Evaluation of foreign apricot cultivars in Hungary

Szalay L., Balázs G. and Nagy P.

BUESPA, Faculty of Horticultural Science, Department of Fruit Science
H-1118 Budapest, Villányi út 29–43., Hungary

Summary: The extension and renewal of cultivar assortment is one of the key elements in the improvement of apricot production. Competitiveness can only be achieved by planting cultivars which meet all market requirements and yield reliably under the environmental conditions of the given production site. Beside breeding programmes, the range of cultivars can also be extended by the domestication of foreign cultivars. Most apricot cultivars have low ecological tolerance, therefore, cultivars improved or developed in other countries should only be involved in production after due consideration. The suitability of such cultivars has to be examined for several years. Foreign apricot cultivars have been tested in our cultivar collection for over 10 years. Hereby, the most important aspects of market value and the adaptability to the environmental conditions of the production site are demonstrated. According to the results of our examinations the production of early ripening 'Orange Red' and 'Goldrich' can be promising in Hungary. From cultivars ripening in the peak season only those are expected to be widely produced which differ from Hungarian cultivars or surplus them in some respects. From the cultivars examined 'Harogem' which ripens at the same time as 'Gönci magyar kajszi' has remarkably aesthetic fruits with glossy surface, while the large fruits of 'Hargrand' has firm pulp. Late ripening cultivars have significant importance in the northern border of production. According to our examinations the cultivars 'Callatis', 'Comandor' and 'Sirena' are applicable in Hungary to extend the harvesting season.

Key words: *Prunus armeniaca*, apricot cultivars, domestication, cultivar evaluation

Introduction

Apricot production is traditional in Hungary. Written notes certify that apricot could be found in gardens as early as the fourteenth century *(Nyujtó & Tomcsányi,* 1959), but its production might have started even earlier. Some sources believe that apricot was known by people living in the area of the Carpathian basin in the ninth or tenth century *(Szőts,* 1941). To Hungary several apricot genotypes were taken in different routes, and the specific cultivar assortment of the area developed by the intercrossing of such genotypes. 'Gönci magyar kajszi' is one of the highly valuable representatives of this individual cultivar range. It is often planted in the orchards in the neighbouring countries *(Nyujtó & Surányi,* 1981). Although the major part of apricot yield is produced by domestic cultivars in Hungary, cultivars developed and grown in other areas of the world have been tested and introduced for a very long time, in fact, from the beginnings. Foreign cultivars with favourable fruit quality which are capable of adapting to the conditions of Hungarian production sites are involved in production. The latest example of this process is the French cultivar 'Bergeron' *(Szabó in G. Tóth* 1997).

As the competition in the market becomes more and more intensive, the availability of cultivars ensuring longer picking period and meeting the requirements is of high importance *(Pedryc & Szabó,* 1995; *Pénzes & Szalay,* 2003). According to *G. Tóth in Papp* (2003) the success of apricot production is basically determined by the cultivar, and the changes in the application of cultivars are mostly governed by the demand on the cultivars and the cultivar assortment. The renewal and extension of the selection of cultivars is, therefore, an essential part of the improvement of production. Consequently, as many foreign cultivars have to be tested as possible to enable the selection of cultivars with excellent quality which can be safely produced under the ecological conditions of the given production site.

Most apricot cultivars have low ecological tolerance, therefore, the suitability of foreign cultivars has to be profoundly tested for several years.

The domestication of imported cultivars fails mainly due to insufficient frost tolerance and winter hardiness, hence, the examination of the frost tolerance of winterer organs and the pace of their development in winter is an important part of cultivar evaluation. These factors cannot be completely defined by field studies, therefore, laboratory analyses are also required *(Pedryc* et al. 1999; *Szalay* 2001). The time of blooming is also a significant factor of yield reliability *(Pedryc,* 1992). The maturity dates of traditional Hungarian cultivars are close to each other, and their picking season is short. This is the reason why it is important to extend the ripening period by introducing early and late maturing cultivars. In northern production sites, the range of late maturing cultivars is proposed to be extended in the first place since the advantages of late ripening can be best utilized here.

Material and method

Location and conditions of examinations

The examinations were carried out in the cultivar collection established in 1992 in Szigetcsép in the northern

part of the production region in the Great Plain. The distance between the rows is 6 meters, the trees are planted with a spacing of 4 meters. The height of the trees is 100 cm and they have natural crown shape. The branches of the trees were not cut back before fruit setting. Since then the trees are maintained by branch pruning every 3rd or 4th year. The orchard was not irrigated and fruits were not thinned. The trees were grafted on myrobalan rootstock. From the cultivars tested 'Goldrich' and 'Orange Red' originate from the USA, five cultivars ('Harlayne', 'Harglow', 'Hargrand', 'Harogem' and HW 409) are Canadian, while the others come from Romania. 'Gönci magyar kajszi' was used as a control. Four trees were planted from each cultivar, but not all trees are alive.

Phenologic examinations

The development of flower buds in winter was studied by the examination of the pace of microsporogenesis. The transition of flower buds from endodormancy to ecodormancy is indicated by the spike stage. This is the first visible sign of the formation of pollen mother-cells. In the next stage the completely developed pollen mother-cells can be seen. Then comes the tetrad stage when the reducing division of pollen mother-cells occurs. In the following stage microspores and pollen-grains can be observed. The blooming time of the cultivars was recorded on the basis of observations made in the field. The day when 5% of the flowers were open was considered the beginning of blooming, and the end of blooming was recorded when 95% of the flowers dropped their petals.

For the evaluation of the cultivars the following phenologic stages were highlighted: spike stage (transition from endodormancy to ecodormancy), tetrad stage, and blooming time.

Phenologic examinations were carried out between 1998 and 2004 on trees at fruiting age.

Determination of yield

After the picking of fruit the yield was measured by each tree. As Szigetcsép lies in an area where frost damage is common, there was no measurable yield every year. Therefore, yield was only defined in three years, namely in 1996, 1999 and 2003.

Determination of fruit quality

Thirty pieces of fruit were picked from each cultivar at 90–95% ripening for laboratory examination. Quality parameters were defined by averaging the values of the 30 pieces of fruit. The weight, diameter and height of fruits were measured. The firmness of pulp was determined by penetrometer, and the dry matter (sugar) content of squeezed juice was defined by refractometer. Sightliness was judged by the shape, size and colour of the fruits. Fruit quality was determined in 1996, 1999 and 2003. The scores of the cultivars were defined by averaging the data of these three years.

Determination of the ecological adaptability of cultivars

In the course of the 12-year-long experiment the health of the trees was continuously examined, and the severity of the symptoms of diseases occurred was recorded. The frost tolerance and winter hardiness of the trees were evaluated by field observations and laboratory analyses. The biotic and abiotic stress resistance of the cultivars manifested at this site were ranked on a scale of 0–10 after the results of examinations had been added up. When the suitability of the cultivars for the given production site was evaluated not only the results of examinations were taken into consideration but we laid special emphasis on how many trees were alive 12 years after being planted and what were their conditions like.

Results

Phenologic traits

The length of the endodormancy of flower buds and the pace of flower bud development are important indicators of winter hardiness. 'Gönci magyar kajszi' used as a control has average winter hardiness. The endodormancy of the cultivar 'Sulmona' ended at the same time as that of 'Gönci magyar kajszi', while

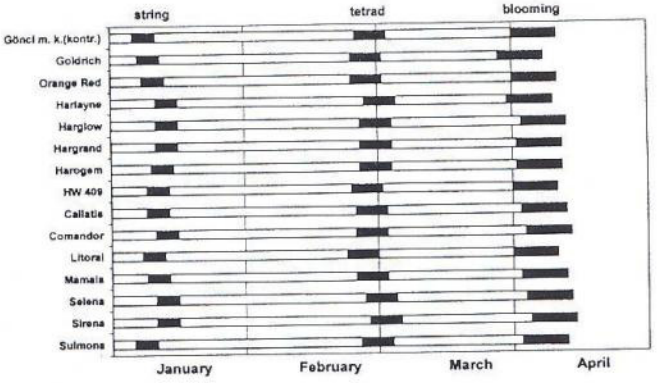

Figure 1 Phenologic stages of flower development of apricot cultivars (Szigetcsép, average of several years)

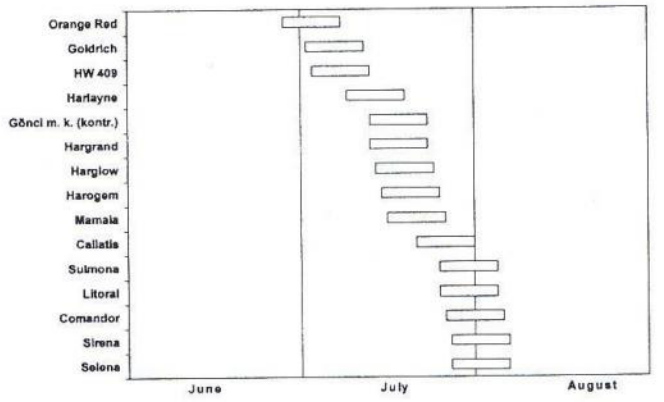

Figure 2 Maturing date of apricot cultivars (Szigetcsép, average of several years)

Table 1 Yield of apricot trees

Cultivar	Yield by trees (kg/tree)			Total yield of 3 years (kg/tree)
	1996	1999	2003	
Goldrich	17	45	56	118
Orange Red	32	66	48	146
Harlayne	44	71	90	205
Harglow	18	44	35	97
Hargrand	29	55	59	143
Harogem	37	64	108	209
HW 409	16	35	15	66
Callatis	40	85	88	213
Comandor	42	64	72	178
Litoral	22	46	39	107
Mamaia	31	54	79	164
Selena	10	41	37	88
Sirena	18	55	46	119
Sulmona	47	68	100	215
Gönci magyar kajszi (control)	34	58	65	157

the endodormancy stage of all the other cultivars finished a few days later than that of the control. On the average of the years examined this occurred at the beginning of January *(Figure 1)*. The tetrad stage also took place with a difference of some days around the control at the end of February. Blooming time occurred at the beginning of April on the average of several years *(Figure 1)*. The blooming date of 'Gönci magyar kajszi' took place in the middle of this period. The cultivars 'Goldrich' and 'Harlayne' bloomed a few days earlier than the control, while the blooming of 'Orange Red', 'HW 409' and 'Litoral' occurred at the same time as that of 'Gönci magyar kajszi'. All the other cultivars bloomed a few days later than the control.

Yield

The yields of the three years considered are presented in *Table 1*. 'Harlayne', 'Harogem', 'Callatis' and 'Sulmona' were found to be outstandingly high yielding, however, this considerable quantity was not always accompanied by high quality. 'HW 409', 'Selena' and 'Harglow' gave low yield. The yielding abilities of the other cultivars were adequate.

Fruit quality

Table 2. summarizes the quality parameters of the cultivars examined.

For fresh consumption large and aesthetic fruits are demanded. Fruits with a diameter larger than 40 mm can only be sold for this purpose. This size was reached or exceeded by all the cultivars except for 'Harlayne'. 'Goldrich' and 'Hargrand' produced outstandingly large fruits. The firmness of fruit pulp is important from the viewpoint of transportability. 'Goldrich', 'Orange Red' and 'Hargrand' had really firm pulp. The pulp of 'Harlayne' and 'Harglow' was soft, while the pulp firmness of all the other cultivars was average. Sightliness, which basically defines the market value of fruits, was determined on the basis of the fruits' size, shape, surface and colour. 'Orange Red' and 'Harogem' surpassed the other cultivars with their aesthetic appearance, nice colour and shiny surface. The fruits of the Romanian cultivars also had good appearance, they meet the actual requirements of the market. The low score of 'Litoral' is explained by the fact that its pale colour differs from that of the common cultivars in the Hungarian market.

Ecological adaptability

The data referring to the ecological adaptability of the apricot cultivars observed in the production site in Szigetcsép for 12 years can be found in *Table 3*.

The frost tolerance of winterer organs was examined by artificial freezing during the last winters, and natural frost damage was also recorded. The detailed results of these

Table 2 Quality of apricot fruit

Cultivar	Fruit			Shape index (diameter/ height)	Firmness of pulp (kp/cm²)	Refraction (%)	Sightliness (0–10)
	Weight (g)	Diameter (mm)	Height (mm)				
Goldrich	102.5	55.6	56.8	1.02	2.5	15.9	8
Orange Red	67.5	48.3	49.0	1.01	2.9	12.6	10
Harlayne	18.2	33.0	32.9	0.99	0.6	16.2	4
Harglow	44.1	40.2	44.6	1.11	0.7	15.3	7
Hargrand	70.2	49.8	48.1	0.97	2.6	14.9	6
Harogem	38.5	41.3	42.0	1.02	1.6	11.5	10
HW 409	52.0	44.1	47.2	1.07	1.5	12.2	4
Callatis	48.8	40.9	45.0	1.10	1.1	13.4	8
Comandor	50.9	42.6	48.2	1.13	1.2	13.0	8
Litoral	45.6	41.3	46.4	1.12	1.1	15.0	7
Mamaia	49.3	43.3	44.1	1.02	1.3	14.9	9
Selena	60.4	45.3	48.4	1.07	1.4	13.2	8
Sirena	49.2	40.0	45.1	1.13	1.4	15.9	8
Sulmona	60.9	46.5	47.6	1.02	1.2	14.4	8
Gönci magyar kajszi (cont.)	54.1	46.0	47.8	1.04	1.1	10.2	9

Table 3 Biotic and abiotic stress resistance of apricot trees in Szigetcsép

Cultivar	Frost tolerance	Resistance to diseases caused by			The condition of tress at the age of 12 years (0-10)	Suitability for the production site (0-10)
		viruses	bacteria	fungi		
		(0-10)				
Goldrich	5	10	8	7	8	7
Orange Red	4	9	8	8	8	7
Harlayne	9	10	7	8	7	6
Harglow	7	4	7	4	5	5
Hargrand	8	8	7	5	6	6
Harogem	7	8	8	2	6	6
HW 409	6	8	4	3	1	0
Callatis	8	8	8	7	9	9
Comandor	8	8	9	7	10	10
Litoral	5	8	5	7	6	5
Mamaia	6	8	5	6	4	5
Selena	8	8	7	8	8	8
Sirena	8	8	9	8	10	10
Sulmona	8	8	4	6	5	6
Gönci magyar kajszi (contr.)	7	8	6	8	10	10

experiment have already been published (*Szalay*, 2001; *Pénzes & Szalay* 2003). On the basis of the results of the experiments the Canadian cultivars – with the exception of 'HW 409' – were found to have good frost tolerance. The Romanian cultivars also had good cold hardiness, however, 'Litoral' and 'Mamaia' were proved to have unfavourable frost tolerance. Cultivars with good frost tolerance had better cold hardiness than that of 'Gönci magyar kajszi'. The frost tolerance of 'Goldrich' and 'Orange Red' were found to be worse than that of the control.

The symptoms of diseases were recorded every year, and the resistance of the cultivars was evaluated on the basis of these observations. Virus infection was not observed on the cultivars 'Goldrich' and 'Harlayne'. On the other cultivars mild symptoms of virus infections were detected, while on the fruits of 'Harglow' severe virus infection was found in several years. Branch necrosis caused by the bacterium *Pseudomonas syringae* could be observed on every cultivar, however, to different extents. 'HW 409', 'Litoral', 'Mamaia' and 'Sulmona' suffered from the most serious symptoms. The mildest infection was observed on 'Comandor' and 'Sirena'. 'Harogem' and 'HW 409' were the most susceptible to fungal diseases causing shoot necrosis, leaf spot and fruit rot. The health conditions of 12-year-old trees were very varying by each cultivars. In the case of the cultivars 'Orange Red', 'Callatis', 'Comandor' and 'Sirena' all the trees planted were alive and were in excellent condition, while the health conditions of the cultivars 'Harglow', 'HW 409', 'Mamaia' and 'Sulmona' were really weak. Scores lower than 6 refer to the fact that not all trees planted are alive. On the basis of the results of the experiments carried out up to the present the cultivars 'Calaltis', 'Comandor', 'Selena' and 'Sirena' are perfectly suitable for the production site in Szigetcsép. On the other hand 'HW 409' is not suitable at all. For the other cultivars further examinations are required.

Discussion

The aim of the breeding programme started in Romania several decades ago was to develop late ripening apricot cultivars with good fruit quality and favourable frost tolerance and winter hardiness (*Cociu*, 1982; *Cociu*, 1991). The cultivars examined in our experiments originate from this programme, and they are the cultivars used most widely in Romania (*Stancu* et al., 1991). They were found to be late ripening in Hungary as well, therefore, the picking season can be extended by them.

The Canadian cultivars were described by their breeders as cultivars with good frost tolerance, good disease resistance and high market value (*Layne & Gadsby*, 1995; *Layne*, 1996). In the site of our cultivar collection, which is not really favourable for apricot from ecological point of view, these cultivars were found to have good frost tolerance and the market value of their fruit was high with the exception of 'Harlayne', however, they were proved to be susceptible to fungal and bacterial diseases to different extents. The main value of the cultivars 'Harlayne' and 'Goldrich' is their resistance to the virus plum pox (*Karayiannis*, 1995; *Polák* et al., 1995). No viral infection was observed on these cultivars in our experiments either. On the other cultivars symptoms of viral infection were detected but this reduced fruit quality only in the case of 'Harglow'.

The two cultivars from the United States are widespread not only in the USA but also in several European production sites, and they are in great demand due to their high market value (*Moreau-Rio*, 2001; *Mezzetti* et al., 2002; *Wurm* et al., 2002). Their fruit quality was good in Szigetcsép as well. However, owing to their low frost tolerance they are proposed to be planted in places where the risk of freezing is little.

As a summary we can state that several foreign cultivars examined are promising for extending the Hungarian cultivar

Table 4 Summing evaluation of apricot tress on the basis of fruit quality and suitability for the production site

Cultivars proposed to be plantedin Hungarian orchards	Orange Red, Callatis, Comandor, Sirena
Cultivars proposed to be planted if the results of further examinationsare favourable	Goldrich, Harglow, Hargrand, Harogem, Litoral, Selena, Sulmona, Mamaia
Cultivars not proposed to be planted in Hungary	Harlayne, HW 409

assortment. *Table 5* shows which cultivars are considered to be suitable for planting in Hungarian orchards, which cultivars require further tests, and which cultivars are judged to be unable for successful production in Hungary.

'Orange Red' can be a valuable cultivar of the early picking season. Its aesthetic and large fruits, which can also endure the difficulties of transportation, make it suitable mainly for fresh consumption. However, it is proposed to be planted in hilly production sites because of its susceptibility to frost.

'Callatis', 'Comandor' and 'Sirena' can be used to extend the duration of picking since they ripen later than traditional Hungarian cultivars produced in the largest quantity. These late ripening cultivars are of high importance mostly in northern production sites, the advantages of this trait can be best utilized here. The fruits of all three cultivars have good quality and are suitable for both fresh consumption and processing.

'Harlayne' and 'HW 409' were found to be inappropriate for production because of their low fruit quality. For the other cultivars further examinations are required before being involved in production.

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