

First selections of the Hungarian apple breeding program for multiple resistance

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Summary: The aim of the first Hungarian apple breeding program for multiple resistance started in the beginning of the nineties is to widen Hungarian apple assortment by good quality, resistant apple cultivars with excellent productivity and ecological capability to the most important fruit growing areas in Hungary. In the first years of seedling production we made early selection for susceptibility to apple scab in greenhouse. After this, field observation of susceptibility to powdery mildew, scab and canker and a yearly negative selection was carried on. From 1997, fruit quality was evaluated as well, and from 2001 the resistance of shoots to *Erwinia amylovora* (Burrill/Winslow et al.) was examined using inoculations in greenhouse conditions. From the progenies of crosses in 1992 and 1993, six candidates were announced to national recognition out of hybrids examined for more than a decade. Descriptions of these selections from 'Prima' progenies and the most important data of their resistance, growing habit, morphological characteristics and fruit quality are shown in this article.

Key words: *Malus x domestica*, apple, selection, scab, mildew, fire blight, description

Introduction

People endanger the environment by production technologies in apple orchards, requiring plenty of energy and chemicals, and we consume and produce the most from apple fruit. Therefore introduction and wide-ranging dissemination of environment friendly technologies are the most reasonable in case of this species. The integrated production is an actual issue all over the world, which makes the reduction of plant protection treatments and costs, but does not necessarily provide a comprehensive solution against fungal and bacterial diseases. At the same time, important demands are supplying consumers with good quality fruits with no chemical residues, as well as an expressive reduction of chemicals polluting the environment. An additional endeavour is the production according to marketing trends.

Multiresistant apple cultivars result a reduction of principal cost assuring environment friendly technologies and target production. Therefore resistance or tolerance to more diseases has aligned to the aims of apple breeders defined earlier (eg. good productivity, excellent quality, ecotolerance).

A new breeding program – unique in Hungary – was started at the Department of Fruit Science of the University of Horticulture and Food Industry in the beginning of the 90's (G. Tóth et al., 1994), continuing former breeding works (Kovács, 1986). The aim of this program is to widen the Hungarian apple cultivar assortment by table, double utilized or industrial apple cultivars of good quality and excellent productivity, which are suitable for Hungarian production areas, and which are the most favourable for environment friendly and cost saving cultivation technologies, because of

their diverse disease resistance. Aims in connection with disease resistance: durable and high-level or field resistance to present Hungarian biotypes of *Venturia inaequalis* (Cke./Wint.) causing apple scab, field resistance to powdery mildew caused by *Podosphaera leucotricha* (Ell. et. Ev./Salm.), to fire blight (caused by: *Erwinia amylovora* (Burrill/Winslow et al.) and to canker caused by *Nectria galligena* (Bres.). After this the quality of fruits was tested.

Material and method

An early selection of seedlings was made in greenhouse in a stage of 2–4 leaves after inoculation with conidial suspension of the pathogen *Venturia inaequalis* (G. Tóth et al., 1998), and after a rapid cultivation of seedlings (Fischer, 1994) the trees could pass juvenile stage within one year. In the second-third year by the method of Krüger (1994) we evaluated their susceptibility to powdery mildew, spontaneously infection in field. We kept those hybrids which were resistant or moderately susceptible to powdery mildew. Then in the following 3–4 years we evaluated the fruits on grafted trees, meanwhile observation of field susceptibility to powdery mildew, scab and canker and a yearly negative selection was carried on.

Examination of fruit quality was carried out in our department's fruit laboratory. Beside evaluation and measuring of size, coloration, flesh firmness and inner values (titrable acid content, refraction), we examined the most important features of pedicel, sepal and receptacle hole as well. Vigour of trees, canopy habit and density were observed, as well as most important characteristics of shoots and leaves.

Table 1. Resistance to powdery mildew, growing and morphological characteristics of the scab resistant selections (Szigetcsép, 2000–2003)

Selection	Year	Density of flowers (0–3)	Fruit set (0–3)	Mildew in June (0–3)	Mildew in Sept. (0–3)	Canker (0–3)	Growth (dwarf, medium, vigorous)	Canopy (upright, spreading, drooping)	Leaf size (1–3) (3=largest)	Thickness of one-year-old shoot (1–3)
MR-03	2000	2	2	0	0	0	v.	s.	2	2
	2001	2	2	2	1	0	v.	s.	2	2
	2002	2	1	2	2	0	v.	s.	2	2
	2003	3	3	0	0	0	v.	s.	2	2
MR-09	2000	0	0	1	1	0	m.	s.	2	2
	2001	1	1	0	0	0	m.	s.	2	2
	2002	2	1	1	1	0	m.	s.	2	2
	2003	2	1–2	0	0	0	m.	s.	2	2
MR-10	2000	2	2	0	0	0	v.	s.	2	3
	2001	0	0	0	0	0	v.	s.	3	3
	2002	1.5	2	0	0	0	v.	s.	3	3
	2003	3	3	0	0	0	v.	s.	3	3
MR-11	2000	1	1	0	2	0	m.	s.	2	2
	2001	1	1	0	0	0	m.	s.	2	2
	2002	2.5	1	0	0	0	m.	s.	2	2
	2003	2	2	0	0	0	m.	s.	2	2
MR-12	2000	0	0	0	0	0	m.	s.	2	2
	2001	2	2	0	1	0	m.	s.	2	1
	2002	2.5	1	0	0	0	m.	s.	2	1
	2003	3	2	0	0	0	m.	s.	3	2
MR-13	2000	1	1	1	0	0	m.	s.	2	2
	2001	2	3	0	1	0	m.	s.	2	1
	2002	2	2	0	0	0	m.	s.	2	1
	2003	3	3	0	0	0	m.	s.	2	2

Table 2. Susceptible of shoots to the local strains of *Erwinia amylovora*

Selection and cultivar	Speed of disease development			Disease severity			Bacterial multiplication		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
MR-03	–	MR	MR	–	MR	MR	–	MR	MR
MR-09	–	MR	MR	–	MR	MR	–	MS	MR
MR-10	–	MR	MR	–	MR	MR	–	MR	MR
MR-11	–	MR	–	–	MR	–	–	MS	–
MR-12	–	–	MR	–	–	MR	–	–	MS
MR-13	–	–	MR	–	–	MR	–	–	MR
Remo	MR	MS	MR	MR	MS	MR	MS	MS	–
Idared	S	S	S	S	S	S	S	MS	MS

MR = moderately resistant, MS = moderately susceptible, S = susceptible
Remo = multiresistant cultivar from Drezda-Pillnitz

From 2001, the resistance of shoots to bacterium *E. amylovora* was examined using the tests described in this journal by Kása et al. (2004).

Results

From the progenies of crosses in 1992 and 1993, four candidates were announced to national recognition out of hybrids examined for a decade. The most important characteristics and DUS description of them were published

by G. Tóth (2003). During further observations and examinations in 2003, two new promising hybrids were selected. After one or two years of further examination, more candidates can be chosen from them, which can be announced for national recognition in order to supplement Hungarian variety assortment.

All of these selections show significant resistance to the above mentioned diseases, and considering their growth characteristics as well as their fruit quality, they can be recommended to widen the cultivar assortment in Hungary. Resistance to apple scab and powdery mildew, growing and

morphological characteristics of the trees are shown in *Table 1*. Susceptible of the shoots of the selections to the local strains of *Erwinia amylovora* are shown in *Table 2*. The most important data on fruit internal quality are included in *Table 3*. A brief description of the six selections are written below.

MR-03

Selected from open-pollinated seedlings of 'Prima'. Ripens in early or middle September. Fruit size is medium to large, shape is round conic. Pedicel is short or medium long, pedicel hole is sometimes burned. Calyx and ovary are both closed. Its flesh keeps its outstanding firmness during storage. Flesh is light cream, juicy, taste is sweet-acid, aromatic. The green ground colour is overlaid with

red, gradually darkening when the fruit ripens, and this combines with dissolving bloom and rare but conspicuous white dots. Tree is highly or moderately vigorous, grows thick crest and leaders, the canopy is spreading, globose. (*Figure 1*)

MR-09

Originated from the crossing of 'All Red Jonathan' and 'Prima'. Fruits can be harvested in middle September, rounded oblate, size medium, average weight is 140-150 grams. Its yellowish-green ground colour is covered by a bright red overlay on most of the fruit surface. The cream-coloured flesh is medium firm, its sweet-acid taste, determined by an outstanding inner value is rich in aroma

Table 3. Internal quality of the fruits

Selection and cultivar	Year	Date of examination	Date of harvest	Recovery (%)	Refraction (Brix%)	Malic acid (%)	Abs. 420nm (water=0)
MR-03	1999	14. Oct.	01. Sept.	79.00	9.50	0.99	0.27 0.20
	1999	16. Nov.	07. Sept.	83.10	12.50	0.70	
	2000	17. Sept.	28. Aug.	66.13	14.00	0.93	
	2001	06. Sept.	28. Aug.	55.00	14.58	1.04	
	2003	01. Dec.	03. Sept.	50.67	13.10	0.65	
	2003	05. Dec.	08. Sept.	48.80	13.90	0.78	
MR-09	2000	08. Oct.	25. Aug.	50.09	15.30	0.67	0.73
	2001	06. Sept.	06. Aug.	60.00	12.73	0.79	0.51
	2002	14. Oct.	06. Aug.	43.16	13.50	0.91	
	2003	01. Dec.	03. Sept.	48.00	14.30	0.51	
	2003	01. Dec.	08. Sept.	44.44	14.00	0.49	
MR-10	2000	23. Sept.	28. Aug.	72.95	11.80	0.39	1.64
	2002	14. Oct.	15. Aug.	54.95	14.10	1.00	
	2002	16. Sept.	15. Aug.	55.41	13.25	0.64	
	2003	01. Dec.	27. Aug.	47.73	12.40	0.46	
	2003	01. Dec.	27. Aug.	40.00	13.50	0.49	
MR-11	1999	14. Oct.	01. Sept.	81.00	12.10	0.70	0.54 0.33
	1999	16. Nov.	08. Sept.	81.40	11.80	0.57	
	2000	17. Sept.	28. Aug.	52.11	12.40	0.93	
	2001	06. Sept.	06. Aug.	55.00	11.68	0.78	
	2002	14. Oct.	02. Sept.	65.85	13.85	0.80	
MR-12	1999	14. Oct.	02. Sept.	80.00	21.50	0.83	0.42
	1999	16. Nov.	06. Sept.	83.10	12.80	0.53	
	2001	05. Sept.	17. Aug.	53.00	11.96	0.83	
	2003	01. Dec.	24. Sept.	46.05	15.80	0.65	
	2003	01. Dec.	23. Sept.	46.15	14.40	0.49	
MR-13	2001	05. Sept.	17. Aug.	51.00	13.49	0.65	0.75
	2002	10. Sept.	25. July	57.78	12.90	0.91	
	2003	01. Dec.	22. Aug.	46.34	13.50	0.38	
	2003	01. Dec.	18. Aug.	33.33	13.20	0.43	
Jonathan Naményi Jonathan Jonathan Jonathan M40 Jonathan Jonathan	2000	23. Sept.	23. Sept.	58.83	12.90	0.49	0.38
	2001	21. Sept.	12. Sept.	54.00	13.94	0.79	0.12
	2002	10. Sept.	15. Aug.		13.35	0.98	
	2002	14. Oct.	08. Sept.	61.81	14.60	0.73	
	2003	01. Dec.	10. Sept.	48.00	14.30	0.57	
Prima	2000	22. Oct.	21. Aug.	57.16	10.40	0.40	0.69
	2002	14. Oct.	19. Aug.	71.97	12.85	0.82	
	2003	01. Dec.	27. Aug.	40.63	12.00	0.46	
Tenroy (Royal Gala) Gala	2002	14. Oct.	19. Aug.	67.83	13.60	0.48	
	2002	14. Oct.	19. Aug.	67.83	11.35	0.39	



Figure 1: MR-03



Figure 4: MR-11



Figure 2: MR-09

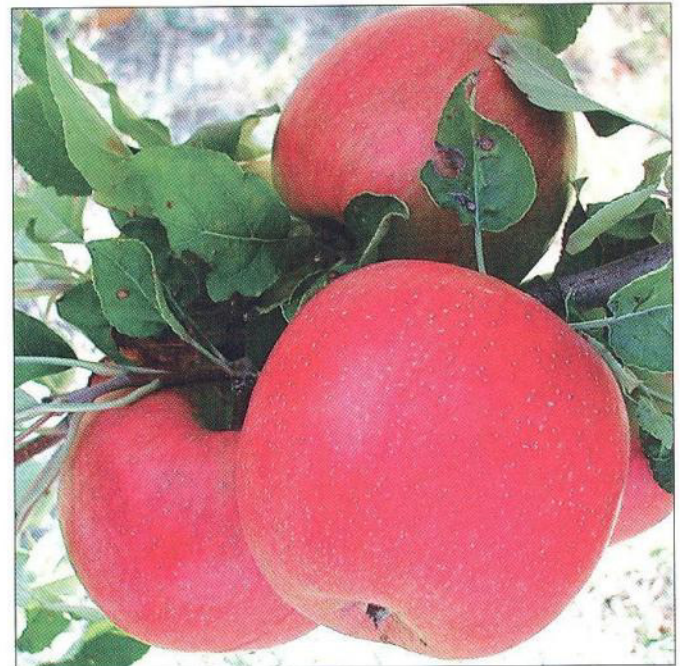


Figure 5: MR-12



Figure 3: MR-10



Figure 6: MR-13

and has a slight scent. Pedicel is medium long, calyx and ovary are both closed. Tree is moderately vigorous, the canopy is spreading, medium dense. (*Figure 2*)

MR-10

A free pollinated seedling of 'Prima', Ripens in late August, fruit size is medium, average weight is 130–140 grams, form is slightly oblate, true conic. Its yellowish-white ground colour is covered by an overlay of bright red stripes and slight bloom on 80% of fruit surface. Pedicel is short or medium long, calyx is closed or half-open, ovary is totally closed. Flesh remains outstandingly firm during storage. Flesh colour is yellowish-white, taste is harmonic, combined with a tender aroma. Tree is moderately vigorous, of pyramidal habit, the canopy is spreading, medium dense. (*Figure 3*)

MR-11

Breded by crossing 'Prima' and a seedling of 'Raritan'. Can be harvested in middle September. Fruit size is medium, average weight is 140–160 grams. Form is rounded oblate, the widest at the centre, and slightly ribbed from the calyx. Its yellowish-green ground colour is covered by an overlay turning from carmine into cherry-red, with a slight bloom. Pedicel is medium long, calyx and ovary are both closed. Flesh is firm, does not soften during storage, colour is yellow, taste is enjoyably subacid, with a high refraction, gentle flavour and aroma. Tree is moderately vigorous, the canopy is spreading, expanded, middle dense. (*Figure 4*)

MR-12

Arised from progenies of 'Prima' and 'Granny Smith'. It can be harvested in late September or in early October. The fruit is large, its shape is round-elongated. The pedicel is medium long. Keeps its outstanding flesh firmness during storage. The flesh is light cream, juicy, taste is acidic-sweet, pleasant. The green ground colour is covered by a light pink and later bright red cover colour in ripening. The tree is moderately vigorous, the canopy is spreading, medium dense. The twigs are slightly woolly, of claret-brown colour, older parts are light brown. Dark green leaves are large, with sharply serrated margin, the shape is a bit elongated. The leaf-base is wedged, the apex of leaf-blade is sharp-pointed. (*Figure 5*)

MR-13

A hybrid of 'Jonathan M 41' and 'Prima'. Fruits can be harvested in middle August. The fruit is medium-sized, its shape is rounded oblate. Its yellow ground colour is covered by a dark red cover colour. The pedicel is medium long, the pedicel hole is deep, its calyx is shallow and wide. The tree is moderately vigorous, the canopy is spreading, medium dense. Leaves are medium large, a bit elongated, prolate in the middle, colour is bright, the leaf-back is slightly woolly. The leaf-margin is serrated, the leaf-base is sharp. The leaf-apex is sharp-pointed. (*Figure 6*)

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