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The potential use of pheromone and bait traps for monitoring adult populations of the European sunflower moth, [*Homoeosoma nebulellum* (Den. & Schiff.) (Lep: Pyralidae)] [1]

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ÖZ

Feromon ve yem tuzakların Avrupa ayçiçeği güvesi, *Homoeosoma nebulellum* (Den.&Schiff) (Lep: Pyralidae), ergin popülasyonlarının izlenmesinde kullanım olanakları

Çalışma Ankara ili Kalecik ilçesinde çerezlik ayçiçeği alanlarında Avrupa ayçiçeği güvesi, *Homoeosoma nebulellum* (Den.&Schiff) (Lepidoptera: Pyralidae)'a karşı cezbedicilerin etkinliğini ve zararlının bulaşma oranına etkisini belirlemek amacıyla 2012-2013 yıllarında yapılmıştır. Çalışmada pekmez ve protein hidrolizat içeren besin tuzakları ile eşeysel çekici feromon-su kombinasyonu tuzaklar cezbedici araçlar olarak kullanılmıştır. Avrupa ayçiçeği güvesinin erginlerine karşı yapılan bu çalışmada, sayımlar hafta da iki kez olmak üzere ayçiçeği hasadının yapıldığı tarihe kadar devam etmiştir. Söz konusu zararlının ayçiçeğindeki bulaşma oranını belirlemek için çalışma başlangıcında ve hasat öncesinde sayım yapılmıştır.

Zararlının ayçiçek tablalarına bulaşma oranları pekmez, protein hidrolizat ve feromon-su tuzaklarının asıldığı tarlalarda 2012 yılında sırasıyla %10, %11 ve %11 olarak tespit edilirken, 2013 yılında sırasıyla %9, %7 ve %7 olarak gerçekleşmiştir. Bulaşma oranlarında bir farklılık gözlenmemiştir. Bulaşmanın olduğu ayçiçeği tablalarındaki ortalama larva sayısı pekmez, protein hidrolizat ve feromon-su tuzaklarının asıldığı tarlalarda 2012 yılında sırasıyla 3.60, 4.73 ve 3.91 adet larva, 2013 yılında ise 3.55, 3.28 ve 2.71 adet larva olarak tespit edilmiştir. Sonuçlarımıza göre, pekmez ve protein hidrolizat kullanılan tuzaklar Avrupa ayçiçeği güvesi erginlerini cezbetmemiştir. Buna karşın, feromon-su tuzakları diğer cezbedicilere göre daha yüksek etkinlik göstermekle birlikte parsel başına 1 adet tuzak oranında kullanıldığında bulaşma oranını azaltamamıştır.

[1] This study is part of a doctorate thesis "A Study Regarding the Determination of Biology, Natural Predators and Control Methods of European Sunflower Moth [*Homoeosoma nebulellum* (Den.&Schiff) (Lepidoptera: Pyralidae)] in Ankara".

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Anahtar kelimeler: Avrupa ayçiçeği güvesi, *Homoeosoma nebulellum*, tuzak, cezbedici yem, feromon

ABSTRACT

This study was carried out to determine the efficiency of various attractants against The European sunflower moth *Homoeosoma nebulellum* (Den. & Schiff.) (Lepidoptera: Pyralidae) and the effect of attractants on the infestation rate in confectionary sunflower fields in the Kalecik district of Ankara between 2012 and 2013. In this study, traps baited with grape molasses, protein hydrolisate baits and sex pheromone-water combination were used as attractive devices. The larvae on the sunflower heads were counted in order to determine the infestation rate before the harvesting period.

The percentage of infested heads of sunflowers by larvae were estimated as 10%, 11% and 12%, respectively, for the grape molasses, protein hydrolisate baits and pheromone traps in 2012, while infestation rates were 9%, 7% and 7%, in the same order, in 2013. There were no statistical differences between the percentage damage in different baits. The average number of larvae on the sunflower head was 3.60, 4.73 and 3.91 in 2012 and 3.55, 3.28 and 2.71 respectively in 2013 Based on our results, grape molasses and protein hydrolisate traps were not attractive to sunflower moth adults. On the other hand, pheromone-water traps were found to be more effective than the other traps but they did not decrease the infestation rate when used at a density of 1 trap/plot.

Keywords: European sunflower moth, *Homoeosoma nebulellum*, trap, attractant bait, pheromone

INTRODUCTION

Sunflower production plays an important role in Turkey's economy, yet there are many negative factors affecting its yield, including plant pests and diseases. The European sunflower moth [*Homoeosoma nebulellum* (Den. & Schiff.) (Lepidoptera: Pyralidae)] is an oligophagous pest that feeds only on plants belonging to Asteraceae family. This Palearctic species is commonly distributed in sunflower fields from Europe to Azerbaijan, Iran, Russia and China (Permana et al. 1993, Zong-Ze 2010, Ismayilzade et al. 2015). The larvae of the European sunflower moth can consume various parts of sunflowers, including pollen, ovaries of female flowers and maturing seeds. Annual seed losses of up to ~460 kg/ha was recorded in Azerbaijan (Ismayilzade et al. 2015).

In Turkey, sunflower moth damage was first detected in the Central Anatolia region in 1985 (Zeki and Öneş 1993). Later, Zeki et al. (2007) found that *H. nebulellum* adults occurred in the Ankara, Çorum and Yozgat provinces from late April to late October with four distinct flight peaks in pheromone traps. In the same study, larval damage rates of 3.76% were determined, especially in confectionery type sunflower seeds.

Fermented or degenerated raw material residues such as molasses and pure or processed chemical materials such as grape molasses, ammoniac derivatives, borax salts, enzymatic acids and protein hydrolysates and their formulations may serve as attractants for insect pests (Birişik ve ark. 2013). Hughes et al. (1998) used rotten banana and grape molasses to capture 23 and 37 lepidopteran species in forest and pasture areas, respectively, in Costa Rica. About 100 butterfly species were caught in traps baited with a mixture of grape molasses, honey and beer in Finland (Laaksonen et al. 2006). According to Kovanci and Walgenbach (2005), agricultural pests like the oriental fruit moth (*Grapholita molesta* Busck) adults can also be monitored by using terpinyl acetate bait traps in apple orchards under mating disruption. Likewise, Cichon et al. (2013) suggested the use of pheromone and food (terpinyl and brown sugar) bait traps in integrated pest management programmes for monitoring and control of insects pests including the oriental fruit moth in peach and nectarine orchards.

Pesticides are commonly applied for controlling the European sunflower moth throughout the world. In Turkey, there are few studies on the chemical and alternative control of this pest. In this study, the potential use of bait and pheromone-water traps for monitoring field populations of the European sunflower moth was evaluated as a new approach.

MATERIAL AND METHOD

We performed our study in the sunflower fields of Hacıköy and Alibeyli villages located in the Kalecik district of Ankara, Turkey in 2012 and 2013 and between July and August. We used Delta type adhesive traps with sexual attractant pheromone (©CSALOMON) as a control.

Trap efficiency assessment

Pheromone-water traps as well as bait traps containing protein hydrolisate (Ziray %10) bait and molasses (grape molasses) were installed 1.5-2.0 meters above ground and spaced 25 meters apart in order to keep the effects of the various attractants separate. One trap was used for each replicate (Zeki et al. 2007, Szabo 2010). Two liter bottles were used as bait and pheromone-water traps (25x12x10 cm). The recipe for the bait traps consisted of 1:4 (food:water) and 2-3 grams of yeast (İren et al. 1984). Traps were installed during the pollination period of sunflowers, and traps were checked every two weeks. During checks, the number of mature moths was noted, traps were cleaned, baits were refilled, and pheromone capsules were replaced. This application was continued until harvest time.

Infestation rates and average larvae numbers

During the growing season, larval infestation rates were determined twice by counting the number of trapped larvae after the traps were installed (R5 sunflower vegetation period) and before the harvest. Phenological phases of the sunflowers were followed using the Schneiter scale. In all replicates, countings were performed on 100 randomly selected sunflowers and recorded as infested or healthy. Data was presented as the infestation rate (%) (Zeki et al. 2007). To estimate the number of larvae, infested sunflower plants were transferred to the laboratory. Every larvae was collected from sunflowers and counted. The average number of larvae for each infested sunflower was calculated by dividing the total number of sunflowers by the number of infested sunflowers. Meteorological data for Kalecik region was provided by the Turkish State Meteorological Service.

Statistical analysis

We used randomized block design with 4 different characteristics (delta type pheromone trap, pheromone-water trap and bait traps with grape molasses and with protein hydrolisate (Ziray) and 4 replicates (each of plot is 3 da). Countings were performed every week (6 times in total). Efficiency of the traps was assessed based on 2 factors (trap*time) and factor levels were assessed according to the experimental design. Infestation rates were determined according to the experimental design of the randomized blocks with 4 replicates. Values and percentages obtained from the countings were transformed using square root and arcsine transformation functions, respectively. In case differences were found between treatments during the variance analysis, the Duncan test was used to separate treatment means at the significance level of 5%. Statistical analyses were performed using SPSS package program.

RESULTS

Trap effectivity assessment

2012 yılı çalışmaları

Although pheromone-water traps performed better than other experimental traps, they were not as effective as the delta type traps used as a control. We found differences in the number of moths caught in different traps installed in different fields by counting time (trap * counting time interaction) (F=3,332; p=0,001). Delta traps proved to be the most effective trap type during the counting period dated August 18, 2012, with 3.00 moths/trap, whereas bait traps with grape molasses and protein hydrolisate were not as effective. The counting dates and the number of moths caught for 2012 are given in Table 1.

Table 1. The number of moths caught in different trap types (Delta, Pheromone-water, baited with grape molasses and protein hydrolisate) in 2012 in the Kalecik district

Trap Type	Dates					
	24.07.2012	31.07.2012	06.08.2012	12.08.2012	18.08.2012	24.08.2012
Delta type trap	0.50±0.29 a* B** (0.00-1.00)	2.25±0.48 a A (1.00-3.00)	1.50±0.29 a AB (1.00-2.00)	1.50±0.29 a AB (1.00-2.00)	3.00±0.71 a A (1.00-4.00)	2.50±0.87 a A (0.00-4.00)
Pheromone –water type trap	0.25±0.25 a AB (0.00-1.00)	0.75±0.25 b AB (0.00-1.00)	0.00±0.00 b B (0.00-0.00)	0.00±0.00 b B (0.00-0.00)	1.00±0.49 b A (0.00-2.00)	0.75±0.25 b AB (0.00-1.00)
Bait trap with Grape molasses	0.00±0.00 a B (0.00-0.00)	0.00±0.00 b B (0.00-0.00)	0.00±0.00 b B (0.00-0.00)	0.00±0.00 b B (0.00-0.00)	0.50±0.29 b A (0.00-1.00)	0.00±0.00 b B (0.00-0.00)
Bait trap with Ziray	0.00±0.00 a A (0.00-0.00)	0.25±0.25 b A (0.00-1.00)	0.00±0.00 b A (0.00-0.00)	0.00±0.00 b A (0.00-0.00)	0.00±0.00 b A (0.00-0.00)	0.00±0.00 b A (0.00-0.00)

* Values with different lower case letters in the same column highlight statistically significant differences.
** Values with different capital letters in the same line highlight statistically significant differences.

During the course of the study, the number of moths caught in delta type traps, pheromone-water traps, baits with grape molasses, and protein hyrolisate baits were 45, 11, 3 and 1, respectively. The highest number of moths caught was 12 in the delta type traps in August 18, 2012. The performance of pheromone-water type traps for the same period was only 4 moths (Figure 1a, 1b and 1c).

Figure 1. The traps used to capture with the European sunflower moths [*Homoeosoma nebulellum*] (a, c) and moth in the trap (b).

2013 yılı çalışmaları

The total number of moths caught in 2013 were similar to those in 2012. Although pheromone-water traps performed better than other experimental traps, they were not as effective as the delta type traps, which were used as a control. We found differences in the number of moths caught in different trap types by counting time (trap type * counting time interaction) (F=55.725; p=0.001). The best performance was achieved on August 09, 2013 with 18.25 individuals per trap, but the performance of the bait traps with grape molasses and protein hydrolisate was very poor. The counting dates and the number of moths caught for 2013 are given in Table 2.

During the course of study the number of moths caught in delta type traps, pheromone-water traps, baits with grape molasses, and protein hydrolisate baits were 188, 112, 8 and 3 respectively. The highest number of moths caught was 73 in delta type traps in August 09, 2013. The pheromone-water type traps caught 38 moths at the same period.

The average temperature was higher in 2013 compared to 2012, whereas there were fewer days with rain (Figure 2a and 2b). Moth populations dramatically decreased due to heavy rains in July-August 2012.

Table 2. The number of moths caught in different trap types (Delta, Pheromone-water, baited with grape molasses and protein hydrolisate) in 2013 in the Kalecik district

Trap Types	Dates					
	12.07.2013	19.07.2013	26.07.2013	02.08.2013	09.08.2013	16.08.2013
Delta type trap	2.00±0.71 a* C** (1.00-4.00)	9.50±0.96 a B (7.00-11.00)	5.25±0.85a BC (3.00-7.00)	7.25±0.63 a AB (6.00-9.00)	18.25±1.89 a A (14.00-23.00)	4.75±1.11 a BC (3.00-8.00)
Pheromone – water type trap	2.75±0.85 a CD (1.00-5.00)	5.25±0.95 b BC (4.00-8.00)	6.50±1.04 a B (4.00-9.00)	2.25±0.48 b D (1.00-3.00)	9.50±1.04 b A (7.00-12.00)	1.75±0.48 b D (1.00-3.00)
Bait Trap with Grape Molasses	0.00±0.00 b A (0.00-0.00)	0.50±0.29 c A (0.00-1.00)	0.50±0.29 b A (0.00-1.00)	0.25±0.25 c A (0.00-1.00)	0.75±0.48 c A (0.00-2.00)	0.00±0.00 b A (0.00-0.00)
Bait Trap with Ziray	0.00±0.00 b A (0.00-0.00)	0.00±0.00 c A (0.00-0.00)	0.00±0.00 b A (0.00-0.00)	0.25±0.25 c A (0.00-1.00)	0.50±0.29 c A (0.00-1.00)	0.00±0.00 b A (0.00-0.00)

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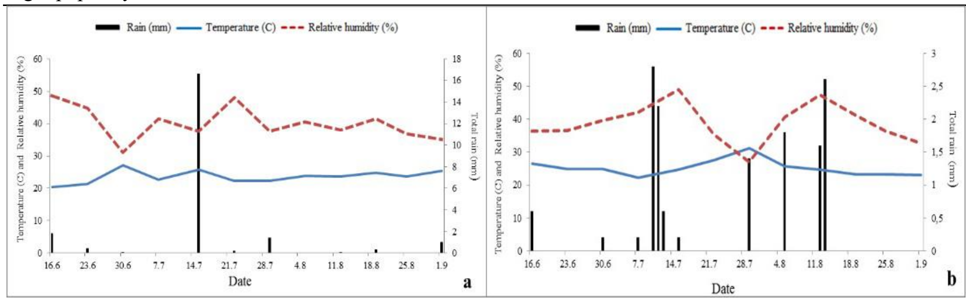

Figure 2. Climate information from the Kalecik district, Ankara in 2012 (a) and 2013 (b).

Infestation rates

We failed to find out any differences between counting dates for infection rates in terms of trap types (trap * time) (F=1.914; p=0.181). In addition, there were no differences observed in the infestation rates among the different trap types (F=2.522; p=0.107) (Table 3). However, significant differences were detected in the number of infested sunflowers in different counting dates with different traps (F=76.667; p=0.001). The first counting performed on August 06, 2012 showed an infestation rate of 7.50%, but infestation rate was increased to 10.31% in the counting performed on August 24, 2012. In 2012, the infestation rates in the last counting performed in the fields with delta, pheromone-water, molass and protein hydrolisate traps were 9.25%, 11%, 10% and 11%, respectively.

In 2013, there were no significant differences in infestation rates between counting dates in terms of trap types (trap * time) (F=1.665; p=0.227). Besides, no differences were found for infestation rates among different trap types (F=2.540; p=0.106) in the fields. But we determined some differences in the number of infested sunflowers for different counting dates (F=114.759; p= 0.001). The first counting performed in July 07, 2012 showed an infestation rate of 4.5%, whereas this rate increased to 7.5% for the counting performed in August 23, 2013. In 2013, the infestation rates in the last counting performed in the fields with delta, pheromone-water, grape molasses and protein hydrolisate traps were 7%, 7%, 9% and 7%, respectively (Table 3).

Table 3. The number of larvae counted in infested sunflowers in the fields treated with different trap types in 2012 and 2013 (Delta, Pheromone-water, bait with grape molasses and protein hydrolisate bait)

Trap Type	**2012**		**2013**	
	First counting	Last counting	First counting	Last counting
	06.08.2012	24.08.2012	26.07.2013	23.08.2013
Delta type trap	7±0.41 a* B**	9.25±0.63 a A	4±0.71 a B	7±0.41 a A
Pheromone –water type trap	8±0.41 a B	11±0.41 a A	4±0.00 a B	7±0.71 a A
Bait Trap with Grape Molasses	8±0.41 a B	10±0.71 a A	5±0.41 a B	9±0.71 a A
Bait Trap with Ziray	7±0.41 a B	11±0.41 a A	5±0.41 a B	7±0.41 a A

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Determination of the number of larvae on infested sunflowers

We found significant differences between the number of larvae caught on different dates with different traps in 2012 (trap * time) (F=7.124; p=0.005). The average number of larvae caught in the fields with delta type traps and molasses baits were lower compared to fields with protein hydrolisate baits. The average number of larvae on infested sunflowers in 2012 was 3.78, 3.60, 4.73 and 3.91 respectively for fields with delta type traps, molass bait, protein hydrolisate bait and pheromone-water baits.

In 2013, we could not find any differences between the trap types in terms of the average number of larvae between counting dates (F=0.106; p=0.955). However, there was a significant difference between fields with different traps in terms of the average number of larvae (F=4.359; p=0.027). The average number of larvae in fields with the delta type pheromone and pheromone-water traps was lower compared to the fields with molasses traps (Table 4).

There was less larvae in the fields treated with delta type traps and pheromone-water traps than other traps, but no significant differences were observed due to the percentages of infested sunflowers. In 2012, the average number of larvae with delta type, pheromone-water, molasses and protein hydrolisate traps was 3.78, 3.91, 3.60 and 4.78, respectively, whereas in 2013 the infestation rates were 2.96, 2.71, 3.55 and 3.28, respectively (Figure 3a, 3b and 3c). The total number of larvae collected was 664 in 2012 and 379 in 2013.

Table 4. The average number of larvae and moths on infested sunflowers collected from study fields with baits and pheromone-water traps in 2012 and 2013.

Trap Type	**2012**		**2013**	
	First counting	Last counting	First counting	Last counting
	06.08.2012	24.08.2012	26.07.2013	23.08.2013
Delta type trap	2.18±0.19 a* B**	3.78±0.65 a A	1.81±0.37 a B	2.96±0.43 a A
Pheromone –water type trap	2.62±0.40 b B	3.91±0.40 ab A	1.75±0.34 a B	2.71±0.21 a A
Bait Trap with Grape Molasses	2.12±0.27 a B	3.60±0.37 a A	2.40±0.32 ab B	3.55±2.14 ab A
Bait Trap with Ziray	2.28±0.18 a B	4.73±1.52 b A	1.80±0.21 a B	3.28±0.84 ab A

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Figure 3. The damage caused by the European sunflower moths (*Homoeosoma nebulellum*) on the head of a sunflower (a and b) and larvae eating seeds (c).

DISCUSSION

Although there is no study on the use of bait traps for monitoring the European Sunflower Moth, there have been many studies on other lepidopteran pests. It was shown that baits using molasses as an attractant can be used successfully for monitoring the adult flight activity of the Sainfoin seed worm (Tamer 1990). İren and Bulut (1981) reported that adult populations of *Synanthedon myopaeformis* (Bork.)(Lep.: Sesiidae) and *Cydia pomonella* (L.) (Lep.: Tortricidae) can be successfully controlled in orchards using baits with molasses. Kovanci and Walgenbach (2005) effectively monitored the populations of the oriental fruit moth in mating disruption orchards using traps baited with terpinyl acetate. Baits containing 100 ml of wine, 900 ml of water, 25 g of sugar and 25 ml of vinegar were able to catch the adults of some lepidopteran species belonging to the families of Thyatiridae, Papilionidae, Pieridae, Nymphalidae and Satyridae (Tezcan and Okyar 2004). Önuçar and Ulu (1995) reported that baits with molasses are quite promising for decreasing the population of apple clearwing moths. However, in our study, molasses and protein hydrolisate baits did show any attractivity to the adults of the European sunflower moth, with molasses giving the poorest results.

Zeki et al. (2007) reported that the population density of the European sunflower moth could be monitored by using pheromone delta type sticky traps and pheromone funnel traps. We also achieved similar results in our study, with Delta type pheromone traps and pheromone-water traps proving successful in controlling the population. Although pheromone-water and pheromone-delta type traps were effective in catching the adult moths both in 2012 and 2013, the infestation rates remained similar to other baits. This is likely due to the inadequate number of traps deployed for monitoring populations in each field. Although traps were effective in catching some of the males, surviving males managed to mate with females, and thus the infestation rates did not decrease.

Our results showed that baits containing grape molasses and protein hydrolisates were not effective in monitoring adult populations of the European sunflower moth. Since the number of adult moths captured in traps was too low, it would not be feasible to use these baits in monitoring population

Bases on our results, we concluded that delta type pheromone traps and pheromone-water traps can be effectively used to monitor adult population fluctuations of the European sunflower moth. By detecting the adult emergence and flight period times in these traps, necessary control actions could be taken and, thus excessive use of insecticides might be avoided.

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