

First Evidence of *Halyomorpha halys* (Hemiptera: Pentatomidae) Infesting Kiwi Fruit (*Actinidia chinensis*) in Greece¹

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The brown marmorated stink bug, *Halyomorpha halys* Stål (Hemiptera: Pentatomidae), is a native pest of eastern Asia (China, Korea, and Japan), which was accidentally introduced into the United States and Europe (Hoebeker and Carter 2003, Proc. Entomol. Soc. Wash. 105: 225–237; Leskey et al. 2012, Outlooks Pest. Manag. 23: 218–226; Xu et al. 2014, Biol. Invasions 16: 153–166). In Europe, *H. halys* was first reported around 2004 (Haye et al. 2014, J. Pest Sci. 87: 407–418). It was primarily considered as an urban and household pest (Wermelinger et al. 2008, Mitt. Schweiz. Entomol. Ges. 81: 1–8; Inkley 2012, J. Entomol. Sci. 47: 125–130); however, *H. halys* is a highly polyphagous species that easily flies from plant to plant infesting more than 100 different host plants, with a preference for those belonging to the families Rosaceae and Fabaceae, often resulting in substantial economic damage (Lee et al. 2013, Environ. Entomol. 42: 515–523; StopBMSB 2018, Stopbmsb.org; Tillman et al. 2017, J. Entomol. Sci. 52: 455–459). Due to its polyphagous nature and climate adaptation, *H. halys* has rapidly become a key pest of many annual and perennial crops in invaded countries (Lee 2015, Appl. Entomol. Zool. 50: 277–290). In the United States, its feeding damage resulted in US\$37 million of losses in apple orchards in 2010 (Rice et al. 2014, J. Integr. Pest Manag. 5: 1–13). *Halyomorpha halys* has also been reported in Italy feeding on several crops including peach, pear, apricots, plums, apples, persimmons, and tomatoes (Bariselli et al. 2016, OEPP/EPPO Bull. 46: 332–334). Moreover, reports from kiwi fruit (*Actinidia chinensis* L.) growers in Italy indicate that

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fruit loss on affected orchards can be 30% of more (Bernardinelli et al. 2017, Notiziario ERSA 1: 24–26; Pasqualini et al. 2017, Fruticultura 3: 24–27).

In Greece, *H. halys* was initially reported in the autumn of 2011, causing a nuisance in houses in the center of Athens (Milonas and Partsinevelos 2014, OEPP/EPPO Bull. 44: 183–186; Gariepy et al. 2015, J. Pest Sci. 88: 451–460; Morrison et al. 2017, Sci. Rep. 7: 16941). The study reported herein provides the first direct observation of *H. halys* feeding on kiwi fruit in Greece.

The study was conducted in the kiwi growing areas of Plaka Litochorou (N 40°06', E 22°33') (Northern Greece, southern part of Central Macedonia region, Pieria Prefecture, and Dion Municipality) and Vergina (N 40°29', E 22°19') (Northern Greece, Central Macedonia region, Imatheia Prefecture, and Alexandria Municipality). The kiwi varieties that were cultivated were "Tschelidisi" and "Haywarth", respectively. Weekly visual observations were made directly in kiwi orchards and in nearby areas from late May to the end of October 2017.

In August 2017, in two different kiwi orchards in Northern Greece, located in the area of Imatheia and Pieria, respectively, we observed substantial infestation on kiwi fruits. After thorough examination, it appeared that the kiwi trees were infested by *H. halys* (Fig. 1A). To our knowledge, this is the first published report of direct damage by *H. halys* on any crop and particularly on kiwi fruits in Greece. Field observations showed that females of *H. halys* laid clusters of eggs on the underside of leaves (from late May to mid June) as well as on fruits (from end July to mid August). Freshly deposited eggs were light green and turned white before hatching. Both nymphs and adults were observed using their stylets to pierce and feed from the kiwi fruits. Feeding injury to fleshy kiwi fruits resulted in characteristic dark, sunken areas on the skin (located close to the stalk) and deformation (Fig. 1B) as well as internal tissue damage (areas with white corky tissue formation) (Fig. 1C), rendering them unsuitable for sale at the market. Feeding injury also reduces subsequent yield by causing fruit abortion due to rapid fruit rot. Damages are more evident on the field edges and on wet areas within the orchards. Farmers and kiwi fruit cooperatives are particularly concerned because vast numbers of *H. halys* individuals likely migrate from other crops to kiwi orchards from August–September. Also, application of chemical insecticides is insufficient to prevent these potentially constant attacks on kiwis, increasing the risk of toxic residues in the fruits.

The cultivation of kiwi fruit was first introduced into Northern Greece in 1973 in Pieria Prefecture (Manolopoulou and Papadopoulou 1998, Food Chem. 63: 529–534). Since then, cultivation has expanded to many other areas, with a mean production of 180,000 tons over recent years (Fig. 2). Kiwi fruit is considered an important commercial fruit with confirmed export potential. Thus, early detection is crucial for the management of *H. halys* due to its ability to rapidly spread to new areas through human transportation and the movement of goods, particularly agricultural commodities (Lupi et al. 2017, J. Entomol. Acarol. Res. 49: 67–71). Tracking the current spread is especially relevant in the case of territories with kiwi orchards or even other crops that could suffer serious economic losses by the uncontrolled expansion of this invasive species. Action should be taken to monitor and reduce current populations of *H. halys* to stem its potential expansion into the nearby major commercial tree fruit production areas.

Although the presence of *H. halys* in the Imatheia and Pieria areas (Northern Greece) has been well documented, the nature and extent of the feeding damage



Fig. 1. (A) Dorsal view of *Halyomorpha halys*; (B) dark, sunken areas on the skin of kiwi fruits located close to the stalk due to *H. halys* infestation; (C) white corky internal tissue formation on a kiwi fruit due to *H. halys* infestation.

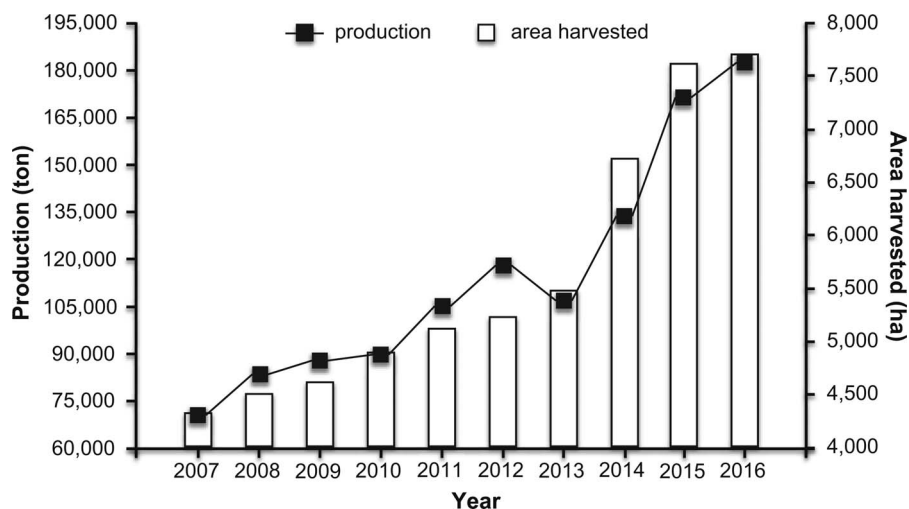


Fig. 2. Area harvested (in ha) and production (in tons) of kiwi fruit trees over the last decade in Greece (Source: FAO 2018, www.fao.org).

that could be inflicted to kiwi fruits by *H. halys* require further investigation. A better understanding of the biology and habits of this pest is essential and will contribute greatly to its efficient management. The timing of feeding relative to the developmental stage of the crop should be assessed, as the amount and the type of damage depends upon the stage of kiwi fruit development.