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A new harmful thrips species in orange in Antalya Province: *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae)

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ABSTRACT

This study discusses the damage of an invasive insect species chilli thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) on orange trees cv. Washington in the Finike district of Antalya Province, Turkey in 2021. This harmful thrips species was recorded for the first time in a citrus grove in Turkey. Thrips cause inward curling of fresh leaves on the young shoots and also necrosis, mostly silvery-white. The biology, ecology, and control of this species are briefly given.

1. Introduction

According to USDA (2020) data, in 2019, a total of 92 million tons of citrus fruits were produced in the world, including 46 million tons of oranges, about 32 million tons of tangerines, 8 million tons of lemons, and 7 million tons of grapefruits. The leading countries in the world orange production in 2019 are respectively, according to their production amounts; Brazil (34%), China (16%), EU (13%), and USA (10%). Turkey ranks 7th in the world orange production with a production amount of 1.8 million tons. Although Turkey produced approximately 4.3 million tons of citrus fruit in 2019, almost all of the production is provided from the Aegean and Mediterranean Regions. 83% of Turkey's total orange production, 90% of tangerine production, 92% of lemon production, 97% of grapefruit production is provided from the Mediterranean Region of Turkey (TÜİK 2020).

There are multiple biological factors such as diseases, pests and weeds which can cause economic damage and limit the agricultural yield in citrus. Among the recorded insect species in citrus areas, thrips are recognized as a pest in general. They have been well described with their diverse life histories and habitats, in particular Thysanoptera order, which constitutes 1% of approximately 6000 thrips species, was reported as a serious pest (Morse and Hoddle 2006; Mound and Morris 2007). The feeding habits of thrips species are quite different, and they can be classified as phytophagous (plant-feeding), mycophagous (fungal-feeding), and predatory species (Morse and Hoodle 2006). Many thrips (Thysanoptera) species have been reported to feed on citrus (Rutaceae) worldwide (Blank and Gill 1997; Childers and Nakahara 2006). These species feed on the flowers, fruits, and leaves of citrus, and their typical damage is in the form of silvery scars. Scars formed on fruits negatively affect the quality of the product and thus reduce its market value (Tekşam and Tunç 2009). The most important pest thrips species attacking citrus; *Scirtothrips citri* (Moultan) (citrus thrips) and *Scirtothrips aurantii* Faure (South African citrus thrips) in South Africa (Grove et al. 2000), *Scirtothrips dorsalis* Hood (Yellow tea thrips) in East Asia (Masui 2007), and *Pezothrips kellyanus* (Bagnall) (Kelly's citrus thrips) in Australia, New Zealand (Webster et al. 2006; Froud et al. 2001) and two Mediterranean islands in Sicily (Marullo 1998), Southern Cyprus (Vassiliou 2007). Longo (1985) reported that there are more than 40 thrips species which appear in citrus areas in the world. Yet only a few species are harmful such as *Scirtothrips* spp. and *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) which are considered pests as they cause scarring on young fruits.

To date, *Frankliniella occidentalis* (Pergande), *Thrips major* Uzel (Thysanoptera: Thripidae) and *T. tabaci* were reported on citrus in Turkey, however they were not taken into account as economically important pests (Nas et al. 2007; Tekşam and Tunç 2009; Ölçülü and Atakan 2013). Tekşam and Tunç (2009) reported that *T. major* was the most common species in citrus fruits in the Antalya Province, and the scarred fruit rates due to thrips was less than 2%. Although *F. occidentalis* occured intensely in the lemon flowers in the Tarsus district of Mersin Province, Turkey, no wound formation on the fruits was observed (Atakan et al. 2016). The Hawaiian flower thrips, *Thrips hawaiiensis* (Morgan) (Thysanoptera: Thripidae) was recorded for the first time in 'Yediveren' lemons in the Eastern Mediterranean Region of Turkey (Mersin Province) (Atakan et al. 2015), this thrips causes considerable damage to lemon fruits (Atakan et al. 2021).

On September 12, 2021, in the Antalya Province, Finike district, Turkey, some damage was observed in a orange orchard with Washington variety, especially in young shoots. Collected samples were brought to the laboratory and thrips were detected on shoots and leaves. As a result of the microscopic slides, it has been determined that this species is *Scirtothrips dorsalis*, also known as chilli thrips or yellow tea thrips, which seriously damaged blueberry plants in Adana Province in 2020 and was recorded for the first time in Turkey (Atakan and Pehlivan 2021). This study provides some brief information about *S. dorsalis*, an important pest of citrus fruits, and the definition of thrips damage investigated in plant samples. It can provide basic information regarding morphological features, damage, ecology and biology of this species, and also contribute to the control studies that must be carried out before it spreads throughout larger areas.

2. Materials and Methods

2.1. Sampling

Due to the damage observed which was similar to thrips damage especially on the leaves of the fresh shoots of the trees, in an orchard where approximately 20 years old Washington orange trees were planted in Finike, Antalya, on September 12, 2021, leaf samples were taken. The damaged leaves were randomly collected and brought to the Entomology laboratory of the Plant Protection Department of Çukurova University, Adana Province, Turkey.

2.2. Identification of thrips

The thrips specimens were collected from the leaves with the help of a fine-tipped brush and placed into tubes containing 60% ethyl alcohol. Afterwards, the samples were kept in AGA (10 parts 60% ethyl alcohol, one part glycerin and one part glacial acetic acid) for two days in order to facilitate their preparation by softening their bodies and once achieved, they were reintroduced into 60% alcohol. The samples were taken separately in glass petri dishes and kept in 10% potassium hydroxide for about 1 hour at 48 degrees on the hot plate. Body contents were macerated by entering through the hind leg bases of thrips individuals with a fine-tipped needle, cleaned by passing through alcohol series and transferred to a HOYER medium to prepare their microscopic slides. Thrips preparations were kept in an oven at 47 degrees to let them dry (Mound and Kibby 1998). The morphological features of the specimens (male and female individuals) were examined under the stereoscopic microscope (40X) and identified by the first author.

3. Results and Discussion

3.1. Identification and biology

The images obtained by making the preparations of female and male *Scirtothrips dorsalis* are shown in Figure 1a, b, and their natural appearance on the leaves is shown in Figure 2 a, b. Adult females are about 1.2 mm long, with dark wings and dark

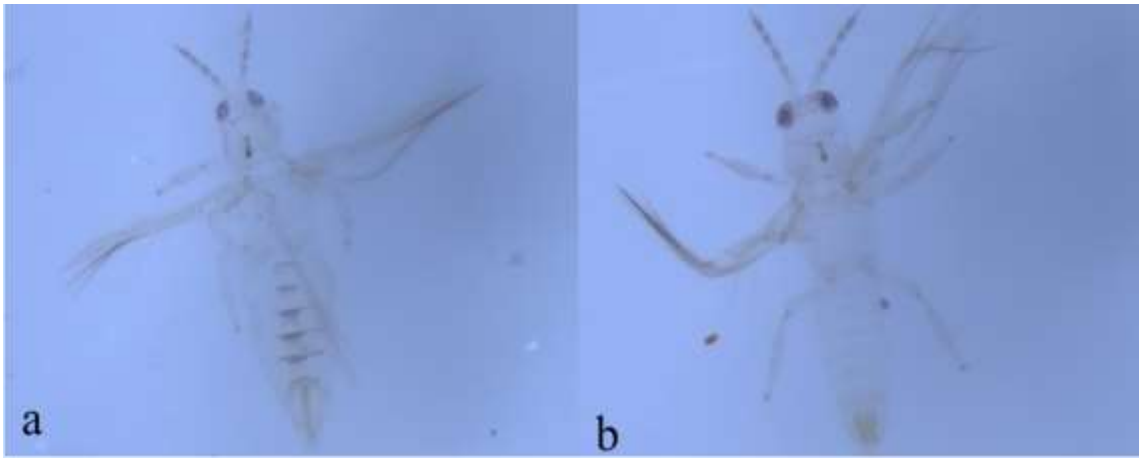

Figure 1. Microscopic slide images of adult female (a), and male (b) *Scirtothrips dorsalis* (Photo by E. Atakan, 2021).

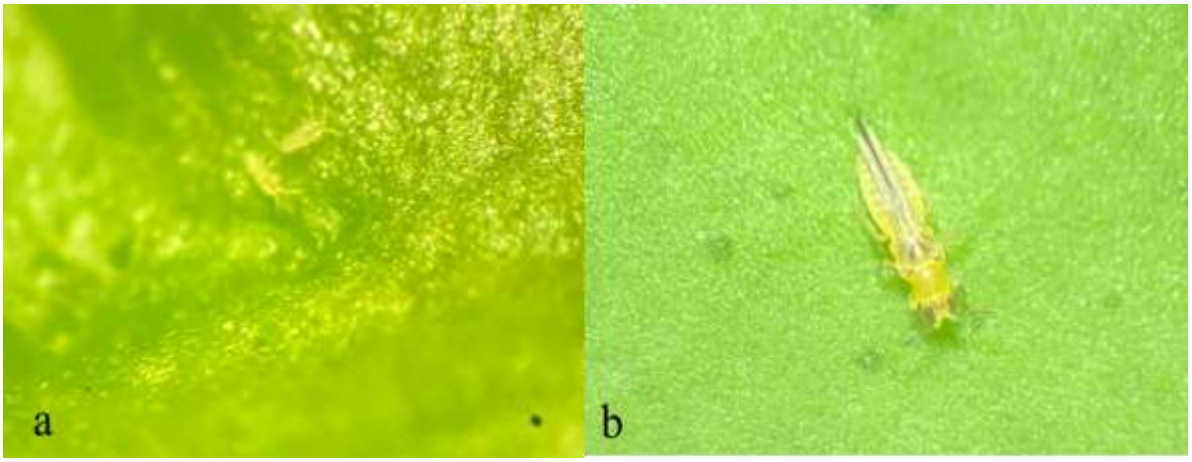

Figure 2. Natural appearances of the larvae (a) and adult female (b) *Scirtothrips dorsalis* (Photo by L. Bakırcıoğlu Erkılıç, 2021).

spots on the abdomen forming missing stripes visible on the back (Figure 1a). Adult males are smaller than females, have no spots on the back, and are lighter in colour (Figure 1b). Larvae are transparent or light yellowish in colour (Figure 2a). Detailed morphological diagnosis of the species has been given in a previous study (Atakan and Pehlivan 2021).

Scirtothrips dorsalis eggs are microscopically 0.075 mm long and 0.070 mm wide. Eggs are kidney-shaped and creamy white (Seal et al. 2009). Since thrips inserts eggs in plant tissues, it is very difficult to detect its eggs. The eggs hatch in two to seven days, depending on the temperature. Larvae and adults tend to accumulate near the midrib or borders of the host plant. The two larval stages (first and second) are completed in eight to ten days and the pupal stage lasts 2.6-3.3 days. Unlike other thrips, the pupae of this species are usually found on leaves, leaf litter, curled leaves, sometimes hidden under the sepals of flowers and fruits (Seal et al. 2009). Adults and larvae are found in the fresh leaves of the end shoots of trees.

3.2. Host plants

Even though *S. dorsalis* caused serious damage to the green parts of the blueberries in a greenhouse in Adana province (Atakan and Pehlivan 2021), no data are available concerning the host habitat of this species in the ecological regions where *S. dorsalis* has been detected in Turkey, up to now. To the best of our knowledge, *S. dorsalis* has been reported to infest a wide variety of host plants belonging to more than 100 plant taxa from 40 families (Mound and Palmer 1981; Venette and Davis 2004; Klassen et al. 2008; Kumar et al. 2013). Although the main hosts of *S. dorsalis* are acacia, mimosa and Saraca (Fabaceae), it has been recorded as a pest on several economically important host plants. For instance, Venette and Davis (2004) listed the potential hosts such as bananas, beans, cashews, citrus, cocoa, maize, cotton, eggplant, grapes, mangoes, melons, peanuts, peppers, strawberries, roses, sweet potatoes, tea, tobacco and tomatoes. Moreover, *S. dorsalis* is an important pest of ornamental plants in Florida (Klassen et al. 2008; Osborne 2009). Additionally, this thrips was found in 13 of 181 plant species sampled in Colombia, including citrus fruits (Ravelo et al. 2018). When this study was prepared for publication, strawberry leaves were seriously damaged due to *S. dorsalis* in autumn in Adana Province.

3.3. Damage

With their sucking mouthparts, adults and larvae of *S. dorsalis* absorb the cell sap of the leaves, causing the leaf to curl upwards and reduce the leaf size. Inward curls on the fresh leaves of the end shoots and also silvery-white necrosis formations are presented in Figure 3. Thrips individuals were not found in the old leaves and fruits of orange trees, and the typical signs of damage were not observed. The damage caused by *S. dorsalis* feeding may become superficially similar to mite damage (Sanap and Nawale 1987; Seal et al. 2006). In many host plants, after a dense population occurred, thrips started to feed on the upper surface of the leaves.

In this study, *S. dorsalis* individuals were detected on account of the damage to the shoots of orange trees in September. Presumably, spraying in the early period, especially in the flowering and young fruit period of citrus, may have suppressed the pest thrips. Jae-Wook et al. (2012) reported that *S. dorsalis* peaks in citrus orchards in South Korea (Jeju Island) in July or autumn, producing silver-grey or dark-coloured spots on the fruits. These injured tissues appear as a halo around the fruit stalks. According to that study, the rate of damaged fruit ranged from 0.04% to 0.09%. Moreover, *S. dorsalis* was reported in citrus fruits in Fars, Iran in 2015 (Minaei et al. 2016). According to that study, the harmful thrips species caused curling and hardening of the leaves on the fresh shoots, and silvery scars on the fruit surfaces of citrus.

3.4. Control

Effective control methods for *S. dorsalis* are still in the research phase. Some suggestions including crop rotation, removal of host weeds, and introducing predators or parasitoids have been made by the World Vegetable Center (AVRDC) to control this harmful thrips. Besides, it is always recommended to use insecticides from different classes in order to prevent the development of insecticide resistance. While synthetic pyrethroids can not effectively suppress *S. dorsalis* in pepper (Seal et al. 2006), soil or green parts applications of imidacloprid, one of the neonicothionide group insecticides, provides successful results in the management of *S. dorsalis* without harming beneficial insects (Seal and Kumar 2010). Foliar applications of imidacloprid from the soil much more successful

Figure 3. Damage symptoms on orange leaves as a result of feeding of *Scirtothrips dorsalis* (Photo by L. Bakırcıoğlu Erkılıç, 2021).

(Seal et al. 2008). However, the use of some insecticides from this group (i.e., imidacloprid) is prohibited in Turkey.

On the other hand, predatory *Orius* species (Hemiptera: Anthocoridae), known as minute pirate bugs, and entomopathogenic nematodes, *Thripinema* spp. (Tylenchida: Allantonematidae), have been reported to suppress the field populations of the pepper thrips (Kumar et al. 2017). The adults of the insidious flower bug, *Orius insidiosus* Say (Hemiptera: Anthocoridae), effectively feed on thrips larvae and adults. Even if the thrips populations are greatly reduced, *O. insidiosus* may continue feeding on aphids, mites, moth eggs and pollens, with no significant reduction in population density. *Thripinema* species, parasitize adult female thrips, significantly reducing their egg production and thus significantly suppressing the thrips population density. Arthurs et al. (2009) evaluated two predatory mites, *Neoseiulus cucumeris* and *Amblyseius swirskii* (Acarina: Phytoseiidae) as potential biological control agents of *S. dorsalis* and *A. swirskii* elicited the promising results in the control of *S. dorsalis* on hot pepper plants. Among the potential predators of thrips: *Chrysoperla* spp., ladybugs, predatory thrips species such as *Franklinothrips vespiformis* (Vespiform thrips), *Scolothrips sexmaculatus* (Six-pointed thrips) (Thysanoptera: Aeolothripidae), *Selenothrips rubrocinctus* (Giard) (Red banded thrips), *Leptothrips mali* (Fitch) (Black hunter thrips) (Thysanoptera: Phlaeothripidae) and predatory mites including *Amblyseius* spp., *Euseius hibisci* (Chant) and *Euseius tularensis* Congdon (Acarina: Phytoseiidae) were reported (Arthurs et al. 2009).

4. Conclusion

In addition to the invasive *T. hawaiiensis*, which is a problem in lemons in the Eastern Mediterranean Region of Turkey, yet another invasive species, *S. dorsalis*, was recently recorded on orange trees in a limited area in the Finike district of Antalya Province. Except for the location where the first record of this thrips species on a citrus groves was made (locations Finike and Turunçova), this thrips has not been detected yet on the citrus groves in the following locations, Sahilkent, Hasyurt and Kumluca in Antalya Province, where citrus cultivation is common. However, its distribution and economic importance in citrus orchards in the Mediterranean Region of Turkey is not known yet; these basic issues need to be investigated for control efforts. Currently, there are insecticides with temporary licenses against *T. hawaiiensis* in citrus in Turkey. Although the economic importance of newly detected *S. dorsalis* in citrus fruits in Turkey is unknown, *T. hawaiiensis* continues to be a problem in lemons. Citrus producers randomly apply different groups of insecticides against thrips, mostly in the form of mixtures. In this way, the application of pesticides may cause different ecological problems in citrus ecosystems. Solution suggestions against invasive thrips species that are harmful to citrus fruits should be sought in integrated pest control programs. In this context, there is a need for basic studies on *S. dorsalis* in citrus groves in Turkey.

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