DOI: 10.22620/agrisci.2024.43.022

Effect of exclusion net on the acarofauna in apple orchard

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Abstract

Exclusion netting is an environmentally friendly plant protection method that could affect apple arthropod communities. To evaluate the effects of exclusion net on apple mite population, a two-year study comparing phytophagous mites and their predators' densities was conducted. The study was carried out in 2021-2022 in an apple orchard on the experimental field of the Agricultural University-Plovdiv. During the experiments no chemical pesticides were applied. The acarofauna in the apple orchard was represented by four families, with the highest population density being predatory mites of the family Phytoseiidae. The population density of the observed phytophagous mites from the family Tetranychidae on the young apple trees never reached the established for the crop economic threshold. Although no significant difference was observed in the abundance of predatory mites, their population density was slightly higher in the exclusion net plot. This is attributed to the better microclimate created in this section of the apple orchard.

Keywords: acarofauna, apple, Bulgaria, phytophagous mites, predators, spider mites.

INTRODUCTION

Apple is grown as a long-lived perennial crop, and orchards provide relatively stable ecological habitats to support a diverse arthropod fauna. Species composition depends on many factors, but always includes both phytophagous species representing the pest's entomo- and acarofauna and predators controlling their populations. In the past, when pest control in apple orchards relied on broad-spectrum insecticides, pests such as mites, developing throughout the growing season with a large number of generations, greatly increased their population density and caused serious damage to the crop. The intensive application of pesticides in apple agrocenoses destroys the balance between species in the arthropod fauna. There are two reasons why these small arthropods (mites) became a serious problem in apple orchards after the introduction of insecticide sprays: the rapid development of insecticide resistance among aphids and mites and the suppression of their natural enemies (Dennehy et al., 1988; Croft, 1993; Warabieda et al., 2020).

Therefore, the inclusion of mite control in the integrated apple pest management system is a modern trend, meeting both environmental requirements and consumer needs for high-quality, pesticide-free apple production.

Bulgarian apple orchards are attacked by three important tetranychid mites - the hawthorn spider mite (*Amphitetranychus viennensis* (Zacher, 1921)), the european red mite (Panonychus ulmi (Koch, 1836) and the two-spotted spider mite (*Tetranychus urticae* Koch, 1836) (Stoeva, 2017). A fourth species, *Bryobia rubrioculus* (Scheuten, 1857), has been a significant pest (Balevski et al. 1982) is rarely a problem in apple orchards today. The apple rust mite (*Aculus schlechtendali* (Nalepa, 1890)) is also present throughout the country and at very high population densities may damage the foliage of apple trees.

An important element of modern ecological systems for the protection of fruit crops are the natural regulators of pests and the evaluation of their ability to control the populations of the latter below the economic injury level. The interest in predatory mites is primarily related to their ability to regulate the population density of economically important species of spider mites.

The main objectives of this study were to estimate the species complex and population density of phytophagous mites in apple orchards with and without an exclusion net and to assess the status of the main groups of predatory mites.

MATERIALS AND METHODS

Experimental Design

During the period 2021-2022, field trials were conducted at an apple orchard in the experimental field of the Agricultural University-Plovdiv (42.132953, 24.768614). The trees were planted with an average spacing of 4 m between the rows and 2 m in-between the trees in the row, a total of 125 trees per ha. Two rows were covered with insect net (with supporting metal structure), and two - without insect net. The nets were deployed after full bloom until harvest, permitting better insect pollination during the flowering period. No pesticide treatments were conducted in the experimental apple orchard.

The studies were conducted on 8 apple varieties, with all trees planted in 2019 and at the beginning of fruit-bearing age at the time of this study. Five of the apple varieties were new for Bulgaria: Enterprise, Modi, Gemini, Pinova and Fujion, and three - well-established: Super Chief, Rosella and Crimson Crisp.

Mites Monitoring

Leaf sampling method was used to record the species composition and population density of phytophagous and predatory mites on the different apple varieties. Permanent microscope slides were prepared for species identification. Observations were made every two weeks throughout the growing season in both variants of the experiment (exclusive netting and non-netting). The data were statistically processed by Microsoft Excel 365.

RESULTS AND DISCUSSION

The acarofauna in the experimental apple orchard was represented by four families, with the highest population density being predatory mites of the family Phytoseiidae (Fig. 1- 2).

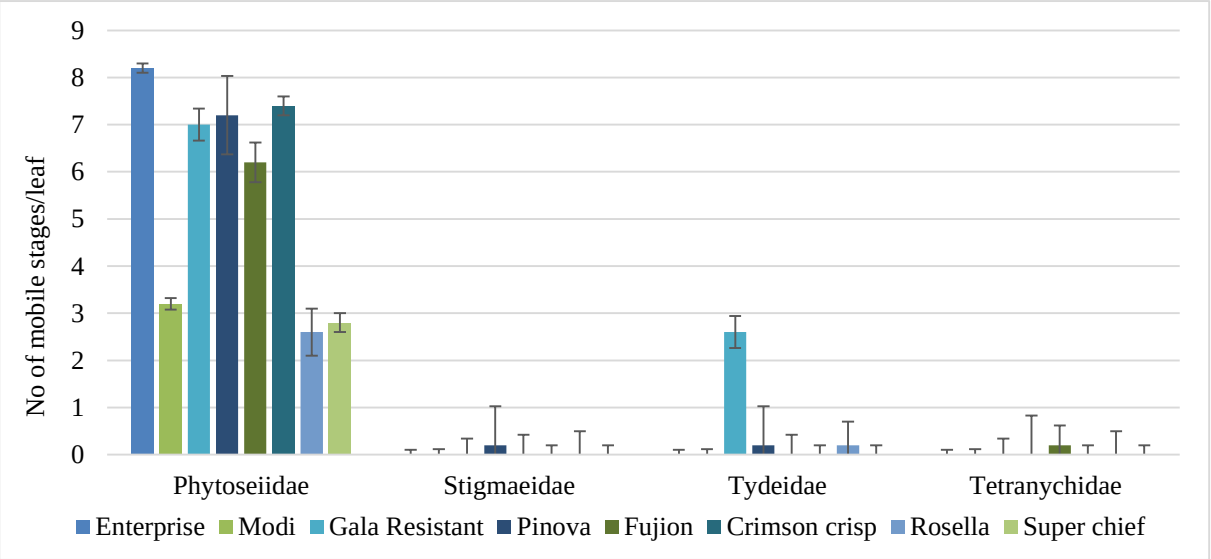

Figure 1. Average population density of the phytophagous and predatory mite families on different apple varieties under exclusion net

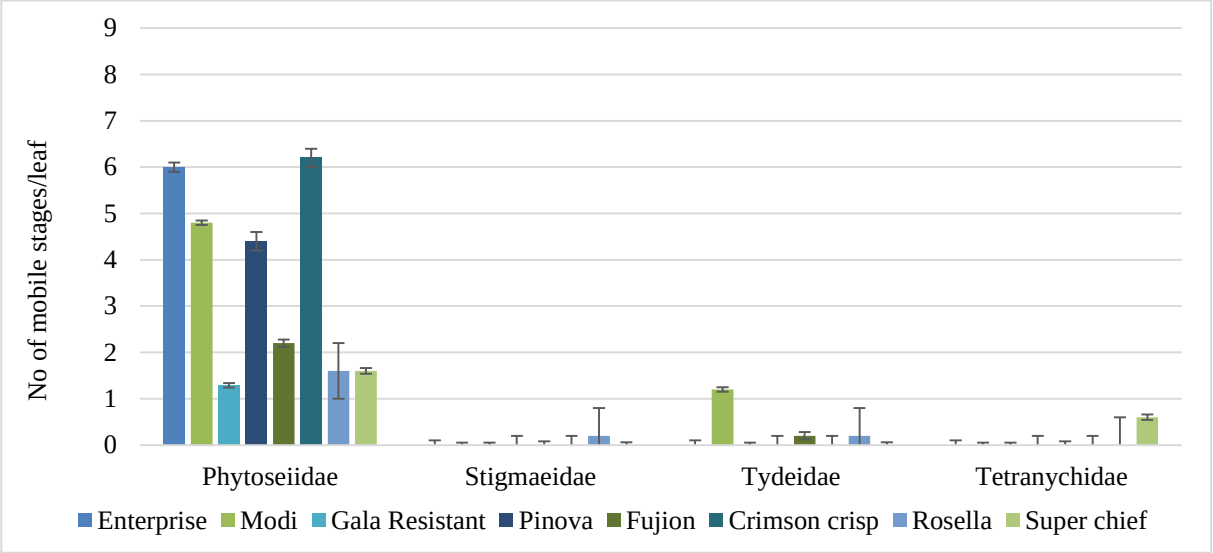

Figure 2. Average population density of the phytophagous and predatory mite families on different apple varieties without exclusion net

Phytophagous acarofauna was represented by a single species of tetranychid mite, two spotted spider mite (*Tetranychus urticae*, Koch 1836) (Fig. 3), characterized by its polyphagy and ability to develop on develop on different hosts. The species was recorded at an extremely low population density, less than one mobile individual per leaf, well below the economic threshold. Spider mites of the genus *Tetranychus*, characterized by an extremely wide range of host plants, are often reported on orchards. In the spring and summer, the mites feed mainly on annual crops and weeds, and in the second half of the summer, when the temperature is high and the relative humidity is low, and the herbaceous plants in and around the orchards dry up, the mites move to the fruit trees.

Other tetranychid mites such as European red mite, hawthorn spider mite or brown apple mite, traditionally found in intensive apple orchards, were not recorded.

Phytoseiid mites, registered in a highest population density, are important biological control agents of other mite groups and small insects. Population density of this family varied between 1.3 and 6.2 mobile stages/leaf in the rows without an exclusion net and between 2.6 and 8.2 in the rows under the net.

Figure 3. Adult of two spotted spider mite *Tetranychus urticae*

According to their prey specificity phytoseiid mites could be categorized into four different types: Type I - highly specific to *Tetranychus* sp., Type II - broadly specific (tetranychids most favoured), Type III - generalists predators (wide range of foods acceptable) and Type IV - primarily pollen feeders. The species *Kampimodromus aberrans* (Oudemans, 1930) and *Euseius finlandicus* (Oudemans, 1915), registered in the experimental orchard in 2021-2022, belong to the third and fourth types of predators, respectively, according to the described classification. *K. aberrans* is a generalist predator that has been widely known to occur

mainly on plants with pubescent leaves (Kreiter et al., 2002; McMurtry et al., 2013).

E. finlandicus is a phytoseiid predator for which pollen constitute an important part of the diet. This predator is known to feed also on eriophyoid and tetranychid species and has been reported mainly on glabrous leaves (Seelmann et al., 2007; Kopačka & Zemek, 2023).

After phytoseiid mites, stigmaeids, specially the genera *Zetzellia* Oudemans, is considered the most important spider mite predators in apple orchards. *Zetzellia mali* (Ewing) (Fig. 4) is a predator of both eriophyid mites and spider mites and occurred throughout the apple orchards in Bulgaria (Balevski et al., 1982). In our studies, this species was found in only one of the apple varieties, respectively in Rosella in the variant without a net and in Pinova in the variant with a net. The population density was very low - 0.2 mobile stages per leaf in both variants of the experiment.

Tydeidae family was also recorded at a relatively low population density - from 0 to 2.6 mobile stages per leaf. Tydeids are reported as plants and fungi feeders, scavengers and predators. In apple orchards, they are most often an alternative prey for phytoseiid mites.

Figure 4. Adult of stigmeid mite *Zetzellia mali*

CONCLUSIONS

The acarofauna of apple in the experimental orchard in the region of Plovdiv, where no chemical pesticides were applied, included mainly predators from the family Phytoseiidae.

Phytophagous mites were represented by the polyphagous spider mite species *Tetranychus urticae* at a population density below the economic threshold for apples.

Exclusion netting does not affect the population density of the phytophagous mites, while the predator species population is slightly more abundant on the leaves of the covered apple trees.

ACKNOWLEDGEMENTS

The authors acknowledge the financial support by the Bulgarian National Science Fund through the research project KP-06-IP-Kitai/2 “Research on sustainable pest and disease management in apple orchards in Bulgaria and China based on precision ecological control methods”.

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