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CURRENT STATUS OF HALYOMORPHA HALYS IN TURKEY

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Abstract

The brown marmorated stink bug, scientifically known as *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae), is widely recognized as a prominent invasive pest. Since its detection, it has rapidly disseminated to numerous nations worldwide and continues to inflict harm on hundreds of plant species. *Halyomorpha halys* was recorded for the first time in Türkiye in Istanbul and Artvin in the Eastern Black Sea Region near the border with Georgia in 2017. During the last 7 years, *H.halys* has spread to all provinces in the Eastern Black Sea Region. It is also reported to have spread to İstanbul, Yalova and Kocaeli provinces in the Marmara Region. The damage status of *H. halys* varied in the provinces where it was distributed. Especially in areas with monoculture agricultural products, the level of damage and population growth increased significantly. *Halyomorpha halys* possesses a considerable capacity to cause harm to approximately 300 plant species globally, encompassing agricultural crops, nuts, vegetables, and ornamentals, owing to its extensive range of hosts The most damaged plant in the Eastern Black Sea region is hazelnut, followed by corn and kiwi. As a result of the damage caused by *H.halys*, the level of damage to hazelnut fruit after emgii was determined to be more than 40% in some districts of the Eastern Black Sea region. However, hazelnuts with excessive damage in this region cannot be sold. The economic loss in hazelnut is estimated to be millions of dollars only for the year 2024. The Ministry of Agriculture and Forestry of the Republic of Turkey has prepared an action plan for this pest species. As a result of this plan, the insect population and damage is expected to decrease.

Keywords: The damage status, Distribution, Hazelnut, Economic loss

1. Introduction

Global warming and the increase in international trade cause agricultural and forest pests to spread to different continents and countries. These pests, known as invasive species, can cause major outbreaks shortly after their introduction. The brown marmorated stink bug [*Halyomorpha halys* (Stål,

1855) (Hemiptera: Pentatomidae)] is one of the invasive pests in many countries around the world. *Halyomorpha halys* is native to China, Japan, Korea and Taiwan (Rider, 2006). This invasive species was first recorded in Pennsylvania (USA) in the mid-1990s (Hoebeke and Carter, 2003). In Europe, it was first detected in Switzerland in 2004 (Haye et al., 2014). As of 2023, *H. halys* was found in Albania, Austria, Belgium, Bulgaria, Canada, Chile, China, Corsica Island, Croatia, Czech Republic, France, Georgia, Germany, Greece, Guam, Hungary, Iceland, India, Italy, Liechtenstein, Japan, Kazakhstan, Korea North, Korea South, Macedonia, Malta, Myanmar, Nigeria, Norway, Poland, Romania, Russian Federation, Serbia, Spain, Slovakia, Slovenia, Sweden, Switzerland, Taiwan, Türkiye, Ukraine, United Kingdom, United States of America and Vietnam (Wermelinger et al., 2008;; Heckmann, 2012; Milonas and Partsinevelos, 2014; Vetek et al., 2014; Macavei et al., 2015; Seat, 2015; Dioli et al., 2016; Gapon, 2016; Simov, 2016; Göktürk, 2020).

Halyomorpha halys was recorded for the first time in Artvin in the Eastern Black Sea Region near the border with Georgia in 2017 (Göktürk and Tozlu, 2019). *H. halys* has spread to all of the Black Sea Region over the last seven years. Additionally, reports indicate its spread to the Istanbul and Yalova provinces in the Marmara Region (Göktürk, 2023).

The brown marmorated stink bug overwinters in the adult stage among fallen plant debris, under the bark of trees, in holes, and in different residential areas, and especially prefers dry areas (Lee et al., 2013). Despite reports of 4-6 generations per year in South Asia (Lee et al., 2013), researchers have only found 1 or 2 offspring in its distribution areas to date (Rice et al., 2014). Adults of H. halys mate about two weeks after emerging from their overwintering sites in spring. Shortly afterwards, mated females begin laying eggs on the underside of host plants' leaves. The emergence of adults from overwintering sites can begin in April but peak between mid-May and early June. Females usually lay a total of 360–400 eggs in clusters of 20–30. Oviposition occurs on a weekly basis and can last up to two months. The insect's oviposition season starts in June, with the maximum number of eggs laid in July, and ends at the end of August. The same host plant can host both adult and various nymphal stages, as females lay new eggs throughout the season (Göktürk, 2020).

Adults and nymphs of *H. halys* cause damage by injecting digestive enzymes directly into the fruit and sucking plant juices through their stinging mouthparts (Rice et al., 2014). The signs of feeding damage on tree fruits are characterized by surface discoloration, indentations or distortions, and regions of internal necrosis (Joseph et al., 2015). Consequently, such products are deemed unmarketable (Bariselli et al., 2016). Moreover, the pest enters houses during overwintering and congregates in huge groups in such structures, and the negative effects of the foul odors it emits on human health make it a major urban problem (Inkley, 2012).

Halyomorpha halys has the capacity to damage about 300 plant species globally, including agricultural crops, nuts, vegetables, and ornamentals. The main host species of *H. halys* include hazelnuts, almonds, pistachios, apples, kiwis, olives, peaches, citrus fruits, pears, plums, nectarines, apricots, cherries, maples, lilacs, persimmons, maize, soybeans, tomatoes, okra, peppers, aubergines,

tomatoes, grapes, and rice, with varying preferences among different hosts (Nielsen and Hamilton, 2009; Maistrello et al., 2017).

Halyomorpha halys is a pest that is difficult to control because it spreads over large areas in a short time and has a wide range of hosts (Bergmann et al., 2016). *H. halys* poses significant economic risks to numerous crops due to several key factors. Firstly, its highly polyphagous nature allows it to feed on a wide variety of plants, making it a versatile pest. Secondly, *H. halys* has the ability to pose a threat over long periods of time, leading to prolonged damage to crops. In addition, its capacity to spread between different hosts and habitats further increases economic risks. Finally, unlike native pentatomids, both nymphs and adults of *H. halys* can feed on and damage crops, increasing the potential damage caused Reports in North America attribute losses of up to 70 percent of crop value in fruit and vegetables to *H. halys*. In New Jersey and the surrounding region, it caused a loss of approximately $37 million in apples and peaches in 2010 (Seetin, 2011). In 2010, it also caused serious losses in corn, peppers, tomatoes, soy beans, grapes, and ornamentals grown in nurseries (Leskey et al., 2012a; Rice et al., 2014). Since its first detection in Italy, *Halyomorpha halys* has become a significant pest in many crops, including hazelnut orchards (Bosco et al., 2018). Peach and pear orchards in Italy, along with those of apricot, plum, apple, persimmon, and tomato, experienced economic damages (Bariselli et al., 2016). In Georgia, the pest caused approximately 52.7–68.6 million USD in damage to hazelnuts in 2016 (Murvanidze et al., 2018).

IPM programs for *H. halys* are under development (Leskey et al., 2012a). Insecticide control is the most commonly used in IPM programs. According to various studies, dimethoate, malathion, bifenthrin, mehydathion, endosulfan, methomyl, chlorpyrifos, acephate, fenpropathrin, and permethrin have demonstrated efficacy against *H. halys* (Leskey et al., 2012b). Pheromone traps are also frequently used in monitoring and controlling activities against *H. halys*. The most commonly used are PHEROCON Brown Marmorated Stink Bug brand sticky traps and PHEROCON® CSB' type pheromone capsules (Aldrich et al., 2009). Another control method is biological control. Studies have shown that insects, spiders, and entomopathogens have a suppressive effect on insects (Balusu et al., 2019; Fusu and Andreadis, 2023; Göktürk et al., 2023).

In this study, the distribution, population, and economic damage status of *H. halys* in Turkey were tried to be revealed by utilizing the literature.

2. Materials and methods

In this study, pheromone traps were hung along the coastal area of the whole Black Sea Region in order to determine the distribution of the beetle. Pherocon BMSB Dual Lure pheromone traps were used to catch *H. halys* adults. Pherocon BMSB Dual Lure pheromone traps were used as trap material. These traps were hung in hazelnut, kiwi, corn, bean and citrus gardens in early May at a height of 1.5–2.0 m above the soil surface, and the traps were checked twice a week. We conducted periodic controls from May to October. The study hung 400 pheromone traps between 2018 and 2023 to determine the presence of the insect in the area. In addition, information on the distribution of the insect was obtained from the personnel of the Ministry of Agriculture and Forestry, and the literature was also utilized.

3. Results and Discussion

Examining the risk maps prepared based on the potential distribution areas and ecological requirements of *Halyomorpha halys* worldwide reveals that the coastal parts of the Black Sea region offer the most suitable climatic conditions for the insect. The first sighting of *Halyomorpha halys* occurred in Artvin in the Eastern Black Sea Region, and within 7 years, it spread to the entire Black Sea region and part of the Marmara Region. In this process, after its first detection in 2017, it was first seen in Artvin province by years, and in 2019, it was observed in Rize and Trabzon agricultural areas in addition to Artvin. In 2020, *H. halys* continued its spread, reaching Giresun and Ordu provinces. In 2021, observations began in Samsun. In 2020, *H. halys* was seen in Sinop and Kastamonu, and in 2023, it continued its spread along the entire coastline, reached the Marmara Region, and reached Istanbul (Figure 1).

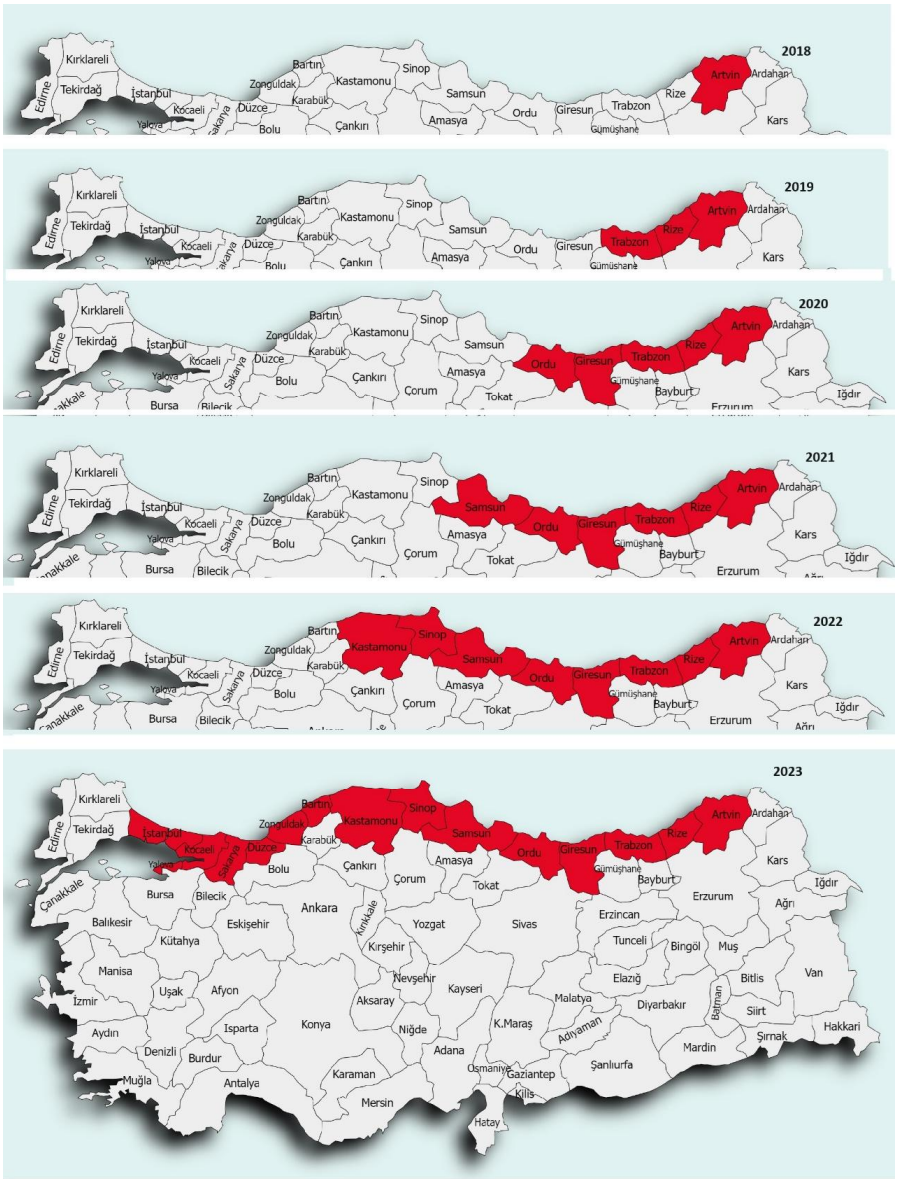

Figure 1. Distribution of *Halyamorpha halys* in Turkey

Considering the favorable climate and host conditions of the area and the annual flight of the insect, it was not surprising that the spread of *H. halys* along the coastline of approximately 1350 km was so rapid. Wiman et al. (2015) report that adults of *H. halys* can fly an average of 2.7–5 km per day and up to 75 km or 117 km in a year. In addition to natural flights, vehicle traffic is thought to be effective in the spread of *H. halys*. Intensive commercial activities between the Black Sea and the Marmara Region are effective in the spread of the insect. Especially the stopover of vehicles coming from Artvin province in Giresun and Ordu provinces has been effective in the transport of the insect. Therefore, one of the reasons for the initial long-distance contamination is anthropogenic factors. Wallner et al. (2014) stated that *H. halys* was transported long distances by vehicles after the initial contamination and named this situation as stratified diffusion.

Temperature is one of the main factors affecting the biological development and spread of *H. halys*. In the region, the population and damage to the beetle are higher, especially in the south and near the sea. In these areas, the insect emerges from winter quarters earlier, and the number and duration of eggs are longer. This causes the vegetation to last longer and thus the damage to increase. It was determined that 5 to 420 *H. halys* adults per week fell into the traps hung in the distribution areas of the beetle. During the surveys carried out between April and October, the least number of insects caught in the traps was in June and July, and the highest number was in April, August, and September. Giresun and Ordu provinces had the highest number of *H. halys* in 2024 in terms of population density and damage (Figure 2).

Figure 2. Population and damage status of *Halyamorpha halys*

The reason for the high amount of damage caused by the insect in these areas is that the most common plant in the area is hazelnut. In many hazelnut-growing countries in the world, it has been reported that the pest causes serious yield and quality losses due to feeding directly on the fruit (Hedstrom et al., 2014; Bosco et al., 2017; Haye and Weber, 2017). In Turkey, there are approximately 700,000 hectares of hazelnut orchards, and approximately 610,000 metric tons of hazelnut are produced annually (TMO, 2020). Although there are about 15 pest species that can cause significant economic

losses in both yield and quality in terms of prevalence and population density in Turkish hazelnut orchards, the most dangerous of these is *H. halys*. The average hazelnut damage caused by species other than *H. halys* in hazelnut orchards in Turkey was found to be 7.44% (Ak et al., 2018). The damage rate of *H. halys* on hazelnuts in Giresun and Ordu provinces is 30-40% in some areas (Figure 3). These areas are especially the orchards located close to the sea and on the south side. The commercial value of damaged hazelnuts also decreases. While hazelnuts that are not damaged by the beetle are bought for 120-140 Turkish Liras, hazelnuts damaged by the beetle are bought for 50 Turkish Liras. Hazelnuts that are highly damaged by the insect are used in hazelnut oil production when they become bitter.

Figure 3. *Halyomoprha halys* damage in hazelnut

Among the crops where the pest causes significant losses, apple, pear, peach, kiwifruit, maize, tomato, pepper, and cereals are the most known, and all these crops are grown in Turkey. Moreover, the fact that the pest is generally observed in the Black Sea region does not mean that its spread will be limited to this region. As a matter of fact, when the spread of brown skunk in other countries is analyzed, it is seen that it has spread to the whole country in a short time. In general, it has been observed that the population level of invasive species increases exponentially before reaching its peak, and this increase accelerates from year to year (Mack et al., 2000). Studies have shown that the population of *H. haly*s increases by 75% every year (Nielsen et al., 2013). The risk map prepared according to the potential distribution areas and ecological requirements of *H. halys* shows that the Black Sea region in particular has very favorable climatic conditions for the pest and that it can spread to other regions of Turkey (Haye et al., 2015; Kistner et al., 2017). Considering that the spread of the insect will continue in this way, it is possible that it will spread to Tekirdağ, Bursa, Balıkesir, Amasya, Bolu, and Karabük provinces in 2025. It is thought that the reason why it has spread only on the coast and has not traveled to the inland provinces until this time is due to the fact that the coastal parts of the Black Sea Region and the mountains of the inland provinces are parallel to the sea. Streito et al. estimated that *H. halys* may expand to the inland regions of Turkey until 2040 (Streito et al., 2021).

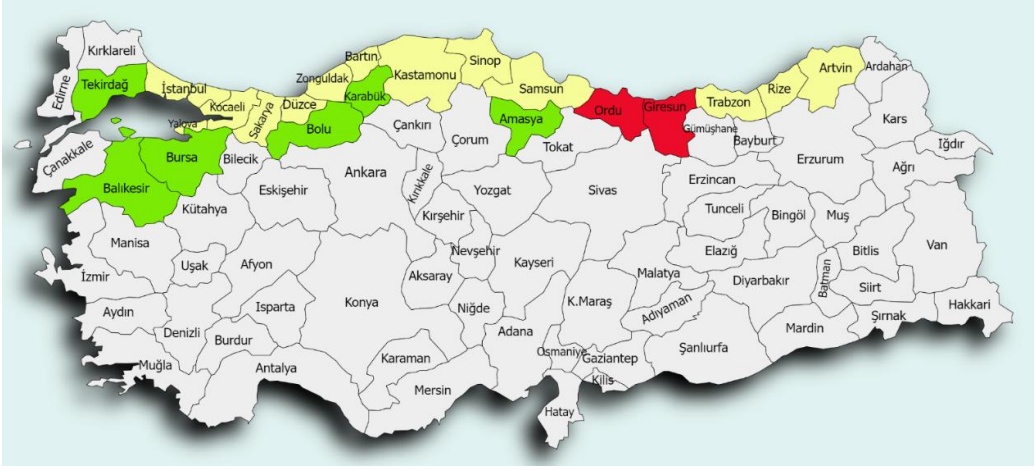

Figure 4. Estimated distribution of *Halyamorpha halys* in 2025

Efforts to control *H. halys* have been ongoing in Turkey since 2021. Chemical, biological, and biotechnical control methods are tried to be used together. In this context, Decis 2.5 EC is recommended as a chemical pesticide for the Eastern Black Sea Region in Turkey. PHEROCON® CSB' type pheromone traps are used for biotechnical control. Within the scope of biological control, Trissolcus japonicus, the egg parasitoid of *H. halys*, should be used.

In conclusion, we can say that *H. halys* is an important insect pest for Turkey. It economically threatens many agricultural crops in Turkey, especially hazelnut. Considering the fact that many cultivated plants grown in Turkey are among the main hosts of this pest, it is seen that it carries a much greater risk than many invasive species previously encountered. The control activities carried out so far have not yielded complete success. Therefore, it is urgent and imperative to take more effective measures against this pest, especially internal quarantine. Since *H. halys* prefers closed areas (houses, warehouses, workplaces, etc.) as a pest in the fight against *H. halys*, mechanical control should be carried out by collecting and destroying from the points where it clusters from the beginning of the wintering period.

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