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AUTHORS: Ekrem ATAKAN

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Pest and beneficial insect species detected on broad bean in the Çukurova region of Turkey

Ekrem Atakan^{1,*} ¹Çukurova University, Faculty of Agriculture, Department of Plant Protection, Adana, Turkey

*Corresponding Author: eatakan@mail.cu.edu.tr

Abstract

Broad bean plants have an important status in human nutrition because they are rich in protein. In this study, harmful and beneficial insect fauna on pods of broad bean were studied in a limited area. The study was carried out in the commercial broad bean production areas in Çukurova region of Turkey between the years 2014-2016. In each survey, 4-8 fields were visited to determine the numbers of pest and predatory insect species. The size of commercial fields sampled varied from 0.5 to 1.0 ha. Sampling was carried out when plants were in the flowering-pod formation stage. Insect species were sampled by beating the plants vigorously into a white plastic container. A total of 14 harmful insects from 4 genera were identified. Western flower thrips, *Frankliniella occidentalis* (Pergande) dominated the pest insect fauna (a total of 444 individuals) accounting 40.07% of the total number of adults. Relatively high numbers of thrips and aphids were determined. A total of 9 predatory insect species from 2 genera were recorded. The most common predatory bug was *Orius niger* (Wolff) accounting for 76.83% of total adults collected. *Orius niger* was often detected with thrips species on flowers of plants. No damage due to insect pest species detected was observed throughout the sampling periods. This study suggests that growing faba bean in the winter-spring period, especially in agricultural areas having poor plant diversity in the Mediterranean region, could be useful for conservation and augmentation of beneficial insects.

Keywords: Pest, Beneficial, Insect, Broad bean

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Introduction

Broad bean is grown in almost all parts of Turkey; however, it is principally cultivated in the Mediterranean and Aegean regions such as Antalya, Aydın and Mersin provinces in Turkey. In 2017, fresh bean production was 37 511 tons and the area planted was 3.953,7 ha in Turkey (Anonymous, 2017). Faba bean production is fourth among the leguminous crops grown in Turkey.

There are various harmful and useful insects on the broad bean, which is important in human nutrition and also useful in soil nitrogen fixation. Harmful and beneficial insects on broad bean in Turkey have been studied in a limited area and often in experimental plots. (Atakan, 2010, 2012 and 2016)

In Turkey, the insect species and their pest status on faba bean in commercial fields have been studied. In previous studies performed in the same ecological area, insect pests of broad bean and their economic importance were described by Atakan and Ulusoy (2008) and the seasonal abundance of the western flower thrips, *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) and the generalist predator *Orius niger* (Wolff) (Hemiptera: Anthocoridae) were studied by Atakan (2010). Pest status of insects of faba bean in the Mediterranean countries including Tunisia, Syria was documented by Weigand and Bishara (1991). According to Weigand and Bishara (1991), aphids and *Sitona* spp. were

the main pests of faba beans in those countries. Nuessly et al. (2004) reported 61 herbivorous insect pest species and 32 predator and parasitoid species on faba bean in Florida (USA); and *Aphis craccivora* Koch (Hemiptera: Aphididae) was the most damaging pest of faba bean in their study. Although some associations between pest thrips and generalist predators on faba bean flowers have been studied in the restricted area of Balcalı (Adana province, Turkey), the fauna of thrips and beneficial insects and the their pest status on broad bean in commercial fields of faba bean in the Çukurova Region of Turkey are not well understood. During the winter and early spring months, the flowering broad bean can have ecological effects in the protection of beneficial insects, providing shelter and oviposition area, nectars and pollens sources. In commercial bean production areas, harmful and beneficial insect fauna and their densities due to pesticide applications may vary.

The aim of this study was to investigate the fauna of harmful and beneficial insects on broad bean in commercial farms in Çukurova region of Turkey. In addition, observing the damage status of harmful insects may contribute to studies of integrated pest control in broad bean fields in the region.

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Material and Methods

The study was carried out in the commercial broad bean production areas in Çukurova region of Turkey between the years 2014-2016. Abundance of pest and beneficial insect species were investigated in commercial faba bean fields during the 2014-2016 growing seasons in Adana Province, Turkey. Surveys were carried out once a month during the growing season. During surveys, the same fields were regularly sampled. In each survey, 4-8 fields were visited to determine the numbers of thrips and predatory insects. The size of the commercial fields sampled varied from 0.5 to 1.0 ha. Sampling was carried out when plants were in the flowering-pod stage. Each field was divided into four quarters (1.250-2.500 m² sub-plots) as replicates. Five plants in each sub-plot were randomly selected. Insect species were sampled by beating the plants vigorously into a white plastic container (37 × 28 × 7 cm) for about 5 sec. Collected insect species were counted by using a hand lens in the field. Most *Orius* specimens were released to the plots and a few were taken to the laboratory for identification. Insects that could not be identified in the field were transported to the laboratory and some of them were killed with the help of a killing jar. Small and soft-bodied insects were kept in 60% ethanol. In the laboratory, the thrips samples were transferred into vials containing AGA solution (i.e. 10 parts 60% ethanol, one part glacial acetic acid, and one part glycerin) and kept for one day. Thrips species were slide-mounted and identified under a binocular microscope.

Thrips (adults) were identified by using the keys given by zur Strassen (2003) and Balou et al. (2012). *Orius* spp. were identified with the keys given by Önder (1982) and Tommasini (2004). Other isolated predators and pestiferous insect species were identified by reference to materials stored in the Entomology Laboratory of the Department of Plant Protection, Faculty of Agriculture, University of Çukurova, Adana, Turkey. No identification keys are available for nymphs of *Orius*. Therefore, these were treated as a single group.

Results

Total numbers of insect pest species on broad bean

The total numbers of insect pest species collected from broad bean plants are given in Table 1. The highest number of aphids, *Aphis fabae* Scop. (Hemiptera: Aphididae) (101 individuals) was detected on 26 March 2015.

A relatively higher number of this aphid was recorded on 14 April 2015. The number of *Acyrtosiphon pisum* (Harris) (Hemiptera: Aphididae) was the highest on 14 April 2015. On the other sampling dates, few numbers of aphid species were encountered. Only three individuals of *Epicometis hirta* Poda (Coleoptera: Scarabaeidae) were recorded on flowers on 26 March 2015.

Leafhopper, *Empoasca decipiens* Paoli (Hemiptera: Cicadellidae) was regularly sampled throughout the study. The numbers were relatively higher on plants leaves on 6 February 2015 (54 individuals), on 26 March 2015 (109 individuals) and on 14 April 2015 (49 individuals). Similar to the leafhoppers, individuals of *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) were recorded on flowers throughout the growing season. The highest density on broad bean flowers was recorded on 8 December 2015 (103 individuals). Excluding 16 December 2014, 14 April 2015, and 11 November 2015, the numbers of these pest thrips were similar, ranging 55-74 individuals on flowers.

Meligethes sp. (Coleoptera: Nitidulidae) were observed on flowers of plants on 6 February 2015 (16 individuals) and 26 March 2015 (8 individuals). Total densities of this pest declined to zero level on other sampling dates. A few numbers of curculionid, *Sitona* sp. (Coleoptera: Curculionidae) were detected on flowers on 6 February 2015 and 26 March 2015. A relatively high number of *Thrips hawaiiensis* (Morgan) (Thysanoptera: Thripidae) (20 individuals), which is a serious pest of citrus lemon in Mersin province, Turkey, was extracted from flowers of broad bean plants on 8 December 2015. On other sampling dates, there was no thrips species or their numbers were very low.

Total numbers of predatory insect species on broad beans according to sampling dates are shown in Table 2. Predatory thrips, *Aeolothrips collaris* Priesner (Thysanoptera: Aeolothripidae) were detected on only one sampling date (1 individual). Predatory mirid, *Campylomma nicolasi* Puton and Reuter (Hemiptera: Miridae) was not found on some sampling dates, its density ranged between 2 and 13 individuals. Very few numbers of coccinellid predators [*Coccinella septempunctata* L. and *Hippodamia variegata* (Goeze)] (Coleoptera: Coccinellidae) were recorded throughout the sampling dates. Predatory anthocorid, *Orius laevigatus* were found scarcely on flowers when compared to another predatory bug *Orius niger* (Wolff) (Hemiptera: Anthocoridae). *Orius niger* was the most common predatory bug in surveyed commercial fields in this study. Total density of this beneficial insect was highest (77 individuals) on 26 March 2015. Its numbers were very few at the nonflowering stage of sampled plants i.e. in November.

In this current study, 14 pest insect species in 4 genera were identified. In previous studies done in Balcalı district, Adana province, Turkey, 17 harmful insect species and one genus were determined (Atakan and Ulusoy 2008). Harmful insect species and their densities found in those previous studies were higher than were found in the current study. This is probably due to intense insecticides applications in commercial fields in the region. However, in those previous studies, no insect damage on broad bean plants was detected. Additionally, no insect damage was also observed on plants grown in the surveyed commercial fields. This study suggests that insecticide applications performed against pest insects such as aphids and leafhoppers in the region are not needed. A total of 9 predatory beneficial insect species in 2 genera were also identified. Captured predatory insect species numbers and diversity were similar to previous studies done in Balcalı location which is a polyculture area (Atakan and Ulusoy, 2008; Atakan and Malik, 2018).

Proportions of pest and predatory insect species on broad bean

Seasonal numbers and proportions of pest insect species identified in the surveyed fields are given Table 3. *Frankliniella occidentalis* dominated the pest insect fauna (total number was 444 individuals) accounting for 40.07% of the total number of adults. *Empoasca decipiens* was the second most common insect species, comprising 21.49% of the total individuals. *Aphis fabae* and *Acyrtosiphon pisum* had similar proportions in total number (11.60% and 18.43%, respectively).

Proportions of other pest insect species collected from plants were less than 3%. *Frankliniella occidentalis* was found to be the dominant pest thrips in the current study. This may be due to its wide host range, high reproductive rate,

wide geographic distribution and better adaptation to hard winter conditions (Kirk and Terry, 2003). This pest thrips is commonly found on many host plants (Atakan 2008a, b) and wild plants (Atakan and Uygur 2005; Atakan and Tunç, 2010) in the Çukurova region.

Seasonal numbers and proportions of beneficial insect

species identified in the surveyed fields are given in Table 4. A total of 9 predatory insect species in 2 genera were identified during this study. *Orius niger* dominated the predatory insect fauna, accounting for 76.83% of total adults.

Table 1. Total numbers of pest insect species on broad bean according to sampling dates in Çukurova Region of Turkey during 2014-2016.

Insect species	28 Nov., 2014	16. Dec., 2014	6. Feb., 2015	26.Mar., 2015	14. Apr., 2015	11. Nov., 2015	8. Dec., 2015	20.Jan., 2016	23 Feb., 2016
<i>Meligetes</i> sp.	0	0	16	8	0	0	0	0	0
<i>Sitona</i> sp.	0	0	9	3	0	0	0	0	0
<i>Aphis fabae</i>	0	0	10	101	16	0	0	2	0
<i>Acyrtosiphon pisum</i>	0	3	0	43	158	0	0	1	0
<i>Epicometis hirta</i>	0	0	0	3	0	0	0	0	0
<i>Empoaca decipiens</i>	0	1	54	109	49	2	6	5	13
<i>Dolycoris baccarum</i>	0	0	0	0	1	0	0	0	1
<i>Lygus</i> sp.	0	0	0	0	0	1	0	0	0
<i>Oxycarenus hyalinipennis</i>	0	0	0	0	0	1	0	0	1
<i>Frankliniella occidentalis</i>	65	23	51	74	8	9	103	56	55
<i>Isonurothrips australis</i>	0	1	0	0	0	0	0	0	0
<i>Kakothrips priesneri</i>	1	0	0	0	0	0	0	0	0
<i>Melanthrips pallidior</i>	0	0	0	2	0	0	1	0	0
<i>Thrips hawaiiensis</i>	0	0	0	0	0	1	20	0	0
<i>Thrips major</i>	0	0	0	0	0	0	0	0	1
<i>Thrips meridionalis</i>	0	0	0	0	0	0	0	0	2
<i>Thrips tabaci</i>	0	0	2	2	2	0	0	0	0
Total	66	17	142	345	234	14	130	64	73

Table 2. Total numbers of beneficial insect species on broad bean according to sampling dates in Çukurova Region of Turkey during 2014-2016.

Insect species	28 Nov., 2014	16. Dec., 2014	6. Feb., 2015	26 Mar., 2015	14. Apr., 2015	11. Nov., 2015	8. Dec., 2015	20 Jan., 2016	23 Feb., 2016
<i>Coccinella septempunctata</i>	0	0	2	0	0	0	0	0	0
<i>Hippodamia variegata</i>	0	0	0	0	0	0	0	0	1
<i>Campylomma nicolosi</i>	10	4	3	0	0	13	3	0	2
<i>Orius majusculus</i>	0	1	1	0	0	0	2	1	0
<i>Orius laevigatus</i>	0	9	3	0	0	1	1	3	1
<i>Orius niger</i>	7	58	33	77	8	7	22	19	12
<i>Piocoris erythrocephalus</i>	0	0	0	0	0	1	0	0	0
<i>Chrysoperla carnea</i>	0	0	0	0	0	0	0	4	1
<i>Paederus</i> sp.	1	0	0	0	0	0	1	0	0
<i>Tachyphorus</i> sp.	2	0	0	0	0	0	0	0	1
<i>Aeolothrips collaris</i>	0	0	0	1	0	0	0	0	0
Total	20	72	42	78	8	22	29	27	18

Table 3. Proportions of pest insect species on broad bean in Çukurova Region of Turkey during 2014-2016.

Order/Family	Total no of pest insects	The proportion in total number (%)
Coleoptera/Curculionidae		
<i>Sitona</i> sp.	12	1.07
Coleoptera/Nitulidae		
<i>Meligethes</i> sp.	24	2.15
Coleoptera/Scrabaecidae		
<i>Epicometis hirta</i> Poda	3	0.26
Hemiptera/Aphididae		
<i>Aphis fabae</i> Scop.	129	11.60
<i>Acyrthosiphon pisum</i> (Haris)	205	18.43
Hemiptera/Cicadellidae		
<i>Empoasca decipiens</i> Paoli	239	21.49
Hemiptera/Lygaeidae		
<i>Nysius</i> sp.	15	1.34
<i>Oxycarenus hyalinipennis</i> Costa	2	0.17
Hemiptera/Miridae		
<i>Lygus</i> sp.	1	0.08
Hemiptera/Pentatomidae		
<i>Dolycoris baccarum</i> (L.)	1	0.08
Thysanoptera/Aeolothripidae		
<i>Melanthrips pallidior</i> Priesner	3	0.26
Thysanoptera/Thripidae		
<i>Frankliniella occidentalis</i> (Pergande)	444	40.07
<i>Isoneurothrips australis</i> Bagnall	1	0.08
<i>Thrips hawaiiensis</i> (Morgan)	22	1.97
<i>Thrips major</i> (Priesner)	1	0.08
<i>Thrips tabaci</i> Lindeman	7	0.62
<i>Kakothrips robustus</i> (Uzel)	1	0.08
<i>Thrips meridionalis</i> Uzel	2	0.17
Total	1112	100

Table 4. Proportions of beneficial insect species on broad bean in Çukurova Region of Turkey during 2014-2016.

Order/Family	Total no of beneficial insects	The proportion in total number (%)
Coleoptera/Staphylinidae		
<i>Paederus</i> sp.	2	0.63
<i>Tachyphorus</i> sp.	3	0.94
Coleoptera/Coccinellidae		
<i>Coccinella septempunctata</i>	2	0.63
<i>Hippodamia variegata</i> Goeze	1	0.31
Hemiptera/Anthocoridae		
<i>Orius laevigatus</i> (Fieber)	18	5.69
<i>Orius majusculus</i> (Reuter)	5	1.58
<i>Orius niger</i> (Wolff)	243	76.89
Hemiptera/Lygaeidae/Geocorinae		
<i>Piocoris erythrocephalus</i> (Lepeletier and Serville)	1	0.31
Hemiptera/Miridae		
<i>Campylomma nicosi</i> Puton and Reuter	35	11.19
Neuroptera/Chrysopidae		
<i>Chrysoperla carnea</i> (Stephens)	5	1.58
Thysanoptera/Aeolothripidae		
<i>Aeolothrips collaris</i> Priesner	1	0.31
Total	316	100

Orius niger was followed by *C. nicosi* with a proportion of %11.19. The proportion of *Orius laevigatus* was 5.63%. Proportions of other predatory insects were less than 2%. *Orius niger* was the most notable predatory bug. The results agree with findings of Tommasini (2004), who found that *O. niger*, *O. laevigatus*, and *Orius majusculus* (Reuter) were common anthocorid species in the Mediterranean basin. *Orius niger* was dominant in northwestern Italy, whereas *O. laevigatus* was more common in the warmest locations of the country (Bosco et

al., 2008). Thus, the predominance of insect species may depend on location.

Orius and thrips species identified in this study visited mostly flowers during the flowering periods of plants in commercial fields. High numbers of both insects inhabited the flowers in previous studies done in the Balcalı location (Atakan and Malik, 2018). In addition, there was a positive and significant relationship between numbers of thrips and numbers of *O. niger* found on the flowers (Atakan and Malik, 2018). According to the findings of some studies, *Orius*

1962; Salas –Aguilar and Ehler, 1977; Kiman and Yeragan, 1985). Nuessly (2004) also indicated that considerable numbers of beneficial insect species colonized the faba bean grown in southern Florida (USA). The broad and closed flower structure of broad bean may have created favorable conditions in protecting beneficial insects from hard winter conditions and predations.

Seasonal numbers of some predatory insects related to some pest insects

Table 5. Seasonal numbers of some predatory insects identified with some pest insects on broad bean in Çukurova region of Turkey during 2014-2016.

Pest insects	Predatory insects		
	<i>Campylomma nicolosi</i>	<i>Orius laevigatus</i>	<i>Orius niger</i>
<i>Acyrtosiphon pisum</i>	1	3	23
<i>Aphis fabae</i>	2	0	51
<i>Frankliniella occidentalis</i>	22	15	135
<i>Empoasca decipiens</i>	5	8	80
<i>Meligethes</i> sp.	2	3	30
<i>Nysius</i> sp.	0	2	5
<i>Sitona</i> sp.	2	1	25

Table 6. Prey/predator ratios on broad bean in Çukurova region of Turkey during 2014-2016.

Sampling dates	Prey (thrips) /predator (<i>Orius</i>)	Prey (leafhopper)/predator (<i>Orius</i>)
28 Nov., 2014	9.28	-
16 Dec., 2014	0.39	0.01
6 Feb., 2015	1.54	1.63
26 Mar., 2015	0.96	1.41
14 Apr., 2015	1.0	6.12
11 Nov., 2015	1.28	0.28
8 Dec., 2015	4.68	0.27
20 Jan., 2016	2.94	0.26
23 Feb., 2016	4.58	1.08

Prey/predator ratios

Monthly prey (thrips or leafhopper (*Empoasca*)/predator (*Orius* spp.) ratios are presented in Table 6. Prey (thrips)/predator (*Orius*) ratios were less than 10 thrips per *Orius*. The highest prey predator ratio was detected on 16 December 2014 as 9.28 thrips per *Orius*. Prey/predator ratios were lower (less than 5 thrips per *Orius*) when compared to the previous sampling date. Prey (leafhoppers)/ predator (*Orius*) ratios on the sampling dates were less than 7 leafhoppers per *Orius*. The ratio was relatively greater on 14 April 2015 as 6.12 leafhoppers per *Orius* when compared the ratios found on other sampling dates. Leafhopper/*Orius* ratios were less than 2 leafhoppers per *Orius* on the most sampling dates.

Frankliniella occidentalis was under the predation risk in the flowers due to *Orius* attacks. There was clear suppression of *F. occidentalis* populations by *Orius* on the broad bean. Prey-predator ratios on most sampling dates were very lower (less than 10 thrips per *Orius*) than previously reported ratio, 217 thrips per *Orius*, which is critical for *Orius insidiosus* to sufficiently suppress the population of *F. occidentalis* in greenhouses (Sabelis and van Rijn, 1997). Effective suppression of the thrips by a predator depends on several factors including initial population densities of the prey and predator, their fecundity and structure of the host plants (Osekre et al., 2008). The leafhoppers/*Orius* ratios were low on most sampling dates; however, this may not indicate efficient predation of the leafhoppers by the *Orius* species since pest leafhoppers feed

Seasonal numbers of some predatory insects identified with some pest insects on broad bean are given in Table 5. Most *O. niger* were detected together with *F. occidentalis* and *E. decipiens*. Relatively higher densities of *O. laevigatus* were also found in association with *F. occidentalis*. A relatively higher number of *C. nicolosi* was found in association with *F. occidentalis*. The numbers of predatory insects found together with other pest insects were low.

mostly on foliage and *Orius* species visit mostly flowers. In light of this, leafhoppers may have a lower predation risk due to generalist predators, such as *Orius* species.

Conclusions

As a result, broad bean is rich in beneficial and harmful insect fauna even though they were captured in fewer numbers in the commercial fields. Majority of the identified pests on broad bean are polyphagous pests and were already recorded in Adana (Atakan and Ulusoy, 2008). According to previous study done in same area (Atakan, 2010) no pest insect damages were observed even in the non-insecticide treated plots of the broad beans. This result is in agreement with the findings of current study. Therefore insecticide applications are not recommended, this is especially important for the protection of natural enemies including predators. Broad bean is especially more attractive to generalist predatory bugs, *Orius* species (mainly *O. niger*). For this reason, the cultivation of the broad bean in monocultural agricultural systems can increase efficiency of these predatory taxa through providing overwintering, feeding, mating sites, and thus their reproduction. Beneficial insects may have an important role in suppressing pest insects on summer crops in the region. For this purpose, the insect biodiversity may be increased with the faunistic studies on broad bean in different ecological regions of Turkey, and the importance of these beneficial species can be converted to a useful position in terms of pest management on subsequent arable crops.

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