



Spread and Damage of Citrus Longhorned Beetle [*Anoplophora chinensis* (Forster, 1771) (Coleoptera: Cerambycidae)] to Hazelnut Orchards in Turkey

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ABSTRACT

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Turkey is the largest hazelnut producer, and the Trabzon is one of the important provinces with an annual production of 47.000 tons. The citrus longhorned beetle [*Anoplophora chinensis* (Forster, 1771) (Coleoptera: Cerambycidae)] is not an indigenous pest to Turkey. It is a polyphagous woodboring beetle with a large host range including ornamental plants and fruit trees such as *Citrus* and *Corylus*. The insect was intercepted for the first time on maple and willow plants in a nursery in Istanbul in 2014. Domestic trade of those plants caused the spread of the insect from Istanbul to Trabzon in 2016. Since then, the insect has been spreading at speed in villages of Maçka district. However, the spread of the insect could have not been prevented. The insect was detected in 250 ha in 2020, but the area enlarged to 409 ha in 2021. Quarantine measures and eradication studies have been applied in the region that chemicals were sprayed and infested plants were destroyed. Currently, hazelnut orchards of 286 ha were dismantled and more than 172,000 oaks were removed and destroyed in Akmescit, Alaçam, Armağan, Bahçekaya, Duralı, Esiroğlu, Günay, Hızarlı, Işıklar, Öğütlü and Temelli villages. To compensate the losses, objective yield estimates were made by the Ministry of Agriculture and Forestry officials and 2.6 \$ per kg was set to pay to the growers for the period of 4 years. By the end of 2021, 539 growers were paid of about 1.975.000 \$ for compensation. Although the infestation and the spread of the insect is monitored it poses a real threat to hazelnut sector in the Black Sea region.

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Introduction

Hazelnut (*Corylus avellana* L.) is the fifth largely produced tree nut crop with annual production of 1.003.120 tons as an average of 2018 and 2019 (FAO) after walnuts (4.422.667 tons), cashew (4.026.820 tons), almonds (3.361.024 tons) and chestnuts (2.385.150 tons). Turkey is a major hazelnut producer with 645.523 tons in the world by far supplying about 65% of the world production. The Eastern and Western Black Sea coasts under the influence of temperate maritime climate provided by the Black Sea constitute the main production area. Turkish hazelnut industry is driven by exports. Any obstacle encountered in production will affect the amount of the crop, and consequently the price and the international trade. Biotic and abiotic stresses such as adverse weather conditions and pest and diseases in addition to the chronic problems of aged orchards, small farm sizes and insufficient cultural practices are the main concerns in the production (Erdogan, 2018; Turan, 2018).

Often, outbreaks of alien diseases and pests affecting Turkish hazelnut culture emerge as new challenges to be overcome. They were never existed before or known to be harmful to hazelnuts. In general, global climate change and rapid increase in international trade of plant materials with new transportation routes are blamed for emergence of these exotic species (Tuncer et al., 2020; Hızal et al., 2015). For example, powdery mildew (*Phyllactinia guttata*) has been an insignificant disease in hazelnut orchards in the past. However, an epidemic outbreak caused by a new species of *Erysiphe corylacearum* was first observed in the Eastern Black Sea region in 2013 (Sezer et al., 2017). Within two years the disease spread out to Western Black Sea region, and severe losses as high as 20% were observed in some orchards (Erdogan, 2018). Similarly, brown marmorated stink bug [*Halyomorpha halys* (Stal, 1855) (Hemiptera: Pentatomidae)], an invasive pest species indigenous to China, Japan, Korea and Taiwan, was recorded for the first time in 2017 in the Eastern Black Sea

Region near the Georgian border (Günçan and Gümüş, 2019). This polyphagous insect is a real potential threat to Turkish hazelnut sector that may cause crop losses about 30%. It rapidly spread along the Black Sea region, which has been currently reported in 8 provinces (Özdemir and Tuncer, 2021).

Recently, another invasive species of citrus longhorned beetle (known as turunçgil uzun antenli böceği, teke böceği or drakula böceği in Turkish) was reported as a first record for Turkey. Damage to ornamental and fruit trees in particular may result in important economic losses. Since it is a new threat to hazelnuts, a prime importance was given that its detection, spread, damage on hazelnuts and eradication efforts are discussed.

Detection And Spread of *Anoplophora Chinensis* in Turkey

The citrus longhorned beetle *Anoplophora chinensis* (Forster, 1771) (Coleoptera: Cerambycidae) is a poliphagous woodboring beetle with a quite wide host range including ornamental plants and fruit trees such as citrus and hazelnut (*Corylus*). It is a quarantine pest. Detection of the pest is usually associated with finding live adults or exit holes around the collar of trees (Figure 1). *A. chinensis*, found for the first time in Europe in 2000 in Italy. A study made in Lombardy region revealed that genus *Acer*, *Corylus*, *Betula*, *Carpinus* and *Fagus* were those preferred by the insect and from which it has the highest rate of adult's emergence. Infestations by the insect was mostly found on plants in genus *Acer* (36%) followed by *Corylus* (18.6%), *Betula* (10.5%), *Carpinus* (9.4%), *Platanus* (5.3%) and others (Cavagna et al., 2013). The report of Loomans et al. (2013), indicated that the Netherlands has regularly intercepted the citrus longhorned beetle on consignments of bonsais and plants for planting coming from China and Japan since 1980, and first out-breaks have been detected since 2007 on trees and shrubs outside nurseries. Interestingly, detection dogs or sniffer dogs used in Austria were able to find all stages of the insect development in standing or imported plants and wood packaging material in different environments, and they were successful in Netherlands, Italy, Croatia, Switzerland, and Germany as well (Hoyer-Tomiczek and Sauseng, 2013).

In Turkey, *A. chinensis* was intercepted for the first time as an alien insect on maple (*Acer palmatum* and *Acer saccharum*) and willow (*Salix caprea*) plants in a nursery in Şile town of Istanbul in June of 2014. The adults were captured in different districts of Istanbul later in that year and in 2015 (Hızal et al., 2014; Altunışık, 2015; Bozkurt, 2018). The second report was made by Yıldız (2017) who detected the adults in a nursery on imported maple trees from China in 2014 in Bartın province located in about 250 km northeast of Istanbul as the crow flies in the western Black Sea region. Third report was made for infestations and serious damages were detected on the ornamental Japanese maple (*Acer palmatum*) in the municipal nursery on 5 ha land located in Maçka district of Trabzon province in 2016 (Figure 2). It was thought that the pest was transported to the region from Istanbul with maple plants which were used for landscaping around the facilities constructed for the European Youth Olympic Games held in Trabzon 2011 (Eroğlu et al., 2017). The pest was

reported for the first time in Antalya province in the Mediterranean region in the south of Turkey in 2016, on *Acer negundo* plants, where citrus is heavily produced. The molecular analysis by sequencing of mtCOI region of adult samples revealed that origin of the Antalya population was China (Topakcı et al., 2017). Apparently, *A. chinensis* was introduced to Turkey several years before 2014 with imported ornamental plant species through international trade, and later spread within the country by domestic trade.

After the detection of *A. chinensis* for the first time in Turkey, a regulation was issued on Official Gazette (#29033) in 2014 based on the European Union *Anoplophora chinensis* (Forster) commission decision (01.03.2012, #2012/138/EC) to regulate the principles and procedures for preventing the entry and spread of citrus longhorned insect [*Anoplophora chinensis* (Forster)] into Turkey, where host plants, surveys-inspections, research studies, measures to be taken for prevention of spread and eradication methods were described (Anonymous, 2014).



Figure 1. Adults of *Anoplophora chinensis* (a), a larvae and galleries / holes formed by feeding of the larvae and adult in hazelnut trunk (b) and exit holes of adults (c)



Figure 2. Eradication area in 2020 (red spots) and the spread area by the end of 2021 (green circle) of *Anoplophora chinensis* in Esiroğlu town and nearby villages in Maçka district of Trabzon province



Figure 3. Eradication studies for *Anoplophora chinensis* in Esiroğlu town (above) and Durali village (below) in Maçka district of Trabzon province

Damage of the *A. chinensis*

In the trunk and the main roots, the feeding larvae make galleries below the bark and later enter the woody tissues of the lowest portions of the trunk and roots. Thus, the trees are weakened and often seriously damaged or killed by larval attack. The insect and the damage on the hazelnut plant is shown in Figure 1.

Pupation takes place in the upper part of the feeding area. The adult beetles emerge from the round exit holes about 10-15 mm in diameter located on the roots that are visible on the ground, and at the base of trunks up to 3-4 cm above ground level, and move upward on the trunk, feeding on suckers and tender bark of young shoots and sometimes leaves. The adults live for about 1-3 months, generally between May and August. Single eggs are deposited by females in small incisions made in the bark at the bottom of the trunk near the roots. It may take one or two years to complete their life cycle under natural conditions (Anonymous, 2013; Eroğlu et al., 2017; Usta et al., 2017; Bozkurt, 2018; Tuncer et al., 2020).

Spread of *A. chinensis* to hazelnut orchards and eradication efforts

For eradication of *A. chinensis*, careful inspection of all the host plants within an area of about 100 m around each tree in which an exit hole or larval cavity is detected and

removal and destruction of all trees bearing insect or insect traces are necessary (Yıldız, 2017; Eroğlu et al., 2017). After the first detection of the pest in 2014 in Istanbul province 1311 infested trees of maple, willow, poplar and plane were destroyed by removal of plants with roots and by chipping and burning them by the joint work of Istanbul Directorate of Provincial Agriculture and Forestry and Istanbul Metropolitan municipality (Altunışık, 2015). Since then, surveys and eradications continue that the trees on which adult emergence was detected are marked between May and October, and the infested plants are destroyed between November and March. In addition, thousands of maples, horse chestnut, willow, crape myrtle and plane plants are sprayed for the feeding and flying adults.

Detection of citrus longhorned beetle on ornamental plants in municipality nursery in Esiroğlu town in Maçka district of Trabzon province (Eroğlu et al., 2017) aroused fear among the hazelnut growers since Trabzon is one of the significant hazelnuts producing provinces with annual production of 47.000 tons (average of 2019 and 2020) in the Eastern Black Sea region (TUIK, 2021). Our field investigations showed that Mincane is the main cultivar (about 50%) in this region. In the orchards, the mixture of several other cultivars such as Çakıldak and Kalınkara (few), Foşa, Sivri and Tombul (relatively high) also exist. Interviews with the growers revealed that they were not familiar with citrus longhorned beetle. In 2017, the surveys of Trabzon Provincial Directorate of Agriculture and Forestry resulted in detection of infested hazelnut trees in the orchards near the municipality nursery. Subsequent surveys estimated infested area of 125 ha which was later extended to 150 ha. Later, surveys showed the spread of the insect over wider area of about 250 ha in 2020, and reached to 409 ha in 2021 in Esiroğlu town and surrounding villages of Akmescit, Alaçam, Armağan, Bahçekaya, Durali, Günay, Hızarlı, Işıklar, Öğütlü and Temelli (Figure 2). Our field inspections indicated that the main source of the spread was distribution of infested ornamental plants from the municipal nursery to the region, as well as the spread of the insect itself. After the first detection, chemical sprays were applied by the officials to prevent the spread with the use of Imidacloprid (34 ha in 2018 and 42.6 ha in 2019) and Lambda-Cyhalothrin-EC (76 ha in 2020 and 120 ha in 2021). In 2019, after the critical evaluation of the spread and the damage of the insect in official meeting to which former author has attended the Governorship of Trabzon declared the area as quarantine zone, and ordered the creation of buffer zones among the villages, and the eradication of infested plants. However, our observations showed that the growers were reluctant and unwilling to dismantle their orchards because of widespread concern among them about economic losses and dismantling costs. Later, the government issued Plant Quarantine Compensation Support Regulation (#2019/52) to compensate the crop losses of the growers who dismantled their orchards (Anonymous, 2019). The article #5 defined the amount of the payment as 2.6 \$ per each kg of harvested hazelnut to be paid to the growers according to the objective yield estimates for the orchard for a duration of 4 years which is the prohibition period for replanting. The officials of the Ministry of Agriculture and Forestry estimated the appropriate compensation to be 3.070.000 \$ in total. In 2020, the Chamber of Agriculture in

Maçka district was assigned for eradication of the pest in infested hazelnut orchards by the Presidential Decision (#3190) (Anonymous, 2020a). The cost of the dismantling should be paid to Chamber of Agriculture in Maçka district as 18% of the compensation support payment to be paid to growers.

After the declaration of compensation payments by the government, 24 growers willingly dismantled their infested orchards of 13.5 ha in 2019. Destructive removal of the plants with roots were applied that piles of the trunk and branches were burned and the roots either were burned or buried at 2 m deep of soil (Figure 3). In early 2020, additional 2.5 ha orchard was dismantled by the 5 growers. Subsequently, dismantling rate increased that the area reached to 286 ha by the end of 2021 where more than 172.000 ocaks (a group of 4-6 plants planted around 1.2 m circle in Turkish planting system) were removed and destroyed (Anonymous, 2021).

The growers are not allowed to plant hazelnut for 4 years in their cleared fields, instead they are encouraged to plant vegetables such as bean, corn and potato. In 2019, the growers received 143.000 \$ compensation payments based on the yield potential of the orchards, between 80 to 140 kg per decare, which was determined by the experts (Anonymous, 2020b). Total of 539 growers were paid about 1.975.000 \$ for compensation by the end of 2021 (Anonymous, 2021).

Conclusions

A. chinensis is very important pest to hazelnuts, other fruit trees such as citrus and ornamental / forest trees, and causes serious economic losses. Unfortunately, the spread of the insect could have not been prevented in hazelnut growing area in Trabzon province despite the creation of buffer zones and eradications. Thus, all the quarantine measures and eradication efforts should be applied strictly to prevent further spread to neighboring hazelnut producing provinces.

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