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Short Communication

First record of *Peridroma saucia* Hübner (Lepidoptera: Noctuidae) in transgenic soybeans

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ABSTRACT

The widespread cultivation of transgenic soybeans has caused significant changes in the spectrum of Lepidoptera larvae, both in the number of species as well as on their densities in the field. Transgenic crops producing *Bacillus thuringiensis* (*Bt*) insecticidal proteins have successfully reduced the incidence of the most common caterpillars infesting soybeans, namely *Anticarsia gemmatalis* (Lepidoptera: Erebidae) and *Chrysodeixis includens* (Lepidoptera: Noctuidae). However, lepidopteran species not previously recorded on the crop have been recently found, and are of concern due to the possibility of adaptation to the genetically modified cultivars. The occurrence of *Peridroma saucia* Hübner (Lepidoptera: Noctuidae) is described for the first time in Brazil feeding on genetically modified soybean cultivars.

Introduction

Soybean, *Glycine max* (L.) Merrill (Fabaceae: Phaseoleae) is the most important commodity crop in Brazil (Conab, 2017). The primary caterpillars that attack leaves are the velvetbean caterpillar, *Anticarsia gemmatalis* (Hübner) (Lepidoptera: Erebidae) and the soybean looper, *Chrysodeixis includens* (Walker) (Lepidoptera: Noctuidae). The introduction of glyphosate-tolerant soybean and genetically modified insect-resistant plants which express the Cry1Ac protein from the bacterium *Bacillus thuringiensis* (Berliner) (Eubacteriales: Bacillaceae), has provided a satisfactory control of these pests (Bernardi et al., 2012). However, insect species not susceptible to the expressed toxin may develop into secondary pests and cause damage to the crop (Wu and Guo, 2005; Zhao et al., 2011; Catarino et al., 2015).

The variegated cutworm *Peridroma saucia* (Hübner) (Lepidoptera: Noctuidae) is a polyphagous, cosmopolitan species that damages various cultivated plants like peanuts, sunflowers, soybeans and grapevines (Álvarez et al., 2009). Larvae have a variable feeding behavior, damaging tubers underground and climbing orchard trees and attacking the fruits. In the UnitedStates the attacks of this cutworm occur sporadically and in isolated regions (Rings et al., 1976). In Turkey it is one of the most abundant and harmful species for agriculture (Yuksel et al., 2018). In Brazil, the presence of *P. saucia* was reported by Klesener et al. (2016) on apple orchards in northern Paraná state.

In South America, *P. saucia* is frequently recorded attacking different food and ornamental plants (Quimbayo et al., 2010). In Argentina *P. saucia* is described causing damage to artichokes (Vasicek, 1983) and alfalfa (Baudino, 2004; Baudino and Villareal, 2007). In Colombia, Fajardo and Cardona (2006) described the development of the immature stages and adult longevity of *P. saucia* reared during the larval stage on flowers of the Peruvian lily, *Alstroemeria* sp. (Alstroemeriaceae). Quimbayo et al. (2010) consider *P. saucia* as one of the most economically important species in Colombia due to its wide distribution and polyphagous habit. According to Butin and Pedigo (1985) larvae of *P. saucia* have nocturnal habits, making it difficult their observation in the field.

We describe for the first time in Brazil the occurrence of *P. saucia* on genetically modified soybeans expressing the Cry1Ac protein of *B. thuringiensis* as well as on a cultivar tolerant to the herbicide glyphosate (RR soybean).

Material and methods

The survey was conducted in two 14 hectare-areas of genetically modified soybeans in São José dos Pinhais (25°36′46.0″S, 49°08′21.5″W), Paraná state, Brazil between January and March 2018. One area was planted with soybeans expressing tolerance to the herbicide glyphosate, Roundup Ready® (RR) variety NA5909RG and the other with variety Syn13671IPRO expressing Cry1Ac protein of *B. thuringiensis* (*Bt*) which confers resistance to

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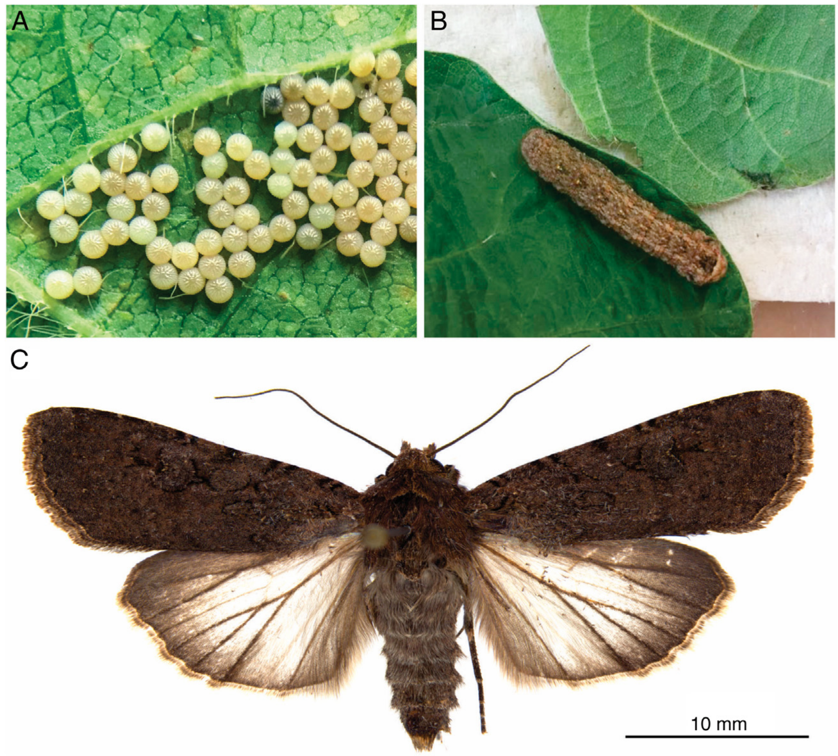

Fig. 1. Developmental stages of *Peridroma saucia* collected in genetically modified soybeans: (A) eggs, (B) larvae and (C) adult emerged in laboratory (scale = 1 cm).

target lepidopteran species as well as tolerance to the herbicide glyphosate. No insecticide treatments were made in both areas, and only fungicide (azoxystrobin + benzovindiflupyr; cyproconazole + difenoconazole; trifloxystrobin + protioconazole) and herbicide (glyphosate) were applied on both areas. Samplings were taken weekly by the beat cloth method (Shepard et al., 1974) in 20 points within each experimental area. Egg masses and larvae of *P. saucia* were taken to the laboratory and individualized in 4 × 7 cm plastic flasks at 25 ± 2 °C, relative humidity of 60 ± 10% and 14:10 (L:D) photophase. Field collected larvae and those hatched in laboratory from the field-collected eggs were fed with RR and *Bt* soybean leaves; 180 larvae were evaluated in each treatment up to the pupal stage. After adult emergence, moths were killed and pinned, and the species identified based on the specialized bibliography (Lafontaine, 2004).

Results and discussion

During the 2017–2018 soybean crop, 38 larvae were collected in RR and two in *Bt*-growing areas. Additionally, egg-masses (Fig. 1A) were collected in both areas during the vegetative (January) and reproductive stages of the crop (January–March). Of the total collected larvae (Fig. 1B) and fed in laboratory with transgenic soybean tolerant to glyphosate (RR), 37% successfully completed larval development and reached the adult stage (Fig. 1C), 29% were parasitized, three by specimens of Hymenoptera and eight by specimens of Diptera and 34% died of natural causes or by entomopathogens. Both larvae found on *Bt*-soybean and larvae hatched from the egg-masses collected in the field consumed leaves of *Bt* soybeans and completed development until the adult stage. Our results show that *P. saucia* can survive and reproduce on both RR and *Bt* soybeans, with potential to cause damage to the crop. Since there were no previous reports of *P. saucia* feeding on soybeans, it is reasonable to assume that the species is naturally tolerant to transgenic *Bt* soybeans. However, there was a high adaptative cost to the new host, because out of 180 larvae feeding on RR soybeans, 97 (53.9%) completed the larval stage and pupated, while in the *Bt* treatment only 57 (31.7%) reached the pupal stage. In order to assess the toxicity of these cultivars to a susceptible species, 60 third-instar larvae of *A. gemmatalis* were fed on the Cry1Ac hybrid, and total mortality was recorded before ecdysis to the fourth instar. Despite the poor performance of the first generation of *P. saucia* on genetically modified soybeans, it is possible that, in the course of generations, the adaptation of the species to the new host will be significantly improved.

Tolerance of insect pests to *Bt* Cry proteins can impair the selection advantage of this technology, and favor other species that are tolerant to *Bt* proteins. This is the case with *Spodoptera* spp. (Lepidoptera: Noctuidae) that exhibits low or no susceptibility to *Bt*-soybean containing the protein Cry1Ac (Bernardi et al., 2014), and in some soybean areas in Brazil, they are already considered key pests in the crop (Bueno et al., 2011). When the populations of target pests are efficiently controlled by a *Bt* toxin, secondary non-susceptible pests may become primary pests, occupying the ecological vacant niche and using the available resource, causing significant damage to the crop (Wu and Guo, 2005; Gross and Rosenheim, 2011).

Outbreaks of secondary pests are occasionally reported in transgenic soybeans in Brazil, and although they do not occur in extensive areas and do not cause damage of economic relevance, production losses can be observed in localized areas (Bueno et al., 2011; Marques et al., 2017). Therefore, it is necessary to survey the species and their occurrence along the crop seasons, since rearrangement of primary pests has been previously recorded in soybeans. This was the case of the soybean looper, *C. includens*, which until the late 1990s was considered a secondary pest, but with the changes in the phytosanitary management of soybeans, became a key pest of the crop (Moscardi et al., 2012). Despite the success in controlling the target pests, the cultivation of *Bt* soybean

(Cry1Ac) also changed crop management and may cause changes in the pest population over the years.

Information about the impact of *Bt* technology on non-target pests is important for the development of successful pest management programs on transgenic crops. More studies about the biology of *P. saucia* are needed to evaluate leaf consumption, development and reproduction of this species. It remains to be investigated if larvae of *P. saucia* are able to consume soybean pods

Conflicts of interest

The authors declare no conflicts of interest.

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