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Mite fauna on transgenic soybean in an experimental station in western Bahia, Brazil

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ABSTRACT

The aim of this study was to identify mite fauna associated with soybean crops and to report new species of the Monsoy 8349 IPRO variety in the municipality of Luís Eduardo Magalhães, western region of Bahia. Samplings were performed in an area with transgenic soybeans, subdivided into three treatments: T01, with no use of agricultural pesticides; T02, complete package of pesticides, except for acaricides; and T03, complete package of pesticides including acaricides. Twenty plants were selected per treatment at each sampling; one apical, one median, and one basal leaf were collected from each plant, totaling 60 leaves per treatment. A total of 1,292 mites were found, belonging to three families, five genera, and six species. The major phytophagous mite species found were *Mononychellus planki* McGregor and *Tetranychus urticae* Koch, while the major predatory mites found were *Neoseiulus transversus* Denmark & Muma and *Euseius concordis* Chant.

Keywords: *Glycine max*; Tetranychidae; Phytoseiidae; biological control.

INTRODUCTION

Soybean is a major agricultural crop in Brazil, cultivated in 35 million hectares with a production of 114 million tons in the harvest of 2018/19 (EMBRAPA, 2019). In the state of Bahia, the cultivated area is larger than 1.5 million hectares, with mean yield of 5.3 million tons, approximately 5% of national production and 58% of production in the Northeast (CONAB, 2017–2018). This crop had a higher expansion from 1990 to 2008 in the western region of the state, but exploited areas for this crop only increased in 2001 in the municipality of Luís Eduardo Magalhães. Over the last years, soybean crop yield has increased by reducing losses caused by limiting factors such as pest insects, especially mite species (ÁVILA; GRIGOLLI, 2014).

Studies conducted in Brazil have identified a few phytophagous mite species as the most frequent and most damaging to soybean crops: *Mononychellus planki* McGregor, 1950, *Tetranychus desertorum* (BANKS, 1900), *Tetranychus gigas* (PRITCHARD; BAKER, 1955), *Tetranychus ludeni* Zacher, 1913, *Tetranychus urticae* Koch, 1836 (Tetranychidae), and *Polyphagotarsonemus latus* (BANKS, 1904) (Tarsonemidae) (GUEDES et al., 2007; ROGGIA et al., 2009; ÁVILA; GRIGOLLI, 2014). Also, several predator species were reported in soybean crops, such as: *Euseius alatus* De Leon, 1966, *Galendromus annectens*, De Leon, 1958, *Iphiseiodes zuluagai* (DENMARK; MUMA, 1973), *Neoseiulus anonymus* Chant & Baker, 1965, *Neoseiulus benjamini* Schica, 1981, *Neoseiulus californicus* McGregor, 1954, *Neoseiulus idaeus* (DENMARK; MUMA, 1973), *Neoseiulus transversus* (DENMARK; MUMA, 1973), *Neoseiulus tunus* De Leon, 1967, *Phytoseiulus fragariae* Denmark & Schicha, 1983, *Phytoseiulus macropilis* (BANKS, 1904), *Proprioseiopsis cannaensis* (MUMA, 1962), *Proprioseiopsis neotropicus* Ehara, 1966 e *Typhlodromalus aripo* De Leon, 1967 (ROGGIA et al., 2009; REZENDE et al., 2012; REICHERT et al., 2014; CAVALCANTE et al., 2017, 2018).

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The aim of this study was to identify the mite fauna associated to soybean crops of the Monsoy 8349 IPRO variety in the municipality of Luís Eduardo Magalhães, western region of Bahia; and to report new predator species for this culture and analyze if phytophagous and predators species have any significant correlation.

MATERIAL AND METHODS

The investigation was conducted at the experimental station of Fundação de Apoio à Pesquisa e Desenvolvimento do Oeste Baiano (Fundação Bahia), 12°04'52.3"S 45°42'47.3"W, between November 2018 and March 2019 in the municipality of Luís Eduardo Magalhães located in the western region of Bahia. According to Köppen's classification, the climate in the municipality is BSh, hot and dry with winter rains.

The experiment was carried out in an area with transgenic soybeans subdivided into three treatments: T01, with no use of agricultural pesticides; T02, with a complete package of pesticides, except for acaricides; and T03, with a complete package of pesticides including acaricides. Each treatment contained 15 rows with 0.5 m spacing, and covered an area of 336 m^2. Sowing occurred on November 30, 2018, and the variety used was Monsoy 8349 IPRO. This genotype was chosen because it was the most frequently used variety both in previous harvests and in the region.

Seeds were treated with carbendazim + thiram (0.08 g), fipronil (0.02), inoculant (0.05), 4-indol-3-ylbutyric acid + gibberellic acid + kinetin (0.06). Products and dosages used in treatments T02 and T03 (Table 1) for phytosanitary management, as well as application dates, were defined according to soybean development stages and considering the protocols adopted by regional farmers.

Table 1. Agricultural pesticides used in the treatments "complete package of agricultural pesticides, except for acaricides" (T02) and "complete package of agricultural pesticides" (T03), in the municipality of Luís Eduardo Magalhães, Bahia, 2018/19 harvest.

Commercial Brand	Chemical group	Active ingredient	Dosage per application (per ha)	Number of applications
Score flexi	triazole	difenoconazole + propiconazole	0.3l	1
Serenade	fungicide/fungistatic, bactericide/ bacteriostatic, and microbiological nematicide	Bacillus subtilis QST lineage 713 13.68 g/L	0.1l	3
Certero	benzoylurea B	triflumuron'	0.1l	3
Fox	strobilurin/triazolinthione	trifloxystrobin + prothioconazole	0.4l	2
Mospilan	neonicotinoid	acetamiprid	0.25	1
Elatus	strobilurin/ pyrazole carboxamide	azoxystrobin + benzovindiflupyr	0.2l	2
Simboll cooper	triazole	flutriafol	0.5l	2
Abamex*	avermectin	abamectin	1.5l	1
Polo*	phenylthiourea	diafenthiuron	0.6l	2
Oberon*	spiromesifen	keto-enol	0.5l	2

*Used only in treatment T03.
Source: Adapted from AGROLINK (2019).

Samplings were first conducted biweekly, and then became weekly when the presence of mites was confirmed. Samplings started in the V2 stage, according to the classification proposed by FEHR; CAVINESS (1977) and ended at harvest. A total of 20 plants were randomly sampled in each treatment. Three leaves per plant were removed (apical, median, and basal), totaling 60 leaves per treatment.

Leaves were stored in plastic bags, which were labeled and transported in a thermal box to the Laboratório de Fisiopatologia of Universidade Estadual da Bahia (UNEB), where they were analyzed under a stereo microscope. Mites found were mounted on microscopy slides in Hoyer's medium (FLECHTMANN, 1985). Slides were settled in an oven (50–60 °C) for 10 days for fixation and diaphanization of specimens. After this period slides were identified using labels and stored in appropriate boxes in an acclimatized room with controlled relative air humidity. Mite identification was performed at the Laboratório de Acarologia of Universidade do Vale do Taquari, with the aid of a phase contrast microscope and dichotomous keys (LINDQUIST, 1986; BAKER; TUTTLE, 1994; CHANT; MCMURTRY, 2007). Bioestat 5.0 was used for statistical analyses and the correlation coefficient (*r*) was performed to evaluate the mite preference in each treatment (AYRES et al., 2007).

RESULTS

A total of 1292 mites were found, belonging to three families, five genera, and six species (Table 2). The highest richness was found in treatment T01, with five species, followed by T02, with four species, and T03, with the lowest amount, three species. On the other hand, treatment T02 had the highest abundance, with 857 mites; T01 with 233 mites and T03 with 202 mites. No mites were found on the adaxial face of the leaves examined.

Table 2. Mite fauna found in area with transgenic soybeans subdivided into three treatments: T01, with no use of agricultural pesticides; T02, with a complete package of pesticides, except for acaricides; and T03, with a complete package of pesticides including acaricides, in the municipality of Luís Eduardo Magalhães, Bahia, 2018/19 harvest.

Family	Species	T01	T02	T03	Total
Phytoseiidae	*Euseius concordis*	7	0	0	7
	Neoseiulus transversus	41	0	0	41
	Neoseiulus gracilis	0	1	0	1
Tarsonemidae	*Tarsonemus* sp.	19	37	37	93
	Mononychellus planki	100	746	18	864
Tetranychidae	*Tetranychus urticae*	66	73	147	286
Total		**233**	**857**	**202**	**1,292**

Source: Elaborated by the authors.

Tetranychus urticae and *M. planki* were present in all treatments, i.e., they accounted for 99% of specimens collected. *M. planki* had the highest abundance compared to the other species; during the study period, 846 specimens were found, of which 746 were present in T02.

In the present study, it is reported for the first time the presence of *Euseius concordis* (CHANT, 1959) and *Neoseiulus gracilis* (MUMA, 1962) on soybean crops. The highest number of predatory mites was observed in T01, with no chemicals applied. For this site was observed significant correlation between *E. concordis* and *Tarsonemus* sp. ($r = 1$; $p < 0.0001$), *E. concordis* and *M. planki* ($r = 0.89$; $p = 0.0005$), *N. transversus* and *Tarsonemus* sp. ($r = 0.79$; $p = 0.0059$), and *N. transversus* and *M. planki* ($r = 0.93$; $p = 0.0001$). *Neoseiulus transversus* may be an effective predator on the *M. planki* control in T01; a ratio of approximately four phytophagous per predatory mites were accounted for. These results may suggest the higher potential for biological control in this treatment without agrochemicals application, as also observed by ALI (1998). Studies have reported that insecticides/acaricides have a direct effect on predatory mite fauna in many agricultural crops (SATO et. al., 2009; 2016; FOUNTAIN; MEDD, 2015; MAROUFPOOR et al., 2016; SCHMIDT-JEFFRIS et al., 2021), and this is supported by the data obtained in the present study.

In T02, *M. planki* was more abundant species, showing not being directly affected by pesticides. However, pesticides seem to have affected populations of Phytoseiidae, as only one specimen of *N. gracilis* was found, which correlated with *Tarsonemus* sp. ($r = 0.91$; $p = 0.0002$).

The abundance of *M. planki* exposed to acaricides in T03 decreased in relation to T02; *T. urticae* seems to have benefited from the application of all pesticides (including acaricides) because in T03 it presented the highest abundance observed in the present study. No phytoseiids were collected in this experimental area.

According to BUENO et al. (2012), increase in pest mite population under these conditions might be associated to: (1) predator inhibition, as only one phytoseiid specimen was found in T02 and none in T03; (2) improved plant conditions, derived from fertilization or from changes in plant physiology caused by pesticides (trophobiosis); and (3) the stimulation of mite reproduction provided by pyrethroid, neonicotinoid insecticides, and others (hormoligosis). CAMPBELL (1978) and BOYKIN; CAMPBELL (1982) observed that some pesticides can contribute to increased mite populations in peanut fields by stimulation of the mite's reproductive potential.

Further studies must be carried out to evaluate the potential of *N. transversus* in the control of *M. planki*; the effects of pesticides on *M. planki* and *T. urticae* in soybean in Brazil.

AUTHORS' CONTRIBUTIONS

Conceptualization: Rocha, S. **Data curation:** Rocha, S.; Bizarro, G.L. **Formal analysis:** Rocha, S; da Silva, G.L. **Investigation:** Rocha, S.; Bizarro, G.L; Johann, L. **Methodology:** Rocha, S; da Silva, G.L; Johann, L. **Supervision:** Johann, L. **Writing – original draft:** Rocha, S.; Bizarro, G.L; Johann, L. **Writing – review & editing:** Bizarro, G.L; Johann, L.

AVAILABILITY OF DATA AND MATERIAL

All data generated or analyzed during this study are included in this published article.

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CONFLICTS OF INTEREST

The authors declare there is no conflict of interests.

ETHICAL APPROVAL

Not applicable.

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