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Floral phenology investigation of scab resistant apple varieties and multi-resistant candidates – bred in Hungary – in 2007–2008

Bodor P.[1], Gaál M.[2] & Tóth M.[1]

[1] *Department of Pomology, Faculty of Horticultural Science, Corvinus University of Budapest, HUNGARY, H-1118 Budapest, Villányi út 29–43.; peter.bodor@uni-corvinus.hu*
[2] *Department of Mathematics and Informatics, Faculty of Horticultural Science, Corvinus University of Budapest, HUNGARY, H-1118 Budapest, Villányi út 29–43.*

Summary: Apple (*Malus x domestica*) is considered practically self-incompatible, polleniser is essential for its economical cultivation. When choosing a polleniser many biological and economical parameters should be taken into consideration. Scab resistant apple varieties and multi-resistant candidates – bred in Hungary – were investigated in our experiment in 2007–2008. Blooming time groups were created according to the overlap of the blooming of the varieties and candidates. Observations were set up in Szigetcsép – the Research Station of Faculty of Horticultural Science. The orchard was planted in 1997. Trees were trained to slender spindle on Rootstock M9. Varieties have been assigned four blooming time groups. 'Reglindis' started blooming in both years. Candidate MR-09 belonged to the early group in 2007 and to the mid-early group in 2008. Latest varieties are 'Freedom' and 'Baujade'. Candidate MR-10 belonged to the mid-late group.

Key words: apple (*Malus X domestica*), blooming time group, blooming phenology, relative blooming order

Introduction

Apple (*Malus x domestica*) is considered practically self incompatible that is why cross pollination is essential. Many biological and economic parameters should be taken into consideration when choosing pollinizer. Blooming time of scab resistant apple varieties and multi resistant candidates were investigated in this experiment. Blooming time groups were created according to the overlap of the blooming of the varieties and candidates.

Many scientists have investigated the opportunities of variety association in the case of nowadays cultivated commercial varieties. According to *Tóth* (2001), apple varieties bloom from 16^{th} April to 20^{th} May in the average of several years. 300 varieties were investigated for 20 years by *Soltész* (1992). 30 days difference occurred in the beginning of blooming in his experiment (it was 25^{th} March in 1990 and 25^{th} April in 1987). 35 days difference (it was 14^{th} April in 1990 and 18^{th} May in 1980) occurred in the beginning of blooming of 'Golden Delicious' in a 22 years experiment of *Blasse* et al. (1992). Although beginning of blooming depends highly on the site of cultivation *Gasser* (1994) reports similar results of a 25 years Italian experiment. Differences among sites of cultivation are well illustrated by the experiment of *Kronenberg* (1985). *Keppel* (1991) have investigated the blooming time of almost 150 apple varieties for four years. Such a large number of varieties did not allowed to make daily evaluation, only the beginning and the end of blooming were recorded. These data are informative about the length of blooming time of the varieties, but in the aspect of variety association main blooming phenophase would be more significant. *Fischer* (2002) investigated not only old and nowadays used commercial varieties but also new foreign and Dresden-Pillnitz varieties. He classified the varieties into four blooming time groups (early, mid-early, mid-late and late). *Soltész* (1992) recommends using six blooming time groups, in order not to confuse categories when classifying new varieties.

Phenophases of blooming are beginning of bloom, main bloom and end of bloom. Beginning of bloom can be observed with the highest accuracy, and this indicates the genetic differences among varieties the best. However literature data can not be easily compared as beginning of blooming is expressed diverse (according to the ratio of opened flowers 1–15%). The most effective method is to consider the day to the beginning of blooming when first flower is opened and flowering continues in the following days (*Soltész*, 2002). Whereas beginning of blooming does not give sufficient information about the overlap of the varieties. *Blasse* et al. (1992) take into consideration not only the beginning of blooming but also the main bloom phenophase. We have to notice that they define end of blooming as 50% of petal fall. It is hard to evaluate this value accurately in the practice and can be only guesstimated. That is why we classified varieties into blooming time groups according to the main bloom phenophase. Groups can be differentiated easier in 2008 than in 2007. In year 2007 high spring temperature caused shorter blooming period and main bloom took only few days for the whole cultivar assortment (*Bodor & Tóth*; 2007).

Materials and methods

Observations were set up in Szigetcsép – the Research Station of Faculty of Horticultural Science. The orchard was planted in 1997and supplied with irrigation and supporting system. Trees were trained to slender spindle on Rootstock M9. In order to the easier comparison to the literature date we also investigated non resistant apple variety 'Idared'. Multi-resistant candidate varieties from our breeding program are also involved in this experiment (*Table 1*). Morphological and fruit parameters of these candidates are summarized in the paper of *Tóth* (2001).

Table 1. Varieties and candidates under examination

susceptible control	resistant varieties (breeding country)				Hungarian candidates
	Germany	France	Czech Republic	USA	
Idared	Reglindis Reka Renora Resi Resista Retina	Baujade X-63-97	Produkta Rubinola Topaz	Freedom Liberty Prima Priscilla	MR-09 MR-10

200–300 flowers were labelled on different trees for floral phenology evaluations. Branches from different points of the compass were used. One year old twigs were excluded according to the methods of *Wertheim* (1996). Number of buds, opened flowers and worn flowers were counted daily. Data were turned to percentage values and illustrated on floral phenograms according to *Nyéki* (1980). Beginning of bloom, main bloom and end of bloom can be distinguished well on the phenograms.

Varieties have been assigned four blooming time groups (early, mid-early, mid-late and late). Data were evaluated with cluster analysis of SPSS software. Variables were the daily recorded percentage of opened flowers (8–27th April in 2007 and 9th April – 4th May in 2008).

Between-groups linkage method was used to create blooming time groups.

Results and discussion

Overlap of the blooming time of the varieties can be illustrated with the diagram of the opened flowers as *Figure 1*. shows some examples. Early blooming 'Reglindis' and 'Prima' gave similar running diagrams; their main bloom are almost on the same day. It is also well illustrated on the figure that late blooming 'Baujade' and 'Freedom' varieties started blooming when the previously mentioned ones passed main bloom phenophase. Candidate MR-10 and 'Renora' variety from the mid-early group are also illustrated on the figure. As these varieties show some overlap with the early ones, the division of the blooming time groups is difficult and varieties on the edge of a group might be good polliniser of the varieties of the neighbouring group.

We graded the investigated varieties according to their main bloom (*Tables 2–3*). We considered the day or days with the highest ratio of opened flowers as the main bloom phenophase. This grading is subjective but cluster analysis helped us creating the blooming time groups as it divided the

Table 2. Blooming time groups (Szigetcsép 2008)

blooming time group	variety	date																									
		4. 9.	4. 10.	4. 11.	4. 12.	4. 13.	4. 14.	4. 15.	4. 16.	4. 17.	4. 18.	4. 19.	4. 20.	4. 21.	4. 22.	4. 23.	4. 24.	4. 25.	4. 26.	4. 27.	4. 28.	4. 29.	4. 30.	5. 1.	5. 2.	5. 3.	5. 4.
early	Reglindis		1	2	5	12	22	**35**	**36**	30	25	20	17	14	11	10	6	3	2								
	Idared			1	3	8	15	26	**33**	**31**	28	25	20	12	7	2											
	Prima			1	3	5	12	24	**34**	**35**	22	10	9	8	6	5	3	1									
	Liberty					1	4	12	**28**	**31**	26	10	8	7	6	5	2										
mid-early	MR-09			1	3	5	8	15	26	**35**	**33**	23	18	13	6	2	1										
	Retina				1	3	8	16	25	37	**43**	**50**	40	35	26	20	12	6	2								
	Reka					1	3	8	16	22	**28**	**30**	25	18	22	20	12	6	3	1							
	Produkta					1	3	8	19	23	**29**	**25**	23	19	14	10	6	4	2								
mid-late	X-63-97					1	4	8	16	23	26	**30**	**28**	22	21	20	15	12	8	4	2						
	Renora						1	3	5	9	13	**50**	35	30	25	20	10	8	4	2							
	MR-10						1	3	7	15	26	**30**	**28**	23	16	5	4	2									
	Rubinola							1	3	8	12	20	**41**	**43**	35	20	12	6	4	2							
	Topaz							2	4	12	16	30	**40**	**37**	30	10	4	2	1								
late	Resi							2	4	6	10	15	18	28	**33**	**30**	25	20	12	7	3	1					
	Priscilla								3	6	10	15	22	28	**35**	**30**	25	20	17	14	12	10	6	3	1		
	Resista										1	3	8	22	**37**	**40**	32	26	22	18	13	10	6	2			
	Freedom										1	6	15	25	**32**	**30**	**30**	26	21	17	13	10	6	4	2		
	Baujade											1	5	6	15	25	**30**	**32**	**30**	26	23	20	15	11	6	3	

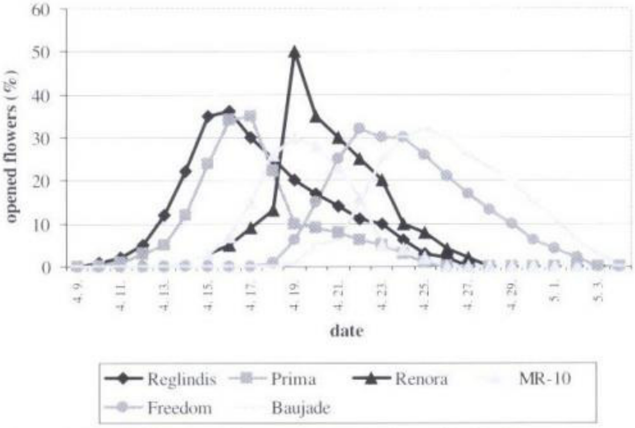

Figure 1. Floral diagram of some variety (Szigetcsép 2008)

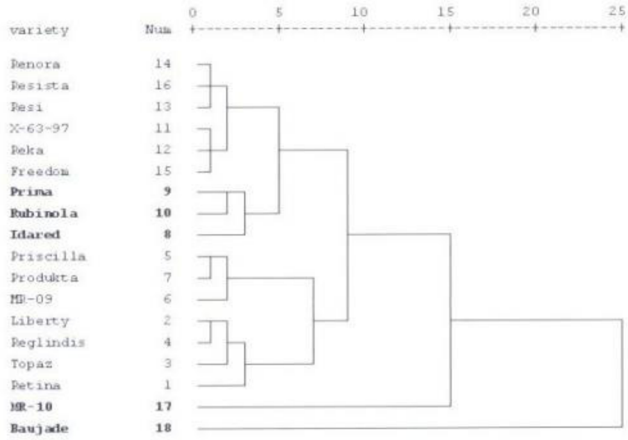

Figure 3. Blooming time groups – dendogram (Szigetcsép 2007)

early and late group unambiguously. The statistical method gave a bit different result for mid-early and mid-late group as it also took into consideration the length of blooming of the varieties. Dendograms of Cluster analysis are shown in *Figures 2–3*. Nevertheless we kept our groups as the suitability for pollination depends highly on the overlap of the main bloom phenophase of the varieties.

Table 3. Blooming time groups (Szigetcsép 2007)

blooming time group	variety	date 4. 8.	4. 9.	4. 10.	4. 11.	4. 12.	4. 13.	4. 14.	4. 15.	4. 16.	4. 17.	4. 18.	4. 19.	4. 20.	4. 21.	4. 22.	4. 23.	4. 24.	4. 25.	4. 26.	4. 27.
early	Retina		1	3	7	13	23	33	22	11	5	6	3								
	Liberty		1	4	9	12	29	38	31	26	13	6	1								
	Topaz		1	5	10	11	18	44	47	30	16	6	3								
	Reglindis		1	4	11	20	33	39	43	20	8	9	5	4	3						
	Priscilla				1	1	7	19	19	9	3	3	3								
	MR-09					2	8	20	21	20	16	15	11	5	2						
mid-early	Produkta					1	5	7	28	16	7	7	6	3							
	Idared			1	5	11	5	9	36	51	18	6	3								
	Prima			1	5	7	13	27	32	38	26	14	7	2							
	Rubinola				3	5	15	34	49	45	28	9	7	3	1						
	X-63-97					5	10	14	29	34	25	17	13	5	2						
	Reka					1	5	16	31	41	29	21	14	7							
mid-late	Resi						1	10	18	36	34	22	15	8	2						
	Renora						2	8	20	38	36	28	22	13	6	2					
	Freedom						4	14	29	43	31	25	23	11	7	2					
	Resista						3	5	18	39	43	36	21	13	7	4	1				
	MR-10							3	17	30	36	43	32	25	18	13	9	7	3	1	
late	Baujade									4	6	12	20	22	30	30	33	20	13	5	

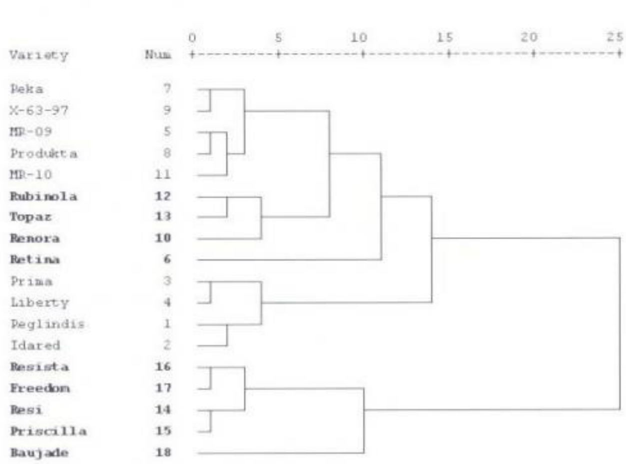

Figure 2. Blooming time groups – dendogram (Szigetcsép 2008)

We did not experienced totally same results in the two years. E.g. 'Reglindis' or 'Liberty' belonged to the early group in both years and 'Baujade' belonged to the late group. Some variety takes different place in the relative blooming order e.g. 'Retina' was one of the earliest variety in 2007 while it belonged to the mid-early group in 2008. 'Priscilla' showed the highest variation as it belonged to the early group in 2007 and to the late grouping 2008 (*Table 4*). *Soltész* (2002) investigated the stability of the blooming order of the varieties in the case of 86 varieties for 20 years. He pointed that the beginning of blooming never showed same trend even under equal circumstances (age of trees, training system, rootstock etc). According to him 10 years of observation can be informative but can not define the place of a variety in the blooming order.

Relative blooming order of the varieties also can vary according to the geographical position. Due to an experiment; two varieties bloom together only in 14 places from the 119 observations. One of the varieties bloom earlier in 87 cases, and the blooming order was reciprocal in 18 cases (*Soltész*, 2002). We also found differences when comparing our results to *Fischer's* (2002) experiment. E.g. 'Reka' belonged to the mid-early group in our experiment while Fischer ranked it to the early group. Whereas 'Reglindis' belonged to the early group and 'Renora' to the mid-late one in both experiments. In some cases we found similar results than Fischer in the one experiment year but different result in the other year. E.g. 'Topaz' belonged to the mid-late group – like in Fischer's experiment – in 2008 but it belonged to the early group in 2007.

Although relative blooming order shows variation according to the site of cultivation and the year; we find relative blooming order a useful and informative parameter for growers in order to make a suitable variety association.

Table 4. Differences in relative blooming order in 2007–2008

blooming time group	varieties in: 2007	2008
early	Reglindis	Retina
	Idared	Liberty
	Prima	Topaz
	Liberty	Reglindis
		Priscilla
		MR-09
midearly	MR-09	Produkta
	Retina	Idared
	Reka	Prima
	Produkta	Rubinola
		X-63-97
		Reka
midlate	X-63-97	Resi
	Renora	Renora
	MR-10	Freedom
	Rubinola	Resista
	Topaz	MR-10
late	Resi	Baujade
	Priscilla	
	Resista	
	Freedom	
	Baujade	

same group
1 group difference
2 group difference
3 group difference

Nowadays 4–5 varieties are recommended for a 10 hectare commercial orchard. As a matter of fact, it is not so determinative that if we create the traditional four groups or the six groups recommended by *Soltész* (2002). Relative blooming order seems to be useful for the practice especially if we take into consideration the main bloom phenophase.

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