

Self fertility of pear varieties conditioned by natural self pollination (autogamy)

Nyéki J.¹, Soltész M.² and Iváncsics J.³

¹Debrecen University, Faculty of Agricultural Science (DATE),
H-4032 Debrecen, Böszörményi út 138.

²College of Kecskemét, Faculty of Horticulture,
H-6001 Kecskemét, Erdei F. tér 1.

³Veszprém University, Georgicon Faculty of Agricultural Science,
H-8361 Keszthely, Festetics u. 7.

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Key words: autofecundity, autogamy, auto-fertile pear varieties, frequency of autogamy, distinction of varieties, seed content of fruits.

Summary: Authors studied the autofertility depending on natural self pollination (autogamy) in 59 pear cultivars during 4 seasons at three locations with different ecological conditions (Helvécia, Kecskemét-Kisfái, Keszthely). The aim of the experiments was to determine the autogamous tendencies of varieties hitherto unexplored in the Hungarian gene bank, or to check data found in the literature. A total of 42616 isolated pear flowers produced 1.2% fruits with at least one viable seed in each. The 59 varieties observed did not set fruit by autogamy on either of the three sites during the four years of the study. The triploid ($3n=51$) varieties were entirely self-sterile. According to the highest autogamous fruit set, during the experimental period, the varieties have been assigned to four groups: (1) Entirely auto-incompatible (0% fruit set), (2) auto-incompatible (0.1 to 0.9%), slightly self fertile (1.1 to 5%) and (4) self fertile (5.1 to 10%). According to the number of **viable seeds per fruit** resulting from autogamy, the varieties are assigned to three groups as (1) low seed content (less than 3 seeds per fruit), medium (3.1 to 5) and (3) high (more than 5 seeds). Thus, the assessment of the number of seeds per fruit resulting from autogamy is indispensable as a proof of the absence of parthenocarpy.

Introduction

Individual plants, and varieties are considered to be auto fertile if they set fruit and develop viable seeds by autogamy, i.e. in absence of the pollen of other individual plant or variety which is considered to be an effective pollinator. In the commercial pear production, however, the criterion of **self fertility** must be restricted to varieties which are able to produce dependable yields in **monovarietal blocks** of the plantations too, whereas trees of self sterile varieties must be planted in the vicinity of other varieties because in absence of the pollen of effective pollinators no reliable yields are expected (See references in Nyéki & Soltész 1996).

Eight pear varieties were studied as for their autofecundity in 1954 and 1956, in Hungary by Maliga (1956). One variety (*Bosc Flaschenbirne*) proved to be autofertile with 1.2 % set and 1 seed per fruit. Two of the rest, 7 varieties, Bartlett and Árpával érő, were entirely self sterile, whereas the other 5 varieties set parthenocarpous fruits, i.e. the fruits did not contain viable seeds in *Curé*, *Olivier des Serres*, *Arabitka*, *Doyenné d'Hiver*, *Bon Chretien d'été*.

Nagy (1960) repeated the study of the same 8 varieties in 1955. He found 3 of them to be self sterile (*Árpával érő*, *Curé*, *Doyenné d'Hiver*), and 2 self fertile (*Arabitka*, *Olivier*

des Serres), moreover 3 varieties seemed to be self fertile, only, because their fruits did not contain viable seed (*Bosc Flaschenbirne*, *Bon Chretien d'été*, *Bartlett*). Fruit set of *Arabitka* (local variety) was 55 %, and the seed content was 2.2 per fruit which would mean, according to Nagy, that this self fertile variety may be planted in commercial production without pollinator variety. The same researcher continued his work with the same varieties during a period of 3 years at the same site, and stated that the self fertility or sterility is not a stable varietal character of the pear because of its expression is subject to environmental variations (meteorological and site specific influences) as the seasonal differences may prove it. Nyéki (1972) extended the experiments to a number (52) of pear varieties during 1967 - 1970. There were 4 varieties only, i.e. 7.7% of the varieties, which set fruits by autogamy, *Bosc Flaschenbirne*, *Madame Du Puit*, *Madame Favre*, *General Osmanwill*, all the rest of varieties proved to be self sterile.

Materials and methods

Experiments to explore autofecundity of pear varieties were performed at three growing sites with different

Table 1 The ratio of pear varieties prone to set fruit by self pollination at 3 sites and 4 seasons under conditions of natural autogamy

Year	Kecskemét Kiszfői		Helvécia		Keszthely	
	No. of varieties	Ratio (%) of va.s set fruit & seed	No. of varieties	Ratio (%) of va.s set fruit & seed	No. of varieties	Ratio (%) of va.s set fruit & seed
1988	23	26.1	45	22.2		
1989	23	26.1	45	11.1		
1990	23	13.0	45	6.7		
...						
1996					15	73.3
Mean over years		21.7		13.3		73.3

ecological conditions (Kecskemét-Kiszfői, Helvécia, Keszthely) in four years (1988 - 1990, and 1996). The number of varieties observed was 59. Every time, i.e. variety and year, 85 to 527 flower buds were isolated by pergamin paper bags in order to restrict the fertilization of the stigmata to natural autogamy without artificial intervention. The ratio of mature fruits per flowers isolated has been observed and the content of viable as well as empty seed per fruit registered. Values presented are per cent ratios of the observations.

Results

The ratio of autogamous pear varieties

Table 1 illustrates the relations of autogamy among the pear varieties at the three growing sites and the four seasons. Ripe fruits containing viable seeds developed on the isolated branches are considered to be autogamous fruit sets. The highest ratio of autogamy was observed at Keszthely, the site which is considered to be the most suitable for pear production, and in the year 1996. Among the sites of the Great Plain, at Kecskemét-Kiszfői was a high rate of autogamy in the three years of observation. In addition to the effect of the growing site, the role of the seasonal fluctuation is evident from the data. A high rate of autogamous fruit sets has been observed in 1988, thus the ratio of autogamous varieties was 22 to 26%.

Table 2 presents data expressing the tendency of autogamy of pear varieties to be expected under Hungarian growing conditions. The mean ratio of autogamous fruit set at three sites and four seasons was 1.2%. There was generally one viable seed per fruit. That is a proof of self sterility as a characteristic property of the pear species.

Table 2 Fruit set (%) and the number of viable seeds per fruit at 3 growing sites and in 4 seasons (1988-1990, 1996) under conditions of natural self pollination (autogamy)

Growing site	Number of flowers isolated	Ratio of fruit set (%)	Mean number of viable seed per fruit
Kecskemét-Kiszfői	16311	0.3	0.7
Helvécia	23340	0.2	0.4
Keszthely	2965	3.2	1.9
Total	42616		
Mean	1.2	1.0	

The frequency of autogamy

In *Table 3* we find the distribution of frequencies of autogamous fruit sets within the group of varieties with some tendency to autogamy. There were 28 varieties out of 59 in that group. The last two columns of *Table 3* show the number of cases within the sum of observations (sites x

Table 3 Frequency of autogamous fruit set in pear varieties

No	Variety	Number of sites	Number of years	How many times self fertile	the variety was self sterile
1	Arabitka (local)	2	6	4*	2
2	Árpával érő (local)	1	3	2	1
3	Bella di giugno	1	3	2	1
4	Beurrée Durondeau	1	3	1	2
5	Buzás körte (local)	2	6	4	2
6	Conference	2	4	3	1
7	Duwals	1	1	1	-
8	Erdei piros	1	3	1	2
9	Flemish Beauty	2	6	1	5
10	Bergamotte d'Esperen	2	6	4*	2
11	Père Fétel	2	4	1	3
12	Beurrée Giffard	1	3	1	2
13	Jules Guyot	1	3	1	2
14	Beurrée d'Hardenpont	2	6	3	3
15	Jeanne d'Arc	1	1	1	-
16	Kieffer's Seedling	2	4	1	3
17	Magyar kobak (local)	1	1	1	-
18	Mercedes	1	1	1	-
19	Nagy szegfűkörte (local)	1	3	2	1
20	Napoca	1	3	1	2
21	Passe Crassane	2	4	1	3
22	New York 10274	1	1	1	-
23	Curé	1	3	1	2
24	Beurrée Pringalle	1	1	1	-
25	Olivier des Serres	3	7	1	6
26	Doyenné d'hiver	2	5	1	5
27	Beurrée de Windsor	1	1	1	-
28	Zöld Magdolna	1	3	1	2

Remark:*Fruits set by autogamy did not contain viable seed, i.e. they were parthenocarpous in both cases, out of the four fruits all proved to be seedless

years) of each variety when the latter was considered to be self fertile or self sterile. It is evident that no one pear variety proved to be consequently self fertile or self sterile at every site and in each season. The highest rate of autogamy was experienced in *Buzás körte* (local variety) with 4 to 2 cases, whereas highest rate of self sterility was displayed in *Flemish Beauty*, *Olivier des Serres*, and *Doyenné d'Hiver*.

Comparison of varieties of diploid versus triploid genetic structure

There were four varieties of triploid constitution ($3n = 51$) in the assortment: *Belle d'Angevine*, *Duchesse d'Angouleme*, *Beurrée Diel* and *Curé*. At three sites and in four seasons those triploid varieties did not set fruit at all on

Table 4 The effect of the growing site on self fertility and on seed set of pear varieties

Variety	Year	Kecskemét-Kisfái*	Helvécia	Keszthely
Flemish Beauty	1988	3.6 : 2.0	0	
	1989	0	0	
	1990	0	0	
Père Fétel	1988		0	
	1989		0	
	1990		0	
	1996		-	7 : 2.2
Kieffer's Seedling	1988	0		
	1989	0		
	1990	0		
	1996	-		0.9 : 4.0
Passe Crassane	1988		1.2 : 4.1	
	1989		0	
	1990		0	
	1996		-	0
Olivier des Serres	1988	0	0	
	1989	0	0	
	1990	-	-	3.8 : 2.2
Doyenné d'Hiver	1988	0	0	
	1989	0	0	
	1990	0.5 : 3.0	0	
Arabítka	1988	1.8 : 0.0	1.5 : 1.6	
	1989	1.8 : 0.4	1.5 : 4.5	
	1990	0.0	0.0	
Buzás körte	1988	0.0	2.0 : 0.8	
	1989	1.6 : 1.5	1.0 : 4.0	
	1990	1.2 : 0.5	0.0	
Conference	1988		1.3 : 2.8	
	1989		0.0	
	1990		1.0 : 4.0	
	1996		-	7.7 : 5.6
Beurrée d'Hardenpont	1988	1.0 : 5.4	0.0	
	1989	0.0	1.5 : 6.2	
	1990	0.0	0.0	

Remark * 3.6 : 2.0 = the first number means the % ratio of fruit set, the second is the mean number of seeds per fruit

Table 5 A list of pear varieties proved to be entirely self-sterile (0% fruit set), at 3 sites and 4 seasons: 1988-1990, 1996

No	Variety	No	Variety
1	Belle d'Angevine	17	Max Red Bartlett
2	Duchesse d'Angouleme	18	Mercedes
3	Aromata de Bistrica	19	Nagoritzta
4	Aurora	20	Nordhauser
5	Bonne Louise d'Avranche	21	Esperen d'été
6	Bohusné vajkörtéje	22	Bon Chretien d'été
7	Beurrée Bosc	23	Packham's Triumph
8	Butirra P. Morettini	24	Red Clapp's
9	Clapp's Favourite	25	Forelle
10	Beurrée Diel	26	Republica
11	Devoe	27	Santa Maria
12	El Dorado	28	Seckel
13	Madame Favre	29	Bartlett
14	Beurrée Hardy	30	Vérbélű
15	Ilonka		
16	Early Bosc		

the isolated flowers which would mean that they are entirely self sterile. There was only one outstanding case with the variety *Curé* at Kecskemét-Kisfái in 1989 when the rate of fruit set was 0.8%, and the mean seed content per fruits was 3.6. According to our system, however, it did not contradict to the assignment to the self sterile category.

In the diploid varieties ($2n = 34$), on the contrary, considerable tendency of autogamy has been revealed at all the three growing sites, i.e. Kecskemét-Kisfái: 21%, Helvécia: 14%, Keszthely: 79% of the varieties are rated to be inclined.

Variation of autogamy of the varieties according to the growing site

In *Table 4* all the varieties are listed which proved to be autogamous at least at one site out of two or three. It turned out of the data that an increased rate of autogamy (7%) was only in *Père Fétel* at Keszthely. The effect of growing site on the tendency to autogamy of varieties displayed in *Table 4* should be studied more intensely in the future.

The classification of pear varieties according to their tendency to autogamy

Varieties observed at three sites and during four seasons have been assigned to **four groups** according to the **highest rate of fruit set** experienced (*Table 5* and *6*):

- (1) Entirely self sterile = 0% fruit set, 52.5%,
- (2) Self sterile = 0.1 to 1%, 8.5%,
- (3) Slightly self fertile = 1.1 to 5%, 30.5%,
- (4) Self fertile = 5.1 to 10% 8.5% of fruit set, varieties.

In other words, the yield of 52.5% of the pear varieties is **entirely dependent on the presence of effective pollinators**, but 91.5% of the 59 varieties **cannot produce dependable yields in monovarietal plantations**.

Table 6 Classification of pear varieties according to their highest rate of fruit set by self pollination (3 sites, 4 seasons)

Self steril (0.1-1% set ripe fruit)	Slightly self fertile (1.1-5% set)	Self fertile (5.1-10% fruit set)
Erdei piros	Arabítka	Conference
Kieffer's Seedling	Árpával érő	Père Fétel
Curé	Bella di giugno	Jeanne d'Arc
Doyenné d'hiver	Beurrée Durondeau	New York 10274
Zöld Magdolna	Buzás körte	Beurrée Pringalle
	Duvals	
	Flemish Beauty	
	Bergamotte d'Esperen	
	Beurrée Giffard	
	Jules Guyot	
	Beurrée d'Hardenpont	
	Magyar kobak	
	Mercedes	
	Nagy szegfűkörte	
	Napoca	
	Passe Crassane	
	Olivier des Serres	
	Beurrée de Windsor	

The number of viable seeds per fruit

According to the seed content of fruits at three sites and in four seasons allowed another classification of the pear varieties (Table 7):

- | | | |
|-------------------------|--------------------------|----------------------|
| (1) Low seed content | = less than 3 per fruit, | 57.1 %, |
| (2) Medium seed content | = 3.1 to 5 seeds, | 28.6 %, |
| (3) High seed content | = more than | 14.3 % of varieties. |

The major part (57%) of varieties had an imperfect seed set autogamously judged by the low seed content, and a high (more than 5 seed per fruit) content was found in 14.3% of the varieties. The high seed content is considered to be a precondition of normal shape and size of the fruit.

Table 7 Classification of pear varieties according to the number of viable seeds per fruit set by self pollination at 3 sites, 4 seasons

Low seed content below 3 (0.4–3)	Medium seed content 3.1–5 seed/fruit	High seed content more than 5 (–6.4)
Bella di giugno	Arabitka	Árpával érő
Beurrée Durondeau	Buzás körte	Conference
Duwals	Erdei piros	Bergamotte d'Esperen
Flemish Beauty	Jules Guyot	Beurrée d'Hardenpont
Pere Fétel	Kieffer's Seedling	
Beurrée Giffard	Nagy szegfűkörte	
Jeanne d'Arc	Passé Crassane	
Magyar kobak	Curé	
Mercedes		
Napoca		
New York 10274		
Beurrée Pringalle		
Olivier des Serres		
Doyennée d'hiver		
Beurrée de Windsor		
Zöld Magdolna		

The registration of seed content in autogamously set fruits is decisive in the determination of autogamy. Referring to the examples presented in this paper (*Arabitka*, *Bergamotte d'Esperen*), the seemingly autogamous fruit set may turn out to be a case of **parthenocarpy**.

Conclusions

a) Not a single variety, out of 59, proved to be dependable in autogamy during the four seasons and at the three growing sites. The majority of the pear varieties studied in Hungary are entirely self sterile (53%), but some low level and irregular autogamy was found in 39% of the varieties.

b) The level of autogamy varied according to growing sites and seasons but none of the varieties set fruit regularly without allogamous pollination. The autogamy experienced in the local variety, *Arabitka*, did not corroborate the high rate (55%) found by Nagy (1960) in one year, therefore the authors emphasise the necessity of pollinator varieties. High rates of autogamy indicated in the literature are to be revised because contradictions cannot be solved but by repeated (3 or 5) tests over sites and years, only.

c) The effect of the season proved to be more important whereas that of the growing site was not unequivocal in the expression of autogamy. The best example of strong seasonal influence was the year 1996 at Keszthely. The high temperature (20–25 °C) during the blooming period of pears caused conspicuous differences in the rate of autogamous fruit set. Besides the entirely self sterile varieties a relatively high rate (7–9%) of fertility occurred in some other varieties.

d) No sign of autogamy was experienced in triploid ($3n = 51$) varieties. The colour variants of entirely self sterile varieties as *Clapp's Favorite* and *Bartlett (Red Clapp's, Red Williams)* displayed the same type of fertility as their original variety.

References

- Maliga P. (1956):** Körtetermékenyülés (Fertilisation of pears). Manuscript.
- Nagy P. (1960):** Körtéfajták termékenyülési vizsgálata (A study of fertilisation in pear varieties). Ph. D. thesis of the MTA (Hungarian Academy of Science) Manuscript, Budapest. 151 p.
- Nyéki J. (1972):** Contribution to the auto-sterility and auto-fertility conditions of pear varieties. *Kísérletügyi Közlemények* LXV. (1–3), 13–27
- Nyéki J., Soltész M. (1996):** Floral Biology of Temperate Zone Fruit Trees and Small Fruit. Academic Press, Budapest, 377 p.