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Marked Improvement of Hungarian Sour Cherries Grown in Iran by Cross-Pollination 1: Fruit Set

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Abstract: Cross-pollination, Natural and artificial self-pollination were performed in addition to open pollination in three Hungarian sour cherry cultivars (*Érdi bőtermő*, *Érdi jubileum* and *Cigány meggy*), planted under Mashhad, Iran climatic conditions. An experiment conducted using factorial based on randomized completely block design during 2005 and 2006, with 6 replications in 2005 and 4 replications in 2006. Flowers before anthesis and in balloon stages were isolated with paper bags from guest pollens and pollinated in appropriate time. Arc-sinus transformation was carried out on the data of final fruit set percentages obtained from cross pollination, open pollination, natural and artificial self pollination. The averages of final fruit set showed the advantage of open pollination (14.6%) in compare with natural self pollination (4.4%) and artificial self pollination (13.0%). *Siah mashhad* sweet cherry cultivar with more than 70% overlap of flowering and 9.8% fruit set in 2005 and 17.9% in 2006 was the best among applied pollen donors for *Érdi bőtermő* sour cherry cultivar. Also, *Siah mashhad* with more than 50% overlap of flowering time and 25.8% fruit set was the best polliniser for *Cigány meggy* sour cherry. Among the pollinisers, *Siah mashhad* was the best for *Érdi jubileum* with more than 50% overlap and 15.2% fruit set.

Key words: *Érdi bőtermő*, *Érdi jubileum*, *Cigány meggy*, open pollination, cross pollination, artificial and natural self pollination

INTRODUCTION

Hungarian sour cherry (*Prunus cerasus* L.) cultivars (*Érdi bőtermő*, *Érdi jubileum* and *Cigány meggy*) are cultivars cultivated in Mashhad, Iran climatic conditions. These are a midlate cultivar with large, dark-red aromatic fruits suitable for processing and fresh consumption use.

Sour cherry is an allotetraploid species, a spontaneous hybrid between the diploid sweet cherry (*Prunus avium* L.) and tetraploid ground cherry (*Prunus fruticosa* Pall.). Some sour cherry cultivars are self-compatible; the others are fully or partially self-incompatible (Crane and Lawrence, 1929).

Fertility of sour cherry cultivars has been studied from the twenty century. Middlebrook (1916) described 9 self fertile sour cherry cultivars. Kostina (1926) also, mentioned that among 29 sour cherry cultivars, 9 of them were self fertile. Crane and Lawrence (1929) showed that among sour cherry and duke cherry cultivars there were entirely self sterile and also cultivars with high degrees of self fertility. First information's on sour cherry self fertility was mentioned by Maliga (1953) and Husz (1943). In sour cherry maximum fruit set due to self fertility could reach to 50%. Amount of fruit set has been reported 64% (Nyéki *et al.*, 2008a).

Cold and rainy weathers during blooming period have negative affects on the yield of self sterile sour cherry cultivars means that yield reduces highly. Nyéki *et al.* (2008a) reported that yearly variations have more salient effects on the yield of self sterile sour cherries in comparison with self fertile ones, namely, in self fertile varieties yield is stable. In sour cherry the highest rate of fruit set reaches when flowers pollinate exactly when they are opening. Therefore pollination should occur after emasculation in balloon stage up to one to two days later.

Ability of cultivars to fertilize each other could be shown only by pollination. Nyéki *et al.* (2008a) mentioned that fruit set obtaining from open pollination in *Pándy* sour cherries is low and highly variable during different seasons. He expressed there is a direct correlation between the rate of self fertility and the yield which obtains from open pollination.

Nyéki *et al.* (2002) showed that self sterile and highly self sterile sour cherry varieties with open pollination set 12.1 and 6.3% of fruits, respectively. Meanwhile, self fertile and highly self fertile sour cherry varieties set 29 and 29.4% fruits, respectively during open pollination.

Nyéki *et al.* (2008b) showed fruit set obtains from open and self pollination is mainly related to climatic conditions and therefore highly variable during seasons

and the amount of fruit set fluctuation by self pollination is higher than open pollination. They showed that results of open pollination of self sterile Pándy 7 sour cherry were more variable than self fertile cultivars. Differences between self and open pollination was between 9.8 to 25.2%. This fact shows the importance of honey bees even for self fertile varieties.

Open pollination of highly self fertile cultivars could lead to higher fruit set (Nyéki *et al.*, 2008b).

Brozik and Nyéki (1980) expressed the ability of cultivars to set fruit after open pollination as below:

- Low : <10%
- Medium : 10.1-20%
- High : 20.1-30%
- Extremely high : >30%

Nyéki *et al.* (2008b) expressed the fertility groups on the basis of fruit set after natural self pollination as below:

- Entirely self sterile : 0%
- Self sterile : 0.1-1%
- Partially self fertile : 1.1-10%
- Self fertile : 10.1-20%
- Highly self fertile : >20%

Sour cherry flowers should be pollinated during 24 h after anther dehiscence. Later pollination could reduce the rate of fruit set (Free and Spencer-Booth, 1964). Nyéki *et al.* (2008b) observations showed useful effects of artificial self pollination on fruit set even in self fertile varieties in comparison with natural self pollination. We could define pollinizer cultivars to fine and weak pollinizers according to their fertilization ability. Also, we could compare and assess the results of controlled cross pollination with open pollination.

The objective of this study was to determine suitable cultivars to be used as pollinators for Hungarian sour cherry cultivars (*Érdi bõtermõ*, *Érdi jubileum* and *Cigány meggy*), planted under Mashhad, Iran climatic conditions.

MATERIALS AND METHODS

The experiments were carried out for a period of 2 years (2005 and 2006) on Hungarian sour cherry cultivars cultivated in Mashhad, Iran. Defining the effect of pollination treatments and comparison of pollination methods was executed using factorial experiments based on Randomization Complete Block Design (RCBD) with 6 replications in the first year (2005) and four replications during second year (2006).

Statistical analyses were carried out with the use of SAS and EXCEL software's. All observations were calculated in percentage scale (data related to final fruit set percentages), Arc-Sinus transformation was carried out on the data.

For pollen collection, branches were cut off at the white bud stage and placed in water in an insect free room. Cutting off the end of branches were applying everyday in order to excluding the vessels closure. A few days later, pollens were collected in Petri dishes by rubbing the flowers onto gauze stretched over the dishes. The fresh pollen was then transferred onto the isolated flowers with hair brushes.

For open pollination, four branches from four sides of the tree were choosing with at least 100 flowers. In order to study the cross and self pollination for every polliniser variety, in balloon stage, four branches were choose from several maternal trees and isolated with paper bags.

Hand pollination carried out when 70% of flowers inside the bags opened. The germination of pollen grains was also studied in a solution of 10% sucrose and 15 ppm boric acid.

Final fruit set percentage in each pollination treatment including open pollination, natural and artificial self pollination and cross pollination calculated.

Érdi bõtermõ, *Érdi jubileum* and *Cigány meggy* cultivars were used as reciprocal male and female cultivars. *Siah mashhad*, *Shishei* sweet cherry and also local sour cherry were used as pollen donor cultivars.

RESULTS AND DISCUSSION

Natural self pollination: In 2005, maximum fertility due to natural self pollination was in *Érdi bõtermõ* cultivar (4.9%) and minimum fruit set was in *Érdi jubileum* (3.3%). in 2006, maximum fruit set was observed in *Cigány meggy* cultivar (8.9%) while *Érdi jubileum* (2.2%) shows minimum percentage of fruit set (Table 1).

According to Nyéki *et al.* (2008b) fertility groups based on fruit set after natural self pollination, cultivars with 1.1-10% fruit set are named partially self fertile. However, Apostol (1996) put this cultivars into self fertile (10.1-20% fruit set after natural self pollination) group.

Results derived from two years of experiments under Iran climatic conditions showed that this cultivars are partially self fertile and should consider compatible polliniser for them.

Artificial self pollination: Nyéki *et al.* (2008b) observations showed the beneficial effects of artificial self pollination on fruit set in comparison with natural self

Table 1: Final fruit set percentage of natural, artificial self pollination and open pollination in sour cherry cultivars during 2005 and 2006

Cultivars	2005			2006		
	Natural self pollination	Artificial self pollination	Open pollination	Natural self pollination	Artificial self pollination	Open pollination
<i>Érdi bőtermő</i>	4.9	9.0	14.7	3.0	7.3	10.4
<i>Cigány meggy</i>	4.6	10.8	13.0	8.9	28.7	24.4
<i>Érdi jubileum</i>	3.3	12.0	13.5	2.2	10.5	12.1
Average	4.3	10.6	13.7	4.7	15.5	15.6

pollination even in self fertile varieties. Average fruit set percentage in sour cherry increased via artificial self pollination. Table 1 shows that fruit set obtained from this method of pollination ranged from 9.0 to 12.0% during 2005.

In 2006, results of artificial self pollination showed high percentage of fruit set (28.7%) in *Cigány meggy* sour cherry which is so high in comparison with natural self pollination. Comparison of average fruit set obtained from artificial self pollination by natural self pollination showed the significant differences which reveals the importance of putting bee hives in the garden.

Open pollination: In 2005, average fruit set of open pollination was 13.7% while during 2006; average fruit set was 15.6%. According to results of Brozik and Nyéki (1980) about ability of cultivars to set fruit after open pollination, present results represented that we should put these three cultivars (*Érdi bőtermő*, *Érdi jubileum* and *Cigány meggy*) to medium group (10.1-20% fruit set after open pollination). During 2006, *Cigány meggy* sour cherry cultivar showed high fruit set (20.1-30%) after open pollination. In this year the amount of fruit set by open pollination in *Cigány meggy* cultivar was 24.4%.

Usually, the average fruit set obtains from open pollination is higher than artificial self pollination, which is caused by effective pollination of bees and the existence of different pollens. Nyéki *et al.* (2008b) mentioned that there is a direct relation between the rates of self fertility and the yield obtains from open pollination. Higher degrees of self fertility resulted in better yield from open pollination.

Relation between self and open pollination is shown in Fig. 1. This experiment confirmed the relation between self and open pollination which has shown previously by Nyéki *et al.* (2008b). Accordingly, there is close relationship between fruit set of self and open pollination.

In self sterile and partially self fertile sour cherry cultivars, the percentage of fruit set obtain from open pollination is low. In fact there is a direct relationship between percentages of fruit set obtain from self pollination and open pollination.

Cross pollination: In this stage of experiments all three cultivars (*Érdi bőtermő*, *Érdi jubileum* and *Cigány meggy*) pollinated with the pollens of pollinising

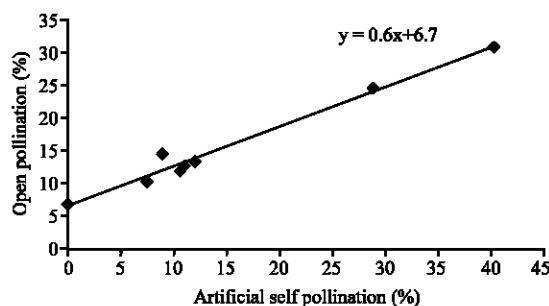


Fig. 1: Correlation between artificial self pollination and open pollination in sour cherry cultivars

cultivars (*Shishei* sweet cherry, *Siah mashhad* sweet cherry, local sour cherry, *Érdi bőtermő*, *Érdi jubileum* and *Cigány meggy*).

Érdi bőtermő: In 2005, there were not significant differences among the two pollen donors (*Siah mashhad* with 9.9% and local sour cherry with 8.2% final fruit set) for *Érdi bőtermő* from the viewpoint of fertility (Table 3). Also the rate of fertility obtained from artificial self pollination and cross pollination with *Siah mashhad* was not significantly different. In this year, the rate of fertility obtained from open pollination (14.7%) was not significantly different with the result of cross pollination.

In 2006, *Shishei* sweet cherry cultivar caused little fruit set (0.7%) on *Érdi bőtermő* according to Maliga (1953) classification. In this classification, local sweet cherry, *Cigány meggy* and *Érdi jubileum* pollens could fertilise *Érdi bőtermő* flowers to some extent (Table 3). But in 2006 year *Siah mashhad* was the best pollen donor for *Érdi bőtermő* which caused 17.9% fruit set and showed significant difference with other pollen donors. As it shown in Table 3, there is significant difference between cross pollination of *Érdi bőtermő* with *Siah mashhad* and artificial self pollination. According to Maliga (1953), *Siah mashhad* could be grade as medium cultivar (10.1-20% fruit set) after cross pollination. Totally, we could introduce *Siah mashhad* as a proper polliniser for *Érdi bőtermő* according to synchronous flowering and the amount of fruit set.

Cigány meggy: In 2005, among the two pollinisers (*Érdi bőtermő* and *Érdi jubileum*) used to pollinate *Cigány meggy*. The *Érdi jubileum* was better with

Table 2: Final fruit set (%) of cross pollination in sour cherry cultivars

♀	♂	Years	<i>Érdi bőtermő</i>	<i>Cigány meggy</i>	<i>Érdi jubileum</i>
<i>Érdi bőtermő</i>		2005	-	-	-
		2006	-	5.8bcd	2.6cd
<i>Cigány meggy</i>		2005	9.1ab	-	14.3a
		2006	23.7ab	-	12.9bc
<i>Érdi jubileum</i>		2005	9.6ab	10.5ab	-
		2006	6.2ab	10.8ab	-

Averages with the same letter(s) in each column are not significantly different in LSD = 0.05

Table 3: Cross pollination of sour cherry cultivars by sweet and sour cherry pollens

♀	♂	Years	<i>Shishei</i> sweet cherry	local sour cherry	<i>Siah mashhad</i> sweet cherry	<i>Érdi bőtermő</i>	<i>Cigány meggy</i>	<i>Érdi jubileum</i>	Average
<i>Érdi bőtermő</i>		2005	-	8.2bc	9.9b	-	-	-	9.0
		2006	0.7d	3.7cd	17.9a	-	5.8bcd	2.6cd	4.8
<i>Cigány meggy</i>		5005	-	-	-	9.1ab	-	14.3a	11.7
		2006	22.0ab	21.9ab	25.8a	23.7ab	-	12.9bc	21.3
<i>Érdi jubileum</i>		2005	-	-	-	9.6ab	10.5ab	-	10.1
		2006	11.8ab	10.2ab	15.2a	6.2ab	10.8ab	-	10.0
Average			11.5	11.0	14.5	12.2	9.1	9.9	

Means with the same letter(s) in each column are not significantly different in LSD = 0.05

14.3% fruit set. The other polliniser which did not show synchronous reproductive organs activity with *Cigány meggy* could not set proper fruit (9.1%) after cross pollination (Table 2).

Results of open pollination of *Cigány meggy* in 2006, showed the high (24.4%) fertility. So we could place it into high fertility group in this year.

Focusing on the results of self and open pollination during 2006, it could be deduced that among the pollinizers used for *Cigány meggy*, *Siah mashhad* was the best one with 25.8% fruit set after cross pollination. Although there was synchronous activity between reproductive organs of *Érdi jubileum* and *Cigány meggy* but the results of cross pollination (in 2006) with *Érdi jubileum* was not satisfactory (12.9%).

Local sour cherry and *Shishei* sweet cherry were good pollinizers for *Cigány meggy* with 21.9 and 22.0%, respectively. Regarding the cross pollination of *Cigány meggy* and *Érdi bőtermő* with each other, although their reproductive organs activity was not synchronous (20%), but the results were different. The amount of fruit set on *Cigány meggy* sour cherry as a maternal tree after receiving the pollens of *Érdi bőtermő* was rather high (9.1 and 23.7% in 2005 and 2006, respectively) in comparison with reverse combination. In 2006, when *Cigány meggy* were used as a pollen donor for *Érdi bőtermő*, it could causes only 5.8% fruit set (Table 2).

Totally among the pollinizers used for *Cigány meggy* cultivar, *Siah mashhad* sweet cherry gave the best results.

***Érdi jubileum*:** In 2005, when *Érdi bőtermő* and *Cigány meggy* were used as pollen donors for *Érdi jubileum*, there was not significant differences from

the viewpoint of fertility and fruit set, but there was better overlap between *Cigány meggy* and *Érdi jubileum*. Altogether during the two years of experiments, *Érdi jubileum* was better polliniser for *Cigány meggy* cultivar (14.3 and 12.9% fruit set) than the time when we used *Cigány meggy* as polliniser for *Érdi jubileum* (10.5% and 10.8%), (Table 2). There was more than 90% overlap of flowering between these two cultivars.

Among the cultivars used as pollen donors for *Érdi jubileum* during 2006 (*Shishei*, *Siah mashhad* sweet cherry, *Érdi bőtermő*, *Cigány meggy* and local sour cherry), averages showed the advantage of *Siah mashhad* (15.2% fruit set). In this year, fruit set obtained from open and artificial self pollination was 12.1 and 10.5%, respectively which shows the importance of fertility obtains from *Siah mashhad* pollinizer.

We could also consider *Shishei* sweet cherry as a good pollinizer for *Érdi jubileum* with 11.8% fruit set. According to Maliga (1953) we could classify *Shishei* as medium fruit set (10.1-20%) after cross pollination.

Finally, comparison of fertility relations and results of cross pollination with pollinizers, revealed that *Siah mashhad* sweet cherry with the average of 14.5% fruit set (Table 3) was the best pollinizer for Hungarian sour cherry (*Érdi bőtermő*, *Érdi jubileum* and *Cigány meggy*) cultivars. Also we could deduct that *Siah mashhad* sweet cherry is the best among parental varieties used in this experiment.

CONCLUSION

The three Hungarian sour cherry cultivar well adapted to Iran, Mashhad climatic conditions and could be used for establishment of new orchards also. Among the cultivars (*Shishei*, *Siah mashhad* sweet cherry,

Érdi bőtermő, *Cigány meggy* and local sour cherry) used as pollen donors, *Siah mashhad* sweet cherry was the best and *Shishei* sweet cherry is a good pollen donor for *Érdi bőtermő*, *Érdi jubileum* and *Cigány meggy* sour cherry cultivar. The *Érdi bőtermő* could not be used as pollen donors for any of the above mentioned cultivars.

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