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PREDATORS OF ROSY APPLE APHYD, (DYSAPHIS PLANTAGINEA) PASS., (HOMOPTERA, APHIDIDAE) IN BULGARIAN APPLE ORCHARDS

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Summary

The presence of predators associated with Rosy apple aphid, Dysaphis plantaginea, (Pass.) (Homoptera: Aphididae) was surveyed in two apple orchards in two different ecological regions in Bulgaria during 2012. In the colonies of D. plantaginea in both orchards were found 18 predatory species belonging to respective orders Coleoptera – 5 (Coccinellidae 4, Cantharidae 1), Diptera – 4 (Syrphidae 3, Cecidomyiidae 1), Hemiptera – 4 (Anthocoridae 3, Miridae 1), Neuroptera – 4 (Chrysopidae 4), Dermaptera – 1 (Forficulidae 1). Some of the most frequent predators in this research were Adalia bipunctata (L.) (Coleoptera: Coccinellidae), Episyrphus balteatus (DeGeer) (Diptera: Syphidae) and Aphidoletes aphidimyza (Rond.) (Diptera: Cecidomyiidae). In April, when the colonies of D. plantaginea were small in numbers, syrphid eggs and larvae were mostly found and less often ladybird eggs and larvae. Other predators such as Anthocoris nemoralis (Fabr.), Orius minutus (L.) and Orius majusculus (Rt.) (Hemiptera: Anthocoridae), Deraeocoris ruber (L.) (Hemiptera: Miridae), Chrysopa carnea (Steph.), Ch. septempunctata (Wesm.), Ch. perla (L.) and Ch. prasina **(**Burm.) (Neuroptera: Chrysopidae), Forficula auricularia (L.) (Dermaptera: Forficulidae) and Cantharis fusca (L.) (Coleoptera: Canthariididae) were also observed to feed in the colonies of D. plantaginea. Although these predators are considered to play an important role in the regulation of aphid populations, they did not prevent D. plantaginea damage that affected up to 45 % of the terminals in one orchard and up to 43 % in another. Some possible causes for this ineffectiveness are discussed.

Key words: Bulgaria, Rosy apple aphid, aphidophagous, biological control

Introduction

Dysaphis plantaginea, (Pass.) (Homoptera: Aphididae) is one of the most frequent and deleterious aphid species on apple trees in Bulgaria. It is a migratory species with main host *Malus* spp. and intermediate host *Plantago* spp. In a period of mass multiplication the aphids settle on the fruit clusters where they cause rolling up of leaves and deformation of shoots. When feeding they exude toxins which block the growth of fruit which stay small and underdeveloped. In order to prevent from this damage, every year in early spring one to three insecticide treatments are performed. On one hand, these treatments are serious threat to their natural enemies and pollinators. On the other hand they pose a hazard of resistance emergence due to the repeated use of one and the same chemicals. This makes it necessary to develop alternative approaches to control the pests. The growth of resistant cultivars is probably one of the ways to solve the problem. In connection with this, in our country as well as abroad, hybridization programs are developed, including varieties, resistant to particular species of aphids (e.g. ’Florina’ cultivar to the species *D. plantaginea*) (Dapena and Miñarro, 2001, Kutinkova and Djuvinov, 2004).

The use of natural enemies of aphids like bio-agents and leaving strips of wild plant species as suitable habitat for aphidophagous predators (Wyss, 1995; Wyss *et al*., 1995), or further colonization of local natural enemies (Wyss *et al*., 1999a), could be other alternative approaches to control of *D. plantaginea.*

In Bulgaria, purposeful research connected with specifying the complex of *D. plantaginea*’s predators has not been carried out until now. The purpose of this research is to study the predatory insect species to *D. plantaginea* and to estimate their effectiveness in the control of its populations.

Materials and methods

The experiments were carried out in 2012 in two apple orchards in two different ecological regions in Bulgaria. One of orchards is experimental, located on the territory of the Fruit Growing Institute in the city of Plovdiv and the other one - in an abandoned, located on the periphery of the town of Shumen.

The experimental orchard of 0.4 ha in Plovdiv, consisted of 13-year old apple trees, 14 of them resistant and one susceptible (‘Golden Delicious’) to apple scab, grafted on MM – 106. This orchard was conducted following organic guidelines. In summer months the orchard was sprayed with summer oils to control aphids and granulosis virus to control codling moth. Treatments against other apple pests were not needed. Copper and sulfur preparations were used against fungal diseases.

The abandoned orchard of 0.5-ha in Shumen, consisted of 30-year old cv ‘Golden Delicious’, ‘Red Delicious’, ‘Fuji’ and ‘Melrose’, grafted on MM – 106. Neither insecticides, acaricides nor fungicides were sprayed in this orchard in the last 10 years.

In order to minimize effects, 10 trees of each orchard, only cv. ‘Golden Delicious’, were sampled for the presence of *D. plantaginea.* Five shoots of each selected tree were randomly selected and marked with colored plastic strips. From mid April to the moment when all D. plantaginea had migrated to a secondary host the 50 selected shoots were examined on a weekly basis for the presence of aphid colonies.

Number and types of predators was recorded weekly during the spring by visual examination on 25 shoots randomly selected among those infested with D. plantaginea in the two gardens. Eggs and larvae were brought back to the laboratory in order to determine their species. Predators were reared individually in glass containers on *D. plantaginea* or *Aphis pomi* at 23-25^{o}C and 75% humidity. Identifications of predatory species were made using keys of insect species in the adult stage by Dorohova et al. (1989).

Results

Aphids

The percentage of growing shoots with colonies of *D. plantaginea* in both orchards was high, reaching 45 % in some moments (fig. 1 and 2). In the experimental orchard the first colonies were observed in the middle of April and the last ones until the end of June, when the aphids migrated to *Plantago* spp., their second host (fig. 1). The peak of the mass multiplication was registered end of May. The sprays with summer oil on 14th May; 28th May and 11th June did not affect significantly the populations of *D. plantaginea* which could be explained with the fact that the efficacy of contact insecticides in the rolled leaves decrease considerably (Hull & Starner, 1983).

In the abandoned orchard the first colonies were observed in the middle of April as well but the aphids remained on the developing shoots until the first ten days of July (fig. 2). In that orchard the peak of multiplication of aphids was registered in the first half of June.

Predators

In the colonies of D. plantaginea in both orchards were found 18 predatory species belonging to orders Coleoptera – 5 (Coccinellidae 4, Cantharidae 1), Diptera – 4 (Syrphidae 3, Cecidomyiidae 1), Hemiptera – 4 (Anthocoridae 3, Miridae 1), Neuroptera – 4 (Chrysopidae 4), Dermaptera – 1 (Forficulidae 1) (fig. 3 and 4). The most frequent and numerous of these were the species of family Syrphidae, Cecidomyiidae and Coccinellidae, while the rest of the predator species were found less often and in lower numbers. The most abundant and the first observed syrphid was *Episyrphus balteatus* (De Geer), although *Scaeva pyrastri* (L.) and *Syrphus ribesii* (L.) were also recorded. The most common and frequent species of coccinellids was *Adalia bipunctata* (L.); they were 85% of the total number of all Predatory ladybirds. In the *D. plantaginea* colonies were observed other coccinellid species like *Coccinella septempunctata* (L.), *Propylea quatuordecimpunctata* (L.) and *Adalia decempunctata* (L.) as well as the cecidomyiid fly – *Aphidoletes aphidimyza* (Rondani).

At the beginning of vegetation in *D. plantaginea* colonies were found mostly predatory ladybirds and syrphid flies. In the experimental orchard, in more than 70% of the colonies were observed eggs and larva’s of syrphid flies while the coccinellids in both orchards were lower in number (fig. 3 and 4).

The third most frequent predator in this study, the cecidomyiid fly *A. aphidimyza* was found for the first time in both orchards at the end of the first decade of May. The number of this predator in the following weeks increased fast and at the beginning of June its presence in the colonies of *D. plantaginea* reached 65% (Fig. 3 and 4).

In May in the colonies of *D. plantaginea* larvae of syrphid flies were most often found but in June, with increasing numbers of aphid populations, mostly larvae of coccinellid and cecidomyiidae flies were observed. Along with these predators in the colonies was occurrence of anthocorids and mirids like Anthocoris nemoralis (Fabr.), Orius minutus (L.) and Orius majusculus (Rt.) (Hemiptera: Anthocoridae), Deraeocoris ruber (L.) (Hemiptera: Miridae), and chrysopids (Chrysopa carnea (Steph.), Ch. septempunctata (Wesm.), Ch. perla (L.) and Ch. prasina **(**Burm.) (Neuroptera: Chrysopidae), whose presence in the abandoned orchard was stronger than in the experimental one. At the beginning of June in the abandoned orchard these predators could be found in 40% of the colonies of *D. plantaginea*. In that orchard, in addition to these predators in the *D. plantaginea* colonies were found other predatory species like *Forficula auricularia* (L.), (Forficulidae) and *Cantharis fusca* (L.) (Cantharidae) but mostly rarely and in low number.

Spiders were rarely observed in both apple orchards and although they were not seen feeding on D. plantaginea, they can play an important role in decreasing aphid populations principally in autumn (Wyss *et al.*, 1995).

In *D. plantaginea* colonies was reported significant presence of ants. These insects develop in symbiosis with aphids and their presence in the colonies of *D. plantaginea* is probably not accidental but with a particular mission to protect aphids from the negative impact of their natural enemies.

Discussion

In previous studies Wyss *et al.* (1999b) demonstrated the efficacy of *E. balteaus, A. bipunctata* and *A. aphidimyza* predators on *D. plantaginea* colonies. In this study these three species are some of the most frequent and common predators too. Although they play an important role in regulating the populations of *D. plantaginea* aphids, they are not capable to reduce *D. plantaginea* populations below under an economic threshold (1-2 infested shoots after flowering) (Fig. 1 and 2).

There might be several main reasons for the inability of these predators to prevent the damage caused by *D. plantaginea*. One of them is the fast reaction of apple leaves as a result of aphids feeding. The onset of symptoms can be seen within 24 hours (Forrest & Dixon, 1975). Although the aphid populations can be controlled by their natural enemies, the typical for the species symptoms of damage could be seen on the leaves and fruit. In this case the significance of aphidophagous could be bigger only if more resistant cultivars are grown. Secondly, there are essential differences in the speed the predator and prey develop. When the predator develops relatively slower than its prey, it is incapable to response adequately to the growing number of prey. Due to this the predator is not as effective as the time for its development is similar to that of the prey. This is the case with predator ladybirds which feed with aphids (Dixon *et al*., 1997). Thirdly, the aphidophagous coccinellids behave as if they are “prudent predators” (Hemptinne and Dixon, 1998). The theory of optimal feeding of the aphidophagous coccinellids forecasts that in the aphid colony there will be optimal number of eggs whose maximum will be equal to the biomass of the offspring. Theory also predicts that if the egg-laying females lay the optimal number of eggs, their offspring will not affect substantially the size of aphid colonies (Kindlmann and Dixon, 1993). Field and experimental results confirm this prognosis model. Thus gravid females respond to both the abundance and quality of their prey, avoiding aphid colonies that are already exploited and/or too old to support the full development of the ladybird offspring, and so they are not effective bio-agents (Hemptinne et al., 1992; Hemptinne et al., 1993). There is also evidence that aphidophagous syrphids behave similarly (Hemptinne et al., 1993; Scholz and Poehling, 2000).
Parasitism has not been studied in this work, and although some parasited aphids were observed, parasitoids seem to play a minor role in regulating populations of *D. plantaginea*, probably due to the host alternation of this species, ant attendance and hyper parasitism (Cross et al., 1999). Interspecies predation could also be a reason for this, but it was not a subject of this study, although, according to Wyss et al. (1999b), in other experiments the two most numerous predators in our apple orchards *A. bipunctata* and *E. balteatus* showed that they not only affect but have a negative effect on aphid populations which is explained by an additional method.
This study clarifies to a certain degree the efficacy of *D. plantaginea* predators and increases the need of similar future research in order to improve the natural control of populations of this aphid species. It could serve as the basis for developing such strategies as artificial breeding and placing of natural or introduced aphid predators or preservation and stimulation of the natural enemies’ aphidophagous by leaving zones of wild vegetation.

Conclusion

Although these predators are considered to play an important role in the regulation of aphid populations, they did not prevent D. plantaginea damage that affected up to 45 % of the terminals in one orchard and up to 43 % in another.

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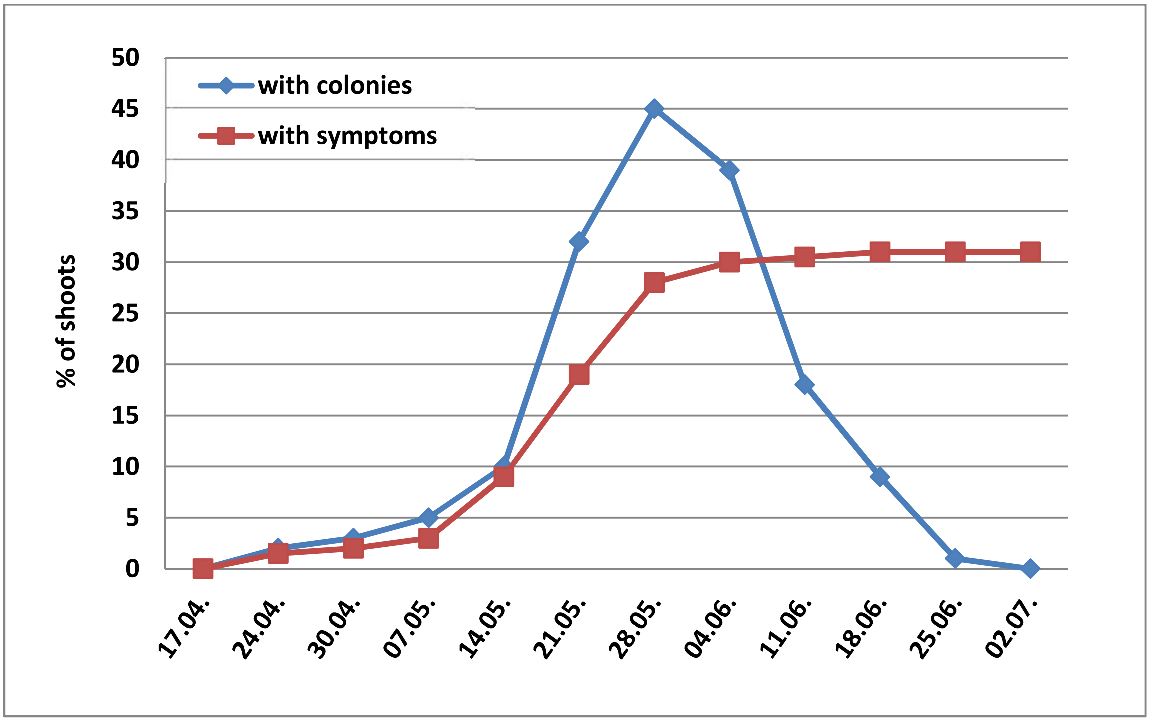

Fig.1. *D. plantaginea* occurrence and shoot damage in the experimental apple orchard in Plovdiv in 2012.

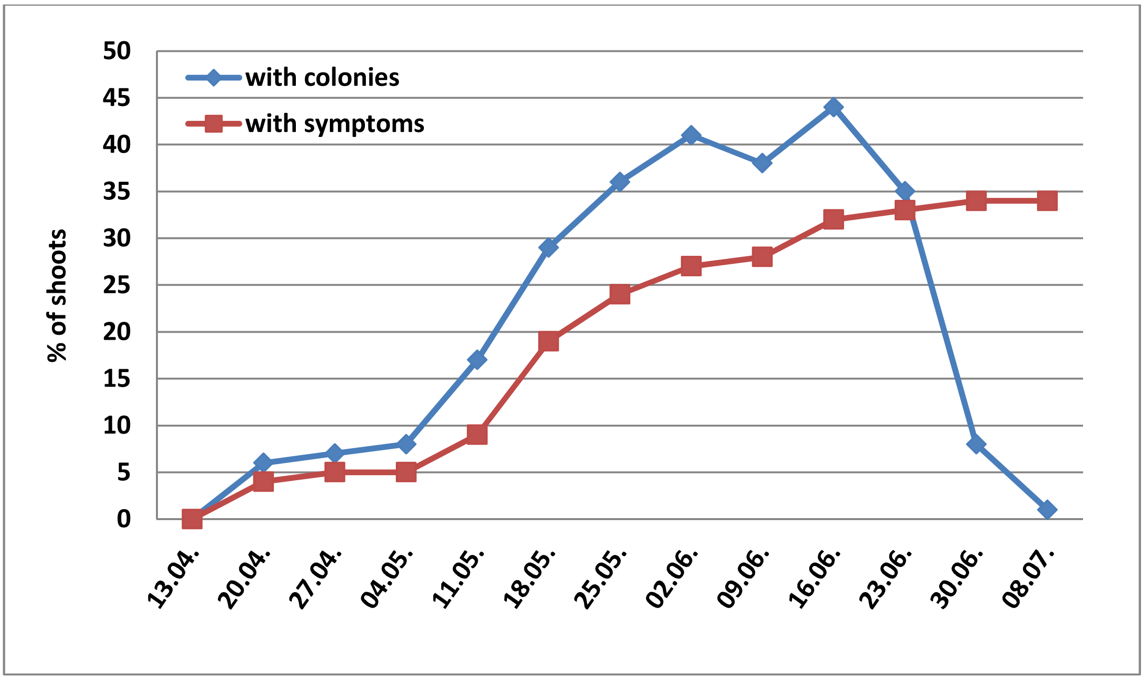

Fig.2. *D. plantaginea* occurrence and shoot damage in the abandoned apple orchard in Shumen in 2012.

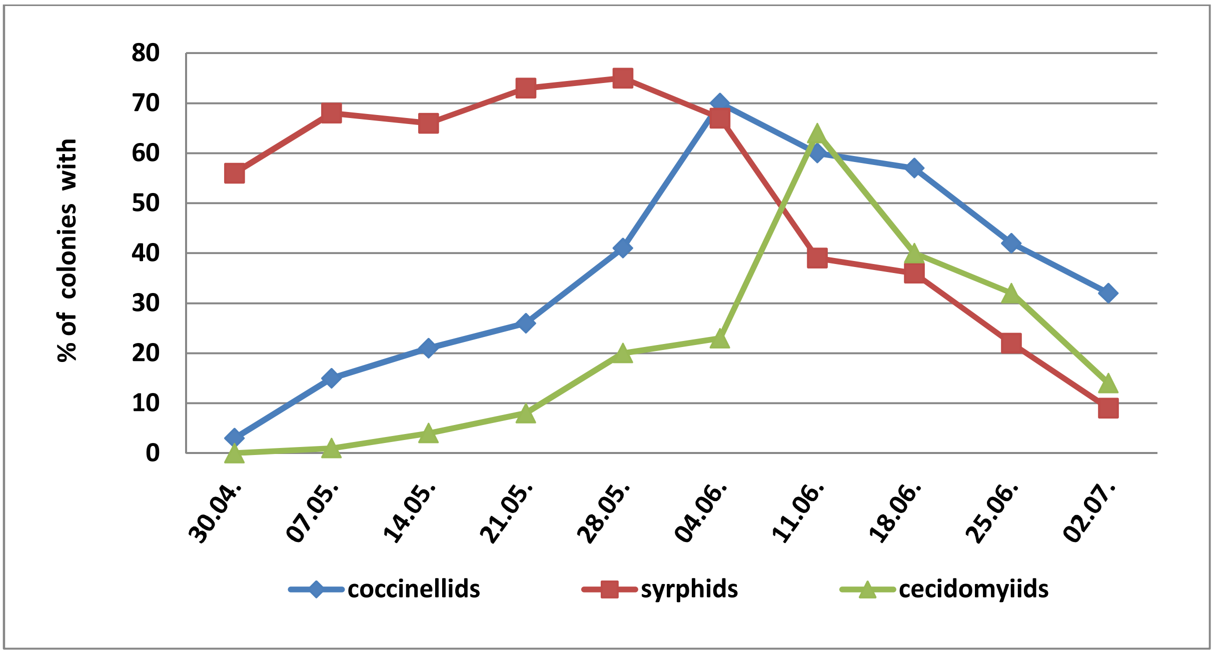

Fig.3. Coccinellid, syrphid and cecidomyiidae ocurrence on *D. plantaginea* colonies in the experimental orchard in Plovdiv in 2012.

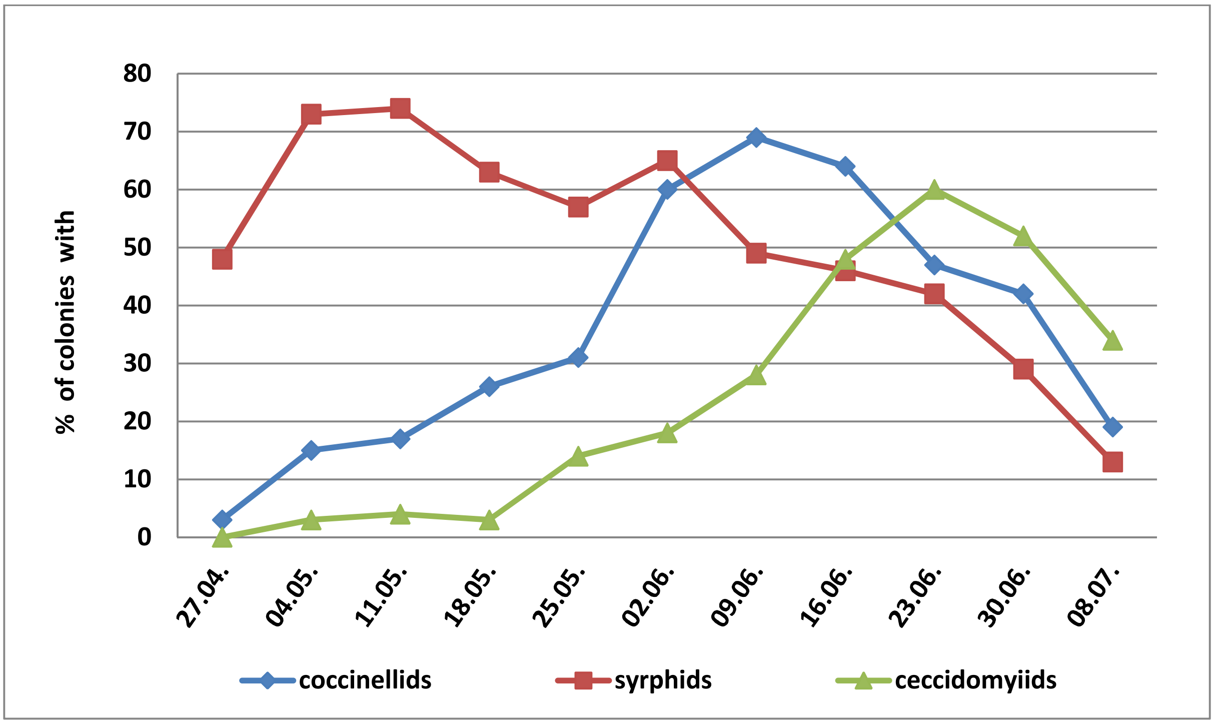

Fig.4. Coccinellid, syrphid and cecidomyiidae ocurrence on *D. plantaginea* colonies in the abandoned apple orchard in Shumen in 2012.