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Can We Use the Predatory Mites against the Invasive Bamboo Pest Spider Mites?

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Two invasive spider mite species (*Stigmaeopsis nanjingensis* Ma and Yuan, 1980 and *Schizotetranychus bambusae* Reck, 1941) were spotted on bamboo collections in Hungary. The possibilities of biological control were investigated on these mites with two different predatory mite species (*Phytoseiulus persimilis* Athias-Henriot, 1957 and *Hypoaspis miles* Berlese, 1892 [*Stratiolaelaps scimitus* Womersley, 1956]). The species *Phytoseiulus persimilis* consumed larger amount of *S. bambusae* mites than *Stratiolaelaps scimitus* mites and none of the predatory mite species could consume the *S. nanjingensis* species with its special nets.

Keywords: Biological control, Tetranychidae, Phytoseiidae, *Stigmaeopsis nanjingensis, Schizotetranychus bambusae*, *Phytoseiulus persimilis*, *Stratiolaelaps scimitus*.

The different species, subspecies and varieties of bamboo are non-native plants in Hungary, however, they are grown in many places (Kontschán et al., 2014). These are fast-growing, versatile plants and they are mostly planted as ornamental plants in Hungary, as in the rest of Europe (Kleinhenz and Midmore, 2001). Over the past few years, intensive acarological studies were focused on bamboo associated mites in Hungary (Kontschán and Neményi, 2013; Kontschán et al., 2014, 2015; Ripka, 1998, 2011; Ripka and Kaźmierski, 1998; Ripka et al., 2005, 2013, 2015) but our knowledge about it is still insufficient.

Schizotetranychus bambusae Reck, 1941 and *Stigmaeopsis najingensis* Ma and Yuan, 1980 are non-native, invasive spider mite species in Hungary. *S. bambusae* was found on a *Phyllostachys sulphurea* f. *sulphurea* bamboo in November 2013, ELTE Botanical Garden (Kontschán et al., 2014). *S. nanjingensis* was discovered in July 2013 on the leaves of *Phyllostachys aurea* planted in a public area near the Plant Protection Institute of Hungarian Academy of Sciences (Kontschán and Neményi, 2013). The damage caused by *S. nanjingensis* are white-yellowish round or oval patches on the leaf surface (Pelizzari and Duso, 2009) and the leaves sucked by *S. bambusae* are with brown spots. *S. bambusae* forms loose webs, meanwhile *S. nanjingensis* makes dense webs (Zhang et al., 2000). *Typhlodromus bambusae* Ehara, 1964 predatory mite is the only known natural

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enemy of *S. nanjingensis* which is able to crawl under their nets (Zhang et al., 1999) and it plays a large role in the biological control against this species (Pelizzari and Duso, 2009).

Phytoseiid predatory mites are the most important natural enemies of phytophagous mites (McMurtry, 1997) and these are the most commonly used species for biological control (McMurtry, 2010). The *Phytoseiulus persimilis* predatory mite specializes in the family Tetranychidae. *P. persimilis* is a selective predator and it is able to quickly reduce the number of spider mites (Walzer and Schausberger, 1999). However they only provide short-term protection (Walzer and Schausberger, 1999), thus they are often combined with other predatory mites (McPartland et al., 2000). This species has been used successfully for biological control in greenhouses and on the field, ever since the 1960s (Spollen and Isman, 1996).

Hypoaspis miles and *Stratiolaelaps scimitus* are often confused with each other. We cannot be sure which species can be found in the commercially available products, because the identification of the two species requires experience. *S. scimitus* is a fast-moving predatory mite that lives on the surface of the ground, but they are able to climb up onto plants (Kontschán and Ács, 2014).

In the biological tests we wanted to examine if there was a difference between *Phytoseiulus persimilis* and *Stratiolaelaps scimitus* predatory mites in the consumption of *Stigmaeopsis nanjingensis* and *Schizotetranychus bambusae* spider mite species. Also they wove two differently structured webs, thus we wanted to see if the webs have any influence on the predatory mites manner.

Materials and Methods

The experiments were carried out with two different invasive spider mite species (*Schizotetranychus bambusae* and *Stigmaeopsis nanjingensis*) and two commercially available predatory mite species (*Phytoseiulus persimilis* and *Hypoaspis miles*). After the study of the *Hypoaspis miles* specimens it was proven to be an entirely different species, namely *Stratiolaelaps scimitus*. Only female adult specimens were used from both predatory mites.

The used bamboo leaves originated from bamboo collections of Szent István University Arboretum, Budapest, Szent István University Botanic garden, Gödöllő and ELTE Botanic garden, Budapest. The collected leaves were placed in plastic bags which were transported to the lab. The test was carried out under laboratory conditions.

The 1×3 cm pieces were cut from the collected leaves. During the experiment two different cases were set up. In the first case these leaf pieces were cut from non damaged leaves and in the second case from damaged leaves (with the mites and the mite's webs on them). These leaves were placed underside up on a wet cotton pad (3×5 cm) in a Petri dish. The Petri dish was filled with water to the top of the cotton wool. The wet cotton pad prevented the mites from escaping and kept the leaf fresh as well. In the first case 8 spider mites were transferred onto the leaf pieces. During one experiment 13 repetitions were made. In 10 Petri dishes 1–1 predatory mite was placed next to the spider mites. The control group was the remaining 3. The second method was marked with "W" (Web) written after the spider mite's name. In the experiment both predators were used against both spider mites.

The surviving mite specimens were counted for three days from the initial state. During the experiment the presence of the predatory mite was always provided. The results of the experiment were compared using Student's *t*-tests.

Results

The average of the predated specimens of the control and treated repetitions were compared with each other in the first test. There was a strong correlation between the days and the average number of dead specimens.

There were significant differences between control and treated examinations (without a net) in the case of *P. persimilis – S. bambusae* (P value = 0.0108), *P. persimilis – S. nanjingensis* (P value = 0.00002) and *S. scimitus – S. nanjingensis* (P value = 0.0094). In these cases we can talk about actual predation on the spider mites. However *S. scimitus – S. bambusae*'s consumption rate is not significantly different from the control group (P value = 0.1051) (Fig. 1).

In the repetitions using the second method (with webs on the leaves) only the *P. persimilis – S. bambusae* (W) was significantly different (P value = 0.0118). In the data of *P. persimilis – S. nanjingensis* (W) there was no difference. *P. persimilis* predatory

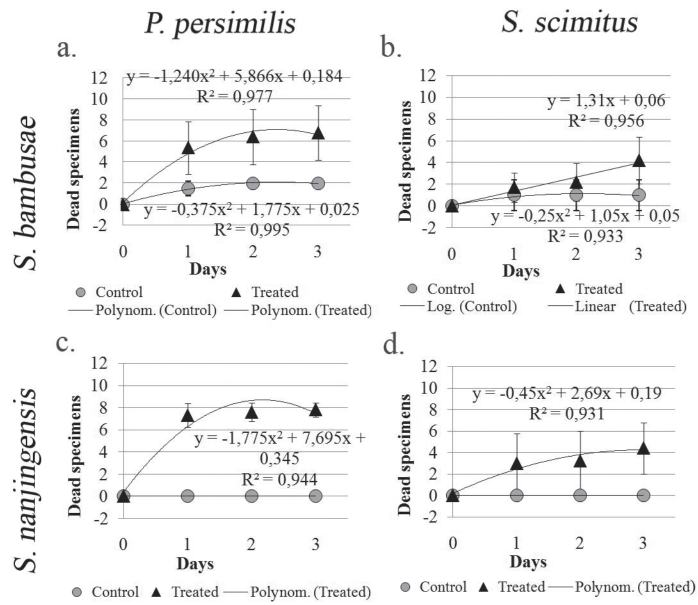

Fig. 1. Differences in control and treated groups (leaves without web). Pairings: a. *S. bambusae* and *P. persimilis*; b. *S. bambusae* and *S. scimitus*; c. *S. nanjingensis* and P. *persimilis*; d. *S. nanjingensis* and *S. scimitus*

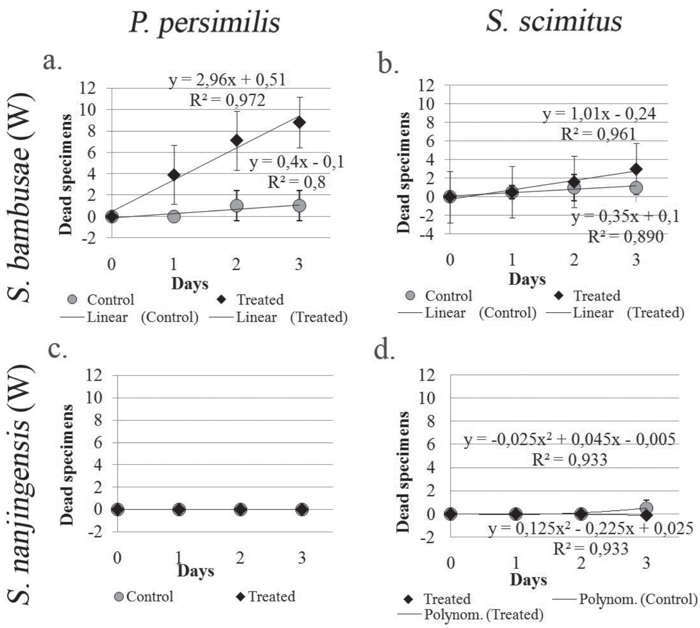

Fig. 2. Differences in control and treated groups (W = leaves with web). Pairings: a. *S. bambusae* (W) and *P. persimilis*; b. *S. bambusae* (W) and *S. scimitus*; c. *S. nanjingensis* (W) and *P. persimilis*; d. *S. nanjingensis* (W) and *S. scimitus*

mites were not able to consume the *S. nanjingensis* spider mites due to the protection of their dense webs (Fig. 2).

P. persimilis consumed an average of 8 individual spider mites of *S. bambusae*, *S. bambusae* (W) and *S. nanjingensis*. An exception is *S. nanjingensis* (W) where the predatory mite could not consume the prey underneath their nets. There was no significant difference in the mortality rate of *S. bambusae* and *S. nanjingensis*. In the experiments *S. scimitus* consumed an average of 4 specimens from each spider mite species except *S. nanjingensis* (W).

Both of the predators consumed a similar amount of *S. bambusae* spider mites, with or without the web. *P. persimilis* consumed significantly larger amount of *S. bambusae* specimens (Fig. 3).

P. persimilis attacked significantly more *S. nanjingensis* specimens (without their web) than the *S. scimitus,* however, none of the predatory mite species were able to reach them under their nets (Fig. 4).

Discussion

In Hungary only two tetranychid mite species have been found on bamboo taxa: *Stigmaeopsis nanjingensis* and *Schizotetranychus bambusae*. Both species are non-native

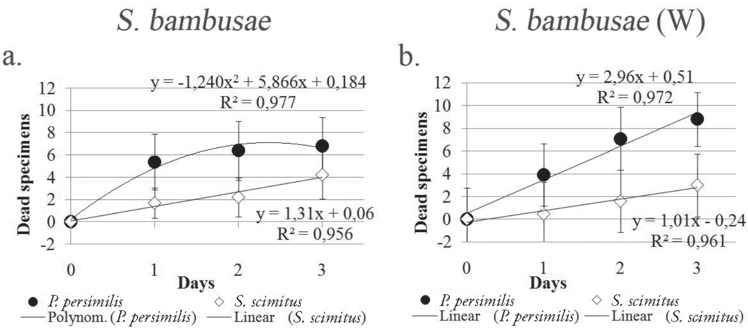

Fig. 3. Consumption comparison between *P. persimilis* and *S. scimitus* on: a. *S. bambusae*; b. *S. bambusae* (W = leaves with web)

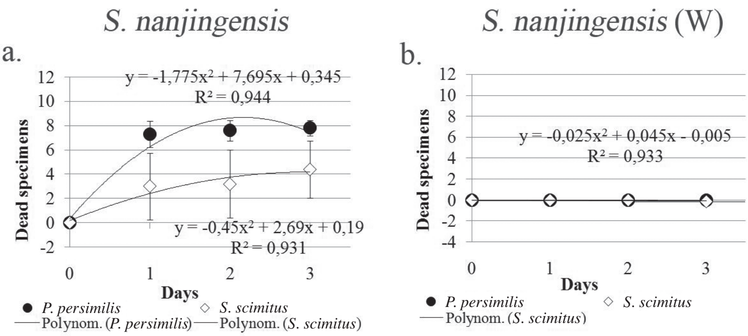

Fig. 4. Consumption comparison between *P. persimilis* and *S. scimitus* on: a. *S. nanjingensis;* b. *S. nanjingensis* (W = leaves with web)

pests introduced by human transport from East Asia. Based on the biological control test both of the commercially available predatory mites (*Phytoseiulus persimilis* and *Stratiolaelaps scimitus*) were able to consume the spider mites without their webs in laboratory conditions. However, *P. persimilis* consumed twice as much spider mites than the other predator.

The web of *S. bambusae* did not inhibit the predator activity. On the other hand, the predatory mites were unable to break through or crawl under the tightly woven web of *S. nanjingensis* species. The only known natural enemy of *S. nanjingensis* is the predatory mite *Typhlodromus bambusae* which is able to crawl under their net and destroy the mites in it (Zhang et al., 1999).

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