Blooming phenology and fertylity of sour cherry cultivars selected in Hungary

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Summary: Experiments were conducted during the period between 1972 and 2002 at three sites in Hungary. At Érd 97, Helvécia 10, and Újfehértó, 3 cultivars were studied in variety collections. Observations were made on the blooming phenology (start, main time, end and length of the bloom period), on the blooming dynamics (the rate of the open flowers counted every day), on the receptivity of sexual organs, on the fruit set following self- and open-pollination and on the effect of association of varieties in the orchards (choice, rate and placement of pollinisers).

Based on the results the rate of the overlap of the blooming times were calculated and varieties were assigned into five bloom time groups according to their main bloom. Self-fertility conditioned by natural self pollination was studied and good pollinisers were chosen (sweet, sour and duke cherry varieties) for the self-sterile and partially self-fertile varieties.

The necessity of bee pollination was proved by different pollination methods: natural self-pollination, artificial self-pollination, open pollination.Summary: Experiments were conducted during the period between 1972 and 2002 at three sites in Hungary. At Érd 97, Helvécia 10, and Újfehértó, 3 cultivars were studied in variety collections. Observations were made on the flowering phenology (start, main time, end and length of the bloom period), on the flowering dynamics (the rate of the open flowers counted every day), on the receptivity of sexual organs, on the fruit set following self- and open-pollination and on the effect of association of varieties in the orchards (choice, rate and placement of pollinisers).

Key words: *association of varieties, blooming time groups, self-incompatibility, self-fertility*

Introduction

Sour cherry production is an important industry and its results also export item in Hungary. All except one of the registered and available 22 varieties are of Hungarian origin. The assortment is rather rich, moreover, regional selection and pedigree breeding promise currently new varieties.

Fertilisation in the *Pándy meggy*, then leading variety, concerned the growers since the 19th century. *Maliga* (1942) surveyed the relevant literature. Self-fertility and its relation to fruit set obtained by open pollination has been assessed in several Hungarian and foreign varieties by *Nyéki* (1974). All variants of *Pándy meggy* proved to be self-incompatible, and mutually inter-incompatible. *Nyéki* et al. (1992) called the attention on the fact that the self-incompatible Pándy meggy cannot be fertilised by several self-fertile varieties (*Debreceni bőtermő, Kántorjánosi, Újfehértói fürtös*), i.e. they are inter-incompatible.

Sugar content of nectaries is high in sour cherry flowers; thus honeybees are attracted. Earlier observations stated the beneficial effect of bee activity in both, self-incompatible as well as self-fertile varieties. i.e. fruit set increased substantially (*Benedek* et al., 1990).

In the present paper first of all the variability of fruit set depending on self- or alternatively open pollination in sour cherry varieties has been analysed.

Material and method

Observations of **blooming dynamics** followed the method applied by *Nyéki* (1974) on flowers distributed to the four quarters of the heavens on the end of branches, a sample comprising 100–500 flowers per variety. Starting with the beginning of bloom, every day at the same time (*between 10 and 12 a.m.*) the number of flowers according to their stage of development from the bud phase, opening and petal shedding was registered.

Flowers are considered to be **open** if the anthers and the pistil are easily recognised from above, and the stigma is green or yellow. The stigma of **fading** flowers started browning. Those dynamic observation served as a basis of determining the **start of blooming** (with the first open flowers), the **main blooming period** (when more than 50% of flowers opened) and the **day of main bloom** (when the number of open flowers reached the maximum) and the **end of bloom** (when the last flower faded).

According to the start of blooming varieties are grouped into 5 categories (*early, medium early, intermediate, medium late, late*).

Studies of fertilisation are coined with the method of *Rudloff & Schandere* (1950).

Autogamy was stated on 20–30 cm long branches of different orientation (N, E, S, W) covered still at bud stage with parchment paper bags. 5-10 isolated units comprising 100–400 flowers represented each variety. Paper bags were eliminated 3–4 days after the blooming period finished. The effect of **artificial self pollination** or **geitonogamy** was checked on isolated branches prepared as in the case of autogamy, except that the fully open flowers were hand pollinated once with previously collected and stored (at +4 °C) pollen of the same variety, subsequently, the bags were restored until the end of blooming period as in the case of autogamy.

Open pollinated flowers are observed, equally, on 5–10 branches 1.5–2 meter above ground level of four different orientation and comprising 100–500 flowers per variety..

Fruit set was registered and compared in all treatments at 1–2 weeks before fruit ripening.

Results and discussion

Blooming time

Sour cherry belongs to the group of fruit trees blooming medium early but the latest among the stone fruits. In the start of blooming cultivated varieties cover a period of 4–7 days, during some seasons exceptionally also 10 days. Most authors distinguish three blooming time groups in sour cherry varieties. Present observations derived from three growing sites, 101 varieties, and a long period of years (1972–2002), which allowed the establishment of five blooming time groups. In *Table 1* the propagated varieties are shown separately from the most important Hungarian and foreign varieties.

Neighbouring blooming time groups differ by 1–2 days only, depending on the season. In order to achieve considerable (more than 20%) fruit set a self-incompatible variety should be pollinated by a compatible polliniser, when their blooming period is overlapping each other by 70%, at least. In a system of 3 blooming time groups varieties belonging to the same group should be combined, whereas with 5 groups the overlap also of the neighbouring groups may prove to be sufficient for safe fruit set. Synchronous blooming or the extent of overlapping, however, may change yearly.

Variants of the variety *Pándy* differ in blooming time, thus *Pándy 48* is medium early blooming, *Pándy 279* is late in blooming. Blooming of *Pándy 48* is yearly variable, thus the 70% overlap was hardly achieved with the medium late blooming *Cigánymeggy 7, Cigánymeggy 59* and late blooming *Parasztmeggy* and *Schattenmorelle (Table 2)*. After having studied five potential pollinisers, only *Germersdorfi 57*, a sweet cherry variety proved to be a safe polliniser. *Pándy 279* seemed to overlap (by more than 70%) the bloom of *Cigánymeggy 7, Cigánymeggy 59, Parasztmeggy* and *Schattenmorelle*, whereas *Germersdorfi 57* was not sufficient in every year.

Self-fertilty

Self fertility of sour cherry varieties is a genetically determined property. In the extent of self-fertility there are substantial differences. In the growing practice, the self-incompatible varieties (e.g. types of the *Pándy meggy* group), as unsafe yielders are loosing space, whereas the popularity of self-fertile varieties is increasing.

Nyéki (1989) rated stone fruit varieties according to their extent of self-fertility into five groups. Sour cherry varieties observed on those three growing sites are assigned to those five groups as shown in *Tables 3* and *4*. In the assortment of sour cherries all variants between complete self-incompatibility and highly self-fertility are represented.

Table 1 Blooming time groups of sour cherriy varieties

early	medium early	intermediate	medium late	late
Érdi bőtermő	Meteor korai Csengődi Cigánymeggy C. 404 Maliga emléke Pándy 48	Favorit Érdi nagygyümölcsű Korai pipacsmeggy	Érdi jubileum Cigánymeggy 7 Cigánymeggy 59 Pándy Bb. 119	Pándy 279 Debreceni bőtermő Kántorjánosi 3 Újfehértói fürtös Oblacsinszka
Török meggy Egri fürtös 102 Törpe meggy		Montmorency (Nagy Gobet) Cigánymeggy 3	Hartai meggy Fanal C.-215 Cigánymeggy 60	Paraszt meggy Schattenmorelle(Latos meggy)

Table 2 Minimal and maximal overlap (%) of blooming periods in the Pándy meggy group of sour cherries with the potential polliniser varieties (Érd, 1972–1974)

C ?	Cigánymeggy 7	Cigánymeggy 59	Parasztmeggy	Schattenmorelle	Germersdorfi 57
Pándy 48	57–82	57–64	57–73	57–57	71–100
Pándy 279	75–100	75–90	80–90	75–80	60–90

A high yield requires a 20–30% fruit set. Most of the sour cherry varieties are unable to set as much fruit at natural self pollination. Our data corroborate the statement of Ryabov & Ryabova (1970), which means that self-fertile sour cherry varieties are yielding safely in every year because they are less subject to adversities due to weather and to growing site. Partially self-fertile varieties may produce 0–1% as well as more than 10 % fruit set; variability of their yield is much higher than of the self-fertile varieties *(Table 4)*. Maximum yields of partially self-fertile varieties may amount 4.5 times their minimum yields, whereas only 2.5 times in self-fertile varieties

The high yearly variation of fruit sets is shown in *Table 5*. In the *Pándy meggy* type of varieties being partially self-fertile the yields show multiple differences depending on the season. Selfed flowers yield nearly 0% fruit, and the maximum yields did not reach 20% in any of them. As a mean of 19 years there were three varieties with similar rates of fruit set. Earlier observations (Nyéki, 1974) proved the beneficial effect of geitonogamy on the rate of fruit set in relation to natural self pollination or autogamy even in self-fertile varieties. In partially self-fertile varieties the advantage of geitonogamy was much less expressed than in the self-fertile group. However, natural autogamy allowed a higher variation in fruit set than geitonogamy within the clone. *Table 6* proves that geitonogamy (hand pollination with pollen of the same clone) fruit set increased by a factor of 2–3 in relation to natural self-pollination or autogamy. Self-incompatible varieties (e.g. *Pándy 7*) did not set fruit even after geitonogamous hand pollination.

Free pollination

Fruit set on open pollinated flowers varied substantially according to growing site as well as to the season, which proves the high susceptibility of sour cherry to ecological adversities. Most decisive is the influence of weather on fruit set during the blooming period. Nyéki (1989) stated that fruit set of open pollinated *Pándy meggy* types is low and seasonally highly variable.

Tables 3 and *4* shows fruit sets of the varieties assigned to five self-fertility groups. Within the group of *Cigánymeggy* there are varieties, which are very poorly (e.g. *Cigánymeggy 60*), or well fertilised (e.g. *Hartai meggy, Paraszt meggy*). Some favourable seasons may produce high (26–27%) fruit sets even in self-incompatible varieties (e.g. *Cigánymeggy 215, Cigánymeggy 1317*). At present, only the best fertilised *Cigánymeggy* types are admitted to be propagated (*Cigánymeggy 7, Cigánymeggy 59*). Some varieties (e.g. *Montmorency 3*) may set fruit at rates more than 50%.

Table 3 Comparison of fruit set obtained by open pollination and by self-pollination in sour cherry varieties.

Variety	Self-fertility groups	Self-fertility	Free pollination (%)	Difference between free- and self-pollination (%)
Cigánymeggy 1317	completely self-incompatibile (0%)	0	19.5	19.5
Törpe meggy		0	4.7	4.7
mean		**0**	**12.1**	**12.1**
Cigánymeggy 60	self-incompatible (0.1–1%)	0.2	6.1	5.9
Cigánymeggy 215		0.1	15.5	15.5
Török meggy		0.3	6.4	6.4
mean		**0.2**	**9.3**	**9.1**
Cigánymeggy C.404	partially self-fertile (1.1–10%)	6.3	28.8	22.5
Debreceni bőtermő		5.5	22.8	17.3
Diemitzer		7.1	20.2	13.1
Kántorjánosi		5.0	20.1	15.1
Montmorency 1		5.3	32.5	27.2
Montmorency 2		2.0	17.5	15.5
Nagy Gobet		1.2	9.5	9.5
Újfehértói fürtös		6.0	23.1	17.1
mean		**4.8**	**21.8**	**17.0**
Cigánymeggy 7	self-fertile	14.4	23.3	8.9
Cigánymeggy 59		13.6	23.9	10.3
Hartai meggy		11.8	28.2	16.4
Latos meggy		10.4	27.3	16.9
Montmorency 3		11.6	41.9	30.3
Parasztmeggy		19.5	30.3	10.8
Schattenmorelle 2		18.5	38.9	20.4
Schattenmorelle 3		16.7	32.8	16.1
Schattenmorelle 4		16.9	28.3	11.4
mean		**14.5**	**29.0**	**14.5**
Schattenmorelle 1	highly self-fertile (more than 20%)	**25.3**	**29.4**	**4.1**

Site and date of the observations:
[1] Érd-Elvira 1972–1974,
[2] Helvécia 1987–1988.
[3] Újfehértó 1983–2002.

Table 4 Extreme values of fruit set obtained by self- and free pollination in sour cherry varieties and types

Variety (type)	Self-incompatibility group	Self-fertilisation (%)			Open fertilisation (%)		
		minimum	maximum	difference	minimum	maximum	difference
Cigánymeggy 1317[1]	complete self-incompatibility (%)	0.0	0.0	0.0	12.6	26.0	13.4
Törpe meggy[1]		0.0	0.0	0.0	2.6	6.7	4.1
mean		0.0	0.0	0.0	7.6	16.4	8.8
Cigánymeggy 60[1]	self-incompatibility (0.1–1%)	0.0	0.6	0.6	0.0	8.9	8.9
Cigánymeggy 215[1]		0.0	0.2	0.2	8.5	27.4	18.9
Török meggy[1]		0.0	0.9	0.9	1.4	12.7	11.3
mean		**0.0**	**0.6**	**0.6**	**3.3**	**16.3**	**13.0**
Cigánymeggy C.404[2]	partial self-fertility (1.1–10%)	4.4	8.2	3.8	24.5	33.1	8.6
Debreceni bőtermő[2,3]		0.5	12.7	12.2	6.6	38.3	31.7
Diemitzer[1]		6.4	8.8	2.4	14.2	26.2	12.0
Kántorjánosi[2,3]		0.0	10.9	10.9	3.0	37.1	34.1
Montmorency 1[1]		2.9	7.6	4.7	2.8	36.0	33.2
Montmorency 2[1]		0.7	3.0	2.3	7.7	27.5	19.8
Nagy Gobet[1]		0.2	2.2	2.0	5.0	14.0	9.0
Újfehértói fürtös[2,3]		0.7	18.7	18.0	3.0	42.5	39.5
mean		**2.0**	**9.0**	**7.0**	**8.4**	**31.8**	**23.4**
Cigánymeggy 3[1]	self-fertility (10.1–20%)	8.4	13.1	4.7	4.7	24.4	19.7
Cigánymeggy 59[1,2]		8.5	26.7	18.2	144	225	8.1
Hartai meggy[1,2]		6.9	17.1	10.2	18.2	39.7	21.5
Latos meggy[1]		8.6	12.1	3.5	17.9	36.7	18.8
Montmorency 3[1]		3.7	19.5	15.8	32.3	51.5	19.2
Paraszt meggy[1,2]		10.8	30.0	19.2	15.9	42.7	26.8
Schattenmorelle 2[1]		12.8	29.0	16.2	27.9	46.5	18.6
Schattenmorelle 3[1]		16.1	17.3	1.2	25.6	40.0	14.4
Schattenmorelle 4[1]		9.6	24.2	14.6	27.5	29.1	1.6
mean		**8.8**	**21.6**	**12.8**	**19.3**	**35.2**	**16.9**
Schattenmorelle 1[1]	high self-fertility (more than 20%)	15.7	33.5	17.8	19.0	39.7	20.7

Site and date of the observations:
[1] Érd-Elvira 1972–1974,
[2] Helvécia 1987–1988.
[3] Újfehértó 1983–2002.

Table 5 Self- and free fertilisation of sour cherry varieties (%) (Újfehértó, 1983–2002)

Variety	Type of fertili-sation	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	mean of years
Újfehértói fürtös	self	18.7	11.8	2.7	10.0	3.2	4.2	2.4	9.2	6.3	5.7	2.6	3.2	1.3	6.9	–	1.7	0.7	1.4	5.0	13.0	5.8
	free	14.3	21.7	22.9	41.0	22.1	31.5	12.2	16.0	40.7	25.6	28.7	–	3.0	18.2	13.2	24.3	22.8	19.9	19.3	36.5	22.8
Kántor-jánosi	self	9.1	7.9	1.8	4.2	3.9	3.9	6.3	6.0	40.4	8.2	4.1	5.1	0.0	4.4	–	1.7	5.5	1.8	4.1	10.9	4.9
	free	9.2	16.9	11.9	28.6	16.5	20.7	30.5	14.2	29.4	27.6	27.0	–	3.0	26.7	16.2	26.7	22.0	16.1	8.0	16.3	19.4
Debreceni bõtermõ	self	8.5	2.2	2.2	5.4	5.4	6.3	12.7	5.5	10.6	6.1	3.6	4.8	8.3	2.9	–	4.0	5.0	0.5	3.9	11.2	5.7
	free	16.7	–	16.5	24.7	26.8	35.6	25.6	18.5	29.5	36.8	38.3	–	6.6	13.8	13.9	22.8	25.2	8.1	11.7	42.5	23.0

Table 6 Comparison of fruit set (%) in sour cherry varieties obtained by natural self-pollination (autogamy), artificial self pollination (geitonogamy) and free pollination (Helvécia, 1988-1989)

Variety	1988			1989		
	natural self-fertilisation (autogamy)	artificial self-fertilisation (geitonogamy)	free fertilisation	natural self-fertilisation (autogamy)	artificial self-fertilisation (geitonogamy)	free fertilisation
Pándy 7	0	0	7.0	0	0	27.0
Debreceni bõtermõ	1.4	17.2	9.4	6.8	21.8	31.8
Kántorjánosi	5.2	10.2	17.4	6.7	10.8	37.1
Cigánymeggy C 404	4.4	17.0	24.5	8.2	21.8	33.1
Újfehértói fürtös	3.2	1.5	15.7	12.2	21.6	35.7
Cigánymeggy 59	8.6	28.7	31.0	11.7	32.6	36.6
Cigánymeggy 7	6.8	16.7	21.4	17.4	34.5	37.4
Parasztmeggy	14.7	23.1	33.6	17.1	39.7	42.7
mean	**5.5**	**14.3**	**20.0**	**10.0**	**22.9**	**35.2**

As mentioned, self-incompatible and partially self-incompatible varieties yield more variably not only after self pollination but also with free pollination in relation to the self-fertile varieties.

Nyéki (1989) stated that the higher the self-fertility of a variety the higher yields are expected also with open pollination. A linear correlation exists between the rate of self-fertility and the productivity at open pollination at $P = 0.01$ level. It is also proved by data appearing on *Table 3*. Completely and highly self-incompatible varieties set fruit with open pollination at rates of 12.1% and 9.3%, whereas self-fertile and highly self-fertile sour cherry varieties produced the highest fruit set: 29.0% and 29.4%.

Conclusions

Self-incompatible and partially self-incompatible sour cherry varieties must be planted with associated polliniser varieties. Appropriate polliniser varieties are to be chosen from groups of synchronous blooming period. If three blooming time groups are considered, the partners should belong to the same group, whereas from the five groups, they may be taken from the neighbouring blooming time groups too.

The rate of self- and open fertilisation is highly variable depending on the growing site as well as on the season. Variation of fruit set (and yield) is a good deal lower in self-fertile varieties than in self-incompatible and partially self-fertile varieties. Consequently, the safest yields are expected in self-fertile varieties.

Artificial self-pollination (geitonogamy) resulted in 2–3 times higher rates of fruit set in relation to natural self-pollination (autogamy), except in completely self-incompatible varieties. Highest fruit set is expected on open blooming flowers visited by bees. The advantage of open pollination is clearly evident in self-fertile and completely self-fertile varieties too. Consequently, it should be stated that bee pollination increased yield not only in self-incompatible varieties but also in self-fertile sour cherry plantations.

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