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Scientific Note

Tetranychus ludeni Zacher, 1913 (Tetranychidae) and *Phytoseiulus macropilis* (Banks, 1904) (Phytoseiidae) in apple trees grown in a greenhouse in southern Brazil: injuries and control

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Abstract. This study reports the presence and injuries caused by *Tetranychus ludeni* Zacher, 1913 (Acari: Tetranychidae) on apple tree seedlings (*Malus domestica* Borkh: Rosaceae) in nurseries in southern Brazil. The ability of the predatory mite of *Phytoseiulus macropilis* (Banks, 1904) (Acari: Phytoseiidae) to control *T. ludeni* infestations in this environment was also evaluated. *Tetranychus ludeni* infestation was observed during routine monitoring at the Acarology Laboratory of the University of Vale do Taquari - Univates, Lajeado, Rio Grande do Sul. Injuries were observed on the leaves, with gradual growth linked to the population increase of *T. ludeni*. In the control seedlings, there was defoliation and weakening of the plant. *Phytoseiulus macropilis* released on infested plants controlled the populations of this phytophagous mite. Fifty specimens of *P. macropilis* were released in each seedling. *Tetranychus ludeni* caused injuries to apple seedlings, while *P. macropilis* proved to be efficient in controlling this phytophagous mite.

Keywords: Agroecology, Biological control, Plant health, *Malus domestica.*

Brazil is among the largest apple producers in the world and has been growing in the foreign market through the advancement of exports to several countries (Kist 2019). Brazilian apple production is mainly concentrated in the southern region of the country, due to the favorable environment for culture (Kist 2019). Among the main problems of this crop in Brazil are mite infestations, such as those of *Panonychus ulmi* (Koch, 1836) (Acari: Tetranychidae) that reach high populations, causing injuries and damage (Ferla & Moraes 1998; Monteiro 2002; Silva et al. 2022). In addition, the occurrence of *Aculus schlechtendali* (Nalepa, 1890) (Acari: Eriophyidae) and *Tetranychus ludeni* Zacher, 1913 (Acari: Tetranychidae) has been reported, however, with no record of economic damage (Flechtmann 1996; Ferla et al. 2018; Nascimento et al. 2020). Changes in agroecosystems and the indiscriminate use of chemicals in apple crops favor the population increase of phytophagous mites, as they reduce the presence of natural enemies (Lorenzato & Secchi 1993; Schmidt-Jeffris & Beers 2018).

Tetranychus ludeni is associated with more than 300 species of plants, some of which are of economic importance, such as carrots, beans, eggplant, pumpkin and papaya (Zhang 2003; Gotoh et al. 2015). It preferentially attacks the apical and median leaves of the plants, using their stylets to pierce the epidermis and suck the cellular contents (Moraes & Flechtmann 2008). In Brazil, *T. ludeni* can occur in high populations in several crops, such as cotton, soybeans and beans, causing injuries and damages (Moraes & Flechtmann 2008; Mendonça et al. 2011; Reichert et al. 2014; Reichert et al. 2016). At temperatures close to 30 °C, there is an increase in reproduction and fecundity, raising populations to the level of injuries (Silva 2002; Gotoh et al. 2015). Gotoh et al. (2015) suggested that because *T. ludeni* is well adapted to warmer climates, it could displace *Tetranychus urticae* Koch, 1836 (Acari: Tetranychidae) in some crops, and become one of the main agricultural pests in the world. In apple trees, so far, there is only one occurrence reported by Flechtmann (1996) in the Country of Porto Alegre, state of Rio Grande do Sul.

Phytoseiidae are widely distributed worldwide, and some species are recognized as important natural enemies used in programs of applied biological control of phytophagous mites (Sato et al. 2007; McMurtry et al. 2013). Species of the genus *Phytoseiulus* Evans, 1952, are specialist predators (Group Ia) that feed specifically on spider mites of the genus *Tetranychus* (McMurtry & Croft 1997; McMurtry et al. 2013). Studies demonstrated the potential of *Phytoseiulus macropilis* (Banks, 1904) (Acari: Phytoseiidae) to control *T. urticae* in strawberries (Ferla et al. 2007), tomato (Sato et al. 2011) and soybean (Reichert et al. 2014; Rezende et al. 2014). Lorenzato & Secchi (1993) reported the presence of *P. macropilis* in apple trees.

There are few studies about *T. ludeni* associated with apples and no reference to injuries caused by this mite species in adult plants or apple tree seedlings. Thus, this study aims to record the presence and injuries caused by *T. ludeni* in apple tree seedlings in nurseries in southern Brazil, as well as to evaluate the ability of the predatory mite *P. macropilis* to control infestations in this environment.

Apple tree seedlings were acquired from a commercial nursery in the municipality of Lajeado, state of Rio Grande do Sul, Brazil. The plants were kept in a greenhouse in black plastic pots (11 L) containing organic compost and soil, irrigated every three days and kept isolated to be used in a laboratory experiment. Natural infestations of *T. ludeni* were observed on 20 apple plants of the Gala cultivar, seedlings, during routine monitoring. Infested leaves were collected and triaged for specimen identification at the Acarology Laboratory of the University of Vale do Taquari - Univates (Labacari), Lajeado, Rio Grande do Sul. The collected mites were mounted on microscope slides with Hoyer's medium and taken to a drying kiln at a temperature between 50-60 °C and kept for seven days. The identification was carried out at Labacari using an Optical Microscope with phases contrast - (Zeiss Imager Z2) and dichotomous key (Baker & Turtle 1994). Specimens were deposited in the reference collection of the Laboratory of Acarology at Univates (ZAUMCN).

The stock rearing of *P. macropilis* was established in bean trays (*Phaseoulus vulgaris* L.: Fabaceae) and the mites fed with *T. urticae* under laboratory conditions (25±1 °C temperature, 12 hours of photophase and 70±5% of relative humidity) during the evaluation

period.

Fifty stock rearing predatory mites were released per plant, with the aid of a fine-tipped brush, one month after recording the presence of *T. ludeni* on the seedlings. Two seedlings were kept isolated and without the presence of the predator. The seedlings were kept isolated in a greenhouse during the evaluation period of *P. macropilis* populations feeding on *T. ludeni*. Every week, two leaves were taken from each plant to evaluate the populations of phytophagous and predatory mites under a stereoscopic microscope (40×). The experiment finished in one month, when no phytophagous mites were observed.

This is the first record of *T. ludeni* causing injuries to apple seedlings in a commercial nursery in Rio Grande do Sul (Fig. 1). *Tetranychus ludeni* is not considered a species of economic importance in apple crops (Ferla et al. 2018; Nascimento et al. 2020), and has been reported only once before infesting apples in Brazil (Flechtmann 1996).

Tetranychus ludeni was observed for the first time in January, a period of high temperatures that favored the survival of this mite (Silva 2002; Gotoh et al. 2015). Initially the occurrence was in the oldest leaves, and soon it spread throughout the plant, including the apical leaves, as in other cultures (Silva 2002). After a week, the first signs of injuries, formation and rapid growth of the web were recorded, in addition to considerable population growth. In the first evaluation, an average of 10 mites/leaf were observed and, after three weeks, the populations reached 40 mites/leaf. The observed injuries were similar to those caused by other phytophagous species of economic importance in the crop (Lorenzato 1988; Silva 2002; Moraes & Flechtmann 2008). The adaxial surface of the leaves showed darkening and reddish spots characteristic of leaf tanning (Fig. 2). With the population increase, the entire plant was colonized, and the leaves showed injuries that increased levels gradually. The behavior of *T. ludeni* on apple seedlings was similar to that observed by Silva (2002) on cotton leaves where the species is already established.

One week after the release of *P. macropilis*, it was possible to notice the frequent presence of populations of the predator, with an average of six predatory mites/leaf. In one month, 18 mites/leaves were already observed. As well as the considerable decrease of phytophagous mites

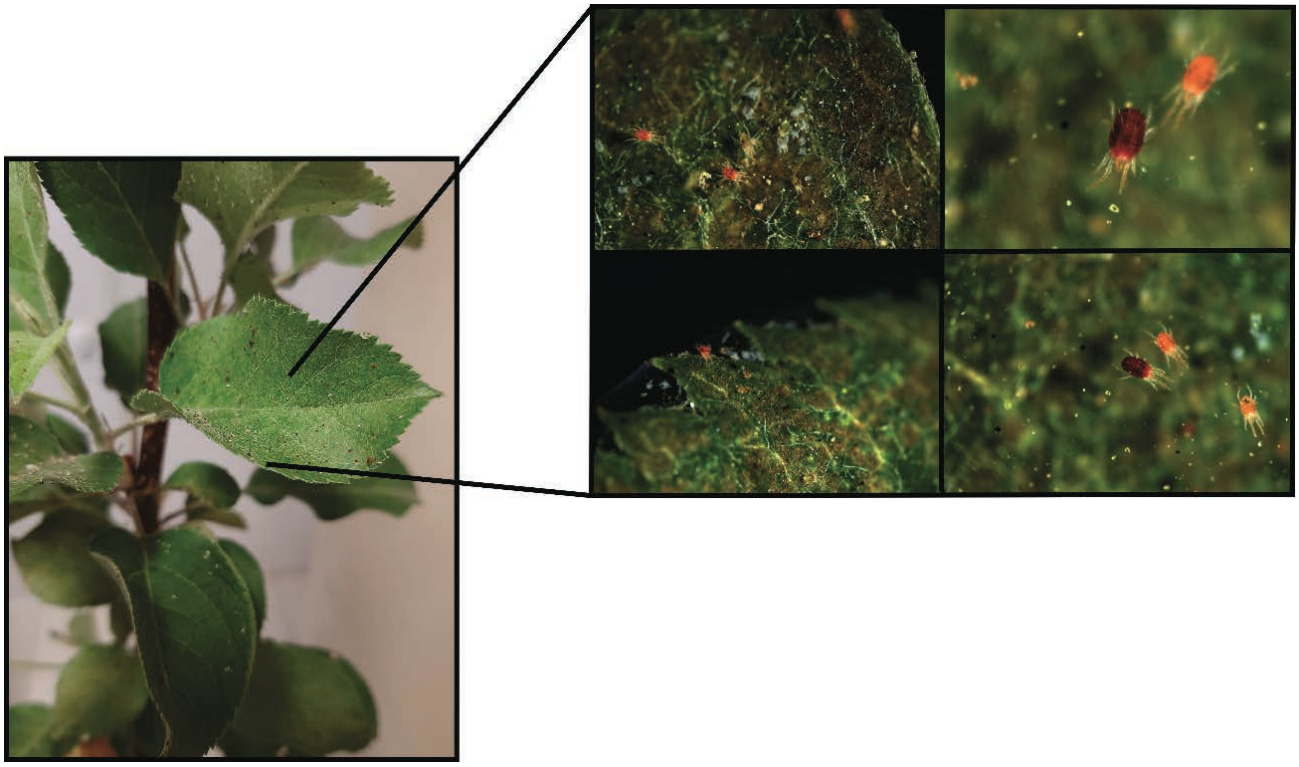

Figure 1. Apple tree leaves showing injuries caused by *Tetranychus ludeni* Zacher, 1913 (Acari: Tetranychidae).

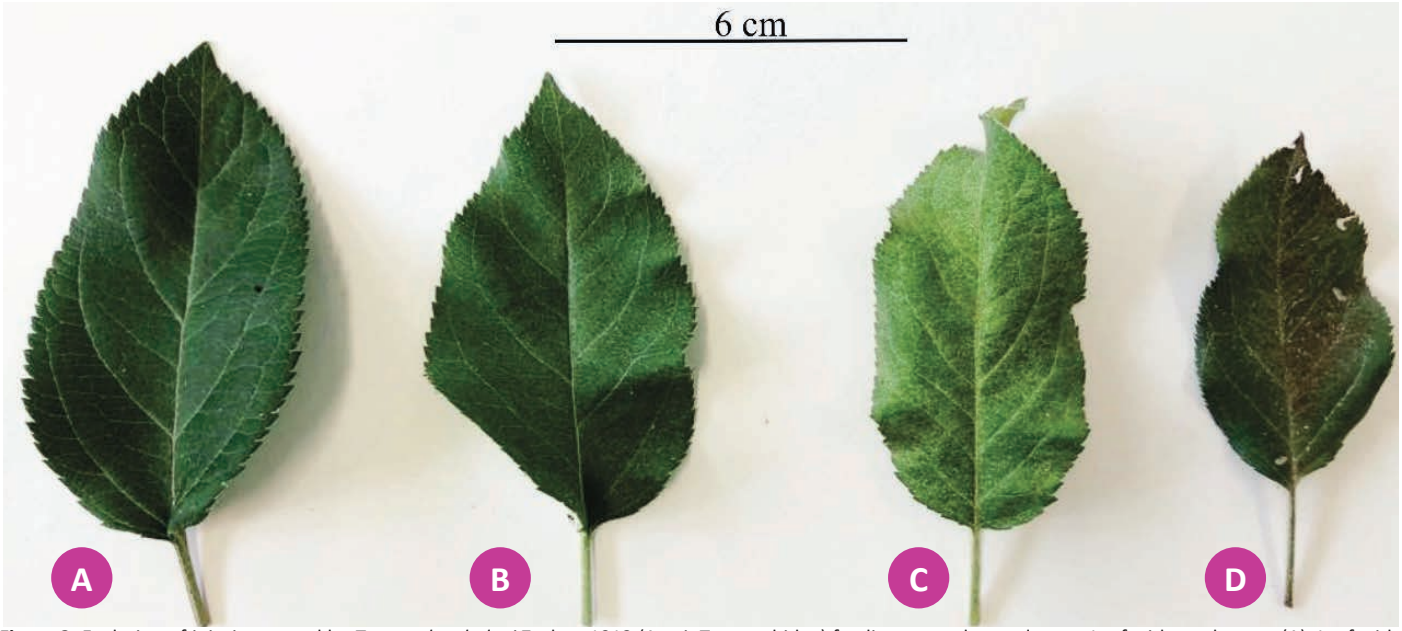

Figure 2. Evolution of injuries caused by *Tetranychus ludeni* Zacher, 1913 (Acari: Tetranychidae) feeding on apple tree leaves. Leaf without damage (A); Leaf with injuries (B); Leaf with initial damage (C); Damaged sheet (D).

that quickly had their populations controlled until the disappearance of all specimens, in the fourth week. The control plants showed a progressive increase in *T. ludeni* and injuries populations, reaching a high level of injuries. After four weeks, defoliation and weakening of the plant were observed.

The report of the occurrence of *T. ludeni* causing injuries to seedlings of apple trees serves as a warning to nurseries and growers because it is a species that in several cultures is already considered of economic importance. In addition, these results suggest *P. macropilis* as a possible controller of *T. ludeni* populations in apple trees. From the present record, it is important that further studies are carried out to investigate the occurrence of *T. ludeni* in apple trees, considering its potential as a possible cause of economic damage in situations where populations reach commercial apple orchards. In addition, it is interesting to investigate the potential of *P. macropilis* as a candidate for controlling *T. ludeni* populations in apple plants, which could serve as an alternative to prevent future problems that producers may face due to the emergence of *T. ludeni* in apple trees.

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Authors' Contributions

PAR with the cultivation and maintenance of apple tree seedlings. WBW with mite identification and photographic record. PAR and WBW with the monitoring of infestations and writing of manuscript; NJF with manuscript revisions and major revisions.

Conflict of Interest Statement

The authors declare no conflict of interest.

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