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SPECIES COMPOSITION OF TETRANYCHID MITES (*TETRANYCHIDAE*) AND PREDATORY MITES (*PHYTOSEIIDAE*) OCCURRING ON RASPBERRY PLANTATIONS IN POLAND

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Abstract: Modern methods of raspberry protection aim at a substantial reduction of chemicals use. The investigation on potential biological control of phytophagous mites on this crop has been begun. Field studies on the occurrence, species composition, and density of populations of tetranychid mites (*Tetranychidae*) and phytoseiid mites (*Phytoseiidae*) in different areas of raspberry growing in Poland was carried out in 2000–2001. Leaf samples were collected from 71 plantations located in five of the main regions of Polish raspberry production. There were clear differences in the densities of tetranychid mite populations between regions, with raspberry spider mite *Neotetranychus rubi* (Träg.) being more numerous than two-spotted spider mite *Tetranychus urticae* (Koch.) in most except the Skierniewice region.
Among the phytoseiid mites collected from raspberry leaves, eleven species were identified. Although their occurrence and species composition varied with region, *Amblyseius bryophilus* Karg, *Euseius finlandicus* (Oudemans) and *Amblyseius andersoni* (Chant) were the most common; each species occurred at least in three regions. Results obtained showed good prospects for the deployment of the phytoseiids in biological control of spider mites on raspberry.

Key words: *Tetranychus urticae, Neotetranychus rubi, Phytoseiidae,* raspberry, Poland

INTRODUCTION

Raspberry (*Rubus idaeus* L.) is one of the most economically important soft fruit crop in Poland. The yield of this crop may be significantly lowered by infestation with various species of spider mites (Łabanowska 1978; Boczek 1999; Tuovinen et al. 2000). Up to middle of seventies *Tetranychus urticae* (Koch.) has been viewed as the most numerous and serious species, whereas *Neotetranychus rubi* (Träg.) has

been found to occur mainly on wild raspberry bushes, seldom appearing on cultivated raspberries (Skorupska 1975). At the end of the eighties Michalska and Kropczyńska (2002) found *N. rubi* occurring much more frequently in protected, commercial raspberry plantations in comparison with previous years.

The information in the Polish as well as in foreign literature on natural enemies of spider mites in raspberry is rather scarce. In Finland Tuovinen (1995) identified on raspberry field plantations such species of phytoseiid mites as *Phytoseius macropilis* (Banks), *Phytoseius juvenis* Wainstein & Arutunjan, *Anthoseius rhenanus* (Oudemans) and *Euseius finlandicus* (Oudemans). According to this author, special attention should be devoted to *P. macropilis* and *E. finlandicus*, because of their widespread abundance and ability to reproduce using alternative food, such as pollen. Another phytoseiid species, known to occur on wild raspberry is *Typhlodromus pyri* (Gordon and Taylor 1976; Boller et al. 1988; Baillod et al. 1996).

Studies on the introduction of predatory mites onto raspberry plants have been also conducted but the results obtained were contradictory. In Canada *Phytoseiulus persimilis* was able to hold populations of the two-spotted spider mite at a low level throughout 8 weeks after its introduction (Wood et al. 1994). A similar study conducted in Belgium, but in greenhouse, showed that the effect of the releases of *P. persimilis* was unsatisfactory, and that more effective control could be obtained with the introduction of *Amblyseius californicus* (McGregor) combined with the predatory midge *Therodiplosis persicae* (Meesters et al. 1998). Recently, the role of native and introduced predatory mites in management of spider mites on raspberry was studied in Finland, Italy and Switzerland (Tuovinen et al. 2000). The authors concluded that the natural phytoseiid populations have been the key factors in spider mite management in all areas of investigation.

The goal of the research reported here was to examine the occurrence, species composition, and density population of spider mites as well as phytoseiid mites in different regions of raspberry growing in Poland.

MATERIALS AND METHODS

The field surveys were carried out in August 2000 in 67 plantations located in five of the main regions of Polish raspberry production: Skierniewice, Płońsk, Lublin, Brzezna and Czerwińsk. Skierniewice, Płońsk and Czerwińsk are located in the center, Lublin in the East-Southern, and Brzezna in South of Poland. Both conventionally managed plantations (i.e. incorporating broad-spectrum insecticides) as well as abandoned (unmanaged) ones were included into the investigation. The abandoned plantations were mainly located in the vicinity of the forests or uncultivated areas. In all regions dominant raspberry cultivars were Norna, Veten, Promise, Malling Seedling and Polana. A sampling unit consisted of fifty whole leaves, which were randomly collected from each plantation. In each sample the number of active stages of *Neotetranychus rubi, Tetranychus urticae* and *Phytoseiidae* was determined using a stereomicroscope; then all phytoseiid mites were collected, mounted in Hoyer solution and identified to species.

In August of 2001 the survey was conducted according to the same methods. The leaf samples were collected in the regions of Skierniewice, Płońsk and Brzezna.

Some plantations surveyed in 2000 were investigated again and additionally four new plantations were included in the study.

Counts of *T. urticae* and *N. rubi* were compared between regions and between commercial and abandoned plantations surveyed in 2000. The data obtained expressing a number of active stages of mites per 10 leaves were transformed according to formula $y = \log (x + 1)$. The multiple range Duncan test was used to determine the significant differences between the means at probability level $p = 0.05$.

RESULTS

The results obtained in 2000 showed a significantly higher density of raspberry spider mite populations than those of two-spotted spider mite in regions of Płońsk, Brzezna and Czerwińsk (Tab. 1). There was no significant difference between the numbers of either species in Lublin region. Only in Skierniewice region the density of raspberry spider mite population was significantly lower than that of two-spotted spider mite. Here, the highest population density of *T. urticae* and the lowest of *N. rubi* were also observed.

Similarly, in 2001 raspberry spider mite was found to be dominant in six of eleven surveyed plantations (Tab. 2). Sometimes a very high density of its population was noticed and, for example in one sample taken in Brzezna (sample code 51/Brzezna) 38.8 active stages per leaf in 2000 and 24.6 in 2001 was counted.

Solely in the region of Płońsk and in the case of *N. rubi* only, the densities of mites in untreated (abandoned) plantations was significantly higher than that observed in treated (commercial) ones (Tab. 3). In the locality of Czerwińsk the leaf samples were collected only from commercial plantations, so that the pest distributions depending on the state of raspberry plantations could not be analyzed.

The results of the investigation showed that predatory phytoseiid mites occurred in 30 of 71 inspected plantations. They were the most numerous in southern Poland (Brzezna region) where their average number per leaf reached 0.4 specimens (Fig. 1). The highest density of the predators was also observed in this region and, in one location 1.7 mites per leaf was noticed. The abundance of phytoseiid mites on raspberry plants in Płońsk, Skierniewice and Lublin was much lower in comparison with Brzezna. Their average numbers in these areas were 0.08, 0.05 and 0.03 mites per leaf

Table 1. The populations density of the two-spotted spider mite *Tetranychus urticae* Koch and the raspberry spider mite *Neotetranychus rubi* (Träg) in different regions of Poland – August 2000

Region	Number of surveyed plantations	Active stages per leaf	
		T. urticae	*N. rubi*
Skierniewice	16	2.8 d	0.1 a
Płońsk	13	0.2 ab	0.9 c
Lublin	20	0.4 ab	0.5 b
Brzezna	13	0.4 ab	1.1 c
Czerwińsk	5	0.2 ab	0.9 c

Means in rows and columns followed by the same letter are not significantly different at $p = 0.05$, Duncan's multiple range test

Table 2. The population density of the two-spotted spider mite *Tetranychus urticae* Koch and the raspberry spider mite *Neotetranychus rubi* (Träg) in some raspberry plantations – Augusts 2000 and 2001

Plantation (sample code)/ Region of location	Active stages per leaf			
	2000		2001	
	T. urticae	*N. rubi*	*T. urticae*	*N. rubi*
69/Skierniewice	–	–	0	0.4
70/Skierniewice	–	–	0	0.5
12/Skierniewice	3.6	0	0.02	0
13/Skierniewice	16.1	0	2.0	0.02
68/Płońsk	–	–	0	0
21/Płońsk	1.5	0.3	0.8	0.2
71/Płońsk	–	–	0	8.9
51/Brzezna	7.5	38.8	0.04	24.6
52/Brzezna	0.1	0.1	0.2	0.5
59/Brzezna	0.2	0	0	0
60/Brzezna	0.6	13.2	0	4.0

Table 3. The occurrence of two-spotted spider mite *Tetranychus urticae* Koch and raspberry spider mite *Neotetranychus rubi* (Träg) on commercial (treated) and abandoned (untreated) raspberry plantations in Poland – August 2000

Region	Active stages per leaf			
	Tetranychus urticae Koch		*Neotetranychus rubi* (Träg)	
	Commercial (treated)	Abandoned (untreated)	Commercial (treated)	Abandoned (untreated)
Skierniewice	3.0 bc	3.4 c	0.2 ab	0.1 a
Płońsk	0.3 a	0.3 a	0.7 a	13.0 b
Lublin	0.7 a	0.1 a	0.6 a	0.9 a
Brzezna	0.3 a	0.7 a	0.7 a	1.6 a
Czerwińsk	0.2 a	–	1.1 b	–

Explanation – see table 1

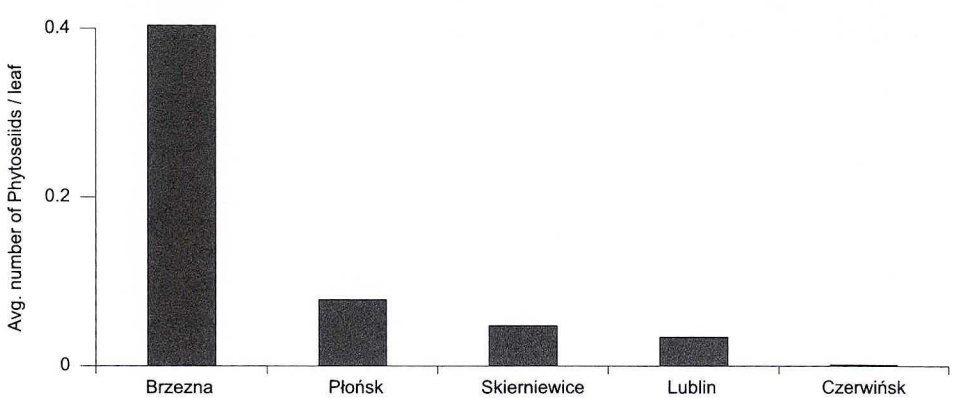

Fig. 1. The density of phytoseiid mites *(Phytoseiidae)* on raspberry plantations in different regions of Poland – August 2000

respectively. Almost no predatory mites were observed in plantations of Czerwińsk: only 3 specimens were found in all leaf samples collected from this region.

The following 11 species of phytoseiid mites were identified during the investigation: *Phytoseius juvenis* Wainstein & Arutunjan, *Amblyseius bryophilus* Karg, *Euseius finlandicus* (Oudemans), *Amblyseius andersoni* (Chant), *Neoseiulus fallacis* (Garman), *Amblyseius filixis* Karg, *Typhlodromus pyri* Scheuten, *Anthoseius rhenanus* (Oudemans), *Sejulus tiliarum* (Oudemans), *Neoseiulus reductus* (Wainstein), and *Prioprioseiopsis okanagensis* (Chant) (Tab. 4). First four species, *P. juvenis, A. bryophilus, E. finlandicus* and *A. andersoni* were the most numerous and consisted of 31.9%, 21.1%, 19.9% and 15.6% of all identified specimens, respectively.

Table 4. The species composition of phytoseiid mites (*Phytoseiidae*) on raspberry plantations and their distribution in different regions of Poland – August 2000

Species	% of identified specimens	Regions of the occurrence*	Total number of samples (plantations) containing a species	Found in plantations	
				Commercial (sprayed)	Abandoned (unsprayed)
Phytoseius juvenis Wainstein & Arutunjan	31.9	B	5	+	+
Amblyseius bryophilus Karg	21.1	S, L, B	4	–	+
Euseius finlandicus (Oudemans)	19.9	S, P, L	5	+	+
Amblyseius andersoni (Chant)	15.6	S, L, B	5	+	+
Neoseiulus fallacis (Garman)	5.4	S, B	4	–	+
Amblyseius filixis Karg	1.8	B	1	–	+
Typhlodromus pyri Scheuten	1.2	S	2	–	+
Antoseius rhenanus (Oudemans)	1.2	L	1	–	+
Sejulus tiliarum (Oudemans)	0.6	L	1	+	–
Neoseiulus reductus (Wainstein)	0.6	B	1	–	+
Prioprioseiopsis okanagensis (Chant)	0.6	L	1	+	–

*regions: S – Skierniewice, P – Płońsk, L – Lublin, B – Brzezna

DISCUSSION

The results obtained showed that both species of spider mites feeding on raspberry, *Tetranychus urticae* and *Neotetranychus rubi,* can occur in relatively high population density. It was especially surprising to find distinct and widespread infestation of cultivated raspberries with *N. rubi.* In Latvia, Petrov and Petrova (1985) documented increases of the populations as well as damage caused by this species in wild raspberries. Based on these results, they concluded that *N. rubi* can spread to, and rapidly multiply on cultivated raspberry plants too. Also at eighties, an increase of populations of this pest on cultivated, sprayed raspberry plantations in Poland has been noted by Michalska and Kropczyńska (2002). The study of the same authors on a competition between *T. urticae* and *N. rubi* on four raspberry cultivars has not shown a dominance of any of these species.

Such extensive incidence of *N. rubi* as a consequence of the development of resistance or tolerance of this species to pesticides typically applied in Polish raspberry production seems to be less probable (Gajek 2003). The main factor determining

the high densities of this species could be disruption of its natural enemies caused by the use of broad spectrum pesticides like synthetic pyrethroids. Thus, its population, especially in treated, commercial plantations might significantly increase. However, this explanation can not be fully accepted either. In such situation the visible increase of the population of two-spotted spider mite should also be observed. On the other hand, some food preferences of such natural enemies like phytoseiids may play important role here. If *T. urticae* is more preferred by phytoseiids than *N. rubi,* then the second one may inhabit raspberry plantations more intensively.

Some phytoseiid species found during the study are considered the most promising candidates for biological control of spider mites on raspberry. Considering the number of identified specimens *P. juvenis* was the most numerous but occurred only on fields in Brzezna. Moreover, this species represents a group of *Phytoseius* which is rather regarded as non-effective predator of phytophagous mites. *A. bryophilus* was also relatively abundant and occurred in four abandoned (unsprayed) plantations located in three areas. The occurrence of *A. bryophilus* only in unsprayed plantations suggests that it is highly susceptible to pesticides. Furthermore, the information in the literature on this species is scare, and therefore, its role in controlling of spider mites requires a better knowledge. Other two species, *E. finlandicus* and *A. andersoni* were found to be common, too. Both were present in three different areas and each inhabited five plantations, abandoned and commercial as well. Since they are already widespread, these species may prove especially valuable in the biological control of phytophagous mites on raspberry in Poland. Their wide distribution in other fruit crops and field margins was also established in other studies (Kropczyńska-Linkiewicz 1973; Tuovinen and Rokx 1991; Liguori 1995; Jaworski 2000). Although they commonly occur on various plants, they are known as efficient antagonists of spider mites (Sarthou et al. 1990; Tuovinen 1993; Tuovinen et al. 2000; Gajek and Niemczyk 2001). The occurrence of other species was infrequent.

Considering results presented here, the deployment of the phytoseiids for biological control of spider mites on raspberry seems to be possible in practice. Nevertheless, studies of the effectiveness of some phytoseiid species, such like *E. finlandicus* and *A. andersoni,* requires particular attention. Additionally, their food preferences in relation to *Tetranychus urticae* and *Neotetranychus rubi* have to be investigated.

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POLISH SUMMARY

SKŁAD GATUNKOWY PRZĘDZIORKÓW (*TETRANYCHIDAE*) I ROZTOCZY DRAPIEŻNYCH (*PHYTOSEIIDAE*) WYSTĘPUJACYCH NA PLANTACJACH MALIN W POLSCE

Poprzez nowoczesne, proekologiczne metody ochrony malin, tradycyjne wykorzystanie środków ochrony roślin ulega stałej redukcji. Do metod takich należy także biologiczne zwalczanie szkodliwych gatunków roztoczy tej uprawy. Przeprowadzone badania miały na celu określić w jakim stopniu metoda ta może być zastosowana na plantacjach malin w Polsce. W tym celu, w pierwszym etapie badań przeprowadzono obserwacje polowe nad występowaniem oraz składem gatunkowym zarówno przędziorków (*Tetranychidae*) jak i roztoczy drapieżnych z rodziny (*Phytoseiidae*).

W latach 2000–2001 przeprowadzono lustracje 71 plantacji, zlokalizowanych w pięciu rejonach uprawy malin: Skierniewice, Lublin, Nowy Sącz, Płock i Czerwińsk. Przeprowadzone analizy prób liści na obecność roztoczy wykazały, że w rejonie Lublina, Nowego Sącza, Płocka i Czerwińska dominującym gatunkiem przędziorka był przędziorek malinowiec *Neotetranychus rubi* (Träg.). Przędziorek chmielowiec *Tetranychus urticae* (Koch.), który do niedawna najliczniej zasiedlał maliny w warunkach Polski, okazał się gatunkiem dominującym jedynie w rejonie Skierniewic.

Na liściach malin stwierdzono także występowanie jedenastu gatunków roztoczy drapieżnych z rodziny *Phytoseiidae*. Jakkolwiek ich skład gatunkowy różnił się w zależności od rejonu obserwacji, najliczniej występującymi gatunkami były *Amblyseius bryophilus* Karg, *Euseius finlandicus* (Oudemans) and *Amblyseius andersoni* (Chant).

Przeprowadzone badania wykazały, że w warunkach Polski istnieje duży potencjał do zastosowania w praktyce biologicznych metod zwalczania przędziorków na plantacjach malin.