

Original article (Orijinal araştırma)

The lepidopteran pests of sweet potato: First record of *Helcystogramma triannulella* (Herrich-Schäffer) (Lepidoptera: Gelechiidae) with population development and natural enemies in Turkey¹

Tatlı patatesteki zararlı lepidopterler: Türkiye’de *Helcystogramma triannulella* (Herrich-Schäffer) (Lepidoptera: Gelechiidae)’nın ilk kaydı, popülasyon gelişmesi ve doğal düşmanları

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Summary

The study was conducted in Hatay Province, east Mediterranean Region, Turkey in 2012 and 2013 to determine major lepidopteran pests of sweet potato and to document the population development of the newly recorded species *Helcystogramma triannulella* (Herrich-Schäffer) (Lepidoptera: Gelechiidae) in 2013. Four lepidopteran species, *Aedia leucomelas* (L.) (Noctuidae), *Agrius convolvuli* (Linnaeus) (Sphingidae), *Hydriris ornatalis* (Duponchel) (Crambidae) and *H. triannulella* were found. This was the first detection of *H. triannulella* in Turkey, so its population development was studied in the second year. The larval population of *H. triannulella* began to increase towards the end of July and reached its peak in mid-August. During the study, predators, *Hippodamia variegata* (Goeze), *Oenopia conglobata* (L.), *Scymnus interruptus* (Goeze), *Scymnus mediterraneus* Khnzorian, *Stethorus gilvifrons* (Mulsant) (Coleoptera; Coccinellidae); *Nabis viridulus* Spinola (Hemiptera: Nabidae) were found in the folded parts of the leaves, and parasitoids, *Apanteles* sp., *Chelonus* sp. (Hymenoptera: Braconidae) and *Compsilura concinnata* (Meigen) (Diptera: Tachinidae) were obtained in the laboratory from larvae of *H. triannulella*.

Keywords: *Helcystogramma triannulella*, *Ipomoea batatas*, first record, sweet potato

Özet

Bu çalışma Türkiye’nin, Doğu Akdeniz Bölgesi’nde bulunan Hatay ilinde tatlı patates bitkisinin başlıca lepidopter zararlılarını ortaya çıkarmak amacıyla 2012-2013 yıllarında yürütülmüş ve Türkiye için yeni kayıt tür olan *Helcystogramma triannulella* (Herrich-Schäffer) (Lepidoptera: Gelechiidae) ’nın popülasyon gelişimi 2013 yılında belirlenmiştir. Tarla gözlemleri sonucunda dört lepidopter tür, *Aedia leucomelas* (L.) (Noctuidae), *Agrius convolvuli* (Linnaeus) (Sphingidae), *Hydriris ornatalis* (Duponchel) (Crambidae) ve *H. triannulella* belirlenmiştir. Bu çalışmada *H. triannulella* Türkiye’de ilk kez kaydedilmiştir. İkinci yıl bu türün popülasyon gelişmesi araştırılmıştır. Deneme alanında *H. triannulella*’nın larva popülasyonu Temmuz sonunda artmaya başlamış ve ağustos ortasında tepe noktasına ulaşmıştır. Çalışma boyunca predatörler, *Hippodamia variegata* (Goeze), *Oenopia conglobata* (L.), *Scymnus interruptus* (Goeze), *Scymnus mediterraneus* Khnzorian, *Stethorus gilvifrons* (Mulsant) (Coleoptera; Coccinellidae); *Nabis viridulus* Spinola (Hemiptera: Nabidae) yaprakların katlanmış kısımlarından ve parazitoidler *Apanteles* sp., *Chelonus* sp. (Hymenoptera: Braconidae) ve *Compsilura concinnata* (Meigen) (Diptera: Tachinidae) laboratuvarında *H. triannulella* larvalarından elde edilmiştir.

Anahtar sözcükler: *Helcystogramma triannulella*, *Ipomoea batatas*, yeni kayıt, tatlı patates

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Introduction

Sweet potato [*Ipomoea batatas* (L.) Lam., Solanaceae], is native to South America, and it is now grown in more than 100 countries with a combined annual production of over 100 Mt (FAO, 2016). Its storage roots and green parts are used as food and animal nutrition (Bovell-Benjamin, 2007; Kaya & Çalışkan, 2010) as well as natural colorant in layer egg yolk (Kaya & Yıldırım, 2011). Dry matter content of storage roots is around 20-30%, while the starch, sugar and protein account for about 30,10 and 5% of total dry matter, respectively (Woolfe, 1992). Storage roots are also quite rich in provitamin A (β -carotene), vitamin C (ascorbic acid) and vitamin B complex (Edmond & Ammerman, 1971; Woolfe, 1992).

As an important cash crop for small farms, sweet potato is grown in some villages of Hatay Province, in the east Mediterranean Region of Turkey. Çalışkan et al. (2007) indicated that sweet potato could be adapted to both the Mediterranean and southeastern Anatolia region of Turkey, and that high yields could be achieved in these areas.

There are several biotic and abiotic factors that limit growth and yield of sweet potato crops around the world. Insects are one of major the biotic constraints to crop growth, yield and quality given that both sweet potato storage roots and haulms are damaged by a diversity of insects (Jansson & Raman, 1991; Schalk et al., 1991; Ames et al., 1997). Clearwing moths *Synanthedon* spp. (Lepidoptera: Sesiidae) are reported as storage root feeders and stemborers; sweet potato stemborer *Omphisia anastomasalis* (Lepidoptera: Pyralidae) is reported as stemborer; sweet potato butterfly *Acraea acerata* Hew. (Lepidoptera: Nymphalidae), sweet potato hornworm *Agrius convolvuli* L. (Lepidoptera: Sphingidae), armyworms *Spodoptera eridania* (Stoll), *Spodoptera exigua* (Hübner) and *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae), leaf folders *Helcystogramma convolvuli* (Walsingham) (Lepidoptera: Gelechiidae) and *Herpetogramma hipponalis* (Walker) (Lepidoptera: Pyralidae) are reported as foliage feeders of sweet potato by Ames et al. (1997). Also, leaf folders are considered important defoliators of sweet potato. *H. convolvuli* is known to be a common leaf folder of sweet potato. However, the leaf folder, *Helcystogramma triannulella* (Herrich-Schäffer) (Lepidoptera: Gelechiidae) had not been reported to occur in Turkey. *Helcystogramma triannulella* had been recorded in China, Europe, India, Kazakhstan, Korea, Japan and Russia (Ponomarenko, 1997; Li & Zhen, 2011). Across this distribution, *Ipomoea aquatica* Forsk, *Ipomoea batatas* (L.), *Calonyction aculeatum* (L.), *Calystegia sepium* var. *japonica* (Choisy), *Convolvulus aroensis*, *Convolvulus arvensis* L. and *Pharbitis nil* (L.) from Convolvulaceae, and *Hibiscus syriacus* L. from Malvaceae are recorded as host plants of *H. triannulella*. Insecticides are usually applied to suppress populations of this pest, but alternative control methods such as biological control and using resistant cultivars have also been applied recently in different regions (Jones et al., 1987; Chalfant et al., 1990; Jansson & Raman, 1991; Schalk et al., 1993; Thompson et al., 1999).

Choosing the most appropriate insect management program mainly depends on insect species, feeding types, damage level, as well as the socioeconomic status of growers. Hence, determination of major insect pests of sweet potato crops, as well as their effects on crop yield and quality in a certain environments is essential for ecological and economic pest control program. Unfortunately, there is currently limited information available about sweet potato insect diversity in the Mediterranean Basin. Initially this study was conducted to determine major lepidopteran pests of sweet potato crops in a Mediterranean-type environment in Turkey, then subsequently to investigate the population development and natural enemies of *H. triannulella*, which was detected for the first time in Turkey during the first year of the study.

Materials and Methods

Determination of sweet potato lepidopteran pests

The study was conducted in Reyhanlı, Hatay Province (36° 50" N, 36° 25" E, 128 m) in the Mediterranean Region of Turkey. Larval samples of Lepidoptera were collected by irregular sweet potato field surveys during 2012 and 2013. Larvae of each species were placed into different plastic containers with part of sweet potato foliage and taken to the laboratory. The collected larval samples were incubated

in a plant growth chamber at $26\pm 1^{\circ}\text{C}$, $70\pm 5\%$ RH and 16L:8D photoperiod, until pupal formation or adult hatching, or emergence of any possible natural enemies. Emerged adults of lepidopteran pests were identified based on male genitalia. All specimens of the pest were deposited in the Museum of Mustafa Kemal University, Hatay, Turkey.

Population development and natural enemies of *Helcystogramma triannulella*

In late July 2012, some folded leaves of sweet potato were noticed during field observations. When the folded leaves were examined, a larva was seen in each folded part of leaf (Figure 1). This was also found on *Convolvulus* sp. in these fields. Larvae of pest species were cultured to obtain adults in plastic containers in the laboratory. Four of the six larvae collected developed to adults within 10 d, while the other two died. The adult specimens were identified as *H. triannulella* by Ole Karsholt (Zoological Museum, Natural History Museum of Denmark, Universitetsparken 15, DK-2100 Copenhagen, Denmark). This was a new record for Turkey.

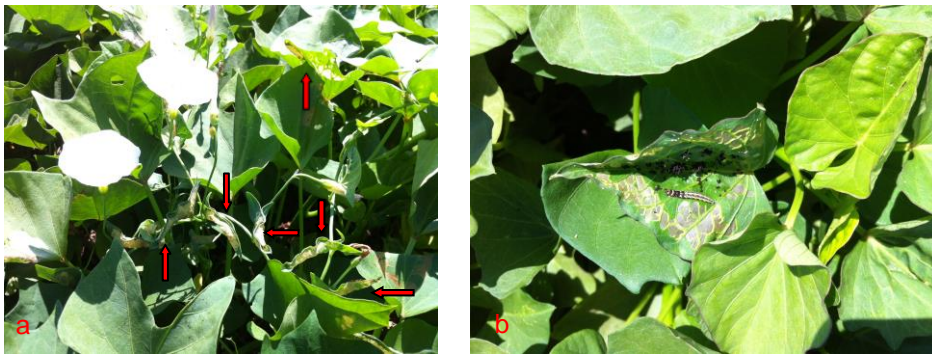


Figure 1. (a) Folded leaves of sweet potato, and (b) larva of *Helcystogramma triannulella*.

Consequently, in 2013, the population development of *H. triannulella*, was studied. For this purpose, sweet potato seedlings were planted on 11 June 2013 and 40 randomly selected plants were examined weekly to record the number of folded leaves and larvae within these folds. At the same time, folded leaves were also examined for predators; individual predators were collected for identification. Additionally several larvae (5-7) of the *H. triannulella* were collected every week and cultured to obtain potential parasitoids. Predator species (Nabidae and Coccinellidae) and tachinid parasitoids were mounted on insect pins, and braconid parasitoids were placed in 70% alcohol for identification.

Results and Discussion

Four lepidopteran species, *Aedia leucomelas* (L.) (Noctuidae), *Agrius convolvuli* (L.) (Sphingidae), *H. triannulella* and *Hydriris ornatalis* (Duponchel) (Crambidae) were found in sweet potato fields. The lepidopteran species obtained were as follows:

Aedia leucomelas (L.) (Noctuidae)

Material examined: 1♂, Reyhanlı, Hatay Province ($36^{\circ} 50''$ N, $36^{\circ} 25''$ E, 128 m) 14.IX.2012, leg. K. Kaya.

Host plants: Asteraceae: *Chondrilla juncea* L.; Convolvulaceae: *Convolvulus arvensis* L., *Convolvulus erubescens* Sims, *Ipomoea batatas* (L.), *Ipomoea pes-caprae* (L.) R. Br., (Anonymous, 2016a).

Distribution in Turkey: In the warm coastal areas close to the Black Sea and the Mediterranean Sea (Hacker, 1989; also Hacker, 1990): Adana, Amasya, Antalya, Bilecik, Bursa, Giresun, İstanbul, Ordu, Samsun, Tekirdağ (Koçak & Kemal, 2009) and Muğla (Baron, 2014).

Agrius convolvuli (L.) (Sphingidae)

Material examined: 1♀, Reyhanlı, Hatay province ($36^{\circ} 50''$ N, $36^{\circ} 25''$ E, 128 m) 23.VIII.2012; 1♂, 09.IX.2013, leg. K. Kaya.

Host plants: Convolvulaceae: *Calystegia* spp., *Convolvulus* spp., *Ipomoea batatas* (L.); Zygophyllaceae: *Zygophyllum dumosum* Boiss. (Akin, 2012; Ames et al., 1997).

Distribution in Turkey: Amasya, Ankara, Balikesir, Bursa, Konya, Malatya and Tokat (Koçak & Kemal, 2009).

***Hydriris ornatalis* (Duponchel) (Crambidae)**

Material examined: 1♂, 1♀, Reyhanlı, Hatay Province (36° 50" N, 36° 25" E, 128 m) 13.VIII.2013; 2♀♀, 18.VIII.2013, leg. K. Kaya.

Host plants: Convolvulaceae: *Ipomoea batatas* (L.); Mimosaceae: *Acacia monticola* J.M. Black; Polygonaceae: *Emex spinosa* (L.); Rosaceae: *Malus pumila* Mill. (Anonymous, 2016b).

Distribution in Turkey: Adana and Antalya (Koçak & Kemal, 2009).

***Helcystogramma triannulella* (Herrich-Schäffer)**

Material examined: 2♂♂, 1♀, Reyhanlı, Hatay Province (36° 50" N, 36° 25" E, 128 m) 9.VIII.2012; 2♂♂, 10.VIII.2013; 3♀♀, 11.VIII.2013; 4♂♂, 2♀♀, 18.VIII.2013; 1♂, 1♀, 24.VIII.2013, leg.K. Kaya.

New record for Turkish fauna.

Diagnosis: Wingspan 13.0-17.0 mm. Head smooth; ocellus absent; antenna ciliate; forewings with circular spots at middle and near end of cell, with oval dark brown spot at middle of upper side (Figure 2a). Valva elongate, exceeding apex of uncus in the male genitalia (Figure 2b); aedeagus stout (Figure 2c).

Host plants: Convolvulaceae: *Calonyction aculeatum* (L.), *Calystegia sepium* var. *japonica* (Choisy) *Convolvulus arvensis* L., *Ipomoea aquatica* Forsk., *Ipomoea batatas* (L.), *Pharbitis nil* (L.); Malvaceae: *Hibiscus syriacus* L. (Li, 2002; Lee & Byun, 2015).

Distribution: China, Europe, Kazakhstan, Korea, India, Japan, Russia, (Ponomarenko, 1997; Li & Zhen, 2011; Lee and Byun, 2015), Central Asia, Taiwan, Transcaucasian region Caucasus, (Ponomarenko, 1997; Lee & Byun, 2015) and Europe (Karsholt & Razowski, 1996; Ponomarenko, 1997; Lee & Byun, 2015).

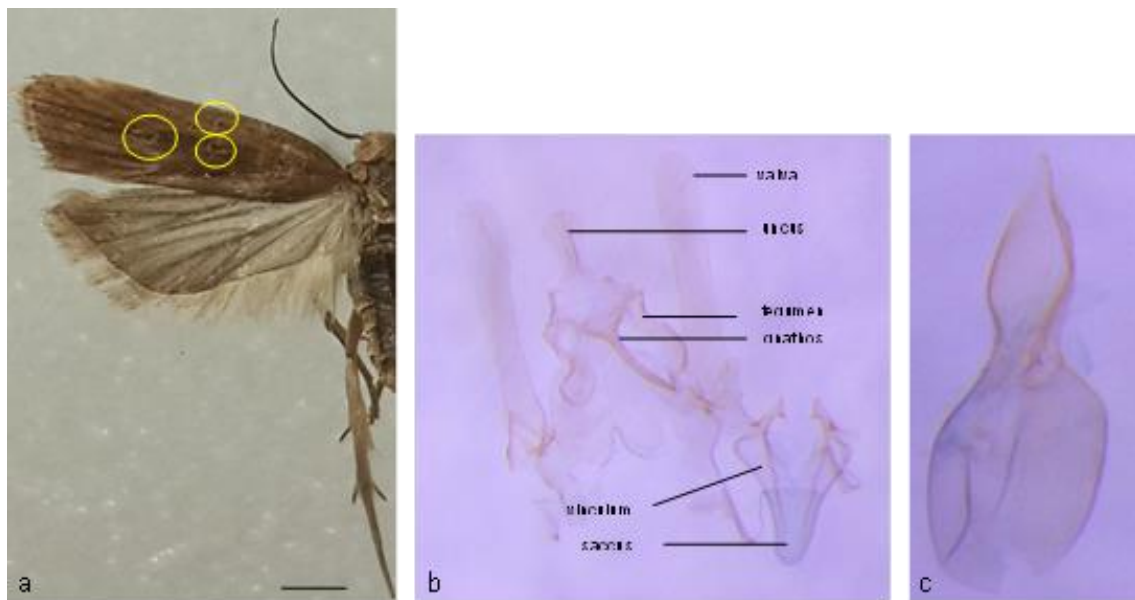


Figure 2. (a) Adult of *Helcystogramma triannulella*, (b) male genitalia, and (c) aedeagus. Scale bar = 1 mm.

Population development of *H. triannulella* is shown in Figure 3. First larvae of *H. triannulella* were seen on 7 July. The larval population of the pest in the experimental plot began to increase in late July and reached its peak on 10 August. In August, 10 larvae per plant were observed on some plants. After the August peak, density of the pest larvae declined gradually until 14 September, and finally disappeared (Figure 3). Over this period several natural enemies were detected in the field or from cultured larvae *H. triannulella*. During the sampling period, the pest was also observed feeding on *Convolvulus* sp. in the same field.

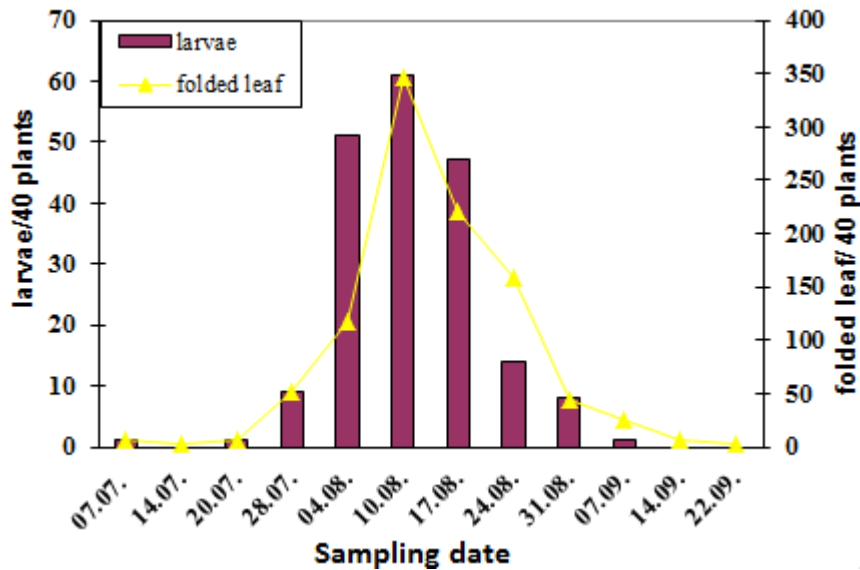


Figure 3. Number of folded leaves and larval population of *Helcystogramma triannulella* in sweet potato in 2013.

During the sampling, predator species belonging to Nabidae (Hemiptera) and Coccinellidae (Coleoptera) families were found between some folded leaves although no larvae of *H. triannulella* were detected. The parasitoid species from Braconidae (Hymenoptera) and Tachinidae (Diptera) families emerged when the sampled larvae were incubated in the laboratory. Especially the species belonging to Coccinellidae were abundant between empty folds, with up to 12 larvae per folded leaf (Figure 4).



Figure 4. Coccinellid individuals found between empty folds of sweet potato leaves.

In total, six predators and three larval parasitoid species were found in the field. Predators obtained were *Hippodamia variegata* (Goeze), *Oenopia conglobata* (L.), *Scymnus interruptus* (Goeze), *Scymnus mediterraneus* Khnzorian, *Stethorus gilvifrons* (Mulsant) (Coleoptera: Coccinellidae) and *Nabis viridulus* Spinola (Hemiptera: Nabidae). Franzman (2002) reported that *H. variegata* is the most important natural enemy of aphids, whiteflies, mealybugs, lepidopteran and coleopteran insects in many countries. It is known that this species feeds on eggs and first instars of *Ostrinia nubilalis* (Kayapınar & Kornoşor, 1993), *Pieris rapae* L. (Schmaedick & Shelton, 2000) and *S. exigua* (Atlıhan et al., 2003). Likewise, Yanık (2011) used the eggs of the pyralid, *Ephestia kuehniella* Zell. (Lepidoptera: Pyralidae), for mass production of *O. conglobata*. This work revealed that it is possible to produce up to 20 generations per year of *O. conglobata* on *E. kuehniella*. However, it was reported that *E. kuehniella* eggs were a superior diet for the development rather than the reproduction of *O. conglobata* (Mirhosseini et al., 2015). Also, Atlıhan et al. (2003) reported with reference to Summy et al. (1997) that some *Scymnus* species feed on eggs and larvae of *S. exigua*. Several researchers have also reported that *Nabis* spp. feed on other small and soft insects such as aphids, cicadellids, small larvae of lepidopteran species, nymphs of Heteroptera (Lodos, 1986; Kayapınar & Kornoşor, 1993).

The parasitoids obtained from the larvae were determined as *Apanteles* sp., *Chelonus* sp. (Hymenoptera: Braconidae) and *Compsilura concinnata* (Meigen) (Diptera: Tachinidae). Thirteen species from eight lepidopteran families were reported as hosts for *C. concinnata* (Kara & Tschorsnig, 2003). The braconid species are an important parasitoid group preying on pest lepidopteran populations. Balevski (1999) found that many species from the families Gelechiidae, Gracillariidae, Pyralidae, and Tortricidae are hosts for *Apanteles* species in Bulgaria, and *Apanteles anarsiae* Faure & Alabouvette (Hymenoptera: Braconidae) is also a parasitoid of *Anarsia lineatella* Zell. (Gelechiidae) and *H. triannulella*. Balevski (1999) also reported that different species belong to the genus *Chelonus* are parasitoids of *Helicoverpa armigera* (Hübner) (Noctuidae), *Etiella zinckenella* (Treitschke), *Ostrinia nubilalis* (Hübner) (Pyralidae), *Synanthedon myopaeformis* (Borkhausen) (Sesiidae) and *Cydia pomonella* (L.) (Tortricidae). *Apanteles* sp. and *Chelonus* spp. were also detected on different lepidopteran hosts in Turkey, i.e. *Apanteles* sp. from *Hellula undalis* Fabricius, *Mythimna loreyi* Duponchel, *O. nubilalis*, *Sesamia cretica* Led., *Sesamia nonagrioides* (Lef.), *Spodoptera littoralis* Boisid. and *Chelonus* sp. from *H. undalis*, *M. loreyi* and *S. exigua* (Kaya, 2008; Gözüaçık et al., 2009).

Four harmful lepidopteran species from sweet potato crops, an important cash crop for small farms in Hatay Province, were found in this study. This includes also the first detection of *H. triannulella* in Turkey. These four lepidopteran species can be considered to be potentially harmful insects for sweet potato in the Mediterranean-type environments. Several natural enemies of these species were also found in the sampling area. Therefore, further studies should be conducted to evaluate the effects of these species on yield and quality deterioration in sweet potato crops to determine the economic threshold for chemical treatments or other management practices.

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