**Floral biology of some sour cherry cultivars and their suitability for cultivation**

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**Abstract:** Floral biology of some sour cherry cultivars and their suitability for cultivation. Cultivars ‘Schattenmorelle IR-2’ (British type of ‘Schattenmorelle’), ‘Koral’ (Poland), ‘Debreceni Böttermö’ (Hungary), ‘Újfehértói Fürtos’ (Hungary), ‘Karneol’ (Germany), and ‘Vowi’ (Germany) were examined for their pollen quality, degree of autogamy, cropping and fruit quality – the study encompassed the years 2006–2008. The best quality of pollen was observed in: ‘Koral’ ‘Schattenmorelle IR-2’ and ‘Vowi’, while the worst in ‘Újfehértói Fürtos’. ‘Schattenmorelle IR-2’ and ‘Koral’ had the most fruit after self-pollination, the lowest quantity being recorded in ‘Karneol’. Furthermore, ‘Vowi’, ‘Schattenmorelle IR-2’ and ‘Koral’ gave the highest yield, whereas ‘Karneol’ and ‘Újfehértói Fürtos’ gave the lowest. Finally, ‘Debreceni Böttermö’ and ‘Újfehértói Fürtos’ had the highest fruit quality and ‘Vowi’ had the lowest.

**Key words:** sour cherry, cultivar, pollen quality, self-pollination, yield, fruit quality.

**INTRODUCTION**

Biological properties are of the greatest importance for fruit setting in sour cherry cultivars. These properties are different in every sour cherry variety but they are also influenced by external conditions – mainly by the climate in which given varieties are grown (Wociór, 1976; Wierszyłowski, 1973; Lech, 1990). Therefore, the suitability of sour cherry depends upon biological properties of each variety, which are, in turn, modified by the relevant external factors. The aim of this study was to evaluate some of the biological features of sour cherry cultivars and their influence on the suitability for cultivation in Polish conditions. Some of these biological features change through the years due to different weather conditions of each season. These tests are still continued, to make researchers more familiar with some features, further confirm research results and allow the researchers to draw correct conclusions. Some biological data represented in this publication are the expanded data of Szpadzik et al. (2008).

It is known that blooming is the most important process in plant development. The yield height and fruit quality depend on blooming course conditions, especially on the pollination and fertilisation of flowers (Lech, 1990). The correct process of pollination is one of the most important factors in fruit setting. However, the pollination and fer-
tilisation depend on the pollen quality, the degree of autogamy of the cultivars, climate and weather conditions, and the presence of bees during blooming time. Wociór (1975) believes that viability and germination are most important for pollen quality. He also claims that the germination of pollen is even more important, because not every viable pollen grain is germinatable. However, germination capacity depends on the viability of pollen and also on the weather conditions during the blooming period. Milutinovic et al. (1997) agree with this point of view and mention that pollen germination is positively correlated with fruit setting. The two year research of Szpadzik et al. (2008) on the pollen quality and fruit setting of some sour cherry cultivars showed that two of them, i.e. ‘Debreceni Bötermő’ and ‘Újfehértói Fürtos’ had lower viability and germination capacity of pollen grains as compared with other tested cultivars, such as: ‘Schattenmorelle IR-2’, ‘Koral’ and ‘Vowi’. The authors also noticed that these two Hungarian cultivars had a very low degree of autogamy and they did not give a satisfactory yield. Cultivars which had high quality pollen, had a high degree of autogamy, and gave a good yield as well. According to Lech (1984), satisfactory yield can be obtained when 30% of flowers set fruits. Nevertheless, Nyéki et al. (1997) think that even if 20% of flowers set fruits, the yield is satisfying. They add that varieties should be self-fertile. Most scientists consider a variety self-fertile when it sets 10–20% of fruits after self-pollination. Szpadzik et al. (2008) pointed out that cultivars ‘Debreceni Bötermő’ and ‘Újfehértói Fürtos’ set less than 10% fruits after self-pollination (‘Debreceni Bötermő’ – 5.2%, ‘Újfehértói Fürtos’ – 4.1%), so they are not self fertile in the central Poland conditions, unlike cultivars such as: ‘Schattenmorelle IR-2’, ‘Koral’ and ‘Vowi’, which set above 20% fruits after self-pollination. Wociór (1977) showed that in adverse meteorological conditions (low temperature, rain), self-sterile varieties set few fruits, but self-fertile varieties set above 20% fruits, independently of the weather. Therefore, self-fertile cultivars give a better yield and are not as dependent on weather conditions, as self-sterile cultivars. They can also be planted without the company of other cultivars. Ugolik (1993) additionally notices that pollination in self-fertile cultivars is possible without bees, thanks to gentle air movement. It moves the pollen grain from the stamen to the pistil and from one flower to the other.

Paydaş et al. (1998) claim that variety selection is the main factor in increasing fruit quality, but the knowledge of the fertilisation biology of different varieties is very important, if one wants to get a satisfactory yield.

The most important ratio for fruit quality is sugar and acids content. Poll and Petersen (2003) indicate that the soluble solids content in sour cherry cultivars is modified by meteorological conditions during ripening. Sun and high temperature increase the synthesis of sugar in fruit. According to Płocharski (2000), the major factor influencing fruit quality is the level of their maturity. He affirms that immature fruits have more acids, less soluble solids content, and less anthocyanin than mature fruits.
MATERIALS AND METHODS

The research was conducted in the orchard of Warsaw University of Life Sciences in Warsaw, Wilanów, on 6 sour cherry (*Prunus cerasus*) cultivars: Schattenmorelle IR-2 (British type of ‘Schattenmorelle’), ‘Koral’ (Polish), ‘Debreceni Bötermő’ and ‘Újfehértói Fürtös’ (Hungarian), ‘Karneol’ and ‘Vowi’ (German). All trees were planted in the spring of 2001 on deep, loamy alluvial soil, spaced 4 × 2 m, on *Prunus mahaleb* L. rootstock. The quality of pollen (2006–2008) was investigated by means of viability and germination tests on three points of time: at the beginning, in full bloom and at the end of bloom. The viability test was performed according to the triple colouring method (Alexander, 1969). The germination tests were done using the petri-agar method (0.6% agar +12% sucrose medium) (Vasilakaksis and Porlingis, 1985). The degree of autogamy was tested by counting the percentage of fruit set after self-pollination. Yield was counted in kilograms per tree. Fruit weight was described in grams. The elasticity of skin (firmness) was measured with the Magness Taylor Penetrometer – the results were shown in Newtons. The soluble solids content was checked using Abby’s refractometer, while acidity was measured on a pH meter and the results were also shown after conversion into malic acid content. The frost damage in 2007 made it impossible to observe some features, such as the degree of autogamy, yield and fruit quality, of two varieties: Debreceni Bötermő and Karneol.

The results were analyzed statistically with the Statgraphics® Plus 4.1 program using one-way analysis of variance. Significant differences between treatment means were evaluated using Newman-Keuls test at $P = 0.05$.

RESULTS AND DISCUSSION

The blooming period

During the three years of research the meteorological conditions varied. The most favourable temperature for pollination and the best fruit setting conditions seemed to be observed in 2006. The temperature during blooming time was about 20°C and there were no spring frosts.

In 2007, after a short, smooth and snow-free winter, the spring frosts appeared during the blooming and the primordial growth period. They caused damage to most of the flowers and, in some earlier cultivars, also primordias. No fruit were set and there was no yield at that time.

The first three months of 2008 were quite warm for that season. Temperature in March went above 10°C. But the blooming period was chilly and rainy – average temperature during that period did not exceed 13°C.

The quality of pollen (viability and germinability)

The years 2006, 2007 and 2008 confirmed some differences in pollen quality (Tab. 1). As it has already been mentioned, in 2006 and 2007 Hungarian cultivars had the lowest pollen viability and germination, while the highest quality of pollen was observed in ‘Koral’ ‘Schattenmorelle IR-2’ and ‘Vowi’.

In 2008 – similarly to former years – the highest viability of pollen was noted in the ‘Koral’ cultivar; it was approxi-
The quality of pollen in sour cherries can be modified not only by the cultivar properties but also by the correct course of microsporogenesis and by weather conditions during the winter and spring periods (Wociór, 1976).

The degree of autogamy and yielding

In 2006 and 2008 the lowest percentage of fruit set after self-pollination was obtained from: ‘Újfehértói Fürtös’, ‘Karneol’ and ‘Schattenmorelle IR-2’ (34%), and in 2008 in ‘Koral’ – above 40%. In 2008 both ‘Vowi’ and ‘Schattenmotelle’ set above 12% fruit after self-pollination, less than in 2006.

### TABLE 1. Viability and germination of pollen depending on the cultivar in 2006–2008

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Pollen viability (%)</th>
<th>Pollen germination (%)</th>
<th>Average of the three years: 2006–2008 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006 ¹</td>
<td>2007 ¹</td>
<td>2008</td>
</tr>
<tr>
<td>Schattenmorelle IR-2</td>
<td>81.7 b B</td>
<td>83.2 bc B</td>
<td>66.9 bc A</td>
</tr>
<tr>
<td>Koral</td>
<td>84.0 b A</td>
<td>88.6 c A</td>
<td>78.8 c A</td>
</tr>
<tr>
<td>Debreceni Bötermő</td>
<td>77.0 b B</td>
<td>71.8 a B</td>
<td>52.2 b A</td>
</tr>
<tr>
<td>Újfehértói Fürtös</td>
<td>60.4 a B</td>
<td>70.0 a B</td>
<td>33.6 a A</td>
</tr>
<tr>
<td>Karneol</td>
<td>77.3 b B</td>
<td>69.6 a AB</td>
<td>57.2 b A</td>
</tr>
<tr>
<td>Vowi</td>
<td>81.7 b B</td>
<td>79.6 b B</td>
<td>66.8 bc A</td>
</tr>
</tbody>
</table>

Data marked with the same small letters – there are no statistical differences within the column.
Data marked with the same capital letters – there are no statistical differences within the row.
¹ Some data was adapted from: Szpadzik et al., 2008.

0.9% (Tab. 1). ‘Schattenmorelle IR-2’ and ‘Vowi’ had an inconsiderably lower viability of pollen (almost 70%). The lowest pollen viability – about 24% – was observed in the ‘Újfehértói Fürtös’ cultivar. There were no statistical differences in germination capacity between the cultivars ‘Schattenmorelle IR-2’, ‘Koral’, ‘Karneol’ and ‘Vowi’ – it totaled above 39%. The cultivar ‘Debreceni Bötermő’ had an inconsiderably lower germination capacity as compared to the aforementioned cultivars. The lowest germination capacity in 2008 was recorded for ‘Újfehértói Fürtös’ but it was only slightly lower than in ‘Debreceni Bötermő’.

The degree of autogamy and yielding

In 2006 and 2008 the lowest percentage of fruit set after self-pollination was obtained from: ‘Újfehértói Fürtös’, ‘Karneol’ and ‘Debreceni Bötermő’ (Tab. 2). The highest degree of autogamy in 2006 was observed in ‘Schattenmorelle IR-2’ (34%), and in 2008 in ‘Koral’ – above 40%. In 2008 both ‘Vowi’ and ‘Schattenmotelle’ set above 12% fruit after self-pollination, less than in 2006.
The highest yield per tree in 2008 was obtained from ‘Koral’ (above 20 kg/tree) (Tab. 2). An inconsiderably lower yield was produced by ‘Schattenmorelle IR-2’ and ‘Vowi’ (about 19 kg/tree), while a considerably lower yield, as compared with other cultivars, was obtained from ‘Karneol’ (slightly above 5 kg/tree), ‘Debreceni Bötermö’ and ‘Újfehértói Fürtös’ (both below 4 kg/tree). These data confirm the results of 2006, when ‘Debreceni Bötermö’, ‘Újfehértói Fürtös’ and ‘Karneol’ were the worst yielding cultivars.

Hungarian (Nyeki et al., 1997) and some Polish (Grzyb, 2003) researchers claim that the ‘Debreceni Bötermö’ cultivar is self-fertile. According to Hungarian researchers, ‘Újfehértói Fürtös’ is self-fertile, while Grzyb (2003) considers it partly self-fertile. The preliminary observations of this research do not fully confirm these data. The two cultivars gave unsatisfactory results after self-pollination. Davarynejad et al. (2008) admitted that some sour cherry cultivars approached the self-fertile types under favorable conditions, whereas under unfavorable conditions they are almost self-incompatible.

Cultivars Schattenmorelle IR-2, Koral and Vowi were the best yielding ones. They were also characterized by the highest quality of pollen and they had a high percentage of pollen functionality. They are self-fertile cultivars. These data confirm the reports of many scientists that only self-fertile cultivars can guarantee a reliable yield and that we should pay more attention to them (Wierszyłowski, 1973).

**Fruit quality**

The years 2006, 2007 and 2008 showed some differences in fruit quality. In 2006, the tested cultivars differed in the following aspects of fruit quality: fruit weight, firmness, soluble solids content and acidity (Tab. 3). The average fruit weight varied from 7.7 g in ‘Karneol’ to 5.4 g in ‘Vowi’. The cultivars ‘Újfehértói Fürtös’, ‘Debreceni Bötermö’ and ‘Karneol’ had the highest firmness (elasticity of skin) – above 2.5 N. Significantly lower firmness characterized the following cultivars: ‘Schattenmorelle IR-2’ and ‘Vowi’. ‘Koral’ had the lowest elasticity of skin – less than 2 N. The cultivar ‘Újfehértói Fürtös’ had the highest soluble solids content – it totaled almost

### TABLE 2. The degree of autogamy and yield depending on cultivar

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Fruit set after self pollination (%)</th>
<th>Yield (kg/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schattenmorelle IR-2</td>
<td>34.0 c</td>
<td>*</td>
</tr>
<tr>
<td>Koral</td>
<td>30.7 bc</td>
<td>*</td>
</tr>
<tr>
<td>Debreceni Bötermö</td>
<td>5.2 a</td>
<td>*</td>
</tr>
<tr>
<td>Újfehértói Fürtös</td>
<td>4.0 a</td>
<td>*</td>
</tr>
<tr>
<td>Karneol</td>
<td>0.6 a</td>
<td>*</td>
</tr>
<tr>
<td>Vowi</td>
<td>23.4 b</td>
<td>*</td>
</tr>
</tbody>
</table>

*no fruit set and yielded because of spring frosts
Data marked with the same small letters – there are no statistical differences within the column.

1Some data was adapted from: Szpadzik et al., 2008.
The remaining cultivars showed statistically lower soluble solids content. The highest acidity (pH) was reported in ‘Debreceni Bötermő’ (almost 3.5) and the lowest in ‘Schattenmorelle IR-2’, ‘Koral’ and ‘Vowi’. The highest acidity after conversion into the malic acid content was observed in ‘Koral’ and ‘Vowi’ – above 2%, while ‘Újfehértói Fürtös’, ‘Debreceni Bötermő’ and ‘Karneol’ had the lowest.

In 2007 ‘Koral’ had the biggest fruit and ‘Újfehértói Fürtös’ the smallest among the four tested cultivars (Tab. 3). The firmness varied from 4.5 N in ‘Újfehértói Fürtös’ to 2.1 N in ‘Schattenmorelle IR-2’. The cultivar ‘Újfehértói Fürtös’ had the highest soluble solids content (almost 17%) but it was only slightly higher than in ‘Koral’ (0.5% less than ‘Újfehértói Fürtös’). Soluble solids content in ‘Schattenmorelle IR-2’ and ‘Vowi’ was confirmed to be at the same level and it was significantly lower as compared with the remaining cultivars. All tested cultivars had similar acidity and there were no significant differences between them. The highest acidity after the conversion into the malic acid content was observed in ‘Koral’ – about 2.5% and the lowest in ‘Schattenmorelle IR-2’ – somewhat more than 1%.

In 2008 Hungarian cultivars were the most interesting ones. Both ‘Debreceni Bötermő’ and ‘Újfehértói Fürtös’ had similar fruit size (varied from 7 to 7.8 g) and they were characterized by the highest: elasticity of skin (above 3 N), soluble solids contents (about 16%) and pH (over 3) as compared with other cultivars. They also showed the lowest acidity in terms of the malic acid content. Features such as high skin elasticity could affect the shelf-life duration and, possibly, susceptibility to both mechanical damage and infection by rot organisms (Predieri et al., 2004). The soluble solids content, high pH and low malic acid content could be the evidence of a special flavour of these fruit.

Taking into consideration each fruit quality characteristics similarity between the ‘Schattenmorelle IR-2’ and ‘Vowi’ fruits is visible. The cultivar ‘Koral’ had bigger fruits (about 1 g), higher elasticity of skin (about 0.7 N), similar soluble solids content and higher acidity. The cultivar ‘Vowi’ had the biggest soluble solids content and its firmness varied from 2.1 N (in 2006) to 2.8 N (in 2008). The cultivar ‘Koral’ had the biggest fruit and the smallest soluble solids content.
solids content and lower pH as compared to ‘Schattenmorelle IR-2’ and ‘Vowi’. It is worth mentioning that ‘Karneol’ had the highest fruit weight of all the cultivars – above 10 g.

According to Płocharski (2000) there is a big, natural variability of mass and some properties of fruit quality in sour cherries, but the most important factor is the cultivar. He also claims that the weather and maturity of fruit are most responsible for chemical component content in fruit. This author prescribes the evaluation of maturity by soluble solids content – the minimum is 11.5%. Present results show that all the fruit of each cultivar were mature.

CONCLUSIONS

1. Cultivars: ‘Schattenmorelle IR-2’ (British type of ‘Schattenmorelle’), ‘Koral’ (Polish) and ‘Vowi’ (German) reached a high degree of autogamy as compared with other tested cultivars.

2. The self-fertile cultivars (‘Schattenmorelle IR-2’, ‘Koral’ and ‘Vowi’) had more viable pollen and its germination capacity was higher as compared with the cultivars which set few fruits after autogamy.

3. Cultivars: Schattenmorelle IR-2’, ‘Koral’ and ‘Vowi’ seem to be very interesting for cultivation in our country because of their high degree of autogamy and yield.

4. Due to a low pollen quality, cultivars: ‘Debreceni Bötermö’ (Hungary), ‘Újfehértói Fürtös’ (Hungary) and ‘Karneol’ (Germany) did not give a satisfactory yield after self-pollination. In Polish conditions they probably need some pollinators to set a lot of fruit.

5. Hungarian cultivars had the best fruit quality. Despite that, their production in Poland seems to be unprofitable because of poor yielding.

REFERENCES


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