The biology and population dynamics of the bulb mite, Rhizoglyphus robini Claparede (Acari: Acaridae)

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Article

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Abstract

In this study, the population dynamics of Rhizoglyphus robini Claparede (Acari: Acaridae) were examined in two distinct garlic and onion cultivation regions within Kastamonu Province during the years 2018–2019. Weekly samplings were conducted separately from both the bulb and green parts of onion plants at each location. No pesticide applications were made in the areas where the population density of R. robini was assessed. During each growing season, 12 samples were collected from each onion site, resulting in a total of 48 samples for this study. The fluctuations in population density displayed similarities between the two locations, with average intensity values in the bulbs reaching their peak, particularly in May and June. Conversely, no significant density was observed in the green parts of the onions, as the mite population in these areas remained at a low level.

1. INTRODUCTION

Onion (*Allium cepa* L.) and garlic (*Allium sativum* L.) are among the oldest cultivated plants, utilized for both culinary and medicinal purposes. These widely recognized food sources are abundant in various phytonutrients, which are regarded as vital constituents of the Mediterranean diet. Additionally, they are employed in the treatment and prevention of numerous health conditions, including cancer, coronary heart disease, obesity, hypercholesterolemia, type 2 diabetes, hypertension, cataracts, and gastrointestinal disturbances such as colic pain, flatulent colic, and dyspepsia. The health-promoting effects of these plants are attributed to thiosulfinates, volatile sulfur compounds responsible for their characteristic pungency. (Lanzotti, 2006).

The Acaridae family encompasses a significant proportion of the plant pest mites classified within the Astigmata order. Notably, the majority of these mites are fungivorous, with some exhibiting facultative phytophagy. Additionally, certain species within this family are known to parasitize various insects and vertebrates. The Acaridae family is extensive, with members distributed globally, comprising over 400 identified species across nine genera. The genus *Rhizoglyphus* is particularly detrimental, as its species cause damage to the roots and other subterranean plant structures. Important species within the genera Acarus and *Tyrophagus* also warrant attention. The *Rhizoglyphus* genus includes species of significance that have been documented in storage facilities, ornamental plants, and greenhouses, with *Allium* spp. and species from the Liliaceae family identified as primary hosts (Fan and Zhang, 2003). A review of global studies indicates that the genera *Rhizoglyphus* and *Tyrophagus* (Acari: Acaridae) are among the most harmful to bulbous plants. *Rhizoglyphus robini* (Claparede) (Acari: Acaridae) has been identified as a significant pest species (Gerson et al., 1985; Kuwahara, 1985; Ho and Chen, 1987; Diaz et al., 2000). Gerson et al. (1983) reported that *Rhizoglyphus robini* is a damaging mite species found in onion bulbs, resulting in considerable economic losses, and it is capable of sustaining its vitality at a temperature of 35°C.

The two most prevalent mite species, *Rhizoglyphus echinopus* and *Rhizoglyphus robini*, are likely cosmopolitan and pose a threat to a diverse range of crops including onions (*Allium cepa*), various other

Allium species, as well as *Lilium*, *Hyacinthus*, and numerous vegetables, cereals, and ornamentals in various environments such as storage, greenhouses, and fields. Managing these soil pests is made challenging by several factors, including the absence of effective sampling techniques for evaluating field populations and forecasting outbreaks, the lack of integrated management strategies, and limited understanding of their field biology and ecology. The management of bulb mites is further complicated by their rapid generation time, substantial reproductive capacity, extensive food preferences, interactions with other pests and pathogens, and distinctive adaptations for dispersal. Traditionally, control measures for these acarine pests have depended on the application of synthetic miticides and insecticides; however, this method is increasingly restricted due to established resistance and the withdrawal of registration for certain products. Alternative control strategies, encompassing cultural and biological control, have exhibited limited efficacy; however, further development and implementation are necessary. (Díaz et al., 2000; Straub, 2004).

In this study, *R. robini* was identified as the predominant harmful species in the region. The population density of *R. robini* was assessed in onion crops in Kastamonu.

2. MATERIALS AND METHODS

In the samplings, a total of five plants, including roots from each field, were collected for the bulb and green parts. Upon arrival at the laboratory, the samples were severed using a knife to ensure separation of the bulb and leaves, subsequently placing them into Berlese funnels for extraction. The green parts were examined microscopically to detect live mites prior to extraction. Following the extraction process, diagnostic assessments were conducted on the samples. Density studies were performed biennially in the same onion fields during the years 2023 and 2024, specifically in Kovalca Village-Centrum (41°29'17.27" N, 33°50'33.52" E) and Ahmetbey Village-Centrum (41°27'35.00" N, 34°47'41.52" E) (Fig. 1).

2.1 Statistical analyses

To analyze the density of *R. robini*, which adversely affects *Allium cepa*, a one-way analysis was conducted to ascertain the number of mites and the variance in temperature and humidity values. Following the determination that there was no statistical difference in density, temperature, and humidity between the two designated areas, the relationship between the number of mites and the temperature and humidity values for each evaluated park was examined using correlation analysis based on field data. Measurements were conducted under a microscope, with a minimum of ten mites assessed in micrometers (μm). Mean and standard error values were calculated. Climate data (temperature and humidity values) were obtained from the local meteorological station.

3. RESULTS

3.1 Definition of *Rhizoglyphus robini* (Claparede), 1869

Order Astigmata

Family Acaridae

Genus *Rhizoglyphus* (Claparédè), 1869

Rhizoglyphus robini (Claparede), 1869

Synonymous: *Rhizoglyphus rhizophagus* Banks 1906, *Rhizoglyphus solani* Oudemans 1924, *Rhizoglyphus feculae* Oudemans 1937, *Rhizoglyphus echinopus* Zakhvatkin 1941, *Rhizoglyphus hyacinthi* Boisduval ve Southcott 1976 (Diaz *et al.*, 2000).

Width: 427,50 ± 0,98 (292,46–564,86), Length: 652,35 ± 1,18 (470,83 798,84) (n:10). They are relatively large mites. Adults are milk-white in color, length up to 1.1 mm. The external vertical seta and the internal scapular seta are generally short in adults. The hairs in the inner scapular set are microsetian. Tarsi I and tarsi II are found on solenidion, sigma I, II. Gnathosoma and legs are brown. In male, a pair of anal succer on anal plate, while the female is in *receptaculum seminis* (Fig. 2). The male adult is 603–671 μm long. Dorsal idiosomal seta is short. Seta (sci) is 7–25 μm long. The supracoxal set is thin and has a length of 14–39 μm. Aedeagus is narrow and conical. In the Tibia IV, the dorsal spine has a solid structure and is 10–13 μm long. The adult female is 676–934 μm long. The copulatrix of Bursa was opened to the inside of the closed Reseptaculum semilis with two open V-shaped plates (Fan and Zhang, 2003).

Distribution

Austria, Australia, Belgium, Canada, China, Egypt, England, France, Germany, Greece, Holland, Israel, Italy, Korea, Japan, Mexico, New Zealand, Poland, Russia, South Africa, Sweden, the USA, Turkey (Fan and Zhang, 2003).

Remarks: R. Robini identified the most common and harmful types of important harmful mites in studies determining the fauna of mites in bulbous flowers in Turkish in 2000 and 2002. Aykut and Yılmaz (2010) identified *R. robini* in house dust in Muş-Hasköy. Kılıç and Toros (2000) reported on *R. robini* damage on onion in İzmir-Bayındır, Menemen and Tire.

3.2 Population density of *Rhizoglyphus robini (Claparede), 1869*

Sample result for monitoring the development of *R. robini* population, showed the similar changes in two years and in two fields of onion.

Due to the lower than average temperature in the region in April 2018, the intensity of mites increased from the beginning of May 2018 and reached its peak in the village of Kovalca in about a month. The number of mites peaked on April 27, 2018, with 7.0 mites per corm; on June 8, 2018, the number reached a peak of 10.5. In April 2018, the average temperature and humidity values in the region were low, and due to rainfall in the region, the density of *R. robini* was low, so no damage was observed in the early stages (2.8 mites per corm). From mid-May to June 2018, the population density was low due to low temperatures, high humidity and low rainfall. Due to the increase in temperature and average humidity, the density of mites increased, reaching two peaks at the end of May and June 2018 (12.6 mites/corm; 10.5 mites/corm) (Fig. 1). (Fig. 2). Due to above-average temperatures in the region in April 2019, mite densities reached high levels about 20–25 days earlier than expected. Despite the lower temperatures, the mite count peaked earlier than expected on May 2, 2016 and May 26, 2016 (4.6: 4.5 mites/bulb) due to increased humidity. Subsequently, mite densities remained low until the last week of May 2019.

In April, May and June 2018, due to heavy rainfall and leaching, the density of leaf mites was low. This situation did not change despite the increase in temperature and humidity in the area in June and July 2018. The density reached a peak of 1.5 mites/leaf only on April 13, 2018, and the average flow rate in other months was 0.1. Although the mite density increased only slightly in April 2019, due to the continued strong rainfall and leaching, the mite population intensity in the green part of May and June 2019 was low (0.1 and 0 mites/cm^2, respectively) (Fig. 2).

Mite densities began to increase in Ahmetbey in late April 2018. Mite densities peaked in May 2018 (15 May 2018) (13.9 mites/bulb) as average temperatures increased during the growing season. Populations remained low during post-peak counts, and a very low peak was observed again in early June 2018 (1.3 mites/bulb). Overall, population densities were low during much of the growing season in 2018 due to continued heavy rainfall and below-average temperatures from April to June. Mite population densities in onions in 2019 were lower compared to 2018 (Fig. 3).

Due to high rainfall, low temperatures and strong flushing pressure, the density of mites on leaves was low. The density increased only due to short-term temperature increases from the second half of May to the end of June 2018. The density of mites in the green part in 2019 was comparable to that in 2018 (Fig. 3).

4. DISCUSSION

In this study, various environmental factors—including a prolonged period of intense rainfall between April and May, a limited number of sunny days, abrupt fluctuations in temperature and humidity, persistently low temperatures, and the influence of washing events—were found to influence the population density dynamics of R. robini during the 2018 and 2019 seasons. Population density analyses indicated that the density of R. robini within the bulbs was relatively low in April of both years. However, a gradual increase was observed beginning in mid-May, culminating in peak density levels by the end of June.

Furthermore, when the intensity of *R. robini* infestation on the leaves was assessed, the values were generally low and exhibited parallel trends across both years, suggesting a consistent pattern of foliar colonization under comparable environmental conditions.

The density of this harmful mite was demonstrated first time in our country by this study. For this reason, it is a comprehensive study which is guiding and light-keeping which will be the basis for both the mite taxonomy and the important species in these cultivated plants. This study shows that the density of *R. robini* in soil is closely related to soil temperature and humidity.

5. CONCLUSIONS

This study represents the first documented evidence of the population density of this harmful mite species within the national context. As such, it constitutes a comprehensive and pioneering contribution, serving as a reference point for future research in both mite taxonomy and the identification of economically significant species associated with cultivated crops. The results indicate that the population density of *R. robini* in soil is significantly influenced by edaphic factors, particularly soil temperature and moisture levels.

Understanding the biology and behavior of *R. robini* is essential for developing integrated pest management strategies. Continued research into the life cycle, distribution mechanisms, and interactions with pesticides will help mitigate impacts on agriculture.

Declarations

Author Contribution

The preparation of the article, field research, analysis, and all results were performed by the corresponding author, Cihan Cılbırcıoğlu.

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Figures

Figure 1

Population density areas of Kastamonu

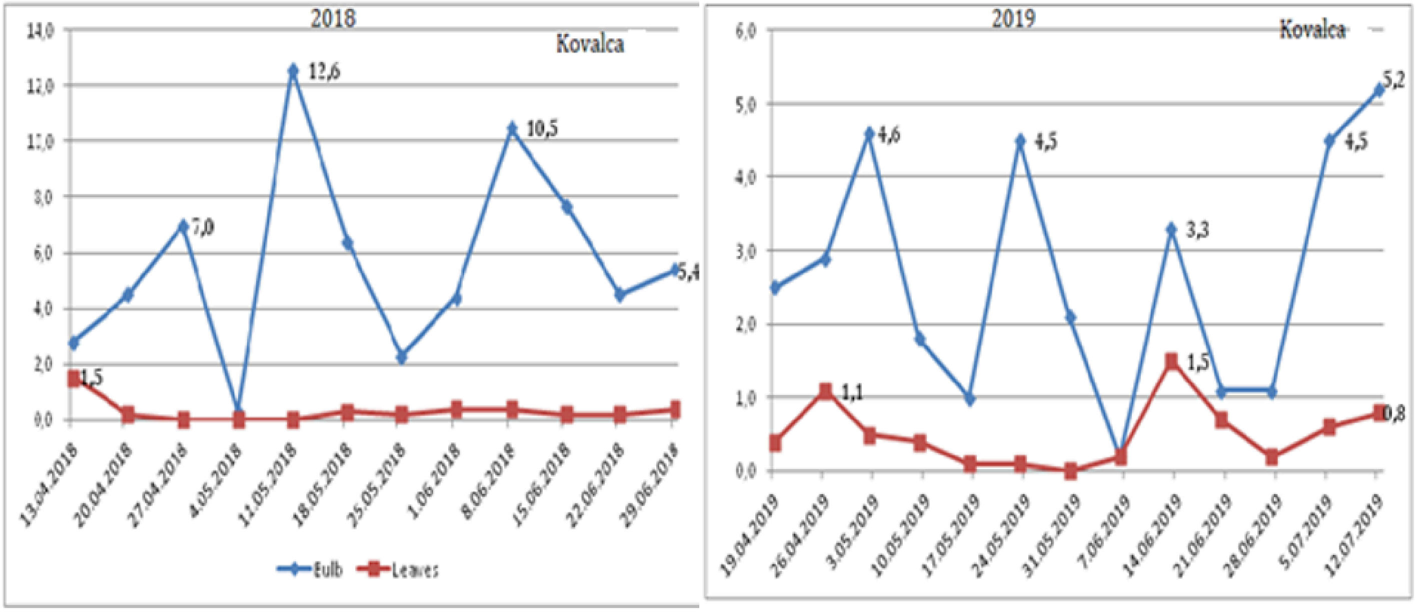

Figure 2

Population density of the onion *mite R. robini* on onion bulbs and leaves in Kovalca, Türkiye, 2018-2019.

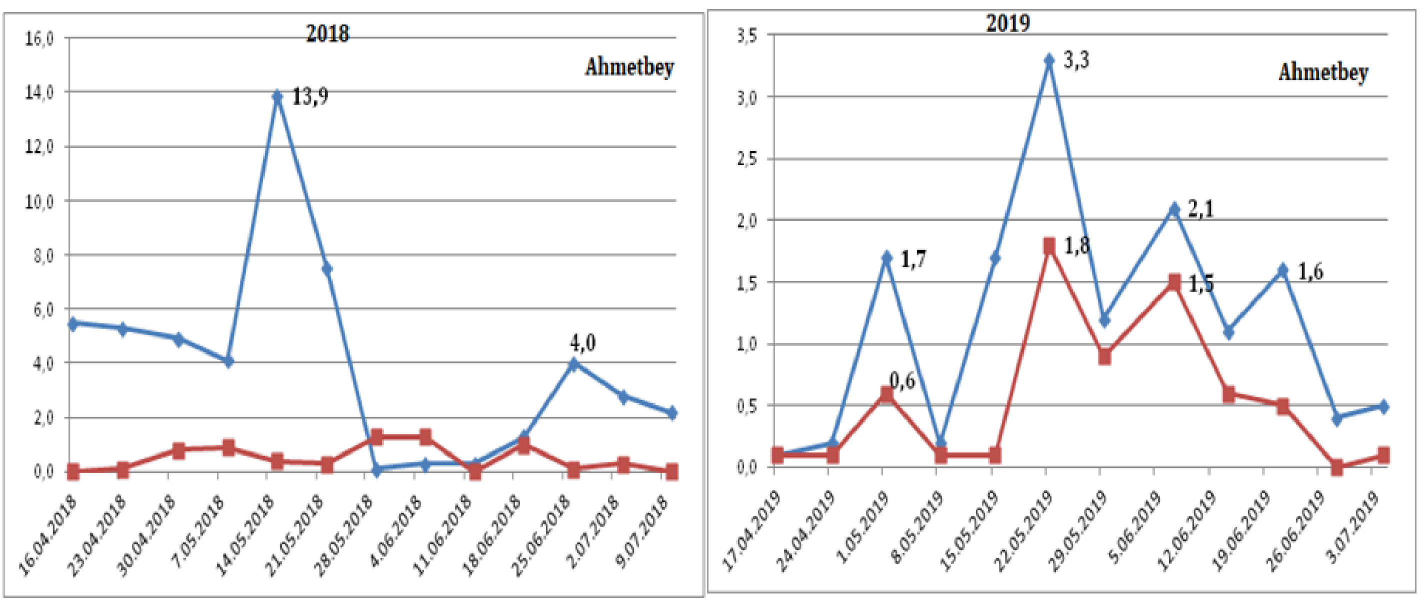

Figure 3

Population density of the onion mite *R. robini* on onion bulbs and leaves in Ahmedbey, Türkiye, 2018-2019.