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Adult population fluctuation of Oriental fruit moth, *Grapholita molesta* (Lep.: Tortricidae), in peach orchards of Çanakkale, Turkey

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Abstract

The study was conducted in eight different peach orchards in Central, Lapseki and Bayramiç districts of Çanakkale province. The adult population change of Oriental fruit moth, *Grapholita molesta* Busck, was studied using pheromone traps. The species *G. molesta* was abundant in all sampling orchards between 2008 and 2009. The emergence of adults started from middle of April through November in both years. There was positive correlation between daily average temperature and the number of adults caught in the traps. Four to five flight periods were observed, throughout the season, in April, June, July, August and October. The adult population development curves suggest that the pest has four to five generations per year depending on the daily temperatures in early spring. We concluded that late cultivars would be more vulnerable to the pest because of the high number of adult moths in August and September.

Key words: peach, Oriental fruit moth, *Grapholita molesta*, population development, Turkey

چکیده

نوسانات جمعیت حشرات کامل شب‌پره میوه شرقی، *Grapholita molesta* (Lep.: Tortricidae)، در باغ‌های هلو در چاناق‌قلعه، ترکیه

علی ازپینار، ایلکه ازبک و علی کورشت شاهین

این تحقیق در هشت باغ هلوی مختلف در بخش‌های Central، Lapseki و Bayramiç استان Çanakkale انجام شد. تغییرات جمعیت حشرات کامل شب‌پره میوه شرقی، *Grapholita molesta* Busck، با استفاده از تله‌های فرمونی بررسی شد. این شب‌پره در سال‌های ۲۰۰۸ و ۲۰۰۹ در تمام باغ‌هایی که نمونه‌برداری صورت گرفت، به فراوانی وجود داشت. در هر دو سال، ظهور حشرات کامل از اواسط آوریل شروع شد و تا نوامبر ادامه یافت. همبستگی مثبتی بین متوسط دمای روزانه و تعداد حشرات کامل شکارشده در تله‌ها وجود داشت. در طول فصل، چهار تا پنج دوره پروازی در ماه‌های آوریل، ژوئن، جولای، اوت و اکتبر مشاهده شد. براساس منحنی‌های رشد و نمو جمعیت حشرات کامل، بسته به دماهای روزانه در اوایل بهار، این آفت چهار تا پنج نسل در سال دارد. نتیجه‌گیری می‌شود که به‌دلیل تعداد زیاد شب‌پره‌ها در ماه‌های اوت و سپتامبر، ارقام دیررس نسبت به این افت آسیب‌پذیرتر خواهند بود.

واژگان کلیدی: هلو، شب‌پره میوه شرقی، *Grapholita molesta*، رشد ونمو جمعیت، ترکیه

Introduction

Peach is one of the most important stone fruits in Turkey after apricot. Turkey is one of the top six countries in the world by producing about 546 tons of peach per year (Anonymous, 2011a). Çanakkale province contributes significantly to economy by producing 48 tons of peach for domestic consumption and export (Anonymous, 2011b). Peach production mostly occurs in Lapseki, Bayramiç and Central districts with respectively production rates of 74%, 10% and 14% of the total production of Çanakkale province.

Loss of peach production, due to diseases and pests, is estimated at the rates of 50 - 60% (Kılıç *et al*., 2001). One of the most destructive pests of peach is Oriental fruit moth (OFM), *Grapholita molesta* Busck, (Lep.: Tortricidae), which is also a key pest in China, Italy, Hungary, Bulgaria and Brazil (Cravedi, 2000; Arioli *et al.*, 2005; Choi *et al.*, 2008; Ivanova *et al.*, 2008; Hari & Penzes, 2010) where its larvae damage to the shoots and fruits of peach (Tomse *et al.*, 2004; Hazır, 2008; Poltronieri *et al.*, 2008). The existence of the pest has been widely recorded in all peach-producing areas of Çanakkale province (Ergüden *et al.*, 1999; Özpınar *et al.*, 2009). The larvae of OFM also attack other fruits including apricot, apple, pear, quince and plum (Reis *et al.*, 1988; Hickel *et al.*, 2003; Arioli *et al.*, 2005; Anonymous, 2008). Recent expansion of orchards has led to a sharp increase in the population of *G. molesta* in Çanakkale province. Gençsoylu *et al.* (2006), Hantaş & Çetin (2006), Hazır (2008) and Kovanci *et al*. (2009) investigated the control methods of the pest in Turkey. Majority of Çanakkale's peach farmers prefer to use synthetic pesticides as an

effective and economic method against the OFM, although lack of knowledge about the biology of the pest usually causes unnecessary or untimely applications of pesticides that lowers the efficiency of the control program and leaves excessive chemical residue on fruits (Cravedi, 2000; Il'ichev *et al.*, 2004).

This study was aimed at determining the flight periods and changes in the population of the OFM, in Çanakkale.

Materials and methods

The peach orchards of Lapseki, Bayramiç and Central districts of Çanakkale province were selected for their ecological and geographical situations during 2008-2009. According to Özbek *et al.* (2008) the size of 37% of the peach orchards in Çanakkale is less than 2.5 acres. We chose five orchards in Central district, with various ecological properties, three ecologically similar orchards in Lapseki district, and one orchard in Bayramic district (table 1). The orchards in Central and Lapseki districts were near seashore, while the orchard in Bayramic was located inland. Pheromone traps were placed on branches at height of 1.5-2.0 m above the ground. Pheromone traps were installed in the orchards of Central district on 7th of March and in Lapseki and Bayramiç on 15th of March. The pheromone traps were "Pherocon" Delta VI type with lures containing Z-8-Dodecenly acetate 0.10 mg/lure manufactured by Trece Inc.

We used one trap for orchards smaller than 1.25 acres and two traps for orchards bigger than 1.25 acres according to Anonymous (2011c). The traps were checked twice a week and pheromone lures replaced every four weeks. In orchards with two traps, the number of adults was calculated as the average of the traps per week.

All orchards were commercially maintained, being run by IPM programs except the collection orchard in Dardanos (in Central district) which contained Glohaven, Early Red, J. H. Hale, Blake, Cresthaven, Dixired and Redhaven cultivars and was free of insecticides for two years. The IPM applications in the commercial orchards were based on the Peach IPM Program executed by the government. Climate Data was obtained from the climate stations in Kepez orchard of Central district, in Sacaklı village of Bayramic district and in Umurbey orchard of Lapseki district. Humidity data was not evaluated because it went beyond the threshold stated by Anonymous (2009). The selected orchards were located close to other orchards containing different cultivars of peach and nectarine. Phenological observations were made according to the early cultivars.

Results and discussion

During the years 2008-2009 adult flight pattern and population growth rate of *G. molesta* was investigated. The results for Dardanos and Kepez orchards were given in fig. 1.

Mean temperature was 13 °C and first adult flight was recorded in Dardanos on 14 March, 2008. First peak point was on 22 April with 98 individuals, which was followed by other peak points on 12 June (28 adults), 19 August (38 adults) and 4 November (45 adults). The last adult was captured on 29 November. Total of four peak points were determined for Dardanos in 2008. In the second year, no adults were collected because the daily mean temperature was lower than 10 °C between 7-29 March. First adults were captured on 31 March when temperature rose to 12.60-14.99 °C. There were four peak points on 12 May (21 adults), 12 June (19 adults), 4 August (21 adults) and 4 September (12 adults). Our records show that flight started earlier in 2008 with a higher population. There was a negative correlation between average temperature and the number of adults in traps in Kepez in 2008 (r = -0.19) and a positive correlation in 2009 (r = 0.17).

First adult flight in Kepez was determined on 14 March, 2008 with the rise of the daily mean temperature to 15-16 °C. The first peak point was found with 41 adults on 22 April. Density of the pest was low in May and the adult numbers increased to 26 in June and to 85 adults in July, which was the 2nd peak

point. This orchard contained mid-early peach cultivars. The adult numbers decreased and their flight period ended in October because of two insecticide applications on 2 June and 12 July. In the 2nd year of the study, the flight period started on 31 March and first peak point was found on 16 April with 14 adults. Other peak points were recorded on 23 June with 32 adults, 20 July with 37 and 25 August with 99 adults. There were a total of four peak points in 2009. The flight period ended in October, after 2 insecticide applications on 5 June and 20 July. Population development curves and flight pattern curves were found to be similar in both years. The correlation between average temperature and number of adults in traps were positive in both years as r = 0.62 in 2008 and r = 0.31 in 2009.

In the peach orchard of Saraycık village, first flight was recorded on 24 March, 2008. Adult numbers rose to 135 on 22 April and ended on 5 June. The flight period restarted on 19 June and reached to 40 adults. Adult number remained at the same level throughout June and increased slightly (42 adults) on 19 August. Flight decreased by September, but another peak point was recorded on 4 November with 36 adults. First flight started on 31 March, 2009 and first peak point was on 27 April with 31 adults. Second peak point was on 30 June with 60 adults and third peak point was on 25 August with 74 adults. Adult numbers were low through September and flight ended on 18 November. Pest density was high at the beginning of the season in the first year and in June and August in the second year. In this orchard, which contained mid-early and late cultivars, there was one insecticide application in June and July and two applications in August, 2008. In 2009, there was one insecticide application in June and July. There was positive correlation between average temperature and the number of adults in traps in 2008 (r = 0.17) and in 2009 (r = 0.34).

In the peach orchard of Halileli village, first flight was recorded on 14 March, 2008 (fig. 2). Four peak points were recorded on 22 April, 30 June, 26 August and 4 November with 42, 15, 16 and 23 adults, respectively. In the second year, first adults were captured on 31 March and the peak points were on 27 April, 26 June, 20 July and 31 August with 56, 26, 19 and 35 adults, respectively. In the first year of the study, three insecticide applications were recorded on 19 March, 11 July and 4 August but there were no applications in the second year when the pest population was higher. The correlation between average temperature and number of adults in traps was positive for both years as r = 0.51 in 2008 and r = 0.15 in 2009.

In Umurbey orchard of Lapseki district, flight started on 1 April 2008 and reached 46 adults on 24 April. Flight reached peak points with 25 adults on 16 June, 24 adults on 14 June and 80 adults on 18 August (fig. 3). Flight decreased throughout September and increased slightly on 14 October (13 adults) and ended in the middle of November. In the second year of the study, flight started late March and reached to peak points on 27 April,, 12 July, 24 July and 28 August with 14, 43, 52 and 72 adults, respectively. Insecticides were used in this orchard of mid-early cultivars on 24 June and on 21 July 2008 and 15 July and 23 July 2009. The increase of the pest density at the end of the season was due to migration of adults from nearby apple and quince orchards. The correlation between average temperature and number of adults in traps was positive for both years as r = 0.58.

In Yeniceköy, first flight was recorded on 17 March 2008 and first peak point occurred on 14 April with 69 adults (fig. 3). Adult numbers decreased in the beginning of May and reached to the second peak point on 16 June with 54 adults. Two additional peaks were recorded on 7 July (54 adults) and on 18 August (120 adults). Flight reached to 17 on 14 September and ended on 4 October. In the following year, flight started on 31 March. First peak point was on 27 April (87 adults), which was followed by the second peak on 12 June (64 adults) and the third peak was on 4 September with the highest number of the captured adults (113) in the year. In this orchard, which is a mixed orchard of peach and apple, insecticides were

applied at the beginning of June and at the end of July. There was positive correlation between average temperature and number of adults in traps in 2008 (r = 0.53) and in 2009 (r = 0.04).

In Çardak, flight started on 1 April 2008 and first peak was on 14 April with 44 adults, which ended on 12 May (fig. 4). Later, flight started with lower numbers. Peak points were on 9 June (22 adults), 7 July (69 adults) and 18 August (133 adults). Adults were captured in the trap throughout September and October and flight ended in early November. Thus there were 4 flight periods throughout the year. In the following year, flight started on 31 March and reached to 30 adults on 15 May. At the end of May adult numbers increased again and reached to 58 adults on 12 June, while the flight continued through August. A total of 170 adults were captured on 4 September and flight ended in November. There were two insecticide applications in 2008 on 15 June and 15 July, and in 2009 on 20 June and 18 July. The reason for the increase of adults in September was likely for the migration of insects from nearby orchards. The correlation between average temperature and number of adults in traps was positive for both years as r = 0.59 in 2008 and r = 0.42 in 2009.

In Ahmetçeli village, in the first year of the study, flight started on 24 March and the first peak point was on 17 April with 98 recorded adults (fig. 4). On 5 June (32 adults) and 10 July (41 adults) two more peaks were recorded. Flight ended on 24 October. In 2009, first adults were captured on 24 April and a peak occurred on 30 April with 73 adults. Throughout the season there were two more peaks with 22 adults on 11 June and 208 adults on 27 August. Adult numbers decreased and ended in November. In both years, the flight pattern was similar at the beginning of the season in this orchard. In 2009, the pest density was higher than as the season was nearing to end. Even though the pest population was high at the beginning of the season, the early cultivar Early Red was not affected. There were four insecticide applications in 2008 and two applications in 2009. There was positive correlation between average temperature and number of adults in traps in 2008 (r = 0.58) and in 2009 (r = 0.14).

Although the population of the pest changes in different orchards, flight started 15 days earlier in 2008, because the daily mean temperature was under 10 °C in March. In most of the orchards, flight persisted until the end of November. Similar studies confirmed the same flight pattern in Aydın Province of Turkey (Gençsoylu *et al.*, 2006). According to Ivanova *et al.* (2008), first adult emergence was on the first week of May in Bulgaria. Hazır & Ulusoy (2010) determined that flight started late March through early October in Adana Province. The first peak point of adults was in the middle of April, when fruits began to form in the orchards with early cultivars in 2008.

In some of the orchards in Central and Lapseki districts, five light periods were recorded in April, June, July, August and October. Elsewhere there were four flight periods. It is concluded that 4-5 flight periods throughout the year existed and the pest had 4-5 generations per year. The pest had four generations in Adana province (Hazır & Ulusoy, 2010), five generations in Bursa province (Kılınçer & Kovancı, 1986) and four generations in Bulgaria and Aydın provinces (Gençsoylu *et al.*, 2006; Ivanova *et al.*, 2008). Also in Korea, with a similar climate, the pest had four generations (Chang-Yeo *et al.*, 2001). But it had five generations in Brazil and China (Arioli *et al.*, 2005; Zhi *et al.*, 2008). Kim *et al*. (2011) determined that the population of the pest has reached to 4 major peaks in the middle of April to early May, June, July, and middle of August to early September, using different types of traps in apple orchards. Hazır & Ulusoy (2010) showed that the pest was able to produce up to five generations in Adana and Mersin provinces of Turkey.

As the result of the study it is determined that *G. molesta* has four-five flight periods per year, starting from the middle of May and ending in November and it is estimated that the pest has four-five generations per year in Çanakkale. Emergence time and number of the

Table 1. Sampling orchards for adult development of *Grapholita molesta* in Çanakkale province in 2008-2009.

Sampling locations		Peach cultivars	Blossom period	Harvest time	Orchard age	Orchard size (decare)
Central District	Dardanos	Collection			9	5
		Blake	5-8 April	25 July		
	Kepez	Glohaven	30 March	15 July	15	5
		Summer Rich	5-7 April	25 July		
		J. H. Hale	5-8 April	30 July		
	Saraycık	Elberta	15 April	15 August	19	18
		Monreo	15-20 April	15 August		
	Halileli	J. H. Hale	5-8 April	30 July	15	35
		Elberta	15 April	15 August		
	Umurbey	Blake	5-8 April	25 July	6	5
Lapseki	Yeniceköy	Elberta	15 April	15 August	14	5
	Çardak	J.H. Hale	5-8 April	30 July	10	10
Bayramiç	Ahmetceli	Early Red	15 March	10 June	11	9
		Glohaven	30 March	15 July		
		J.H. Hale	5-8 April	30 July		
		Cresthaven,	15 April	15 August		

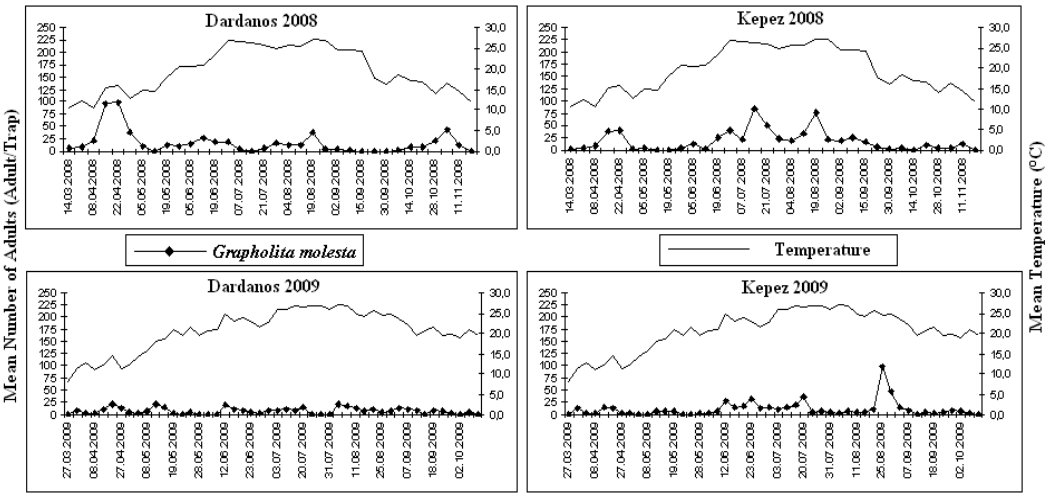

Fig. 1. Flight pattern of *Grapholita molesta* in Dardanos and Kepez orchards in 2008-2009.

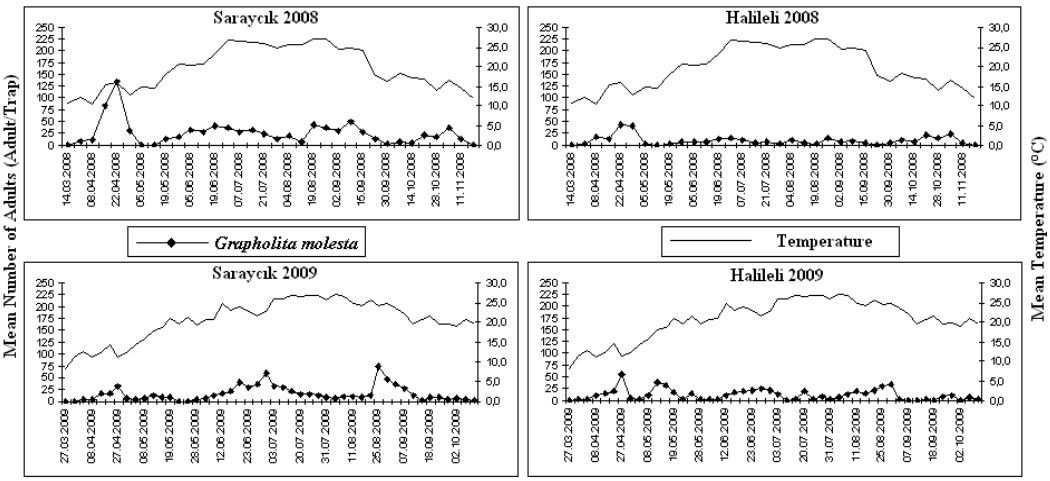

Fig. 2. Flight pattern of *Grapholita molesta* in Saraycık and Halileli orchards in 2008-2009.

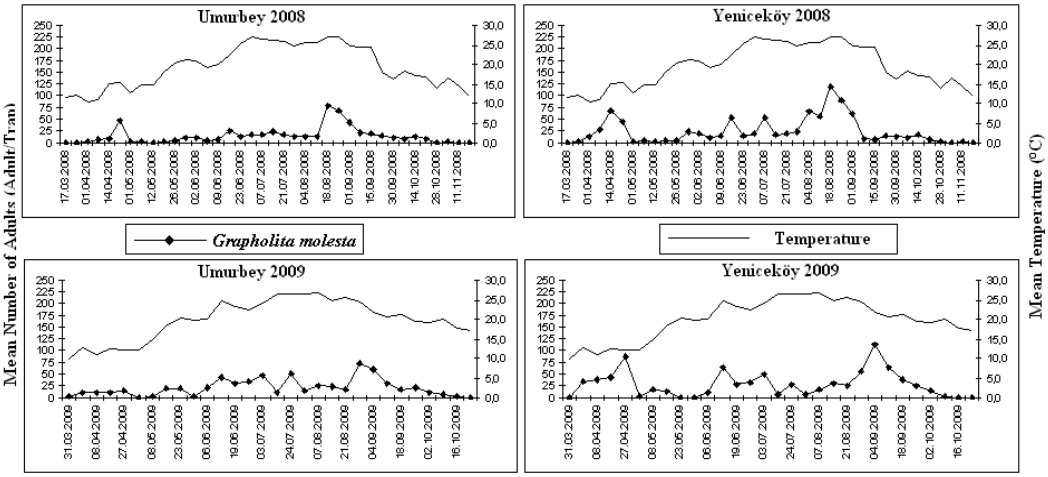

Fig. 3. Flight pattern of *Grapholita molesta* in Umurbey and Yeniceköy orchards in 2008-2009.

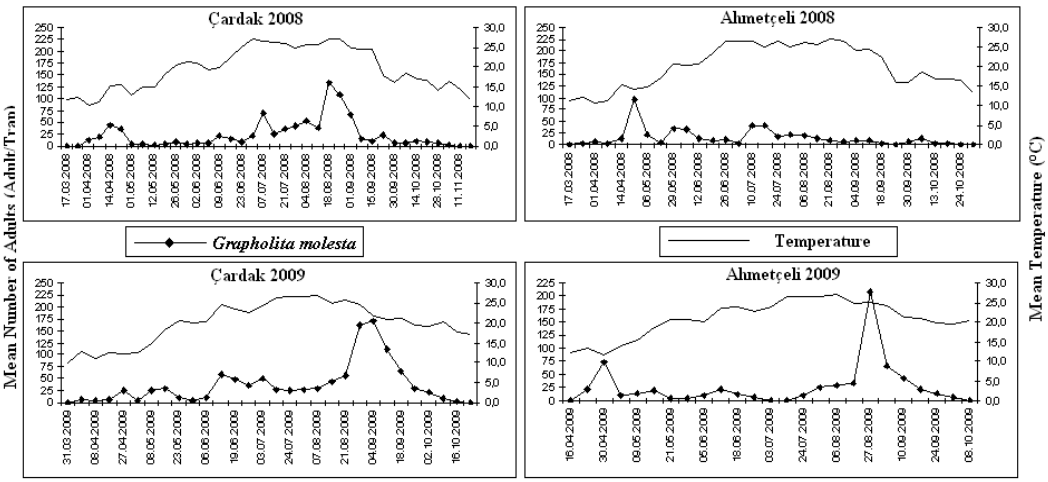

Fig. 4. Flight pattern of *Grapholita molesta* in Çardak and Ahmetçeli orchards in 2008-2009.

overwintering adults depend on the temperature values and generally ended in May. The highest adult number was recorded in August and September. It is likely resulted from ceasing of insecticide application or adult pest migrations from other orchards. This result, which complicates the determination of application periods, is an indicator that shows the late cultivars are more vulnerable to damage. These findings suggest that for a successful IPM, isolated peach orchards with a single cultivar type should be selected.

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