ISSN 2236 - 4420

Mites (Acari) associated with soybean culture (*Glycine max*), in the southeast region of Goiás state

[1]Ana Cristina Cerqueira Cavalcante, [1] Peterson Rodrigo Demite, [2] Marana Emídia da Silva Carneiro, [2] Luana Silva Nunes, [2] Alexandre Igor de Azevedo Pereira

[1] Universidade Federal do Amazonas, Instituto de Ciências Exatas e Tecnologia, Rua Nossa Senhora do Rosário, nº 3.863, Tiradentes, CEP 69103-128, Itacoatiara, AM, Brasil. E-mails: anacris.cavalcante@gmail.com, peterson_demite@yahoo.com.br
[2] Instituto Federal Goiano, Rodovia Geraldo Silva Nascimento km 2,5, CEP 75.790-000, Urutaí, GO, Brasil. E-mails: maranaemidia@hotmail.com, luana.agropec@gmail.com, aiapereira@yahoo.com.br

Abstract: The soybean crop has great importance for the state of Goiás. However, the information about the mites (Acari) associated with this culture is incipient. This study was led out to investigate the diversity of mite species that occur in soybean cultivation in Southeastern of Goiás state. In february 2016 six soybean crop collections were carried out in the municipalities of Ipameri, Silvania, and Urutaí, two areas by each municipality. In each area, 10 collection points were selected, equidistant 10 meters from each other in a zigzag sampling; ten leaves were sampled per collection point, totaling 100 leaves per area. Specimens belonging to seven species of five families (Blasttisociidae, Lolinidae, Phytoseiidae, Tarsonemidae, and Tetranychidae) were registered. The most abundant species, *Mononychellus planki* (McGregor) (Tetranychidae), was recorded in all areas sampled. The predators *Aceodromus convolvuli* Muma (Blattisociidae) and *Neoseiulus transversus* Denmark & Muma (Phytoseiidae) was registered for the first time for this crop.

Keys Words: Density, *Mononychellus planki*, Tetranychidae.

Ácaros (Acari) associados à cultura de soja (*Glycine max*), na região sudeste do estado de Goiás

Resumo: A cultura da soja possui grande importância para o estado de Goiás. No entanto, as informações a respeito dos ácaros (Acari) associados a esta cultura ainda são incipientes. Este estudo foi conduzido para investigar a diversidade de espécies de ácaros que ocorrem na cultura da soja no sudeste goiano. Foram realizadas em fevereiro de 2016 seis coletas em lavouras de soja nos municípios de Ipameri, Silvânia e Urutaí, duas em cada município. Em cada área, 10 pontos de coletas foram selecionados, eqüidistantes 10 metros, com caminhamento em zig-zag; 10 folhas foram amostradas por ponto de coleta, totalizando 100 folhas por área. Espécimes pertencentes a sete espécies de cinco famílias (Blasttisociidae, Lolinidae, Phytoseiidae, Tarsonemidae e Tetranychidae) foram registrados. A espécie mais abundante foi a fitófaga *Mononychellus planki* (McGregor) (Tetranychidae), sendo registrada em todas as áreas amostradas. Os predadores *Aceodromus convolvuli* Muma (Blattisociidae) e *Neoseiulus transversus* Denmark & Muma (Phytoseiidae) foram registrados pela primeira vez para este cultivo.

Palavras chave: Densidade, *Mononychellus planki*, Tetranychidae.

Introduction

The mites (Acari) are important components of plant canopies, being extraordinarily diverse, both in natural and agricultural environments (May, 1988, Walter, Proctor, 1998 & Walter, 2004). These organisms correspond to the second most diverse group of arthropods after insects (Moraes & Flechtmann, 2008). Despite plants harbor numerous species of mites, relatively few are considered pests. Still, these phytophagous species are of fundamental importance because they attack several species of plants of agricultural importance (Moraes & Flechtmann, 2008).

Some phytophagous mites may cause huge economic losses to soybean crops [*Glycine max* (L.) Merril, Fabaceae] leading to direct damage to the plants. However, other mites may act as biological control agents, helping to prevent or reduce not only the population of the phytophagous mites, but also of pest insects such as the whitefly *Bemisia tabaci* (Genn., 1889) (Aleyrodidae) (Guedes, Navia, Lofego, Dequech, 2007, Roggia, Guedes, Kuss, Arnemann & Navia, 2008).

Soybean is one of the most important crops worldwide, with Brazil being the second largest producer and the largest soybean exporter in the world Food and Agriculture Organization of the United Nations [FAOSTAT] (2016), United Sates Department of Agriculture [USDA] (2018). According to Instituto Brasileiro de Geografia e Estatística [IBGE] (2018) it is the most important annual crop in the country, occupying more than 33 million hectares (crop 2017-2018), and cultivated in 17 states and Distrito Federal from all Brazilian regions. Currently, the state of Goiás occupies fourth place in the national soybean production (IBGE, 2018).

Despite the relevant importance of this crop for Goiás state and for Brazil, there is still little information on the occurrence of mites associated with soybean. Only two studies were carried out in the state of Goiás, in the municipalities of Chapadão do Céu, Cristalina, Edealina, Jataí and Rio Verde (Rezende, Lofego, Navia, Roggia, 2012, Rezende, Lofego, Nuvoloni & Navia, 2014). In these studies, 19 mite species were recorded for the state, the most frequent species being the soybean green mite *Mononychellus planki* (McGregor, 1950) (Tetranychidae), registered in plantations in all five municipalities studied. Thus, the present study aimed to investigate the diversity of mite species that occur in the soybean crop in the southeastern region of the state of Goiás.

Materials and methods

The study was conducted in the geographic region of the “Estrada de Ferro”, southeast of the state of Goiás, with collections in soybean crops (varieties NA 5909, M7110 IPRO, 791 Bayer, NS 7200), carried out during in February of 2016. At the time of collection, the soybean plants were in the reproductive phenological stage, with pod development. The collections were carried out in six areas, two in each municipality: Ipameri [IP1 (17°33’29”S; 48°10’76”W) and IP2 (17°34’30”S; 48°12’07”W)], Silvânia [SI1 (16°39’37”S; 49°34’39”W) and SI2 (16°37’50”S; 48°34’39”W)], and Urutaí [UR1 (17°30’09”S; 48°12’20”W) and UR2 (17°29’44”S; 48°13’20”W)]. Ten sampling points were chosen in each area, with a distance of ten meters each, in a zigzag sampling. At each point, ten leaflets were collected for the extraction of mites, totaling 100 leaflets per area. The leaves were cut from the middle part of the plant. During the collections, leaflets of the plants were sampled and stored in paper bags inside polyethylene bags, kept in isothermal polystyrene boxes with ice, and then transported to the laboratory.

In the laboratory, the collected material was examined under a stereomicroscope (40x) and the mites found were mounted on microscopy slides with Hoyer's medium (Krantz & Walter, 2009). A fine brush was used to collect the mites from the leaves and to mount them in the medium. The assembled slides were kept in a forced air circulation oven at 50-60 °C for up to three days to fix the position, distension, and clarification of the specimens. Subsequently, the edges of the cover slip were sealed with varnish. The identification of the specimens was done under phase contrast microscopy. The mites were identified with the use of identification keys and specific literature (e.g. Krantz & Walter, 2009) and the keys from "The Acarology Summer Program" workshop (Ohio, Ohio State University). Descriptions of the species identified *Aceodromus convolvuli* Muma, 1961, *Mononychellus planki* (McGregor, 1950), *Neoseiulus transversus* Denmark & Muma, 1973 and *Tarsonemus bilobatus* (Suski, 1965) were consulted for confirmation.

All examined leaves were measured to

obtain the leaf area and, consequently, the density of the mites per square decimeter (dm^2) of leaf tissue was quantified. This measure was calculated from the data of length and width of each leaflet, with the multiplication by 0.7104, according to Adami, Hastenreiter, Flumingman and Faria (2011).

The chemicals used in the studied areas, as well as their dosages, were obtained with the owners of the areas sampled (Table 1.).

Table 1 - Chemical control used in each soybean area sampled in the year 2016, in the southwest region of the state of Goiás.

Area*	Chemical pesticide	Classification	Dosage	Cultivars
IP1	Lannate®	insecticide	500 mL/ ha	M7110 IPRO
	Aproach Prima®	fungicide	300 mL/ ha	
IP2	Standak Top®	insecticide	110 mL/ ha	NA 5909
	Fox®	fungicide	400 mL/ ha	
SI1	Standak Top®	insecticide	100 mL/ ha	NA 5909
	Orkestra SC®	fungicide	270 mL/ ha	
SI2	Avatar®	insecticide	400 mL/ ha	NA 5909
	Unizeb Gold®	fungicide	1.5 kg/ ha	
UR1	Interprid®	insecticide	200 mL/ ha	791 Bayer
	Aproach Prima®	fungicide	350 mL/ ha	
UR2	Galil®	insecticide	300 mL/ ha	NS 7200
	Elatus®	fungicide	200 g/ ha	

*Area: IP1: Ipameri 1; IP2: Ipameri 2; SI1: Silvânia 1; SI2: Silvânia 2; UR1: Urutaí 1; UR2: Urutaí 2.

Results and discussion

A total of 1,676 mites belonging to seven species of five families were recorded (Table 2.). The highest richness was recorded in an area of Urutaí (UR1), with five species. On the other hand, in Silvânia (SI2), only a single species was recorded (*Mononychellus planki*). Tetranychidae (Trombidiformes) was the most frequent family, being registered in all areas sampled, and abundant in five of these; only in the SI2 area, in Silvânia, this species was recorded in small abundance. An undetermined species of the genus *Oligonychus* (Tetranychidae) was also recorded, but with only one individual collected in the UR1 area. In the family Tarsonemidae (Trombidiformes) two species were registered: *Tarsonemus bilobatus* and *Tarsonemus* cf. *confusus*. One undetermined species of Iolinidae (Trombidiformes) was recorded.

For the order Mesostigmata, *Aceodromus convolvuli* (Blattisociidae) was recorded in two areas (IP1 and SI1) and *Neoseiulus transversus* (Phytoseiidae) was registered in IP2. The richness of mites recorded in the soybean areas sampled in this study was low. However, two species of predators, *N. transversus*, and *A. convolvuli*, were recorded for the first time in this crop.

In Brazil, *A. convolvuli* has been reported in associated with coffee crop (Mineiro et al., 2006a, Mineiro, Raga, Sato & Lofego, 2009), as well as in weed plants within cassava crop (Rodrigues, Paraíba & Moraes, 1996) and jatropha crop (Cruz et al., 2012, 2014). Cruz et al. (2014) reported *A. convolvuli* in association with tetranychid mites. According to these authors, *A. convolvuli* may be a predator of Tetranychidae and Tenuipalpidae mites. *Neoseiulus transversus* was also previously reported on coffee crops (Mineiro et al., 2006ab, 2009) and grape crops (Domingos, Melo, Oliveira,Gondim, 2014 & Ferla et al., 2011), and jatropha crops (Lofego, Rezende, Verona & Feres, 2013), in addition to weeds inside jatropha crops (Rezende & Lofego, 2012). Moraes and McMurtry (1983) found *N. transversus* associated with *M. planki* on a leguminous plant (*Rhyncosia minima* (L.) DC).

Table 2 - Abundance and density (dm^2) (in parentheses) of the mite species recorded on soybean in each area sampled in 2016, in the southwest region of the state of Goiás.

Mites recorded	Abundance and density (dm2) /area*						Total
	IP1	IP2	SI1	SI2	UR1	UR2	
ORDER TROMBIDIFORMES							
IOLINIDAE							
Unidentified species	-	-	-	-	1 (0.021)	-	1 (0.004)
TARSONEMIDAE							
Tarsonemus cf. *confusus*	-	-	-	-	2 (0.042)	-	2 (0.008)
Tarsonemus bilobatus	-	1 (0.030)	-	-	10 (0.207)	-	11 (0.045)
TETRANYCHIDAE							
Mononychellus planki	382 (8.064)	132 (3.982)	365 (6.352)	2 (0.072)	508 (10.553)	269 (9.022)	1658 (6.800)
Oligonychus sp.	-	-	-	-	1 (0.021)	-	1 (0.004)
ORDER MESOSTIGMATA							
BLATTISOCIIDAE							
Aceodromus convolvuli	1 (0.021)	-	1 (0.017)	-	-	-	2 (0.008)
PHYTOSEIIDAE							
Neoseiulus transversus	-	1 (0.030)	-	-	-	-	1 (0.004)
Total	383 (8.085)	134 (4.042)	366 (6.369)	2 (0.072)	522 (10.844)	269 (9.022)	1676 (6.874)

*Area: IP1: Ipameri 1; IP2: Ipameri 2; SI1: Silvânia 1; SI2: Silvânia 2; UR1: Urutaí 1; UR2: Urutaí 2.

As for phytophagous mites, this is the first record of the genus *Oligonychus* in soybean crop in Brazil. The most abundant species recorded in Southeastern of Goiás state was *M. planki*, a species commonly associated with soybeans in Brazil (Guedes et al., 2007, Rezende et al., 2012 & Roggia et al., 2008). This tetranychid mite has already been recorded on 64 plant species (Migeon & Dorkeld, 2017). According to Roggia et al. (2008), the attack of these mites on soybean causes chlorosis on both sides of the leaf, evolving to a grayish color, with the leaves later showing an aged appearance. In Brazil, examples of other crops attacked by this mite are cotton (*Gossypium herbaceum* L., Malvaceae), peanuts (*Arachis hypogea* L., Fabaceae) and beans (*Phaseolus vulgaris* L., Fabaceae) (Moraes & Flechtmann, 2008). According to Rezende et al. (2012), this mite is of relevance for the agriculture of the country, with more studies of biological aspects and its control being required.

The mite density recorded in this study was 6.87 mites/dm^2. The area with the highest density was UR1, in Urutaí. The most abundant species, *M. planki*, had its highest density recorded in UR1 (10.8 individuals/dm^2), followed by the areas of UR2 (9.02) and IP1 (8.08). The other six species sampled in this study had densities below 0.21 mites/dm^2.

The population density of *M. planki* in the present study was higher than that reported by Rezende et al. (2014) for the entire mite community registered in soybean areas in Goiás, Minas Gerais, Mato Grosso do Sul states and in the Distrito Federal. The highest density recorded by these authors (2.14 mites/dm^2) in an area located in Chapadão do Sul, Mato Grosso do Sul, was about three times lower than that recorded for *M. planki* in this study (6.8 individuals/dm^2).

The high density of *M. planki* in soybean plants may have been due to an indirect effect of the application of chemical pesticides for the control of other arthropods or diseases. Usually, chemical control methods are not required for *M. planki* in soybean. Furthermore, no pesticide is registered for control of this species in the above culture (Agrofit, 2017).

The indirect effects on *M. planki* may be due to a positive effect of certain chemical compounds on this tetranychid mite, due to the phenomena called trophobiosis and/or hormoligose. A few studies have demonstrated that the populations of phytophagous mites may increase following the application of pesticides, such as those belonging to the chemical groups of organophosphates, pyrethroids, and neonicotinoids (Barros, Degrande, Soria & Ribeiro, 2007). According to Reis and Zacarias (2007), excessive use of cupric and neonicotinoid fungicides may be associated with an increase of the mite *Oligonychus ilicis* (McGregor, 1917) (Tetranychidae) in coffee. The soybean crop, throughout its cycle, is subject to the attack of several arthropods and occurrence of diseases, being the chemical pesticides widely used. Among the products indicated for soybean, many belong to the group of organophosphates, pyrethroids, in addition to some neonicotinoids (Agrofit, 2017). Some of these products used in the chemical control may have a stimulating effect on *M. planki* favoring the population increase. Studies by Reis and Teodoro (2000) confirm the increase of oviposition of *O. ilicis* after being exposed to copper oxychloride.

Another hypothesis refers not only to the high density of *M. planki* but also to the small number of predators recorded in this study. Pesticides can have a negative effect on natural enemies by promoting ecological imbalance. Thus, reducing the action of natural enemies may favor resurgence, as well as the possibility of secondary pests becoming primary (Degrande, Reis, Carvalho & Belarmino, 2002). Predatory mites act as natural biological regulators, keeping populations of phytophagous mites at low levels (Gerson, Smiley & Ochoa, 2003). These phytophagous species, which are generally not considered to be of agricultural importance, can, in these situations, reach high population levels and cause damage to the crop. Thus, in the absence of these predators, phytophagous mites such as *M. planki*, which would generally not require the use of control methods, may become a pest.

Conclusions

The richness of mites recorded in the soybean areas sampled in this study was low.

Mononychellus planki is the most abundant and frequent species recorded in soybean crops in southeast of Goiás state.

The high density of *M. planki* and the low diversity of mites, mainly of predators, in soybean plants may have been due to an indirect effect of the application of chemicals.

Acknowledgment

To Antonio C. Lofego and Reinaldo J.F. Feres, Universidade Estadual Paulista "Júlio de Mesquita Filho" [UNESP] São José do Rio Preto for the identification of the Tarsonemidae and Tetranychidae species, respectively; to the owners of the areas sampled, for allowing access to their crops. To Conselho Nacional de Pesquisas and Fundação de Amparo à Pesquisa do Estado de Goiás [CNPq/ FAPEG], under the Programa de Desenvolvimento Científico e Tecnológico Regional (DCR) (Proc. 303016/2014-0 and 2014/0267000874) for the financing.

References

Adami, M., Hastenreiter, F. A., Flumingman, D. L., & Faria, R. T. (2011). Estimativa de área de folíolos de soja usando imagens digitais e dimensões foliares. *Bragantia,* 67, 1053-1058. http://dx.doi.org/10.1590/S0006-87052008000400030

Agrofit. (2017). *Sistema de Agrotóxicos Fitossanitários*. Brasília, DF: Ministério da Agricultura, Pecuária e Abastecimento. Recuperado em 19 de agosto, 2017, de http://agrofit.agricultura.gov.br/agrofit_cons/principal_agrofit_cons.

Barros, R., Degrande, P. E, Soria, M. F., & Ribeiro, J. S. F. (2007). Desequilíbrio biológico do ácaro-rajado *Tetranychus urticae* Koch, 1836 (Acari: Tetranychidae) após aplicações de inseticidas em

algodoeiro. *Arquivo Instituto Biológico,* 74, 171-174.

Cruz, W.P., Sarmento, R.A., Pedro-Neto, M., Teodoro, A.V., Rodrigues, D.M., & Moraes, G.J. (2014). Population dynamics of *Aceodromus convolvuli* (Acari: Mesostigmata: Blattisociidae) on spontaneous plants associated with *Jatropha curcas* in central Brazil. *Experimental & Applied Acarology,* 64, 309-319. doi: 10.1007/s10493-014-9828-5.

Cruz, W.P., Sarmento, R.A., Teodoro, A.V., Erasmo, E.A.L., Neto, M.P., Ignacio, M., & Jr., D.F.F (2012) Acarofauna em cultivo de pinhão manso e plantas espontâneas associadas. *Pesquisa Agropecuária Brasileira,* 47(3), 319-327. http://dx.doi.org/10.1590/S0100-204X2012000300002.

Degrande, P. E., Reis, P. R., Carvalho, G. A., & Belarmino, L. C. (2002*). Metodologia para avaliar o impacto de pesticidas sobre inimigos naturais* (Cap. 5, pp. 71-94). São Paulo: Manole.

Denmark, H.A., & Muma, M.H. (1973). Phytoseiid mites of Brazil (Acarina: Phytoseiidae). *Revista Brasileira de Biologia*, 33, 235-276.

Domingos, C.A., Melo, J.W.S., Oliveira, J.E.M., & Gondim Jr., M.G.C. (2014). Mites on grapevines in northeast Brazil: occurrence, population dynamics and within-plant distribution. *International Journal of Acarology*, 40 (2), 145-151. ,http://dx.doi.org/10.1080/01647954.2014.891651

Food and Agriculture Organization of the United Nations. (2016). Crops: Sobean. Recuperado em 03 Julho, 2018, de http://www.fao.org/faostat/en/#data/QC.

Ferla, N. J., Johann, L., Klock, C., Majolo, F., & Botton, M. (2011). Phytoseiid mites (Acari: Phytoseiidae) from vineyards in Rio Grande do Sul State, Brazil. *Zootaxa*, 2976, 15-31.

Gerson, U., Smiley, R. L., & Ochoa, R. (2003). *Mites (Acari) for pest control* (539p). Oxford: Blackwell Science.

Guedes, J. V. C., Navia, D. Lofego, A. C., & Dequech, S. T. B. (2007). Ácaros associados à cultura da soja no Rio Grande do Sul, Brasil. *Neotropical Entomology,* 36, 288-293. Recuperado de http://dx.doi.org/10.1590/S1519-566X2007000200017

Instituto Brasileiro de Geografia e Estatística. (2018). *Levantamento Sistemático da Produção Agrícola.* Recuperado em 9 julho, 2018, de https:// https://sidra.ibge.gov.br/home/lspa/brasil

Krantz, G. W., & Walter, D. E. (2009). *A Manual of Acarology* (3rd ed., 807p). Austin: Tech University Press.

Lofego, A.C., Rezende, J.M., Verona, R.L.C., & Feres, R.J.F. (2013) Mites (Acari) associated with three species of the genus *Jatropha* (Euphorbiaceae) in Brazil, with emphasis on *Jatropha curcas*. *Systematic and Applied Acarology,* 18 (4), 411–423. http://dx.doi.org/10.11158/saa.18.4.10

May, R.M. (1988). How many species are there on earth? *Science*, 241, 1441-1449. doi: 10.1126/science.241.4872.1441

McGregor, E.A. (1950). Mites of the family Tetranychidae. *American Naturalist*, 44, 257-420.

Migeon, A., & Dorkeld, F. (2017). *Spider mite web: a comprehensive database for the Tetranychidae*. Recuperado em Septembre 19, 2017, de http://www.montpellier.inra.fr/CBGP/spmweb.

Mineiro, J.L. C., Sato, M.E., Raga, A., Arthur, V., Gangani, K.G., & Barbosa, F.V. (2006b). Diversidade de ácaros (Arachnida: Acari) em cincos cultivares de duas espécies de cafeeiros (*Coffea* spp.) em Garça, estado de São Paulo. *Arquivos do Instituto Biológico,* 73 (3), 333–341.

Mineiro, J.L.C., Raga, A., Sato, M.E., & Lofego, A.C. (2009) Ácaros associados ao cafeeiro (*Coffea* spp.) no estado de São Paulo, Brasil. Parte I. Mesostigmata. *Biota Neotropical,* 9 (1), 37-46.

Mineiro, J.L.C., Sato, M.E., Raga, A., Arthur, V., Moraes, G.J., Sarreta, F.O., & Carrijo A. (2006a) Diversidade de ácaros (Arachnida: Acari) em *Coffea arabica* L. cv. Mundo Novo, nos municípios de Jeriquara e Garça, Estado de São Paulo. *Biota Neotropical,* 6, 2-15. http://dx.doi.org/10.1590/S1676-06032006000200012.

Moraes, G. J., & Flechtmann, C. H. W. (2008). *Manual de acarologia agrícola: acarologia básica e ácaros de plantas cultivadas do Brasil* (308p). Ribeirão Preto: Holos Editora.

Moraes, G.J., & McMurtry, J.A. (1983) Phytoseiid mites (Acarina) of northeastern Brazil with descriptions of four new species. *International Journal of Acarology*, 9 (3), 131-148.

Muma, M.H. (1961). Subfamilies, genera and species of Phytoseiidae (Acarina: Mesostigmata). *Bulletin of the Florida State Museum*, 5, 264-302.

Reis, P. R., & Teodoro, A. V. (2000). Efeito de oxicloreto de cobre sobre a reprodução do ácaro-vermelho-do-cafeeiro, *Oligonychus ilicis* (McGregor). *Ciência e Agrotecnologia,* 24 (2), 347-352.

Reis, P. R., & Zacarias, M. S. (2007). *Ácaros em cafeeiro* (Boletim técnico, n. 81). Lavras: EPAMIG.

Rezende, J. M., Lofego, A. C., Navia, D., & Roggia, S. (2012). Mites (Acari: Mesostigmata, Sarcoptiformes and Trombidiformes) associated to soybean in Brazil, including new records from the Cerrado areas. *Florida Entomologist,* 95, 683-693. https://doi.org/10.1653/024.095.0319.

Rezende, J. M., Lofego, A. C., Nuvoloni, F. M., & Navia, D. (2014). Mites from Cerrado fragments and adjacent soybean crops: does the native vegetation help or harm the plantation? *Experimental & Applied Acarology,* 64, 501-518. https://doi.org/10.1007/s10493-014-9844-5

Rezende, J.M., & Lofego, A.C. (2012). Mites (Mesostigmata, Prostigmata, Astigmatina) associated with weeds among physic nut crops (*Jatropha curcas* L.: Euphorbiaceae) in Brazil. *Systematic and Applied Acarology,* 17(1), 15–26. http://dx.doi.org/10.11158/saa.17.1.5.

Rodrigues, G.S., Paraíba, L.C., & Moraes, G.J. (1996) Pairwise association as a criterion for the selection of collection sites of natural enemies of the cassava green mite, *Mononychellus tanajoa* (Bondar). *Scientia Agricola,* 53, 2-3. http://dx.doi.org/10.1590/S0103-90161996000200022.

Roggia, S., Guedes, J. V. C., Kuss, R. C. R, Arnemann, J. A., & Navia, D. (2008). Spider mites associated to soybean in Rio Grande do Sul, Brazil. *Revista Agropecuária Brasileira,* 43(3), 295-301. http://dx.doi.org/10.1590/S0100-204X2008000300002.

Susk, Z.W. (1965). Tarsonemid mites on apple trees in Poland. II. *Tarsonemus bilobatus* n.sp. (Acarina, Tarsonemidae). *Bulletin de l'Academie Polonaise des Sciences*, 13, 539-544.

United Sates Department of Agriculture. (2018). Foreing Agricultural Service: Brazil: Oilseeds and products annual. Recuperado em 03 julho, 2018, de https://www.fas.usda.gov/data/brazil-oilseeds-and-products-annual-2.

Walter, D. E., & Proctor, H. C. (1998). Predatory mites in tropical Australia: local species richness and complementarity. *Biotropica,* 30, 72-81. http://dx.doi.org/10.1111/j.1744-7429.1998.tb00370.x

Walter, D. E. (2004). *Hidden in plain sight: mites in the canopy* (Chap. 11, pp. 224-241). San Diego: Academic Press.

Recebido em: 12/10/2017
Aceito em: 29/08/2018