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Six promising selections from the Hungarian apple breeding program for multiple resistance

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Summary: An apple breeding program has been carried out at the Department of Fruit Science for more than a decade. Several apple selections have been released from the progenies of crosses in 1992 and 1993. Six candidates were submitted for national recognition out of the hybrids examined for more than a decade. The six selections are resistant against all the three most important apple diseases (apple scab, powdery mildew and fire blight). Scab resistance is controlled by the Vf gene originating from the species *Malus floribunda* 821 and transmitted by cultivar Prima. Heterozygote Vfvf genotype of the six cultivar candidates was proved by molecular genetic examinations of Dept. Genetics and Plant Breeding. Characteristics of these selections from 'Prima' progenies are shown on the base of our own observations.

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

Introduction

An apple breeding program was started at the Department of Fruit Science of the University of Horticulture and Food Industry in the beginning of the 1990s (*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-purpose or industrial apple cultivars of good quality and excellent productivity, which are suitable for Hungarian production areas, and which are the most favourable for environmentally-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* (Burill/Winslow et al.) and to canker caused by *Nectria galligena* (Bres.).

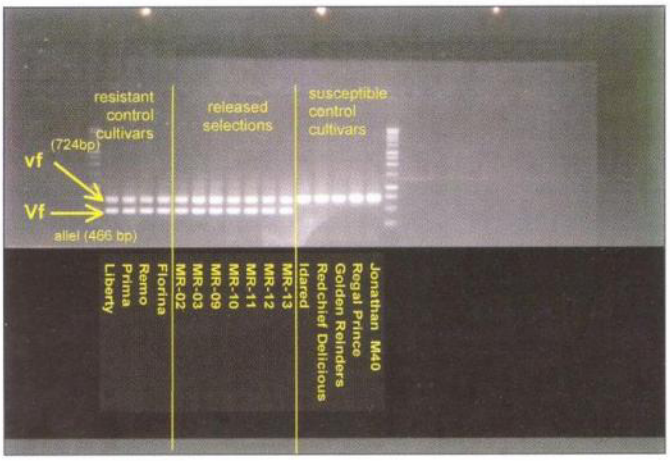

Figure 1 Heterozygote Vfvf genotype of the six cultivar candidates was proved by molecular genetic examinations of Dept. Genetics and Plant Breeding

Six candidates were submitted for national recognition out of the hybrids examined for more than a decade. The six selections are resistant against all the three most important apple diseases (apple scab, powdery mildew and fire blight). Scab resistance is controlled by Vf gene originating from the species *Malus floribunda* 821 and transmitted by cultivar 'Prima'. Heterozygote Vfvf genotype of the six cultivar candidates was proved by molecular genetic examinations of Dept. Genetics and Plant Breeding (*Figure 1*). Characteristics of these selections from 'Prima' progenies are shown on the base of our own observations (*Table 1–3*). First results of this breeding work have been published earlier (*Tóth* et al. 2003).

Tree and fruit description

MR–03

Origin: Open-pollinated seedling of 'Prima' carrying Vf gene. Year of crossing is 1992, nursing of seedlings started in 1993. It was submitted for national certification in 2003.

Season and type: Recommended harvest time is the first part or middle of September. Suitable for juice and concentrate production, as well as for fresh consumption after storage for those who like acidic apples. Possible consumption season is from November till end of March.

Table 1 Characteristics of MR-03 and MR-09

CHARACTERISTIC	MR-03	MR-09
Tree: vigor	vigorous and medium	medium
Tree: habit (columnar types excluded)	spreading	drooping
Dormant one-year-old-shoot: pubescense	weak	strong
Dormant one-year-old-shoot: thickness	medium	medium
Dormant one-year-old-shoot: length of internode	short	short
Dormant one-year-old-shoot: number of lenticels	medium	few
Leaf blade: length	medium	medium
Leaf blade: width	medium	medium
Leaf blade: ratio length/width	medium	large
Petiole: length	medium	medium
Fruit: size	medium-large	medium
Fruit: ratio height/width	medium	medium
Fruit: position of maximum width	towards stalk	towards stalk
Fruit: shape	broad globose conical	globose conical
Fruit: ribbing	weak	weak
Fruit: aperture of eye	partly closed	closed
Fruit: size of eye	medium	medium
Fruit: depth of eye basin	medium	medium
Fruit: width of eye basin	wide	medium
Fruit: thickness of stalk	medium	medium
Fruit: length of stalk	short	medium
Fruit: depth of stalk cavity	medium	small
Fruit: width of stalk cavity	medium	medium
Fruit: bloom of skin	small	absent
Fruit: greasiness of skin	absent	absent
Fruit: ground colour (if visible)	green	green yellow
Fruit: amount of overcolour	very high	medium
Fruit: over colour	purple	red
Fruit: intensity of over colour	dark	medium
Fruit: pattern of over colour of skin	solid flush	solid flush
Fruit: amount of russet around eye basin	absent	absent
Fruit: amount of russet on cheeks	absent	absent
Fruit: amount of russet around stalk cavity	low	low
Fruit: size of lenticels	medium	small- medium
Fruit: firmness of flesh	firm	medium
Fruit: colour of flesh	cream	cream
Time of beginning of flo wering (10% open flowers)	medium early	medium early
Time of maturity for consumption	medium	medium

Fruit and market value: Fruit size is medium to large, depending on fruiting intensity, shape is wide rounded, slightly conic to sepal, widest at the pedicel edge. Its green ground colour is covered by an intense red or claret cover colour on the total fruit surface, gradually darkening with ripening, and this combines with dissolving bloom and rare but conspicuous white dots.

The pedicel hole is narrow, conic, middle deep, slightly parched on some fruits, the pedicel is short. The calyx hole is wide, middle deep, regular curliness and partition is frequent at the edge of sepal. The calyx is medium-sized, closed, the ovaries are perigynous, receptacle and are both closed. Flesh firmness is great at harvest, remaining during storage. Flesh colour is bright cream, juicy, taste is acidic-sweet, rich inner values consociate with special aroma and a slight scent. Fruits were stored in good quality until the end of March in a normal storage room.

MR–03

Shoot system: Its tree is highly vigourous when young, later moderately vigorous, grows thick crest and leaders, but laterals growing squarely to crest create a spreading, globose canopy form. Twigs are of medium thickness, brightly brown, bringing fruits mainly on short fruiting laterals. Leaves are reverse ovate or elliptic on long shoots, elliptic around fruit groups, they are skin-like thick, dark green with upper surface naked, the lower surface wooly, the margin is twice serrated. The base of leaf runs onto leaf-stalk, leaf-peak is pointed.

Features of flowering and flower morphology: The flowers belong to the middle early – middle late flowering group. The flower-bud colour is light pink, opened flowers are white. The middle-large petals are elliptic, medium-long, opened petals overlap each other in inflorescence. Staminal and pistillate rounds are of middle height, staminal round is right over the pistillate round.

Resistance: It is resistant against apple scab. Its resistance against powdery mildew is also acceptable, because slight or medium symptoms of infection were observed only in two years in an orchard not treated with fungicides for 12 years. In our glasshouse examinations, moderate shoot resistance and moderate fruit susceptibility was observed after inoculation with *Erwinia amylovora*.

MR–09

Origin: It was made from the crossing of 'All Red Jonathan' (female cultivar) and 'Prima' (male cultivar) with Vf resistance in 1993, nursing of seedlings started in 1994. Examination in the National Institute for Agricultural Quality Control is in progress since its submission in 2003.

MR–09

Season and type: Optimal harvest time is the middle of September.

Resembling to Jonathan, it is recommended for fresh consumption and for processing as well. Fruits can be consumed after 2–3 months of storage during the whole winter season.

Fruit and market value: The fruit shape is rounded conic, medium-sized. Its yellowish green ground colour is covered by a bright red overlay on most of the fruit surface. The pedicel is medium long, not or slightly arising from the hole. The receptacle hole is raddish shaped, ovary near sepals is medium large. The calyx hole is of medium width and medium depth, slight ribbing of sepal edge flattens before ripening. Both the calyx and the ovary are closed. Its cream coloured fruit flesh is medium firm after harvest and after storage till June as well. Its acidic sweet taste based on harmonic inner values and high polyphenol content is riched by a pleasant aroma.

Shoot system: Its tree is moderately vigorous, the shoot system is spreading, branching disposition is strong, which can result in a dense canopy. Twig colour is light brown, slightly bright, surface of older fruiting branches is bright grey. Flower-buds are formed on medium and long twigs, as well as on short spurs. Leaves are ovate or elliptic, their upper surface is medium green, slightly bright, the lower surface is slightly wooly and light green, edge is unpointedly serrated. The leaf stalk is medium long and slightly wooly. The base of leaf runs onto leaf-stalk, the leaf-peak is pointed

Features of flowering and flower morphology: The flowers belong to the in middle early – middle late flowering group. Its light pink flower-buds develop comparatively small flowers with white petals. Opened petals touch each other, their form is mostly ovate, their stalk is medium long. The style and stamen are short, staminal and the pistillate rounds are on the same level.

Resistance: Its resistance against apple scab is very good. In more than ten years of observation, slight symptoms of powdery mildew showed only in three years, mostly on young trees. After inoculation with *Erwinia amylovora*, moderate resistance or moderate susceptibility was observed.

MR–10

Origin: It was selected in our cultivar collection from seedlings set in 1992 after open pollination of 'Prima' (Vf), and nursing of seedlings started in 1993. Examination of the candidate is in progress since its submission in 2003 in the National Institute for Agricultural Quality Control.

Season and type: According to our present data, it can be harvested in late August. As a nice autumn apple, it is recommended for fresh consumption till December.

Fruit and market value: The size is medium large or large, the shape is wide conic rounded. Its yellowish white ground colour is overlaid on great part of fruit surface, the showiness of which is increased by a slight bloom and presence of small white lenticells. Its conic pedicel hole is shallow and comparatively narrow, the pedicel hole is of medium length or short, sometimes thickened. The calyx hole is of medium width and medium depth, the edge is smooth, ribbing is not present. The calyx is medium large, closed or half-open, sepals are small, pointedly connivent. The receptacle hole is onion shaped, inferior, ovary is medium large, closed. Its flesh firmness is medium, flesh colour is yellowish white, taste is acidic-sweet, with a nice flavour right after harvest. It is moderately disposed to pre-harvest fruit-fall. Its storability requires further examinations, but according to experiences, its fruit can be stored for short periods.

Shoot system: Its tree is moderately vigorous. Its crests and branches are dominant, canopy habit resembles to pyramid. Its branch system is spreading, the branching vigour is medium. Shoots and twigs are medium long or long, a little thicker than medium. Twig colour is brownish red. Fruits form mainly on short fruiting twigs. Its ovate leaves are medium large, light green or green, upper surface is bright, lower surface is naked or slightly wooly. Base of leaf runs onto leaf-stalk, leaf-peak is pointed, leaf-margin is serrated like a hook.

Features of flowering and flower morphology: According to observations, its flowering time is medium late – late. Flower-bud colour is typical dark pink, elliptic and medium large petals of opened flowers have light pink veins. Petals often touch each other, or slightly overlap, their shape is elliptic or reverse ovate, they get narrow towards the

MR–10

Table 2 Characteristics of MR-10 and MR-11

CHARACTERISTIC	MR-10	MR-11
Tree: vigor	medium	medium
Tree: habit (columnar types excluded)	spreading	drooping
Dormant one-year-old-shoot: pubescense	weak	strong
Dormant one-year-old-shoot: thickness	medium-thick	medium
Dormant one-year-old-shoot: length of internode	short-medium	short
Dormant one-year-old-shoot: number of lenticels	medium	medium
Leaf blade: length	length	very length
Leaf blade: width	medium	medium
Leaf blade: ratio length/width	large	very large
Petiole: length	length	medium
Fruit: size	medium-large	medium-large
Fruit: ratio height/width	medium	medium
Fruit: position of maximum width	towards eye	in middle
Fruit: shape	broad globose conical	flat globose
Fruit: ribbing	absent	weak
Fruit: aperture of eye	closed-partly closed	closed
Fruit: size of eye	medium	medium
Fruit: depth of eye basin	medium	medium
Fruit: width of eye basin	medium	medium
Fruit: thickness of stalk	medium	medium
Fruit: length of stalk	short	medium
Fruit: depth of stalk cavity	medium	deep
Fruit: width of stalk cavity	small	medium
Fruit: bloom of skin	small	very small
Fruit: greasiness of skin	absent	tárolás alatt alakul ki
Fruit: ground colour (if visible)	green yellow	green yellow
Fruit: amount of overcolour	medium	medium
Fruit: over colour	red	pink-purple
Fruit: intensity of over colour	medium	medium-dark
Fruit: pattern of over colour of skin	solid flush	solid flush
Fruit: amount of russet around eye basin	absent	absent
Fruit: amount of russet on cheeks	absent	absent
Fruit: amount of russet around stalk cavity	low	low
Fruit: size of lenticels	small	small
Fruit: firmness of flesh	medium	firm
Fruit: colour of flesh	yellowish-white	yellowish
Time of beginning of flowering (10% open flowers)	medium late	medium late
Time of maturity for consumption	early	medium

medium long petal stalk. Staminal and pistillate rounds are almost on the same level, in medium height.

Resistance: According to 12 years of open field observations and greenhouse *Erwinia amylovora* tests, it proved to be outstandingly resistant against all the three diseases (scab, powdery mildew, fire blight).

MR–11

Origin: The crossing was made in 1993, with the female cultivar 'Prima' transmitting Vf gene, and with a male cultivar which is an open-pollinated seedling of 'Raritan'. Nursing of seedlings started in 1994. It was submitted for national registration in 2003.

Season and type: It can be harvested in middle or late September. Because of its special scent, its suitability to fresh consumption requires further evaluations. It can be recommended undoubtedly for processing, its season can last for 2-3 months after harvest.

Fruit and market value: Fruit size is medium large or large, form is rounded oblate, widest in the middle. Coloration changes from carmin into cherry-red during harvest, can deepen to brownish red when over-ripe. Its covering colour covers the whole fruit surface, with a slight bloom. Its conic pedicel hole is deep and medium wide, pedicel is medium long and medium wide. Its calyx hole is medium deep and medium wide, edge has a slight curly ribbing, and mainly on ripening fruits, this slight, widening ribbing grows to middle of fruit, but rarely modifies its rounded form. Calyx is medium large and closed, sepals are small, not well-marked. Receptacle hole and calyx pipe are rounded, situated mostly near calyx, closed. The relatively small ovary is perigynous. Its firm and not softening flesh even during storage is yellowish, its taste is nicely acidic. A medium sugar content, high polyphenol content and a special scent and aroma joins to the high acid content. According to our experiences, it can be stored until February at least in an uncontrolled cold storage room.

Shoot system: Its tree is moderately vigorous, branch system is spreading, diffuse, canopy is widening, medium dense, its branches are well ramified. Twig thickness is medium, twig colour is brownish, wooly. Fruits develop mainly on short fruit twigs. Colour of its medium large leaves is bright green, the lower side is slightly wooly. Its shape is elliptic, the edge is sharply serrated. The base of leaf is elliptic, the leaf-peak is pointed.

It is an interesting genetic heritage, that in the base of branches of grafted female tree there is some cellular

MR–11

proliferation, which strongly resembles to the formation introduced at species *Malus sieversii*, as well as at varieties 'Chiloe' and 'Burr Knot', showing good rooting ability.

Features of flowering and flower morphology: Its flowering time is medium late. Flower-bud is pink, medium size petals are white, their margin are slightly pinked, overlap each other. Petal shape is wide ovate, ends in a rounded point. Staminal and pistillate rounds are in medium height, but in alternating levels.

Resistance: According to our observations of 12 years in an orchard not treated with fungicides, it has a strong resistance against scab and powdery mildew. In our greenhouse and laboratory tests fruits, flowers and, except one year, shoots as well showed moderate resistance against fire blight.

MR–12

Origin: Originates from the crossing of 'Prima' with Vf resistance (female cultivar) and 'Granny Smith' (male cultivar) in 1993, nursing of seedlings started in 1994. Year of submission for national registry is 2005.

Season and type: According to our experiences, it can be harvested in late September, and after 2-3 months of storage it can be consumed till April. On the base of its decorative appearance and good reception by consumers, it is recommended mostly for fresh consumption, but its inner values make it suitable for processing as well.

Fruit and market value: Its fruit is very large, shape is rounded elongated, widest at the middle.

First a light pink, then a bright red covering develops on its yellowish green ground colour during ripening. Cover colour is washed or striped, and usually does not cover the whole fruit surface. On the side less exposed to sunlight, a striped or streaky cover colour develops in some years. The surface is spotted by quite densely placed lenticells of medium size. Its conic, very deep and medium wide pedicel hole and wide calyx hole are usually not burned. Its pedicel is medium long. It keeps its high flesh firmness values even during storage. Fruit flesh colour is cream, juicy, taste is nicely sweet-acidic, and the high acid content is joined by a very high soluble dry matter content and also a very high polyphenol content. The receptacle hole and the closed ovary are perigynous. The bitter pit observed on very large fruits in some years forecasts the need of Ca leaf fertilization.

MR–12

Shoot system: Its tree is moderately vigorous, branches are spreading, canopy is medium dense. Twigs are medium wooly, claret-brown, older parts are light brown. The dark

Table 3 Characteristics of MR-12 and MR-13

CHARACTERISTIC	MR-12	MR-13
Tree: vigor	medium	medium
Tree: habit (columnar types excluded)	spreading	drooping
Dormant one-year-old-shoot: pubescense	medium	strong
Dormant one-year-old-shoot: thickness	medium-thick	thin-medium
Dormant one-year-old-shoot: length of internode	medium	medium
Dormant one-year-old-shoot: number of lenticels	few	much
Leaf blade: length	lenhth	medium
Leaf blade: width	medium	medium
Leaf blade: ratio length/width	large	medium
Petiole: length	medium	medium
Fruit: size	large-very large	small
Fruit: ratio height/width	medium	medium
Fruit: position of maximum width	in middle	in middle
Fruit: shape	oblong globose conical	flat globose
Fruit: ribbing	weak	weak
Fruit: aperture of eye	partly closed	open
Fruit: size of eye	large	medium
Fruit: depth of eye basin	medium	medium
Fruit: width of eye basin	wide	medium
Fruit: thickness of stalk	medium	medium
Fruit: length of stalk	medium	medium
Fruit: depth of stalk cavity	deep	deep
Fruit: width of stalk cavity	medium	medium
Fruit: bloom of skin	absent	small
Fruit: greasiness of skin	forms during storage	absent
Fruit: ground colour (if visible)	green yellow	green yellow
Fruit: amount of overcolour	low- medium	medium-high
Fruit: over colour	pink-red	red
Fruit: intensity of over colour	medium	dark
Fruit: pattern of over colour of skin	solid flush with stripes	solid flush
Fruit: amount of russet around eye basin	absent	absent
Fruit: amount of russet on cheeks	absent	absent
Fruit: amount of russet around stalk cavity	absent	absent
Fruit: size of lenticels	large	.
Fruit: firmness of flesh	firm	medium
Fruit: colour of flesh	cream	cream
Time of beginning of flowering (10% open flowers) early	medium early	early-medium
Time of maturity for consumption	medium	early- medium

green leaves are medium large, shaped elliptic or wide ovate, their edge is unpointedly serrated. The base of leaf runs onto leaf-stalk, the leaf-peak is pointed.

Features of flowering and flower morphology: Its flowering time is middle early – middle late. From its light red flower-buds white, slightly pink, elliptic petals develop, which overlap each other a little. Inflorescence and petals are remarkably large. Staminal and pistillate rounds are on the same level. *Resistance:* Open field observations of ten years proved its high level resistance agains scab and powdery mildew. On the basis of two years of greenhouse examination, shoots and fruits showed moderate resistance agains fire blight, however, flowers proved to be susceptible in a one-year test.

MR–13

Origin: Crossing was made in 1993, female cultivar is 'Jonathan M 41', male cultivar is 'Prima', transmitting its Vf resistance. Nursing of seedlings started in 1994. Year of submission for national registry is 2005.

Season and type: According to our experiences, it can be harvested in late August in optimal maturity. It keeps good quality from right after harvest till end of spring. Its comparatively small size, bright or dark red cover colour, harmonic taste and inner values can fulfil the needs of nursery and school pupils, therefore its introduction is recommended using a former foreign advertisement as 'healthy apple for nursery kids'. Beside fresh consumption, it can be suitable for processing as well on the basis of its inner values.

Fruit and market value: Its fruit is small, shape is rounded oblate. Its greenish yellow ground colour is overlaid by a dark red washed cover colour on most of the surface. Its pedicel hole is deep and medium wide, calyx hole is shallow and wide, none of them are disposed to suberification. The pedicel is medium long, slightly emerging from fruit, the calyx is small, half or totally closed. Its cream-coloured flesh is firm, juicy, the taste is sweet-acidic with very pleasant flavour, and high polyphenol content increases its health preserving effect. The receptacle hole and the ovary are perigynous. Its storability is not yet known, it kept well its taste and quality in an uncontrolled cold storage room until the end of May.

Shoot system: Its tree is moderately vigorous, canopy is widening, branch system is sparse. Leaves are small or medium large, ovate or elliptic shaped, widening in the middle, their colour is bright, lower surface is slightly wooly. The leaf-margin is pointedly serrated, the leaf-peak is pointed, the base of leaf runs onto the leaf-stalk.

MR–13

Features of flowering and flower morphology: Flowering time is middle early. From its especially dark pink flower-buds light pink petals develop. Middle-large opened petals overlap. Staminal and pistillate rounds are in medium level, the staminal round is right over the pistillate round.

Resistance: It preserved its high level resistance against apple scab in the untreated orchard. During ten years, the slightest symptom of powdery mildew infection was observed in some years. According to our glasshouse examinations, shoots, flowers and fruits show moderate resistance or moderate susceptibility to *Erwinia amylovora*.

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