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**ARTICLE**

- Mapping the occurrence and density of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) in Mato Grosso do Sul State, Brazil** 28  
José Fernando Jurca Grigolli, Crébio José Ávila, Harley Nonato de Oliveira, Germison Vital Tomquelski and Viviane Santos



## Full Length Research Paper

# Mapping the occurrence and density of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) in Mato Grosso do Sul State, Brazil

José Fernando Jurca Grigolli<sup>1\*</sup>, Crébio José Ávila<sup>2</sup>, Harley Nonato de Oliveira<sup>2</sup>, Germison Vital Tomquelski<sup>3</sup> and Viviane Santos<sup>2</sup>

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The species *Helicoverpa armigera* is one of the most important polyphagous and widely distributed pests in the world. Its occurrence was recently reported on soybean and cotton, in the states of Goiás, Mato Grosso and Bahia, Brazil. This study aimed to evaluate the occurrence and density of *Helicoverpa armigera* in Mato Grosso do Sul State, an important pest for agriculture and identified in Brazil in 2013. 81 Delta trap baited with *H. armigera* sex pheromone Biocontrole<sup>®</sup> were installed in 26 counties in the State of Mato Grosso do Sul. Results showed that *H. armigera* was observed in all counties installed with Delta traps. Furthermore, over 80% of collected moths belong to the *H. armigera* species, and the cotton regions apparently show a highest occurrence of *H. armigera* in the pheromone traps.

**Key words:** Monitoring, sex pheromone, sampling.

## INTRODUCTION

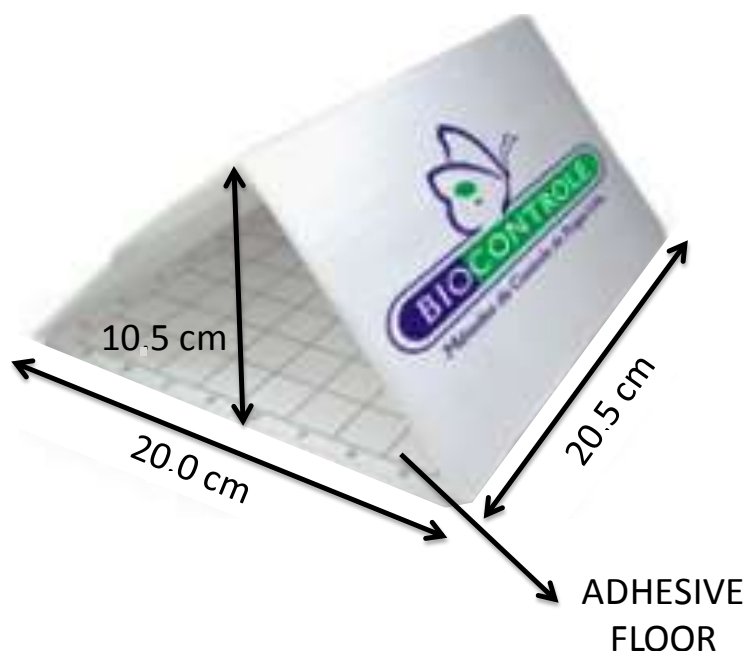
*Helicoverpa armigera* (Hübner, 1808) (Lepidoptera: Noctuidae) is a polyphagous pest of agricultural crops, whose larvae have been registered on more than 60 species of cultivated and wild plants, and belonging to approximately 67 botanical families (Fitt, 1989; Pogue, 2004). *H. armigera* can cause damage to various economically important crops, such as cotton, soybeans, sorghum, corn, tomatoes, and fruits (Reed, 1965; Fitt, 1989; Moral Garcia, 2006).

This pest has recently extended its considerable range

from Europe, Asia, Africa and Oceania (Zalucki et al., 1986; Guo, 1997) to the New World and to the Neotropical countries. It was formally reported in Brazil (Czepak et al., 2013), Paraguay (Senave, 2014) and Argentina (Murúa et al., 2014).

*H. armigera* causes severe losses in different plant species, especially cotton, sorghum, beans, soybeans, canola, corn and tomato (Fitt, 1989; Romeis and Shanower, 1996; Pogue, 2004; Moral Garcia, 2006). The female moths lay around 1000 to 1500 eggs, singly,

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**Figure 1.** Delta traps provided by Biocontrole® and its measures (cm) used on the experiment in different counties of the State of Mato Grosso do Sul, Brazil.

on leaves, flowers, fruits and stalks, which makes clear their reproductive potential (Fye and McAda, 1972).

Their caterpillars fed on leaves and stems, but its preference is for new plants parts, inflorescences, fruits and pods (Reed, 1965, Wang and Li, 1984), causing damage to both vegetative and reproductive stages. Direct damage to the structures of flowering and fruiting of host plants by *H. armigera* caterpillars and the extensive use of insecticides result in low productivity and high costs of control, respectively (Lammers and MacLeod, 2007; Fathipour and Naseri, 2011).

The economic impacts of this pest with control costs and yield losses were estimated in approximately US\$ 5 billion worldwide annually (Lammers and MacLeod, 2007), and recently estimated in up to US\$ 72 billion *per annum* in USA (Kriticos et al., 2015). In Brazil, damage reports reached approximately US\$ 0.8 billion in the first crop season (2012/13) after pest occurrence (Bueno et al., 2014).

Since this pest was registered in Brazil, the Brazilian Government has prioritized the registration of new insecticides to control *H. armigera* (Brasil, 2015). However, the real distribution on Brazilian territory is still unknown. Thus, this study aimed to evaluate the occurrence and density of *H. armigera* in Mato Grosso do Sul State, Brazil.

## MATERIALS AND METHODS

81 Delta traps provided by Biocontrole® (Figure 1), baited with the

synthetic sex pheromone of *H. armigera* were installed in 26 counties in the state from June through September 2014 (inter-season). Counties Água Clara, Amambaí, Antônio João, Aral Moreira, Bandeirantes, Bela Vista, Bonito, Caarapó, Camapuã, Cassilândia, Chapadão do Sul, Costa Rica, Douradina, Fátima do Sul, Itaporã, Jardim, Laguna Carapã, Maracaju, Naviraí, Paraíso das Águas, Ponta Porã, Rio Brillhante and Sonora three traps were installed for each location, while the counties Dourados, São Gabriel do Oeste and Sidrolândia four traps were installed. The predominant agricultural landscapes in each sampling site are given in Table 1, and reflects the crops used in the inter-season. These counties were selected according to the most important agricultural areas throughout the State of Mato Grosso do Sul, Brazil. Delta traps were installed 50 cm above the plants canopy, and evaluations were performed weekly, when adhesive floors were changed. Sex pheromone capsule was changed monthly, according to the manufacturer. After removal of adhesive floors, these were packed with PVC film, and transported to the Foundation MS laboratory for identifying the genus of collected moths. It was registered the number of moths of the genus *Helicoverpa* spp. and other species collected by the traps in each County.

The moths of the genus *Helicoverpa* spp. were sent to the Agrônômica laboratory (located at Porto Alegre, RS, Brazil) for identification of the species. The method used for this was morphological analysis of the male genitals (Hardwick, 1965; Pogue, 2004). This laboratory is accredited by the Ministry of Agriculture, Livestock and Supply for the issue of pest identification reports (Brasil, 2014). To guarantee the sampling quality, moths were sent within 24 h after adhesive floor was collected to provide good conditions for species identification.

The numbers of moth per trap per week were used to establish a score where higher than 3.0 *H. armigera* moths per trap per week indicates high infestation; moderate infestation, with captures between 0.5 and 3.0 *H. armigera* moths per trap per week; and low infestation, where the mean capture was lower than 0.5 *H. armigera* moths per trap per week.



**Table 1.** Agricultural landscape observed in each sample sites (traps baited with sex pheromones of *H. armigera*) at the different counties.

County	Agricultural Landscape			
	Trap 1	Trap 2	Trap 3	Trap 4
Água Clara	Crotalaria	Crotalaria	Pasture	-
Amambaí	Corn	Corn	Corn	-
Antonio João	Corn	Oat	Corn	-
Aral Moreira	Corn	Millet	Millet	-
Bandeirantes	Corn	Cotton	Corn	-
Bela Vista	Oat	Pasture	Oat	-
Bonito	Corn	Corn	Corn	-
Caarapó	Corn	Corn	Corn	-
Camapuã	Crotalaria	Pasture	Turnip	-
Cassilândia	Pasture	Pasture	Corn	-
Chapadão do Sul	Millet	Turnip	Sorghum	-
Costa Rica	Pasture	Millet	Crotalaria	-
Douradina	Corn	Corn	Corn	-
Dourados	Showcase	Corn	Beans	Turnip, guava, forage
Fátima do Sul	Corn	Corn	Corn	-
Itaporã	Corn	Corn	Corn	-
Jardim	Pasture	Pasture	Corn	-
Laguna Carapã	Corn	Wheat	Oat	-
Maracaju	Corn	Corn	Crambe	-
Naviraí	Corn	Corn	Cotton	-
Paraíso das Águas	Turnip	Crotalaria	Crotalaria	-
Ponta Porã	Corn	Corn	Beans	-
Rio Brilhante	Oat	Oat	Corn	-
São Gabriel do Oeste	Corn	Millet	Cotton	Oat
Sidrolândia	Corn	Corn	Corn	Corn
Sonora	Corn	Corn	Corn	-
<b>Total traps</b>	<b>81</b>			

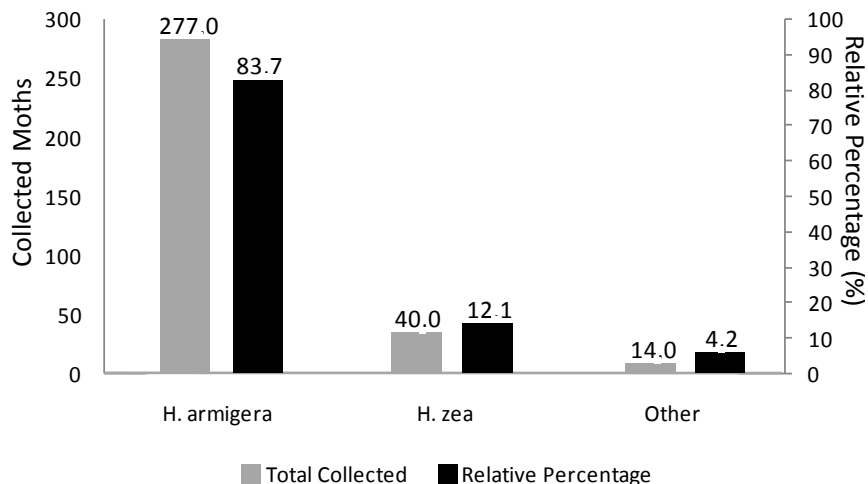
## RESULTS AND DISCUSSION

The results obtained showed a prevalence of *H. armigera* species in relation to *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae) in the State of Mato Grosso do Sul, Brazil. It was collected 277 (83.7%) of *H. armigera* moths in the sampling period, 40 (12.1%) moths of *H. zea*, while 14 (4.2%) individuals that could not be identified (Figure 2). Unidentified moths were related to the female moths of *Helicoverpa* genus, which prevents the use of the adopted identification method, or damaged moths during shipping process to the laboratory.

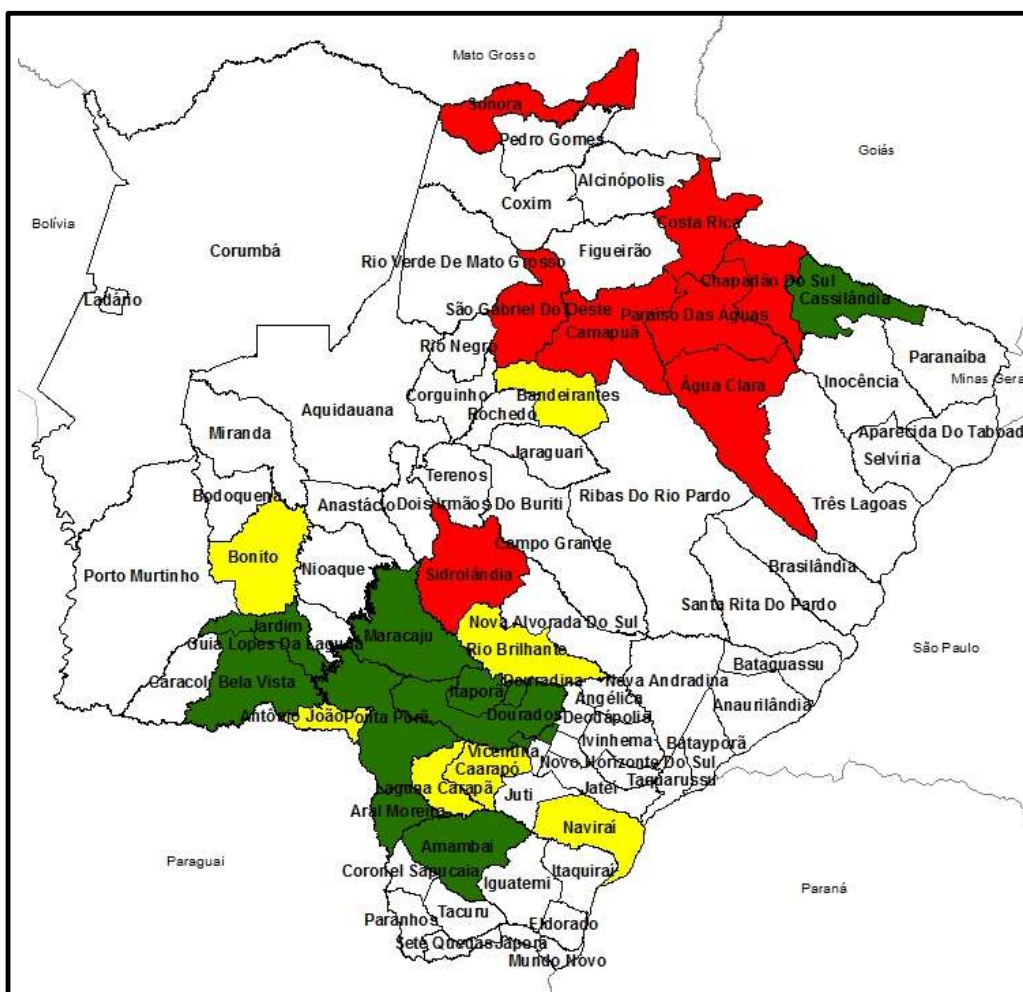
Specimens of *H. armigera* were observed in all counties, showing this pest is wide spread throughout Mato Grosso do Sul State. Counties with the highest incidence of *H. armigera* were Água Clara, Camapuã, Chapadão do Sul, Costa Rica, Paraíso das Águas, São Gabriel do Oeste, Sidrolândia and Sonora, which almost all are situated in the northern part of the State, where cotton is grown during the season. Counties Antônio João, Bandeirantes, Bonito, Caarapó, Laguna Carapã,

Naviraí and Rio Brilhante showed occurrence of collected individuals in moderate amount. Counties Amambaí, Aral Moreira, Bela Vista, Cassilândia, Douradina, Dourados, Fátima do Sul, Itaporã, Jardim, Maracaju and Ponta Porã, which mainly grow soybeans, showed a low occurrence of the pest in the pheromone traps (Figure 3). It is important to highlight that Água Clara, Camapuã, Chapadão do Sul, Costa Rica, Paraíso das Águas, São Gabriel do Oeste, Sidrolândia and Sonora are cotton grower counties during the regular season, while the other counties are soybean grower during the regular season. Agricultural landscapes presented on Table 1 refer to crops when the experiment was conducted (inter-season). These results suggest that the kind of crop in the area can influence the pest density, and also its distribution throughout the State.

The management of *H. armigera* populations poses great challenges for the Brazilian soybean farmers, because the lack of information available on the chemical and biological control of this pest in Brazil. These difficulties led the Brazilian Ministry of Agriculture and



**Figure 2.** Number of individuals and relative percentage of *Helicoverpa armigera*, *Helicoverpa zea* and other unidentified individuals in sex pheromone traps in different counties of the State of Mato Grosso do Sul.



**Figure 3.** Map of *Helicoverpa armigera* occurrence and density in Mato Grosso do Sul State, Brazil. Red - average  $\geq 3.0$  moths per trap per week; yellow - average between 0.5 and 3.0 moths per trap per week; and green - average  $\leq 0.5$  moths per trap per week.

Food Supply to take immediate measures, such as the emergency registration of insecticides for the control of *H. armigera*. It makes the control recommendations susceptible to doubt and errors (Perini et al., 2016).

These results are critical to preview *H. armigera* outbreaks on a State basis, and this can contribute to reduce the economic impact of this pest on crops, and also to develop monitoring and pest management programs in Mato Grosso do Sul, Brazil.

It gets more important if we consider insecticide resistance of *H. armigera* worldwide. Due to its wider host range, high fecundity, multiple generations, migratory behavior and insecticide resistance, it has become a much more difficult pest to manage (McCaffery, 1998). The frequent and indiscriminate use of insecticides has resulted in the development of resistance in many insect populations (Ferre and Van Rie, 2002; Sayed and Wright, 2006). Moderate to high levels of resistance to Pyrethroid, organo-phosphate, fenvalerate, phoxim, and emamectin benzoate insecticides were previously reported in a field population of *H. armigera* (Ahmad et al., 1995; Yang et al., 2013).

Based on the results obtained, it can be concluded that *H. armigera* is probably widely distributed in all counties in the State of Mato Grosso do Sul that grow soybean and cotton. However, the traditional cotton regions apparently show a highest occurrence of *H. armigera* in the pheromone traps. In addition, it was found that over 80% of individuals caught in traps with sex pheromone belong to *H. armigera* species. It is suggested that further studies should be carried out to check the damage caused by *H. armigera* in different crop systems in order to determine the damage that this pest can cause in each crop.

The first report of *H. armigera* in Brazil was in 2013 (Czepak et al., 2013), realized on a pest outbreak in 2012/13 season. However, the analysis of insects previously collected and deposited in museums by several authors (Teston and Corseuil, 2004; Specht et al., 2005, 2013; Zenker et al., 2010) suggested that at least in the State of Rio Grande do Sul, Brazil, the introduction of *H. armigera* occurred after December 2008 and before May 2011 (Sosa-Gomez et al., 2015). According to the same authors, the earliest *H. armigera* samples mentioned in the published literature are from May 22, 2012 (Leite et al., 2014) and one larvae of *H. armigera* in soybean fields from Rolândia county, State of Paraná, in October of 2008 (Sosa-Gómez et al., 2015). Based on the evidence provided by these data and considering a scenario of introduction of *H. armigera* in the country before 2008, it is reasonable to infer that this pest had enough time to build up populations detected as outbreaks in the 2012/2013 growing season (Embrapa, 2013; Sosa-Gomez et al., 2015).

The detection of *H. armigera* as a devastating component in high-value commercial crops, such as cotton and soybean (Czepak et al., 2013; Sosa-Gomez et al., 2015),

shows the vulnerability of Brazil and other countries in South America regarding quarantine pests. Additionally, efforts to elucidate invasion paths and origin are essential to design strategies for preventing future pest introduction and adopting science-based policies (Estoup and Guillemaud, 2010; Guillemaud et al., 2011).

## Conclusions

1. *Helicoverpa armigera* is widely distributed in Mato Grosso do Sul, Brazil.
2. Most of individuals caught in delta traps with sex pheromone belong to *H. armigera* species.

## Conflicts of Interests

The authors have not declared any conflict of interests.

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