Ph.D. thesis

Environmentally friendly regulation of harmful phytophagous mite populations on horticultural plants

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I. A KUTATÓMUNKA ELŐZMÉNYEI, CÉLKITŰZÉSEK

The geographical features of Hungary, the excellent growing areas of the country and the ideal climatic conditions for the production create the possibility for the realization of high-quality crop production. The crop production is inconceivable without reasonable and sustainable crop protection. The sustainable plant protection technologies have the least impact on the environment. To achieve this goal it is necessary to carry out researches in the field of the environment-friendly integrated pest management approach.

During my researches the role of predatory mites in limiting the number of phytophagous mite populations on horticultural crops had been studied in Soroksár Research Station of Corvinus University of Budapest. The aims of this study were to identify the phytophagous mite species occurring in evergreen coniferous trees, to observe the phytophagous and the zoophagous mite population dynamics and to study the relations between the number of mite species and the biotic and abiotic factors. During my examination I was also studying the movement of mite between the older fruit orchards and a newly planted apple orchard.

During my examination the following research questions were developed:

- Based on the pesticide treatments, which predatory mite species occur in evergreen coniferous trees?

- What kind of population dynamics is observed of the phytophagous and the zoophagous mite in the evergreen plantations?
- Are there any measurable effects between the number of predatory mites and some abiotic and biotic factors under open field conditions?
- Is the colonisation of a newly planted apple orchard possible by phytoseiid mites from the neighbouring older orchards?
- How long does the colonisation by phytoseiid mites take of a newly planted apple orchard from the neighbouring older orchards?
- Is there any difference in the colonisation dynamics of various predatory mite species?
- How does the predatory mite species composition change in the following years after the colonization?

II. MATERIALS AND METHOD

Examinations in evergreen ornamental collections

The phytoseiid mite populations had been studied in unsprayed (Soroksár Research Station of Corvinus University of Budapest) and in sprayed evergreen ornamental collection (Ajka-Bódé, County Veszprem) in Hungary between 2010 and 2012. In the unsprayed plantation 25 evergreen taxons had been examined in the genus Juniperus, Abies, Picea Pinus, Thuja, Taxus, Cupressus, Chamaecyparis and Taxodium. In the sprayed plantation 24 evergreen taxons had been examined in the genus Larix, Metasequoia, Taxodium, Abies, Cedrus, Chamaecyparis, Cupressocyparis, Cupressus, Juniperus, Picea, Pinus, Sequiadendron, Taxus and Thuja. In the unsprayed plantation shoot samples had been taken monthly from March 2010 to February 2012, and in the sprayed plantation from October 2010 to November 2011. In the dormancy period mites were extracted from the shoots with the Berlese-Tullgren funnel. In the growing season mites were extracted from the shoots with the washing method of Zachadra.

Examinations in fruit orchards

The colonisation of a newly planted apple orchard by phytoseiid mite species from the neighbouring older orchards were studied in Soroksár Research Station of Corvinus University of Budapest between 2010 and

2012. The young apple orchard was planted in 2009. The young apple orchard was bounded from southwest and northeast by older apple orchards, from northwest by cherry orchards and from southeast by plum orchards. 46 examination plots were identified in the studied area. From each sampling 10 leaves had been taken per plots from April 2010 to September 2010, from April 2011 to August 2011 and from May 2012 to September 2012. Mites were extracted from the leaves with the washing method of Zachadra.

During the time of my examination 24 "soil" and 22 "air" traps were used to determine whether the mite species are able to immigrate passively into the newly planted apple orchard by using wind and which mite species are able to immigrate actively into the orchard by crawling on the ground. The catches of the traps were checked weekly from June 2010 to September 2010 and from April 2011 to August 2011.

III. RESULTS

Examinations in evergreen ornamental collections

During the time of my examination eight predatory mite species have been identified on evergreen coniferous trees, namely *Amblyseius andersoni, Amblyseius tenuis*, *Anthoseius bakeri, Anthoseius involutus, Typhlodromus baccettii, Typhlodromus bichaetae, Typhlodromus pyri* and *Typhlodromus ernesti* belonging to the Phytoseiidae family.

In the evergreen plantations there was a strong linear correlation between the number of phytophagous and the

zoophagous mites. In the unsprayed evergreen plantation there was a correlation between the number of phytophagous mites and the effective temperature. In the sprayed evergreen plantation there was no correlation. The phytoseiids were much more numerous in the unsprayed trees and in the unsprayed plantation more phytoseiid species were present. However the difference in the number of phytophagous mites was not significant between the unsprayed and in the sprayed evergreen plantation. The evergreen plants were more injured by mite species from the family Tenuipalpidae then by mite species from the family Tetranychidae.

Examinations in fruit orchards

During the time of my three years long examination eight predatory mite species have been identified in fruit orchards. In the apple orchards seven predaceous mite species have been identified viz. *Amblyseius andersoni, Euseius finlandicus, Anthoseius occiduus, Kampimodromus aberrans, Paraseiulus triporus* belonging to the family Phytoseiidae and *Zetzellia mali* belonging to the family Stigmaeidae.

In the plum orchard eight zoophagous mite species have been identified viz. *Amblyseius andersoni, Euseius finlandicus, Anthoseius occiduus, Kampimodromus aberrans, Paraseiulus triporus*, *Phytoseius macropilis* and *Typhloseiulus simplex* belonging to the family Phytoseiidae, and *Zetzellia mali* belonging to the family Stigmaeidae.

In the cherry orchard four zoophagous mite species have been identified viz. *Amblyseius andersoni, Euseius finlandicus* and *Paraseiulus triporus* belonging to the

family Phytoseiidae and *Zetzellia mali* belonging to the family Stigmaeidae.

In the examined apple orchards during the three years the dominant zoophagous species were *Amblyseius andersoni* and *Zetzellia mali*, and the most significant phytophagous species was *Tetranychus urticae* (Tetranychidae). During my study I have examined the colonization dynamic of the newly planted apple orchard by these three dominant mite species.

In the first year the dominant species was the *Amblyseius andersoni* in the new-planted apple orchard but out of the two neighboring apple orchards just the northeastern apple orchard had *Amblyseius andersoni* as the most common mite species. In the southwest apple orchard the dominant mite species was *Zetzellia mali.*

In the second year of my examination the abundance and species diversity of phytophagous mites were almost the same in the three apple orchards. *Zetzellia mali* was the dominant species the in the second year in three apple orchards.

In the third year of my examination *Amblyseius andersoni* has become the dominant species in the apple orchards. During the three years the presence of *Tetranychus urticae* was not significant on the fruit trees.

During my study by using of aerial traps I have caught seven mites species, viz. *Amblyseius andersoni, Neoseiulus pepperi, Euseius finlandicus, Anthoseius occiduus* and *Neoseiulus subtilisetosus* belonging to the family Phytoseiidae, *Zetzellia mali* belonging to the family Stigmaeidae and *Tetranychus urticae* belonging to the family Tetranychidae.

The species *Amblyseius andersoni, Neoseiulus subtilisetosus, Amblyseius agrestis, Amblyseius graminis, Kampimodromus aberrans* and *Paraseiulus triporus* belonging to the family Phytoseiidae and *Tetranychus urticae* belonging to the family Tetranychidae were captured in soil traps.

IV. NEW SCIENTIFIC RESULTS

1. The dominance of *Amblyseius andersoni* on treated and untreated evergreen ornamental trees has been established.

2. *Amblyseius tenuis* and *Typhlodromus baccettii* have been collected from evergreen ornamental plants in Hungary for the first time and these are new records from Hungary.

3. It has been proved that the native predatory mites are able to colonize a newly planted orchard and these mites can play an effective role in limiting phytophagous mite populations damaging fruit trees.

4. It has been observed that *Zetzellia mali* is easily able to became the most abundant species in newly planted orchards but later *Amblyseius andersoni* is able to supplant the *Zetzellia mali* species from the orchards.

5. It has been proved with the help of aerial traps that *Amblyseius andersoni, Neoseiulus pepperi, Euseius finlandicus, Anthoseius occiduus* and *Neoseiulus*

subtilisetosus belonging to the family Phytoseiidae, *Zetzellia mali* belonging to the family Stigmaeidae, and *Tetranychus urticae* belonging to the family Tetranychidae are able to be dispersed by the wind, therefore they are able to travel over bigger distances.

6. It has been proved that *Amblyseius andersoni*, *Neoseiulus subtilisetosus*, *Amblyseius agrestis*, *Amblyseius graminis*, *Kampimodromus aberrans* and *Paraseiulus triporus* belonging to the family Phytoseiidae and *Tetranychus urticae* belonging to the family Tetranychidae species have ambulatory dispersal as they were captured in soil traps.

7. The occurrence of *Neoseiulus pepperi* and *Neoseiulus subtilisetosus* have been reported for the first time in Hungary.

V. DISCUSSION

The phytoseiid predatory mites have an outstanding importance in the regulation of the harmful mite populations on horticultural crops. The phytoseiid mites are widely occurred as a native predator on different crops. Due to their great species composition and relative abundance on undisturbed environmental area and hedgerows, it is assumed that the native predatory mites are able to colonise a newly planted orchard, and these mites can play an effective role in limiting phytophagous mite populations.

During my study, I have examined the colonisation dynamic of a newly planted apple orchard. The process of the colonisation by the phytophagous and the zoophagous mites was successful by the end of the first year. On the basis of the results it is assumed that, *Zetzellia mali* can adapt faster to the changing conditions, compared to the phytoseiid mites, so *Zetzellia mali* became easily the most abundant species in the examined apple orchards. I suppose that *Amblyseius andersoni* could build up its population slower than *Zetzellia mali* in the changing conditions, but after *Amblyseius andersoni* had built up its population it was able to supplant the *Zetzellia mali* species from the orchards.

During the three years the number of *Tetranychus urticae* did not occur in large numbers on the fruit trees. On the basis of these results predatory mites can diminish phytophagous mite populations damage on fruit trees. The *Zetzellia mali* preyed effectively the eggs of Tetranychus urticae and with particular of *Amblyseius andersoni* they

limited the populations of harmful mites in the orchards of Soroksár.

I was led to the conclusion that the predatory mite abundance in the orchards greatly depends on predatory mite abundance on the neighbouring plants. The number of predatory mites has big effect on the available amount of food as well. On one hand the amount of alternative food on the other hand the presence of large amount of phytophagous mites. The interplant of the evergreen trees and brushes in the bordering hedgerow of the orchards are a good solution in order to increase the numbers of predatory mites.

During the time of our examination phytoseiid mite species were identified with a great number on the unsprayed evergreen trees and bushes. Not only the abundance but also the diversity of predatory mites was high. Probably the pollen of evergreen plants is a suitable alternative food and also the large numbers of phytophagous mites (belonging to the family Tenuipalpidae) is excellent food source of the predatory mites. On the evergreen detected tenuipalpid mites usually did not occur on the fruit trees so if we plant the evergreen trees among the bordering hedgerow we will not increase the risk that harmful mites species will damage the fruit trees but the abundance of predatory mites will be higher in the orchards.

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