridae species when employing the D-vac sampling method. Besides, Parajule et al. (2006) stated that there was no significant difference in catch efficiency between vacuum and sweep net methods for cotton mirid species, *Pseudatomoscelis seriatus* (Reuter). Although this study resulted in a higher number of *Lygus* species using the D-vac sampling method when compared to the sweep net, the accuracy of insect estimates obtained through the use of sweep net and D-vac methods is dependent upon various factors, including the specific insect species under consideration, their developmental stage, their spatial distribution within the canopy, the particular crop being sampled, and the influence of abiotic factors (Harper et al. 1993). Hence, taking into account the aforementioned factors, it is believed that both methods can be utilized in an integrated way to achieve precise population estimations.

In the present investigation, an examination was conducted to establish a correlation between the detrimental effects caused by *Lygus* spp. species and the phenological stages of cotton. The findings of this study revealed that these species cause damage specifically during the squares and boll periods, an effect that can be attributed to the population and increase of these pests within the cotton ecosystem. Nevertheless, it has been established that the period during which they cause the most severe damage is during the phase of cotton boll formation. Similarly, Özgür et al. (2019) reported that when the Miridae population is high, there is an increase in the number of bolls with discoloration and the number of bolls being shed onto the ground. They also observed an increase in the damage rates caused by *C. pallidus* on cotton bolls. Besides, Ateş (2018) stated similar findings to those obtained in our study, indicating that in

Aydın province, *Lygus* spp. start causing damage to newly forming small cotton bolls and increase their population significantly after this period.

According to the findings of damage assessment studies conducted in 2020, it was observed that the average percentage of small black spots on bolls in Gencan Village of Sur district was 6.3%, whereas, in Şükürlü Village of Çınar district, the rate of these spots was recorded as 2.5%. In the year 2021, the rate of pest-related damage in Gencan Village was recorded to affect approximately 8.7% of the bolls. Similarly, in Şükürlü Village, the damage caused by pests accounted for approximately 6.6% of the bolls. This damage was primarily attributed to the feeding activities of pests, which involve piercing and sucking. During the second year of the study, although the *Lygus* population was lower than the previous year, there was a proportional rise in the number of discolored bolls. The observed decrease in population size during the second year is thought to be attributable to the negative consequences of insecticides applied by cotton cultivators to control various cotton pests on the population density of *Lygus* species. This observation supported by Musser et al (2009) the management of tarnished plant bugs in cotton fields primarily involved the use of insecticides targeted at other pests during the flowering stage, therefore, economic damage from tarnished plant bugs during flowering was relatively uncommon.

According to the findings of Özgür et al. (2019), it was observed that even in the presence of low mirid populations, cotton crops in the Çukurova region experienced substantial damage. The study conducted in Harran Ovası revealed a negative correlation between the population of *C. pallidus* and the timing of cotton field planting. Specifically, early-planted cotton fields exhibited a lower population of *C. pallidus,* whereas cotton fields planted at later dates demonstrated a higher population of this species. The increased presence of squares and young bolls in early-planted cotton was identified as the contributing factor to the more favorable conditions that facilitated the population growth of *C. pallidus* (Efil and İlkan 2003). Furthermore, it has been determined that the initial damage caused by *Lygus* species occurred in early June, while the most significant occurrence of boll damage occurred in August. In this study, an investigation was conducted to establish a correlation between *Lygus* spp. species and cotton phenology. The findings of this study revealed that *Lygus* spp. species cause damage to cotton plants specifically during the boll formation and boll period. Furthermore, the highest degree of damage was once again observed during the period of cotton boll formation and boll development.

It is widely known that *Lygus* species population densities fluctuate year to year in response to plant types, biotic and abiotic environmental conditions as well and agronomic practices (George et al. 2021, Oeller et al. 2021, Özgür et al. 2019). The number and distribution of *Lygus* bugs may fluctuate over time as a result of the influence of several factors on population dynamics. The population dynamics of *Lygus* bugs in different environments can be greatly affected by both biotic factors, such as the availability of host plants and the presence of natural enemies, and abiotic factors, like temperature, humidity, and rainfall. For successful pest management techniques and long-term agricultural sustainability, an awareness of these aspects is crucial. Additionally, it was found that populations of *Lygus* spp. in Diyarbakır exceeded the economic threshold during both years of the study. Therefore, cotton producers need to be vigilant against plant bug species in cotton production areas from the flowering period onward. As the population of pests increases, the damage rate during the flowering, boll formation, and boll period may rise (Efil and İlkan 2003). Thus, appropriate cultural measures should be taken against *Lygus* species. Moreover, if chemical control is necessary, it is essential to choose pesticides with minimal impact on beneficial insects. This ensures the preservation of ecosystem balance and effective control of pests while maintaining the contribution of natural enemies, making it crucial for sustainable agricultural practices.

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Author's Contributions

Authors declare the contribution of the authors is equal.

Statement of Conflict of Interest

The authors have declared no conflict of interest.

ÖZET

Pamuk üretimi boyunca birçok zararlı etmen ortaya çıkmakta ve önemli ürün kayıplarına yol açmaktadır. Bunlar içerisinde yer alan *Lygus* spp. (Bitki tahtakuruları) pamuğun generatif döneminden başlayarak meydana getirdikleri zarar ile önemli ürün kayıplarına yol açabilmektedir. Bu çalışma Diyarbakır ili pamuk üretim alanlarındaki *Lygus* spp. türleri, yayılış alanları ve pamuktaki popülasyon gelişimini belirlemek amacıyla 2020 ve 2021 yıllarında yürütülmüştür. *Lygus* türlerini belirlemek için Diyarbakır ilinde 7 ilçeden toplam 244 adet tarladan örneklemeler pamuğun fenolojik dönemine göre atrap ve böcek toplama aleti (D-vac) kullanılarak

yapılmıştır. Popülasyon değişimi çalışmaları ise iki farklı örnekleme yöntemiyle (atrap ve D-vac) ile her iki yıl Sur ve Çınar ilçelerinde iki farklı tarlada haftalık olarak gerçekleştirilmiştir. Çalışmada *Lygus gemellatus* (Herrich-Schäffer) and *Lygus pratensis* (Linnaeus) olmak üzere toplam iki bitki tahtakurusu türü saptanmıştır. Bu iki tür arasında *Lygus gemellatus* en yoğun ve yaygın tür olduğu, 2020 yılında %91.2, 2021 yılında ise %74.7 oranında bulunduğu belirlenmiştir. Zararlıların çalışma yapılan her iki yılda, mayıs ayı sonunda (çiçeklenme döneminden önce) pamuk alanlarında görüldüğü belirlenmiştir. Bu dönemden sonra popülasyonun arttığı görülmüş ve özellikle *L. gemellatus* popülasyonunun pamuğun taraklanma (koza oluşturma) döneminde en yüksek seviyeye ulaştığı tespit edilmiştir. Buna karşın *L. pratensis* popülasyonu ise koza (olgunlaşma) döneminde en üst düzeye çıkmıştır. D-vac Gencan'da atrap metoduna göre istatistiksel olarak daha fazla sayıda tahtakurusu yakalarken ($p < 0,05$), Şükürlü'de her iki yöntem de istatistiksel olarak benzer sayıda tahtakurusu yakalamıştır. Biyotik ve abiyotik faktörlere bağlı olarak her iki zararlının popülasyon yoğunluğunun yıldan yıla değişebildiği sonucuna varılarak, pamuğun generatif döneminden itibaren bu zararlılara karşı yapılacak sürveylerle dikkatli olunması gerektiği önerilmektedir.

Anahtar kelimeler: sürvey, zararlı böcekler, zarar, popülasyon, bitki tahtakuruları

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