Article

The invasion of *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) toward Southeastern Türkiye

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ABSTRACT

The fall armyworm, *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) has rapidly expanded its distribution on a worldwide scale and was recently introduced in Türkiye from the eastern side of the Mediterranean region. Regular surveys were followed in the Southeastern region, Türkiye and confirmed the expansion of the pest in new territories. The larval specimens were noticed by specific diagnostic features, particularly an inverted Y-shape marking on the head capsule and four black spots in a square pattern on the dorsal side of the eighth abdominal segment. The pest has very recently arrived in Suruç county of Şanlıurfa province in Southeastern Türkiye. However, its early invasion remained restricted since other surrounding maize lands in other counties of Şanlıurfa, namely, Akçakale, Bozova, Harran, Karaköprü, and Siverek, and other neighboring provinces, Diyarbakır and Mardin, as well as far eastern provinces such as Batman and Şırnak were found uninfested. This study emphasizes the requirement of continuous monitoring efforts to establish an understanding of Integrated Pest Management strategies (IPMs) including native and invasive maize pests.

Keywords: Invasive species; lepidopteran maize pests; Noctuidae; rapid dispersion; Southeastern Anatolia Region The fall armyworm

Spodoptera frugiperda (JE Smith) (Lepidoptera: Noctuidae)'nın Güneydoğu Anadolu Bölgesi istilası

ÖZET

Güz kurdu, *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) dünya çapındaki yayılımını hızla genişletmiş ve yakın zamanda Akdeniz Bölgesinin doğu yakasından Türkiye'ye giriş yapmıştır. Türkiye'nin Güneydoğu Anadolu Bölgesinde düzenli olarak yapılan surveyler, zararlının yeni bölgelere yayıldığını doğrulamıştır. Larva örnekleri, özellikle baş kapsülü üzerinde yer alan ters Y şeklinde bir işaret ve sekizinci abdomen segmentinin dorsal kısmında kare şeklinde dört siyah nokta gibi spesifik teşhis özellikleriyle fark

edilmiştir. Zararlı, Güneydoğu Anadolu Bölgesi Şanlıurfa ilinin Suruç ilçesine çok yakın zamanda gelmiştir. Ancak, Şanlıurfa'nın diğer ilçeleri olan Akçakale, Bozova, Harran, Karaköprü ve Siverek ile diğer komşu iller olan Diyarbakır ve Mardin'in yanı sıra Batman ve Şırnak gibi daha doğu illerindeki diğer çevre mısır arazilerine henüz bulaşmadığından, erken istilası sınırlı kalmıştır. Bu çalışma, yerli ve istilacı mısır zararlılarını içeren Entegre Zararlı Yönetimi stratejilerinin (IPM'ler) anlaşılması için sürekli takip çalışmalarının gerekliliğini vurgulamaktadır.

Anahtar Kelimeler: İstilacı türler; lepidoptera mısır zararlıları; Noctuidae; hızlı yayılım; Güneydoğu Anadolu Bölgesi; Güz kurdu

1. INTRODUCTION

Maize, *Zea mays* L., stands out among the major crops in Türkiye and its cultivation has been driven by the ever-increasing demand. Recently, maize cultivation in Southeastern Türkiye has achieved an approximate area of 2.000.000 da, 88% of which predominantly consists of second-crop maize lands (TUIK, 2023). Second-crop maize production in this region surpasses the total maize cultivation across the country by at least fourfold, while first-crop maize production still plays a significant role in maize production areas in Türkiye (TUIK, 2023). As maize cultivation, particularly second-crop maize lands, continues to expand in the region, the emphasis on ensuring the health and quality of crops becomes increasingly vital.

Maize cultivation in Türkiye faces significant challenges, primarily due to the detrimental feeding activity of various lepidopteran stem borers. Among them, *Sesamia* spp. (Lepidoptera: Noctuidae) and *Ostrinia nubilalis* (Hübner) (Lepidoptera: Crambidae) have persistently remained key pests, leading to considerable reductions in maize yields over an extended period, until very recently in Türkiye, including the Southeastern region (Gözüaçık & Mart, 2005; Tonğa, 2021). The last decade has witnessed the emergence of an era dominated by invasive species, including pests affecting maize crops. For example, *Chilo partellus* (Swinhoe, 1885) (Lepidoptera: Crambidae) was introduced in the Mediterranean region of Türkiye in 2014 (Bayram & Tonğa, 2016) and voraciously expanded its invasion areas toward Southeastern Türkiye with a restricted area in early expansion times in 2022 (Tonğa & Rüstemoğlu, 2023). Very recently, the Mediterranean region maize fields of Türkiye were found infested by the fall armyworm, *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae), another invasive pest species, in 2022 (Pehlivan & Atakan, 2022). In September 2023, regular samplings yielded the determination of *S. frugiperda* infestation in Suruç county of Şanlıurfa, Türkiye. Immediate surveys targeted surrounding fields in the counties of neighboring provinces to document the region-wide distribution of the pest. The larval specimens were recognized based on their

morphological traits and incubated specimens confirmed the morphological resemblance of adult specimens to *S. frugiperda* adults as well (EPPO, 2015).

Spodoptera frugiperda is a highly polyphagous and voracious invasive pest originating from tropical and subtropical areas of the Americas. The pest is still on quarantine lists in many countries in Africa, Asia, and Europe, including Türkiye (EPPO, 2023). This study aims to report the ongoing invasion of *S. frugiperda* in Türkiye toward the Southeastern region.

2. MATERIALS AND METHODS

2.1 The survey program

Regular samplings aimed at monitoring maize pest populations are conducted in the Southeastern Türkiye region every September. Due to the recent introduction of *C. partellus* into the region through the counties of Şanlıurfa province, surveys started in the same counties to monitor the potential introduction of the new invader, *S. frugiperda*. Surveys were, afterward, extended to other neighboring provinces, Diyarbakır and Mardin, which were further extended to the eastern provinces, Batman and Şırnak. The maize plants with any visible damage to the leaves or stems were investigated. The first specimens of *S. frugiperda* were noticed in two maize locations in Suruç county of Şanlıurfa province. The larval specimens were first characterized by four dorsal spots in a squared pattern on the eighth abdominal segment and an inverted Y-shape on the head capsule (EPPO, 2015). Then, 50 plants were randomly sampled from 10 different sampling spots in each field. The plants were carefully checked for the presence of any damage symptoms. The infested plants were dissected without harming the specimens, which were transferred to containers for transportation to constant laboratory conditions with 25 ± 1 ℃, 60 ± 5 RH, and 16 h illumination. The larval specimens were provided with fresh maize plants and the containers were renewed daily. The larval specimens completed their metamorphosis and became adults in the laboratory, confirming the identification based on the appearance of forewing spots (EPPO, 2015). All samplings were performed on the second-crop maize vegetation, and plants were at the reproductive stages between inflorescence emergence and flowering, referring to BBCH scale 51-69 codes (Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie) (Lancashire et al., 1991; Weber & Bleiholder, 1990). The mean number of *S. frugiperda* larvae per plant was compared between two locations using a t-test in GraphPad Prism 8.3.0 (538) (GraphPad Software LLC., Boston, USA). The identification of specimens was kindly confirmed by Dr.

Hend Omar Mohamed (Plant Protection Research Institute, Biological Control Department, Giza, Egypt).

3. RESULTS

3.1 Determination of *Spodoptera frugiperda* in Southeastern Türkiye

The larval specimens and those that became adults were easily recognized and identified as *S. frugiperda* based on their morphological traits (Figure 1). The damage type, actively feeding larva, and its frass are also presented in Figure 1. The pest was recorded in two maize fields in Suruç county, Şanlıurfa (Figure 2). The pest infested 60% of the sampled maize plants in L1, while 20% of the infestation was recorded in L2. The mean number of pest larvae per plant was 0.76 in the former and 0.28 in the latter maize fields. Additionally, the number of *S. frugiperda* larvae per plant was statistically higher in L1 than in L2 (t= 3.46, P<0.001, Figure 3). Immediate surveys across other neighboring counties of Şanlıurfa, namely, Akçakale, Bozova, Harran, Karaköprü, and Siverek, revealed the absence of infestation. Besides, prompt surveys across other neighboring provinces such as Diyarbakır and Mardin revealed the absence of the pest. Further provinces such as Batman and Şırnak were found uninfested as well.
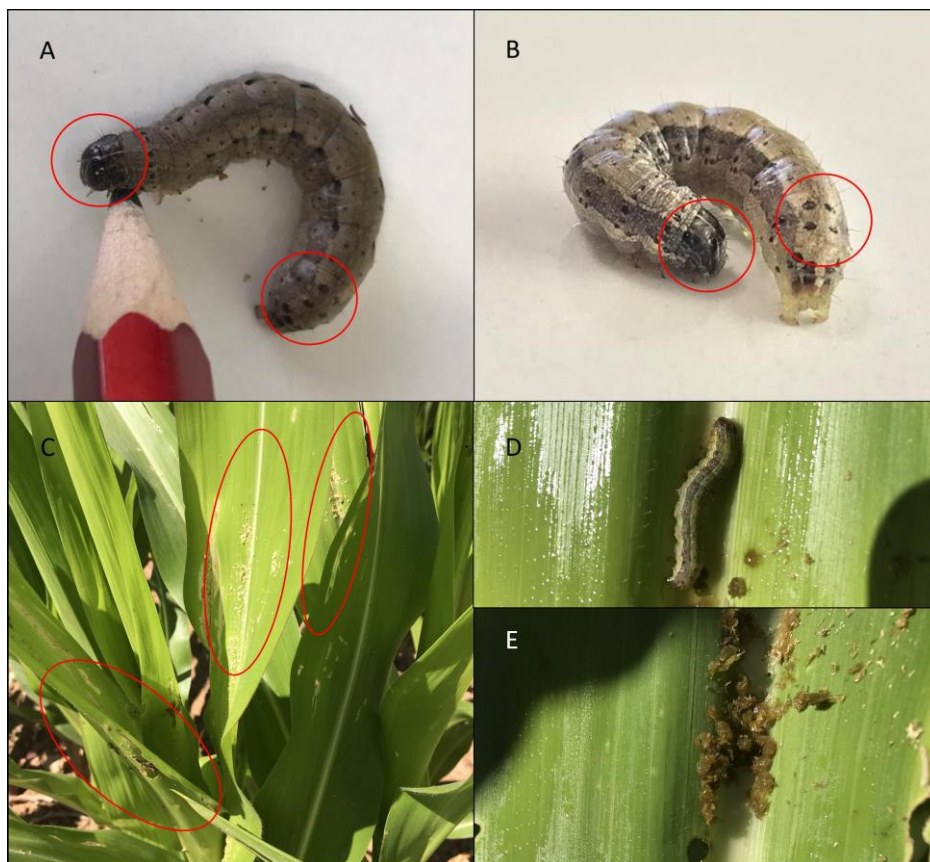

Figure 1. The characteristic morphological traits (A, B), feeding damage (C), an actively feeding larva (D) and larva frass (E).
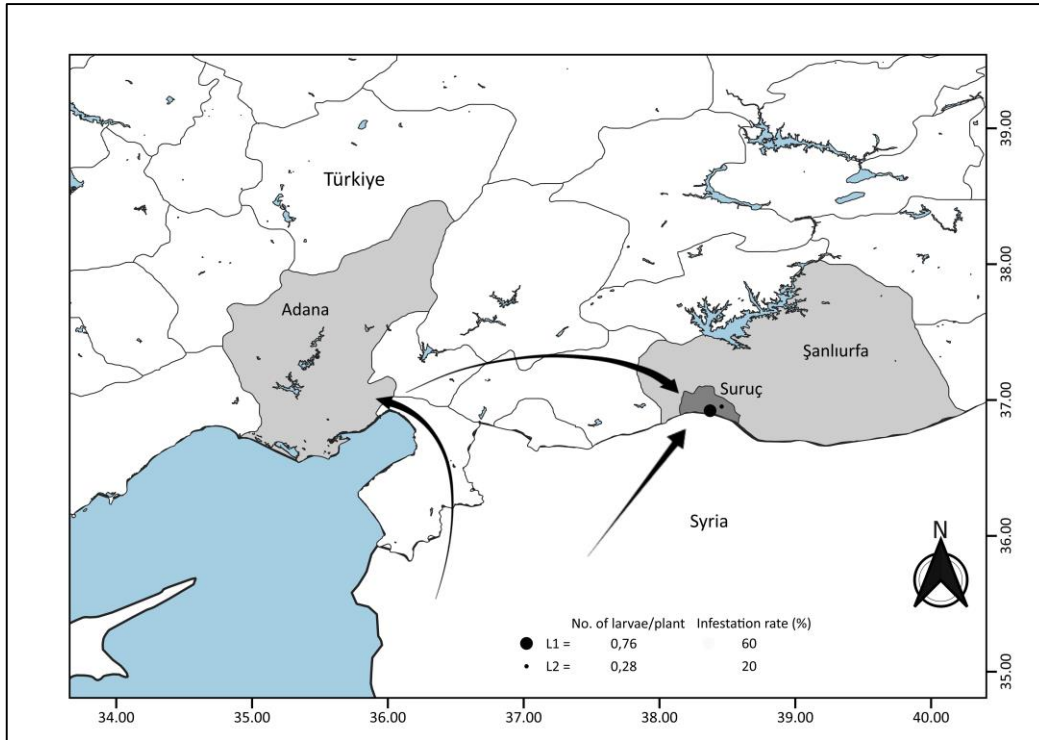
Figure 2. The map for early invasion of Suruç county of Şanlıurfa, Southeastern Türkiye by *Spodoptera frugiperda* along with possible routes of invasion as shown by black arrows. The provinces at the east of Şanlıurfa were uninfested. The legends provide number of pest larvae per plant and location-based infestation rate at two infested locations.
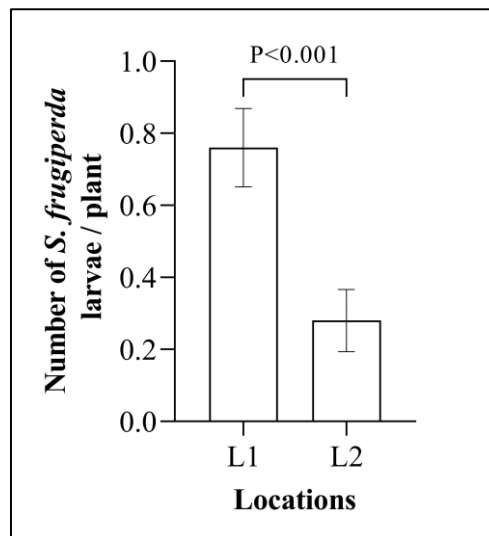

Figure 3. Mean number (± std.er) of *Spodoptera frugiperda* larvae per plant in two locations in Suruç county of Şanlıurfa, Türkiye.

4. DISCUSSION

The occurrence of *S. frugiperda* was only recorded in two maize fields in Suruç county of Şanlıurfa province. Other surrounding territories remaining on the east side were found uninfested. The invasion of the pest in Southeastern Türkiye could have happened toward provinces lying between the Mediterranean and Southeastern regions, namely, Osmaniye, Kilis,

Gaziantep, and Kahramanmaraş since the pest was first reported in the Eastern Mediterranean region of Türkiye, Adana province in 2022 (Pehlivan & Atakan, 2022). Besides, the invasion might have taken place directly from Syria to Southeastern Türkiye since Syria as one of the eastern Mediterranean countries that composes a perfect invasion route for exotic pests.

The early invasion of the pest through Southeastern Türkiye is restricted to two locations, which suggests the maximum expansion of the early invasion in this region might have been affected by current pest management strategies, i.e., chemical control against other insect pests such as *Sesamia* spp., *O. nubilalis,* and *C. partellus*. In addition, invasion toward the region coincided with inflorescence emergence and flowering maize growth stages, which might have caused a restriction on early invasion considering that younger fields could be more favorable to pest expansion until the end of the season. Therefore, it is difficult to conclude an average permanent infestation rate for the region with the present data, while 60 and 20% of host plants in the first and second locations were infested by the pest, respectively. Still, the infestation rates were relatively high, which was most probably due to the high dispersal capacity that is provided based on its competitive capability (Mutua et al., 2022). Extended surveys will address the competitive situation and consequences between *S. frugiperda* and other inter- and intra-guild maize pests such as leaf chewers and stemborers. In a previous survey, we found that the contribution of *C. partellus* to maize stemborer populations was equal to that of *Sesamia* spp. populations, which was previously considered the most significant pest group in the region (Tonğa & Rüstemoğlu, 2023). The establishment of *C. partellus* and, now, the arrival of *S. frugiperda* highlight the significance of extended survey programs and sampling procedures addressing interspecific relationships in maize ecosystems.

The last invader in the region, *S. frugiperda* is polyphagous and can damage a wide array of host plants other than maize. In Southeastern Türkiye, cotton is sown along with maize, both of which, together, dominate the cultivation during the second vegetation period in the region. Since cotton ranks among one of the *S. frugiperda* host plants (Barros et al., 2010), the monitoring programs should include cotton-cultivated fields as well.

5. CONCLUSIONS

This study confirms the expansion of *S. frugiperda* in Türkiye and is first to report its presence in Southeastern region. This study emphasizes the requirement of continuous monitoring efforts to establish an understanding of Integrated Pest Management strategies (IPMs) including native and invasive maize pests.

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