



Soil insects associated with sugarcane crop in Mato Grosso do Sul, Brazil

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ABSTRACT: Pest insects are one of the major factors affecting the productivity of sugarcane, and especially those associated with the soil, which damage the crop if not controlled. There is little information on the insect associated with the soil in the sugarcane crop in the state of Mato Grosso do Sul, Brazil. This study evaluated the occurrence, abundance and population variation of soil-associated insects in sugarcane crops in four counties in the state of Mato Grosso do Sul during a period from September 2009 to August 2010. For the capture of insects, deep in the soil trenches were (50 x 50 x 30 width x length x depth). It was observed that county of Maracaju has a high incidence of soil insects in sugarcane crop. Specimens of the family Scarabaeidae are abundant in sugarcane fields of the state of Mato Grosso do Sul, being *Liogenys suturalis* the predominant species. Soil insects of the Chrysomelidae family were found with greater abundance in Dourados and Naviraí while Noctuidae, represented only by the *Hyponomea taltula*, occurred mainly in Dourados. Insects of the family Termitidae occur in sugarcane fields in the counties of Maracaju and Naviraí but not in Nova Alvorada do Sul and Dourados. *Sphenophorus levis* and *Metamasius hemipterus* were also reported in the sugarcane fields from Maracaju, being the occurrence these species the first record in the Mato Grosso do Sul State. The determined occurrence of different soil insects in the sugarcane fields may help in their management in the four counties studied.

Key words: soil pests, occurrence, abundance, population fluctuation.

Insetos de solo associados à cultura de cana-de-açúcar em Mato Grosso do Sul, Brasil

RESUMO: Os insetos-praga são um dos principais fatores que afetam a produtividade da cana-de-açúcar e, principalmente, aqueles associados ao solo, que prejudicam a cultura se não forem controlados. Existem poucas informações sobre a fauna de insetos associada ao solo na cultura da cana-de-açúcar no estado de Mato Grosso do Sul (MS), Brasil. O objetivo deste estudo foi avaliar a ocorrência, abundância e variação populacional de insetos associados ao solo em lavouras de cana-de-açúcar em quatro municípios do estado de Mato Grosso do Sul durante o período de setembro de 2009 a agosto de 2010. Para a captura de insetos, foram feitas trincheiras (50 cm x 50 cm x 30 cm - largura x comprimento x profundidade) no solo. Observou-se que o município de Maracaju apresenta alta incidência de insetos de solo na cultura da cana-de-açúcar. Exemplares da família Scarabaeidae são abundantes nos canaviais do MS, sendo *Liogenys suturalis* a espécie predominante. Insetos de solo da família Chrysomelidae foram encontrados com maior abundância em Dourados e Naviraí enquanto Noctuidae, representado apenas por *Hyponomea taltula*, ocorreu principalmente em Dourados. Insetos da família Termitidae ocorrem em canaviais nos municípios de Maracaju e Naviraí, mas não em Nova Alvorada do Sul e Dourados. *Sphenophorus levis* e *Metamasius hemipterus* (Coleoptera: Curculionidae) também foram encontrados nos canaviais de Maracaju, sendo a ocorrência dessas espécies o primeiro registro no MS. A ocorrência determinada de diferentes insetos de solo nos canaviais auxiliará o manejo nos quatro municípios estudados.

Palavras-chave: pragas do solo, ocorrência, abundância, flutuação populacional.

INTRODUCTION

The sugarcane crop, *Saccharum officinarum* L., stands out in the world socioeconomic scenario, represents a constantly expanding market as it is the basis for the production of sugar, ethanol and a variety of food and pharmaceutical products (DIAS & SENTELHAS, 2018; ARIF et al., 2019; ALI et al., 2021). The crop is spreading in several states of Brazil,

especially those located in the Midwest. Among these, Mato Grosso do Sul, processed 45 million tons of raw sugar cane in the 2020/2021 harvest (BIOSUL, 2021). However, pests and diseases cause significant losses in the crop's agricultural production, most of which are due to ineffective insect management (KUMAR et al., 2019; IQBAL et al., 2021).

Research on the occurrence and management of pest insects associated to the soil in

the sugarcane crop have been conducted, especially, in the state of São Paulo, Brazil. The most studied soil pests are the *Sphenophorus levis* (Coleoptera: Curculionidae) (ZARBIN et al., 2003; SOARES-COSTA et al., 2011; EVANGELISTA et al., 2015), *Migdolus fryanus* (Coleoptera: Cerambycidae), and also termites (BENTO et al., 1992; MIRANDA et al., 2004; DINARDO-MIRANDA & FRACASSO, 2013). However, little is known about the other groups of soil insect's pests in sugarcane crops. We highlighted damage caused by this group of crop pests, arising from the death of plants, causing a decrease in the stand, reduced or excess sprouting (tillering) and plant lodging which affects both the productivity and the commercial value of the production.

Although, some of the measures used in pest management can be adapted to other country regions, it is necessary to know the occurrence, abundance and population variation of these insects at a regional level, considering the climate and phytogeographical peculiarities of each environment. This information, when properly determined, will contribute to the correct identification of the edaphic pests in the different regions where sugarcane production is being implemented, as well as to the development of effective control strategies at a regional level.

This research studied the occurrence and population variation of soil-associated insects in sugarcane fields of the Mato Grosso do Sul State, Brazil.

MATERIALS AND METHODS

The research was performed in four counties of Mato Grosso do Sul, Dourados (22°13'18"S and 54°48'23"W), Naviraí (23°03'45"S and 54°11'26"W), Nova Alvorada do Sul (21°27'51"S and 54°23'3"W) and Maracaju (21°36'52"S and 55°10'06"W), in agricultural areas intended for the production of sugarcane. The sampled areas were greater than 50 hectares, and the samplings were carried out in plants above 2m in height up to sugarcane ratoons. The sugarcane cultivars sampled were SP 832847, RB 966928, CTC4 and RB 867515 for the areas of Naviraí, Dourados, Maracaju and Nova Alvorada, respectively.

Sampling was centralized in the sugarcane rows, and 10 soil trenches were performed per month in each site during the period from September 2009 to August 2010, having a distance of about 30m between the trenches. To make the soil trenches we use a straight shovel and hoe. The soil withdrawn from the trenches of 0.5m x 0.5m, as well as roots

and stems of the plants were inspected and sorted to find immature and adult forms of the insects. The specimens reported were placed in plastic containers with moistened soil and transported to the laboratory.

Immature forms were reared to obtain adults for later identification, by placing them in 500-mL plastic containers, containing soil and sugarcane roots and kept in a climate chamber (Temp. 25 °C, 12-hour photoperiod) as mentioned by COUTINHO et al. (2022). After identification by expert (Dra. Mariana Cherman - Universidade Federal do Paraná), dried voucher specimens of soil insects resulting from this study were deposited in the collection of the Embrapa Agropecuária Oeste at Dourados, MS, Brazil. The total number of insects reported in the trenches of the different locations was transformed to obtain normality and homoscedasticity and then submitted to analysis of variance, with the treatment means being compared by Tukey's test at 5% probability.

The collection rate, the frequency and consistency studies were conducted for total of the taxa captured of the different places. To calculate the frequency, the following formula was employed: $FI = N/T \times 100$, where FI = frequency index of a particular species or family (%); N = number of individuals of that species or family, and T = total number of individuals collected in each environment according to SILVEIRA NETO (1976). The constancy was calculated using the formula of DAJOZ (1974): $C = (P \cdot 100)/N$, where C = constancy; P = number of collections containing the taxa and N = number of collections performed.

RESULTS AND DISCUSSION

A greater number of insects was collected in Maracaju followed by Naviraí. The value observed in this place was significantly higher than those observed in Naviraí, Nova Alvorada do Sul and Dourados, while the population in Naviraí did not exceed that of Dourados. But was superior to that of Nova Alvorada do Sul, which presented the lower insect density. Although, the number of insects collected differed between the sampling locations, we must consider that the sampling environments that contained different sugarcane cultivars and probably different soil and climate conditions. We know that these parameters can also influence the occurrence of insects in sugarcane crops. In this sense, we must consider that physical, biologic, and chemical factors of the soil in the different sampling environments may have affected both the behavior and the development of subterranean insects, favoring or disfavoring their

survival in the agro-ecosystem, because the insects use the soil for important bio-ecological functions such source for shelter, protection, fooding, moisture, air and heat (BARETTA et al., 2014).

Another aspect that may have interfered with population of insects associated with the soil in sugarcane fields is their dynamic behavior resulting in an aggregated and heterogeneous distribution in the different environments in which they occur. For example, the concentration of sugarcane roots and exudates in the planting furrow can interfere with the spatial distribution of insects in the soil (DINARDO-MIRANDA & FRACASSO, 2013). Similarly, the community of plants, organisms and micro-organisms in the soil also directly influence the richness and abundance of the edaphic insects (BENNETT, 2010).

The most abundant family of soil insects soil reported in the sugarcane fields of Mato Grosso do Sul was Scarabaeidae, with *Liogenys suturalis* Blanchard being the most predominant specie, with constancy and relative frequency of 68.6% and 33.2%, respectively (Table 1). Chrysomelidae was also abundant in Dourados and Naviraí, while Scarabaeidae and Termitidae had higher incidence in Nova Alvorada do Sul and Maracaju, respectively, throughout the entire sampling period (Figure 1).

From the Chrysomelidae family was collected *Percolaspis pulchella* and *Allocolaspis brunnea*. In Dourados, this family had greater abundance in September and only the *A. brunnea* species was found (Table 1). In Nova Alvorada do Sul and Maracaju there were a low incidence of insects of the Chrysomelidae family (Figure 1). The chrysomelids *A. brunnea* and *Percolaspis ornata* occurrence had not previously recorded in sugarcane crop.

Alleculidae was reported only in Nova Alvorada do Sul and Naviraí, with the greatest abundance in the first location (Figure 1), being represented only by *Lobopoda* sp. There are no studies reporting the occurrence of species of this family causing damage to sugarcane in Brazil. MEAGHER & GALLO (2008) also reported *Lobopoda* sp. as insects associated with sugarcane in the United States, but without precisig the damage they cause in this crop. This group has habits apparently saprophytic (HALL, 1988; SRIKANTH et al., 2012).

Curculionidae was found only in Nova Alvorada do Sul and Maracaju (Figure 1). In Maracaju, this family was represented by two important pest species, known as *Sphenophorus levis* and *Metamasius hemipterus* (Linnaeus, 1764). These two species are reported for the first time in the state

Table 1 - Total number of individuals collected (NT), constancy (C) and relative frequency (RF) of different taxa found in trenches performed in sugarcane fields of four counties of Mato Grosso do Sul, Brazil in the period from September 2009 to August 2010.

Family	Specimen	NT	C%	RF%
Alleculidae	<i>Lobopoda</i> sp.	81	31.3	1.3
Cerambycidae	<i>Migdolus</i> sp.	21	8.3	0.3
Chrysomelidae	<i>Allocolaspis brunnea</i>	167	50.0	2.7
	<i>Percolaspis pulchella</i>	133	25.0	2.1
	Not identified	530	56.3	8.5
Curculionidae	<i>Metamasius hemipterus</i>	11	4.2	0.2
	<i>Teratopactus nordicolis</i>	92	22.9	1.5
	<i>Sphenophorus levis</i>	46	14.6	0.7
Elateridae	Not identified	99	47.9	1.6
Scarabaeidae	<i>Paranomala testaceipennis</i>	91	25.0	1.5
	<i>Bothynus</i> sp.	21	20.8	0.3
	<i>Cyclocephala</i> spp.	165	27.1	2.6
	<i>Liogenys suturalis</i>	2077	68.8	33.2
	<i>Macroductylus pumilio</i>	40	20.8	0.6
	<i>Phyllophaga</i> sp.	11	10.4	0.2
Termitidae	Not identified	250	81.3	4.0
	<i>Embirationes heterotypus</i>	224	22.9	3.6
	<i>Neocapritermes opacus</i>	2027	25.0	32.4
Noctuidae	<i>Hyponeuma taltula</i>	175	72.9	2.8
Total		6261		100

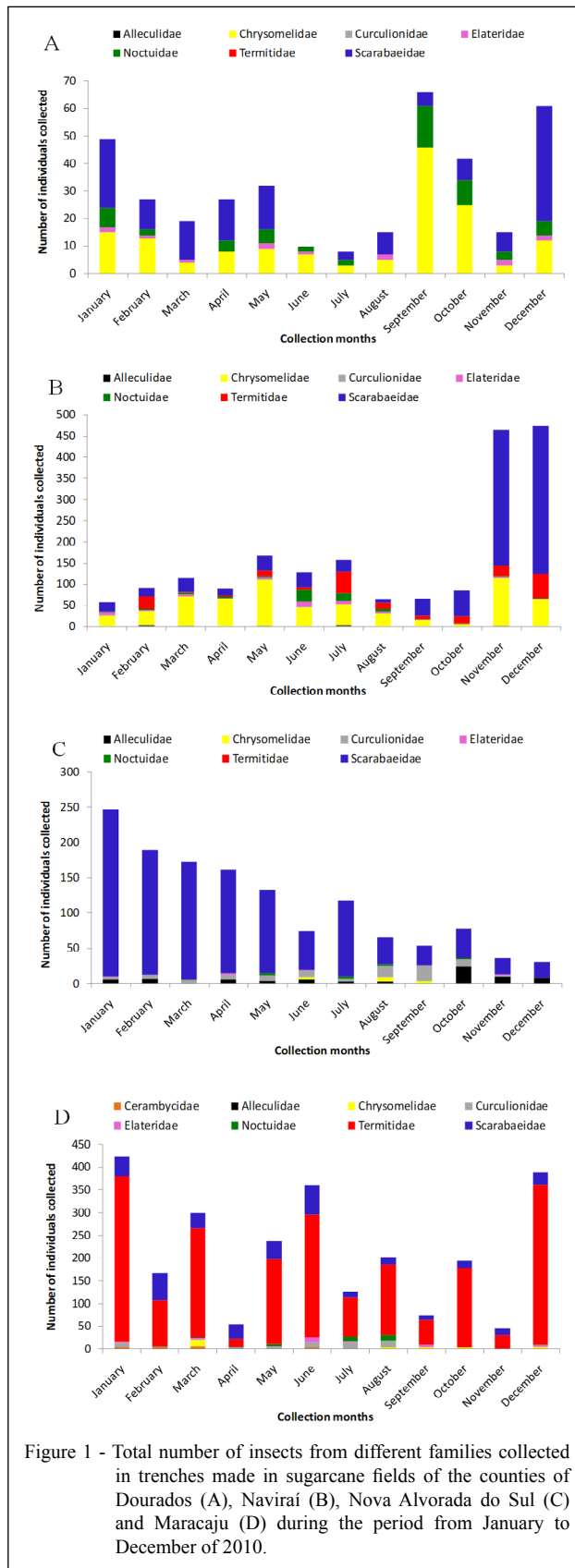


Figure 1 - Total number of insects from different families collected in trenches made in sugarcane fields of the counties of Dourados (A), Navirai (B), Nova Alvorada do Sul (C) and Maracaju (D) during the period from January to December of 2010.

of Mato Grosso do Sul, which were observed since January in the adult form. The larvae and pupae were found since April, within the basal internodes of sugarcane plants.

The finding of *S. levis* in Maracaju may be related to the transport of seedlings harboring larvae on the sugarcane base internodes, or even adults hidden in straw and stems of freshly cut seedlings, since this is the main way of spread of this insect (MORAES & ÁVILA, 2013). The largest number of larvae of *S. levis* and *M. hemipterus* was seen in July and August in Maracaju (Figure 1). The weevil *S. levis* (Coleoptera: Curculionidae) was identified in 1978 and has become an increasingly important pest of sugarcane in Brazil, especially in the state of São Paulo (VANIN, 2008; SOARES-COSTA et al., 2011).

The Elateridae family was collected in all areas, but it was more abundant in the sugarcane fields of Dourados and Naviraí (Figure 1). *Elateridae* species have not been cited as pests of sugarcane in Brazil, whereas in the United States, larvae of this family known as wireworms, are considered important pests in the sugarcane crop, mainly in the South of Florida (CHERRY & STANSLY, 2008). The Noctuidae family was found in the four locations evaluated, and was represented by *Hyponeuma taltula* (Schaus, 1904). However, in Dourados was the place with the highest collection rate of this species and with a higher incidence in September and October (Figure 1). In Maracaju, *H. taltula* caterpillars were captured in July and August.

From the Isoptera order, individuals of Termitidae family were collected in soil trenches with greater abundance only in the sugarcane field of Maracaju, followed by Naviraí (Figure 1). The termites observed in these locations were identified as *Embiratermes heterotypus* (Silvestri, 1901) and *Neocapritermes opacus* (Hagen, 1858) (Isoptera: Termitidae) (Table 1). Although, *N. opacus*, was found inside the sugarcane stalks in a sugarcane field of Maracaju, it has not considered a pest, since it may have penetrated the stalks previously damaged by other organisms, with the opportunistic behavior being more prevalent. *N. opacus* has a wide distribution in South America, including Ecuador, Bolivia, Argentina, Paraguay and Brazil (CONSTANTINO, 1991; AZEVEDO et al., 2017).

Embiratermes heterotypus, does not seem to be a pest, but a beneficial species to the sugarcane crop as it contributes to the maintenance and restoration of soil in addition to favoring the degradation of crop residue, incorporating, and distributing organic matter in this environment, although this species still

requires bio-ecological studies aiming to know their real role in agricultural environments (MIRANDA et al., 2004). *E. heterotypus* is common in the soil and roots of other crops, and only occasionally causing damage to plants.

Specimens of Scarabaeidae were found in sugarcane fields and in every month of this study, except in June in Dourados (Figure 1). However, in Dourados, Naviraí and Maracaju, the number of insects collected was lower than the one observed in Nova Alvorada do Sul. *Liogenys suturalis* (Blanchard, 1850) was the most abundant within this family with high relative frequency and constancy indexes (Table 1). Of the 2,534 adult *L. suturalis* collected, 2,527 (99.7%) were observed in Nova Alvorada do Sul (Table 1).

In Naviraí, the Scarabaeidae family was only represented by individuals of the *Cyclocephala* genus (Figure 1 and Table 1). In Dourados, larvae of Scarabaeidae had peaks in December, and the species representing this family were *Paranomala testaceipennis* Blanchard (Coleoptera: Scarabaeidae) and *L. suturalis* (Figure 1 e and Table 1). Larvae of the family Scarabaeidae were also found throughout the sampling period in Maracaju, being observed especially specimens of *Plectris* sp. (Table 1). The months of July to November were the ones with the lowest occurrence of this group of insects (Figure 1). According to CHERRY (2012), Scarabaeidae larvae are often found in sugarcane in Florida and the most common genera are *Paranomala*, *Cyclocephala*, *Euphoria*, *Tomarus* and *Phyllophaga*. These larvae feed on sugarcane roots cause yellowing of leaves, usually with subsequent atrophy, darkening, loss of roots due to consumption by the larvae, which can cause plant death in highly infested areas. In the sampled areas of Mato Grosso do Sul, the most abundant species was *L. suturalis*. However, the genera *Paranomala*, *Phyllophaga* and *Cyclocephala* were also found (Table 1).

Larvae of the genus *Cyclocephala* are common in several crops of Mato Grosso do Sul, however, it was not evident that these larvae reported in the collections made in the sugarcane fields were causing injury to plants. However, larvae of *Cyclocephala parallela* associated with sugarcane in South Florida, USA were considered as the most serious pest among the species of Scarabaeidae found in that region (GORDON & ANDERSON, 1981). *Phyllophaga* sp. was also collected, but to a lesser extent. This genus is cited as important soil pests in different crops like soybeans and corn (OLIVEIRA & GARCIA, 2003; OLIVEIRA et al., 2007), cassava (OLIVEIRA et al., 2007) besides the sugarcane (GORDON & ANDERSON, 1981).

The Cerambycidae family was found only Maracaju (Figure 1). The collected specimens belong to *Migdolus* genus, however, due to difficulty in obtaining the adults of this species in laboratory conditions, it was not possible to identify them as species level. Although, the family Cerambycidae had not been very abundant in the areas studied, these insects have great economic importance, such as are the larvae of *Migdolus fryanus* (Westwood, 1863), one of the most frequent and important species in sugarcane crop in Brazil (BENTO et al., 1992).

This research also reported the first record of species of soil-associated insects in sugarcane crops in the state of Mato Grosso do Sul, which will be the basis for future projects, especially about integrated management programs for this group of pests in the culture.

CONCLUSION

The sugarcane fields of the four studied municipalities in Mato Grosso do Sul have a great abundance of soil insects. In Nova Alvorada do Sul there is a greater abundance of Scarabaeidae soil insects while in Maracaju the highest occurrence was of the Termitidae family, being *Liogenys suturalis* the predominant species. In Dourados and Naviraí there is a predominance of soil insects of the Scarabaeidae and Chrysomelidae families. *Sphenophorus levis* and *Metamasius hemipterus* were found in the sugarcane fields from Maracaju, being the occurrence these species the first record in the Mato Grosso do Sul State, Brazil.

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DECLARATION OF CONFLICT OF INTEREST

We have no conflict of interest to declare.

AUTHORS' CONTRIBUTIONS

All authors contributed equally for the conception and writing of the manuscript. All authors critically revised the manuscript and approved of the final version.

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