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SPECIAL ISSUE

AMARANTHUS SPP.: A GENUS OF TROUBLESOME WEEDS

SHORT COMMUNICATION

Spodoptera eridania (Lepidoptera: Noctuidae): first report on *Amaranthus hybridus* (Amaranthaceae) in Brazil

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Abstract: **Background:** *Amaranthus hybridus* L. (Amaranthaceae) is an annual, dicotyledonous species that is considered one of the main weed infesting agricultural production systems. Some weeds species are considered host plants to insect pests, serving as "green bridges" for subsequent attacks on the main crop during the season, which can cause significant losses. Recording the occurrence of insects that can reach pest status is important for the deployment of mitigation measures against possible damage and economic losses to crops. The presence of *Spodoptera eridania* (Cramer) (Lepidoptera: Noctuidae) has not been previously registered in association with *A. hybridus* plants.

Objective: Thus, the present study is the first report to describe the occurrence of *S. eridania* on *A. hybridus* in the municipality of Piracicaba, São Paulo, Brazil.

Methods: Images of the larvae while feeding on *A. hybrids* were obtained using an Olympus® E-410 digital camera. The pictures were then sent to the Laboratory of Ecotoxicology and IPM (LEMIP) of the Department of Entomology of Lavras Federal University (UFLA) for species identification.

Results: We observed *S. eridania* larvae larger than 7 cm feeding on the inflorescences and leaves of *A. hybridus*.

Conclusions: This note reports the first occurrence of *S. eridania* larvae feeding on *A. hybridus* in the city of Piracicaba, SP, Brazil.

Keywords: Invasive plant; Pest arthropod; Interaction; Infestation; Injury

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In Brazil there is a complex of caterpillars of the genus *Spodoptera* that cause direct damage to many crops of economic importance, such as corn, cotton, and soybean (Hoffmann-Campo et al., 1985; Santos et al., 2005; Bueno et al., 2011; Favetti et al., 2015; Silva et al., 2017). The species *Spodoptera eridania* (Cramer) (Lepidoptera: Noctuidae) is often present in these crops and others attacking both vegetative and reproductive plant tissues (Santos et al., 2005). The polyphagous habit of *S. eridania* contributes to considerable economic losses in agricultural host crops as it quickly adapts to different agroecosystems, being this lepidopterous considered one of the most polyphagous species (Soo Hoo, Fraenkel, 1966; Bortolotto et al., 2014).

Adult female *S. eridania* lays spherical eggs that are greenish when newly laid, with the embryonic period lasting on average four to six days. The larval period consists of six instars, and the larvae can reach 35 mm in length at the end of the phase; larvae are green or blackish-green with a light brown or reddish-brown head capsule. As larvae develop, they have a narrow dorsal white line and lateral stripes, with a yellowish or whitish stripe on each side of the body, which is interrupted by a dark spot on the first abdominal segment. A series of dark triangles may be present dorso-laterally along the body length. The larval stage can last from 14 to 20 days depending on abiotic factors, especially temperature. Larvae pupate in soil, and the pupae are brown, measuring 16 to 18 mm in length, and the pupal period lasts 11 to 13 days. The adult is a light-gray moth with wingspan of approximately 40 mm, with grayish or straw-yellow forewings with a black dot on the center, while the hind wings are whitish (Capinera, 2011; 2018; Bragard et al., 2020).

The biotic potential and reproductive parameters of *S. eridania* were evaluated by Montezano et al. (2013) in the laboratory, with an artificial diet adapted from Hoffmann-Campo et al. (1985). At the conditions of 25 ± 1 °C, 70 ± 10% RH, and 14-h photophase, the longevity of females was on average 10.80 days, and 9.27 days for males. Pre- and post-oviposition, and oviposition periods were 2.07, 0.6, and 8.13 days, respectively. Mean female fecundity was 1,398 eggs, and the viability was 97.8%. *Spodopera eridania* showed high biotic potential, being estimated at 1.894×10^{25} individuals per female^{-1}.year^{-1}, which indicates a strong capacity to increase its population size in agricultural crops and to cause substantial economic losses.

Larvae of *S. eridania* are voracious, and the adults have high reproductive capacity. Larvae of *S. eridania* have polyphagous habit and can cause damage to crops by causing lesions in the reproductive structures and also by defoliating the plants (Jesus et al., 2013). Silva et al. (2017) demonstrated that soybean and cotton were more susceptible to the development and oviposition of *S. eridania* than wheat and corn. In addition, this insect species is able to develop on invasive weed plants, in which their presence during the off-season can act as "green bridge" as they provide food and shelter to the larvae.

Spodoptera eridania has been previously observed on invasive weed plants of the genus *Amaranthus*, family Amaranthaceae (Montezano, 2014). Larvae of *S. eridania* were collected from *Amaranthus hybridus* L. in Florida, along with emergences of the tachinid parasitoids, *Winthemia rufopicta* (Bigot), *Eucelatori rubentis* (Coquillett), and *Lespensia* sp. (Tingle et al., 1978). *Amaranthus viridis* has been identified as a potential host for *S. eridania* because of its nutrient-rich composition (Silva et al., 2017). Thereby, this condition can promote population growth and infestations of *S. eridania* in successive cultivated plants of economic importance, especially soybeans and cotton during the summer crop season (Tingle et al., 1978; Santos et al., 2005). Considering the economic importance of *S. eridania* in agricultural systems, the present work records the first observation of this pest in *A. hybridus* in Brazil.

Larvae of *S. eridania* were observed feeding on *A. hybridus* plants in May 2021 inside the greenhouse, in the municipality of Piracicaba (22°42'30" S, 47°38'00" W, mean annual precipitation 190 mm, mean temperature 29 °C, 546 m altitude), state of São Paulo, Brazil. Images of the larvae while feeding on *A. hybrids* were obtained using an Olympus® E-410 digital camera. The pictures were then sent to the Laboratory of Ecotoxicology and IPM (LEMIP) of the Department of Entomology of Lavras Federal University (UFLA) for species identification.

Spodoptera eridania larvae of approximately 7 cm in length were naturally found infesting the upper part of *A. hybridus* plants at full bloom. The plants of *A. hybrids* were being cultivated in 540 pots filled commercial substrate in the greenhouse for other experimental purposes. Approximately 20 plants were attacked by on average three blackish-green larvae of *S. eridania* per plant (Figure 1). Inside the greenhouse other family plants were cultivated side by side with *A. hybridus*, including soybean plants. After noticing the natural infestation, *S. eridania* larvae fed on inflorescences and leaves. Some of the *A. hybridus* plants were completely defoliated (Figure 1) after 3 days of noticing the larvae infestation in the greenhouse.

Spodoptera eridania has been mainly associated with soybean and cotton crops; however, its polyphagous behavior has contributed to its ability to quickly adapt to diverse agroecosystems as the larvae can feed on the leaves and reproductive structures of several plants species (Silva et al., 2017). Its relatively short cycle allows this pest insect to produce many generations year round, and consequently have multiple and viable offspring. Larvae of *S. eridania* also present substantial movement between host plants (Fanela et al., 2020), and their presence in agricultural production systems has been noted in the main soybean-producing regions in Brazil (Souza et al., 2014) due to the wide distribution of alternative food sources during the crop season as well as off-season (Machado et al., 2020).

The polyphagous habit of *S. eridania* benefits its growth and development, whereby under stress from food shortages, the larvae tend to attack other host plants, and may consume tender branches and inflorescences, perforate tissues, and even attack the roots of host plants (Jesus et al., 2013; Bragard et al., 2020). Among the plants most attacked by *S. eridania* larvae, those belonging to the families Amaranthaceae, Solanaceae, Fabaceae, and Poaceae predominate, not only because of the higher number of cultivated plants, but also for the large number of invasive species that can serve as primary food sources during the off-season when the main crop is not properly managed, before implementation or after harvest (Bortoli et al., 2012; Montezano et al., 2014).

Weeds of the genus *Conyza* are able to host *S. eridania* larvae and other lepidopteran pests in soybean crops in Brazil, and therefore should be properly managed to reduce the insect populations on the major crops (Dalazen et al., 2016). When feeding during initial development, *S. eridania* larvae can assimilate nutrients from the host plants to meet their nutritional needs, allowing for normal development until adulthood (Panizzi, Parra, 2009). *Spodoptera eridania* larvae showed shorter larval periods and higher pupal weights when fed on the invasive plant morning glory, *Ipomoea grandifolia* (Convolvulaceae), than soybean plants, therefore, this weed species can be considered as an alternative host plants for this pest (Santos et al., 2005). These authors reported also the number of eggs per female laid on the leaves of soybean, cotton, and morning glory, which were high in all treatments, demonstrating that in addition to plants being an alternative food source, they are also suitable substrates for oviposition.

Clover, *Trifolium repens* (Fabaceae), is an invasive plant that presents suitable nutritional conditions for *S. eridania* larval growth and development. Female fertility was higher when *S. eridania* larvae were fed on leaves of clover compared to larvae that ingested plant tissues of peach and apple trees (Silva et al., 2018). In another study, Jesus et al. (2013) evaluated different host plants for the development of *S. eridania* and stated that *Canavalia ensiformis* was the most attractive to the larvae; however, plants of *Raphanus sativus* L. were the most consumed. Plants of *R. sativus* are weeds commonly found in soybean crops, which can host insect pests like *S. eridania*, in

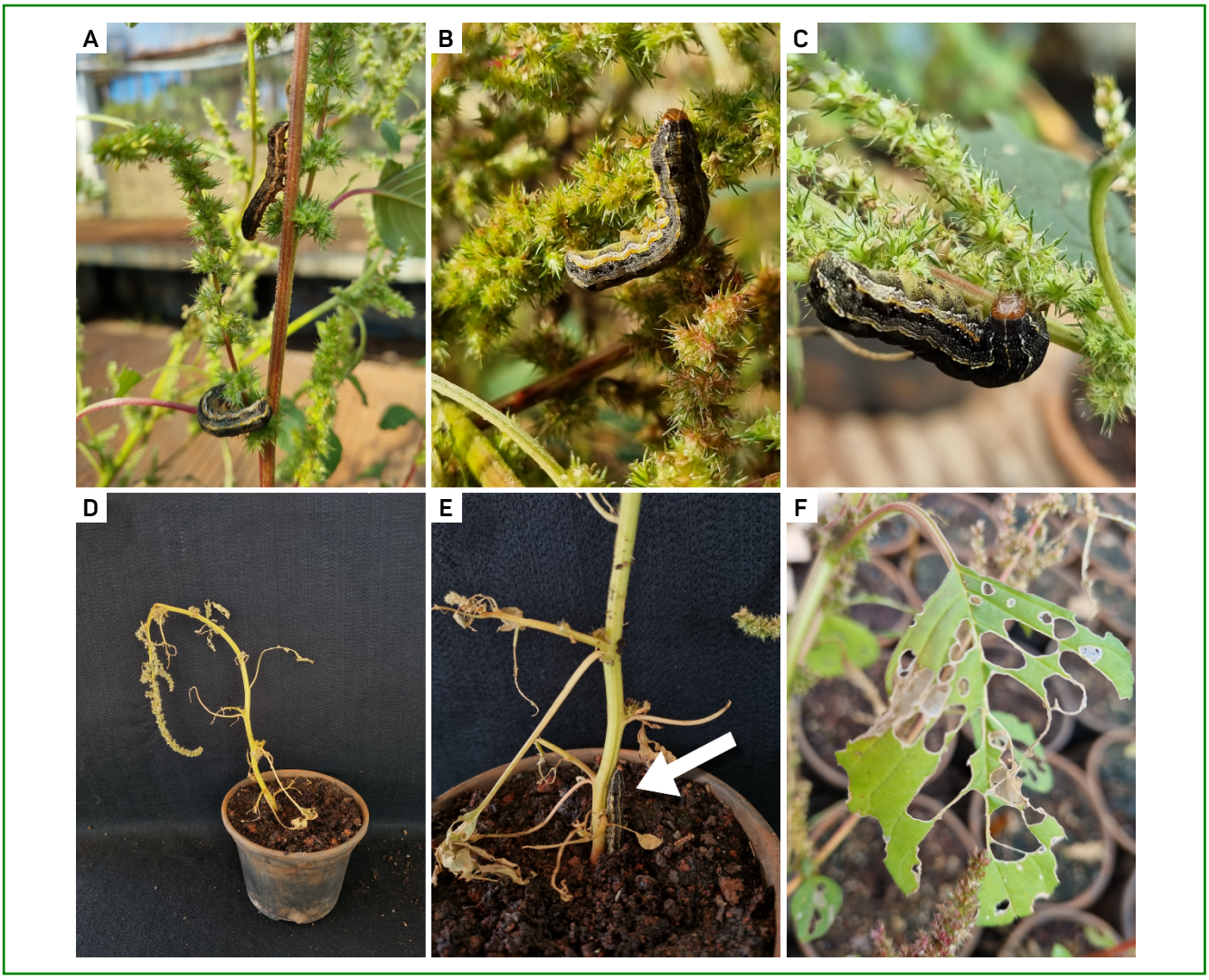

Figure 1 - (a,b,c) *Spodoptera eridania* larvae on *Amaranthus hybridus* plants, (d,e,f) larvae and symptoms of *Spodoptera eridania* attack on *Amaranthus hybridus* plants

addition these plants can compete for light, nutrients, and space with the main crop, leading to lower yields (Santos et al., 2005).

The genus *Amaranthus* has a great importance in agriculture as it includes a lot of species considered as weeds. It has been reported in recent studies difficulty in controlling *A. hybridus* due the resistance to glyphosate, the main herbicide used for its control (García et al., 2020; Resende et al., 2022). Besides that, these plants can remain in crops becoming a green bridge for herbivorous insects that damage crops of interest reducing producer profit (Moraes et al., 2020).

This study reports for the first time the natural occurrence of *S. eridania* larvae feeding on *A. hybridus* in the city of Piracicaba, SP, Brazil. This demonstrates that this invasive weed plant, which is difficult to eliminate in agricultural crops, can serve as "green bridge" to promote the growth and development of *S. eridania*. This can allow for the success of consecutive generations of the insect species and consequent attacks on major agricultural crop systems. Thus, preventive measures should be taken to control *S. eridania* by monitoring its population densities and investigating the existence of associated natural enemies. Furthermore, it is necessary to conduct studies under laboratory, greenhouse, and field conditions to evaluate the bioecological characteristics of *S. eridania* on *A. hybridus* plants to establish more effective management strategies for its control.

Author's contributions

All authors read and agreed to the published version of the manuscript. LSR and KGF: conceptualization of the manuscript and development of the methodology. BHSS

and MN: supervision and project administration. JCP and GAC: data analysis and data interpretation. VCC and PJC. data collection and curation.

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Conflict of Interest

The authors affirm that no conflicts of interest exist.

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