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PRELIMINARY EVALUATION OF POLLEN QUALITY, FERTILITY RELATIONS AND FRUIT SET OF SELECTED SOUR CHERRY CULTIVARS IN POLISH CONDITIONS

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S u m m a r y

Preliminary experiments were carried out in spring 2006. The percentage of fruit set of 'Schattenmorelle IR-2', 'Koral', 'Debreceni Bötermö', 'Újfefértói Fürtos' and 'Karneol' was higher after open pollination compared with self-pollination. The cultivar Vowi had an inconsiderably higher percentage of fruit set after self-pollination compared with open pollination. The percentage of fruit set in 'Debreceni Bötermö' and 'Újfehértói Fürtos' was about 25 % higher after pollination by 'Schattenmorelle IR-2' and 'Koral' compared with the percentage of fruit set after cross – pollination of both cultivars with each other. In general, they did not appear to be good pollinators with each other. The highest quality of pollen was observed for the following cultivars: 'Schattenmorelle IR-2', 'Koral' and Vowi and the lowest result was obtained in 'Újfehértói Fürtos'. The highest yield was given by the following cultivars: Vowi, Schattenmorelle IR-2 and Koral.

Key words: sour cherry, cultivar, pollen quality, pollination, fertility, Poland

INTRODUCTION

It is believed that the main role in fruit set in sour cherries has the process of pollination of flowers. But it is also known that not all cultivars of sour cherry give a high yield. W o c i ó r (1976) observes that pollination depends on many biological and ecological factors. Some biological features of sour cherries make the effectiveness of pollination lower and cause poor fruit set. According to this scientist, these features are the following: low fertility potential of cultivars, short effectiveness of flower pollination period and low pollen quality. This author (1975) believes that viability and germination are the most important for the quality of pollen. He also claims that the germination of pollens is even more important because not every viable pollen grain can be subject to the process of germination in a pollen tube. Wociór called this kind of pollen (viable without germination capacity) non-functional pollen. He said that the viability of a pollen depends not only on the time of taking trials but also on weather conditions during winter and spring periods. However, the germination capacity depends on the viability of pollen and also on weather conditions during the blooming period. W o c i ó r (1975) showed that a cultivar, in order to be a good pollinator, needs to have a high quality of pollen. W i l l i a m s (1970) looks at the case from the same point of view and adds that a good pollinator needs to be compatible with the pollinated cultivar.

Weather conditions during winter and spring are thought to be ecological factors. W i e r s z y ł ł o w s k i (1973) thinks that meteorological conditions during the blooming time have the biggest influence on the process of pollination and fertilization. He claims that chilly weather and rain during the blooming are the most disadvantageous. He points also to problems connected with insufficient pollination of sour cherries and he agrees with Wociór that the correct process of pollination is one of the most important factors in fruit set. L e c h (1990) agrees with this point of view. He also adds that pollination and fertilization most depend on autogamy of cultivars, weather and bees present on a plantation (L e c h , 1984). He claims that satisfactory yield can be obtained when 30% of flowers set fruits. This author also believes that the level of yield is dependant on weather conditions during the winter time as well as during the vegetation period. This scientist has also said that self- fertile cultivars have a more positive effect on yielding and they are not as dependant on weather conditions as self-sterile cultivars. They can also be planted without the company of other cultivars. Besides that, they should not grow without the presence of bees. U g o l i k (1993) agrees with Lech, but he notices that pollination without bees is possible thanks to small

movements of air. It causes the removal of the pollen grain from the stamen to the pistil and from one flower to another, as well. However, he believes that the presence of 2-3 cultivars on the same plantation has a very positive effect on fruit set.

The aim of these studies was to investigate the problem of poor fruit set in selected sour cherry cultivars. A solution of this problem could enable the selection of a cultivar that could increase the production volume in Poland and make it more profitable.

MATERIALS AND METHODS

This research was conducted in the orchard of SGGW in Warsaw – Wilanów (Warsaw Agricultural University) on 6 sour cherry (*Prunus cerasus*) cultivars: Schattenmorelle IR-2 (British type of 'Schattenmorelle'), Koral (Poland), Debreceni Bötermö and Újfehértói Fürtös (Hungary), Karneol and Vowi (German). All trees were planted in the spring of 2001 on deep, loamy alluvial soil, spaced 4 x 2 m, on Prunus mahaleb L. rootstock. The quality of pollen (2006-2007) was investigated using viability and germination tests at three points of time: at the beginning, in full bloom and in the end of blooming time. The viability test was performed according to the triple colouring method (Alexander, 1969). The germination tests were done by using the petri-agar method (0.6% agar + 12% sucrose media) (Vasilakaksis and Porlingis, 1985). The percentage of the functionality of pollen was obtained by mathematical calculations (number of germinated pollen grains/number of viable pollen grains) and shown in percentages. The other investigations were conducted only in the year of 2006. The frost damage in 2007

Table 1
Yielding of sour cherry cultivars in 2006 and frost damages of flowers and primordia depending on cultivar in 2007.

Cultivar	Yield (kg/tree)	Frost damage in 2007 year (%)	
		The first frosts. Damage of flowers (%)	Second frosts. Damage of primordia (%)
Schattenmorelle IR-2	8.2 ab	13.2	83
Koral	8 ab	17	90
Debreceni Bötermö	5.3 bc	17	97
Újfehértói Fürtös	2.7 c	18	94,5
Karneol	1.8 c	22	97
Vowi	10.2 a	32	95

Table 2
The quality of pollen and the percentage of pollen functionality depending on cultivar.

Cultivar	Pollen viability (%)		Pollen germination (%)		Functionality of pollen (pollen germination/ pollen viability) (%)	
	2006	2007	2006	2007	2006	2007
Schattenmorelle IR-2	81.72 a	83.21 ab	66.56 a	48.58 a	81	58.4
Koral	84.07 a	88.66 a	64.5 a	54.82 a	76.7	61.8
Debreceni Bötermö	77.02 a	71.83 c	45.5 ab	28.91 b	63.2	39.3
Újfehértói Fürtös	60.41 b	70.08 c	26.07 b	18.92 c	43.1	27
Karneol	77.36 a	69.6 c	65.33 a	31.78 b	85.5	45.7
Vowi	81.74 a	79.6 b	67.11 a	55.26 a	82.1	69

made it impossible to observe the remaining features. The cultivars: Schattenmorelle IR-2, Koral, Debreceni Bötermö, Újfehértói Fürtös, Karneol, and Vowi were tested in two pollination treatments: open pollination and controlled self pollination. The autogamy level was performed by counting the percentage of fruit set after self pollination. The effectiveness of pollinators on 'Debreceni Bötermö' and 'Újfehértói Fürtös' was estimated by the percentage of fruit set after cross pollination. The following cultivars were used as pollinators: Schattenmorelle IR-2, Koral, Debreceni Bötermö and Újfehértói Fürtös. The damage of flowers caused by spring frost in 2007 was recorded and showed in percentages. The yield was recorded in kilograms per tree.

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

RESULTS

The year 2006 was characterized by a long and frozen winter period with low temperatures (-30˚C). In blooming time, during the day the temperature was usually above 20˚C, but during the night it dropped down to a few degrees of Celsius. No dangerous spring frosts were observed during the blooming. Trees of the Hungarian cultivars first began the blooming time – at the beginning of May (Fig. 1). Two days later the blooming period began for the remaining cultivars. All the cultivars, except for 'Karneol', had five days of blooming. Trees of the cultivar Karneol had a two-day longer blooming period. The highest yield per tree in the year 2006 was obtained form 'Vowi', 'Schattenmorelle IR-2' and 'Koral' (Tab. 1). 'Debreceni Bötermö' gave an insignificantly lower yield compared with 'Schattenmorelle IR-2' and 'Koral'. Poor yielding was observed in the following cultivars: Újfehértói Fürtös and Karneol, but it was insignificantly lower as compared with 'Debreceni Bötermö'.

The year 2007 was characterized by a short, smooth and snow-free winter period. Such conditions caused the vegetation period to begin in early spring. All phenological phases were earlier, as well. There were large temperature fluctuations between day and night during the blooming time (Fig. 2). The trees of the Hungarian cultivars between began blooming first and they had the longest blooming period compared with the other cultivars (Fig. 1). Three days later, the blooming period began in the trees of the Koral cultivar. After the next two days, the cultivar Karneol began the blooming time. The cultivars Schattenmorelle IR-2 and Vowi began the blooming time as the last and they had the shortest

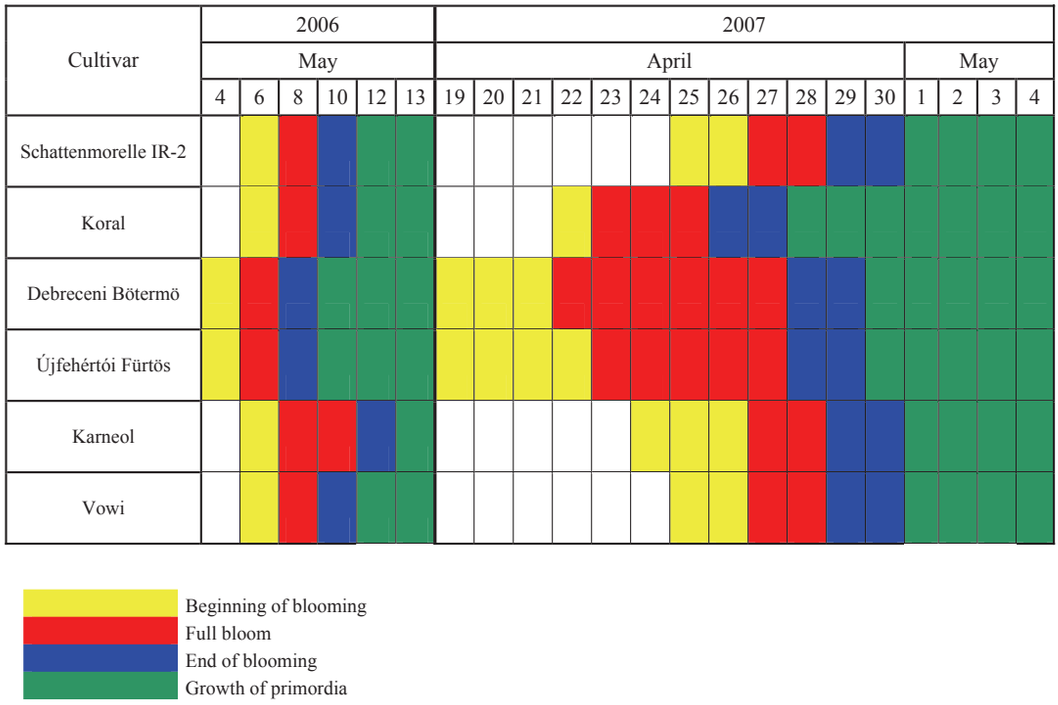

Fig. 1. The blooming process of sour cherry trees depending on cultivar in the years 2006-2007.

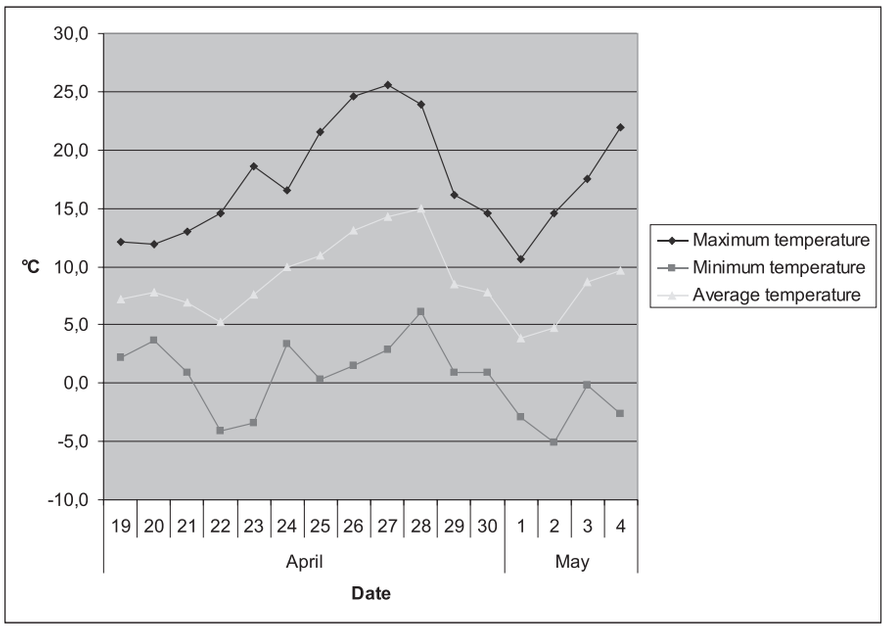

Fig. 2. Temperatures during the blooming period and primordia growth period of sour cherry cultivars in 2007.

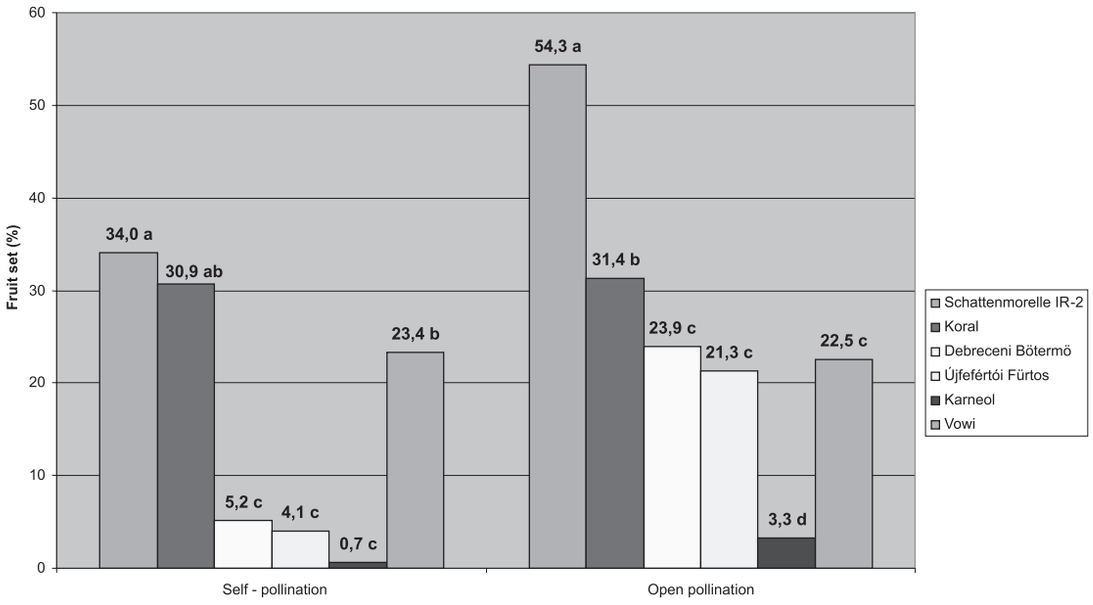

Fig. 3. The percentage of fruit set depending on pollination method and cultivar.

blooming period compared with the other cultivars. The accelerated blooming time contributed to frost damage of flowers and fruit primordia of sour cherry caused by spring frosts. These spring frosts occurred two times. During the first frost time (21-22.04 and 22-23.04), temperatures went down to -4˚C and damaged, on average, above 19% flowers of all cultivars (Tab. 1). The highest number of damages was observed in the Vowi cultivar, and the smallest in 'Schattenmorelle IR-2'. The second period of spring frosts (30.04-1.05; 1-2.05 and 2-3.05; 3-4.05), with temperatures below -5˚C, caused frost damages, on average, in 92% of fruit primordia in the examined cultivars (Tab. 1). The highest number of damages was noted in fruit primordia in the Hungarian cultivars (on average, above 95% of fruit primordia damaged) and the Karneol cultivar (2% more fruit primordia damaged). Because of that, the trees of all the evaluated cultivars did not set fruit in the year 2007.

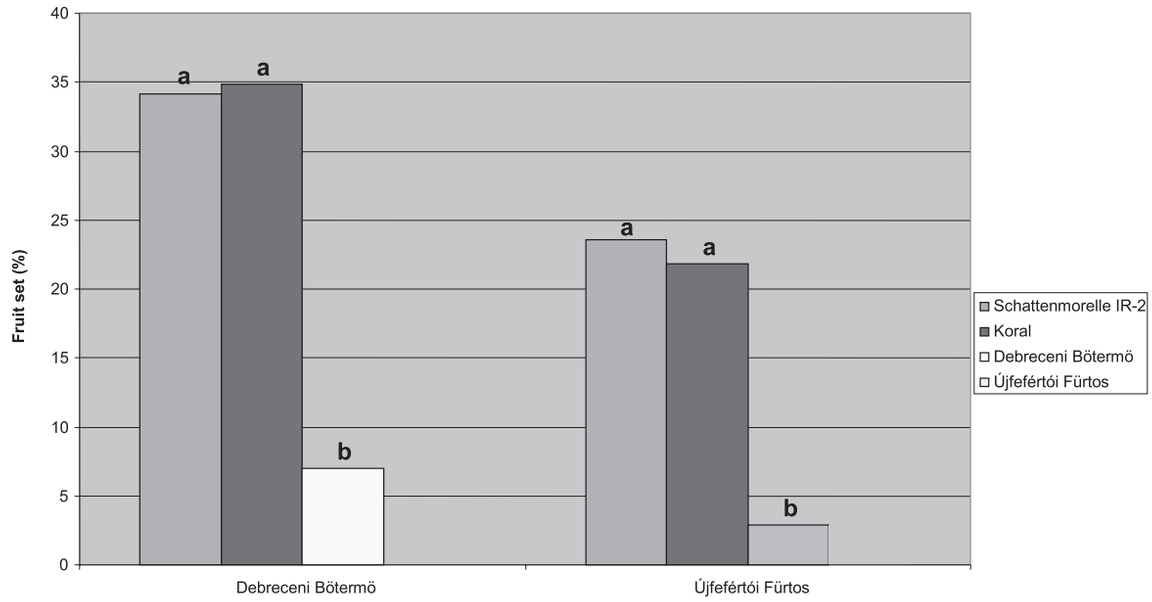

Fig. 4. Effectiveness of pollinators on fruit set in the cultivars: Debreceni Bötermö and Újfefértói Fürtos.

In the investigations during the year 2006, the sour cherry cultivars showed differences in fruit set after self-pollination (Fig. 3). The cultivars Schattenmorelle IR-2 and Koral had the highest percentage of fruit set after self-pollination (above 30%). The Vowi cultivar set about 7% less fruit compared with Koral, after self-pollination. A low level of autogamy was noted in the Hungarian's cultivar – the average being below 5% fruit set. 'Karneol' was the cultivar which set the least number of fruit in this treatment (below 1%).

Every cultivar, except Vowi, set more fruit after open pollination (Fig. 3). The cultivar Schattenmorelle IR-2 had above 50% fruit set in this treatment. 'Karneol' set the least fruit after open pollination compared with the other cultivars.

'Debreceni Bötermö' and 'Újfehértói Fürtös' set the most fruit after using the pollen of 'Schattenmorelle IR-2' and 'Koral' (Fig. 4). The percentage of fruit set was the lowest in case of cross-pollination between 'Debreceni Bötermö' and 'Újfehértói Fürtös' (Fig. 4).

The years 2006 and 2007 confirmed some differences in pollen quality (Tab. 2). In 2006 only the cultivar Újfehértói Fürtös had considerably lower pollen viability compared with the remaining cultivars. A similar situation was in the case of pollen germination. The cultivar Újfehértói Fürtös was characterized by the lowest germination of pollen. The cultivar Debreceni Bötermö had slightly higher germination. A higher percentage of functional pollen grains was observed in the cultivar Karneol. 'Újfehértói Fürtös' had the lowest percentage of functional pollen grains.

In 2007 the highest viability of pollen was observed in the cultivar Koral. 'Schattenmorelle IR-2' had insignificantly lower pollen viability. The Vowi cultivar had slightly lower viability compared with 'Schattenmorelle IR-2'. All the other cultivars were characterized by considerably lower viability of pollen. The highest germination capacity in 2007 was noted in the following cultivars: Vowi, Koral and Schattenmorelle IR-2; the lowest in the cultivar Újfehértói Fürtös. The cultivar Koral was characterized by the highest percentage of functional pollen grains. Similarly to the year 2006, the cultivar Újfehértói Fürtös had the lowest percentage of functional pollen (Tab. 2).

DISCUSSION AND CONCLUSIONS

The cultivars Schattenmorelle IR-2, Koral and Vowi were the best yielding cultivars. They were also characterized by the highest quality of pollen and they had a high percentage of pollen functionality. These are self-fertile cultivars. Findings that only self-fertile cultivars can guarantee reliable yielding are confirmed by reports of many scientists, and we should pay more attention to them (W i e r s z y ł ł o w s k i , 1973).

After a preliminary evaluation of the effectiveness of pollinators on yielding Hungarian cultivars in Polish conditions, we can agree with G r z y b (1998) that the cultivar Újfehértói Fürtös gave a higher yield in the company of pollinators. Fruit set in 'Debreceni Bötermö' is higher when it is planted with other cultivars, such as Schattenmorelle IR-2 and Koral. Accor-

ding to Lech (1980), low pollen viability in cultivars used as pollinators has an influence on poor yield in the pollinated cultivar. He also points out to the fact that self-sterile cultivars are the factor which had a minor role because bees do not move a lot of pollen grains on the pistil. He adds that a big number of pollen grains on the pistil decides about high germination capacity. Results obtained in these studies confirm these data, because the best results after cross-pollination between the Hungarian cultivars were observed after the pollination with the cultivars which had a high quality of pollen. The Hungarian cultivars were not good pollinators for each other.

In 2007 pollen from every cultivar was characterized by lower germination capacity as compared to 2006. The percentage of functional pollen was also lower. It was probably caused by spring frosts. Many scientists agree that the quality of pollen in sour cherries depends on frost damage of flower buds and their generative parts (Wociór, 1976). It is consistent with the obtained results, because spring frosts could cause lower germination capacity in 2007. The influence of spring frosts on pollen viability was not observed. Hungarian scientists (Szabo and Soltesz, 1994) are of opinion that temperature below -2.5˚C during the full bloom period can cause 100% frost damage of flowers. Results of the research showed that after temperature of -4˚C 80% of flowers survived. The same Hungarian scientists think that even 50% of frost damages can guarantee a high yield. In a study conducted in the year 2007, they observed above 90% of frost damages after the second spring frost at the beginning of May, with temperatures below -5˚C.

CONCLUSIONS

1. Hungarian cultivars need the company of pollinators to give a satisfactory yield in Polish conditions. At this time of our studies, the cultivars Schattenmorelle IR-2 and Koral seem to be good pollinators for them.
2. Self-fertile cultivars have a lot of functional pollen and they give a high yield (Schattenmorelle IR-2, Koral, Vowi). Self-sterile cultivars can also have a lot of functional pollen, but they do not give a satisfactory yield (Karneol)
3. Low temperature (-4˚C) during the blooming time has no influence on pollen viability, but it has a high influence on germination of pollen; it means that more pollen grains are non-functional.
4. Low temperature (-5˚C) shortly after the blooming period can damage almost all fruit primordia. In 2007 trees of the evaluated cultivars gave no fruit because of the problem with spring frosts.

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Wstępne badania nad wartością biologiczną pyłku, stosunkami zapylania oraz zawiązywaniem owoców u wybranych odmian wiśni w warunkach centralnej Polski

Streszczenie

W ciągu dwuletnich badań nad żywotnością pyłku i zdolnością jego kiełkowania u 6 odmian wiśni zaobserwowano różnice międzyodmianowe badanych cech biologicznych pyłku. Najwyższy procent żywotnego i kiełkującego pyłku stwierdzono u odmian: Łutówka IR-2, Koral i Vowi. Odmiana Újfehértói Fürtös (Groniasta z Újfehértói) posiadała najniższy procent żywotnego i kiełkującego pyłku. Wstępne badania nad stosunkami zapylania, przeprowadzone wiosną 2006 roku, również wykazują różnice pomiędzy poszczególnymi odmianami. Dwie odmiany węgierskie: Debreceni Bötermö i Újfehértói Fürtös, które w rodzimych warunkach zachowują się jak odmiany samopłodne, w warunkach centralnej Polski do uzyskania zadowalającego plonu potrzebują obecności zapylaczy. Dobrymi zapylaczami dla tych odmian okazały się: 'Koral' i 'Łutówka IR-2'. Drzewa odmian: Koral, Łutówka IR-2 oraz Vowi wydały zadowalający plon po zapyleniu kwiatów własnym pyłkiem. Jednak u drzew wszystkich odmian z wyjątkiem 'Vowi', procent zawiązanych owoców był wyższy w przypadku wolnego zapylenia niż w przypadku zapylenia własnym pyłkiem. Najwyższy plon w 2006 roku uzyskano z drzew odmian Vowi, Łutówka IR-2 i Koral. W 2007 roku kwiaty i zawiązki owoców wiśni zostały uszkodzone przez przymrozki wiosenne. Z tego powodu oszacowanie procentu zawiązanych owoców w poszczególnych kombinacjach zapyleń jak również oszacowanie plonu było niemożliwe. Najbardziej ucierpiały odmiany: Debreceni Bötermö i Újfehértói Fürtös, jak również odmiany niemieckie. Najmniej wrażliwa na przymrozki okazała się odmiana Łutówka IR-2.