Original Scientific paper
10.7251/AGRENG2001054A
UDC 634.22:632.7(497.2)

BIOLOGY, ECOLOGY AND CONTROL OF THE PLUM SEED WASP [*EURYTOMA SCHREINERI* SCHREINER (HYMENOPTERA: EURYTOMIDAE)]

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ABSTRACT

The plum seed wasp, *Eurytoma schreineri* Schr. is a new pest on plum trees in Bulgaria. It is a serious pest for plums in northeastern Bulgaria. This wasp attacks the fruits of various plum cultivars. Damage by *E. schreineri* on plums ranges from 26-92%. The damage percent depends upon bioecological conditions and on the susceptibility of the plum varieties. Late-flowering cultivars are the most sensitive, where the attack can reach up to 90-92% of Stanley cultivar. This is univoltine and overwinters as a fully developed larva within stones of the fallow fruit under the plum trees. During the spring, usually in early May, the adults go out of the fallen mummified fruits and after mating the females oviposit inside the newly formed plum fruit. The egg is inserted into the endosperm of the fruit before the formation of the stone. Incubation lasts about 20-22 days, and hatch begins about the time that the plum seed embryo becomes visible. Larva development is completed by the end of June or early July, then the larvae enter diapause and remain in this state for 1-3 winters. Locally penetrating insecticides, applied when the larvae begin to hatch, provide a significant degree of larval control.

Keywords: *Prunus domestica, plum tree wasp, Eurytoma schreineri, adult emergence, northeast Bulgaria.*

INTRODUCTION

The plum seed wasp, *Eurytoma schreineri* Schr., was first described in Russia by Schreiner (1908) as a pest fruits of plum (*Prunus domestica* L.) in the Astrakhan region (Georgescu, 2006). Initially, the area of spread of the pest covered the southern parts of the European part of Russia, Western Siberia, the southern parts of the Ukraine, Armenia and Georgia Until the research of Nikolskaya (1961), this species has been identified as almond seed wasp, *Eurytoma amygdali* End., which damages the almonds and is found in Russia only in the Caucasus. In the next half of the 20 the century it spread to Moldova (Perju and Peiu, 1980), Wallachia (Copăescu, 1988) and Cluj-Napoca (Perju, 1995), Romania, and Turkey (Özbek et al., 1996). It is reported in Greece (Koveos et al., 2002), but it is also spread in the

Slovak Republic (2011), Moravia (2012) and Bohemia (2013) in the Czech Republic (Pultar, 2014).

The plum seed wasp, *E. schreineri* was detected in Bulgaria for the first time in 2013 (Arnaudov, et al. 2017) in plum orchards in the vicinity of Dobrich and Silistra, northeastern Bulgaria. After 2014 it spread widely in the northeastern parts of the country, causing serious damage to plum production. According to our previous studies, damage from Eurytoma schreineri varies from 26 to 92% depending on the location and variety of the plum orchards. At present *E. schreineri* is considered to be one of the most important pests of plum trees in northeastern Bulgaria.

Eurytoma schreineri belongs to order Hymenoptera, subdivision of Clistogastra, suprafamily Chalcidoidea, family Eurytomidae.

This species is oligophagous and attacks the kernel of the forming fruits, mainly of plums (*Prunus domestica*), *P. domestica* ssp. *Insititia* and mirabelle plums (*P. domestica* ssp. *Syriaca*). Among the preferred species are also cherry plum /myrobalan (*P. cerasifera*) and apricot (*P. armeniaca*). The appearance of this pest on sweet cherry (*P. avium*) and sour cherry (*P. cerasus*) is very rare. Blackthorn (*P. spinosa*) is less attacked, while the almond (*P. dulcis*) is not mentioned as a host (Pultar, 2014).

The pest hibernate as mature larva in the seeds of infested host plants. In late April, when ambient temperature exceeds 10^{o}C, larvae turns into pupe and when the temperature exceeds 15.6°C developed into adult. In the adult stage, it lives only 6-9 days, maximum 15-18 (Gatina, 1989; Kudreavtseva , 1985). Before leaving the pits of infected fruits, adults make round holes in the stone walls with a diameter of 1.0-1.8 mm. After the copulation, the female pierce with her egg-laying the pulp of the fetus and lay some eggs in the not yet hardened stone. The larva feeds on the seed until all or almost all of the embryo is consumed. Only one larvae develops in a fruit. The attacked fruits can not be distinguished from the healthy until they fall on the ground, until their skin becomes dry and does stick tightly to the stone (mummified fruits). The larvae, which have developed, enters into summer diapuse and then hibernate in the fallen fruit, protected by strong walls of stones, until the following spring (Perju, 2002).

The aim of this study was to investigate some aspects of *E. schreineri* biology, associated with determining adult onset and biology of the immature stages.

MATERIALS AND METHODS

The studies were conducted in commercial plum orchards, located in the region of Shumen (43.27 N/26.92 E) and Novi Pazar (43.35 N/27.20 E), during 2018 and 2019. All observations, unless otherwise stated, were made on the Stanley plum variety. In addition, temperature, humidity and rainfall were recorded at the two forecast and warning stations in Shumen and Novi Pazar throughout the study period. Periodically in winter, samples of infected plum fruits were collected under the trees and classified according to the year of production. The pits of infested plum fruits was broken and the developmental stage of *E. schreineri* was

determined. To determine the presence of exit holes and determine the period of emergence of adults, infested plum fruits were put in cages (700 pieces per cage/plum orchard) on the soil surface near the stem of the tree. In spring 2019, the number of wasps emerging from the endocarps was recorded daily. Imaginary adults were collected daily and examined in laboratory to determine the sex of individuals. During spring and early summer, infested plum fruits were sampled also to observe development of the pest. In order to determine the appropriate moment for treatment, the initial appearance of adults, in relation to temperature, biological characteristics of the pest and phenological development of the culture, were monitored daily. Insecticide tests: One contact insecticide, Karate® Zeon (active ingredient, lambda-cyhalothrine) was tested in dose 200 ml/ha. The two strategies have been tested. The first with a single treatment applied only at the beginning of the emergence and the second strategy with a second treatment applied two weeks after the first. At the harvest, the number of infested fruits was counted.

RESULTS AND DISCUSSION

The results from the field investigations were analyzed and summarized in Table 1. The plum seed wasp hibernates as mature larva in the seeds of infested host. In 2019 the first hialine pupe in the Shumen region was observed on 11.04., when the plum trees were in the phenophase 'white bud'. The end of this nymphal stage was recorded 15 days later, on 25.04. At the end of April some individuals began to turn from the stage of hyaline pupae into the black pupa stage. This process lasted until 22.05. At this nymphal stage the antenae, legs and wings of the insect were already clearly visible. The appearance of the first adults was recorded a few days after the end of the last nymphal stage, which coincides with the 'Beginning of fruit growth' (first fruits visible at raceme base) phenophase (10 days after the 'Petal fall' phenophase). Adult flight was relatively short with a duration of about 20 days. The peak of adult flight activity was observed at the end of first decade May until the mid-May. Fig. 1.

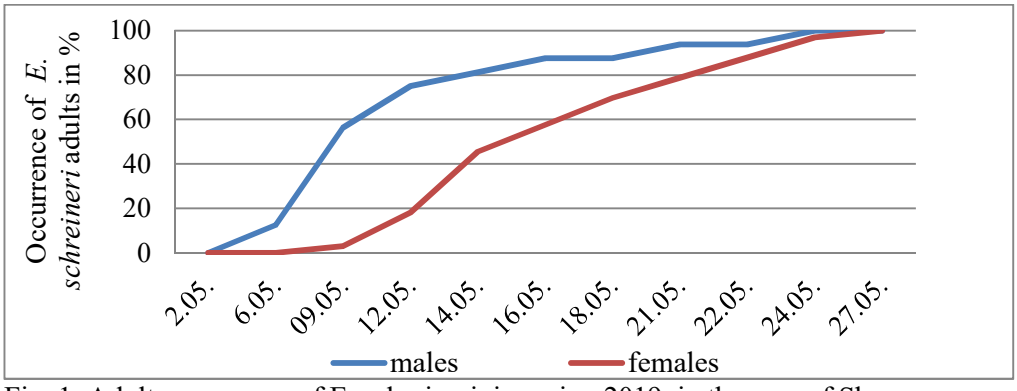

Fig. 1. Adult occurrence of E. schreineri, in spring 2019. in the area of Shumen.

From the data in Table 1 it can be seen that the number of attacked seeds in the samples is 64.8%, which indicate the high damage this pest can cause. It should be noted that the percent of larval and adult mortality is 14.8% and 32.1%, respectively. The lack of snow cover during the winter and the lack of enough rainfall in the spring (Fig. 2 and 3), we consider as the main causes of the high mortality of the wintering generation, although some authors believe that other factors may be responsible for this (fungi, nematodes and others) (Tamas et al., 2009). These assumptions fully correspond to Kudryvtseva's view that the fruits that have fallen on the dry soil are very dry and in such dry stones the adult dies because it is unable to make round holes in the stone walls of the stone (Kudryvtseva, 1985).

Table 1.Observations on the biology of *Eurytoma schreineri*, Shumen, 2019

№	Date	Phenophase	Damage seeds (%)	Vitality of the developing stages			Development stage			
				Dead larvae (%)	Dead adults (%)	Viable individuals (%)	Larvae (%)	White Pupae (%)	Black Pupae (%)	Seeds abandoned (%)
1	11.04	White bud	72	36	0	64	43	57	-	-
2	15.04	Bloom	60	34	0	66	14	86	-	-
3	25.04	Petal fall	68	36	0	64	-	100	-	-
4	30.04.		65	21	18	61	-	78	22	-
5	06.05.	Beginning of fruit growth	76	10	25	65	-	57	36	7
6	09.05.		58	7	44	49	-	43	43	14
7	13.05.		59	4	56	40	-	25	32	43
8	17.05.		61	0	63	47	-	11	18	71
9	22.05.		62	0	61	39	-	4	9	87
10	27.05.		67	0	54	36	-	-	-	100
			64,8	14,8	32,1	53,1				

The appearance of the first males was registered on 6.05., and the first female on 9.05. The male emergence preceded the female emergence of 3 to 4 days. Adults were observed in order to check the sex ratio. The results are shown in Table 2 and Fig 1.

Table 2. Sex ratio of male and female to *Eurytoma schreineri*.

Plum orchard	Number of insects examined					Sex ratio	
	Nr. total	Nr. male	Male %	Nr. Female	Female %	male	female
1	780	291	37,3	489	62,7	1	1.7
2	650	186	28,6	464	71,4	1	2,5
3	830	282	34,0	548	66,0	1	1,9
Total / Average						1	2.03

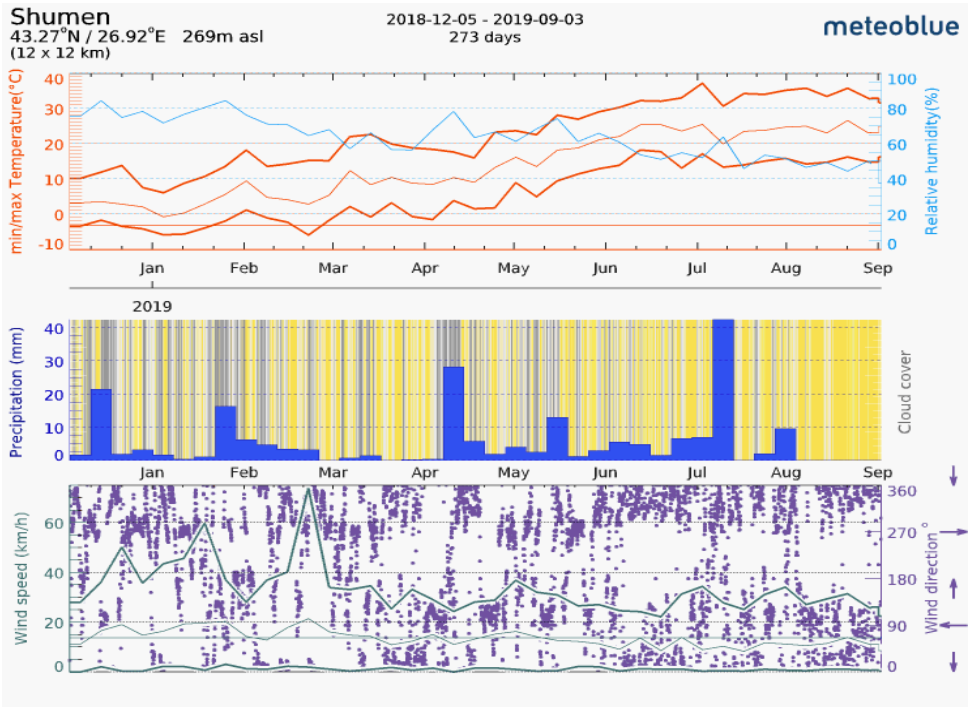

Fig. 2. Climatic conditions (temperature, humidity and precipitation) in the region of Shumen in 2019.

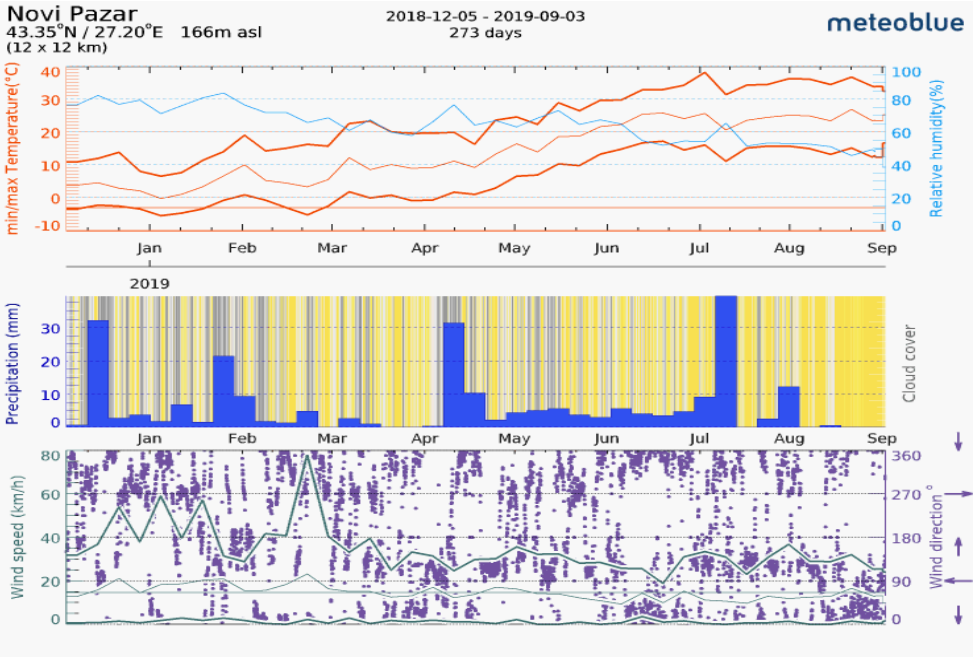

Fig. 3. Climatic conditions (temperature, humidity and precipitation) in the region of Novi Pazar in 2019.

The results from this study showed that, despite the variations between different plum gardens, the sex ratio male:female was about one male for two females and is similar to the observed ratio in the other countries (Panuta, 2008).vAfter mating, each female oviposit inside the newly formed plum fruit. The egg is inserted into the endosperm of the fruit before the formation of the stone. Incubation lasts about 20-22 days, and hatching begins about the time when the plum seed embryo becomes visible, usually at the end of May. Larval development is completed by the end of June or early July, and then the larvae enter diapause and remain in this state for 1-3 winters. Preliminary tests of Karate® Zeon showed their high effectiveness in adult control of *E. schreineri*. The results of the experiments in fields are presented in Table 3. The both applied strategies showed very good effectiveness with a low rate of infestation. The chemical control with a single treatment is cheaper and more advisable, but the optimal time for spraying at the first emergence has to be right.

Table 3. Percentage of infested fruits in plum orchards treated with one and two sprays of Karate® Zeon.

	Novi Pazar	Matnitsa	Shumen
Karate® Zeon, one spray	2,8%	2,5%	1,9%
Karate® Zeon, two sprays	1,2 %	1.0%	0.6%
Untreated control	78%	63%	42%

Locally penetrating insecticides such as thiacloprid and thiomethoxam, applied when the larvae begin to hatch, can also provide good larval control.

CONCLUSIONS

The plum seed wasp, *E. schreineri* has one generation per year in the climatic conditions of Bulgaria. This pest overwinters as mature larva in the seeds of infested host.The appearance of the first males was registered on 6.05., and the first female on 9.05. The peak of adult flight activity was observed at the end of first decade May until the mid-May. The absence of precipitation during the pupae stage leads to the death of the larvae and the adults in the pits.The male emergence preceded the female emergence of 3 to 4 days and the ratio male:female was about one male for two females. Our data shows that a protection of the plum orchards against *E.schreineri* with a single treatment of the contact insecticide Karate® Zeon is satisfactory. However, growers have to be trained to detect the first adult emergence with field cages, in order to apply the treatment at the optimal time at the first adult emergence.

ACKNOWLEDGMENTS

This study was carried out in the frame of projects RD-08-73/29.01.2019, funded by the University of Shumen.

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