Inheritance of the characters related to flower formation, blooming and fertilisation in apple

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Soltész M.

University of Horticulture and Food Industry,
College Faculty of Horticulture
H–6000 Kecskemét, Erdei F. tér 1–3.

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Summary: On the base of observations performed during a period of 20 years the blooming characters of apple varieties and their progenies the following statements are actual.
In blooming dynamics there was no difference between paternal and maternal effects. In the assignment to blooming time groups, the paternal effect prevailed whereas in the tendency of flower initiation on long shoots maternal parent was more decisive. Varieties as 'Golden Delicious', 'Jonathan', 'Red Delicious', 'Rome Beauty' and 'Staymared' and their respective, naturally raised mutants did not differ in blooming characters.
The possibility of predicting the relation to blooming time groups of early (July, August) ripening individuals is low, whereas late (September, October) ripening ones have a good chance to be medium late in blooming time.

Introduction

There are scarce if any references in literature concerning the relation of characters of reproductive processes in apple as parental varieties and their progenies. Consequently, prediction of the characters expected in cross bred populations has little chances.

Apple is a segmental amphiploid species with a complicated Mendelian genetic determination, moreover, the tedious registration of phenological characters takes time let alone the seasonally variable ecological and cultural effects to be distinguished from genetic determination.

Some help is expected, however, from phenological studies exploring the relation between harvest times and their relation to blooming time groups as jointly inherited characters.

Another point of reference is offered by the comparison of blooming characters in mutants and in their respective original varieties.

Material and methods

Observations have been performed in the period between 1973 and 1997 at Helvécia on the Variety-testing Station of the State Institute for Agricultural Quality, subsequently, on the College Faculty at Kecskemét, moreover, seedling progenies derived from cross pollinations of our own experiments. At Helvécia the observation started in 1973 and lasted 20 years with 5 parental varieties ('Cox's Orange Pippin', 'Golden Delicious', 'Jonathan', 'McIntosh', 'Rome Beauty') with 34 progenies. The number of paternal varieties employed was five ('Cox's Orange Pippin', 'Golden Delicious', 'Jonathan', 'McIntosh', 'Red Delicious') with 18 progenies. From 1990 on, new varieties have been included on the experimental field of the College ('Jonagold', 'Gala', 'Elstar').

At Helvécia and Kecskemét as many as 115 mutants have been available from the original varieties: 'Golden Delicious', 'Jonathan', 'Red Delicious', 'Rome Beauty', 'Staymared', 'Jonagold', 'Gala', 'Elstar'. They were subject to studies of blooming phenology. By purposeful crosses, about 40 thousand seedlings have been gained at Helvécia and raised in the nursery of the College. One half of that population has been registered for blooming and fertility characters, whereas the rest has been abolished in juvenile stage. The more detailed study and evaluation of the 20 thousand seedlings is still a matter of progress. This time, crosses of the parental varieties 'Jonathan', 'Red Delicious', 'Golden Delicious', 'Idared', 'Summerred' and 'Granny Smith', only are considered as for their blooming phenology and fertility.

Observations of blooming time were performed according to the methods elaborated by *Herbst & Rudloff* (1939), *Weger* et al. (1940) and *Roemer* (1968–1970).

Flowering intensity (density) was graded according to a scale of 0 to 5.

Blooming time groups are characterised by permanent pilot varieties, yearly, but the final assignment of the individual varieties to blooming time groups (as early, medium early, medium late and late) was derived from statistical frequencies *(Soltész,* 1992).

Earlier observations *(Soltész,* 1986) justified a distinction of long shoots more than 20 cm, as differences in blooming tendency depends on the length of the shoot.

For evaluation of the data the Statgraphics programs have been utilised. The coefficient of variation (s%) followed the formula of *Sváb* (1973).

Results

Table 1 presents the probabilities in blooming features of the progenies depending on the maternal and paternal parent varieties.

Table 1 – The comparison of blooming features between maternal and paternal parents and their progenies in %

Blooming features	Relation betwee parents and progenies	Distribution % related to the maternal parents	of progenies mean of paternal parents
Dynamics of the start of blooming	–	24	22
	=	58	50
	+	18	28
Dynamics of the end of blooming	–	27	28
	=	58	55
	+	15	17
Length of the blooming period	–	18	33
	=	64	34
	+	18	33
Blooming density	–	32	28
	=	50	55
	+	18	17
Tendency of blooming on long shoots	–	18	17
	=	64	39
	+	18	44
Blooming time group	–	26	17
	=	39	61
	+	35	22

– : lower than the mean of the respective parental variety
=: correspondent to the respective parental variety
+: higher than the respective parental variety

The appearance of blooming characters of the parental varieties displayed analogous tendencies in derived varieties as well as in seedling progenies. That means a safe basis in planning of cross combinations as far as blooming phenology are considered *(Table 2).*

In blooming intensity, there was no significant difference between the maternal and paternal effect, whereas the tendency of blooming on long shoots depended more on the maternal parent. That is one component of the length of blooming period of the progeny too. The dynamics of blooming, i.e. the rate of opening and petal-drop, was equally subject to both parents.

The assignment to blooming time groups was more dependent on the paternal parent, thus 2/3 of the progeny bloomed at the same time-group as the paternal parent. In relation to the maternal parent, the segregation of the progeny approached a ratio of 1:1:1.

In *Table 3*, the variation of blooming data is presented. Deviations are not related to the starting variety as it is also one of the mutants, but to the average values.

Table 2 – The comparison of blooming features between maternal and paternal parents and their seedling progenies, in % (Kecskemét-Kisfái)

Blooming features	Relation betwee parents and progenies	Distribution % related to the maternal parents	of progenies mean of paternal parents
Length of the blooming period	–	20	30
	=	58	32
	+	22	38
Blooming density	–	25	26
	=	50	49
	+	25	25
Tendency of blooming on long shoots	–	23	24
	=	58	39
	+	19	37
Blooming time group	–	30	18
	=	35	64
	+	35	18

Remarks are the same as in Table 1.

Table 3 – The variability of blooming features expressed by the values of the coefficient of variation (s%)

Variety	No. of mutants	Start r.time	Main r.time	Lengt first	Lengt secon	Whol length	Flo dens	Long shoots
Jonathan	41	3	2	4	5	3	7	9
Red Del.	35	2	1	4	5	4	8	–
Gold. D.	18	1	2	8	10	5	3	4
Staymar.	11	2	1	2	2	1	3	8
Rome B.	4	1	1	5	2	5	4	3

Abbreviations of the heading in the 3. to 9. columns of the s%:
Start r. time: Relative time of the start of blooming
Main r. time: Relative time of the end of main blooming time
Lengt first: Time elapsed between the start of blooming and the main blooming
Lengt secon: Time elapsed between end of main blooming and end of blooming
Whol length: The whole length of the blooming period (days)
Flo dens: Flower density
Long shoots:Tendency of flowering on lateral buds of the long shoots

A comparison of the range in each blooming character showed that the highest variability was found in the mutant group of 'Jonathan' and 'Golden Delicious', whereas in 'Staymared' there was the less variability. In the group of 'Red Delicious', the value of the coefficient of variation did not change in spite of the fact of a high number in spur variants.

The distribution of apple varieties according to their affiliation to harvesting time groups as well as blooming time groups is shown in *Table 4.* Each harvest time group harbours varieties belonging to at least three different blooming time groups, moreover in the medium early group (August) all the four blooming time groups are represented. In the early harvest group, however, the three blooming time groups are almost equal in number. That means, there is little chance of receiving an early blooming variety which is early ripening too. Varieties of medium early harvest time are in blooming time medium early and medium late in similar rates whereas the extreme categories, early and late blooming, are less expected to appear.

The highest probability to meet medium late blooming time is in the medium late harvest group. The medium late

Table 4 – The probability (%) of predicting the blooming time group (3 to 4 on the heading) according to the date of harvesting time (first column)

Harvest time	Number of var.s	Early bloom.	Medium early	Medium late	Late bloom.
Early	14	42	29	29	–
Medium early	31	13	45	39	3
Medium late	49	–	22	74	4
Late	15	–	19	62	19
Total	113	10	29	56	5

blooming time group is most eligible to produce late (October) harvest time varieties.

Conclusions

It is an important objective of the cross breeding programs to outfit the future varieties with a late and possibly long lasting blooming period in order to increase higher security in yield. With the tendency of producing flowers on long shoots, the probability of early and abundant appearance of reproductive structures is concomitant which enables the grower to apply a wide range of training techniques. Results indicate the importance of choice among the respective parents.

The variability of blooming features between the mutants of the same variety did not exceed the variability of individual plants of the same mutant population. That calls our attention to the possibility of substituting, from the point of view of blooming features, different mutants of the same variety in planning the association of varieties in a plantation. No phenological studies are needed for adequate decisions.

It must be emphasised, however, that observations on the blooming time of mutants are not definitely concluded. The possibility exists that different results will be obtained with mutants induced in other varieties or even within the same varieties in the future with e.g. irradiation techniques.

Some concomitance of the blooming time characters and of the harvest time was stated earlier but the emphasis, that time, has been shifted to the reverse direction, i.e. the harvest time is easier and earlier cleared whereas its joint appearance with the genetically determined blooming characters are anticipated for the benefit of planning cross breeding programs, and on the other hand, in early evaluation of new variety candidates.

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