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ARTICLE

Damage characterization and control tactics to broad mite (*Polyphagotarsonemus latus* Banks) in Paraguay-tea plants (*Ilex paraguariensis* A.St.-Hil.)

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ABSTRACT: (Damage characterization and control tactics to broad mite (*Polyphagotarsonemus latus* Banks) in Paraguay-tea plants (*Ilex paraguariensis* A.St.-Hil.)). The broad mite (*Polyphagotarsonemus latus*) is referred as one Paraguay-tea (*Ilex paraguariensis*) pest, an important culture in the south of Brazil, and not existing studies about its control in the Paraguay-tea culture, the present work aimed to characterize the damages and to evaluate control tactics of this pest of Paraguay-tea seedlings, in green house. In the experiment 1, the Paraguay-tea seedlings were divided in two groups of 50 seedlings, divided in 5 repetitions. In one of the groups the seedlings were artificially infested with mites grown in laboratory. Weekly, during 3 months, the plants were appraised, the alterations possibly related to the mites presence were observed. In the second experiment, an identical group of seedlings was infested by the broad mite and 15 days after the following treatments were applied: **a)** mitecide based on cyhexathin, **b)** *Hirsutella thompsonii* fungus isolated CG 541 (1×10^6 conídios/mL), **c)** distilled water and **d)** without infestation, considered control treatment. The evaluations accomplished were before and at the end of the experiment, consisting in counting the mites in 10 leaves/repetition, determination of the height and number of leaves/plantings and dry weight of all the plants (end). The mites concentrated on the abaxial surface of the apical and younger leaves, which presented the screw borders, abnormal ribs development, rough surface and tan. Early leaves fall was also observed. There was no difference in the size of the plants and leaves number, but a 30% biomass reduction in the fungus treatment plants and in those without treatment has happened. The broad mite caused damages to the seedlings in nurseries and the mitecide control reduced the population of the same and the damages.
Key words: mite, biological control, entomopathogenic fungus, chemical control.

RESUMO: (Caracterização do dano e táticas de controle do ácaro-branco (*Polyphagotarsonemus latus* Banks) em erva-mate (*Ilex paraguariensis* A.St.-Hil.)). O ácaro-branco (*Polyphagotarsonemus latus*) é referido como uma das pragas da erva-mate (*Ilex paraguariensis*), importante cultura no sul do Brasil, e não havendo estudos sobre o seu controle na cultura da erva-mate, o presente trabalho objetivou caracterizar os danos e avaliar táticas de controle desta praga em mudas de erva-mate, em casa de vegetação. No experimento 1, as mudas de erva-mate foram divididas em dois grupos com 50 mudas cada, divididas em 5 repetições. Num dos grupos as mudas foram infestadas artificialmente com ácaros provenientes de criação de laboratório. Semanalmente,durante 3 meses, as plantas foram avaliadas, observando-se alterações possivelmente relacionadas à presença dos ácaros. No segundo experimento, um grupo idêntico de mudas foi infestado pelo ácaro branco e 15 dias após aplicaram-se: a) acaricida à base de cihexatina, b) fungo *Hirsutella thompsonii* isolado CG 541 (1×10^6 conídios/mL), **c)** água destilada. Um quarto lote de plantas (d) foi mantido sem infestação, considerado testemunha absoluta. Foi realizada uma avaliação prévia e outra ao final do experimento, para contagem de ácaros em 10 folhas/repetição, determinação da altura e número de folhas/planta e peso seco médio de todas as plantas (final). Os ácaros se concentraram na face abaxial das folhas apicais e mais jovens, que apresentaram as bordas encarquilhadas, desenvolvimento desproporcional das nervuras, superfície áspera e bronzeamento. Também houve queda precoce das folhas. Não houve diferença no tamanho médio das plantas e número de folhas, mas houve redução de 30% da biomassa nas plantas infestadas e não tratadas e tratadas com fungo. O ácaro-branco causou danos às mudas em viveiros e o controle com acaricida reduz a população dos mesmos e diminui os danos.
Palavras-chave: ácaro, controle biológico, fungo entomopatogênico, controle químico.

INTRODUCTION

The mite studies in the Paraguay-tea (*Ilex paraguariensis* A.St.-Hil.) culture are limited in Brazil, being mentioned the species *Dichopelmus notus* Keifer and *Disela iliciola* Navia & Flechtmann (Acari: Eriophyidae); red mite (*Oligonychus yothersi* McGregor) and Texan mite *Eutetranychus banksi* McGregor (Acari: Tetranychidae); scarlet mite *Brevipalpus phoenicis* Geijskes and broad mite *Poliphagotarsonemus latus* Banks (acari: Tarsonemidae). Some of these species can cause damages at certain population levels (Santana *et al.* 1997, Alves *et al.* 2004, Ferla *et al.* 2005, Navia & Flechtmann 2005). There are still some population studies developed in Paraná (Gouvea *et al.* 2006) and in Santa Catarina (Vieira Neto *et al.* 2007), Brazil.

P. latus is a polyphagous specie, found in cotton, bean, soybean, avocado tree, Barbados cherry, rubber tree, citrus, papaya, passion fruit plant, Brazilian cherry, vine, potato, eggplant, bell pepper, tomato plant, some ornamental plants and yerba mate in Brazil (Moraes

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& Flechtmann 2008). Coll & Saini (1992) related its occurrence in Argentina, mainly in nurseries, where it is common to verify, in the infested plants, the silver and rough leaves. However, *P. latus* was not verified in the culture in Rio Grande do Sul State, Brazil yet (Ferla *et al.* 2005).

In spite of the inexistence of phytosanitary products registered for culture use (Agrofit 2010), it is known that many producers make applications of insecticides and mitecides registered for other pests or other cultures, worsening even more the situation. In Argentina, however, there are information about the population dynamics, and recommendation of chemical control, with dicofol and quinomethionate (Burtnik 2003).

The fungus *Hirsutella thompsonii* (Fischer) has great specificity for phytophagous mites, with its natural occurrence being registered in broad mite population (Cabrera *et al.*, 1987). After, Peña *et al.* (1996) proved, in laboratory, the fungus action on the broad mite, in bean plant leaves.

Considering the potential importance of broad mite *P. latus*, this work was carried out aiming to describe and to quantify the damages caused by the broad mite in yerba mate plants, as well as to evaluate strategies of control, in nurseries seedlings.

MATERIAL AND METHODS

Damage characterization

The experiment begun on April 1st, 1999 and was carried out in greenhouse, with yerba mate seedlings obtained from a commercial producer and planted in plastic vases with capacity of 5 L. Aiming to uniform the nutrition among the treatments, containing soil with organic material are treated weekly with nutritional Hoagland´s solution (Hoagland & Arnon 1938), based on KH_2PO_4 0.01%, KNO_3 0.05%, $Ca(NO_3)_2.5H_2O$ 0.05%, $MgSO_4.7H_2O$ 0.02%, complete micronutrients 0.01%, EDTA 0.01%. The height of the plants was measured on April 19, 1999 and the leaves number of all the experiment seedlings was counted.

The seedlings were divided in two groups, each one constituted by 50 seedlings, divided in five repetitions of ten seedlings. One batch was maintained without mites during the whole evaluation period and the other plants were infested artificially with broad mite *P. latus* provided from yerba mate nurseries, disposing the infested leaves over the seedlings. Infested plant and non infested plants were maintained in a green house, under natural variation of temperature and photoperiod, and covered with voil to avoid the mite movement between plants. For three months, the plants were evaluated weekly, being observed and notes were taken for any alterations that could be related to the mites presence.

Evaluation of control tactics

Another group, containing 50 plants equally divided in five repetitions with ten10 plants for each treatment was constituted, just as described previously, however, 15 days after the infestation, each group randomized received the following treatments: a) mitecide based on cyhexathin (0.5 g/L), b) seedlings treated with isolated *Hirsutella thompsonii* fungus CG 541 (10^6 conidia/mL), c) seedlings treated with distilled water. The control treatment (d) was not infested and, consequently, it did not receive any treatment. The fungus was produced in complete growing culture (0.36 g of KH_2PO_4, 1.05 g of $NaHPO_4.7H_2O$, 0.60 g of $MgSO_4.7H_2O$, 1.0 g of KCl, 10.0 g of glucosis, 5 g of yeast extract, 20 g of agar, 1 L of distilled water) sterilized in autoclave at 120°C for 20 min (Alves *et al.* 1998). After the fungus inoculation, the Petri dishes were maintained for 10 days in acclimatized camera (26±0.5 °C. 12 h of photophase) for growth and conidia production.

The application was repeated biweekly, with knapsack sprayer, using volume enough to wet the plants until the flowing point (approximately 3 mL). Previously to the first application, the population average was evaluated, by counting the mites number on 10 leaves/repetition with a magnifying glass (10×), as well as the height and number of leaves in each plant was determined.

In the last evaluation, after 90 days, the height of the plants was measured again, as well as the number of leaves and the medium number of mites for leaves was determined. Besides, the aerial part of all the plants was collected and spread uniformly in a stove at 70 °C and maintained for 48 h approximately to obtain the dry weight biomass of each treatment (gravimetric method).

The experiments were carried out as a completely randomized experimental design, with treatments arranged in split plot scheme, with to two periods of evaluation and four treatments with 5 and 4 replications, respectively to first and second experiment. Data were transformed before to $\sqrt{x+1}$ and media were compared by the Tukey test at 5% probability using SISVAR statistical package (Ferreira 2004).

RESULTS AND DISCUSSION

Characterization of the damages

The presence of broad mite is usually noticed only when the attack symptoms begin to appear due individuals reduced size. It was verified that the mites concentrate in the abaxial surface of the youngest and edge leaves, being rarely observed in the medium or oldest leaves. After a week of the infestation the leaf margins were down curled (Fig. 1A), due to the epidermis thickening, and later the veins grew disproportionally, just as observed in other cultures attacked by the broad mite, as cotton, coffee, citrus, sweet pepper, nettlespurge, aubergine, among other cultures (Cross & Basset 1982, Silva *et al.* 1998, Kavitha *et al.* 2007, Moraes & Flechtmann 2008). The deformed leaves have interrupted growth (Fig. 1B) and when do not fall early, they stay on the plant with

Figure 1. Effects of the broad mite on *Ilex paraguariensis*. A. Infested leaves margins down curled. B. Difference on growth of infested (left) and non infested plant (right). C. Infested leaf on the plant with coriaceous aspect, with the abaxial surface presenting rough aspect and lightly tan coloration. D. Infested plant with medium (center) and low leaves (right).

coriaceous aspect, with the abaxial surface presenting rough aspect and lightly tan coloration (Fig. 1C). Besides, the most infested plants remained only with the medium and low leaves and with the whole superior extract presenting only the branches with few and small leaves in the tips (Fig. 1D).

However, other species of mites that infest Paraguay-tea plants, as *D. notus* and *O. yothersi* present preference for ripe leaves (Gouvea *et al.* 2006). This behavior is attributed to the high saponin concentration in the young leaves from plant of the genus *Ilex*, and that until the ripening is reduced making possible the mites colonization, just as observed for the mite *O. ilicis* (McGregor) (Potter & Kimmerer 1989). Therefore, it is probable that the broad mite have physiologic mechanisms to metabolize the toxicant components.

Specifically in relation to the Paraguay-tea, similar study was accomplished with the red mite *O. yothersi*, in which was verified the sequence of the symptomatic evolution of the damages caused by the mite, that culminated in the delayed of the leaf development and also precocious leaves fall (Alves *et al.* 2004).

Evaluation of control tactics

It was verified that, although there were differences in the medium size of the plants before the application (13.4 cm for the plants of the fungus treatment and 10.7 for the infested plants and without control), at the end of the evaluation period there was not difference among the treatments (Table 1). In relation to the number of leaves in the plants, the same was observed, however, the attacked plants began to recover about two weeks after the application of the mitecide, not recovering of the already deformed leaves, but, growing new leaves.

The mites caused reduction in the biomass of the infested plants and just treated with water, when compared to the not infested plants and/or treated with the mitecide. The dry weight of the plants treated with mitecide did not differ statistically of the value obtained on the plants not infested with the mite (2.2 and 2.0 g, respectively), however, it was significantly larger than the obtained in the seedlings treated with fungus and water, where occurred reduction of approximately 30% in the dry weight.

Considering that the Paraguay-tea production is measured by weight of green mass, the reduction of the biomass is a great indicative of the damages caused by the broad mite, and by other species, like *O. yothersi* which damages culminate in the delayed of the leaf development and also precocious leaves fall (Alves *et al.* 2004). These evidences show that the mites constitute

Table 1. Morphometric parameters of yerba mate plants (*Ilex paraguariensis*) infested with broad mite (*Polyphagotarsonemus latus*), with and without treatment in greenhouse, before and 90 days after application.

Treatment	Plants Height (cm)		Number of leaves		Dry Weight(g)
	Begin	End	Begin	End	
CG541	13,4±1,14aB	15,6±1,35aA	9,5±0,65aA	9,6±0,9aA	1,5±0,15b
Water	10,7±0,89bB	15,3±1,28aA	7,1±0,65bB	10,1±0,71aA	1,6±0,08b
Cyhexathin	11,7±0,89abB	15,8±1,3aA	7,7±0,74bB	10,1±0,81aA	2,2±0,16a
Control	11,8±0,76abB	17,6±1,11aA	9,6±0,45aA	10,4±0,55aA	2,0±0,14ab

Numbers (± EP) followed by the same small letter in the column and capital letter in the line for each one of the parameters of the plant do not differ significantly using Tukey test (P < 0,05).
Presented original numbers, for statistical analysis were transformed in $\sqrt{x+1}$.

one of the important component of the losses associated to the pests in the Paraguay-tea culture.

This justifies the need to control it, still in the nurseries, to avoid its massive dissemination in the plantations and reach the status of severe pest. Also, it should be avoided that the infested seedlings and with vigor alterations are introduced in the cultivation areas, leading to irregular and heterogeneous plantation, demanding such plants substitution.

In relation to the mites number, significant elevation was verified in the infested plants and that were treated with water pulverization, with verification reaching 13.4 mites/leaf (elevation of four times), while in the plants treated with the mitecide, the initial population that was of 4.5 mites/leaf, it was reduced to zero. The treatment with fungus reduced the population significantly resembling to the chemical treatment (Table 2).

Despite of the fungus treatment was not so efficient as the mitecide in relation to the population reduction, it is highlighted that there was not this same tendency in relation to the dry weight. This may occur because the action of the mitecide was fast, so the application of the product eliminated the mites and made the plants recover it selves, emitting new leaves. This way, it becomes evident that the control with the fungus should be implemented at beginning, before the mite damages get very severe.

Besides, also should be considered that if the fungus did not reduce the broad mite population, at least it did not allow its increase, because there was not difference from the first to the last evaluation. Therefore, it can be reducing the reproductive "fitness" of the species, although studies to confirm this action are necessary, since there is not, until the moment, studies about the mite biotic potential (including information about the longevity, number of generations, reason of population growth, etc.) in the Paraguay-tea culture, just as already accomplished for this mite species, in other cultures, as vine, sweet pepper, lemon, among other cultures of economical importance (Vieira & Chiavegato, 1999; Echer *et al.*, 2002, Ferreira *et al.*, 2006).

Table 2. Medium number of broad mite (*Polyphagotarsonemus latus*) in the yerba mate plants (*Ilex paraguariensis*) with and without treatment in greenhouse, before and 90 days after application.

Treatment	Number of mites	
	Begin	End
CG541	3,3±1,51aA	2,0±1,12bA
Water	3,1±0,74aB	13,4±3,89aA
Cyhexathin	4,5±0,93aA	0,0±0,00bB
Control	0,0±0,00aa	0,0±0,00bA

Numbers (± EP) followed for the same small letter in the column and capital letter in the line do not differ significantly using Tukey test (P <0,05).
Presented original numbers, for statistical analysis were transformed in $\sqrt{x+1}$.

Although until today there is no technical recommendation of chemical pesticide application in Paraguay-tea, it should be think about the practicality aspects and economy in the controlled and rational use of these products in commercial nurseries, where the phytosanitary control is essential. It is pointed out that the recovery of the plants after the treatment proves the efficiency of the method, in spite of the tested mitecide to be considered as high toxicity and dangerous in the environmental point of view, if safety's norms be followed, it can be safe, besides efficient (Agrofit 2010), what does not invalidate the research of control with the fungus *H. thompsonii* that was also shown efficient.

Considering the loss of 30% of biomass due to the mites, new studies should be led seeking to estimate the damages caused by the mite in adult plants and in field, as well as to evaluate potential control strategies, including the entomopathogenics fungi, vegetable extracts, behavior in relation to different yerba mate progenies and predators, just as accomplished for other yerba mate mites (Pasini *et al.* 2003, Oliveira *et al.* 2004, Ferla *et al.* 2005, Gouvea *et al.* 2006, Alves *et al.* 2007).

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