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Original article

Determination of the parasitoids of the European sunflower moth and effectiveness in Ankara province

Ankara ilinde Avrupa ayçiçeği güvesinin parazitoitleri ve etkinliklerinin belirlenmesi

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ABSTRACT

The European sunflower moth [*Homoeosoma nebulellum* (Denis&Schiffermüller)] (Lepidoptera: Pyralidae) is one of the most important sunflower pest in Turkey. Concerning the parasitoids of this pest, the only one study was conducted in Turkey. The aim of this study is the identification of the parasitoids of the European sunflower moth. *Bracon hebetor* (Say.), *B. trucidator* (Marshall), *B. pectoralis* (Wesmael) (Hymenoptera: Braconidae) and *Exeristes roborator* F. (Hymenoptera: Ichneumonidae) were found as natural enemies. *Bracon pectoralis* was determined for the first time on the European sunflower moth in the world. Moreover, it was found that *B. hebetor* was more common among the other parasites and the rate of parasitism was high. Parasitism rate was estimated 9-30% and 0-6.6% in 2013 and 2014, respectively.

INTRODUCTION

Sunflower (*Helianthus annuus* L.), a member of Asteraceae, is an important crop plant which is prevalent in wide cultivation areas. Due to its high ratio of quality oil content around 40-50%, it is cultivated in mass areas in Turkey oil production is supplied with vegetable oils of which 65% is extracted from sunflowers and the rest is supplied with cottonseed, soybean, and other oil crop plants (Yosmanoğlu 2002).

The European sunflower moth [*Homoeosoma nebulellum* (Denis&Schiffermüller)] (Lepidoptera: Pyralidae) is the most crucial pest that affects the production of sunflower oil qualitatively as well as quantitatively. It is reported that only one larva can give harm five to eight seeds and therefore increasing number of larvae can cause high yield losses (Gamundi et al. 1987, Metayer et al. 1991). Two generations of the European sunflower moth occurred in a year of sunflowers fields of Ankara (Yücel and Çobanoğlu 2017). The only study regarding the parasitoids of the European sunflower moth in Turkey was related *Habrobracon hebetor* (Say.) and *Exeristes roborator* F. (Zeki and Öneş 1993). Reymonet et al. (1993), determined that *B. trucidator* Mars. and *H. hebetor* (Say.) (Hymenoptera: Braconidae) are parasitoids of *H. nebulella* in France. Horvath and Vecseri (2005) stated that *H. hebetor* is a natural enemy of *H. nebulellum* and could be effective in controlling the pest. Furthermore, Bei-Bienko et al. (1967) determined that *Apanteles lacteoides* Nixon and *Apanteles lacteus* Nee (Hymenoptera: Braconidae) are parasitoids of *H. nebulellum*.

It is important to identify the beneficial fauna in order to pest management strategies and therefore hinder the process of yield losses. The European sunflower moth is one of the most harmful pests in Central Anatolian region that caused many economic losses. For the purpose of employing natural enemies in pest control methods, the present study was conducted to determine the activity of parasitoids of the pest during the time period of intense harm caused by the pest. Parasitoids that have impacts on the European sunflower moth in sunflower fields of Ankara were identified in the study.

MATERIALS AND METHODS

Survey of the parasitoid species

Observation and sampling were carried out in sunflower fields located in villages of Ayaş, Bala, Beypazarı and Kalecik counties of Ankara province in 2013 and 2014. Sampling was begun in the blooming time of sunflowers and conducted once in every two weeks until harvesting (Table 1).

Table 1. Sampling dates in the study of parasitoid identification

Date	Survey	Ayaş - Beypazarı	Bala	Kalecik
2013	I	26.06.2013	27.06.2013	25.06.2013
	II	11.07.2013	10.07.2013	09.07.2013
	III	26.07.2013	24.07.2013	24.07.2013
	IV	12.08.2013	13.08.2013	14.08.2013
2014	I	02.07.2014	03.07.2014	28.06.2014
	II	18.07.2014	16.07.2014	16.07.2014
	III	06.08.2014	05.08.2014	04.08.2014
	IV	20.08.2014	19.08.2014	19.08.2014

Taking into consideration of the field size, 50 plants were sampled from ten different rows and points based on 10 da calculation. Number of plants sampled was increased in compliance with the field size (Jarvis and Guthrie 1987). Parasitical larvae were transferred to plastic Petri dishes of 9 cm diameter that have blotting papers at the bottom and cheesecloth at the top with 3 cm opening. Then, Petri dishes with larvae were cultured in climate cabinet at 24±1 °C temperature, 65±5% average humidity and 16:8 photoperiod. Parasitoids hatchings were observed during daily controls.

Effectiveness of Bracon species

Parasitoid effectiveness was determined based on the evaluation of larvae collected in 2013 and 2014 from 4 and 3 sunflower fields located in Kalecik district of Ankara province, respectively. Taking into consideration of the field size, 100 plants were sampled from ten different rows and points based on 10 da calculation (Jarvis and Guthrie 1987). For each separate field, infection of the European sunflower moth, larvae number per field, and number of parasitoids collected were determined. Identification of the parasitoid samples was done by Prof. Dr. Ahmet BEYARSLAN (Bitlis Eren University, Faculty of Arts and Sciences, Department of Biology) and Dr. Yasemin ÖZDEMİR [Plant Protection Central Research Institute (retired)].

Evaluation of the results

Parasitism ratio was calculated by modifying Briggs formula as (P/L) x 100 (P: number of larvae parasitized, L: number of larvae) (Briggs 2007).

RESULTS AND DISCUSSION

Determination of parasitoid species was begun from blooming time of sunflowers in June to until harvesting time in 2013 and 2014.

Survey of the parasitoid species

No parasitic activity was observed in the first sampling of sunflower fields in 2013. While also no parasitoid was observed in the third sampling during the second sampling of sunflowers, parasitoids were identified on pests in the fourth sampling of sunflower fields, which was conducted between 12-14 of August in 2013. *B. hebetor* (Say, 1836) was identified from Ayaş, Bala, Beypazarı, and Kalecik whereas *B.* (*Bracon*) *trucidator* (Marshall, 1888) was identified from Ayaş and Kalecik. *B.* (*Bracon*) *pectoralis* (Wesmael, 1838) (Hymenoptera: Braconidae) was also identified from Bala and Kalecik. Parasitoid *E. roborator* (Fabricius, 1793) (Hymenoptera: Ichneumonidae) was found in Bala and Kalecik. A parasitoid specimen belonged Diptera order from Kalecik could not be identified due to deformation.

There had been no observance of parasitic activity in firstly sampling of the sunflowers fields in 2014. Parasitoids were identified on pests in the third sampling of the second production between August 4-6 and in the fourth sampling of the second production between 19-20 of August in 2014. The parasitoids collected from Bala and Kalecik were identified as *Bracon hebetor* (Say, 1836) (Hymenoptera: Braconidae).

Bracon (*Habrobracon*) *hebetor* (*Say 1836*)

Material examined: Ankara-Ayaş-Gençali, (39°53'56 N 31°59'47 E, 927 m), 12.08.2013, 2♀;1♂; Oltan, (39°57'03 N 32°09'03 E, 819 m), 12.08.2013, 3♀;1♂; Bala-Akkoşan, (39°30'35 N 33°23'24 E, 935 m) 13.08.2013, 2♀;2♂; (39°28'21 N 33°23'07 E, 947 m) 05.08.2014, 2♀;1♂; Erdemli, (39°28'26 N 33°20'18 E, 783 m) 05.08.2014, 2♂; Kesikköprü, (39°53'56

N 31°59'47 E, 927 m), 13.08.2013, 2♀;2♂; (39°25'34 N 33°23'03 E, 979 m) 05.08.2014, 2♀;1♂; Beypazarı-Oymaağaç, (40°02'31 N 31°57'11 E, 967 m), 12.08.2013, 1♀; Kalecik-Aktepe, (40°10'09 N 33°29'24 E, 948 m) 19.08.2014, 4♀;2♂; Alibeyli, (40°11'17 N 33°33'04 E, 670 m) 14.08.2013, 6♀;5♂; (40°11'03 N 33°34'27 E, 616 m) 14.08.2013 4♀;1♂; (40°11'24 N 33°33'40 E, 641 m) 04.08.2014, 5♀;5♂; Hacıköy, (40°11'09 N 33°26'09 E, 846 m) 14.08.2013, 2♀;1♂; (40°11'45 N 33°25'57 E, 857 m) 14.08.2013, 2♀;1♂; (40°10'47 N 33°26'36 E, 871 m) 04.08.2014, 2♀;1♂; Gümüşpınar, (40°07'54 N 33°25'57 E, 683 m) 14.08.2013, 1♀;1♂; Tilki, (40°12'33 N 33°31'50 E, 807 m) 04.08.2014 1♀;1♂.

General distribution: Austria, Belgium, Great Britain, Bulgaria, Croatia, Cyprus, Czech Republic, Turkey, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Macedonia, Poland, Russia (Central and South), Slovakia, Slovenia, Spain, Netherlands, Serbia.

Hosts: *Ostrinia nubilalis* Hb., *Etiella zinckenella* Tr., (Pyralidae); *Pexicopia malvella* Hb. (Gelechidae); *Helicoverpa armigera* Hb., *Heliothis peltigera* Den.&Schiff. (Noctuidae).

Bracon (*Bracon*) *pectoralis* (*Wesmael 1838*)

Material examined: Ankara-Bala-Akkoşan, (39°30'35 N 33°23'24 E, 935 m) 13.08.2013, 2♀; Kesikköprü, (39°53'56 N 31°59'47 E, 927 m), 13.08.2013, 1♀;♂; Kalecik-Alibeyli, (40°11'03 N 33°34'27 E, 616 m) 14.08.2013 3♀;1♂.

General distribution: Austria, Belgium, Great Britain, Bulgaria, Croatia, Cyprus, Turkey, France, Germany, Greece, Hungary, Italy, Macedonia, Romania, Russia (Central and South), Slovakia, Spain, Switzerland, Serbia.

Hosts: *Sphenoptera lobicollis* Mar., *Sphenoptera gossypii* Kerr., *Sphenoptera montana* Jak., *Chrysobothris affinis* F. (Buprestidae); *Plagionotus arcuatus* L., *Plagionotus bobelayei* Br. (Cerambycidae); *Tatianaerhynchites aequatus* (L.) (Rhynchitidae); *Pachytychius hordei* Br. (Curculionidae); *Etiella zinckenella* Tr. (Pyralidae).

Bracon (*Bracon*) *trucidator* (*Marshall 1888*)

Material examined: Ankara-Ayaş-Gençali, (39°53'56 N 31°59'47 E, 927 m) 12.08.2013, 3♀;1♂; Oltan, (39°57'03 N 32°09'03 E, 819 m), 13.08.2013, 1♀;1♂; Kalecik-Aktepe, (40°10'06 N 33°29'56 E, 966 m) 14.08.2013, 2♀;2♂; Alibeyli, (40°11'17 N 33°33'04 E, 670 m) 14.08.2013 1♀;1♂.

General distribution: Albania, Austria, Belgium, Great Britain, Bulgaria, Croatia, Denmark, Turkey, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Poland, Romania, Russia (Central, Northwestern and South), Slovenia, Spain, Switzerland, Netherlands, Serbia

Hosts: *Metzneria lappella* L. (Gelechiidae).

Exeristes roborator (*Fabricius, 1793*)

Material examined: Ankara-Bala-Akkoşan, (39°30'35 N 33°23'24 E, 935 m) 13.08.2013, 1♂; Kalecik-Akkuzulu, (40°12'39 N 33°34'41 E, 634 m) 14.08.2013, 1♀;1♂.

General distribution: Albania, Algeria, Austria, Azerbaijan, Belgium, Bosnia-Hercegovina, Bulgaria, Canary Islands, China, Croatia, Cyprus, Czech Republic, Egypt, Finland, France, Georgia, Germany, Great Britain, Greece, Hungary, India, Iran, Israel, Italy, Japan, Jordan, Kazakhstan, Kenya, Korea, Latvia, Libya, Lithuania, Macedonia, Malta, Moldova, Mongolia, Serbia & Montenegro, Morocco, Norway, Pakistan, Poland, Romania, Russia, Slovakia, Slovenia, Spain, Sri Lanka, Sweden, Switzerland, Tunisia, Turkey, Ukraine. Hosts: *Cryptorhynchus lapathi* L., *Larinus sturnus* Schal., *Larinus cynarae* F., *Larinus scolymi* Ol., *Lixus cardui* Ol., *Pissodes harcyniae* Herb. (Curculionidae); *Pyropteron affine* Stgr., *Synanthedon formicaeformis* Esp., *Synanthedon myopaeformis* Bkh., *Synanthedon spheciformis* Den.&Schiff. (Sessidae); *Pseudococcyx turionella* L., *Rhyacionia buoliana* Den.&Schiff., *Retinia resinella* L. (Tortricidae); *Exoteleia dodecella* L. (Gelechidae); *Homoeosoma nebulella* Den.&Schiff., *Myelois circumvoluta* Fourc., *Ostrinia nubilalis* Hb. (Pyralidae); Hyperparasite of *Gregopimpla malacosomae* Sey. (Ichneumonidae). Concerning Braconidae family, the present study identified *B. hebetor* (Say.) from Ayaş, Bala, Beypazarı, and Kalecik, *B. trucidator* Mars. from Ayaş and Kalecik, and *B. pectoralis* (Wesmael) from Bala and Kalecik. Additionally, *E. roborator* F. was identified from Kalecik and Bala. Zeki and Öneş (1993) reported that they identified nine specimens of the parasitoid *Habrobracon hebetor* from *H. nebulella* moth collected in Yeniçimenli, Aksaray and identified 1 specimen of the parasitoid *E. roborator* collected from the same host in Keskin, Kırıkkale. Horvath and Vecseri (2005) pointed out that *B. hebetor* is a natural enemy of *H. nebulellum* and can be employed to controlling of the respective pest. Reymonet et al. (1993) stated that, in France, *H. nebulellum* gets parasitic by *B. trucidator* and *H. hebetor* species of Braconidae family and *Diadegma* sp. (Ichneumonidae). Aragon (2011) also reported that *Polycyrtidea pusilla* (Cress.) (Ichneumonidae) is a pupate parasite of *H. electellum* in Cuba.

Activity of Bracon species

The highest parasitism ratio was obtained for the sunflower field located in the riverside of Kızılırmak in the village of Alibeyli (Table 2). This location displayed the highest parasitism ratio because the location is known for intense production of vegetables, which brings about the prevalence of *Bracon* species.

Table 2. Related to parasitoid activity works conducted in 2013

Location	Counting	Infection of larvae (%)	Number of larvae	Number of larvae parasitized	Parasitism rate (%)	Number of parasitoid
Hacıköy I	I	2	2	0	~	0
	II	3	5	0	~	0
	III	7	16	0	~	0
	IV	11	78	7	9	17
Hacıköy II	I	0	0	0	~	0
	II	4	9	0	~	0
	III	6	21	0	~	0
	IV	8	136	15	11	28
Alibeyli I	I	0	0	0	~	0
	II	7	29	0	~	0
	III	9	72	0	~	0
	IV	12	209	46	22	73
Alibeyli II	I	3	14	0	~	0
	II	5	33	0	~	0
	III	8	96	0	~	0
	IV	10	273	82	30	102

Table 3. Related to parasitoid activity works conducted in 2014

Location	Counting	Infection of larvae (%)	Number of larvae	Number of larvae parasitized	Parasitism rate (%)	Number of parasitoid
Hacıköy	I	0	0	0	~	0
	II	1	1	0	~	0
	III	2	4	0	~	0
	IV	7	121	8	6.6	14
Alibeyli	I	1	1	0	~	0
	II	5	14	0	~	0
	III	6	74	3	4.1	8
	IV	9	211	7	3.3	9
Aktepe	I	0	0	0	~	0
	II	1	1	0	~	0
	III	3	18	0	~	0
	IV	4	38	1	2.6	1

In 2014, the highest parasitism ratio of parasites was captured in the village of Hacıköy (Table 3). Although Alibeyli village also showed parasitism in 2014, parasitic activity was less than in 2013. It is thought that parasitoid prevalence and mature larvae of the pest probably did not coincide in time due to late start and early end of the blooming time experienced in 2014.

Almost all of the Bracon species were identified as *Bracon hebetor* during the studies. It was detected that the pest larvae were parasitized by *Bracon* species by 9-30% in 2013 and 0-6.6% in 2014. Chen and Welter (2002) reported that the parasitoid *Dolichogenidea homoeosomae* (Muesebeck) (Hymenoptera: Braconidae) parasitized Sunflower moth by 11-18%. *B. hebetor* is a gregarine, idiobiont larva ectoparasitoid that employs different species of Lepidoptera as its host. The female parasitoid prefers mature larvae of its host to lay eggs (Gündüz et al. 2008). Horvath and Vecseri (2005) reports that *B. hebetor* is a natural enemy of *H. nebulellum* and can be employed to control the pest.

In the present study, parasitoids of the European sunflower moth were identified. These species were identified as; *Bracon hebetor*, *Bracon trucidator*, *Bracon pectoralis* (Braconidae), and *Exeristes roborator* (Ichneumonidae) (Hymenoptera). *Bracon pectoralis* was determined for the first time on the European sunflower moth in the world. This moth is the new host for *B. pectoralis*. Parasitoid increased its activity around the end of June and suppresses the population of the pest through August both of the growing seasons of 2013 and 2014. Thus, a natural support of *Bracon hebetor* should be sustained in sunflower fields. Especially, releasing the parasitoid species is recommended for the purpose of the biological control for the first offspring of the European sunflower moth on sunflower fields.

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ÖZET

Avrupa ayçiçeği güvesi [*Homoeosoma nebulellum* (Denis&Schiffermüller)] (Lepidoptera: Pyralidae) ülkemizde önemli bir ayçiçeği zararlısıdır. Ülkemizde zararlının parazitoitleri ile ilgili az sayıda çalışma bulunmaktadır. Çalışmamız ile zararlının Ankara ilindeki ayçiçeği alanlarındaki parazitiotleri belirlenmiştir. *Bracon hebetor* (Say.), *B. trucidator*, (Marshall), *B. pectoralis* (Wesmael) (Hymenoptera: Braconidae) ve *Exeristes roborator* F. (Hymenoptera: Ichneumonidae)'un zararlının doğal düşmanı olduğu belirlenmiştir. *Bracon pectoralis*'in zararlıyı parazitlediği dünyada ilk kez tespit edilmiştir. Parazitleme oranını belirleme çalışmalarında *B. hebetor*'un diğer parazitler arasında daha yaygın ve parazitleme oranının yüksek olduğu tespit edilmiştir. Parazitoitlerin zararlı larvalarını 2013 yılında %9–30 ve 2014 yılında %0-6.6 oranında parazitlediği belirlenmiştir.

Anahtar kelimeler: *Homoeosoma nebulellum*, parazitoit, parazitleme oranı, Braconidae, Ichneumonidae

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