The Important Role of *Macrolophus costalis* Fieber, 1858 (Hemiptera: *Miridae*) as a Bio Agent against *Myzus persicae* Sulzer, 1776 (Hemiptera: *Aphididae*) in Tobacco

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Summary

Macrolophus species are important biological control agents and are predators that reduce aphids' population. The aim of the research was to study the role of *Macrolophus costalis* Fieber, 1858 (Hemiptera: Miridae) as a bio agent against *Myzus persicae* Sulzer, 1776 (Hemiptera: *Aphididae*) in tobacco. The experiment determined the dynamics of aphids and mirids population in treated and untreated dense seedling plots. It was found that in the untreated areas the increase in the population of *M. persicae* also increased the number of *M. costalis*. It is noteworthy that the reduction of *M. persicae* did not lead to a decrease in the number of mirids, but on the contrary, it increased their population. In the control (treated) areas, the use of insecticide led to the destruction of aphids, and subsequently the mirids were greatly reduced. After the quarantine period of the active substance expired, the populations of both species increased. Importantly, more mirids were found in the untreated plots as compared to their number in treated plots. The study showed the ability of mirids to successfully reduce the population of *M. persicae* in dense tobacco seedlings.

Key words

mirids, aphids, bio control, agriculture and agroecology, tobacco

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Introduction

Tobacco is a crop which is attacked by a number of insect pests (Dimitrov, 2003). The green peach leaf aphid *Myzus persicae* Sulzer, 1776 is one of the main tobacco pests (Margaritopoulos et al., 2003) and *Macrolophus costalis* Fieber, 1858 is a predator that is used to control it (Dirimanov and Dimitrov, 1975). *M. persicae* is detrimental to tobacco because it sucks saps from tobacco plants and damages the nicotine content of tobacco (Feinstein and Hanna, 1951). Tobacco-adapted lineages of *M. persicae* can detox the consumed nicotine (Puinean et al., 2010; Bass et al., 2014). As a result of sucking, these insects release significant quantities of honeydew (Throne and Lampert, 1985) and transmit viruses (Katis et al., 1992) such as the cucumber mosaic virus and potato virus Y (Dimitrov et al., 2005). *M. persicae* is known to transmit over 100 plant viruses (van Emden et al., 1969). Large aphid populations can negatively affect crop growth and reduce yield (Blackman and Eastop, 2000; Umina et al., 2014; de Little et al., 2017).

M. persicae is a global pest in a broad range of crops (Bass et al., 2014). The control of *M. persicae* is mainly dependent on insecticides. However, this aphid has a high propensity to become insecticide resistant. *M. persicae* has resistance to over 80 insecticides from various chemical groups (Arthur et al., 2022). *M. persicae* control in many countries is mainly dependent on different insecticides: carbamates, organophosphates, synthetic pyrethroids and neonicotinoids (Edwards et al., 2008; Umina et al., 2019).

The abovementioned reasons urge us to pay serious attention to natural predators which are natural regulators of *M. persicae*. One of the main natural predators is *M. costalis*. This mirid is an important biological control agent of *M. persicae* and *Thrips tabaci* Lindeman 1889 (Thysanoptera: *Thripidae*) in tobacco plants in Bulgaria (Dirimanov and Dimitrov, 1975). There are number of studies that have illustrated the important role of *Macrolophus* species as biological control agents (Alomar et al., 1994; Perdikis and Lykouressis, 1996; Lykouressis et al., 2000).

The aim of this research was to study the role of *Macrolophus costalis* Fieber (Hemiptera: Miridae) as a bio agent against *Myzus persicae* Sulzer (Hemiptera: *Aphididae*) in tobacco.

Materials and Methods

Sampling Location and Experimental Design

The research was undertaken in tobacco fields at the Tobacco and Tobacco Products Institute - Markovo, Agricultural Academy, Bulgaria (N 42.075765/E 24.699738). The two-year study determined the population dynamics of *Myzus persicae* and *Macrolophus costalis* in treated and untreated dense seedling oriental tobacco plants. During two years of study dense seedlings with oriental tobacco plants were used in three replicates, untreated and treated with insecticide areas (100 x 80 cm). In both years the experiment began on 15th of March and continued until the end of May. After the first reporting of the aphids, the population dynamics of *M. costalis* and *M. persicae* was estimated with the 100 leaves method used by Radev (2022) through visual observation and direct inspection every 7 days of 100 plants located along the diagonals of each plot area. For the treated (control) plots insecticide with active substance "Spirotetramat" 100 g L^{-1}, 0.15% concentration was used when *M. persicae* appeared, while for the untreated plots only irrigation water was applied.

Statistical Analysis

The data was processed using the regression analysis method and produced mathematical models for the changes in the number of aphids and their predators in treated and untreated areas depending on the period of observation. The multiple correlation coefficient R^2 was taken as an indicator of the significance of the obtained models.

Results

In Ist year of the study the first record of *Myzus persicae* and *Macrolophus costalis* was on May 5th, while in IInd year of the study it was observed on May 3rd. In 1st year of the study more representatives of both studied species were found as compared to 2nd year of study (Table 1 and Table 2).

Table 1. Population dynamics of *M. persicae* and *M. costalis* in treated and untreated plots of dense seedling oriental tobacco during 1st year of study till planting time

Date of inspecting	*Myzus persicae*		*Macrolophus costalis*	
	untreated plots	treated plots	untreated plots	treated plots
	mean ± std	mean ± std	mean ± std	mean ± std
05 May	19.3 ± 1.5	23.6 ± 2.5	4.7 ± 1.5	5.7 ± 0.6
12 May	31.3 ± 3.5	0.0 ± 0.0	18.3 ± 2.5	1.7 ± 0.6
19 May	9.3 ± 2.5	0.0 ± 0.0	20.7 ± 2.1	2.3 ± 0.6
26 May	4.6 ± 2.1	8.3 ± 2.5	19.3 ± 3.2	7.3 ± 1.5

Table 2. Population dynamics of *M. persicae* and *M. costalis* in treated and untreated plots of dense seedling oriental tobacco during 2nd year of study till planting time

Date of inspecting	*Myzus persicae*		*Macrolophus costalis*	
	untreated plots	treated plots	untreated plots	treated plots
	mean ± std	mean ± std	mean ± std	mean ± std
03 May	14.6 ± 2.1	12.7 ± 0.6	4.3 ± 0.5	3.6 ± 0.6
10 May	24.3 ± 1.5	0.0 ± 0.0	8.6 ± 1.5	2.3 ± 0.6
17 May	11.3 ± 2.1	0.0 ± 0.0	11.6 ± 1.5	1.7 ± 0.5
25 May	5.6 ± 1.2	9.3 ± 1.5	15.6 ± 1.5	5.6 ± 1.5

According to the data (Table 1 and Table 2) the following results were found:

In the untreated areas:

Initially, the number of *M. persicae* increased and then quickly decreased. At the same time, the number of *M. costalis* steadily increased during the observed period of 21 days. As the number of mirids increased, they preemptively destroyed the aphids, which is why their decrease was also due (Fig. 1 and Fig. 2).

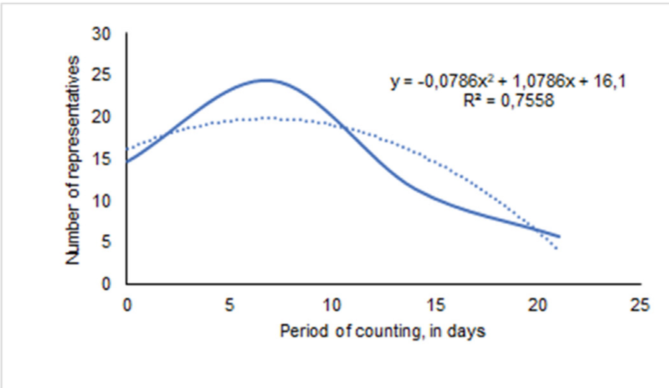

Figure 1. Change in the aphids' number in untreated areas in 2nd year of study

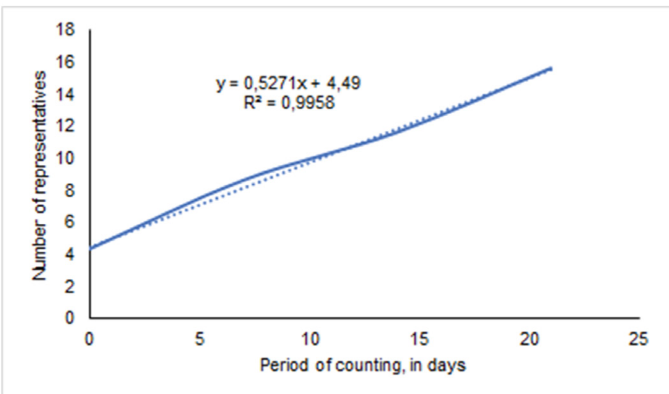

Figure 2. Change in the predators' number in untreated areas in 2nd year of study

In the treated areas:

Initially, the number of aphids decreased as a result of the chemical treatment. This was observed until the 14th day, when its action expired. The number of aphids reported increased on the 21st day. The number of the predators followed the change in the number of aphids - it decreased until the 14th day, and then increased (Fig. 3 and Fig. 4).

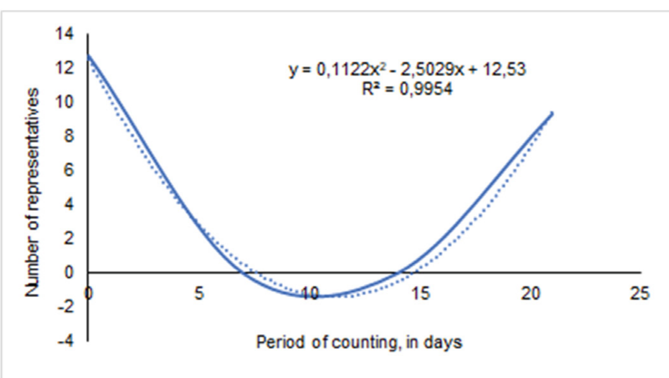

Figure 3. Change in the aphids' number in treated areas in 2nd year of study

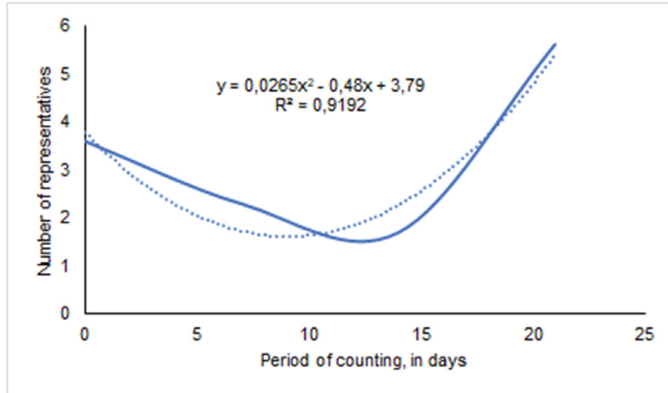

Figure 4. Change in the predators' number in treated areas in 2nd year of study

It must be considered that in the treated areas *M. persicae* and *M. costalis* were in significantly lower quantity than in the untreated areas.

After mathematical processing, the following models were obtained:

- Change in the aphids' number in untreated areas -

$Y = -0.08 * X^2 + 1.08 * X + 16.1$; $R^2 = 0.756$ (Fig. 1)

- Change in the predators' number in untreated areas -

$Y = 0.53 * X + 4.49$; $R^2 = 0.996$ (Fig. 2)

- Change in the aphids' number in treated areas -

$Y = 0.11 * X^2 - 2.5 * X + 12.53$; $R^2 = 0.995$ (Fig. 3)

- Change in the predators' number in treated areas -

$Y = 0.03 * X^2 - 0.48 * X + 3.79$; $R^2 = 0.919$ (Fig. 4)

In three of the variants considered, the coefficient of multiple correlation was close to unity. Only in the model for counting the aphids' number in untreated plots (Fig. 1) it had a smaller value, but close to its lower desired limit (0.85). This led to the assumption that the models could be used to solve practical and scientific tasks.

The resulting models refer to the data reported in 2nd year of study. The pattern of change in the aphids' number and their predators was similar to that in 1st year of study, and some regression coefficients were changed in the models, where:

- Change in the aphids' number in untreated areas -

$Y = -0.09 * X^2 + 0.85 * X + 21.9$; $R^2 = 0.687$ (Fig. 5)

- Change in the predators' number in untreated areas -

$Y = 0.66 * X + 8.82$; $R^2 = 0.644$ (Fig. 6)

- Change in the aphids' number in treated areas -

$Y = 0.16 * X^2 - 4.1 * X + 22.83$; $R^2 = 0.969$ (Fig. 7)

- Change in the predators' number in treated areas -

- $Y = 5.69 –+ 0.05 * X^2 - 0.9 * X + 5.69$; $R^2 = 0.999$ (Fig. 8)

This research showed the importance of the *M. costalis* predator as a bioagent against *M. persicae* and its role for aphids' limitation in tobacco dense seedling. Viral diseases were not found in untreated dense tobacco seedlings.

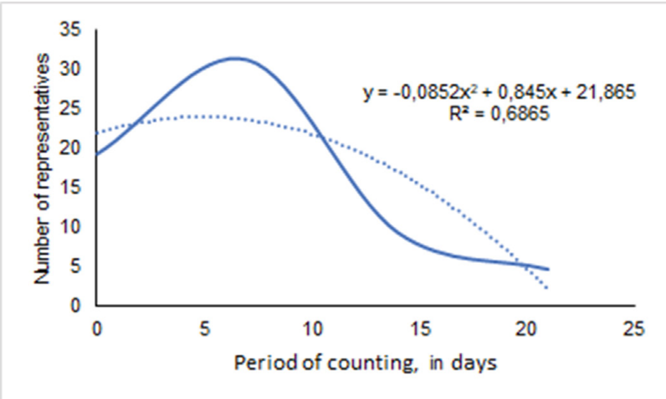

Figure 5. Change in the aphids' number in untreated areas in 1st year of study

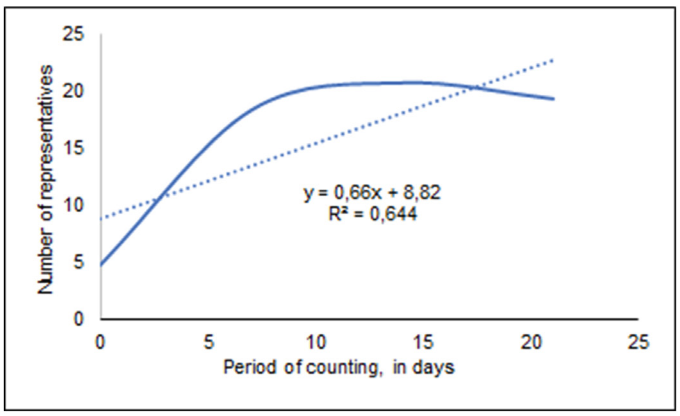

Figure 6. Change in the predators' number in untreated areas in 1st year of study

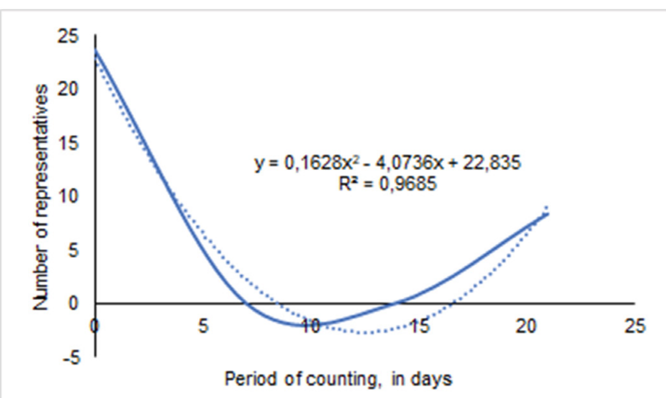

Figure 7. Change in the aphids' number in treated areas in 1st year of study

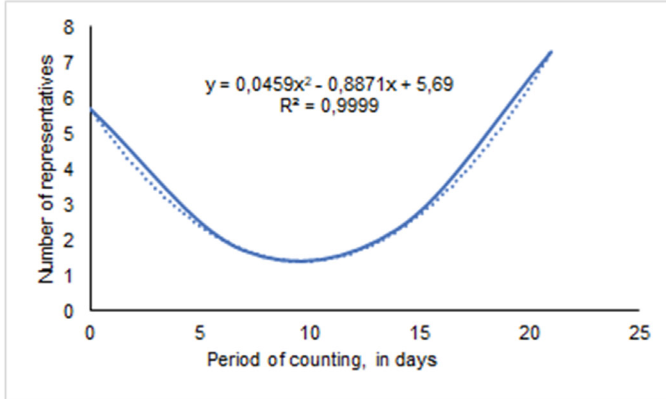

Figure 8. Change in the predators' number in treated areas in 1st year of study

Discussion

The study provided important information about the natural regulation of *M. persicae* population in tobacco plants. The species *M. costalis* is the predator that first appears in tobacco dense seedlings. The aim of the present study was to establish the influence of predator *M. costalis* and its role in the biological control against *M. persicae*. *M. persicae* is a very important pest attacking tobacco worldwide (Dominick, 1949; Semtner, 1984; Lykouressis and Mentzos, 1995). Such information is very important, especially in organic farming, and according to Malausa et al. (1987) numerous studies have determined the importance of the *Macrolophus* species as bioagents.

The results showed good predatory behavior of the mirid against *M. persicae*. According to Margaritopoulos et al. (2003) average total aphids' consumption by *M. costalis* is 61, and total aphids' consumption by a male and female pair till the death of the female is 244. The predatory behavior effect of *M. costalis* towards *M. persicae* should be taken into consideration in pest control. Further research is necessary to prove the need to treat dense tobacco seedlings, in the presence of 10-11 mirids in m^2. The better understanding of the impact of beneficial entomofauna on pests would provide more data about sustainable agriculture and clean environment. The spatial dynamics of predatory insects should be taken into discussion when evaluating their efficiency as bio control agents (Karandinos, 1976).

According to Athanassiou et al. (2003), most aphids were observed during July and August, but the population density *M. costalis* increased in September and mirids were randomly distributed in tobacco plant. In general, the predators not always react numerically to changes in pest numbers (Coll and Izraylevich, 1997). Therefore, it is very important at which stage of crop vegetation the research is carried out. The present study established the importance of mirids as control bioagents in densely planted tobacco seedlings. At a later stage, when the plants were planted in the field, the competition with other predators from *Coccinellidae, Syrphidae, Chrysopidae* and other species increased.

The present research established a high level of mirid efficiency against *M. persicae*. In the experiment, significant differences were found in the presence of aphids and mirids in treated and untreated plants. This work demonstrated the effect of predators as bioagents against pests. Further studies are needed to confirm the usefulness of bioagents in tobacco plants.

CRediT authorship contribution statement

Zheko Radev: Supervising, Data analysis, Original draft preparation

Declaration of Competing Interest

The author declare that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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