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Population Dynamics of Rubber Tree Mites

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Abstract

Calacarus heveae is considered the most common pest mite in rubber tree crops in Southeast and Midwest Brazil. We evaluated the population dynamics of mites in GT 1, PB 235, PR 255 and RRIM 600 rubber tree clones from crops in the Goiás State, Brazil. We sampled leaves between June 2013 and June 2014 in 10 trees for each rubber tree clone. *Calacarus heveae* and *Tenuipalpus heveae* populations were counted in four 1 cm^2-areas distributed on each middle leaflet sampled, whereas all other mites were found on lateral leaflets. *Calacarus heveae* reached a population peak between March and May 2014. PR 255 and RRIM 600 sheltered the densest population of *C. heveae*. We sampled six predatory mite species, highlighting *Euseius citrifolius*. GT 1 and PB 235 had higher abundance of predatory mites. This is the first study carried out on the population dynamics of phytophagous mites associated with rubber trees in the state of Goiás.

Keywords: pest mites, *Hevea brasiliensis*, plant-mite interactions, predatory mites.

1. INTRODUCTION AND OBJECTIVES

Calacarus heveae Feres, 1992 (Acariformes: Eriophyidae), is considered the most common pest mite in rubber tree cultivations (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) of the Brazilian Midwest and Southeastern regions (Daud & Feres, 2007; Feres, 2000; Hernandes & Feres, 2006). High infestations of *C. heveae* can cause yellowing and tanning of the rubber tree leaflets, resulting in intense defoliation (Feres, 1992, 2000; Vieira et al., 2013). *Calacarus heveae* attack can reduces the foliar photosynthetic rate and affect productivity (Daud, Conforto, & Feres, 2012).

The population peaks of *C. heveae* occur at the end of the rainy season and the beginning of the dry season, between February and May (Daud & Feres, 2007). Depending on the infestation level, this mite can cause more than 75% of leaf loss and a reduction of up to 30% in the latex production (Feres, 1992; Vieira & Gomes, 1999), which may compromise the viability and productivity of the rubber tree (Daud, Conforto, & Feres, 2012).

Due to the damage caused by *C. heveae* and other phytophagous arthropods to rubber tree productivity, several control strategies have been evaluated for managing these species in the field, with emphasis on chemical control (Daud, Feres, & Boscolo, 2012; Ferla & Moraes, 2003; Vieira et al., 2006).

According to Daud & Feres (2013), the rubber tree clones can affect the structure of mite communities in the crop, including the occurrence and abundance of phytophagous, mycophagous and predatory mites. According to these authors, the highest estimated amount of mite species was recorded for GT 1 and PB 235 clones, while the greatest abundance of predators and mycophagous was found in GT 1 and phytophagous in PB 235. Thus, there is evidence that different clones have different effects on the organization of mite communities in rubber tree plants.

In Brazil, interactions between rubber tree clones and mites have been studied mainly in the western regions of the state of Mato Grosso (e.g. Daud & Feres, 2007, 2013; Ferla & Moraes, 2008) and in the northwest regions of the state of São Paulo

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(e.g. Silva et al., 2011), although there is lack of information for the Midwest Brazil. Thus, the objective of this research was to evaluate the population fluctuation of *C. heveae* and *Tenuipalpus heveae* Baker (Acariformes: Tenuipalpidae), and to do survey of secondary mites associated with rubber tree clones in the state of Goiás.

2. MATERIALS AND METHODS

The study was carried out in areas belonging to OL Látex Ltda., located in the city of Goianésia, Goiás, Brazil (15° 19' 21" S and 49° 9' 32" W). The rubber clones evaluated were GT 1, PB 235, PR 255 and RRIM 600. The area is in the morphological and climatic domain of the Cerrado, with fragments of natural vegetation of this biome, such as forests and savannahs being found in the surroundings. The climate of the region is Aw according to the Köppen classification, characterized by a well-defined dry season between April and September, and a rainy period between October and March (Alvares et al., 2013). Spraying with insecticides and acaricides were not performed in the evaluated area during the study period.

Bi-weekly sampling for evaluating *C. heveae* and *T. heveae* and monthly sampling for evaluating other species were also carried out between June 2013 and June 2014. These were made randomly in ten plants of each clone. Seven leaves were collected around the canopy for each selected plant at a height of 7 m with the aid of a trimmer with telescope cable. The collected leaves were conditioned in individualized, properly labeled paper bags, which were wrapped in plastic bags and transported to the laboratory in isothermal polystyrene boxes refrigerated with plastic bags containing Gelo X®. The samples were kept under refrigeration at 10 °C for a maximum of one week.

In the laboratory, the central leaflet and a lateral leaflet of each leaf were analyzed under a stereoscopic microscope. The central leaflets were used to evaluate *C. heveae* and *T. heveae*, which were assessed biweekly. For these species, four 1 cm^2 areas were randomly arranged in the leaf limb of the adaxial face for *C. heveae* and the abaxial face for *T. heveae* of each central leaflet. The lateral leaflets of each collected leaf were used to evaluate the occurrence and abundance of the other species monthly, called here as "secondary mites." One of the lateral leaflets of each leaf was thoroughly inspected on the adaxial and abaxial surfaces, and all secondary mites found were put on microscopy slides using Hoyer's medium (Moraes & Flechtmann, 2008). The specimens were identified under optical microscope with phase contrast.

Total population counts and population density were calculated in order to obtain the population fluctuation of *C. heveae* and *T. heveae*. The clones were compared using the 95% confidence interval, considering the population peak between March and May 2014. The density was compared by graphical analysis to verify the overlap of the error bars (Cumming et al., 2007).

3. RESULTS AND DISCUSSION

In total, 100,807 *C. heveae* individuals and only 219 *T. heveae* individuals were counted. During the natural senescence of the leaves, which corresponds to the dry season (July-August), *C. heveae* population showed a decrease in the four clones (Figure 1). The density of this mite gradually increased after the leaves sprouted (September-October), reaching a population peak between March and May 2014 (the end of the rainy season and the beginning of the dry season).

The density of *C. heveae* varied among the evaluated clones. PR 255 sheltered a higher mean density of the mite during the period with major infestations (March to May 2014), similar to the RRIM 600 clone. The lower densities of *C. heveae* were found in the GT 1 and PB 235 clones (Figure 2).

Our results corroborate previous studies that indicated *C. heveae* as the most abundant phytophagous mite in rubber tree crops (Feres, 2000; Feres et al., 2002; Hernandes & Feres, 2006). This species occurred in all clones during the study period, with population peaks between March and May. This pattern has also been observed in previous studies that recorded high *C. heveae* infestations at the end of the rainy season and beginning of the dry season (Daud & Feres, 2007; Hernandes & Feres, 2006; Vieira et al., 2009).

The population dynamics of *C. heveae* throughout the year is probably associated with the rubber tree phenology. The low densities of the mite during the senescence period can be evidenced by the population resurgence soon after regrowth of the plants leaves, when these are still young, and gradual increase of the population along the plant development and foliar maturation (Daud & Feres, 2007). The period in which the leaves are more favorable for phytophagous mites development is between January to April (Daud, Feres, & Hernandes, 2012), coinciding with the *C. heveae* abundance peak, as observed here and by other authors (Daud & Feres, 2007; Feres et al., 2002; Hernandes & Feres, 2006; Vieira et al., 2009). This pattern of increased density of phytophagous mites with the emission of new leaves and peak population at the end of the rainy season were observed for all evaluated clones.

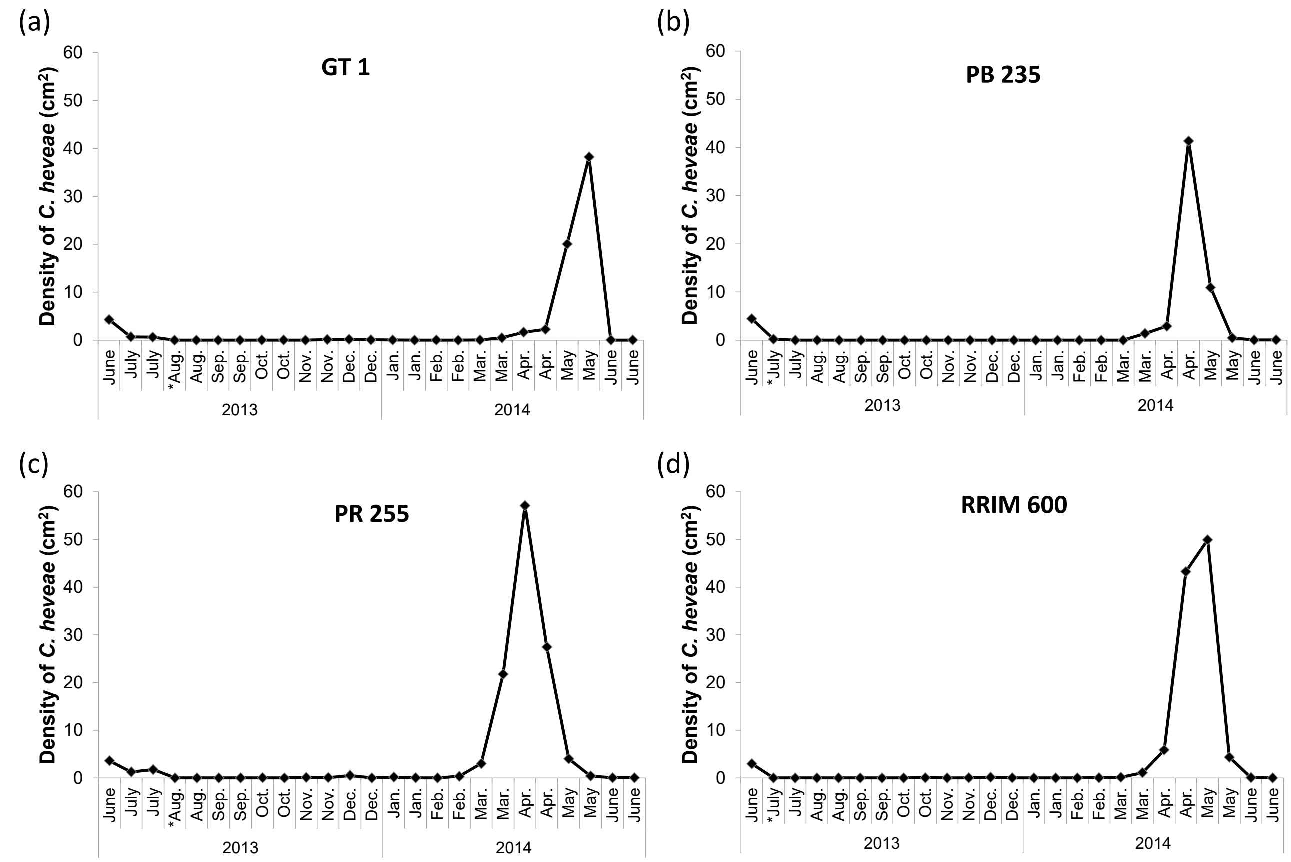

Figure 1. Population fluctuation of *C. heveae* in rubber tree clones, from June 2013 to June 2014, Goianésia, Goiás, Brazil.

* Senescence period: there was no leaf collection.

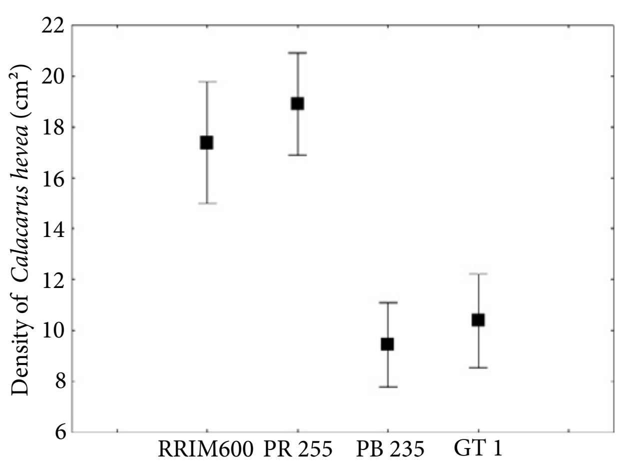

Figure 2. Mean density of *C. heveae* (± IC 95%) in rubber tree clones, Goianésia, Goiás, Brazil.

According to Daud, Feres, & Hernandes (2012), the leaf age and rubber tree clone influence the development, oviposition and survival of *C. heveae*. These authors observed under controlled conditions less survival and longer development time when *C. heveae* individuals were kept in young GT 1 leaves withdrawn from plants in November. However, there was a reduction in the development period, a high reproductive rate, and higher survival of mites were recorded when they were kept in on leaflets removed from plants between January and April. The mites kept in leaves removed from the plants between May and June presented reduced oviposition rates (Daud, Feres, & Hernandes, 2012). In the current study, we observed decreases in *C. heveae* populations starting from May, before the natural senescence of the plants, suggesting that leaves with more advanced age are not suitable for mite development. Therefore, the rubber tree phenology can determine the population dynamics of *C. heveae*.

Daud & Feres (2007) also found differences in relation to the infestation level of *C. heveae* among rubber trees clones in a plantation at Itiquira municipality, State of Mato Grosso. The authors observed the largest *C. heveae* infestations in PR 255 clones. RRIM 600 clone plants showed higher *C. heveae* density when compared to PB 235, which showed the lowest *C. heveae* densities (Daud & Feres, 2007). High density of this mite in PB 235 and low density in GT 1 clones were registered in Jaboticabal, São Paulo (Tanzini, 1999). Here, we observed higher *C. heveae* infestation in PR 255 and RRIM 600, and lowest mite abundance in PB 235 and GT 1, similarly to the results found by Daud & Feres (2007).

In the present study, *T. heveae* is classified as a secondary species, since low abundance was observed during the sampling period. Competition with *C. heveae* may have influenced their population growth, as suggested by Feres et al. (2002). In addition, *T. heveae* is a well-accepted prey by *Euseius citrifolius* Denmark & Muma (Parasitiformes, Phytoseiidae), preferentially in their larval and nymphal stages (Cardoso et al. 2010). In the our study, we recorded *E. citrifolius* as the highest abundant predatory mite in all rubber tree clones evaluated, suggesting a possible control on the *T. heveae* populations by this species.

For secondary mites, 902 individuals belonging to 18 species of 10 families (Table 1) were registered. Among these, 523 individuals belonging to eight phytophagous species from three families; 92 individuals of three mycophagous species in two families; 256 specimens of six predatory species in four families, and only one family of mites with unknown food habits with 22 individuals of a single species.

Phytophagous mites represented 58% of the specimens collected, followed by predators with 29.4%, mycophagous with 10.2%, and unknown food habit in 2.4%. The family with the highest diversity was Tetranychidae with five species sampled, namely *Eutetranychus* sp., *Eutetranychus banksi* (McGregor), *Oligonychus gossypii* (Zacher), *Oligonychus ilicis* (McGregor) and *Oligonychus* sp. The other families had one to two species. The family with the highest abundance was also Tetranychidae, followed by the Phytoseiidae and Winterschmidtiidae. *Euseius citrifolius* was the only species registered in the Phytoseiidae. Winterschmidtiidae showed two species identified up to genus level, *Oulenzia* sp. and *Czenspinskia* sp.

RRIM 600 presented a lower number of secondary mites in the study, mainly due to the smaller number of Tetranychidae mites and predatory species. A higher abundance of secondary mites was observed for PB 235, followed by GT 1 and PR 255. In relation to the abundance of predatory mites, PB 235 and PR 255 clones had similar results, whereas they were slightly higher in GT 1. Furthermore, all clones presented similar numbers for species variety, with GT 1 presenting 13 species, PR 255 with 11, PB 235 and RRIM 600 with nine species each.

The greater abundance of phytophagous species determines the community structure, influencing the occurrence and abundance of other mites species (Daud & Feres, 2013). In a study carried out in the state of Mato Grosso by Demite & Feres (2007), phytophagous represented 98.7% of the total number of individuals collected, while predators represented 1%. Among these, three phytophagous species considered primary mites represented more than 97%, namely *Phyllocoptruta seringueirae* Feres, *T. heveae* and *C. heveae* (Demite & Feres, 2007). Here we observed a similar abundance pattern since phytophagous mites were the most abundant followed by predatory mites.

Table 1. Mites collected in a rubber tree plantation separated by family, genus/species and food habit. Goianésia, Goiás, Brazil.

Family	Genus/Species	FH	GT 1	PB 235	PR 255	RRIM 600	Total
Tenuipalpidae	*Brevipalpus phoenicis*	F	2	0	0	0	2
Tetranychidae	*Eutetranychus* sp.	F	31	2	3	5	41
	Eutetranychus banksi	F	34	71	74	21	200
	Oligonychus gossypii	F	5	1	1	0	7
	Oligonychus ilicis	F	26	51	5	4	86
	Oligonychus sp.	F	35	77	19	21	152
Tydeidae	*Lorryia formosa*	F	15	0	2	15	32
	Lorryia matura	F	0	0	2	1	3
Tarsonemidae	*Tarsonemus* sp.	M	0	0	1	1	2
Winterschmidtiidae	*Oulenzia* sp.	M	1	3	6	2	12
	Czenspinskia sp.	M	22	2	19	35	78
Acaridae	*Neotropacarus* sp.	U	9	3	7	3	22
Bdellidae	*Tetrabdella neotropica*	P	1	0	1	0	2
Iolinidae	*Parapronematus* sp.	P	2	3	2	0	7
	Metapronematus sp.	P	1	1	2	0	4
Phytoseiidae	*Euseius citrifolius*	P	74	65	66	36	241
Stigmaeidae	*Zetzellia quasagistemas*	P	0	2	0	3	5
	Agistemus floridanus	P	3	0	0	3	6
Total			261	281	210	150	902

FH: food habit; F: phytophagous; M: mycophagous; U: unknown food habits; P: predatory mites.

Bdellidae, Iolinidae, Phytoseiidae and Stigmaeidae have some important predatory species of phytophagous mites (Gerson et al., 2003). *Euseius citrifolius* is the most frequently reported predatory species in the Brazilian natural vegetation remnants (Araújo & Daud, 2017), and it is also found in several Brazilian rubber tree plantations (Feres, 2000; Hernandes & Feres, 2006). The highest abundance of *E. citrifolius* found in our study may be related to the presence of Tetranychidae mites. Phytoseiidae mites received more attention from the 1950s on, when these mites were considered important natural enemies of Tetranychidae mites in agroecosystems (Gerson et al., 2003; Moraes et al., 2004). Moreover, due to predatory habits, *E. citrifolius* can contribute to the biological control of the most important pest species (Cardoso et al., 2010) and can feed on several mite groups, thrips and whiteflies (McMurtry et al., 2013). The great abundance and frequency of this mite throughout the year is probably due to its general food habit, with high food diversity including phytophagous mites, insects and pollen (Bellini et al., 2008).

In addition to *E. citrifolius*, we also sampled *Agistemus floridanus* Gonzalez (Acariformes: Stigmaeidae), *Tetrabdella neotropica* Hernandes & Feres (Acariformes, Bdellidae), and two species belonging to Iolinidae. *Agistemus floridanus* had potential in controlling *C. heveae* in the field, since the females have relatively high oviposition when fed with this phytophagous species under experimental conditions (Ferla & Moraes, 2003). Moreover, Iolinidae mites are recognized worldwide as important natural enemies of Eriophyidae (Gerson et al., 2003).

Daud & Feres (2013) suggested a possible effect of clone type on the abundance of phytophagous species in rubber trees, which in turn affect competing species and predatory mites occurrence. The greater abundance of secondary mites presented in the PB 235 clone in the present study was possibly due to higher abundance of Tetranychidae mites. Thus, host plants play a determining role in the mite community organization on rubber trees.

Host plants influences on acarofauna composition may be related to resistance factors. Some papers reported the influence of rubber tree clone on the development of phytophagous mites (Daud, Feres, & Hernandes, 2012; Feres et al., 2010), but more studies are needed to identify biochemical characteristics of the rubber tree clones in relation to resistance against phytophagous mites, as well as the effect of plant physiology on the development of mites (Daud, Feres, & Hernandes, 2012; Vieira et al., 2013).

4. CONCLUSIONS

The population peak of *C. heveae* occurs between March and May in the state of Goiás. Clones differ for the *C. heveae* population and also for other associated mites. PR 255 and RRIM 600 clones have higher *C. heveae* infestations. In relation to predatory mites, GT 1 and PB 235 harbored the highest abundance of these organisms.

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