

A study on occurrence and population trends of the carob moth, *Ectomyelois ceratoniae* (Zeller) (Lepidoptera: Pyralidae) in pomegranate orchards by using pheromone traps

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ABSTRACT

The carob moth (CM), *Ectomyelois ceratoniae* (Zeller) (Lepidoptera: Pyralidae) is a serious pest on pomegranate in Turkey. Pheromone traps, baited with 1 mg Z9, E11-hexadecadienal, Z9-tetradecenal, Z9, E11,13-tetradecatrienal (1:1:8) impregnated in rubber septa were used for seasonal monitoring of this pest in two districts of Hatay province, Turkey. After two years of the study, the pest was found in thirty-three sampled sites. The relative population level of the pest was higher in Kirikhan district than was in Antakya district. The seasonal activity of CM increased from June to October, and the percentage of the total moths caught over the sampling period was high in October and September due to temperature and ripening period of fruits. The major flight period of the pest was observed to be from April through mid-November and thus the pest have four overlapping generations; the first generation develops from mid-April until late June, the second generation from late June to late August, the third generation from September to late October and the fourth generation overwinters as larvae on remaining fruits and completes its development at the beginning of spring, on pomegranate fruit in Hatay province of Turkey.

Key words: carob moth, pheromone traps, pomegranate, Turkey.

INTRODUCTION

Pomegranate, *Punica granatum* L. [Punicaceae: Myrtiflorae], is an important tropical and subtropical tree [22,29], widespread in Turkey where it comprises approximately 307.511 ha with a total produce of 445.750 tons of fruit per annum, and Hatay province's share is 12.239 ha and 20.769 tons [2]. The carob moth [CM], *Ectomyelois ceratoniae* [Zeller] [Lepidoptera: Pyralidae] is well known pest of many fruits [1,9,14,18,23,25]. The pest is a serious pest of pomegranate fruits in Turkey [11,17,27]. In pomegranate orchards, it overwinters in larval stage in damaged fruits [17,28]; the adults appear from April to June [17]. The carob moth females lay eggs on calyx of pomegranate fruit [17,23]. The physical condition of pomegranate crown protects the eggs and facilitate the penetration of young larvae to the fruit [23]. The larvae feed inside the fruit and seriously affect fruit quality [17,23]. Thus, this pest causes significant economic losses affecting as much as 90% of the production of Algeria, Tunisia, Iraq and Iran [12]. For all Tunisian varieties of pomegranate, infestation levels reach to 90% in the south of the country but only 15% in the north [13]. The species caused significant damage to pomegranate fruits in Turkey [17, 31,32]. This pest caused 45-50 % damage in late September and also if the harvest was delayed, damage increased to 60-70 % in Sanliurfa province in 1992 [17]. The damage differed depending on the pomegranate varieties in Turkey. This pest was observed to cause 46.2 % damage on 'Tirbey' and 38.7 % on 'Kızılnar' [8], 47.8 % on 'Kızılnar' and 16.9 % on 'Nizip' varieties of pomegranate [17]. Even though ratio of damage differed depending on the pomegranate varieties, the level of damages in Hatay province reached 15-40% in 2008, 14- 35 % in 2009 [32]. Pheromones could provide a reliable tool for detecting and monitoring the carob moth in the field. The female sex pheromone was identified by [5,6], and the major component responsible for its attractiveness to males was found to be [Z,E]-9,11,13-tetradecatrienal, which was synthesized by [20]. The current study was the first one using pheromone traps to investigate of this pest in Hatay province of Turkey. Our study had two main objectives: [a] to determine whether pheromone traps could provide a reliable tool for detecting and monitoring population trends of this pest on

pomegranate, [b] to evaluate the number of generations occurring on pomegranate orchards in Hatay province of Turkey.

MATERIALS AND METHODS

The study was conducted in 2009-2010 at pomegranate orchards at Antakya and Kırıkhan districts in Hatay province of Turkey. The pheromone baits, 1 mg Z9, E11-hexadecadienal, Z9-tetradecenal, Z9, E11,13-tetradecatrienal (1:1:8 ratio) (Maavit Products, Tel Aviv, Israel)], impregnated in rubber septa was used.

Home-made, sticky Delta traps consisting of transparent PVC foil were used for all field investigations. The surface area of the replaceable sticky plate which was covered with Tangle foot insect glue was 150 cm². The traps were suspended at a height of *ca* 100 cm above ground. Seventeen traps were placed in two districts of Hatay province in 2009, while sixteen traps were set in two districts of Hatay province in 2010. In 2009, the traps were placed in the field in April, while in 2010 they were installed in May. In both years the traps were checked weekly and the trapped moths were counted and removed from the traps. The pheromone baits were also changed with fresh ones in every four weeks. In both years traps were removed in December (Table 1).

RESULTS

In 2009, catches of *E. ceratoniae* were recorded in Antakya and Kırıkhan districts of Hatay province. This pest appeared late-April in Kırıkhan and early-May in Antakya district. The seasonal activity of the pest varied during the sampling period in both districts. Activity of the pest increased from June to October, while it decreased from April to May and late October to November. The largest mean catches per traps were occurred on 21st October (8 moths per trap) in Antakya district and on 7th October (3.8 moths per trap) in Kırıkhan district (Figure 1, 2). In addition, the percentage of the total moths caught over this period were April (0.29%), May (8.75%), June (7.78%), July (13.54 %), August (12.39 %), September (20.46 %), October (34.73 %) and November (2.01%) (Figure 5).

Table 1. The study was carried out in two districts of Hatay province in 2009-2010

District of Hatay province	Number of traps (sites)		Dates of installation of the traps		Dates of changing the baits		Dates of removal of the traps		Variety of the Pomegranate	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Antakya	5	8	15 April	19 May	13 May 10 June 8 July 5 August 2 September 30 September 28 October	16 June 14 July 12 August 8 September 6 October 3 November	2 December	1 December	Karamehmet Katırbaşı	Hicaz Katırbaşı
Kırıkhan	12	8	15 April	19 May	13 May 10 June 8 July 5 August 2 September 30 September 28 October	16 June 14 July 12 August 8 September 6 October 3 November	2 December	1 December	Karamehmet Katırbaşı	Karamehmet Katırbaşı
Total	17	16								

In 2010, catches of *E. ceratoniae* were recorded in two districts of Hatay province. The seasonal activity of the pest varied during the sampling period. The catches of *E. ceratoniae* per traps was higher in Kırıkhan district than those of in Antakya district. The largest mean catches per traps were recorded on 6th October (2.9 moths per trap) in Antakya district and on 18th and 25th August (4.3 moths per trap) in Kırıkhan district (Figure 3,4). In addition, the percentage of the total moths caught over this period were May (3.27 %), June (12.04 %), July (14.80 %), August (20.48 %), September (25.13 %), October (20.48 %) and November (3.78 %) (Figure 5).

In both years, the major flight period of carob moth was occurred from April through mid-November in Hatay province of Turkey. The pest has considerable three overlapping generations; moths are trapped from mid-April until late June (overwintering population), the first generation from late June to late August, the second generation from September to late October and the third generation overwinters as larvae on remaining fruits and completes its development by spring (Figure 1-4).

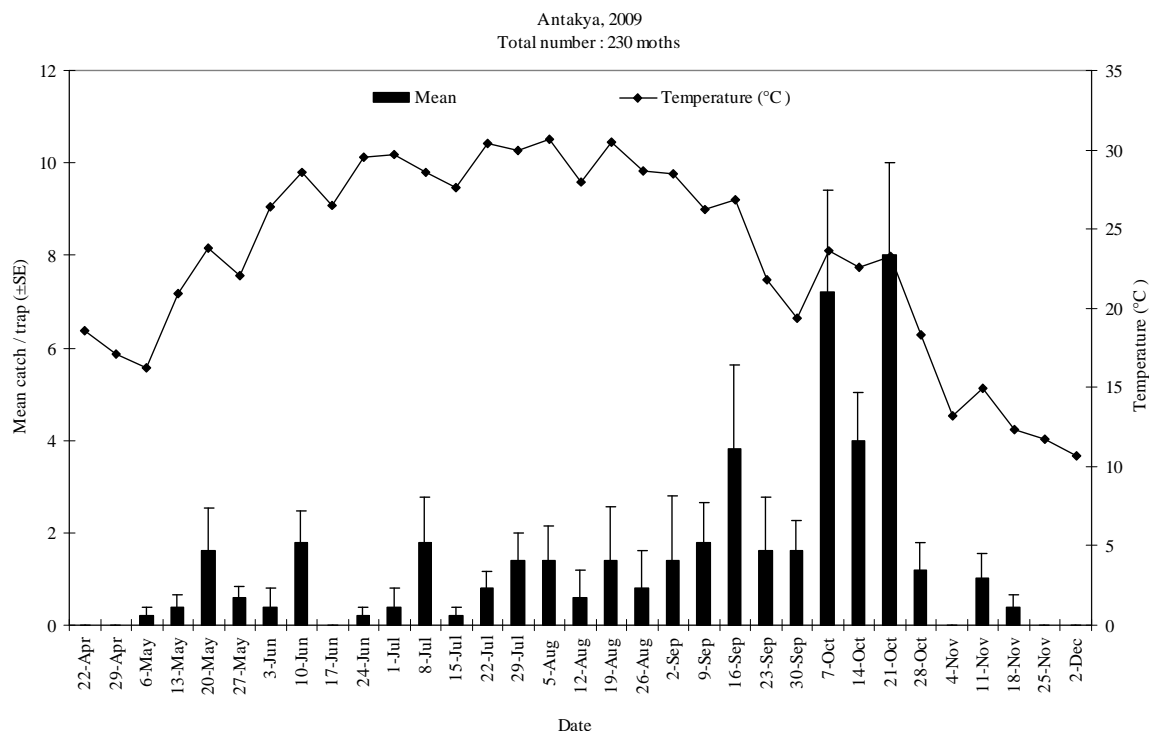


Figure 1. Mean (±SE) catches of carob moth males in traps baited with septa loaded pheromone dosage (15 April–2 December, 2009) and Temperature at pomegranate orchards in Antakya district

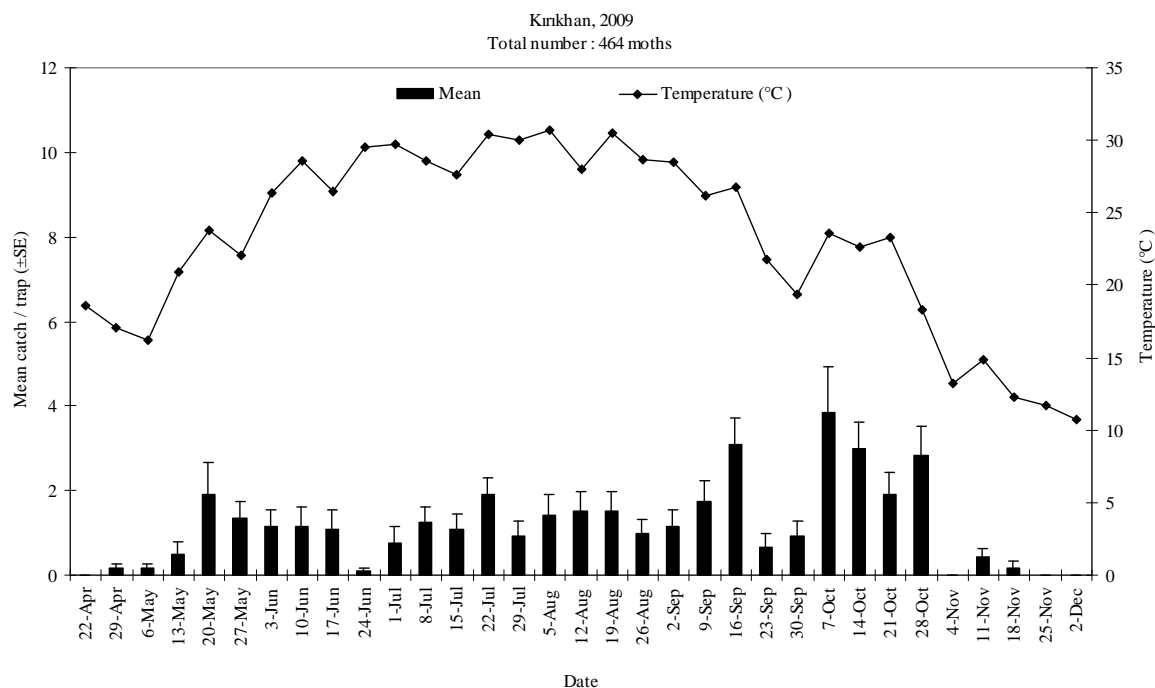


Figure 2. Mean (±SE) catches of carob moth males in traps baited with septa loaded pheromone dosage (15 April–2 December, 2009) and Temperature at pomegranate orchards in Kirikhan district

The generation of the carob moth can be differed according to the variety of the fruit and country in which it occurs. In Israel, this pest have four generations; The first generation develops from mid-April until late June, the second generation from late June to late August, the third generation from September to late October and the fourth generation overwinters and completes its development by spring. The last generation develops on remaining fruit [4]. In Iran, carob moth have four generations [15], in Iraq, it has 4-5 generations on pomegranage fruit [1]. This pest is primarily a pest of dates in California, where it has a number of overlapping generations from early March through December [34]. In Turkey, carob moth is a significant pest of the pomegranate fruit recorded from April to

November in Şanlıurfa province, Hatay province, and Eastern Mediterranean Region of Turkey [17,26,32]. This pest gives four overlapping generations in Şanlıurfa province, Hatay province [17,32] and 4-5 generations in Eastern Mediterranean Region of Turkey [26].

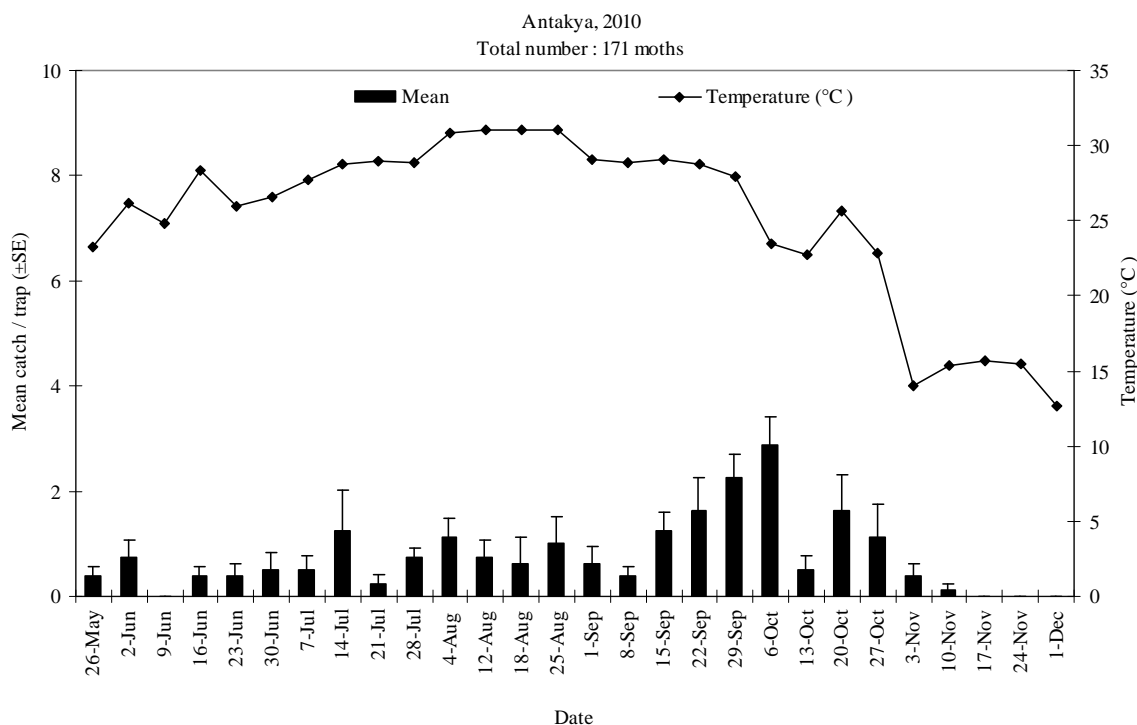


Figure 3. Mean (±SE) catches of carob moth males in traps baited with septa loaded pheromone dosage (19 May–1 December, 2010) and Temperature at pomegranate orchards in Antakya district

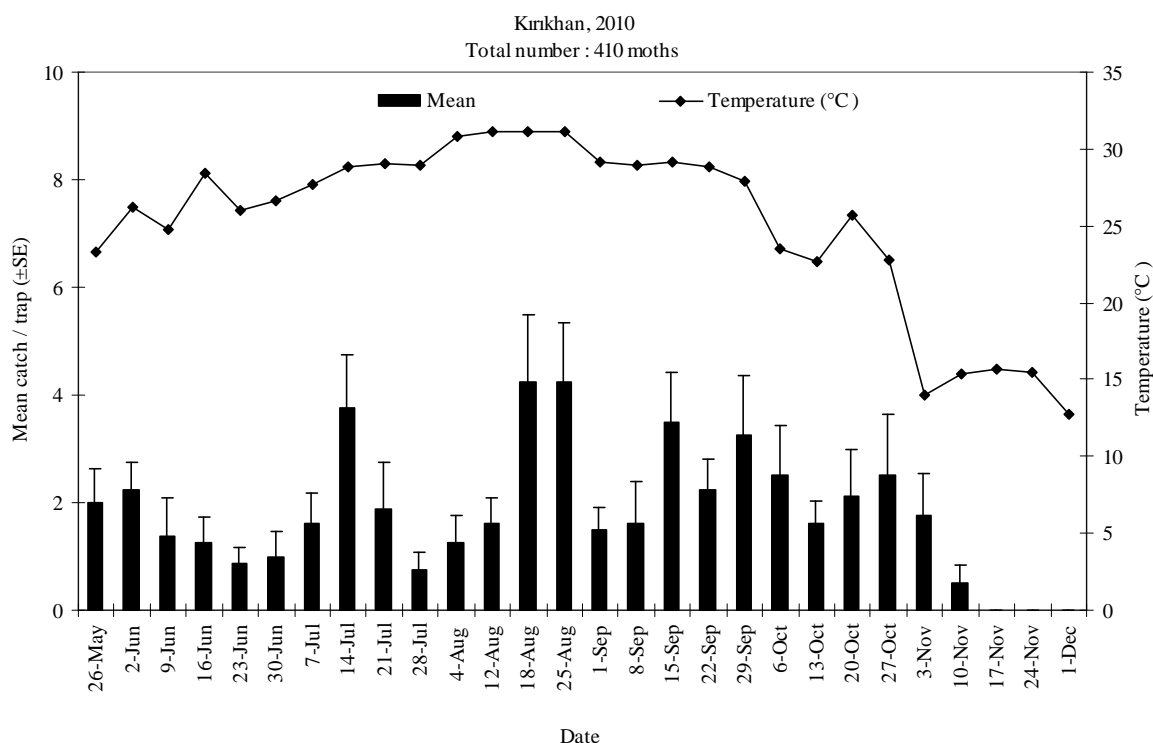


Figure 4. Mean (±SE) catches of carob moth males in traps baited with septa loaded pheromone dosage (19 May–1 December, 2010) and Temperature at pomegranate orchards in Kirikhan district

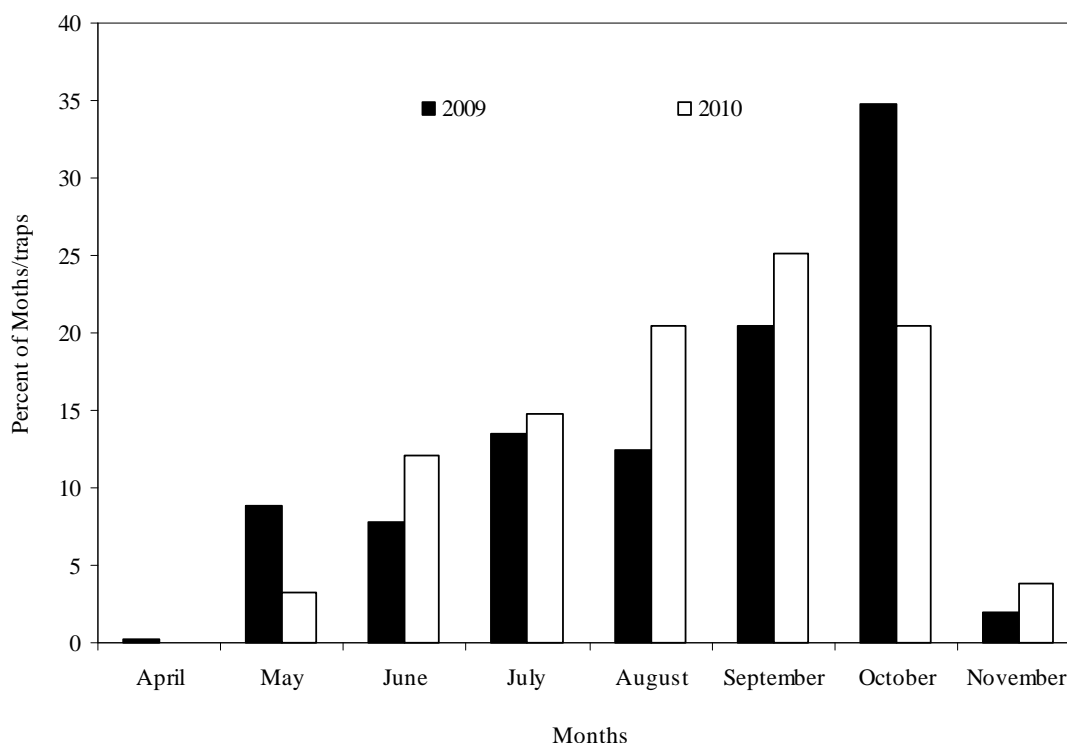


Figure 5. Percentage of the total male moths caught over the sampling period at the pomegranate orchards in Hatay province

DISCUSSION

The sex pheromone of *E. ceratoniae* was identified as an 8:1:1 blend of (Z,E)-9,11,13-tetradecatrienal (Z9,E11,13-14:Ald), Z9,E11-14:Ald, and Z9-14:Ald (5,6,20). Subsequently, pheromone traps were used successfully in several countries for the detection and seasonal monitoring of carob moth, in some cases, for mating disruption. A synthetic blend of (Z-E)-9,11,13-tetradecatrienal, (Z-E)-9,11-tetradecadienal and (Z)-9-tetradecenal (10:1:1) were tested by (3) as the sex pheromone of carob moth. A pheromone mimic [(Z,E)-7,9,11-dodecatrienyl formate] of carob moth was developed by (30). It is quite satisfactory as a trap lure and better than the pheromone blend in field tests. A pheromone mimic [(Z,E)-7,9,11-dodecatrienyl formate] of carob moth was used as a mating disruption for the carob moth (33). As a result, biweekly trap catches of males in fields treated with disruptant were reduced up to 100% in several orchards compared with untreated fields. A study was conducted by (11) to compare effectiveness of different pheromones baited with 1 mg Z9, E11-hexadecadienal, Z9-tetradecenal, Z9, E11,13-tetradecatrienal (1:1:8) and sex pheromone attractant baited with 1 mg (Z,E) 7,9,11-Dodecatrienyl formate) on carob moth. It was found that sex pheromone with delta traps was more effective on the carob moth than pheromone mimic with delta traps.

The seasonal flight period of *E. ceratoniae* was established by the use of pheromone traps in many countries [11,16,19,24,25,26,30,32]. The carob moth can also be caught in pheromone traps virtually year-round [16,19,24,25,26,32]. This pest was recorded from early March to December [19,34], April to November [4,17,26,32] and May to November [24,25].

The seasonal abundance of the carob moth is strongly influenced by temperature [4,7,10,14,17,19,32,34]. The development cycle of the carob moth takes 48 days at 20°C, 30 days at 25°C and 23 days at 30°C [10], 44 days at 25°C and 33 days at 30°C [17]. The pest has first generation from April to June and it completed 41-50 days, generation in July to August takes 28 to 30 days due to temperatures and humidity [21]. Therefore, the seasonal flight period of carob moth was higher from June through October than were in March-May and November-December. In addition, the seasonal activity of this pest on pomegranate was also recorded high from September through October due to harvesting time of the fruit [17,32].

CONCLUSION

The present study used pheromone traps for the first time in Hatay province of Turkey to detect the presence of carob moth. As a result of two-year investigations, the pest was found in thirty-three sites which is located in Antakya and Kırıkhan districts of Hatay province. Our results also showed the population level in different districts: Kırıkhan district had the higher population levels (464 moths/2009, 410 moths/2010) compared to Antakya district (230 moths/2009, 171 moths/2010). In addition, the seasonal activity of carob moth increased from June to October, while it declined from April to May and October to November. Moreover, the percentage of the total moths caught over this period was highest in October and September due to temperature and harvest time of fruits. The major flight period of this pest occurred from April through mid-November and flight peaks was not clearly separated from each other. Thus, the pest have four overlapping generations: The first generation develops from mid-April until late June, the second generation from late June to late August, the third generation from September to late October and the fourth generation overwinters as larvae on remaining fruit and completes its development by spring.

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