Pakistan J. Zool., vol. 52(4), pp 1591-1594, 2020 **DOI**: https://dx.doi.org/10.17582/journal.pjz/20170116190155

Short Communication

Larval Parasitoids and Parasitism Rates of the Cereal Leafminer, *Syringopais temperatella* (Lederer, 1855) (Lepidoptera: Scythridae) in Cereal Fields of Northern Cyprus

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Article Information
Received 16 January 2017
Revised 18 May 2018
Accepted 25 October 2018
Available online 22 April 2020

Authors' Contribution
CG, MG, AK, RD and EA collected and cultured the samples. CG analyzed the data and drafted the manuscript.

Key words
Cereal leaf miner, *Syringopais temperatella*, Larval parasitoids, Parasitism rates, Northern Cyprus.

ABSTRACT

The cereal leafminer, *Syringopais temperatella* Lederer (Lepidoptera: Scythridae) is an important pest in barley and wheat in Northern Cyprus. This study was carried out to identify the larval parasitoids and to determine the parasitism rate of *S. temperatella*. These studies were conducted in 42 cereal fields of 18 villages in Lefkoşa, Girne, Güzelyurt, Gazimağusa and İskele townships in 2012-2013 years, and 1567 and 862 larvae were collected in the two years, respectively. Larvae were kept inside boxes covered with nets in the laboratory at 25±1◦C and 65±5% r.h. Following pupation, adult moths and parasitoids were obtained and percentage of parasitized larvae was determined. At the end of the study, *Bracon* (*Habrobracon*) *stabilis* (Wesmael) (Braconidae) and *Agathis gracilenta* Tobias (Braconidae) species from Hymenoptera order were obtained. *Bracon stabilis* (93.4%) was determined as widespread and in higher level. *A. gracilenta* was identified for the first time as larval parasitoid of *S. temperatella* and also for Northern Cyprus and Cyprus Island. The average parasitism rate in cereal fields was 34.8-18.1% in Güzelyurt, 31.8-12.2% in İskele, 21.0-8.4% in Girne, 16.2-5.4% in Lefkoşa and, 9.5-1.8% in Gazimağusa townships in 2012-2013 years, respectively.

The cereal leafminer, *Syringopais temperatella* (Lederer, 1855) (Lepidoptera: Scythrididae), which is locally known as "Sirividhi" or "Sirvis", is a serious insect pest of cereals in Cyprus (Georghiou and Shiakides, 1957; Vakis, 1975; Melifronides, 1977). Güllü *et al*. (2014) recorded the insect pests; *S. temperatella* and *Mayetiola destructor* (Say, 1817) (Diptera:Cecidomyiidae) in cereal fields in Northern Cyprus. *Syringopais temperatella* caused tremendous yield losses almost every year. The cereal leafminer was reported in wheat and barley fields in Iraq (Abu-Yaman and Jarjes, 1971; Ali *et al*., 2007), Turkey (Kaya, 1975; Güllü *et al*., 1993; Gözüaçık *et al*., 2008), Syria, Lebanon, Asia and the Mediterranean riparian countries (Daamen *et al*., 1989), Iran (Jemsi *et al*., 2002; Jemsi and Rajabi, 2003) and Jordan (Al-Zyoud, 2007). Damage done by larvae, prevents photosynthesis and desiccates the end portions of the leaves due to their feeding between epidermis, which lead to drying up of leaves. Bodenheimer (1930) reported that the damage due to cereal leaf minor increased from 30 to 90% owing to the absence of rainfall in Cyprus over the years. Dry winter and poor soils can increase the damage of larvae at changing rates from 30 to 100%. In Israel, the crop loss was recorded between 15 and 20% (Hüsseini, 1954). The pest reduced the yield by 40-60% in Turkey (Kaya, 1975). Later, Duran *et al*. (1979) estimated the reduction in the field to be around 22% in Turkey. In Iraq, the crop loss was found 10-20% (Abu-Yaman and Jarjes, 1971). In Jordan, the average grain yield reduction by cereal leafminer, *S. temperatella* was estimated at 36.1% for wheat and 50% for barley (Ghabeish *et al*., 2013).

Beside the abiotic factors, biocontrol agents play a crucial role in suppressing the pest population. Among the biotic factors, parasitoids and predators (spiders *etc.*) are significant bio-agents in infested cereal fields with cereal leafminer. Some larval parasitoid species have been recorded on this insect pest in Turkey and

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0030-9923/2020/0004-1591 $ 9.00/0

Jordan (Kaya, 1975; Al-Zyoud, 2007; Yefremova *et al*., 2007; Gözüaçık *et al*., 2008; Pirhadi *et al*., 2008). More detailed surveys on the larval parasitoid species should be conducted. Therefore, this current study was conducted to survey larval parasitoid species of *S. temperatella* and its parasitism rates in cereal fields at five districts of Northern Cyprus during the years 2012-2013.

Materials and methods

The current study was conducted in 42 wheat, barley and oat fields of 18 villages in the districts of Lefkoşa (Nicosia), Gazimağusa (Famagusta), Girne (Kyrenia), Güzelyurt (Morphou) and İskele (Trikomo) of Turkish Republic of Northern Cyprus in the years 2012-2013. A total of 1587 and 865 leaves infested with the larvae of the cereal leafminer, *S. temperatella* were collected between March and April months in the years 2012 and 2013, respectively. Larvae were kept inside boxes covered with nets in the laboratory at 25±1°C, 65±5% RH, and 16L:8D photoperiod. They were controlled daily for emergence of moths and parasitoids. Following a completion of the emergence of the moths and parasitoids, parasitism rates of *S. temperatella* larvae was calculated as the number of parasitoids over the total count of parasitoids and moths. Specimens from the parasitoid species obtained in the survey were stored in 70% alcohol in small plastic tubes and sent to Prof. Dr. Ahmet Beyarslan (Bitlis Eren University, Faculty of Science and Literature, Department of Biology, Bitlis, Turkey) for identification.

Before two-way ANOVA, the data on parasitism rates were transformed by using Arcsin Transformation. The arcsin transformed data were exposed to two-way ANOVA at Randomized Block Design for testing year and districts fixed effects handled in the survey. Mean separation for district effect was performed using Duncan multiple comparison test at 1% significance level. To measure the effectiveness of two-way ANOVA, coefficient of determination (R^2%) and adjusted coefficient of determination (Adjusted R^2 %) were estimated. All the statistical evaluations were made through SPSS 20 software program.

Results and discussion

The survey of the larvae parasitoids of *S. temperatella* in cereal fields in Northern Cyprus revealed the presence of two braconid species; *Bracon* (*Habrobracon*) *stabilis* (Wesmael, 1838) and *Agathis gracilenta* Tobias, 1963**.** *Bracon hebetor* is the most common species. Whereas, *A. gracilenta* was identified for the first time as a larval parasitoid of *S. temperatella* in Northern Cyprus. In previous studies recorded the larvae parasitoid species; including *Pnigalio pecticornis* (Linnaeus, 1758) (Hym.: Ichneumonidae) (Kaya, 1975), *Bracon stabilis* Wesmael and *Apanteles* sp. (Hym.: Braconidae) (Gözüaçık *et al*., 2008) in Turkey; *Anilastus* sp. Förster (Hym.: Ichneumonidae) (Al-Zyoud, 2007) in Jordan; *Diglyphus chabrias* Walker and *Necremnus tidius* Walker (Yefremova *et al*., 2007) and *Sympiesis euspilapterygis* (Erdos) (Hym.: Eulophidae) in Iran (Pirhadi *et al*., 2008; Talebi *et al*., 2011).

Table I.- The number of larvae and parasitism rates in cereal fields in 2012 in Northern Cyprus.

District / Locations	Species	No. of larvae of *S. temperatella*	No. of adult parasitoids	Rates of parasitism (%)
Guzelyurt (Morphou)				
Agirdag	Barley	22	2	9.1
Akcay-Aydin	Barley	70	38	54.3
Akcay	Barley	105	27	25.7
Akcay	Barley	93	35	37.6
Guneskoy	Barley	3	0	0.0
Lefkosa (Nicosia)				
Balikesir-1	Wheat	31	13	41.9
Balikesir-2	Barley	65	11	16.9
Balikesir-3	Barley	129	15	11.6
Balikesir-4	Barley	97	13	13.4
Gazikoy	Triticale	81	29	35.8
Gonyeli	Barley	184	21	11.4
Alaykoy-1	Barley	49	6	12.2
Alaykoy-2	Barley	115	13	11.3
Hamitkoy	Barley	24	11	45.8
Serhatkoy-1	Barley+ Oat	30	5	16.7
Serhatkoy-1	Barley	128	16	12.5
Gazimagusa (Famagusta)				
Cayonu	Barley	32	3	9.4
Guvercinlik	Barley	28	2	7.1
Iskele (Trikomo)				
Bogazici	Barley	12	0	0
Iskele	Barley	43	12	27.9
Kalecik	Barley	96	35	36.5
Kumyali	Barley	31	7	22.6
Girne (Kyrenia)				
Agirdag	Barley	22	2	9.1
Hisarkoy	Barley+ Oat	70	14	20.0
Tepebasi	Barley	49	11	22.4

Table II.- The number of larvae and parasitism rates in cereal fields in 2013 in Northern Cyprus.

District / Locations	Species	No. of larvae of *S. temperatella*	No. of adult parasitoids	Rates of parasitism (%)
Guzelyurt (Morphou)				
Agirdagi-1	Barley	13	7	53.8
Agirdagi-1	Barley	67	11	16.4
Akcay	Barley	47	5	10.6
Lefkosa (Nicosia)				
Balikesir	Barley	38	2	5.3
Gazikoy	Barley	65	6	9.2
Gonyeli	Barley	74	9	12.2
Alaykoy-1	Barley	114	3	2.6
Alaykoy-2	Barley	110	2	1.8
Hamitkoy	Barley	38	4	10.5
Serhatkoy	Wheat	65	1	1.5
Gazimagusa (Famagusta)				
Cayonu	Barley	36	3	8.3
Guvercinlik	Barley	8	0	0
Bogazici	Barley	11	0	0
Iskele (Trikomo)				
Kalecik	Barley	83	13	15.7
Kumyali	Barley	61	5	8.2
Girne (Kyrenia)				
Hisarkoy	Barley	12	0	0
Tepebasi-1	Barley	9	2	22.2
Tepebasi-2	Barley	14	1	7.1

The number of larvae and parasitism rates in cereal fields where the studies were conducted in Northern Cyprus in the years 2012 and 2013 are given in Tables I and II, respectively. As also understood from Tables I and II, It was observed that the highest rates of parasitism 54.3% and 53.8% were recorded in barley fields of Akçay and Aydınköy (Güzelyurt) in 2012 and Ağırdağ (Girne) in 2013, respectively. No parasitoids were encountered at Güneşköy (Güzelyurt) and Boğaziçi (İskele) in the year 2012 and Boğaziçi and Güvercinlik (Gazimağusa) in the year 2013.

Parasitism rates (the arcsin transformed parasitism rates) in cereal fields of Northern Cyprus in the years 2012-2013 are given in Table III.

Table III illustrates the results of ANOVA performed for testing the effects of district and year factors on the arcsin transformed parasitism rates examined in the survey. Both coefficient of determination (R^2 %) and adjusted coefficient of determination (Adjusted R^2 %) reflected that nearly all of the variability in transformed parasitism rate was explained by district ($P<0.01$) and year ($P<0.01$) effects, which were found very significant in the survey. On the other hand, the result revealed that these two main effects were significant sources of variation.

Table III.- Results for the arcsin transformed parasitism rates (two-way ANOVA).

Source	DF	SS	MS	F
District	4	392.608	98.152	79.38**
Year	1	307.359	307.359	248.59**
Error	4	4.946	1.236	
Total	9	704.914		
R^2 (%) = 99.30%; Adjusted R^2 (%) =98.42%				

Table IV.- Average parasitism rates (the transformed rates) of *Syringopais temperatella* in cereal fields in Northern Cyprus during the year 2012-2013.

District	Avg. parasitism rate		Avg. parasitism rate during both years (2012-13)
	During 2012	During 2013	
Guzelyurt	34.8 (35.78%)	18.1 (25.18%)	26.45 (30.48%)[a]
Lefkosa	16.2 (23.73%)	5.4 (13.44%)	10.8 (18.59%)[b]
Gazimagusa	9.5 (17.95%)	1.8 (7.71%)	5.65 (12.83%)[c]
Iskele	31.8 (34.33%)	12.2 (20.44%)	22.00 (27.39%)[a]
Girne	21.0 (27.27%)	8.4 (16.85%)	14.70 (22.06%)[b]
	27.81[A]	16.72[B]	22.27

[A, B,] the difference between the averages of two years with different letter is significant at 1% level; [a, b, c,] the difference between the averages of two locations with different letter is significant at 1% level.

Average parasitism rates and their arcsin transformed rates on *S. temperatella* in cereal fields in Northern Cyprus in the years 2012-2013 are given in Table IV. The significantly difference between the years 2012 and 2013 was found for the transformed parasitism rate and the average transformed rate in the year 2012 was remarkably higher than that in the year 2013 ($P<0.01$). The highest values in the transformed parasitism rate were obtained from Güzelyurt and İskele districts, which were similar to each other, statistically, whereas the lowest transformed rate was recorded in Gazimağusa district, which was lower compared to Girne and Lefkoşa districts.

As shown in Table IV, the highest rates of parasitism were recorded in the year 2012 compared with that in the year 2013. Highest rates of parasitism were recorded at Güzelyurt (Morphou) district in both years (35.78 and 25.18%) while the lowest were at Gazimağusa (Famagusta) district (17.95 and 7.71%) (Table II). In Jordan, Al-Zyoud (2007) reported that parasitism rate was 49.0% created by *Anilastus* sp. In Turkey, the parasitism rate was determined to be 8-10% in the years 2005-2006 (Gözüaçık *et al*., 2008). It was seen that parasitism rates varied from year to year

and from location to location. It is thought that every part of Güzelyurt and in some parts of Iskele districts have more trees, weeds and, polycultures on the basis of irrigation (citrus, potatoes, kolokas (Taro), artichokes *etc.*) causing to higher parasitism rate in comparison with Lefkoşa and Gazimağusa districts. Thus, semi-natural habitats provide natural enemies with prey and alternative hosts of pests having nutritional plant resources and together with shelter and overwintering sites (Médiène *et al*., 2011). Secondly, chemical insecticides used intensively by the cereal growers against *S. temperatella* might negatively affect the parasitoids population. For this reason, the chemical insecticides used against this pest should be of the least harmful or harmless class. In addition, the application of insecticides at the recommended doses and on time is of great importance.

Acknowledgement

We are grateful to Prof. Dr. Ahmet Beyarslan (Faculty of Science and Literature, Department of Biology, Bitlis Eren University, Bitlis, Turkey) for identifying the specimens.

Statement of conflict of interest

The authors declare no conflict of interest.

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