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Population Densities and Distributions of the Western Flower Thrips (Thysanoptera: Thripidae) and its Predatory Bug, *Orius niger* (Hemiptera: Anthocoridae), in Strawberry

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ABSTRACT

Population fluctuations of western flower thrips (WFT), *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) and its predatory bugs, *Orius* spp. (Hemiptera: Anthocoridae) as well as their distributions characteristics in strawberry in Adana province, Turkey were studied in 2007-2008. Populations of thrips and their predators were monitored by sampling of flowers and fruiting parts. *F. occidentalis* was the main thrips species and *Orius niger* (Wolff) was the most prevailing predatory bug of the thrips. Predators and thrips species were found mainly in the flowers, with few numbers of thrips on the fruits. WFT and *O. niger* significantly and regularly distributed over the fruiting parts ($P<0.05$). Thrips and *Orius* peaked in the flowers in mid- or late-May, where plants had low numbers of flowers. Numbers of *Orius* spp. significantly related to numbers of adult or larval thrips in the flowers ($P<0.05$). Numbers of WFT in flowers were much greater at the presence of low population density of *Orius* in 2008. While the lowest *Orius* spp.:thrips ratio in flowers was 1:319 and highest was 1:24 in 2007, the lowest predator:prey ratio was 1:2571 and the highest was 1:233 in 2008. WFT appeared to be not economically important pest even the highest density level of thrips with 24 individuals per flower and with 2 larvae per fruit caused damage of slight discolorations to the flowers and slight scarring to the unripe or ripe fruits in late-May in 2008. This study suggests that the *O. niger* could be a potential candidate for biological control of thrips in strawberry in the Mediterranean region of Turkey.

Key Words: *Frankliniella occidentalis*; *Orius niger*; Abundance; Strawberry; Distribution; Biological control

INTRODUCTION

Turkey has fourth rank in production of the strawberry crop among the European countries (Anonymous, 2004). Marmara, Aegean and Mediterranean region of Turkey are known to be important strawberry production regions. Mersin province located in the eastern Mediterranean region of Turkey is an important area of strawberry production.

Western flower thrips (WFT), *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) is a serious pest thrips species infesting a wide range of arable crops worldwide (Lewis, 1997). This thrips is often considered as a major pest thrips of strawberries grown in protected areas and open fields in some countries (Allen & Gaede, 1963; Argaman *et al*., 1989; Tommasini & Maini, 1995; Linder *et al*., 1998; Steiner, 2003). WFT causes damages of flower abortion, fruit bronzing, and fruit deformations in strawberries. This is more likely due to flowers providing essential resources of nectars and pollens (Trichilo & Leigh, 1988) and mating site for thrips (Rosenheim *et al*., 1990). Several species of thrips are known to be pest damaging strawberry, while others have been associated with the crop but not considered as a pest in strawberry crop.

Western flower thrips, which was recorded for the first time in Turkey in 1993 (Tunç & Göçmen, 2004), has been recently reported to be dominant species in strawberries in the eastern Mediterranean region of Turkey (Atakan, 2008a). This thrips was not recognized as a pest of strawberry in the southeastern Mediterranean region of Turkey (Şekeroğlu *et al*., 1999).

The extent of *F. occidentalis* damage to strawberry is not clearly understood in our region, as various studies have reported contradictory findings. Strawberry growers in our region have widely used pesticides against WFT. In general, chemical control of thrips is difficult, because of their wide geographical distribution, high reproductive capacity and dispersal rates as well as their wide host range (German *et al*., 1992) and their ability to feed on flowers, buds and other organs. Additionally, the inability of insecticides to reach criptic stages of *F. occidentalis* reduce the further efficacy of pesticides (i.e., eggs in the plant tissues & pre-adult stages, pre-pupae & pupae in the soil or in protected places) (Immaraju *et al*., 1992). Control of arthropods with based-

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chemicals often creates some problems. Problems due to widespread use of chemical pesticides encourage use of biological control agents such as predators in controlling of the pest arthropods in arable crops. Therefore, alternative, non-chemical control strategies such as biological control of pest thrips are crucial in thrips pest management in diverse crops including strawberry. Although, polyphagous habits of anthocorid predators, *Orius* species (Hemiptera: Anthocoridae) are well-known, they are often considered as important natural enemy of the thrips (Riudavets, 1995). *Orius niger* (Wolff) that is a palaearctic species (Riudavets, 1995), has been recorded with the pestiferous thrips in cotton (Atakan 2006), various vegetables (Atakan, 2008b) and in fruit orchards (Atakan, 2008c) in the region. *Orius* species in Israel (Shouster *et al*., 2003; Shakya *et al*., 2008) and *O. laevigatus* (Fieber) in Portucal (Frescata & Mexia, 1996) have been recorded together with WFT in strawberry fields. *O. niger* is a major predator of the onion thrips on potato in the Ardabil province, Iran (Fathi *et al*., 2008). Although there are many published papers associated with interactions between thrips and *Orius* populations in various crops, knowledge about prey-predator interactions between WFT and *Orius* and in strawberry in the region is rudimentary.

Standardized sampling protocols are important elements for pest management decision-making (Pedigo, 1988). A sampling technique that allows quick and accurate estimates of the density of pest arthropod populations is critical in evaluating pest abundance against established economic thresholds. The distribution of the WFT and its predatory bug, *O. niger* within strawberry in Turkey or other countries is not well-known. However, within plant distribution characteristcis of WFT in strawberry fields in Australia has been documented by Steiner and Goodwin (2005). Many factors, such as soil moisture, fertility, natural enemies, weather, crop age and within plant variations in micro-climate, nutritional value, plant defences and physical factors can affect the abundance and distribution of insects within-plant canopies (Pedigo *et al*., 1986; Davis, 1994). Knowledge about distribution characteristics of WFT within strawberry plants may allow us to develop a sampling protocol for proper estimation of population levels. Knowing of distributions of both WFT and *O. niger* within strawberry in the region may also allow us to understand predatory ability of the *O. niger* on the various plant parts.

Main objectives of this study were to determine (1) predatory insect species, (2) to determine spatial distributions of *F. occidentalis* and *Orius* spp. (within & between plants), (3) to assess the population fluctuations of both WFT and *Orius* spp. in the flowers.

MATERIALS AND METHODS

Experimental procedures: The field experiments were carried out to assess thrips-*Orius* interactions in the flowers and their plant distributions on cv. Camarosa grown in the strawberry production area of the Yalex Company in Adana province, located at eastern Mediterranean region of Turkey, in years 2007-2008. Experimental area was 0.2 ha. No any chemical pesticide was applied to strawberry plots in the experimental area throughout the sampling periods.

Sampling of insects in flowers: To determine abundance of thrips and predators in the flowers, a total of 60 flowers were sampled on each sampling date. Each of three flowers was picked into one plastic tube (50 mL). Flowers samples in individual tubes were stored in the ice-chest and carried out the laboratory for further processing. For extraction of insects, plant parts were submerged in 2% detergent solution and agitated for 25 sec. The solutions were then poured through a standard testing sieve No. 80 (180 μm). Thrips and predators extracted from solution were transferred into small vials containing 60% ethanol for subsequent processing. Each empty bag was rinsed two times in the same way. Thrips were mounted on microscopic slides, qualified and identified to species. Adults of thrips and predators were counted under the steromicroscope with x 45 magnifications, while immature thrips (thrips larvae) or nymphs of the *Orius* specimens were pooled into a single category, because no comprehensive keys are available for their identification.

Within-plant distributions of western flower thrips and *Orius niger*: To determine distributions of adult and larval thrips and *O. niger* on various plant parts of strawberries, fresh and fully opened flowers, young green fruits and mature fruits were sampled for 5 days on 21 May–4 June in 2008. From 25 plants randomly selected, one flower or fruit from each plant was taken on each sampling date. Fruits and flowers were picked into bags and stored in the ice-chest. Thrips were washed out in the laboratory to determine mean larval and adult populations. Collected thrips were exposed to same processes.

Distribution characteristics of western flower thrips and *Orius niger*: Distribution patterns of both WFT on various plant parts and *O. niger* adults in flowers were explored using Taylor's power law (TPL). Taylor's power law parameter, $Log_{10}(s^2) = log(a) + b\ log(m)$, where the intercept a is a sampling constant and slope b is an aggregation index characteristic for species and host (Taylor, 1961). Estimates of a and b were obtained by regressing variance (s^2) on mean (m) using the logarithmic transformation of both s^2 and m. According to this model, distributions can be broadly classed as regular (b <1), random (b =1) or aggregated (b >1) (Southwood, 1978). Spatial distribution patterns of *O. niger* adults on various plant parts including flowers in May-June period in 2008 were not evaluated, because no *Orius* was found on the fruiting parts or its numbers were low during the sampling dates.

Insect identification: Thrips species were identified by the author. *Orius* spp. were identified by using the key descriptions (Önder, 1982; Tommasini, 2004). Other predators collected were identified by using the reference

material deposited at the Entomology Laboratory of the Plant Protection Department, Faculty of Agriculture, University of Çukurova, Adana-Turkey. Representative adult thrips were slide-mounted for identification.

Statistical analysis: Effects of plant parts on the abundance of adult and larval thrips and *Orius* spp. were analyzed using a general linear model (GLM) at P<0.05. Means were separated by Tukey's honest test at P<0.05. Relationships between the numbers of *Orius* and *F. occidentalis* in the flowers were evaluated by the quadratic regression analysis at P<0.05. All analyses were performed by using the Microsoft statistical program SPSS 15.0. (SPSS, 2006).

RESULTS

Thrips and predatory insect species in flowers: A total of 14 thysanopteran species were recorded during 2007-2008 and were listed with their abundance (Atakan 2008a). Major species belonged to the family Thripidae; representatives of Aeolothripidae and Phlaeothripidae were relatively less common in the flowers of the strawberry crop. The most notable species were descending order *F. occidentalis* (Pergande), *Frankliniella intonsa* (Trybom) and *Thrips tabaci* Lindeman consisting 96.95, 2.14 and 1% of the total adult population, respectively. Other thrips species namely: *Aeolothrips collaris* Priesner, *A. intermedius* Bagnall, *Neohydathothrips gracilicornis* (Williams), *Haplothrips aculeatus* (Fabricious), *H. reuteri* Karny, *H. hispanicus* Priesner, *H. gowdeyi* (Franklin), *Melanthrips fuscus* (Sulzer) and *M. pallidior* Priesner were occasionally found during the samplings and their proportions in the total adult individuals were varied from 0.01 to 0.07%. On the other hand, they accounted for 2% of the adult population.

While *T. tabaci* was the more common in the flowers in March, *F. occidentalis* was the most abundant thrips species accounting for over 80% of the total adult individuals on the most sampling dates in both years (Fig. 1). First adult female of the *F. intonsa* was encountered in the first week of April or in late-March (Fig. 1). Proportions of *F. intonsa* ranged between 1 and 5% throughout the sampling dates in both years. Majority of the *Haplothrips* species appeared in the flowers in late-May or early June.

Most of the predatory insect species were found in the flowers. Generalist predatory bug, *O. niger* (Wolff) was the most common in the flowers, consisting nearly 80% of the total adult predaceous insects (Table I). *Chrysoperla* carnea (Stephens) was the second most common predatory insect species, with accounting for 12% of the total predator population. Other predators listed 1n Table I were occasionally found and their numbers were few during the samplings in both years.

Within-plant distributions of western flower thrips and *Orius niger*: Plant parts affected significantly abundance of both thrips and predators (P<0.001). Interactions between plant parts and insect species were statistically meaningful (P<0.001). Populations of larvae and adult *F. occidentalis* in the flowers were significantly more abundant than those found on green fruits (unripe fruits) and red fruits (ripe fruits) in 2008 (P<0.001; Table II). Seasonal mean numbers of thrips larvae or thrips adults on the green and the red fruits were similar. Individuals of *O. niger* were detected only in the flowers during the sampling course (Table II).

Variance-mean relationship: Taylor's power law regression indicated a significant relationship between the variance and mean for thrips and *Orius* (Table III). Larvae and adults of WFT uniformly distributed over the flowers during 2007-2008 (Table III). Similarly, *O. niger* showed a regular distribution pattern in the flowers in both years (Table III). The TPL regression of the adult and larval thrips data showed a strong positive relationship between Log_{10} variance and Log_{10} mean for the flowers (adult thrips in 2007: R^2=0.90, P<0.001; in 2008: R^2=0.97, P<0.001; larval thrips in 2007: R^2=0.76, P<0.001; in 2008: R^2=0.97, P<0.001). There was a positive relationship between Log_{10} variance and Log_{10} mean for *O. niger* in the flowers (in 2007: R^2=0.94, P<0.001; in 2008: R^2=0.98, P<0.001).

Analysis of variance-mean relationship was done for larval and adult WFT for flowers, green and red fruits in May-June in 2008. Taylor's power law regression indicated a significant relationship between the variance and mean for adult and larval thrips (Table IV). Adult WFT significantly regularly distributed over the flowers (Table IV). There were regular distribution patterns for larval thrips for all three plant parts (Table IV). The TPL regression of the adult thrips data showed a strong and positive relationship between Log_{10} variance and Log_{10} mean for flowers (R^2=0.97, P<0.05), green fruits (R^2=0.99, P < 0.001) and for red fruits (R^2=0.94, P<0.001). There were strong positive relationships between Log_{10} variance and Log_{10} mean for larval thrips in flowers (R^2=0.88, P<0.05), on green fruits (R^2=0.98, P<0.001) and red fruits (R^2=0.90, P<0.05).

Population fluctuations of western flower thrips and *Orius* spp. in flowers: According to the climatic factors [i.e., min, max & average temperature (^oC) and relative humidity (%)], population fluctuations of WFT and *Orius* spp. (nymphs + adults) in the flowers in 2007 and 2008 are shown in Fig. 2. In 2007, adult and larval WFT reached their peak densities (37.3 adults & 9.13 larvae per 3 flowers, respectively) on 15 May, two weeks before the peak density level of the *Orius* spp. (mainly *O. niger*) (Fig. 2b). Average temperature and average relative humidity (RH) were 23.75^oC and 66.50%, respectively when population density of WFT peaked in the flowers (Fig. 2a). Population density of *Orius* was the highest with 0.55 individual per 3 flowers on 29 May, where population densities of both larval and thrips were steadily low. Population density of the predator was negatively related to densities of thrips larvae and to adult thrips in this year (Fig. 3a; Table V; P<0.05). High predator:prey ratios were recorded towards end of the sampling period in 2007 (data not shown). In this year, the lowest predator-prey ratio was 1:319 and highest was 1:24.

Table I: Total numbers of predatory insect species collected from strawberry flowers in Adana province, Turkey in 2007 and 2008

Predatory insects [Order/Family]	Year 2007	Year 2008	Total no	Percent
Orius niger (Wolff) [Hemiptera/Anthocoridae]	90	15	105	78
Orius laevigatus (Fieber) [Hemiptera/Anthocoridae]	5	0	5	4
Orius majusculus (Reuter) [Hemiptera/Anthocoridae]	1	0	1	1
Piocoris erythrocephalus (P.-S.) [Hemiptera/Lygaeidae]	1	0	1	1
Deraeocoris pallens Reuter [Hemiptera/Miridae]	4	0	4	3
Chrysoperla carnea (Stephens) [Neuroptera/Chrysopidae]	5	12	17	13
Total no	106	27	133	100

Table II: Seasonal total and mean numbers of western flower thrips and *Orius niger* on various parts of strawberry plants in Adana province, Turkey in 2008

Plant parts	Thrips adult		Thrips larvae		*Orius niger* adult	
	Total no	Per sample [a]	Total no	Per sample	Total no	Per sample
Flowers	1513	54.88±3.12a	116	13.04±0.74a	19	0.13±0.02a
Green fruits	40	3.04±0.46b	94	4.92±0.04b	0	0.00±0.00b
Red fruits	83	1.60±0.29b	136	2.92±0.08b	0	0.00±0.00b
	F=274.145 df=2, 72, P<0.001		F=20.911, df=2, 72, P<0.001		F=19.385, df=2,72, P<0.001	

[a] Means (±SEM) represented by same letter within the column are not statistically different by the Tukey's honest test (P<0.05)

Table III: Regression statistics and parameter estimates for Taylor's power law and range of population densities of western flower thrips and *Orius niger* in flowers of strawberry in Adana province, Turkey in 2007 and 2008

Years	Insects	*Log* (*a*)	*b* [a]		R^2	df	F	P	Range of densities/per 3 flowers
2007	Thrips adult	0.0446	0.6201	REG	0.92	1,11	133.062	0.0001	1.65-37.30
	Thrips larvae	0.5263	0.4254	REG	0.23	1,11	3.283	0.097	0.10-9.15
	Orius niger adult	0.0332	0.9831	REG	0.94	1,11	140.901	0.0001	0.17-0.55
2008	Thrips adult	-0.1957	0.4727	REG	0.99	1,11	1144.806	0.0001	0.06-53.81
	Thrips larvae	-0.4723	0.8766	REG	0,94	1,11	198.784	0.0001	0.02-18.50
	Orius niger adult	-[b]	-		-	-	-	-	0.01-0.12

[a] Regular distribution, *b* significantly < 1; student t-test (P<0.05)
[(-)b] Regression statistic was not calculated for *Orius niger* in 2008, due to its very low numbers detected in flowers

Table IV: Regression statistics and parameter estimates for Taylor's power law and range of population densities of western flower thrips on various plant parts of strawberry in Adana province, Turkey in 2008

Plant parts	Thrips stages	*Log* (*a*)	*b* [a]		R^2	df	F	P	Range of densities/per plant part
Flowers	Adult	0.3045	0.8028	REG	0.97	1,4	104.62	0.002	4.03-22.48
	Larvae	-0.2208	0.7076	REG	0.88	1,4	23.30	0.017	0.07-1.27
Green fruits	Adult	0.1348	0.9298	REG	0.99	1,4	327.85	0.0001	0.09-0.51
	Larvae	-0.2464	0.7026	REG	0.98	1,4	161.01	0.001	0.12-2.00
Red fruits	Adult	-0.2070	0.8496	REG	0.94	1,4	52.95	0.005	0.06-1.45
	Larvae	-0.2936	0.5912	REG	0.90	1,4	28.44	0.013	0.12-2.24

[a] Regular distribution, *b* significantly < 1; student t-test (P<0.05)

Table V: Relationships between *Orius* spp. (nymphs + adults) and western flower thrips in strawberry flowers in Adana province, Turkey in 2007 and 2008

Years	Associations	R^2	df	F	P	Equations
2007	*Orius* spp.-thrips adult	0.67	2, 10	10. 151	0.004	$Y = -233.14x^2 + 148.24x + 1.875$
	Orius spp.-thrips larvae	0.33	2, 10	2.444	0.137	$Y = -43.876x^2 + 26.081x + 0.4516$
2008	*Orius* spp.-thrips aldult	0.74	2, 10	14.591	0.001	$Y = 213.27x^2 + 386.81x + 3.9757$
	Orius spp.-thrips larvae	0.71	2, 10	12.850	0.002	$Y = 1164.8x^2 – 4.151x + 1.4408$

Population density levels of adult and larval thrips in flowers in 2008 were much greater than those found in previous year. Both adult and larval WFT attained their peak densities with 53.81 and 18.15 individuals per 3 flowers, respectively on 26 May. Average temperature and average RH in 2008 were 22.01°C and 63.81%, respectively (Fig. 2a). *Orius* individuals appeared on the flowers after four weeks of the thrips infestations in 2008. Abundance of *Orius* spp. in the flowers on the most sampling dates was lower in 2008 than those obtained in 2007. *Orius* density was the highest with 0.15 *Orius* per 3 flowers when adult and larval thrips populations peaked in the flowers. By the 12th week, WFT density declined to mean number of 30.53 per 3 flowers, whereas that of the predatory bug was negligible. However, there was a positive relationship between numbers of *Orius* spp. and adult or larval thrips in

2008 (Fig. 3b; Table V; P<0.05). The predator:thrips ratios in the flowers on the most sampling weeks in 2008 were lower than those found in previous year. In 2008, the lowest predator:prey ratio was 1:2571 and the highest was 1:233.

Most of *Orius* nymphs, probably belonging to *O. niger* were detected in mid-May in 2007 and nymphs outnumbered adults by 1.5-or 3-fold in May (data not shown). In 2008, numbers of the *Orius* nymphs were very few through the sampling periods. We noted that plants had relatively low numbers of flowers when numbers of both thrips and *Orius* in abundance peaked in the flowers in May in both years.

Thrips damage: No considerable visible damage, due to thrips feedings, appeared on the flowers or on fruits even at the presence of the highest density of WFT (larvae + adults) with 15 individuals per flower on 11 May 2007, but the damage to the flowers was typical with slight discolorations, necrotic spots on the petals and anthers, after WFT attained the highest density level with 24 individuals per flower in late-May in 2008. Moreover, damage of slight bronzing and scarring to beneath the calyxes of green and red fruits were also detected, when the highest mean number of larval WFT was 2 individuals per fruit in that time. However, degree of the thrips damage to strawberries (i.e., yield & marketing value) is not yet clearly known in the region and also in other parts of Turkey.

DISCUSSION

Western flower thrips was the main thrips species dominating the thrips populations. *T. tabaci* and *F. intonsa* were less common thrips species in the strawberry flowers in our study. However, *F. intonsa*, *T. tabaci* and *T. major* Uzel have been reported as thrips species damaging strawberries in United Kingdom (Buxton & Easterbrook, 1988; Easterbrook, 1991). Dominancy of the WFT in the strawberry plants may be due to its high reproductive rate, wide geographic distributions, wide host plant range including wilt plant species and to high tolerance to cold (Kirk & Terry, 2003).

Orius niger dominated the predatory insect species dwelling the flowers throughout the samplings (Table I). This may be due to year-round availability of its thrips prey on various vegetables, fruit crops (Atakan, 2008b, c) and on weeds (Atakan & Tunç, 2010) in the region. *O. niger* and *O. laevigatus* are common anthocorid insects in the Mediterranean countries. However, the predominance of any of these species may depend on the location. For instance in Italy, *O. niger* was the most common in northwest, while *O. laevigatus* predominated in the warmest locations of the country (Tavella *et al*., 1991, 2000).

Majority of the adult thrips and predatory insects were found in the flowers. Comparatively low numbers of the WFT were recorded on the other plant parts (Table II). Our results are agree with the findings of Steiner and Goodwin (2005) in Australian strawberry fields. They suggest that

Fig. 1: Percentage of *Frankliniella occidendalis*, *Frankliniella intonsa* and *Thrips tabaci* in strawberry flowers in Adana province, Turkey during (a) 2007 and (b) 2008

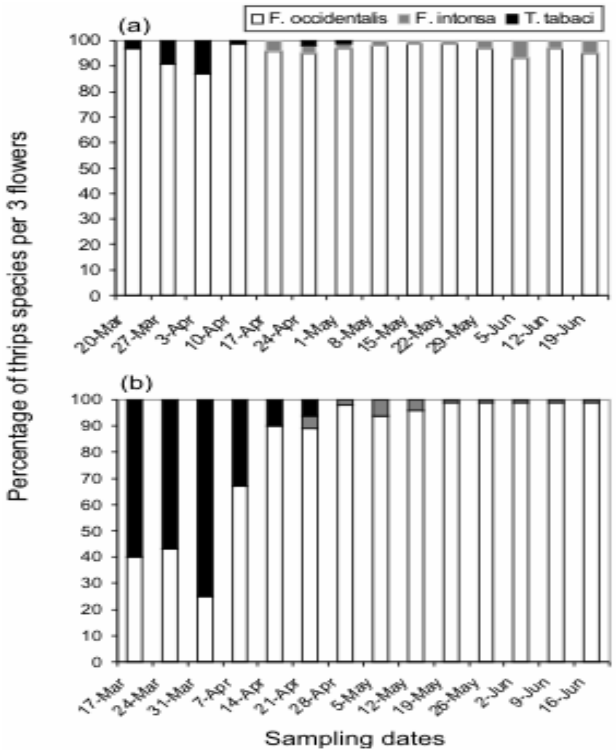
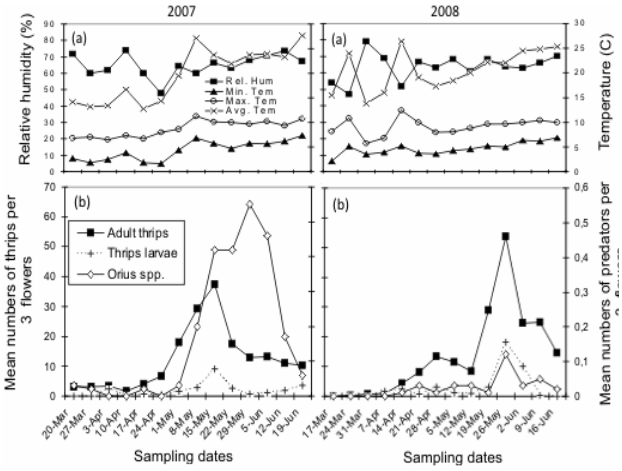
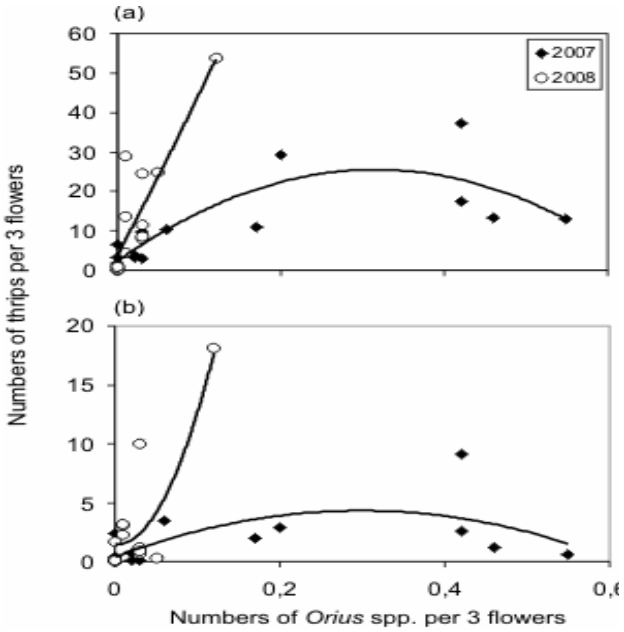


Fig. 2: According to (a) climatic conditions, (b) population fluctuations of western flower thrips and of *Orius* spp. (adults + nymphs) in strawberry flowers in Adana province, Turkey during 2007 and 2008



when flowers are scarce, alternative sampling sites are young green and red fruits. Nymphs and adults of *Orius* spp. (mainly *O. niger*) were found mostly in the flowers. Therefore, these results may indicate that WFT individuals in the flowers could be suffered more by the predation of *Orius*.

Fig. 3: Relationships between (a) *Orius* spp. (nymphs + adults) and adults of western flower thrips, and (b) *Orius* spp. and larvae of western flower thrips in strawberry flowers in Adana province, Turkey during 2007 and 2008



In the present study, adult and larval thrips regularly distributed over the flowers and the fruits (Table III & IV). In contrast to current study, adults and larvae of the WFT significantly aggregated in the strawberry flowers (Koninckx & Ramon, 1992; Linder *et al*., 2000; Steiner & Goodwin, 2005) and on the strawberry fruits (Steiner & Goodwin, 2005). This difference is probably due to different ecological factors occurred in each geographic area and to different sampling procedures (e.g., different sample size) performed for WFT. *O. niger* adults showed a regular distribution pattern in the flowers (Table III). However, various spatial distribution patterns for different *Orius* species have been described for different arable crops. Uniform distributions obtained in the present study would require fewer samples, due to small variances relative to the mean, whereas very aggregated or patchy distibutions require more samples due to larger variances relative to the mean.

Seasonal trends in population fluctuations of WFT and its predatory insects (*Orius* spp.) in 2007 and in 2008 were usually similar but their density levels were clearly different (Fig. 2b). Numbers of thrips in abundance in the flowers in 2008 were much greater but numbers of *Orius* spp. were lower during the samplings, compared to those found in 2007. Climactic factors were usually similar in both experimental years (Fig. 2a). A reason of presence of the greater abundance of thrips in the flowers in 2008 may be due to presence of the lower abundance of *Orius* throughout the sampling dates. *Orius*:thrips ratios obtained on the most sampling dates in 2008 were lower than those found in 2007. In 2007, predator:thrips ratios on the most sampling dates were greater than 1:217 for which Sabelis and van Rijn (1997) indicated as the critical capacity ratio for *Orius insidiosus* (Say) to effectively suppress the populations of WFT in arable crops. Lower abundance of WFT through the growing season in 2007 may attributable to the predatory efficiency of the *Orius*. Findings of the present study are agree with the findings of Coll *et al.* (2005), who they concluded that *O. niger* and *Orius albidipennis* (Reuter) were the dominant predatory bugs of the WFT and these bugs became well established in Israeli strawberry fields in April and appeared to suppress WFT populations at that time. *O. niger* also effectively controlled the *Frankliniella* flower thrips in the unsprayed cotton fields in same ecological area (Atakan, 2006). In the present study, *Orius* successfully produced the nymphs and numbers of the *Orius* nymphs outnumbered the numbers of adults on the most sampling dates in May in 2007. This result may indicate that *Orius* individuals enjoy preying upon the thrips individuals in the strawberry flowers in the region. If the predator-prey ratio observed overtime can serve as a reliable predator effectiveness, this study suggests that *O. niger* could be a promising biological control agent in suppressing populations of the pest thrips in unsprayed strawberry fields in our region.

In conclusion, WFT is the main thrips species in strawberry crops cultivated in the southeastern Mediterranean region of Turkey. However, WFT appeared to be not economically important pest of strawberry even they cause occurrence of the late-season damage to the fruiting parts in the late-season. However, it would be better to plan a further research for determination of degree of thrips damage to strawberries in the region. This study also suggests that *O. niger* could be a potential candidate for biological control of thrips in strawberries in the Mediterranean region.

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