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Research Article

Seasonal activity and damage caused by peach twig borer *Anarsia lineatella* (Lepidoptera: Gelechiidae) on different peach cultivars

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Abstract: Peach twig borer (PTB), *Anarsia lineatella* Zeller, is the most critical pest of peach and other stone fruits in different parts of the world. The objectives of this study were to determine adults' seasonal activity and damage caused by PTB on different peach cultivars (Zafarani, Kardi, Elberta, Red top, and GF_{677}) under natural conditions. The seasonal flight of the adults using pheromone traps indicated that PTB completed three generations per year in peach orchards, Saman, Chaharmahal va Bakhtiari, Iran. The accumulated degree-days throughout the pest activity from April to October were 1916 and 1803 DD in 2014 and 2015, respectively. The ratio of twig and fruit infestation and the number of larval galleries/fruit were studied among the cultivars using a completely randomized block design in four replicates. According to the results, the highest ratio of twig infestation was observed on GF_{677} followed by Zafarani, whereas the lowest on Elberta followed by Kardi cultivar. The longest larval galleries (68.44 ± 1.28 and 56.80 ± 1.24 mm) was observed on GF_{677}, whereas the shortest on Elberta cultivar (39.20 ± 1.64 and 32.40 ± 1.36 mm in 2014 and 2015, respectively). The highest ratio of fruit damage and larval galleries/fruit were observed on Kardi, whereas the lowest was on Red top cultivar. According to the results, the cultivars with hard tissues of twigs and early maturing fruits significantly reduced PTB damage and are recommended for pest management in the infested regions.

Keywords: Peach twig borer, fruit infestation, twig infestation, seasonal flight

Introduction

Peach twig borer (PTB), *Anarsia lineatella* Zeller (Lep.: Gelechiidae) is the most economically important pest that causes significant yield loss in peach *Prunus persicae* Batsch orchards. It is also reported as the major pest of other stone fruits such as almond, apricot, plum, and nectarine (Sciarretta and Trematerra, 2006; Mamy *et al.*, 2014). Larvae of the overwintering generation burrow into developing shoots and eventually kill them. In subsequent generations, as twig tissue hardens, larvae attack the fruits, causing considerable losses in quantity and quality (Roshandel, 2019).

Many studies have been conducted on biological aspects of the peach twig borer, such as host preference (Alston and Murray, 2007; Damos and Savopoulou-Soultani, 2010; Iacob, 1970) and the flight activity using the pheromone traps (Molnar, 1991; Kehat *et al.*, 1994; Zalom *et al.*, 1992; Kocourek *et al.*,

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1996) as well as mating disruption (Molinari and Cravedi, 1991; Pari *et al.*, 1990). Cultural practices such as pruning the infected shoots (Alston and Murray, 2007) and protecting the natural enemies such as *Paralitomastix varicornis* Nees (Roshandel, 2019) decrease the pest population. However, insecticides have been the primary method for controlling pest damage in peach orchards. Because of the difficulties related to chemical control, an alternative management program is required to manage this pest. As a central component of integrated pest management (IPM), host plant resistance is an alternative method to reduce pesticide application and the pest management system's problems (Panda and Khush, 1995). A study by Öztürk *et al.* (2004) showed that PTB preferred peach and almonds more than apricot, whereas Mamay *et al.* (2014) reported peach and nectarine were significantly damaged more than apricot. Moreover, Roshandel (2019) showed that the pest's damage on the soft shell cultivars of almonds was more significant than hard shell cultivars.

Although a few studies were conducted on the host preference of PTB among different *Prunus* species, no previous studies have compared PTB host preference among different peach cultivars. Therefore, the objectives of this study were (i) to determine adult seasonal flight, emergence, peak times, and the number of PTB generations in the studied region, (ii) comparison of PTB damage to twigs and fruits of different peach cultivars under natural conditions.

Materials and Methods

The studied area

The study was conducted during two successive years (2014-2015) in Saman, Chaharmahal va Bakhtiari province, Iran. The area is 32°28" N, 50°54" E, and 1936 m above sea level. Mean annual temperatures were calculated at 13.2 °C and 14.3 °C, mean humidity 36.6 and 35.7%, and total precipitation at 323.60 and 299.10 mm, in 2014 and 2015, respectively. Daily temperature and other meteorological data were collected from the Chaharmahal va Bakhtiari Meteorological Office, Saman Synoptic Station.

Studied cultivars

Four commercial cultivars, including Zafarani, Kardi, Elberta, and Red top, along with a commercial rootstock (GF_{677}), were studied. The experiment was arranged in a randomized complete block design with five treatments in 4 replicates. Each replicate contained four peach trees. Trees were approximately 6-7 years old, 2-3 m in height, and planted at 3 × 4 m distances between and along the rows. No chemical was applied on experimental plots during the period of study.

Pheromone, trap, and installation height

The pheromone dispensers, type of trap, and installation height were provided according to Roshandel (2019). Delta traps (triangle-shaped houses, 25 × 20 cm in base and 15 cm in height) were made of plastic (2 mm diameter) (Nafis Cartonplast Ind., Iran). A sticky insert (25 × 20 cm in length and width, respectively) was placed inside each trap. One pheromone dispenser of *A. lineatella (*PH-049-1RR, Russell IPM Company, UK) was established in the center of the sticky insert. The dispensers were polyethylene containers, each loaded with 10 mg of *A. lineatella* pheromone. Delta traps were installed at the height of 1.5-2 m above ground level on the outer edge of the tree canopy.

Seasonal activity

The seasonal flight of the adults was studied during 2014-2015 using pheromone traps. Four pheromone traps were installed at 50 meters to avoid interference between them. All traps were set at the height of 1.5-2 m above ground, where leaves and branches were removed around entrances. The traps were set up in the peach orchard from April 20 (before the emergence of adult males) to October 30 (the end of the adults' flight) to monitor the pest population. Pheromone traps

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were checked twice a week until the first capture of adults, and after that, they were checked once a week, and numbers of captured moths were recorded. The sticky sheets and the pheromone lures were replaced every two weeks and every month, respectively.

Twig infestation

Twig damage was determined in the early spring (5th and 20th April and May 5) and early fall (1st and 15th of October). For this purpose, ten random twigs from a middle portion (at different sides) of each tree were examined, and the percent of infested twigs was calculated.

Moreover, the length of the larval tunnel was measured on each cultivar during the first week of May.

Fruit infestation

Samplings for the percent of infested fruits and the number of larval tunnel/fruit were done twice a month from July 5 to September 5 (harvesting time). The percentage of infested fruits was determined by examining 10 randomly selected fruits from each tree (a total of 160 fruits of each cultivar). After all, fruits were examined, infested and non-infested fruits were recorded, and the percentage was calculated.

While examining the fruits, the number of larval tunnels/fruit was recorded and compared.

Statistical analysis

Statistical analysis was performed using SAS program (SAS 9.1 Institute Inc) and SPSS (version 22) software. Proc GLM (General linear model) was performed to identify significant differences among the treatments and means compared using the Tukey's test at $P = 0.05$. Data normality was assessed using Kolmogorov–Smirnov test and, data conversion was performed using the formula $\sqrt{x} + 1$, if required. The graphs were created using Excel software.

Calculation of environmental degree day was done based on the following equation (Pedigo and Zeiss 1996):

$$DD = \left(\frac{m_1 + m_2}{2}\right) - m_c$$

Where,

DD: degree-days for a given 24 h period,

m_1: maximum temperature during the period,

m_2: minimum temperature during the period,

m_c: lower temperature threshold for the species, 11.2 °C according to Azarnia (2016).

It is worth mentioning that the assumptions and procedures of Newman (1971) were used to calculate degree-days accumulations.

Results

Results of pheromone traps during both years of study (2014-2015) indicated that *A. lineatella* completed three generations per year in the Saman region, Chaharmahal va Bakhtiari province, Iran. PTB overwintered as 1st and 2nd instar larvae inside the galleries in twigs of peach trees. In the first to the second week of April, when the mean daily temperature increased to 10 °C, the overwintered larvae started feeding inside the galleries. While feeding on the twigs and young branches, the larvae may change their position several times and attack other twigs and shoots. The maximum activity of PTB larvae was observed on the twigs during April. From the third week of April, the fully developed larvae were pupated. The spring moth emergence (1st flight) started from the 3rd and 4th weeks of April 2015 and 2014. The first flight peaked on May 16 (188.82 moths/trap) and May 10 (103.75 moths/trap) in 2014 and 2015, respectively (Figure 1). The second flight started from the third week of June and peaked on June 30 (186.94 moths/trap) and July 8 (105 moths/trap) in 2014 and 2015, respectively. The third flight started in early September and peaked on September 14 and September 7, in 2014 and 2015, respectively (Figure 1). The time between 1st and 2nd flights was about 45 days, whereas between 2nd and 3rd peaks was about 60 days.

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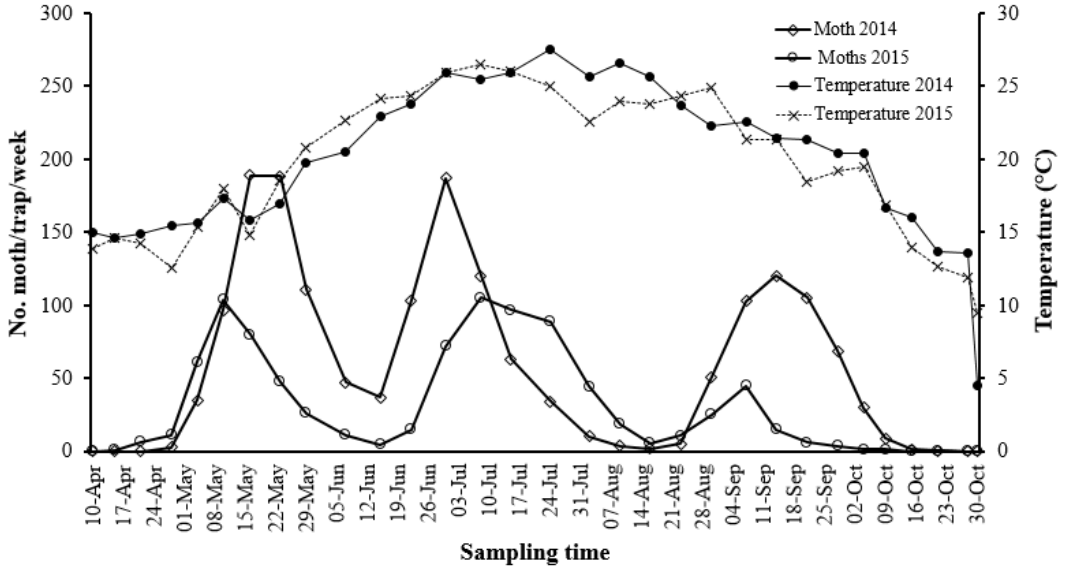

Figure 1 Seasonal activity of adults of peach twig borer, *Anarsia lineatella* Zell., under the field condition in Saman region, Chaharmahal va Bakhtiari province, Iran during 2014-2015.

Females of the 1st and 2nd flights laid their eggs on the fruits, and larvae of the 2nd and 3rd generations attacked the fruits and caused considerable damage to different peach cultivars. The emergence of the adults was observed till the third week of October in both years of study. Females of the last generation laid their eggs on the twigs, and larvae entered the twigs for overwintering until the following spring. The accumulated degree-days throughout the pest activity (April-October) were calculated as 1916 and 1803 DD for 2014 and 2015, respectively. According to Azarnia (2016), the pest required 615 DD to complete a generation. Therefore PTB could complete three generations per year in Saman, Chaharmahal va Bakhtiari province, Iran.

Damage on twigs

Results indicated significant differences among peach cultivars in the ratio of twigs infestation during 2014-2015 (Tables 1 and 2). In early spring 2014, the highest ratio of twigs infestation (42.60 ± 1.99 and 46.80 ± 2.24%) was observed on GF_{677}, whereas the lowest was observed on Elberta (25.40 ± 3.49 and 27.40 ± 3.48%, on April 5 and April 20, respectively) (Table 1). In early autumn (September 20 and October 5), GF_{677} had the highest ratio of twig infestation (49.60 ± 3.48 and 50.80 ± 1.35%). In addition, at the same period, the lowest twig infestation was observed on Elberta (26.40 ± 2.40 and 40.40 ± 2.23%) and Kardi (33.60 ± 2.40 and 38.40 ± 3.06% on September 20 and October 5, respectively) cultivars (Table 1).

The same trend was observed during 2015, in which the most significant damage was observed on GF_{677}, followed by the Zafarani, whereas the lowest was on Elberta, followed by the Kardi cultivar. In general, the pest damage to the twigs of Kardi, Elberta, and Red top cultivars was lower than Zafarani and GF_{677} cultivars (Table 2).

According to the present results, the length of the larval gallery was significantly different among the studied cultivars. In 2014, the longest larval tunnel (68.44 ± 1.28 mm) was observed on GF_{677}, whereas the shortest was measured on Elberta and Kardi cultivars (39.20 ± 1.64 and 35.76 ± 1.67, respectively). Moreover, the same trend in the length of the larval gallery was observed in 2015 (Tables 1 and 2).

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Table 1 Mean (± SE) comparison of twig infestation and length of larval gallery caused by *Anarsia lineatella* on different peach cultivars in 2014.

Cultivar	Twig infestation (%)					Larval gallery (mm)
	April 5	April 20	May 5	October 1	October 15	
Zafarani	20.8 ± 1.53 b	38.4 ± 3.05 a	42.4 ± 2.92 ab	43.6 ± 6.01 ab	40.8 ± 6.11 ab	53.24 ± 1.09 b
Kardi	36.6 ± 6.46 a	26.4 ± 4.49 b	30.8 ± 4.17 c	33.6 ± 2.40 bc	38.4 ± 3.06 b	35.76 ± 1.67 d
Red top	19.6 ± 1.16 b	32.4 ± 3.60 ab	36.0 ± 2.68 bc	35.2 ± 4.31 bc	37.2 ± 2.24 b	44.52 ± 0.67 c
GF_{677}	27.4 ± 2.23 ab	42.6 ± 1.99 a	46.8 ± 2.24 a	49.6 ± 3.48 a	50.8 ± 1.35 a	68.44 ± 1.28 a
Elberta	31.2 ± 12.29 ab	25.4 ± 3.49 b	27.4 ± 3.48 c	26.4 ± 2.40 c	40.4 ± 2.23 ab	39.20 ± 1.64 d

Means in a column with the same letters are not significantly different at $P = 0.05$ of Tukey's test.

Table 2 Mean (± SE) comparison of twig infestation and length of larval gallery caused by *Anarsia lineatella* on different peach cultivars in 2015.

Cultivar	Twig infestation (%)					Larval gallery (mm)
	April 5	April 20	May 5	October 1	October 15	
Zafarani	17.0 ± 1.22 b	32.0 ± 2.55 a	35.0 ± 2.24 ab	36.0 ± 5.10 ab	34. 0 ± 5.09 ab	44.2 ± 0.86 b
Kardi	30.0 ± 5.24 a	22.0 ± 3.74 b	25.0 ± 3.16 cd	28.0 ± 2.00 bc	32.0 ± 2.54 b	29.4 ± 1.03 d
Red top	17.0 ± 1.22 b	27.0 ± 3.00 ab	30.0 ± 2.23 bc	29.0 ± 3.32 bc	31.0 ± 1.87 b	36.8 ± 0.58 c
GF_{677}	22.0 ± 1.22 ab	35.0 ± 1.58 a	39.0 ± 1.87 a	41.0 ± 2.91 a	42.0 ± 1.22 a	56.8 ± 1.24 a
Elberta	26.0 ± 4.58 ab	20.0 ± 3.16 b	22.0 ± 2.54 d	22.0 ± 2.00 c	33.0 ± 2.00 b	32.4 ± 1.36 d

Means in a column with the same letters are not significantly different at $P = 0.05$ of Tukey's test.

Fruit infestation

Analysis of variance on the ratio of fruit infestation and number of larval galleries/fruit showed statistically significant differences among the cultivars in 2014 and 2015.

Damage of second-generation: In 2014, mean comparisons of different treatments at the first sampling time (July 5) showed that the fruit damage ranged from 1.38 to 10.20% on Red top and Elberta, respectively. Differently, in the second sampling (July 20), the lowest and highest fruit damages were recorded on Zafarani and Kardi cultivars, respectively. The mean number of larval galleries/fruit ranged from 1.00 ± 0.16 in Zafarani to 1.64 ± 0.26 in Red top cultivar in the first sampling time. However, on July 20, there was no significant difference in the mean larval galleries among the cultivars at the second sampling time (Table 3).

The same trend was observed for fruit infestation in 2015. As shown in table 4, the highest number of larval galleries/fruit was observed in Red top cultivar, whereas the lowest was in Zafarani cultivar.

Damage of third-generation: Since the fruits of Red top cultivar were harvested in the third decade of July, a comparison was made among the reaming cultivars (Zafarani, Kardi and Elberta). In 2014, the highest ratio of fruit damage (8.63 ± 1.64 and 13.12 ± 5.07%) and the number of larval galleries/fruit (1.88 ± 0.14 and 1.86 ± 0.16, on August 20 and September 5, respectively) was observed on Kardi. In contrast, the lowest ratio of fruit damage (2.38 ± 0.19 and 2.12 ± 1.31%) and the number of larval galleries/fruit (1.06 ± 0.04 and 1.20 ± 0.12, respectively) were observed on Zafarani cultivar (Table 3). The same trend was observed during 2015, wherein the highest ratio of fruit infestation and larval galleries/fruit were recorded on Kardi (Table 4).

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Table 3 Mean (± SE) comparison of fruits infestation and larval galleries by *Anarsia lineatella* among different peach cultivars in 2014.

Cultivar	2nd generation				3rd generation			
	Fruit infestation (%)		No. of larval tunnels/fruit		Fruit infestation (%)		No. of larval tunnels/fruit	
	July 5	July 20	July 5	July 20	August 20	September 5	August 20	September 5
Zafarani	2.92 ± 0.48 c	8.12 ± 1.06 b	1.00 ± 0.16 b	1.11 ± 0.10 a	2.38 ± 0.19 b	2.12 ± 1.31 c	1.06 ± 0.04 b	1.20 ± 0.12 b
Kardi	8.29 ± 0.78 b	15.22 ± 1.76 a	1.13 ± 0.23 b	1.10 ± 0.10 a	8.63 ± 1.64 a	13.12 ± 5.07 a	1.88 ± 0.14 a	1.86 ± 0.16 a
Red top	1.38 ± 0.38 c	13.69 ± 0.96 a	1.64 ± 0.26 a	1.22 ± 0.13 a	ND	ND	ND	ND
Elberta	10.20 ± 0.37 a	14.39 ± 1.06 a	1.33 ± 0.21 ab	1.08 ± 0.08 a	7.00 ± 0.63 a	9.40 ± 0.51 b	1.40 ± 0.24 ab	1.70 ± 0.20 a

Means in a column with the same letters are not significantly different at $P = 0.05$ of Tukey's test.
ND: No data.

Table 4 Mean (± SE) comparison of fruits infestation and larval galleries by *Anarsia lineatella* among different peach cultivars in 2015.

Cultivar	2nd generation				3rd generation			
	Fruit infestation (%)		No. of larval tunnels/fruit		Fruit infestation (%)		No. of larval tunnels/fruit	
	July 5	July 20	July 5	July 20	August 20	September 5	August 20	September 5
Zafarani	3.76 ± 0.78 c	9.73 ± 1.07 b	1.24 ± 0.16 a	1.08 ± 0.13 b	2.44 ± 0.52 b	3.55 ± 0.77 c	1.00 ± 0.10 c	1.08 ± 0.05 b
Kardi	10.26 ± 1.08 b	18.67 ± 1.4 a	1.52 ± 0.33 a	1.38 ± 0.29 ab	11.31 ± 0.59 a	15.91 ± 0.86 a	2.00 ± 0.20 a	2.14 ± 0.19 a
Red top	2.65 ± 0.63 c	16.59 ± 1.21 a	1.84 ± 0.23 a	1.64 ± 0.22 a	ND	ND	ND	ND
Elberta	13.16 ± 0.95 a	18.07 ± 1.02 a	1.52 ± 0.20 a	1.32 ± 0.20 ab	9.52 ± 0.95 a	11.96 ± 0.86 b	1.48 ± 0.20 b	2.00 ± 0.16 a

Means with the same letters in each column are not significantly different at $P = 0.05$ of Tukey's test.
ND: No data.

Discussion

Our results indicated that the activity of overwintered larvae started in early April, and the adults of PTB emerged from late April. Öztürk *et al.* (2004) and Mamay *et al.* (2014) reported that the activity of adults in Malatya province, Turkey started at the beginning of May. In contrast, Alston and Murray (2007) revealed that in the southern and northern parts of Utah (USA), PTB adults emerged in April and May, respectively. These differences might be due to climatic conditions.

This study indicated that PTB completed three generations per year in peach orchards, Saman, Chaharmahal va Bakhtiari province, Iran. According to other researchers, the pest could complete 2-4 generations depending on the host plant's climatic conditions. Studies conducted in California, USA, showed that PTB had three flight peaks (three generations) on peach and four flight peaks (four generations) on almond during April–October (Rice and Jones, 1975; Weakley *et al.*, 1990). Mamay *et al.* (2014) reported that the pest had three generations in peach, apricot, and nectarine orchards in Sanliurfa province, Turkey. Based on Iacob (1970), the pest had three generations in Romania. However, four generations in southern Utah, USA, and three generations in the north of the state were reported by Alston and Murray (2007). On the other hand, Kocourek *et al.* (1996) stated that the pest could complete two generations per year in the Czech Republic. A study by Ahmad (1998) showed that the pest could complete 2-3 generations in Iraq, depending on the environmental conditions.

According to this study, the time between the second and third peaks was longer than the first and second peaks. The results were consistent with those reported by Weakley *et al.*

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(1990) and Zalom *et al.* (1992) in the USA, in which PTB had a temporary diapause period during late spring to early summer (June - July) and was activated again at mid-summer. Similar results were revealed by Mamay *et al.* (2014) in Turkey. The prolonged growth period might be related to high-temperature conditions during July and August. Iacob (1970) showed that 27 °C was the optimum temperature for PTB development. Damos and Savopoulou-Soultani (2008) reported that mean developmental time of the pest increased and survival was substantially reduced at lower (15 °C) and higher (35 °C) temperatures.

Calculated degree days in both years (2014-2015) showed that the pest could complete three generations per year in the studied area. According to Azarnia (2016), the population of PTB required an average of 516.15 DD to complete its development on peach at laboratory conditions. However, Damos and Savopoulou-Soultani (2007) reported a lower average of 400 DD for the first generation of PTB in Greece. On the other hand, Zalome *et al.* (1992) reported that *A. lineatella* needs 600 DD for completing one generation in Utah, USA. In another study Mamay *et al.* (2014) reported 381 degree-days for the emergence of the first adults in Şanlıurfa province, Turkey. It should be considered that these differences are due to examined host plants, the geographical origin of the pest population as well as experimental conditions.

We found that the pest damage was significantly different on the twigs of the studied cultivars. Similar findings were reported among the other host plants of PTB. Mamay *et al.* (2014) showed that the pest damage on peach plants was significantly more than that on apricot and nectarine. In another study, Öztürk *et al.* (2004) revealed that the pest preferred peach and almonds to apricot. According to our results, a greater infestation rate of PTB on GF_{677} twigs could be due to better vegetative growth and more fresh twigs (Bussi *et al.*, 1995; Taha and Azza, 2011) compared to the other cultivars. Mamay *et al.* (2014) indicated that the more significant damage on peach shoots than apricot and nectarine could be due to the nature of peach twigs, which are more lush and palatable. Öztürk *et al.* (2010) showed that the pest preferred peach and almond more than apricot due to short vegetative growth and hard tissue at the tip of the apricot shoots. The maximum activity of PTB larvae was observed on the twigs during April. Therefore, pruning of the infested twigs in early spring (Alston and Murray, 2007) is recommended as an effective method to decrease damage and reduce the pest population in the next generation.

In this study, damage of PTB on the fruits of Red top was lower than other cultivars. That may be because of early harvesting of the Red top cultivar in the third decade of July, contributing to the reduced damage rate in this cultivar. Gençsoylu *et al.* (2006) stated that late-maturing varieties suffered more damage than early maturing varieties. According to Mamay *et al.* (2014), lower damage of apricot fruits than peach and nectarine was related to early harvesting of the apricot fruits in June.

Our results provided important information about the abundance, seasonal flight, and infestation rate of PTB in the peach orchards and should be considered in the pest management program. It seems that planting cultivars with hard-tissue twigs and early harvesting of fruits could be proposed for infestation reduction. Of course, further studies would be necessary to determine EIL, ET and to search for practical methods such as natural enemies and plant resistance/tolerance to control the pest in the infested regions.

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Declaration of conflicting interests

The authors declare that they have no conflict of interest.

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فعالیت فصلی و خسارت کرم سرشاخه‌خوار هلو، *Anarsia lineatella* روی ارقام مختلف هلو

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چکیده: کرم سرشاخه خوار هلو (PTB)، *Anarsia lineatella* Zeller، مهم‌ترین آفت هلو و سایر هسته‌داران در مناطق مختلف جهان است. هدف این مطالعه تعیین تغییرات فصلی جمعیت حشرات کامل و خسارت ناشی از آفت روی ارقام مختلف هلو شامل زعفرانی، کاردی، البرتا، ردتاپ وGF677 بود. بررسی پرواز فصلی حشرات کامل با استفاده از تله‌های فرمونی نشان داد که PTB سه نسل در سال را در باغ‌های هلوی شهرستان سامان از توابع استان چهارمحال و بختیاری، ایجاد می‌کند. میزان روز درجه لازم در طول فعالیت آفت از فروردین تا آبان ماه ۱۹۱۶ و ۱۸۰۳ به‌ترتیب برای سال‌های ۱۳۹۵ و ۱۳۹۶ محاسبه شد. نسبت آلودگی سرشاخه‌ها و میوه‌ها و تعداد تونل لاروی در میوه بین ارقام مختلف با استفاده از طرح بلوک‌های کامل تصادفی در چهار تکرار مقایسه شد. طبق نتایج، بیش‌ترین میزان آلودگی سرشاخه در GF677 و پس از آن در رقم زعفرانی مشاهده شد، درحالی‌که کم‌ترین مقدار در رقم البرتا و کاردی مشاهده شد. طولانی‌ترین تونل لاروی (۱/۲۸ ± ۶۸/۴۴ و ۱/۲۴ ± ۵۶/۸۰ میلی‌متر) در GF677 مشاهده شد، درحالی‌که کوتاه‌ترین تونل لاروی روی رقم البرتا (۱/۶۴ ± ۳۹/۲۰ و ۱/۳۶ ± ۳۲/۴۰ میلی‌متر به‌ترتیب برای سال ۱۳۹۵ و ۱۳۹۶) دیده شد. بیش‌ترین نسبت آلودگی میوه و تعداد تونل لاروی در هر میوه مربوط به رقم کاردی، درحالی‌که کم‌ترین آن در رقم ردتاپ بود. براساس نتایج، ارقام دارای سرشاخه با بافت سخت و هم‌چنین ارقام زودرس به‌طور معنی‌داری خسارت PTB را کاهش داده و برای مدیریت آفت در مناطق آلوده توصیه می‌شوند.

واژگان کلیدی: سرشاخه خوار هلو، آلودگی میوه، آلودگی سرشاخه، پرواز فصلی

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