Monitoring and control possibilities of leaf miners (Agromyzidae) in winter wheat in Poland

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Abstract

Nowadays the higher occurrence of cereal insects is observed. Until recently it has been considered to be of little economic relevance. Today cereal insects develop better, thanks to the climate warming, simplification of agricultural techniques and extensive farming in large areas. One of the most pervasive species is leaf miners from the Agromyzidae family, which larvae feed on inner side of the cereal leaves. In Poland there is more than a dozen species of leaf miners (Walczak 1995). They may occur locally in large numbers, and cause substantial damage to the crops which reduce quality and quantity of the harvest. Larvae of the leaf miner feed on the parenchyma, causing damages (so-called mines). Effective methodology of fighting the insects with chemical means have not been developed yet. Studies of integrated methods of cereals protection carried out so far, have shown that a good practical method of chemical signaling is to control the number of adults trapped on yellow traps. Monitoring of cereal leaf miner flights in winter wheat was carried out in Slupia Wielka and Baborówko (Greater Poland Voivodeship) in the 2011/2012 and 2012/2013 growing seasons. Yellow traps were placed above the tops of wheat during vegetation period. The number of damaged wheat stems was recorded. Fluctuations in weather conditions during the research affected the dynamics of leaf miner flies considerably. The most common species were: Chromatomyia nigra (Ztt.), Chromatomyia fuscula (Ztt.) and Poemyza superciliosa (Ztt.).

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Peer-review under responsibility of the Centre wallon de Recherches agronomiques (CRA-W)

Keywords: leaf miners, Agromyzidae, winter wheat, monitoring, yellow traps

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1. Introduction

In Poland flies of leaf miners (Agromyzidae) on cereal are a common occurrence. Their larvae, which are a harmful stage, feed on parenchymatic tissue of cereal leaves, causing characteristic damages (mines). Occurrence of leaf miners in big numbers contributes greatly to the reduction of the leaves’ assimilation surface. The larvae damage mostly first and second flag leaves, which has a negative impact on the yield and locally can produce losses which are economically significant. The aim of the research was to determine the intensification of occurrence, harmfulness and dynamics of leaf miners (Agromyzidae) on winter wheat.

2. Objective, data and methodology

Experiments with winter wheat were conducted in the 2011/2012 and 2012/2013 growing seasons in Słupia Wielka (średzki district) and in the 2012/2013 growing season in Baborówko (szamotulski district). Observations regarded the dynamics of flight of leaf miners and the developmental stages of leaf beetles. The validity of determined times for chemical control was reflected in the yield. The pests were caught using 3 yellow plates covered with glue with dimensions of 25x40 cm (producer BioBest, Belgium) placed randomly on the plantation. The plates were positioned on poles which enabled for them to be placed higher and higher as the plants grew so that the plates would always be immediately above the field. The traps were replaced in the time April 16 and June 24 in 2012 and between April 22 and June 23 in 2013. The result was presented as an average number of caught flies from the three plates on each plantation.

Selected winter wheat plantations were also sites for observations aimed at determining the number of blades with damaged leaves. The result was presented as a number of mines per 100 analyzed blades. Moreover, in order to determine the count of miners, in May the researchers collected leaves with visible larvae or casters from experimental fields and selected plantations. The specimens were later bred until they became imagines. Mines on the leaves of winter wheat characteristic for particular species were identified using a key (Beiger 2004). The identification of species of leaf miners was done based on preparing male genital apparatuses (Beiger 1989).

The main tool used to analyze the research hypotheses made in the study was a single factor analysis of variance ANOVA. The correlations between the count of miners and the yield was determined using a correlation coefficient (Kozak et al. 2010). Multiple regression analysis was used to verify the hypothesis of whether the temperature and precipitation significantly determined the occurrence of leaf miners. All calculations within the data analysis were performed using the Statistica 10 statistical package.

3. Results

Meteorological conditions in towns where the research was conducted in the years 2012-2013 did not vary in terms of temperature (F1,34 =0.232  p =0.633 ) or precipitation (F1,34 =0.284 p =0.597). Moreover, it was shown that in both towns the average number of mines was at the same level (F1,34 =3.011 p = 0.091).

The dynamics of flight of leaf miners onto winter wheat plantations in particular growing seasons did not vary (F1,34 = 0.058 p = 0.811) (Fig. 1, 2).
The dynamics of flight of leaf miners onto winter wheat plantations in particular growing seasons varied. In 2012 the first miners were observed in mid-April, while in 2013 the first miners appeared on winter wheat plantations a week later compared to 2012 (Fig. 1, 2).

Based on trapping of flies and observations regarding the development of leaf beetles the researchers were able to determine the dates for chemical treatments against both pests as well as estimate the size of yield obtained from particular combinations (Tab. 1), (Fig. 4). The dates of chemical treatments were as follows: in Słupia Wielka – May 14, May 21 and May 28, in Baborówko – May 15, May 25 and May 30 in 2012; in 2013, Słupia Wielka – May 20, May 24 and June 3, in Baborówko – May 20, May 27, June 6. In both towns, in both years of the research the optimum time for the chemical treatment fell during the numerous flight of flies and when the oldest larvae of leaf beetles reached the length of about 2mm.

The result of the variance analysis did not show a statistically significant influence of the date of the treatment on the size of obtained yield ($F_{3,44} = 0.1194 \ p = 0.948$) (Tab. 1).
Table 1. Yield and standard deviations for different treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average yield (kg)</th>
<th>Standard deviation (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>9.62</td>
<td>1.45</td>
</tr>
<tr>
<td>Z1</td>
<td>9.95</td>
<td>2.07</td>
</tr>
<tr>
<td>Z2</td>
<td>9.80</td>
<td>1.58</td>
</tr>
<tr>
<td>Z3</td>
<td>9.60</td>
<td>1.56</td>
</tr>
<tr>
<td>Total</td>
<td>9.74</td>
<td>1.63</td>
</tr>
</tbody>
</table>

Correlation analysis indicated that the number of mines had a statistically significant influence on the obtained yield ($r=0.2619$ $p=0.072$) (Fig. 3).

![Graph showing observed yield depending on the number of mines.](image)

Fig. 3 Observed yield depending on the number of mines.
Multiple regression analysis indicated that out of all meteorological factors only temperature had a significant influence on the number of mines. The temperature coefficient obtained in this model was 0.4367 and indicated that the increase in temperature was reflected in the increase of the number of mines. Further simple regression analysis studying the influence of temperature on the number of mines showed a statistically significant regression coefficient $r=0.4216$ for $p=0.0104$. The correlation between the number of mines and temperature was shown on the figure below (Fig. 5).

There is a statistically significant correlation between the date of the treatment and the number of miners ($F_{3, 44} = 4.88 \ p = 0.005$) (Tab. 2), (Fig. 6).
Table 2. The number of mines and standard deviations for different treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average number of mines</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>8.58</td>
<td>3.26</td>
</tr>
<tr>
<td>Z1</td>
<td>5.25</td>
<td>2.93</td>
</tr>
<tr>
<td>Z2</td>
<td>7.83</td>
<td>5.62</td>
</tr>
<tr>
<td>Z3</td>
<td>12.08</td>
<td>5.23</td>
</tr>
<tr>
<td>Total</td>
<td>8.44</td>
<td>4.94</td>
</tr>
</tbody>
</table>

Fig. 6 Breakdown of the number of mines depending on the date of treatment.

In 2012 a total of 161 leaves with larvae or casters inside the mines were collected for breading in a laboratory. The caster stage was reached by 126 specimens. The imago stage was reached by 98 specimens. Moreover, out of the larvae and casters collected for breading, the imago stage was reached by one *anagyrus pseudococci*. In 2013 a total of 100 leaves with larvae or casters inside the mines were collected for breading in a laboratory. The caster stage was reached by 62 specimens. The imago stage was reached by 38 specimens. Moreover, out of the larvae and casters collected for breading, the imago stage was reached by five *anagyrus pseudococci* (Tab. 3).

The predominant species in the years of the research were: *Chromatomyia nigra* (Mg.), *Chromatomyia fuscula* (Ztt.) and *Poemyza superciliosa* (Ztt.).

When comparing the obtained results with research previously conducted by other researchers (Walczak 1995, 1998; Beiger 1988) it was established that the species composition of miners occurring on winter wheat changes in particular years. The results differed from the ones obtained in previous research. In the years 1995-1998 (Walczak) the miners occurring on winter wheat included the following species: *Phytomyza nigra* (Mg.) and *Agromyza ambigua* (Fil.), *Agromyza mobilia* (Mg.), *Cerodontia pygmaea* (Mg.).

Table 3. The number of leaves, casters, flies of miners and *anagyrus pseudococci* in laboratory breading in 2012 and 2013.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of leaves collected</th>
<th>Number of casters</th>
<th>Number of flies</th>
<th>Number of <em>anagyrus pseudococci</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>100</td>
<td>62</td>
<td>38</td>
<td>5</td>
</tr>
<tr>
<td>2013</td>
<td>161</td>
<td>126</td>
<td>98</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>261</td>
<td>188</td>
<td>136</td>
<td>6</td>
</tr>
</tbody>
</table>
4. Summary and conclusion

1. The most intensive flight of flies onto winter wheat plantations in Wielkopolska in the years of the research occurred in May.
2. The dynamics of flight of leaf miners onto winter wheat plantations in particular growing seasons did not vary statistically.
3. In both years of the research the optimum time for the treatment fell during the numerous flight of flies and when the oldest larvae of leaf beetles reached the length of about 2mm.
4. Variance analysis did not indicate a statistically significant influence of the date of the treatment on the size of the obtained yield.
5. Multiple regression analysis indicated that out of all meteorological factors only temperature had a significant influence on the number of mines.
6. Correlation analysis indicated that the number of mines had a statistically significant influence on the obtained yield.
7. A statistically significant correlation between the date of the treatment and the number of miners was observed.
8. The leaf miners species occurring on winter wheat in the years of the research were *Chromatomyia fuscula* (Ztt.), *Chromatomyia nigra* (Ztt.) and smaller in numbers *Poemyza superciliosa* (Ztt.).
9. The results of the research will enrich current knowledge regarding the count and harmfulness of leaf miners and leaf beetles on cereal plantations in the context of integrated cereal control.

References


