Abstract

Trees of Aesculus spp. are severely damaged by the fungus Erysiphe flexuosa as well as the pest Cameraria ohridella. Both invasive species have spread throughout Europe and they became also serious for horse chestnuts in Poland. The damage caused by E. flexuosa and C. ohridella was assessed and the susceptibility of individual specimens grown in Poznań was compared. Trees least seriously damaged by the pathogen and pest were identified. Powdery mildew occurred on both Aesculus species but significant variation of tree susceptibility was found. Cameraria ohridella attacked exclusively the common horse chestnut causing premature leaf browning and dropping. However, it was possible to identify A. hippocastanum trees with leaves damaged by C. ohridella to a lesser degree.

Key words: Aesculus spp., powdery mildew, horse-chestnut leaf miner, epidemiology

Introduction

Erysiphe flexuosa (syn. U. flexuosa) frequently causes powdery mildew on different species from the genus Aesculus in North America. Symptoms of the disease were described on that continent for A. arguta, A. georgiana, A. glabra, A. hippocastanum, A. pavia and A. ×carenea. Erysiphe flexuosa was also found on horse chestnuts in Eastern Asia in the Russian Far East (Braun 1987). In 2000 the occurrence of this fungus was reported in Europe, where it proved to be a highly invasive pathogen and rapidly spreading in many countries, also in Poland (Ale-Agha et al.

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Presently powdery mildew is found in all regions of Poland (Adamska 2002, Werner 2007, Werner et al. 2009, Karolewski et al. 2010). Initial symptoms include small patches on leaves and then fungal colonies expand and cover the upper and the lower leaf surfaces. Both young and old leaves are usually infected. Severe infection of trees causes premature leaf drop leading to plant vigour loss.

Common horse chestnut was one of the first alien trees, which starting from the 17th century has been planted in Poland as an ornamental tree. At present it is commonly met in forest margins, also extensively planted in different green plantings, often in cultivars, and it has become a frequent element among tree species popularly found in Poland. Additionally, the hybrid of *Ae. hippocastanum* and *Ae. pavia* named red horse chestnut (*Ae. ×carnea*) also is planted in parks, avenues and greens.

Serious concerns related to the future of common horse chestnuts have resulted from the threat posed by a pest, horse-chestnut leaf miner (Wiech et al. 2001, Baranowski et al. 2002, Dziegielewska et al. 2005). *Cameraria ohridella* (Lepidoptera: Gracillaridae) has spread throughout Europe over the last two decades (Augustin et al. 2009). *Cameraria ohridella* develops three generations per year in Poland. The moth overwinters as pupae in dry dropped leaves. Damages are caused by larvae feeding inside leaves. Leaf damage by *C. ohridella* and epidemic occurrence of powdery mildew on horse chestnuts constitute an important problem and thus a strategy of horse chestnut protection against both pathogen and pest needs to be developed.

The aim of this study was to assess the tree infestation rate by *E. flexuosa* in selected plantings and to evaluate the intensity of damage caused by *C. ohridella*, to facilitate a comparison of the susceptibility of individual specimens and identification of trees least seriously damaged by the analyzed pathogen and pest.

**Material and methods**

Horse chestnuts selected for analyses were growing in different Poznań localities: parks (Moniuszki, Wieniawskiego, Marcinl, the park in osiedle Chrobrego), street plantings (Wielkopolska avenue, Chopina, Wojska Polskiego, Staszica) and urban greens at Dąbrowskiego street, Wołyńska street and in the housing districts osiedle Chrobrego and osiedle Jagiell. A total of 169 trees includes 152 *Ae. hippocastanum* and 17 *Ae. ×carnea*. In the years 2008–2011 the incidence of powdery mildew was assessed on all trees growing in those localities. Moreover, in 2011 tree infestation rate by *E. flexuosa* was also determined. The evaluation was conducted on 10 randomly selected leaves from each tree and it was performed in a 4-point scale (1 – leaves with no damage symptoms, 2 – single clusters of coatings on leaf surface, 3 – single leaf fragments not covered by coatings, 4 – the entire leaf surface covered by mycelium). Moreover, in the same year leaf damage by the pest...
C. ohridella was also estimated. Ten leaves from each tree were selected randomly and assessed according to the 5-point scale given by Baranowski et al. (2004). The mean infestation degree of leaves was calculated according to the Townsend-Heuberger formula (Puntener 1981).

Results and discussion

Statistically significant differences in susceptibility to E. flexuosa and C. ohridella between particular trees were found. Observations conducted in 2008–2010 on the spread of powdery mildew on horse chestnuts in different green areas of Poznań showed that the disease was found more frequently on red horse chestnuts, while trees of this species were not damaged by the horse-chestnut leaf miner (Fig. 2). This is in concordance with earlier observations when 80 Ae. ×carnea trees were observed (Werner et al. 2009). In the successive years of study the mildew occurrence ranged from 49.4% in 2008 to 76.8% in 2010 of trees examined, however in 2011 it was slightly lower (Table 1, Fig. 1). Among the analyzed red horse chestnuts there were trees not suffering from the disease (no. 1), trees diseased every year (13–15) and diseased only in some years (1–8, 11–12).

The results indicate that only a few trees of Ae. ×carnea did not suffer from the powdery mildew. This concurs with earlier reports (Milevoj 2004, Werner et al. 2009). However, more extensive studies during successive years are necessary to confirm the health status of trees, since an increasing infection pressure on one hand and weather conditions (particularly during disease development) on the other may lead to overcoming the infection resistance, while trees not suffering from the disease may prove to be valuable maternal material.

On the contrary, in the population of common horse chestnuts only few trees infested with E. flexuosa were found in individual localities. In process of time their number was increasing and depending on the year and locality. The number ranged

<table>
<thead>
<tr>
<th>Observation site</th>
<th>Tree code (no.*)</th>
<th>Trees infested (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
</tr>
<tr>
<td>Szamarzewskiego street</td>
<td>14</td>
<td>33.3</td>
</tr>
<tr>
<td>Wołyńska street</td>
<td>1–8</td>
<td>62.5</td>
</tr>
<tr>
<td>Moniuszki park</td>
<td>13</td>
<td>100.0</td>
</tr>
<tr>
<td>Dąbrowskiego street</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Staszica street</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Wielkopolska avenue</td>
<td>15</td>
<td>100.0</td>
</tr>
<tr>
<td>Wojska Polskiego street</td>
<td>11–12</td>
<td>50</td>
</tr>
<tr>
<td>Annual mean</td>
<td>49.4</td>
<td>72.6</td>
</tr>
</tbody>
</table>

*Trees selected for the assessment of infestation rates.
from 7.4% in 2008 to 45.4% in 2010, while in 2011 it did not exceed 39.1% (Table 2). However, irrespective of the disease intensity trees diseased already in the first year of the analyses were also infested next years.

First symptoms of *C. ohridella* activity were visible earlier on the *Ae. hippocastanum* trees growing in parks where fallen leaves with overwintering pupa were not removed. This is in concordance with previous studies focused on cultural control (Pavan et al. 2003, Kukula-Młynarczyk and Hurley 2007). Damages caused by larvae feeding inside leaves were growing gradually from May to September. The time in which highly infested trees were able to assimilate photosynthetic products was drastically shortened. Yellowing and browning leaves were starting to drop in the second decade of August. Highly infested trees produced smaller seeds what is consistent with the findings of Selleo et al. (2003). Similarly, Thalmann et al. (2003) observed seed weight reduction of infested by *C. ohridella* common horse chestnut trees.

Although common horse chestnuts were infested by horse-chestnut leaf miners, it was possible to differentiate visually between specimens with leaves almost completely damaged by the pest and the leaves significantly lesser damaged, indi-
cating some variation in susceptibility of trees to \textit{E. flexuosa} and \textit{C. ohridella}. Mean infestation rates of trees selected from each locality are presented in Table 2.

The assessment of \textit{E. flexuosa} spread conducted over the period of four years as well as the analysis of data shown in Figure 1 indicate a variation in susceptibility to infestation both between two \textit{Aesculus} species and between individual specimens. It was possible to identify \textit{Ae. hippocastanum} trees damaged by \textit{C. ohridella} to a lesser degree and resistant to powdery mildew. Selection of such trees as maternal trees, particularly for production of young trees by grafting, may be one of the potential methods to reduce damage caused by the pathogen and pest.

\begin{table}
\caption{Infestation of common horse chestnuts by \textit{Erysiphe flexuosa} in Poznań (2008–2011)}
\begin{center}
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Observation site & Tree code (no.*) & 2008 & 2009 & 2010 & 2011 \\
\hline
Chopina street & – & 7.6 & 15.3 & 15.3 & 15.3 \\
Moniuszki park & 16 & 0 & 7.1 & 14.3 & 0 \\
Wieniawskiego park & 31, 32, 33, 34, 35 & 7.4 & 14.8 & 14.8 & 11.1 \\
O. Chrobrego (park) & 22, 23, 24, 25, 26, 27, 28, 29, 30 & 8.7 & 17.4 & 43.5 & 39.1 \\
O. Chrobrego & – & 0 & 12.5 & 18.7 & 0 \\
O. Jagielly & 21 & 0 & 20.0 & 20.0 & 0 \\
Stary Browar (park) & – & – & – & – & – \\
Marcelin (park) & – & 0 & 0 & 0 & 0 \\
Wojska Polskiego street & 36, 37, 38, 39, 40 & 0 & 20.8 & 37.5 & 4.2 \\
Dąbrowskiego street & 18, 19, 20 & 0 & 27.3 & 45.4 & 36.4 \\
Dendrological Garden, the Poznań University of Life Sciences & – & 0 & 0 & 0 & 0 \\
Wołyńska street & 17, 41 & 0 & 0 & 0 & 0 \\
Annual mean & & 2.8 & 13.77 & 20.6 & 10.6 \\
\hline
\end{tabular}
\end{center}
\end{table}

\textsuperscript{*}Trees selected for the assessment of infestation rates.

Streszczenie

\textbf{WYSTĘPOWANIE NA KASZTANOWCACH ORAZ SZKODLIWOŚĆ \textit{ERYSIPHE FLEXUOSA} I \textit{CAMERARIA OHRIDELLA}}

Kasztanowce są silnie uszkadzane zarówno przez \textit{Erysiphe flexuosa}, powodującego mączniaka prawdziwego, jak i przez szkodnika \textit{Cameraria ohridella}. Obydwa inwazyjne gatunki rozprzestrzeniły się w całej Europie i stały się niebezpieczne również dla kasztanowców w Polsce, zwłaszcza dla \textit{Aesculus hippocastanum} i \textit{Ae. \textit{x carnea}}. Celem badań była ocena nasilenia uszkodzeń powodowanych przez \textit{E.}
flexuosa i C. ohridella, aby porównać podatność poszczególnych drzew i zidentyfikować te, które są najmniej niszczone przez patogen i szkodnika. Mączniak prawdziwy występował na obu gatunkach kasztanowca, chociaż zaobserwowano znaczące różnice w podatności drzew. Cameraria ohridella atakował wyłącznie kasztanowca zwyczajnego, powodując przedwczesne żółknięcie i opadanie liści. Jednakże możliwe było zidentyfikowanie drzew A. hippocastanum z liśćmi uszkodzonymi przez szkodnika w mniejszym stopniu.

Literature


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