Quest Journals
Journal of Research in Agriculture and Animal Science
Volume 10 ~ Issue 12 (2023) pp: 07-11
ISSN(Online) : 2321-9459
www.questjournals.org

Research Paper

Parasitism Rate of *Hexamermis* sp. (Nematoda: Mermithidae) on Sunn pest (*Eurygaster integriceps*) (Heteroptera; Scutelleridae) at Different Altitudes in Adıyaman Nemrut Mountain

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ABSTRACK
The most important factor affecting quality and cost in wheat production areas is harmful insects. Sunn pest, Eurygaster integriceps Put. (Heteroptera: Scutelleridae) is one of the most economically important pests of wheat in the Southeastern Anatolia Region of Turkey. Adults of this pest overwintering for approximately nine months under various plants in wintering areas or in the soil around the roots. During this period, Hexamermis sp. (Nematoda: Mermithidae) in wintering areas is one of the important natural enemies of E. integriceps. This natural enemy is thought to have an important potential as a biological control agent in suppressing the pest. This study was conducted in Adıyaman Nemrut Mountain overwintering area, one of the most important overwinter area in Turkey, in 2020 and 2021. As many Sunn pest as possible were collected by hand from 4 different altitudes (900 – 1000, 1000 – 1100, 1100 – 1200, 1200 – 1300 meters) in early March, before the migration from wintering grounds to the plains had started. Thus, parasitism rates in male and female individuals at different altitudes were determined. According to the results obtained; It was determined that the parasitism rate of Hexamermis sp in overwintering area was at different overwintering area elevations. The highest parasitism rate was at 1000 - 1100 meters in both years of the study, followed by parasitism rates at 1100 - 1200 meters altitude were determined. It was determined that the parasitism rates at 900 – 1000 and 1200 – 1300 meters were lowest. Parasitism rates in male individuals are relatively lower than in females were determined.

Anahtar Kelimeler: *Sunn pest, Hexamermis sp., Overwintering area, Parasitism*

***R**eceived 05 Dec., 2023; **R**evised 15 Dec., 2023; **A**ccepted 17 Dec., 2023 © The author(s) 2023.*
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I. INTRODUCTION

The world population is increasing rapidly and the need for food is increasing accordingly. Wheat, which is used both as human food and animal feed, is a strategic product (Akkaya, 1994). Wheat ranks first among the cultivated plants used in human nutrition in terms of cultivation and production in the world. This is because the wheat plant has a wide adaptability. In addition, wheat grain is the basic food of approximately 50 countries due to its appropriate nutritional value and ease of storage and processing. Wheat provides the world's population with approximately 20% of the total calories from plant-derived foods. This rate is 53% in our country. Wheat is used in many food and industrial sectors, especially bakery products. (Lodos, 1961, 1982).

There are many pests, diseases and weeds that cause damage during wheat production. Among the pests, Sunn pest, Eurygaster spp. (Heteroptera: Scutelleridae) is the main pest that negatively affects wheat production in terms of quality and yield both in our country and in some other countries (Critchley, 1998). Sunn pest is one of the most important pests that limits wheat production or negatively affects wheat quality in Western and Central Asia and Eastern Europe. (Brown, 1961, 1965; Critchley, 1998; Parker et al., 2002; Islamoglu and Kornoşor, 2010).

When Sunn pest migrate from overwintering grounds to the plains in the spring, they cause significant damage to the crops by feeding on the leaves, stems and grains of the wheat plant. Sunn pest pierce the grain of the wheat plant with their stylets and inject digestive enzymes through the salivary duct to liquefy the grain contents into slurry to absorb the hardened grain (Dizlek and Islamoglu, 2015; Mehrabadi et al., 2009). Proteolytic

and amylolytic enzymes injected into wheat grains reduce the baking quality of the flour by deteriorating the properties of their gluten (Hariri et al., 2000; Radjabi, 2000; Amin et al., 2004; Allahyari et al., 2010). The resulting bread burns easily, does not rise, and often has a bad taste. If the absorption rate in grains is above 2%, wheat ceases to be an export product. In places where the density of Sunn pests is high, when there is no fighting; It is known that it causes up to 100% damage, especially in wheat for bread, pasta and seeds (Hariri et al., 2000; Radjabi, 2000) .

The most important natural enemies of the insect are the egg parasitoids *Trissolccus* spp. (Hymenoptera: Scelionidae) species. Apart from these, there are adult parasitoids (Tachinidae) and some disease agents. Entomopathogenic nematodes also have an important place in this natural enemy complex. *Hexamermis* spp. (Nematoda: Mermithidae) in the Nemrut overwintering area and, as a result, determining their natural parasitism rates are important for the development of IPM strategies.

In this study, the presence of *Hexamermis* spp. in Adıyaman Nemrut Mountain overwintering area at different altitudes and the parasitism rates in male and female individuals were determined. Thus, it is aimed to put into practice a new and different struggle method that is sustainable and reliable in terms of environment and human health in the control against Sunn pest.

II. MATERIAL AND METHOD

The materials of the study were plastic jars of various sizes, petri dishes, cotton, prince and sterile water.

Determination of Parasitism Rate with Entomoparasitic Nematodes *Hexamermis* spp **in Overwinterings Areas**

The Adıyaman Nemrut Mountain overwintering area, where the studies were carried out, was visited in early March, before the migration of the Sunn pest from wintering area to the plains had started, and as many Sunn pest as possible were collected by hand from 4 different altitudes (900 - 1000, 1000 - 1100, 1100 - 1200, 1200 - 1300 meters) under the plants and plant residues where they were overwintering collected. The collected Sunn pest were placed in plastic jars and bags and brought to the laboratory in an ice box. Male and female Sunn pest collected in the laboratory were dissected separately and their contamination status was checked. Thus, parasitism rates in ♀ and ♂ individuals at different altitudes before migration were determined.

To determine the parasitism status of Sunn pest migrating from the overwintering area to the plains, 100 ♀ and 100 ♂ individuals were collected by hand and trap from 4 different wheat fields. The collected Sunn pest were brought to the laboratory in an ice box. Individuals brought to the laboratory were dissected after being killed and checked for entomoparasitic nematodes. Thus, the parasitism rates of ♀ and ♂ individuals in these periods and the number of nematode larvae in each individual were determined. Since parasite-infested individuals could not be obtained, emphasis was given to studies on overwintering areas.

III. FINDINGS AND DISCUSSION

Sunn pest collected from under overwintering plants at different altitudes (900 – 1000, 1000 – 1100, 1100 – 1200, 1200 – 1300 meters) in Nemrut Mountain in Adıyaman province in 2020 were brought to the laboratory and dissected and parasitism with Hexamermis sp. parasitism rates are given in Figure 1.

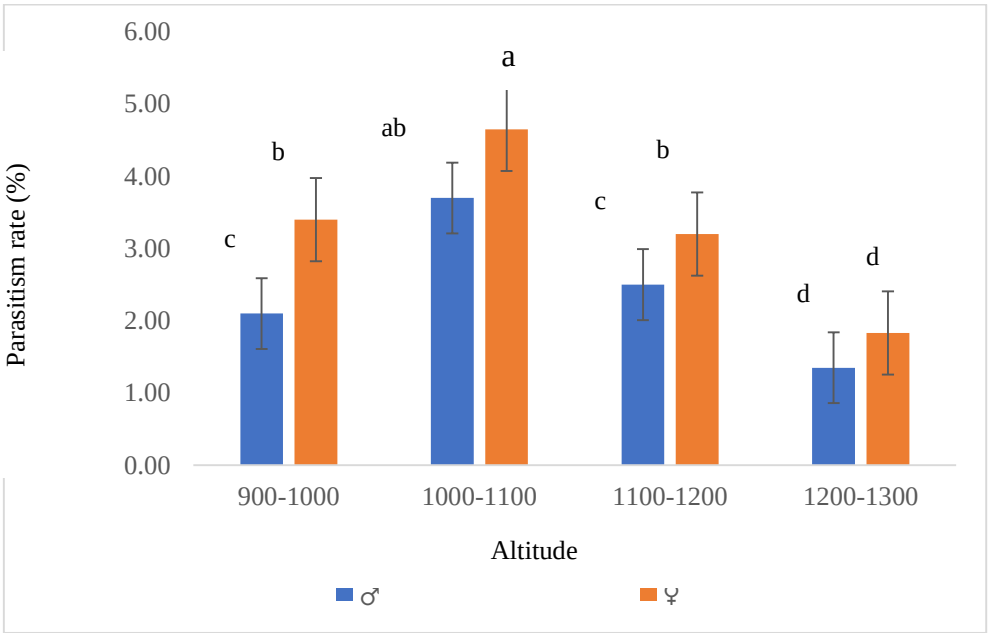

Figure 1. Male and female of Sunn pest individuals parasitizm status with Hexamermis sp at different altitudes in Adıyaman Nemrut Mountain in 2020.

When Figure 1 is examined, a total of 271 Sunn pest were collected from an altitude of 900 - 1000 meters in 2020, 8 of them were found to be parasited with entomopathogenic nematodes. Accordingly, the average parasitism rate was determined to be 2.95%. While 2 of 95 male individuals were found to be parasitic, 6 of 176 female individuals were found to be parasited. Accordingly, the parasitism rates in male and female individuals were determined to be 2% and 6%, respectively.

In 2020, 108 male individuals were collected from 1000 – 1100 meters altitude. While 4 of the male individuals were found to be parasitized, the parasitism rate in males was found to be 3.70%. Accordingly, it was determined that the parasitism rate in female individuals was 4.65%. 280 Sunn pest were collected from an altitude of 1000 - 1100 meters and 12 of them were found to be parasited. Accordingly, the average parasitism rate was determined to be 4.20%.

In 2020, a total of 245 Sunn pest were collected from an altitude of 1100 - 1200 meters and 7 of them were found to be parasited with entomopathogenic nematodes. Accordingly, the average parasitism rate was determined to be 2.85%. While 3 of 120 male individuals were found to be parasited, 4 of 125 female individuals were found to be parasited. Accordingly, the parasitism rates in male and female individuals were determined to be 2.5% and 3.2%, respectively.

In 2020, 74 male individuals were collected from 1200 - 1300 meters altitude. While 1 male individual was found to be parasitized, the parasitism rate in males was found to be 1.35%. It was determined that 3 out of 164 female individuals were parasited. Accordingly, it was determined that the parasitism rate in female individuals was 1.83%. 238 Sunn pest were collected from an altitude of 1200 - 1300 meters and 4 of them were found to be parasited. Accordingly, the average parasitism rate was determined to be 1.68%.

When the 2020 period is evaluated overall, 397 male individuals were collected. While 10 of the male individuals were found to be parasitized, the parasitism rate in males was found to be 2.51%. It was determined that 21 of 637 female individuals were parasited. Accordingly, it was determined that the parasitism rate in female individuals was 3.29%. In 2020, a total of 1034 Sunn pest were collected and 31 of them were found to be parasited. Accordingly, the average parasitism rate was determined to be 2.99%. In 2020, it was determined that the parasitism rates in male individuals were relatively low and the parasitism rate in female individuals was higher.

Sunn pest collected from under overwintering plants at different altitudes (900 – 1000, 1000 – 1100, 1100 – 1200, 1200 – 1300 meters) in Nemrut Mountain in Adıyaman province in 20201 were brought to the laboratory and dissected and *Hexamermis* spp. the rates of Sunn pest parasited with are given in Figure 2.

When Figure 2 is examined, a total of 170 Sunn pest were collected from an altitude of 900 - 1000 meters in 2021, and 4 of them were found to be parasited with entomopathogenic nematodes. Accordingly, the average parasitism rate was determined to be 2.35%. While 1 of 45 male individuals was found to be parasited, 3 of 125 female individuals were found to be parasited. Accordingly, the parasitism rates in male and female individuals were determined to be 2.22% and 2.40%, respectively.

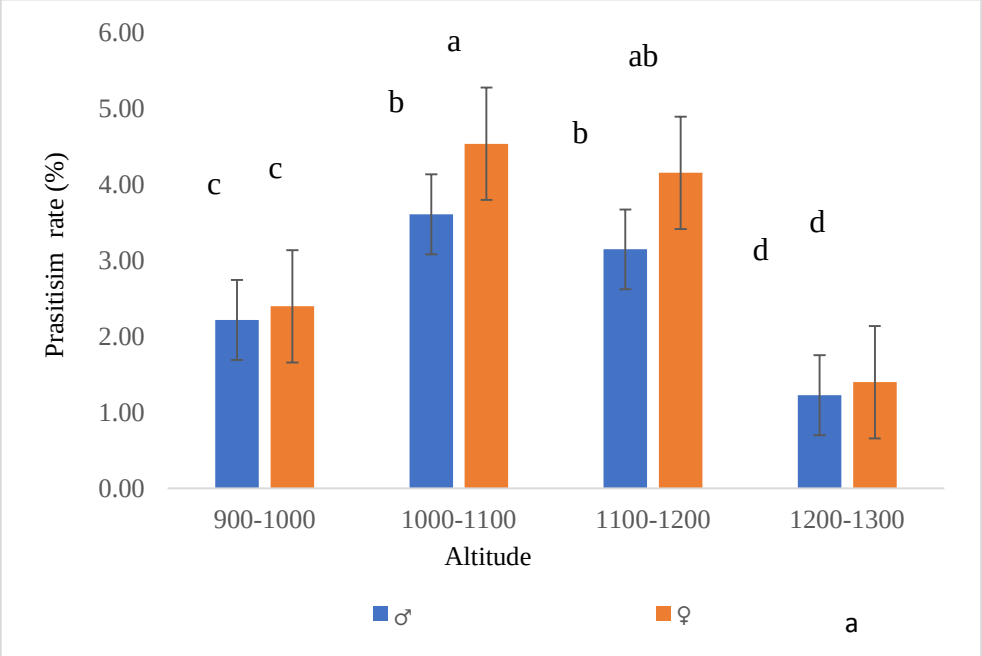

Figure 2. Male and female of Sunn pest individuals parasitizm status with Hexamermis sp at different altitudes in Adıyaman Nemrut Mountain in 2021.

In 2021, 83 male individuals were collected from an altitude of 1000 - 1100 meters. While 3 of the male individuals were found to be parasitized, the parasitism rate in males was found to be 3.61%. It was determined that 6 out of 132 female individuals had parasites. Accordingly, it was determined that the parasitism rate in female individuals was 4.54%. 215 Sunn pest were collected from an altitude of 1000 - 1100 meters and 9 of them were found to be parasited. Accordingly, it was determined that the average parasitism rate was 4.18%.

In 2021, a total of 191 Sunn pest were collected from an altitude of 1100 - 1200 meters, and 7 of them were found to be infected with entomopathogenic nematodes. Accordingly, the average parasitism rate was determined to be 3.66%. While 3 of 95 male individuals were found to be parasited, 4 of 96 female individuals were found to be parasited. Accordingly, the parasitism rates in male and female individuals were determined to be 3.15% and 3.12%, respectively.

In 2021, 81 male individuals were collected from 1200 - 1300 meters altitude. While 1 male individual was found to be parasitized, the parasitism rate in males was found to be 1.23%. It was determined that 2 out of 142 female individuals were parasited. Accordingly, it was determined that the parasitism rate in female individuals was 1.40%. 223 Sunn pest were collected from an altitude of 1200 - 1300 meters and 3 of them were found to be parasited. Accordingly, the average parasitism rate was determined to be 1.34%.

When the 2021 period is evaluated overall, 304 male individuals were collected. While 8 of the male individuals were found to be parasitized, the parasitism rate in males was found to be 2.63%. It was determined that 15 of 495 female individuals were parasited. Accordingly, it was determined that the parasitism rate in female individuals was 3.03%. In 2021, 799 Sunn pest were collected and 23 of them were found to be parasited. Accordingly, the average parasitism rate was determined to be 2.87%. It has been determined that the parasitism rates in male individuals in 2021 are relatively low, as in 2020, and the parasitism rate in female individuals is higher, as in 2020.

When the transmission rates of *Hexamermis* sp. in overwintering area were evaluated in general, it was determined that the transmission rates were different in different overwintering area altitudes. As a matter of fact, in the statistical analysis, a statistical difference between the altitudes of 900 - 1000, 1000 - 1100, 1100 - 1200, 1200 - 1300 meters was found to be significant (for 2021; F1, 58 = 1.115, P = 0.005 and for 2022, F1, 58 = 1.225, P = 0.002) was detected. The highest infection rate was at 1000 - 1100 meters in both years of the study, followed by the parasition rates at 1100 - 1200 meters altitude were determined. The contamination rates at 900 - 1000 and 1200 - 1300 meters were lowest were determined. In studies conducted in 2020 - 2021, it was determined that female individuals were more parasitized than male individuals at all altitudes. The t-test determined that the infection rate in females was higher than in males (t-test: t_{58} = 25.164, P = 0.00).

In the studies carried out in the wheat field, 211 Sun pest were collected by hand and with a trap in 2020, and 302 Sunn pest were collected in 2021 and brought to the laboratory and dissected. However, no entomopathogenic nematode species belonging to the *Hexamermis* genus were found in any of the individuals brought from the wheat field.

IV. CONCLUSION

In this study, it was investigated at which altitude the species belonging to the genus Hexamermis, which cause parasitism in Sunn pest, are found most in overwintering areas, which are important for our country.

Although it has been reported that there is no parasited with this entomoparasitic nematode in Nemrut Mountain, which is an important overwintering area in the Southeastern Anatolia Region, where the worm is a significant problem, this study has determined that the species belonging to the *Hexamermis* genus are found to be less effective at different altitudes. Studies on this entomopathogenic nematode in the world indicate that it has a wide range of hosts from the Coleoptera order, including some beneficial coccinellids (Nickle. et al., 1984). Memişoğlu and Özer (1992, 1994) reported that the mortality rate caused by parasitic nematodes was 15.5% and 7.2% in 1983 and 1984, respectively. Tarla et al. (2012) reported that parasitism rates in 2008 and 2009 were 13.8% and 16.0% in females and 7.5% and 7.1% in males, respectively.

THANKS

I would like to thank Ahmet Furkan İSLAMOĞLU and Berkan İSLAMOĞLU, who gave me all their support in our field work and helped me with the censuses.

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