Witold DANELSKI, Teresa BADOWSKA-CZUBIK, Elżbieta ROZPARA
Research Institute of Horticulture, Skierniewice
ul. Pomologiczna 18, 96-100 Skierniewice, Poland
e-mail: witold.danelski@inhort.pl

OCCURRENCE OF THE APPLE RUST MITE *Aculus schlechtendali* (Nal.) IN ORGANIC CULTIVATION OF APPLE

Summary

A study was conducted in the IO Experimental Ecological Orchard in 2010-2014 to assess the severity of occurrence of the apple rust mite Aculus schlechtendali (Nal.) on apple trees of the cultivars 'Pinova' and 'Topaz' grown at two spacings: 3×1 m and 3.5×3 m. In wintertime, the recorded numbers of females overwintering under the buds on annual shoots were low: 0-3.6 females per bud. The number of rust mites in the summer was the lowest in 2011, with an average of 0.6-11.8 individuals per cm^2 of leaf surface area, and the highest in 2014, when it averaged 42.8-71.9 individuals / cm^2. The largest numbers of the apple rust mite were recorded on the leaves of trees of the cultivar 'Pinova' and the leaves of trees of both cultivars grown at the spacing of 3×1 m.
***Key words**: apple rust mite, Aculus schlechtendali, organic orchard*

WYSTĘPOWANIE PORDZEWIACZA JABŁONIOWEGO *Aculus schlechtendali* (Nal.) W EKOLOGICZNEJ UPRAWIE JABŁONI

Streszczenie

W Ekologicznym Sadzie Doświadczalnym IO, w latach 2010-2014 oceniono nasilenie występowania pordzewiacza jabłoniowego Aculus schlechtendali (Nal.) na drzewach jabłoni odmian 'Pinova' i 'Topaz' rosnących w dwóch rozstawach: 3 x 1 m i 3,5 x 3 m. W okresie zimowym notowano niską liczebność samic zimujących pod pąkami na pędach jednorocznych, która wyniosła 0-3,6 samic/1 pąk. Liczebność pordzewiacza w okresie letnim była najniższa w roku 2011 i wyniosła średnio 0,6-11,8 osobnika/cm^2 liścia, a największa w roku 2014 gdzie wyniosła średnio 42,8-71,9 osobnika/cm^2. Największą liczebność pordzewiacza zanotowano na liściach drzew odmiany 'Pinova' oraz na liściach drzew obydwu odmian rosnących w rozstawie 3 x 1m.
***Słowa kluczowe**: pordzewiacz jabłoniowy, Aculus schlechtendali, sad ekologiczny*

1. Introduction

The apple rust mite *Aculus schlechtendali* (Nal.) inhabits only apple trees and is commonly found in Europe, North America, Asia and Australia [1, 7]. Mild winters and warm summers are conducive to the development of this mite in Poland [6]. In Polish climatic conditions, five generations of the apple rust mite can be found on apple trees [7]. The risk threshold adopted for this mite is from 10 to 40 individuals / cm^2 of leaf surface [3]. The apple rust mite feeds on flowers, developing fruits, and on the underside of leaves. As a result of its feeding activity, light spots appear on the leaves already at the beginning of June. These spots eventually merge and turn brown, and the leaves curl up along the main nerve [7, 12]. The presence of the apple rust mite in numbers of more than 50 per cm^2 can reduce the efficiency of photosynthesis [12]. In the event of this mite occurring in very large numbers, the leaves on which it feeds can wither and fall off, which can inhibit the growth of the affected trees [5]. If the rust mite occurs in large numbers in the spring, it later causes the characteristic russeting of apples [1]. The harmfulness of the apple rust mite has been variously assessed in the literature. In Great Britain, it was found responsible for reduced yielding of trees as a result of lower levels of fruit setting, whereas in Norway the impact of this mite on fruit yield has not been confirmed [8].

2. Material and methods

The study was conducted in 2010-2014, in a plot of the IO Experimental Ecological Orchard (EEO) with apple trees of two cultivars that are commonly recommended for organic farming – 'Pinova' and 'Topaz'. Trees of these cultivars were grown at two spacings: 3×1 m and 3.5×3 m. In early spring, winter surveys of the trees were performed by sampling shoots and examining them for the presence of overwintering deutogyne females of the apple rust mite. In the summer, leaf samples were collected on three dates: in June, July and August. Each test sample consisted of at least 40 leaves, which were used to determine the number of rust mites on 1 cm^2 of leaf surface. All of the assessments were performed using a stereomicroscope. In the experimental plot of the orchard, a plant protection programme was conducted involving the use of preparations permitted, in a given year, in organic farming in Poland. In springtime, treatments against spider mites were performed with preparations based on paraffin oil (Promanal 60 EC or Treol 770 EC). During the growing season, protective treatments against diseases were performed using copper and sulphur preparations (Miedzian 50 WP, Miedzian extra 350 SC, Siarkol extra 80 WP), and against pests using spinosad (SpinTor 240 SC), the cydia pomonella granulosis virus (Madex SC), and horticultural potassium soap. The results obtained during the observations were compared by means of Statistica 10 software using Duncan's test at $p = 0.05$.

3. Results and discussion

The numbers of the apple rust mite found in the Experimental Ecological Orchard varied. During the winter

surveys, the recorded numbers of deutogyne females under the buds on annual shoots were low (Tab. 1). The small numbers of females recorded during early spring are associated with the meteorological conditions during winter. The occurrence of low temperatures in the winter and early spring in the orchard (Fig. 2) resulted in the number of overwintering females remaining at a low level. Kozłowski and Boczek [10] have reported that the mortality rate of deutogyne females in the winter is 24-50%, and during the early spring 29-36%.

Table 1. Results of winter surveys for the presence of females of the apple rust mite in 2010-2014
Tab. 1. Wyniki lustracji zimowej na obecność samic pordzewiacza jabłoniowego w latach 2010-2014

Cultivar / Year	Average number of females per bud				
	2010	2011	2012	2013	2014
Pinova	0,5	0	3,6	0,1	0,8
Topaz	2,5	0	0,1	0	3,2

Source: own work / Źródło: opracowanie własne

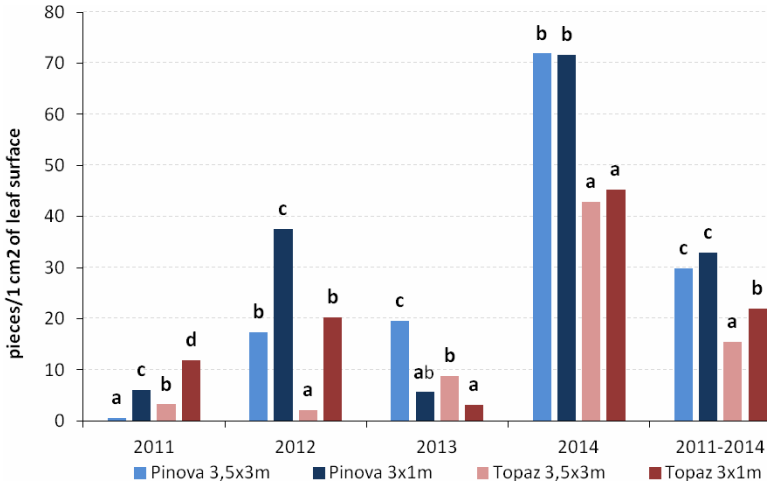
The numbers of the apple rust mite on the leaves assessed during the growing season also varied. The highest number of rust mites per 1 cm^2 of leaf surface was recorded in the samples collected in August (2012) and July (2011, 2013, 2014). In the years 2011-2014, the apple rust mite inhabited more willingly the trees growing at the spacing of 3×1 m (Tab. 2). Comparing the number of deutogyne females during the early spring with the subsequent number of mites on the leaves, it can be seen that the population of the mite developed better on apple trees of the cultivar 'Pinova'. In 2012, there were considerably more females overwintering on the shoots of the cultivar 'Pinova', and also more mites on the leaves of this cultivar. In 2014, significantly more overwintering females were recorded on the shoots of the cultivar 'Topaz' than the cultivar 'Pinova', but during the summer the growth of the population of the rust mite on the latter cultivar was significantly higher, which was reflected in the greater numbers of this mite on the leaves. In that year, there were almost twice as many rust mites on the leaves of the cultivar 'Pinova' than on the leaves of the cultivar 'Topaz'. Differences in the colonization of cultivars by the apple rust mite have been reported by Kozłowski and Boczek [10, 11], Kozłowski [9], and Badowska-Czubik and Olszak [2, 4].

In 2011-2013, the numbers of the apple rust mite on leaves were at relatively low levels. The average number of these mites was within the range from 0 to about 20 individuals per cm^2 of leaf surface, depending on the cultivar and tree spacing. An exception was, in 2013, the cultivar 'Pinova' grown at the spacing of 3×1 m (Fig. 1). The relatively low numbers of rust mites were influenced by low temperatures prevailing in the winter (Fig. 2) and the annual treatments with the preparation Siarkol extra 80 WP. Badowska-Czubik and Olszak [3, 4] have reported on the high efficacy of this fungicide in reducing the numbers of the apple rust mite, and that when comparing the populations of these mites in integrated and organic crops, their numbers are much smaller in the latter. In 2014, the recorded numbers of the rust mite were the highest (Fig. 1) regardless of tree spacing. The cultivar 'Pinova' was colonized by the apple rust mite to a much greater extent. The treatment with the sulphur preparation against the powdery mildew of apple had no effect on reducing the numbers of this mite.

Table 2. Results of summer surveys for the presence of the apple rust mite on the leaves of apple cultivars 'Pinova' and 'Topaz'
Tab. 2. Wyniki lustracji letniej na obecność pordzewiacza jabłoniowego na liściach jabłoni odmian 'Pinova' i 'Topaz'

Tree spacing / date	Average number of apple rust mites per 1 cm^2 of leaf surface.											
	2011			2012			2013			2014		
	VI	VII	VIII	VI	VII	VIII	VI	VII	VIII	VI	VII	VIII
Pinova												
Spacing 3,5x3m	0,0a	1,5a	0,2b	7,9a	35,2d	9,0ab	0,7b	57,8c	0,2a	21,0b	194,5c	0,2ab
Spacing 3x1m	1,0a	16,9c	0,0a	24,2b	14,0b	74,7c	0,0a	15,8ab	1,0c	15,3ab	199,2c	0,2ab
Topaz												
Spacing 3,5x3m	0,0a	9,4b	0,2b	2,4a	3,8a	0,1a	0,9c	24,7b	0,4b	40,9c	87,4a	0,3b
Spacing 3x1m	0,0a	35,5d	0,0a	22,9b	22,4c	15,4b	0,0a	9,1a	0,3ab	10,9a	124,5b	0,1a

Source: own work / Źródło: opracowanie własne



Source: own work / Źródło: opracowanie własne

Fig. 1. Average number of apple rust mites on the leaves of apple trees in 2011-2014
Rys. 1. Średnia liczba pordzewiacza jabłoniowego na liściach jabłoni w latach 2011-2014

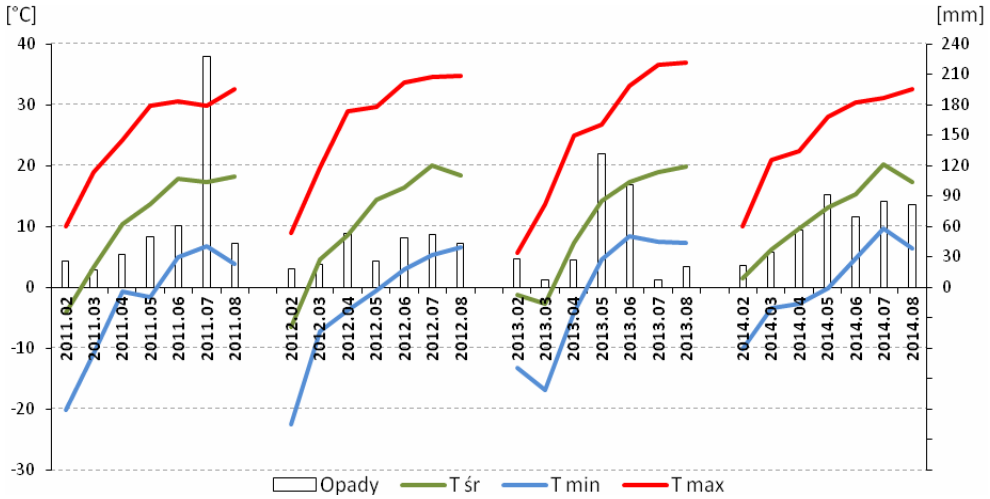


Fig. 2. Weather conditions in EEO in 2011-2014
Rys. 2. Warunki atmosferyczne w ESD, w latach 2011-2014

4. Summary

In 2011-2014, the recorded numbers of the apple rust mite overwintering under the buds on annual shoots were very low. In summertime, the average number of these mites on leaves was the lowest in 2011 and the highest in 2014. In 2011-2013, performing treatments with preparations based on paraffin oil in early spring and with a sulphur preparation in the summer had a positive influence on reducing the numbers of the apple rust mite. In 2014, weather conditions favourable to the development of this mite neutralized the effect of the applied pesticides. The occurrence of mild winters and warm summer periods in central Poland is likely to favour a further increase in the numbers of the apple rust mite in organic orchards. The limited number of plant protection products permitted in organic fruit-growing is a factor contributing to this increase.

5. References

[1] Alford D.V.: Pests of Fruit Crops. A Colour Handbook. 2ed Ed. CRC Press, 2014.: 411-412.
[2] Badowska-Czubik T., Olszak R.W.: Zasiedlenie wybranych odmian jabłoni przez pordzewiacza jabłoniowego *Aculus schlechtendali* (Nal.) Acarina: Eriophyidae. Zeszyty Nauk. ISK, 2003, 11: 51-57.
[3] Badowska-Czubik T., Olszak R.W.: Wpływ wybranych fungicydów na populację pordzewiacza jabłoniowego *Aculus schlechtendali* (Nal.) Acarina: Eriophyidae. Ogólnopol. Nauk. Konf. Ochr. Rośl. Skierniewice, 25-26 lutego 2004. Materiały konferencyjne: 105-107.
[4] Badowska-Czubik T., Olszak R.W.: Liczebność pordzewiacza jabłoniowego *Aculus schlechtendali* nadrzewach odmiany 'Jonagold' prowadzonych metodą integrowaną i ekologiczną. Ogólnopol. Konf. Ochr. Rośl. Sad., Skierniewice, 12-13 lutego 2008: 162-163.
[5] Badowska-Czubik T., Pala E. Pordzewiacz jabłoniowy, Aculus schlechtendali (Nal.) – szkodnik jabłoni. Ochrona Roślin, 1993, 10: 12-13.
[6] Badwoska-Czubik T., Suski Z.W.: Występowanie, szkodliwość i zwalczanie pordzewiaczy w uprawach sadowniczych. Prace Inst. Sad. i Kwiac. Seria C, 1993, 1-2/117-118: 35-38.
[7] Boczek J. Zarys akarologii rolniczej. Warszawa: PWN, 1999, 186-187.
[8] Boczek J., Błaszak Cz.: Roztocze (Acari). Znaczenie w życiu i gospodarce człowieka. Wyd. SGGW, 2005: 175-176.
[9] Kozłowski J.: Czynniki warunkujące wrażliwość odmian jabłoni i reakcja odmian na pordzewiacza jabłoniowego – *Aculus schlechtendali* (Nalepa). Rozprawy Naukowe IOR, Poznań: Wyd. IOR, 1998.
[10] Kozłowski J., Boczek J.: Density and host plants of the apple rust mite – *Aculus schlechtendali* (Nal.) (Acarina: Eriophyoidea). Pr. Nauk. IOR, 1987: 29(1): 39-50.
[11] Kozłowski J., Boczek J.: Overwintering of the apple rust mite *Aculus schlechtendali* (Nal.) (Acarina: Eriophyoidea). Pr. Nauk. IOR, 1987, 29(1): 51-62.
[12] Marjorie H.A.: Agricultural Acarology: introduction to integrated mite management. CRC Press, 2011: 116.