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EFFECTS OF SOME ABIOTIC FACTORS ON PARASITISM RATE OF *EURYGASTER INTEGRICEPS* PUT. (HETEROPTERA: SCUTELLERIDAE) EGGS

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ABSTRACT

The present study evaluated the mean effect of temperature, humidity, leaf wetness time, rainfall, soil moisture and photoperiod on parasitism rate of Sunn Pest (SP) *Eurygaster integriceps* Put. (Heteroptera: Scutelleridae) eggs under natural conditions *Trissolcus semistriatus* Nees. These values were recorded by HOBO device until 20-30% SP eggs of were in the anchor-shaped stage. Egg parasitism rates of the SP were significantly, positively correlated with rainfall and temperature, and not significantly correlated with humidity, leaf wetness time, soil moisture and average sunlight time. The results of multiple regression analysis produced the equation *Y* = -50.662 + 16.833 R + 4.105 T [where *Y* = Parasitism rate (%), R= Rain (mm), T = Temperature (ºC)] both averaged over the period from beginning of April when egg parasitoids began to emerge from overwintering site, until the second week of May, when 20-30% of eggs were in the anchor - shaped stage. The findings suggest that the rain and temperature had a positive impact parasitism rate of the SP eggs.

Key words: Parasitism, *Eurygaster integriceps* eggs, abiotic factors, temperature, rain.

INTRODUCTION

Wheat, *Triticum aestivum* L., and barley, *Hordeum vulgare* L., are important crops in Turkey, cultivated on about 14- 15 million ha annually (Anonymous, 2013). Sunn pest (SP), *Eurygaster* spp. (Heteroptera: Scutelleridae) is the most important harmful insect pest on wheat and barley plants, causing them to wither and die prior to spike formation. They also feed at the base of the spike during the early growing period, resulting in greyish white spikes without kernels called "white spikes" (Lodos, 1961; Canhilal et al., 2005). Fourth and fifth nymphal instars and new-generation adults of the SP feed on grains (Lodos, 1982; Memisoglu and Ozer, 1992). During feeding, the insect injects digestive enzymes into the grain, reducing the baking quality of the dough. If as little as 2-3% of the grain had been fed on, the entire grain lot may be rendered unacceptable for baking purposes because of poor-quality flour (Lodos, 1982; Kinaci and Kinaci, 2007). SP was first reported in the South Anatolia Region of Turkey in 1927 and there have been many epidemics from the 1950s to the present. Studies on the SP were begun in the 1950s in Turkey (Şimsek, 1998). The government managed SP control from 1927 until 2001, when an integrated pest management approach was adopted. SP management was changed from aerial application to ground spraying, which shifted the responsibility to farmers. Currently, ground sprays for SP control are conducted on 1 to 2 million ha annually. The government provides technical support and insecticides and farmers are supposed to apply the insecticide with their equipment, as recommended by official technical consultants.

The adults of SP overwinter under bushes and litter on mountains around cereal fields where aestivation and hibernation takes place. In spring, when soil surface temperature reaches 15°C in overwintering sites, adults migrate to cereal fields.

Scelionid egg parasitoids are the most important biological control agents of SP in

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Turkey. Seventy species of egg parasitoids belonging to the genus *Trissolcus* spp. (Hymenoptera: Scelionidae) have been reared from SP eggs in Turkey (Yuksel, 1968; Simsek and Sezer, 1985; Oncuer and Kivan, 1995; Kocak and Kilincer, 2001; İslamoğlu et al., 2010, İslamğlu, 2012). Egg parasitoids overwinter as adults under bark of different trees and could play an important role in reducing SP populations if they are not disturbed by the use of broad-spectrum insecticides (Lodos, 1961; Yuksel, 1968; Simsek and Yasarakinci, 1986; Simsek and Sezer, 1985).

Climatic conditions are especially important in the spring when cold and wet conditions seriously interfere with reproduction and the survival of young parasitoids. All their vital processes, sexual maturation, feeding, egg-laying, hatching, and development, etc., occur most successfully if the weather is warm, reasonably moist and free of high winds.

Parasitoids effectiveness connected to the capacities of biotic and abiotic factors are known to be fact. Although there were many studies on the biological characters of the SP egg parasitoids, the impacts of abiotic factors were not studied. Effects of temperature, humidity, leaf wetness time, rainfall, soil moisture and photoperiod on the eggs parasitism of SP were determined. These findings can be useful in the SP control strategies of SP in future.

MATERIAL AND METHODS

The studies were carried out in Karapinar (Islahiye), Sazgın (Oguzeli) and Hancağız (Nizip) villages on the three wheat fields from 2002 to 2011. A data logger (HOBO device) was installed in each field at the beginning of the month of April when egg parasitoids began to emerge from overwintering site in each field.

Temperature, humidity, photoperiods, leaf wetness time, rain and soil moisture were recorded in each field. The values were recorded until the second week of May when 20-30% of eggs were in the anchor - shaped stage.

The surveys for egg parasitism by *Trissolcus* spp. were conducted when 20-30% of the eggs were in the anchor - shaped stage. At least 25 egg masses were collected from each field. These egg masses were brought to the laboratory and kept at room temperature. The number of healthy and parasitized eggs was recorded and the parasitism rates (%) were determined (Anonymous, 2004).

Statistical analysis

The relationship among the measured variables was evaluated using Pearson correlation and multiple regression analysis to identify factors that might affect parasitism rate in wheat fields in south-eastern Turkey. SPSS for windows Version 16.0 was used for all statistical analyses. The analysis was performed by combining the average data obtained from each field in the years 2002 to 2011. In multiple regression analysis the dependent variable was parasitism rate eggs of SP data (%); and the independent variables were average temperature, humidity, photoperiods, leaf wetness rate, rain and soil moisture.

RESULTS

SP eggs of the highest parasitism were identified in Islahiye district (55-84%) and the eggs of lowest parasitism were determined in Oğuzeli district (5-20%) between 2002 and 2011 (Table 1). There were significant ($P \leq 0.05$) correlations of parasitism rates eggs of SP with rain (Figure 2, $r=0.676$, $r^2=0.457$, $n=30$, $P=0.000$) and temperature (Figure 2, $r=0.53$, $r^2=0.289$, $n=30$, $P=0.002$) whereas there was no significant correlation with humidity ($r=0.317$, $r^2=0.019$, $n=30$, $P=0.472$), leaf wetness time ($r=0.32$, $r^2=0.104$, $n=30$, $P=0.82$), soil moisture content ($r=0.33$, $r^2=0.109$, $n=30$, $P=0.75$), photoperiods ($r=0.34$, $r^2=0.116$, $n=30$, $P=0.66$).

Stepwise multiple regression analysis of the data revealed as the best model for the relationship between parasitism rate and abiotic factors, a model including temperature and rain $Y = -50.662 + 16.833\ R + 4.105\ TEM$ [where Y = Parasitism rate (%), R = Rain,

TEM = Temperature (°C).]. This model had the best correlation (r=0.755, r^2=0.571 n=30 P=0.000). Stepwise multiple regression analysis of the data show that rain and temperature is significant for SP eggs parasitism and therefore average parasitism rate, temperature and rain was compared in wheat fields in Gaziantep province (Table 2).

Table 1. Temperature, humidity, photoperiod, leaf wetness time, rain, soil moisture and parasitism rate of Karapınar, Sazgın and Hancağız villages from 2002 to 2011

District	Village	Year	Parasitism rate (%)	Temperature (ºC)	Humidity (%)	Photoperiod (hours)	Leaf wetness time (minute)	Rain (mm)	Soil moisture (centibars)
İslâhiye	Karapınar	2002	84	18.3±0.48	66.9±1.90	12.9±0.04	304.1±49.02	3.5±1.40	125.9±11.26
		2003	82	18.4±0.60	56.0±2.63	12.9±0.04	141.3±41.22	2.6±1.30	132.2±11.02
		2004	58	17.2±0.46	56.6±2.24	12.9±0.03	134.0±33.32	0.3±0.18	165.3±8.60
		2005	62	18.0±0.56	60.2±1.93	12.9±0.04	118.8±37.33	1.4±0.01	159.7±9.06
		2006	61	17.6±0.62	78.4±2.33	12.9±0.07	126.4±31.69	0.8±0.80	162.5±4.52
		2007	58	17.5±0.67	67.4±1.54	12.9±0.05	170.0±31.33	1.7±0.69	15.2±0.10
		2008	60	18.2±0.55	61.6±1.98	12.9±0.04	110.3±29.11	0.3±0.19	114.9±0.09
		2009	68	17.0±0.51	66.9±2.26	12.9±0.04	155.7±39.19	2.6±1.09	4.4±0.07
		2010	60	18.2±0.52	67.8±1.87	12.9±0.09	204.5±42.15	1.0±0.38	7.5±0.10
		2011	55	16.5±0.50	77.3±1.49	12.9±0.08	246.8±49.38	1.0±0.32	174.4±4.81
Oğuzeli	Sazgın	2002	12	14.6±0.52	77.0±1.89	12.9±0.04	189.6±49.38	1.2±0.37	1.4±0.59
		2003	13	16.3±0.50	59.8±2.24	12.9±0.04	185.3±40.95	0.7±0.27	1.4±0.01
		2004	5	13.1±0.69	58.6±2.06	12.6±0.09	97.2±25.59	0.1±0.02	3.7±1.24
		2005	8	11.5±0.50	62.6±2.24	12.8±0.04	161.6±40.95	0.2±0.27	0.4±0.01
		2006	9	12.2±0.72	62.0±2.21	12.2±6.02	126.4±28.83	0.1±0.08	4.4±1.21
		2007	11	15.7±0.71	73.3±1.67	12.9±0.04	170.6±31.29	0.8±0.23	7.6±1.32
		2008	18	17.3±0.54	57.3±1.90	12.9±0.03	52.8±15.71	0.2±0.11	6.2±1.53
		2009	11	15.6±0.52	66.3±2.27	12.9±0.04	151.5±33.10	0.4±0.18	40.0±5.95
		2010	20	17.7±0.53	67.0±1.88	12.7±0.12	163.8±32.70	0.6±0.24	2.7±1.14
		2011	14	14.9±0.48	80.1±1.57	12.9±0.04	117.8±48.86	1.2±0.43	2.3±0.01
Nizip	Hancağız	2002	29	17.1±0.53	61.3±2.19	12.8±0.07	220.7±49.83	0.9±0.35	97.0±10.22
		2003	32	18.3±0.57	55.9±2.42	12.9±0.05	137.7±38.96	0.7±0.39	145.3±7.51
		2004	25	17.5±0.54	52.5±2.26	12.9±0.04	135.7±34.38	1.5±0.58	181.8±3.91
		2005	26	17.0±0.59	50.6±2.12	12.7±0.05	98.2±28.89	0.9±0.48	183.9±3.96
		2006	36	20.2±0.56	55.0±2.00	13.1±0.04	157.5±34.63	1.1±0.39	179.0±4.16
		2007	28	17.7±0.75	61.0±1.95	12.9±0.04	149.8±31.02	0.6±0.24	189.6±3.55
		2008	32	19.4±0.57	48.5±1.90	12.9±0.05	45.8±16.28	0.5±0.28	196.7±1.79
		2009	27	17.9±0.55	56.0±2.30	12.9±0.04	36.8±13.20	0.6±0.32	199.4±0.44
		2010	29	19.0±0.56	59.4±2.15	12.9±0.04	105.4±30.42	0.6±0.27	196.8±1.40
		2011	25	19.0±0.57	57.7±2.48	12.9±0.04	107.2±30.08	0.9±0.38	193.4±2.21

As a result of data which were obtained in Gaziantep province from 2002 to 2011, calculations result in İslahiye, Nizip and Oğuzeli district average parasitism rate, temperature and rainfall together with statistical groups are given in Table 2.

Table 2. Parasitism rate, temperature and rainfall in Gaziantep province from 2002 to 2011

District	Village	Parasitism rate (%)	Temperature (°C)	Rain (mm)
Islahiye	Karapınar	64.8±3.21a	17.7±0.20a	1.5±0.75a
Nizip	Hancağız	28.9±1.12b	18.3±0.33a	0.8±0.61b
Oguzeli	Sazgın	12.1±1.41c	14.9±0.65b	0.5±0.22b

The highest parasitism rate was observed in the Karapınar village with 64.8±3.21, the lowest parasitism rate was found in the Sazgın village with 12.1±1.41. When statistically evaluating the results of the parasitism rate of Karapınar, Hancağız and Sazgın village was found to be significant ($F_{2,27}$=159.683, P=0.00). When the temperature was compared each other, the highest average temperature at 18.3±0.33 ºC was in Karapınar village, the lowest average 14.9±0.65 was in Sazgın village. When they were statistically compared with each other, it was found to be significant ($F_{2,27}$=17.034, P=0.00). When precipitation amount area was examined, the highest average rain at 1.5±0.75 (mm) was in Hancağız village and the lowest average rain 0.5±0.22 (mm) was in Sazgın village. The differences between Karapınar, Hancağız and Sazgın village at different rain were found to be statistically significant ($F_{2,27}$=5.321, P: 0.11) (Table 2).

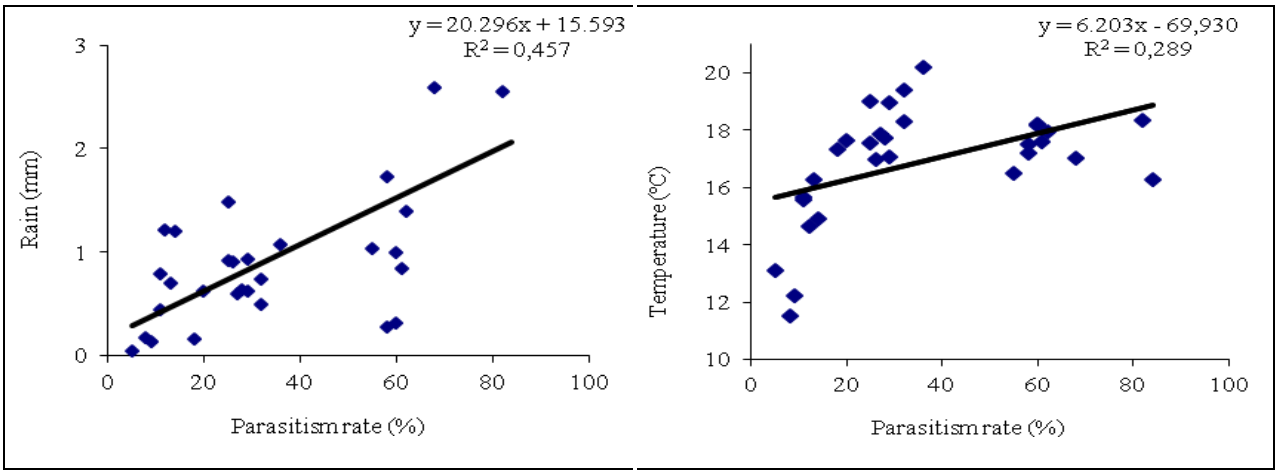

Figure 2. Parasitism rate, temperature and rainfall in Gaziantep province from 2002 to 2011

DISCUSSION

Environmental conditions have been known to be a key factor determining the outcome of ecological interactions between hosts and parasitoids species. Our results demonstrate the pronounced effect that meteorological factors can have on the parasitism rate of *Trissolcus* spp. The result indicate that rain and temperature are positively associated parasitism rate of SP eggs. Our findings were in agreement with earlier studies, which reported that *Trissolcus basalis* (Wollaston) (Hymenoptera: Scelionidae) can develop and emerge successfully over wider range of environmental conditions then *Telenomus chloropus* Thomson (Hymenoptera: Scelionidae) (Orr et al., 1985; İslamoğlu et al., 2010; İslamğlu, 2012). Another study reported that under favourable conditions the egg parasites can effectively control the SP population and ecological conditions is influence the beneficial distribution and searching ability. Accordingly, irrigation has a positive effect on the fecundity and activity of female eggs parasites, especially the hydrophilous and xerophilous species by changing the hydrothermal regime in the crop of the winter wheat (Areshnikov et al., 1987).

Temperature is one of the most important factors influencing the threshold for

development of the parasitoits and host insect. Temperature has a significant effect on longevity and oviposition and post-oviposition periods. Oviposition and post-oviposition periods and longevity decrease with increasing temperature and increasing temperature increases the fecundity rate of parasitoids and host insect.

Mean fecundity (number of eggs deposited per female) measured in other studies for other species of *Trissolcus* at varying temperatures include was 85.4 at 26 ºC for *T. semistriatus* Nees (Memisoglu, 1990) In this study, the lower threshold for development of SP eggs was estimated to be between 12.5 and 14.5 °C for males and females population and complete development required 143.8 and 124.6 degree - days respectively for males and females of the population. Thus wasps from the warmer region developed faster than those from the cooler region. but had a higher thermal threshold for initiating development Biological control programmers that seek to augment wasp populations in wheat fields early in the spring, when natural rates of SP parasitism tend to be low, should consider wasp thermal requirements to ensure the selection and release of locally adapted parasitoids (Iranıpour et al., 2010).

CONCLUSIONS

According to the study, at beginning of April and until second week of May of temperature and rain are very important factors affecting SP parasitism in Gaziantep provinces in south-eastern Turkey. Parasitism may play an important role in biological control of SP. Thus, if areas are determined in which density reached the economic threshold (10 nymphs and new-generation adults/m²) we should not immediately decide to spray especially in the rainy years. This could help reduce insecticide usage against the SP and therefore there will be a reduced need for chemical pesticides that can be damaging to the environment and human health. If the parasitoids population is augmented, one could expect reasonable SP population levels. The results, therefore, suggest that similar studies should be extended to the other regions where SP attacks are important.

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