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Observations of leaf blister mites from the genus *Eriophyes* (Acari: Eriophyoidea) infesting pear trees of Konferencja cultivar

Obserwacje podskórników z rodzaju *Eriophyes* (Acari: Eriophyoidea) zasiedlających drzewa gruszy odmiany Konferencja

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Summary

Leaf blister mites (*Eriophyes* sp.) belong to the superfamily of eriophyoid mites (Acari: Eriophyoidea) and infest trees from the family Rosaceae. Their feeding activity initiate formation of small blistered galls on leaves and flower buds in spring. In 2016 and 2017 observations of leaf blister mites infesting pear trees of Konferencja cultivar were carried out. The aim of observations was to show a general outline of changes in population of leaf blister mites happening during the growing season as well as to indicate, in which period within the year the most intensive occurrence of these pests should be expected. In 2016 the trees were infested more severely than in 2017. In both years the most rapid changes in number of leaf blister mites present on leaves were noticed in May when intensive population growth took place and in September when their population intensively decreased. Based on the course of changes in assessed parameters it can be supposed that generations living in summertime may not have an ability to create galls.

Key words: eriophyoid mites, pear, infestation, galls

Streszczenie

Podskórniki (*Eriopyes* sp.) należą do nadrodziny szpecieli (Acari: Eriophyoidea) i zasiedlają drzewa z rodziny różowatych (Rosaceae). W okresie wiosennym podczas żerowania inicjują powstawanie niewielkich, pęcherzykowatych galasów na liściach i zawiązkach kwiatów. W latach 2016 i 2017 wykonane zostały obserwacje podskórników zasiedlających drzewa gruszy odmiany Konferencja. Celem obserwacji było przedstawienie ogólnego zarysu zmian zachodzących w populacji podskórników podczas sezonu wegetacyjnego, jak również wskazanie, w którym okresie w ciągu roku należy spodziewać się najbardziej intensywnego występowania tych szkodników. W roku 2016 drzewa były dużo silniej zasiedlone aniżeli w roku 2017. W obydwu latach najbardziej gwałtowne zmiany w liczebności podskórników żyjących na liściach zostały zauważone w maju, kiedy miał miejsce intensywny wzrost populacji oraz we wrześniu, kiedy to ich liczba silnie malała. Na podstawie przebiegu zmian w podlegających ocenie parametrach można przypuszczać, iż pokolenia żyjące w okresie letnim mogą nie posiadać zdolności tworzenia galasów.

Słowa kluczowe: szpeciele, grusza, zasiedlenie, galasy

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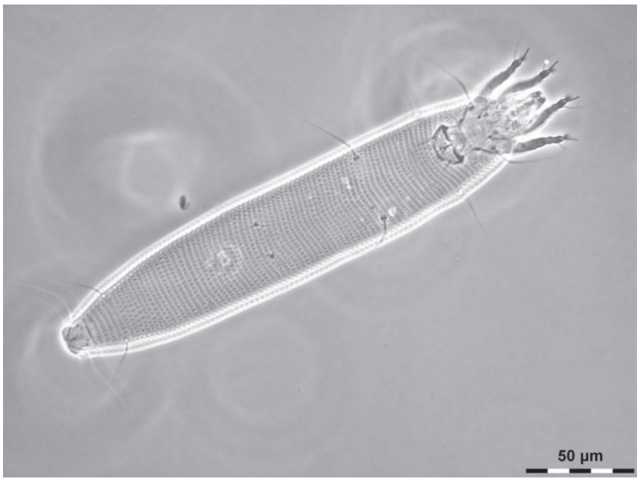
Wstęp / Introduction

Leaf blister mites (*Eriophyes* sp.) (Fig. 1) belong to the superfamily of eriophyoid mites (Acari: Eriophyoidea) and are worldwide distributed. Eriophyoid mites are obligatory phytophages and can live on all parts of plants apart from roots (Skoracka *et al.* 2010). They are economically important pests and cause certain agricultural problems in many countries all over the world (Ali Hammad 2004; Vidović *et al*. 2014). Eriophyoid mites are in majority highly specific regarding the host plant, however some eriophyoids may infest more than one host plant species (Skoracka *et al.* 2010; Kiedrowicz *et al.* 2017).



Rys. 1. Obraz mikroskopowy podskórnika (powiększenie 400x)
Fig. 1. Microscopic picture of leaf blister mite (magnification 400x)
(fotografia autora – author's photo)

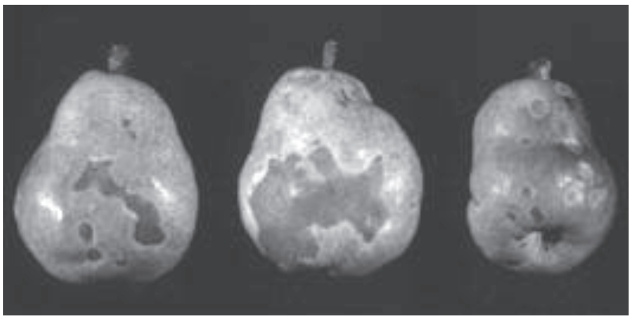
Eriophyoid mites are divided into three groups: free-living mites, refuge-seeking mites and gall-making mites. Free-living mites are also called vagrants and occur only on a plant surface. Refuge-seeking mites can also be observed on a plant surface, except it they get into places such as air cavities on leaves etc. There are some reports that refuge-seeking mites have been found under the leaf epidermis (Petanović and Kiełkiewicz 2010). Gall-making mites induce forming galls and erinea on young leaves, flower buds or shoots, and inside these formations they later live and reproduce. Depending on a mite species galls or erinea can have different size and shape (Wawrzynski *et al.* 2005; Nasareen and Ramani 2014). Furthermore, many species of eriophyoid mites transmit plant viruses and constitute a serious threat to different kind of crops (Navia *et al.* 2012; Nasareen and Ramani 2014; de Lillo *et al.* 2015).

Leaf blister mites belong to the gall-making mites. They infest several plants from the family Rosaceae, like pear (*Pyrus* sp.), apple (*Malus* sp.), European mountain ash (*Sorbus aucuparia* Linnaeus, 1753) or quince (*Cydonia oblonga* Miller, 1754) (Larsen 2011). Till now the exact taxonomical status of leaf blister mites has not been clearly defined. Indeed, in literature data and several reports the leaf blister mites living on different plants were usually presented as separate species, however based on morphological similarities they were also considered to constitute one species – pear leaf blister mite (*Eriophyes pyri* Pagenstecher, 1857) (Nalepa 1925).

Leaf blister mites may have an economic importance in orchards, however, they also infest backyard trees (Larsen 2011). They overwinter sheltered under the bud scales. In late winter, females living in buds lay eggs, from which the first generation will develop (Alston *et al.* 2012). In early spring, when bud swelling occurs, adults and immature stages increase their activity and start feeding intensively, which results in formation of small blistered galls on the abaxial surface of leaves and on flower buds (Fig. 4). Inside these galls, females lay eggs followed later by development of next generations (Gratwick 1992; Easterbrook 1996; Murray and de Francesco 2014). Depending on a climate, type 3–4 generations can be recorded within the year, however, in some cases even 5 generations might occur (Sekrecka and Hołdaj 2013; Boczek and Lewandowski 2016). Galls at the beginning are greenish or yellowish. After short time they change color and finally become brown or blackish and necrotic. Numerous presences of galls affect the photosynthesis efficiency. Severe infestation of mites can cause a premature leaf fall and in consequence significant fruit yield decrease (Gratwick 1992; Alston *et al.* 2012; Badowska-Czubik *et al.* 2014; Murray and de Francesco 2014). Sometimes also fruits are damaged by leaf blister mites and one can observe symptoms such as scarring and russeting (Fig. 2). These symptoms result from galls formed on flower buds during blooming or before (Larsen 2011).

Leaf blister mites are relatively difficult to control because of their sheltered lifestyle. An important aspect in limiting their occurrence is to follow all agrotechnical principles and cultivation of cultivars resistant to phytophagous mites. In case of chemical methods very significant is to perform treatments only when leaf blister mites are present on a plant surface. Otherwise the treatment will not bring expected effects. Relatively satisfying results brings introducing into orchards predatory mite *Typhlodromus pyri* Scheuten, 1857 as a biocontrol agent against leaf blister mites (Praslička *et al.* 2011). Introduction consists of placing special cloth strips containing specimens of this predatory mite on stems or branches (Sekrecka and Niemczyk 2006).

The aim of this study was to show a general outline of changes coming during the growing season in population of leaf blister mites occurring on pear trees (*Pyrus communis* Linneaus, 1753) of Konferencja cultivar. Because of



Rys. 2. Owoce gruszy uszkodzone przez podskórniki
Fig. 2. Pear fruit damaged by leaf blister mites
(http://jenny.tfrec.wsu.edu, autor – author: H. Riedl)

Rys. 3. Dokładna lokalizacja sadu (białe pole)
Fig. 3. Exact localization of orchard (white field)
(https://www.google.pl/maps)

the fact that leaf blister mites are considered as significant pests in orchards and Konferencja cultivar is one of the most popular pear cultivars planted in Poland, the study was also aimed to indicate, in which period within the growing season the mites would occur the most intensively on pear trees. This information is important and to some extend might be helpful at deciding about controlling these pests in pear orchards. Similar observations were carried out by Boczek and Szewczyk (1970), however, the difference is that this study concentrated on a particular pear cultivar. Nowadays, especially in a face of European Union law regarding the integrated pest management (IPM), detailed knowledge about different harmful organisms in agriculture and horticulture is considerably more meaningful than earlier. The observations made in this study allow to become better acquainted with the subject of leaf blister mites and their harmfulness.

Materiały i metody / Materials and methods

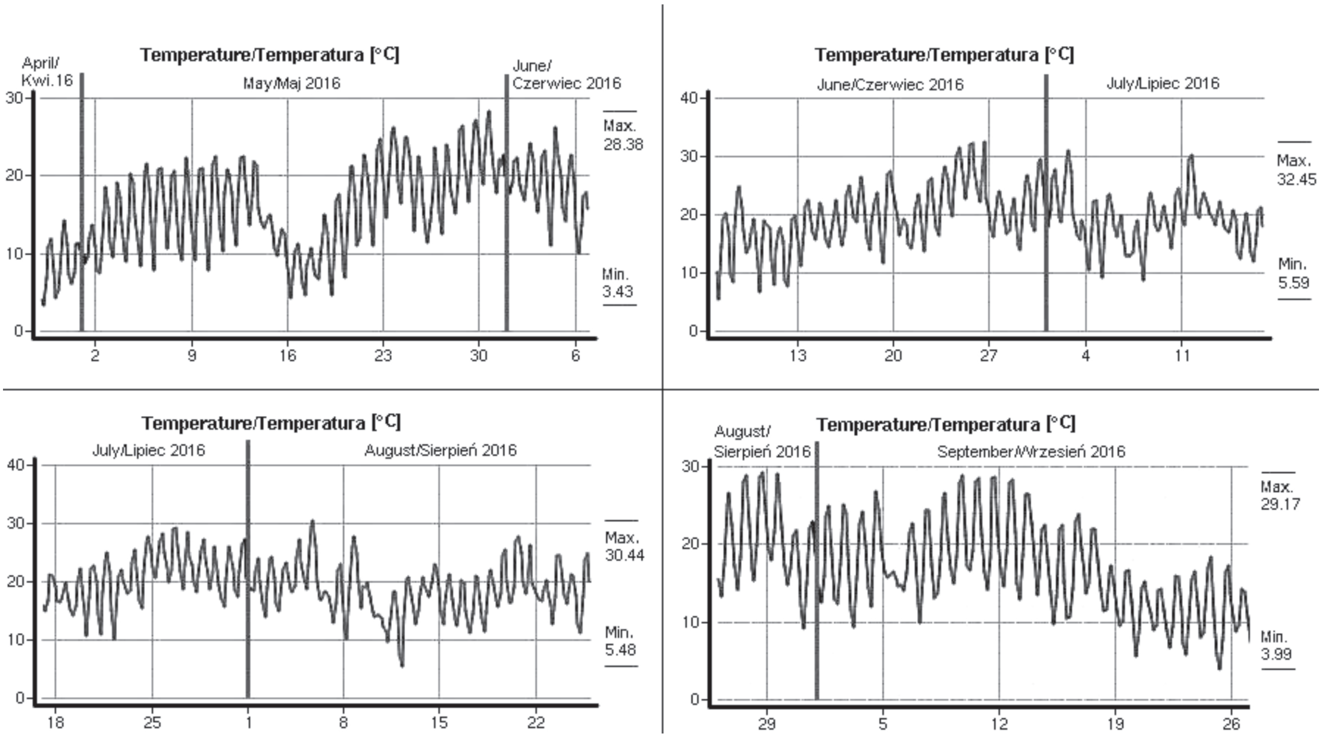
The observations were carried out on pear trees of Konferencja cultivar growing in a small orchard belonging to the Department of Pomology of Warsaw University of Life Sciences in years 2016–2017. The orchard was situated in Warsaw, in northern part of Ursynów district, in the neighborhood of Nowoursynowska Street (Fig. 3).

In orchard apart from pear trees of Konferencja cultivar there were also some Asian pear cultivars like Chojuro, Hosui, as well as Shinseiki and another fruit trees like apple trees, plum trees and apricot trees. All pear trees growing in orchard were planted in 1999, therefore their age during the observations was 17–18 years. The spacing between pear tree rows was 4 m, the distance between trees in row was 2.5 m. Pear trees were about 3.5–4 m high. None chemical treatments with plant protection products and fertilizers were performed in the orchard. Within the whole period of making observations only once some mechanical operation consisting of trimming branches was carried out and it took place around the turn of March and April in 2017.

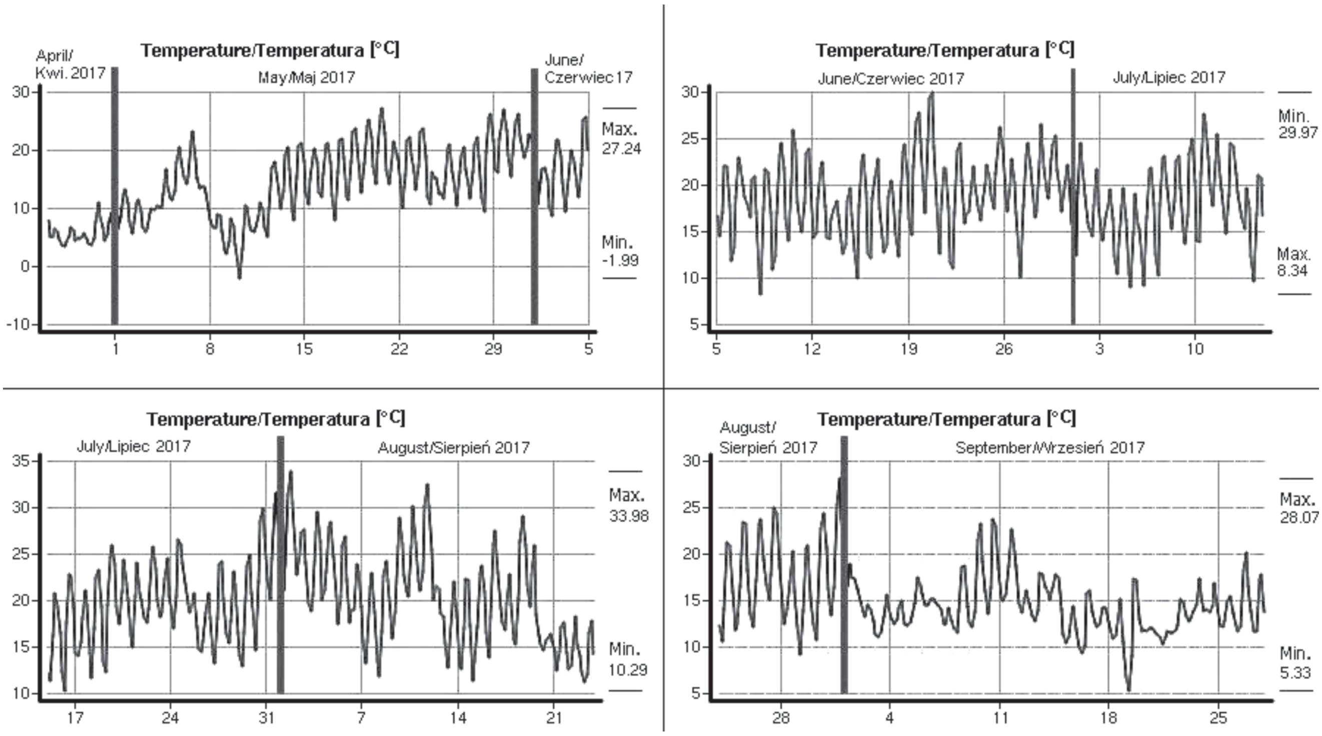
The distribution of weather conditions and temperature in 2017 was different in comparison to 2016, especially regarding precipitation (Fig. 5–10). In both years, the observations were made in few weeks apart, from the third decade of April until the third decade of September. The dates of individual observations in both years were similar to each other.

During every single observation 30 branch fragments were collected (Fig. 4). The experimental material was collected each time from the same 15 trees (2 fragments were always cut from 1 tree). Because different pear cultivars grew next to each other, at the beginning trees of Konferencja cultivar were identified using a scheme illustrating the collocation of cultivars in orchard and later the research material was collected only from those trees. Fragments were cut from randomly chosen younger

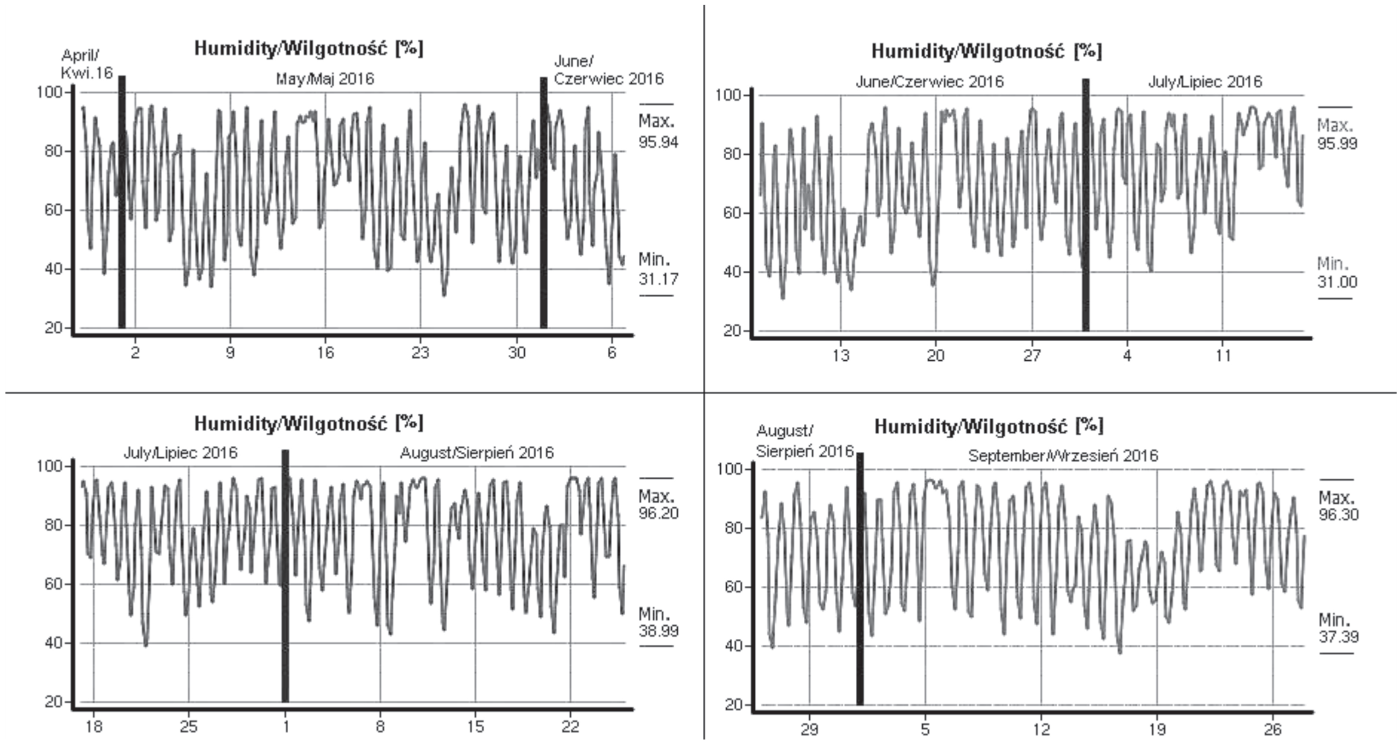
Rys. 4. Porażony fragment gałązki z gruszy odmiany Konferencja zebrany w sadzie podczas obserwacji w 2016 roku
Fig. 4. Infested branch fragment from pear tree of Konferencja cultivar collected in orchard during the observations in 2016
(fotografia autora – author's photo)



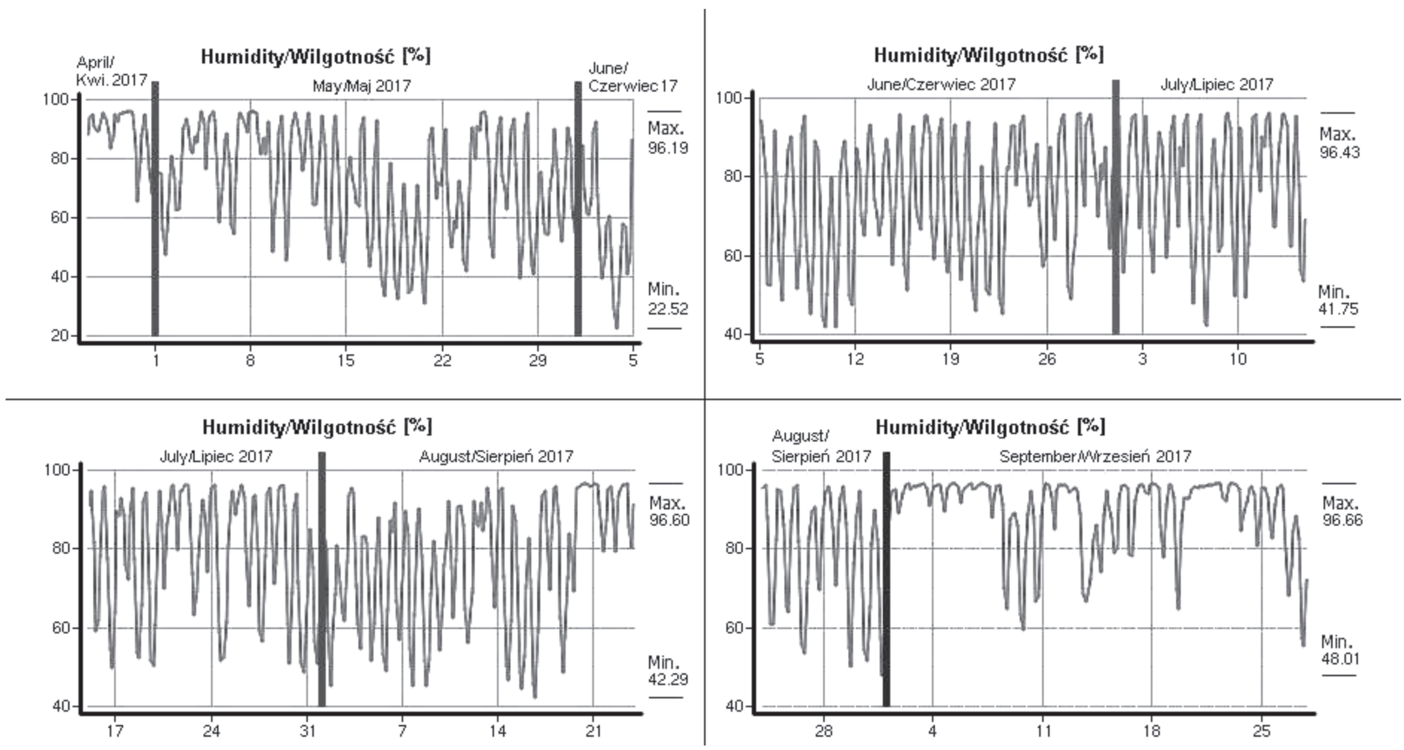
Rys. 5. Rozkład temperatury w Warszawie podczas całego okresu wykonywania obserwacji w 2016 roku
Fig. 5. Distribution of temperature in Warsaw during the whole period of making observations in 2016 (http://www.meteo.waw.pl)



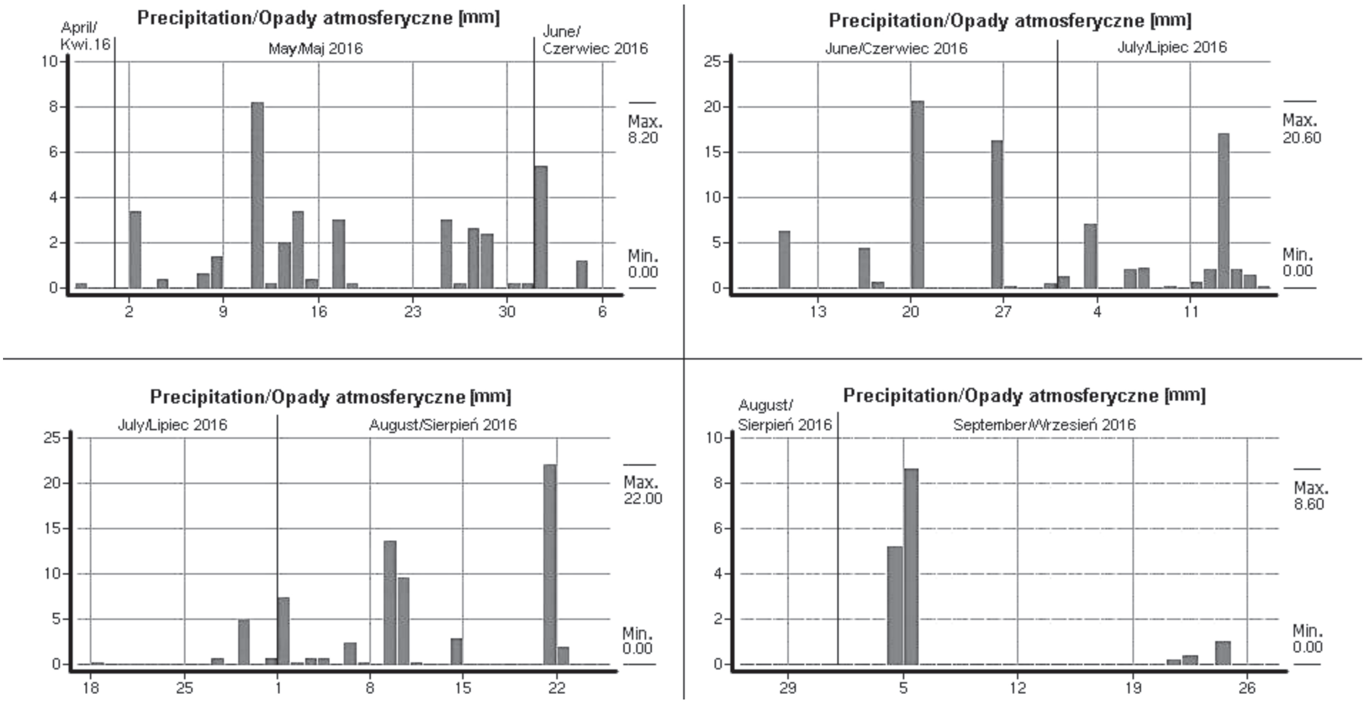
Rys. 6. Rozkład temperatury w Warszawie podczas całego okresu wykonywania obserwacji w 2017 roku
Fig. 6. Distribution of temperature in Warsaw during the whole period of making observations in 2017 (http://www.meteo.waw.pl)



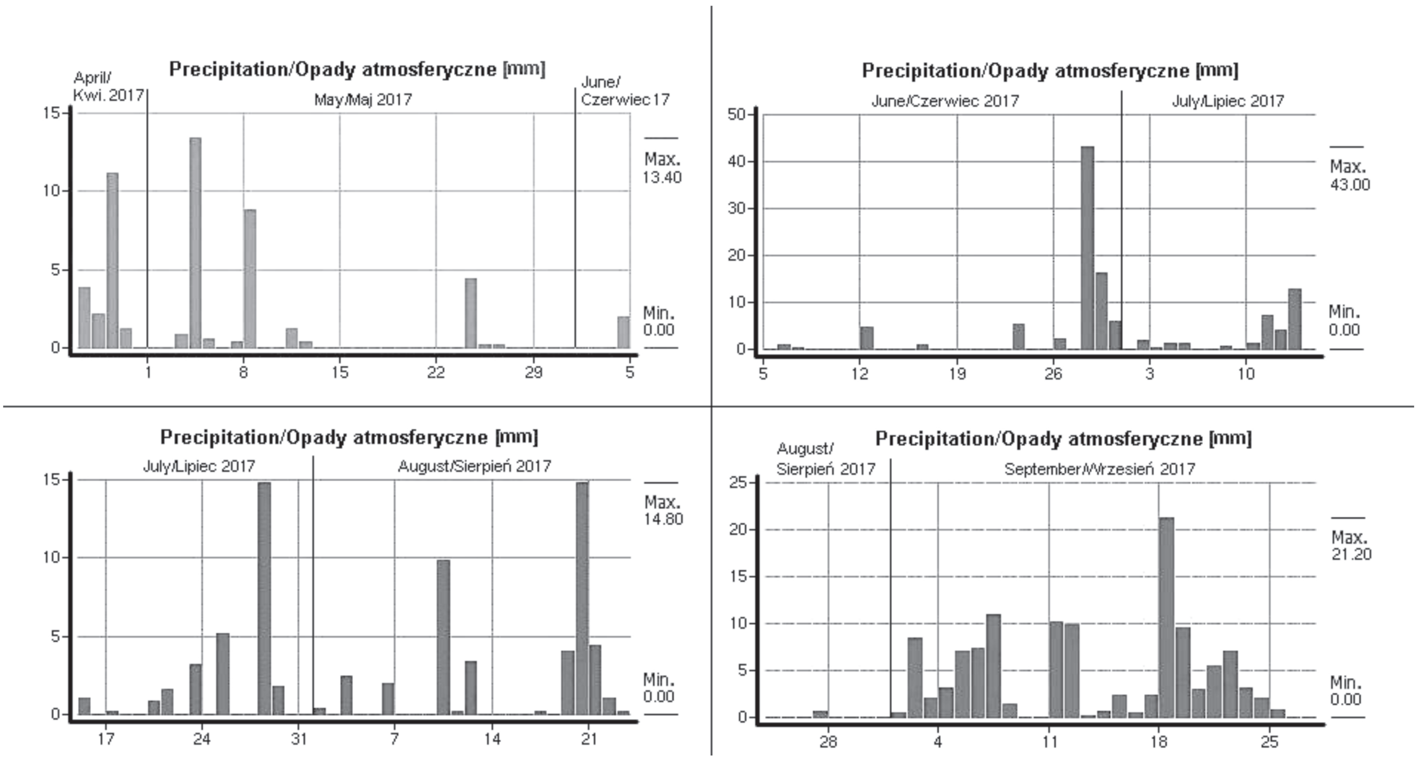
Rys. 7. Rozkład wilgotności w Warszawie podczas całego okresu wykonywania obserwacji w 2016 roku
Fig. 7. Distribution of humidity in Warsaw during the whole period of making observations in 2016 (http://www.meteo.waw.pl)



Rys. 8. Rozkład wilgotności w Warszawie podczas całego okresu wykonywania obserwacji w 2017 roku
Fig. 8. Distribution of humidity in Warsaw during the whole period of making observations in 2017 (http://www.meteo.waw.pl)



Rys. 9. Rozkład opadów atmosferycznych w Warszawie podczas całego okresu wykonywania obserwacji w 2016 roku
Fig. 9. Distribution of percipitation in Warsaw during the whole period of making observations in 2016 (http://www.meteo.waw.pl)



Rys. 10. Rozkład opadów atmosferycznych w Warszawie podczas całego okresu wykonywania obserwacji w 2017 roku
Fig. 10. Distribution of percipitation in Warsaw during the whole period of making observations in 2017 (http://www.meteo.waw.pl)

(2-year-old) as well as older branches situated in lower, middle and upper parts of trees. Leaves growing on collected fragments were in majority fully developed and present during previous observations. A small part of collected leaves was produced in a time between particular samplings.

The collected samples were packed into plastic string bags and taken to the laboratory. From each collected fragment, one rosette of leaves was removed and each leaf from such rosette was exactly checked under binocular for the symptoms of infestation of leaf blister mites. In 2016 from 140 to 186 leaves were checked during individual observations, whereas in 2017 from 162 to 194 leaves. These differences resulted from various number of leaves in rosettes.

Leaves, on which at least one gall was found, were considered as infested and galls on infested leaves were counted. Furthermore, up to 10 galls on each infested leaf were opened in order to check, if they were populated by mites. The gall evaluation considered presence or absence of mites inside the galls. The galls were considered as populated only if at least one alive mite specimen at stage of larva, nymph or adult was present. The percentage of mite occurrence was calculated based on the number of populated galls on each individual infested leaf.

The results received from carried out observations were analyzed by the use of Microsoft Excel and STATISTICA (version 12.5 and 13). For each individual observation was calculated the prevalence which describes the percentage of leaves infested by mites in relation to the total of leaves checked during the single observation. The values of prevalence were developed and presented on graphs. The values of parameters regarding the number of galls on leaves and the percentage of populated galls on infested leaves were elaborated using the method of Friedman's ANOVA and additionally were illustrated by drawing up the graphs of averages with ±0.95 confidence interval.

Wyniki i dyskusja / Results and discussion

Ekstensywność zasiedlenia – Prevalence

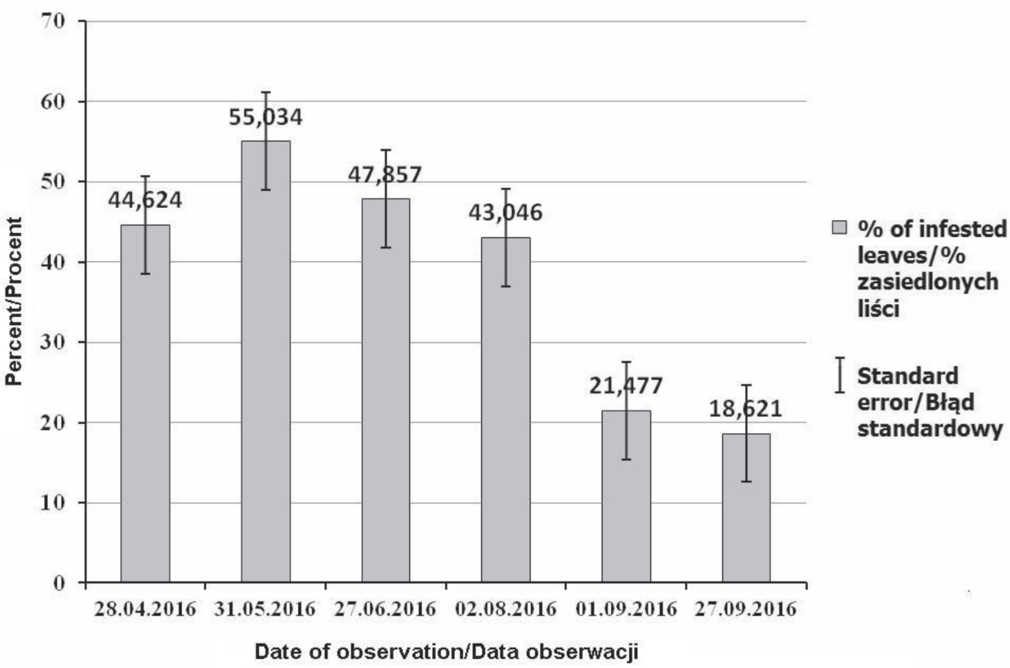
The graphs of prevalence (Fig. 11–12) show a considerable difference regarding the infestation between both years. In 2017 the percentage of infested leaves was much lower than in 2016 and in both years an increase of infestation was recorded in May, while a decline in August and September.

Średnia liczba galasów na liść – Average number of galls per leaf

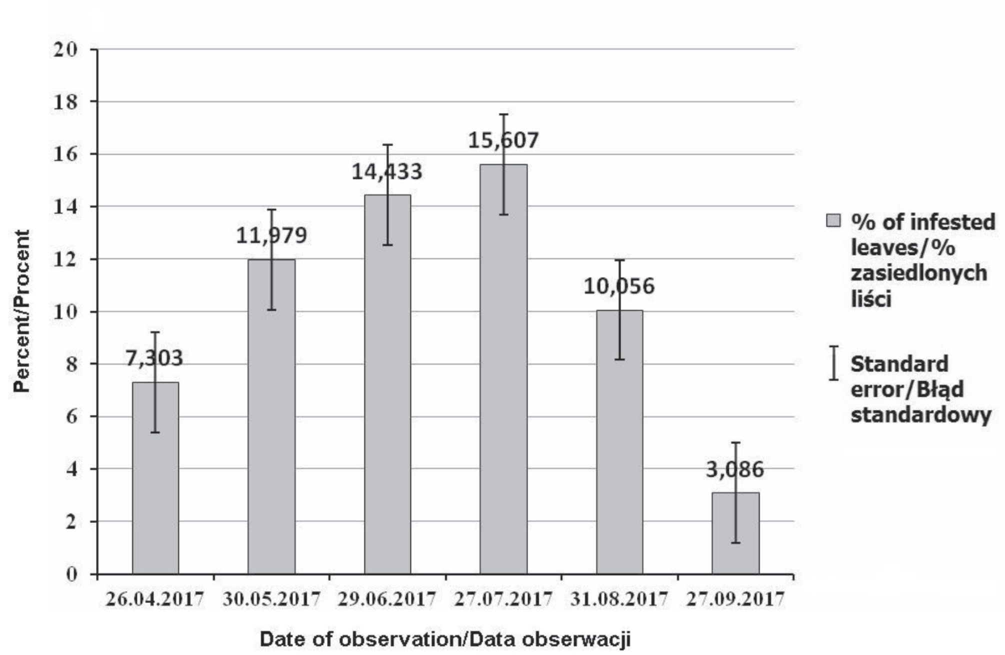
In 2017 (Tab. 2, Fig. 14) the number of galls present on leaves was much lower in comparison to 2016 (Tab. 1, Fig. 13). At the end of September 2017, the leaves collected from trees were almost free from infestation symptoms. The distribution of values for this parameter clearly differs between 2016 and 2017, however in both years it noticeable decreased in August and September.

Średni udział procentowy zasiedlonych galasów na porażonych liściach – Average percentage of populated galls on infested leaves

The distribution of values for this parameter in both years is very similar and the differences are very slight



Rys. 11. Ekstensywność zasiedlenia w 2016 roku
Fig. 11. Prevalence in 2016



Rys. 12. Ekstensywność zasiedlenia w 2017 roku
Fig. 12. Prevalence in 2017

(Tab. 3–4, Fig. 15–16). The most intensive growth was noticeable in May. During the summertime the percentage of populated galls was evidently lower in comparison to May and June. Both in 2016 and 2017 the biggest decline was perceivable in September.

Although the research carried out by Badowska-Czubik *et al.* (2014) showed that Konferencja cultivar is less susceptible to leaf blister mites in comparison to some other cultivars, like Faworytka or Erika, the symptoms of infestation were in general clearly noticeable and on some branches even quite intensive.

A considerable difference regarding the infestation level between both years probably was caused mainly by mechanical activities consisting on trimming branches carried out in early spring of 2017. In consequence some buds probably populated by overwintering mites were removed from trees. Furthermore, pear trees in 2017 were greater infested by some other agrophages, like pear psylla (*Cacopsylla pyri* Linnaeus, 1758), pear scab diesease (*Venturia pirina* Aderhold, 1896), and pear rust disease [*Gymnosporangium sabinae* (Dickson) G. Winter, 1884]. More intensive appearance of those agrophages also could

Tabela 1. Liczba galasów na liściach w 2016 roku – tabela ANOVA
Table 1. Number of galls on leaves in 2016 – ANOVA table

Liczba galasów na liściach w 2016 roku Number of galls on leaves in 2016	ANOVA Friedmana i współczynnik zgodności Kendalla Friedman's ANOVA and Kendall's compatibility factor Chi kwadrat ANOVA – Chi square ANOVA/ (N = 140, df = 5) = 54, 32596 p = 0,00000 współczynnik zgodności – compatibility factor = 0,07761 r średnich rang – r average ranks = 0,07097			
	średnia ranga average rank	suma rang sum of ranks	średnia average	odchylenie standardowe standard deviation
28.04.2016	3,575000	500,5000	35,10714	74,98371
31.05.2016	4,025000	563,5000	61,30714	99,54500
27.06.2016	3,700000	518,0000	28,00000	51,14136
02.08.2016	3,753571	525,5000	39,51429	79,63952
01.09.2016	3,082143	431,5000	17,93571	37,91209
27.09.2016	2,864286	401,0000	10,92857	37,58169

Tabela 2. Liczba galasów na liściach w 2017 roku – tabela ANOVA
Table 2. Number of galls on leaves in 2017 – ANOVA table

Liczba galasów na liściach w 2017 roku Number of galls on leaves in 2017	ANOVA Friedmana i współczynnik zgodności Kendalla Friedman's ANOVA and Kendall's compatibility factor Chi kwadrat ANOVA – Chi square ANOVA/ (N = 162, df = 5) = 23, 20789 p = 0,00031 współczynnik zgodności – compatibility factor = 0,02865 r średnich rang – r average ranks = 0,02262			
	średnia ranga average rank	suma rang sum of ranks	średnia average	odchylenie standardowe standard deviation
26.04.2017	3,388889	549,0000	0,938272	4,200993
30.05.2017	3,518519	570,0000	1,617284	6,426011
29.06.2017	3,669753	594,5000	2,839506	8,067967
27.06.2017	3,654321	592,0000	1,969136	7,127432
31.08.2017	3,509259	568,5000	1,216049	5,239268
27.09.2017	3,259259	528,0000	0,061728	0,346972

Tabela 3. Udział procentowy zasiedlonych galasów na porażonych liściach w 2016 roku – tabela ANOVA
Table 3. Percentage of populated galls on infested leaves in 2016 – ANOVA table

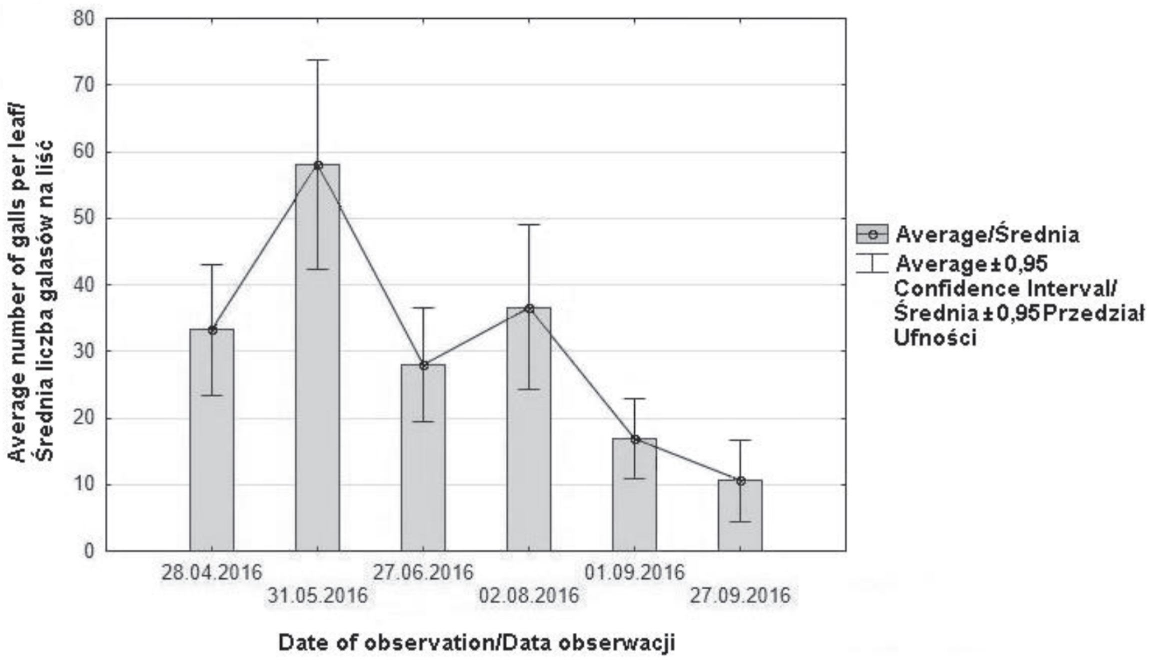
Udział procentowy zasiedlonych galasów na porażonych liściach w 2016 roku Percentage of populated galls on infested leaves in 2016	ANOVA Friedmana i współczynnik zgodności Kendalla Friedman's ANOVA and Kendall's compatibility factor Chi kwadrat ANOVA – Chi square ANOVA (N = 27, df = 5) = 59, 27402 p = 0,00000 współczynnik zgodności – compatibility factor = 0,43907 r średnich rang – r average ranks = 0,41749			
	średnia ranga average rank	suma rang sum of ranks	średnia average	odchylenie standardowe standard deviation
28.04.2016	1,851852	50,0000	10,55556	20,20726
31.05.2016	4,092593	110,5000	56,29630	41,33802
27.06.2016	4,944444	133,5000	74,59259	26,57827
02.08.2016	4,018519	108,5000	52,96296	27,43031
01.09.2016	3,944444	106,5000	48,25926	19,12226
27.09.2016	2,148148	58,0000	15,74074	16,79650

Tabela 4. Udział procentowy zasiedlonych galasów na porażonych liściach w 2017 roku – tabela ANOVA
Table 4. Percentage of populated galls on infested leaves in 2017 – ANOVA table

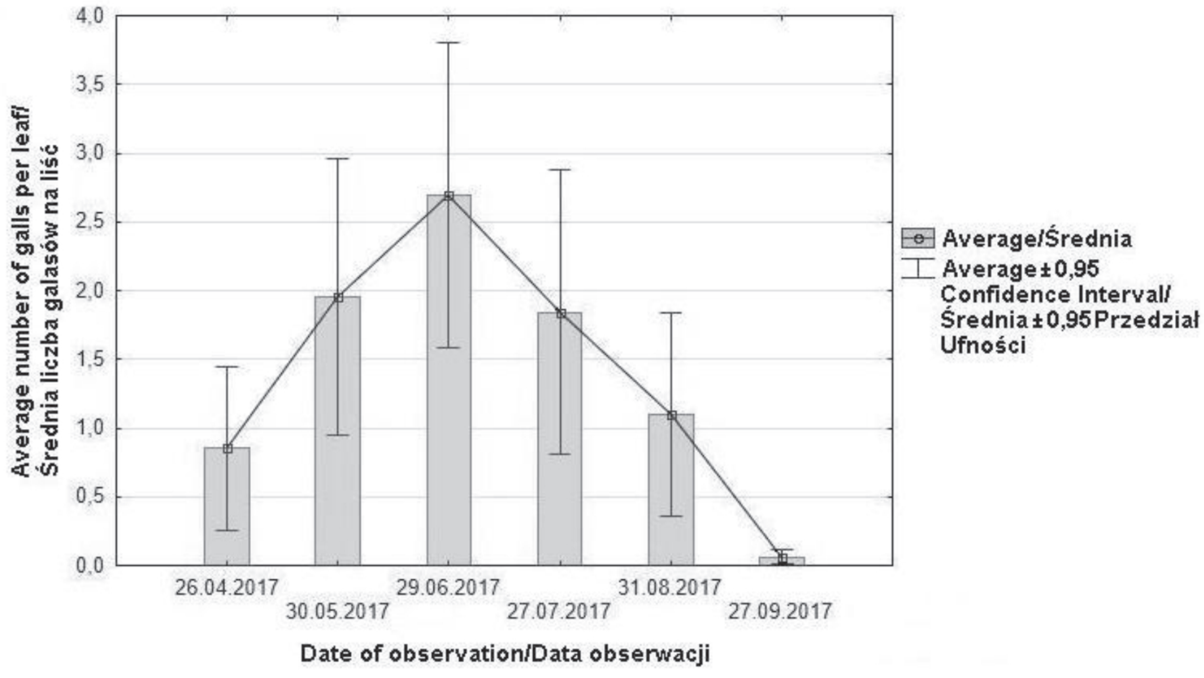
Udział procentowy zasiedlonych galasów na porażonych liściach w 2017 roku Percentage of populated galls on infested leaves in 2017	ANOVA Friedmana i współczynnik zgodności Kendalla Friedman's ANOVA and Kendall's compatibility factor Chi kwadrat ANOVA – Chi square ANOVA (N = 5, df = 5) = 12, 83537 p = 0,02497 współczynnik zgodności – compatibility factor = 0,51341 r średnich rang – r average ranks = 0,39177			
	średnia ranga average rank	suma rang sum of ranks	średnia average	odchylenie standardowe standard deviation
26.04.2017	1,700000	8,50000	2,00000	4,47214
30.05.2017	4,700000	23,50000	68,00000	39,62323
29.06.2017	5,000000	25,00000	77,60000	16,08726
27.06.2017	3,600000	18,00000	50,00000	43,01163
31.08.2017	3,700000	18,50000	49,80000	34,06171
27.09.2017	2,300000	11,50000	20,00000	27,38613

have slightly affected a decline of the leaf blister mite population in 2017. Pear psylla produces a large quantity of honey dew, which settles on leaves and branches (Alston *et al.* 2012; Nin *et al.* 2012). It makes plants sticky and potentially may negatively influence quality of living conditions for such organisms like leaf blister mites. The symptoms of pear scab disease and pear rust disease permanently increased in their severity during the season changing the structure of plant tissue, what also may impact living conditions for leaf blister mites (Juhásová and Praslièka 2002).

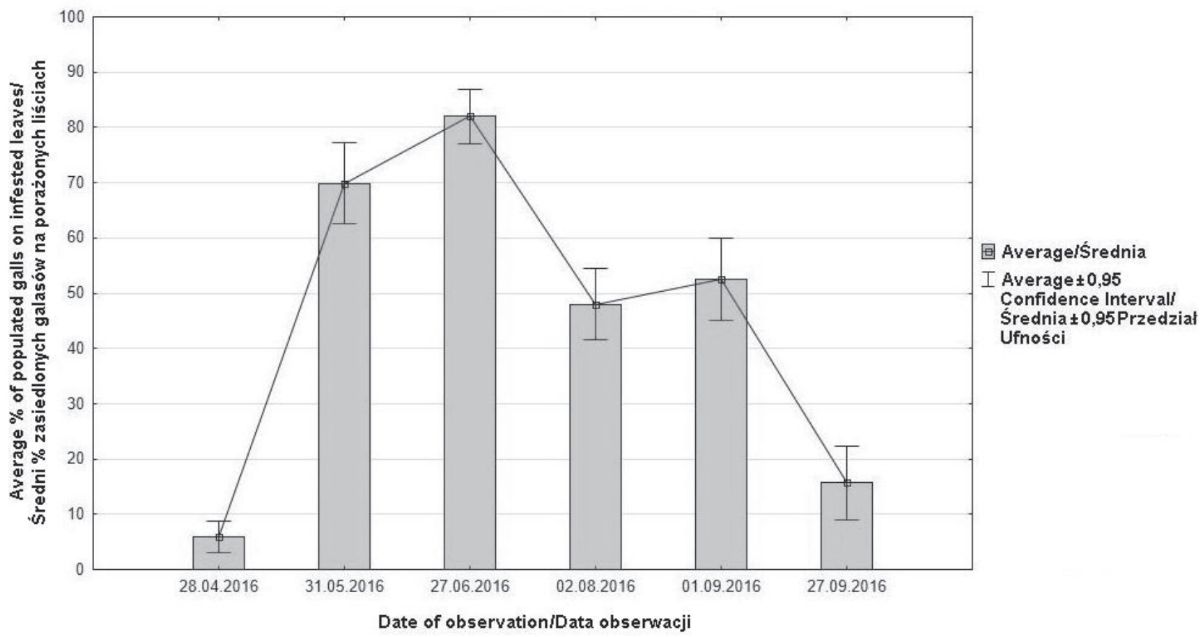
The population growth observed in May is mainly determined by significant increase of temperature, what usu-



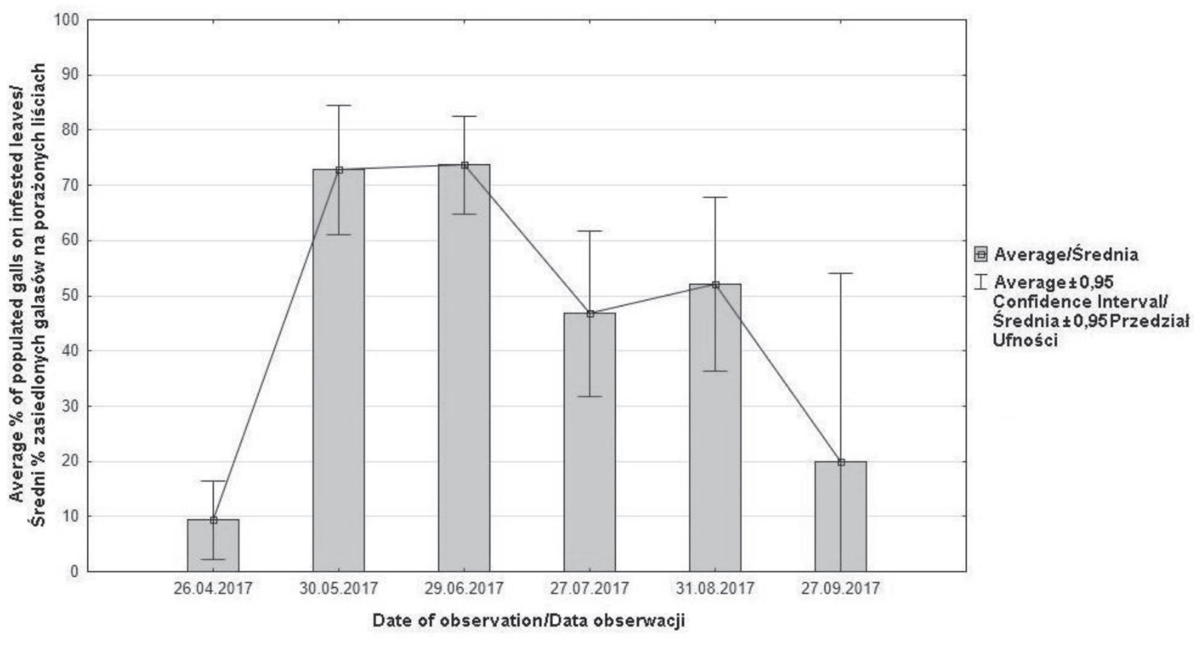
Rys. 13. Średnia liczba galasów na liść w 2016 roku
Fig. 13. Average number of galls per leaf in 2016



Rys. 14. Średnia liczba galasów na liść w 2017 roku
Fig. 14. Average number of galls per leaf in 2017



Rys. 15. Średni udział procentowy zasiedlonych galasów na porażonych liściach w 2016 roku
Fig. 15. Average percentage of populated galls on infested leaves in 2016



Rys. 16. Średni udział procentowy zasiedlonych galasów na porażonych liściach w 2017 roku
Fig. 16. Average percentage of populated galls on infested leaves in 2017

ally takes place during this month. Higher temperature in connection with appropriate weather conditions considerably accelerates plant development, what in turn influences on mites stimulatingly (Chavarria *et al.* 2009; Hatfield and Prueger 2015). Under these conditions after short time, mites of new generations numerously hatch from eggs and within few weeks their number on plants rapidly grows (Maula and Ali Khan 2016).

Decreasing percentage of populated galls in summertime indicates that perhaps already in July or at the beginning of August leaf blister mites start slowly leaving the galls and migrating to the buds. In September when daily average temperature is lower in comparison to July and August, presumably the process of migration considerably accelerates and a part of specimens probably dies. It proves the fact that at the end of September there was no alive mites inside the most of galls (Boczek 1970; Boczek and Szewczyk 1970; Gratwick 1992).

The changes in prevalence and in average number of galls indicate that new galls might not appear in late spring and summer. Therefore, it can be supposed that potentially only a generation coming out from swelling buds in early spring is capable of forming galls, whereas the next generations may already not have such ability (Boczek 1970).

Podsumowanie / Summation

This study presents an outline of seasonal changes in leaf blister mites population infesting trees of commonly grown in Poland pear cultivar. Although the methodology of the study is not very detailed and the frequency of individual observations was not large, several significant things have been reported. First of all, in 2016 the infestation level was much higher in comparison to 2017. This significant difference regarding the infestation occurred after mechanical activities were carried out in orchard before the growing season of 2017. It obviously indicates that treatments like trimming branches about the turn of winter and spring can contribute to reducing the number of pests like leaf blister mites. Secondly, the results from observations show that the biggest changes in leaf blister mites population occur in May when is noticeable a significant population growth and in September when the number of mites present on leaves strongly declines.

Based on the results it can be concluded that the period of most intensive leaf blister mites occurrence lasts most likely about 2–3 months, between May and July. It should be however remembered that the results from this study refer only to the pear and it cannot be totally excluded that on other host plants the course of changes in population could look slightly different.

Wnioski / Conclusions

Based on all observations carried out within this study, the final conclusions are following:

1. In 2016 pear trees were considerably stronger infested by leaf blister mites than in 2017.
2. The most rapid changes in a number of leaf blister mites occurring on leaves take place in May and in September.
3. The most intensive occurrence of leaf blister mites takes place in a period from May to July.

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