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Effect of Some Abiotic Factors on Migration of Sunn Pest (*Eurygaster integriceps* Put.) (Hemiptera: Scutelleridae) from Aestivation Sites to Overwinteing Sites

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ABSTRACT

Although there are many pests of wheat plants, Sunn pest *Eurygaster integriceps* Put. (Heteroptera; Scutelleridae) is the most important pest in Turkey and West Asian countries. In our country, it causes important economic losses in wheat with the epidemics it has made from time to time. *E. integriceps* spends most of its life in overwintering sites. It is thought that knowing the wintering characteristics of Sunn pest will provide important advantages in the fight against this pest. In this study; The effects of air temperature, soil temperature, humidity, soil moisture and photoperiod on the migration of Sunn pest from aestivation sites to overwintering sites were investigated in 2020 and 2021. For this purpose; air temperature, soil temperature, humidity, soil moisture and photoperiod values were recorded with the HOBO device in the overwintering sites. According to the findings; The migration of Sunn pest showed positive or negative correlations with air temperature, soil temperature, humidity, soil moisture and photoperiod, respectively. According to the results of the multiple regression analysis, it was determined that the equation Y = -132.796 + 02.233 T + 11.646 P [where Y= Sunn pest (Number), T= Temperature, P= Photoperiods (H)] is appropriate. This model was determined to have the best correlation (r = 0.755, r^2 = 0.571, n = 122, P = 0.000). Moreover; It is determined that air temperature and photoperiod affect the migration of Sunn pest positively, while other parameters are not statistically significant.

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INTRODUCTION

Wheat is one of the most important food sources in the human diet in Western Asia, millions of decares are planted every year as it is a source of bread. Wheat is cultivated in almost every region in Turkey and constitutes the most important nutrient used in both human nutrition and animal nutrition. Most of the roughage needs of animals are met from wheat straw. It is a highly preferred product because the farmers are used to wheat farming and agriculture is completely mechanized. In addition, wheat is an indispensable product because it is a strategic product (Akkaya, 1994). An average of 19 million tons of product is obtained from wheat, which is cultivated on an average of 22 million decares of land in Turkey every year (Anonymous, 2013).

Sunn pest (*Eurygaster integriceps* Put.) (Heteroptera: Scutelleridae) is the most important pest of wheat in Turkey. Sunn pest made the first outbreak in Turkey in 1927 in the southern region of Turkey. The epidemic, which only took place in Adana province, spread to other provinces in a very short time and caused serious economic losses. During this period, Sunn pest collected by hand and sweep net were purchased by the state from farmers and destroyed. In the 1950s, with the development of organic phosphorus drugs, aerial spraying was started and at the same time, overwinter plants were burned to fight. Sunn pest, which was fought in this way until the 1980s, had an epidemic in all of South and Southeast Anatolia on this date. In the 1980s, ULV spraying was carried out, and in the 1990s, in 75% of the areas where Sunn pest wheat was grown began to cause economic damage. In the 2000s, aerial spraying was banned and biological control studies were emphasized in Turkey (Islamoglu *et al*., 2011).

In some very high mountains; adults of Sunn pest overwinter under bushes or litter on mountains around cereal fields as aestivation period and overwintering period. In the aestivation period of Sunn pest is in the semi-diapause period and they spend in this period in areas average altitude of 1800-2000 m. However, Sunn

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pest migrate from areas average altitudes of 1800-2000 m to areas 900-1200 m in order to be protected from extreme cold in winter (Arnoldi, 1995). This period is called the overwintering period, during this period they are in the full diapause period. Climatic factors especially temperature and humidity seriously affect in the autumn are important for survival of Sunn pest. If the weather is suitable in the autumn in overwintering area occur most successfully all its vital processes as sexual maturation and development body, etc.

With this work; In Adıyaman Nemrut Mountain, the effect of abiotic factors on the migration from the aestivation sites to the overwintering sites was tried to be determined. In addition, the effect of abiotic factors (air temperature, soil temperature, humidity, soil moisture and photoperiods) affecting the migration from aestivation sites to the overwintering areas was determined. Thus, important information about the biology of Sunn pest, which is the most important pest of wheat in our country, in the overwintering areas has been revealed.

MATERIALS AND METHODS

There are alot of overwinter in sites in Turkey. But Nemrut Mountain (37º 09′ N, 37 º 07′ E) is one of the most important overwinter sites of Sunn pest in Turkey (Yuksel, 1968). The general vegetation of overwintering site in Adıyaman Nemrut Mountain consist of *Astragalus dipthterites* Fenzl., *Noea spinosissim* Moq., *Acantholimon* sp. and *Astragalus* ssp. Sunn pest pass aestivation period and hibernation period under these plants. Sunn pest pass aestivation period and hibernation period under these plants (Simsek and Sezer, 1985).

The height of Mount Nemrut is 2150 meters, but the studies were carried out at an altitude of 1600-1800 m. Because Sunn pest is usually found at this height the most. Studies were carried out in Adıyaman Nemrut Mountain overwintering sites in 2020 to 2021 (Fig. 1).

Studies were initiated after the completion of wheat harvest and Sunn pest withdrawal to overwintering sites in late June and early July. Data longer (HOBO device) was established at the beginning of the month of July when Sunn pest begins to migrate from in wheat field to overwintering sites. Average air temperature, soil temperature, humidity, soil moisture and photoperiods were recorded in overwintering sites. The values were taken until late October. Because in this time, Sunn pests have migration from aestivation sites to overwinter sites. However, since the significant changes in the climate data took place in September and October, only September and October data were evaluated in both years.

To determine migration of Sunn pest from aestivation sites to overwintering sites, a total of 10 plants from various locations were cutted and the number of adult Sunn pest recorded every day. These proses were repeated for September and October. Overwintering site of plants were cut from the part close to the soil surface and Sunn pest found both inside the plant and on the soil surface were counted. In order to count the Sunn pest in the cut plants, the Sunn pest between the branches and leaves were manually removed by placing the plants on polyethylene sheets. In addition, the soil under the crown part of each cut plant was searched 4-5 cm below and all of them were recorded.

Fig. 1. Adıyaman Province Nemrut Mountain and the place where the works were carried out in 2020 and 2021.

Counts were continued until no live Sunn pest remained under the plant of overwintering. Thus, the migration dates of Sunn pest from the aestivation sites to the overwintering sites were determined. In addition, the effects of some abiotic factors affecting the migration from the aestivation sites to overwinter sites were determined.

Statistical analysis the relationship among measured variables was evaluated using Pearson correlation and multiple regression analysis to identify factors that might affect migration of Sunn pest from aestivation sites to overwintering sites. All statistical analyzes of the study were made in the SPSS (SPSS for windows Version 15.0) statistical program. The analysis process was performed by combining the average data obtained from Adıyaman Nemrut Mountain in the years 2020 to 2021. In multiple regression analysis the dependent variable was number of Sunn pest data; and the independent variables were average air temperature, soil temperature, humidity, soil moisture and photoperiods.

RESULTS

In the studies carried out, it was determined that the migration from the aestivation sites to the overwintering sites started in late September in both years, and this migration continued increasingly in the beginning of October and was completed towards the middle of this month. In the statistical evaluation made; There were significant ($P \leq 0.05$) correlations of migration from aestivation sites to overwintering sites with temperature (Fig. 2, $r = 0.676$, $r^2 = 0.457$, $n = 30$, $P = 0.000$) and photoperiods (Fig. 2, $r = 0.530$, $r^2 = 0.289$, $n = 122$, $P = 0.002$), whereas there was no significant correlation with humidity ($r = 0.616$, $r^2 = 0.379$, $n = 122$, $P = 0.172$), soil temperature ($r = 0.659$, $r^2 = 0.435$, $n = 122$, P = 0.62), soil moisture content ($r = 0.33$, $r^2 = 0.127$, $n = 122$, $P = 0.75$).

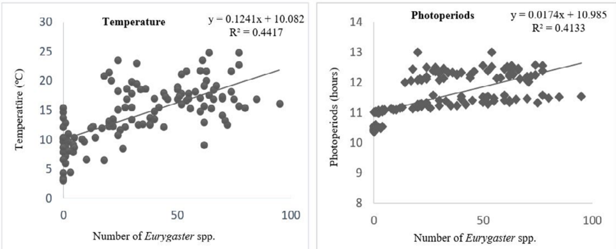

Fig. 2. Migration of Sunn pest from aestivation sites to overwintering sites, temperature and photoperiod in Adıyaman Nemrut Mountain from 2020 to 2021.

Stepwise multiple regression analysis of the data revealed as the best model for the relationship between number of Sunn pest and abiotic factors, a model including temperature and photoperiod Y = -132.796 + 02.233 T + 11.646 P [where Y= Sunn pest (Number), T= Temperature, P= Photoperiods (°C)]. This model had the best correlation ($r = 0.755$, $r^2 = 0.571$, $n = 122$, $P = 0.000$).

The temperatures at 1600 – 1800 m, where Sunn spend the most summer in the Nemrut winter quarters, are given in Figure 3. Temperature gradually decreased from September to October in both years in Mount Nemrut. Accordingly, temperatures in September 2020 varied between 22.55 and 10.27ºC, and the average temperature was 16.24. In October, air temperature in October varied between 16.93 and 3.0ºC, while the average temperature was determined to be 10.12. In the studies in 2021, it was determined that the temperatures in 2021 are relatively warmer than in 2020. Accordingly, while temperatures ranged between 24.77 and 12.52ºC in September, air temperature ranged between 17.90 and 8.57ºC in October. Average air temperatures were found to be 18.82 ºC in September and 12.17ºC in October.

Towards the end of September, when the air temperature of Sunn pest started to decrease, the migration from the aestivation site to overwintering sites started. The average air temperature in this period was 12–13ºC. Migration accelerated at the end of the further decrease in air temperature in early October and was finally completed by mid-October. The average air temperatures in this period were 8-10ºC.

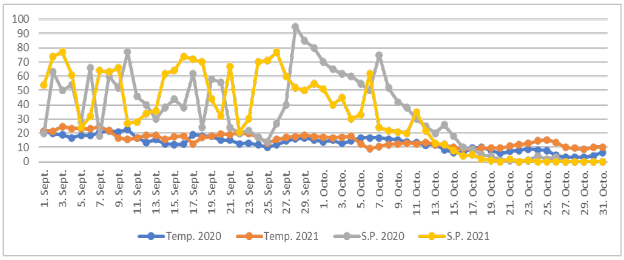

Fig. 3. Average temperatures in Adıyaman Nemrut Mountain between September and October in 2020-2021.

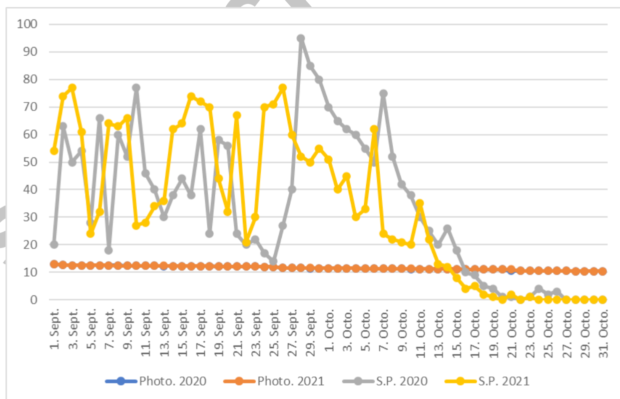

Fig. 4. Photoperiod in Adıyaman Nemrut Mountain between September and October in 2020-2021.

The photoperiod at 1600–1800 meters, where Sunn spend the most summer in the Nemrut winter quarters, are given in Figure 4. Photoperiods naturally decrease from September to October in both years on Adıyaman Nemrut mountain. Accordingly, photoperiod in September varied between 13.00 and 11.50 h, and the average photoperiod was 12.19 h. In October, October is the period when the photoperiod decreases considerably. Migration of Sunn pests from the aestivation sites to overwintering sites begins, especially from the first week of October, and increases considerably in the first week of this month and is completed towards the middle of the month.

DISCUSSION

During the two-year studies in the Nemrut Mountain Sunn pest overwintering sites in Adıyaman, it was determined that the withdrawal of Sunn pest to the overwintering sites was completed at the end of June and the beginning of July. Sunn pest remained in semi diapause under wintering plants until the end of July, August and September. Sunn pest migration from the summer areas to the wintering areas started when the air temperature drops to 12–13°C and the average photoperiod is 12.19 h.

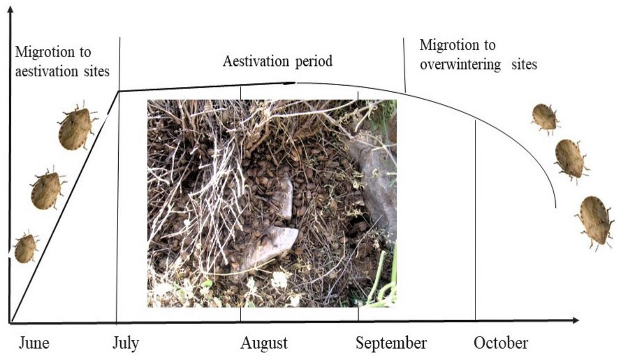

Fig. 5. Sunn pest migration from the aestivation sites to the overwintering sites in Adıyaman Nemrut Mountain in 2020-2021.

Sunn pest migration from the aestivation sites to the overwintering sites continued until the middle of October (Fig. 5). In our study, it has been determined that temperature is one of the two most important factors in the migration of Sunn pest from the aestivation period to the overwintering period, in other words, in the migration from the aestivation sites to the wintering sites. One of the most important factors affecting the development threshold of insects is temperature. In addition, it has been determined that the temperature has important effects on the life span of insects, oviposition and post oviposition periods (Honek and Kocourek,1990; Chapman, 1998). It has been determined that the temperature affects the biological performance of insects such as the development time of the pre-adult stages, the life span of the adults, the mating and reproduction parameters, the start and end times of the diapause (Kontodimas and Stathas, 2005; Cabral *et al*., 2006). In addition, it was determined that the effect of temperature on the rate of development of diapause was significant (Tauber *et al*., 1986). Insects sense the approach of winter thanks to the photoperiod. Therefore, insects in temperate climatic zones generally use the photoperiod to predict adverse conditions (Amiri *et al*., 2011). Many insects go into a state of low metabolism using environmental cues such as photoperiod or air temperature. Thus, it has been reported that they continue their lives by making specific physiological, behavioral and morphological changes in order to survive in adverse conditions (Saunders, 1982; Tauber *et al*., 1986).

It has been observed that different results have been obtained in various studies on the wintering movements of Sunn pest. In the study conducted by Parker *et al*. (2007). in Iran in recent years, they stated that except for the winter in the province of Azerbaijan, which is quite high and flat, the Sunn pest migrates to the wheat field only in March, while there is a migration from high areas to lower altitudes in the autumn in the Azerbaijan overwintering areas. In another study conducted in Iran; Parker *et al*. (2007) reported that at Mount Ghara-agadj (at 1780–2420 m altitude) near Tehran, in the spring Sunn pest migrated to higher altitudes in the summer and then overwintered there and migrated to the wheat fields to feed again in the spring. At the end of the writing period of Sunn pest, some of the Sunn pest migrated to lower elevations (Brown, 1962, 1965). In another study conducted in Ukraine; Arnoldi (1995) reported that Sunn pest migrated to the higher parts of the mountain during its migration to winter quarters, spent the summer period here, and migrated to the lower heights of the mountain towards the end of autumn.

As a result of our studies carried out for two years in Adıyaman Nemrut overwintering sites; abiotic factors are important in the migration of Sunn pests that overwintering sites from their aestivation sites to their wintering sites. Among the abiotic factors such as average temperature, soil temperature, humidity, soil moisture and photoperiods, the most important factors in the migration of Sunn pest from aestivation sites to overwintering sites are air temperature and photoperiod. Towards the end of September, with the decrease in temperature and the shortening of the photoperiod, Sunn pest began to migrate from aestivation sites to overwintering sites. As a result of both the decrease in temperature and the shortening of the photoperiod, migration of Sunn pest from aestivation sites to overwintering sites increased. Towards the middle of October, the air temperature dropped and the photoperiods decreased considerably, and the migration of Sunn pest from the aestivation sites to the overwintering sites was completed. As a result, first of the two most important factors in overwintering sites migration of Sunn is air temperature and the other factor is photoperiod.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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