Malus taxa and the progenies of *Malus floribunda* selected in Hungary, as gene sources of resistance breeding

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Summary: One of our objectives in the apple breeding program of the Department of Fruit Science, beside creating new varieties, is to search for new gene sources. After evaluating the disease resistance of *Malus* taxa available in Hungary, we put the promising selected individuals through further examinations. Their habit and growth vigor was observed, as well as productivity and fruit characteristics were evaluated. *Malus fusca* seems to be a new, promising gene source in Hungary among the examined taxa. Beside its optimal canopy, growth vigor and fruit characteristics, it has the advantage to be in distant relationship to *Malus x domestica*, therefore its resistance is based on a different genetic basis. SBG 1 selection of *Malus spectabilis* can be recommended as a new gene source for resistance breeding. The range of gene sources can further be widened by selected clones of *Malus floribunda* (BA 1), *Malus x zumi* (BA) and *Malus baccata* (SBG 6). An additional value of *Malus* taxa chosen by us is that they show resistance not only to apple scab, but to powdery mildew as well, and according to our results, they have optimal habit, acceptable productivity and good fruit quality. Nine hybrids were selected from first *Malus* progenies which proved to be resistant to apple scab and powdery mildew. These are valuable not only as gene sources of breeding, but as pollenizers or ornamental trees, while their decorative fruits can be used in inside decorations and flower arrangements.

Key words: *Malus* sp., crab apple, gene source, hybrid, morphological, flower and fruit characters

Introduction

In the framework of the apple breeding program at the Department of Fruit Science, we examine the resistance of *Malus* species and varieties found in Soroksár Botanic Garden (SBG) and in Buda Arboretum (BA) to apple scab and powdery mildew, since 1997, for widening gene sources of resistance breeding (*Kovács* and *G. Tóth*, 2002), and we previously evaluated their features inheriting resistance (*G. Tóth* et al. 2003).

In previous examinations it was proved, that new races of the pathogen *Venturia inaequalis* (Cooke) Wint. appear, which can break the resistance based on V_m, V_f resistance genes of some scab resistant apple varieties (*Parisi, Lespinasse* 1996; *Krüger* et al. 1999; *Schärer* and *Kellerhals* 2000; *Fischer C.* et al. 2000; *Bénaouf, Parisi* 2000). Results indicating the change of the pathogen's Hungarian biotype were first presented by *G. Tóth* et al. (1996). Another fact refers to the appearance of a new race, which is graftings from *Malus floribunda* trees in the Soroksár Botanic Garden were infected after inoculation by the suspension from year 2000 of pathogen *Venturia inaequalis* (Cke.) Wint., and an increase in susceptibility was experienced in case of other species and varieties as well (*Kovács* and *G. Tóth* 2002).

A possibility of solving problems emerged during cultivation (eg. disease susceptibility, appearance of new races) is to transmit some genes still present in wild species to cultivated varieties. The number of *Malus* taxa can be estimated at 400–500, which are used mostly as ornamental plants (*Nagy* és *Schmidt* 1991) or pollenizers (*Nyéki* et al., 1982. *Botzner*, 1992), and only a few taxa are used as parent partners in resistance breeding. Those taxa are valuable as gene sources, which have a resistance based on complex genetic grounds, and are resistant not only to scab, but to other diseases as well (eg. powdery mildew, *Erwinia*), and preferably have optimal fruit size. Applying these taxa, the number of back-crossings can be reduced, and the danger of disappearance of resistance genes can be diminished during crossings (*Kellerhals* et al. 1998; *Büttner* et al. 1999; *Fischer C.* et al. 2000).

In present article we evaluate the main characteristics of Hungarian types of *Malus* taxa selected previously on the base of their disease resistance (*Kovács* and *G. Tóth* 2002), as well as of the most valuable individuals from the first progenies of the species *Malus floribunda*. Their morphological, phenological, growth and pomological features will be introduced, which – beside disease resistance – can improve the breeding value of these new gene sources.

Material and method

The breeding value of the *Malus* collection found in Soroksár Botanic Garden (SBG) and in Buda Arboretum (BA) was examined since 1997. In Buda Arboretum there are mostly *Malus* species and cultivars of outstanding ornamental value. In Soroksár Botanic Garden the natural own-rooted seedling population of some taxa (eg. '*Malus*

baccata') can also be found beside different species and varieties.

To continue the selection of *Malus* taxa and hybrids proved to be resistant to apple scab and powdery mildew, their growth features, flower and fruit characteristics, as well as their flowering and fruit setting vigor were examined. During evaluation we followed partly the cathegories of the UPOV's description on apple (growth characteristics, twig thickness, leaf size, fruit size, shape, ground colour, cover colour, length of pedicel), and partly used our own cathegories (leaf shape, flowerdensity and fruit load).

While evaluating growth vigor, weak, medium strong and strong cathegories were differentiated. We distinguished four tree habits: sharply upright, upright, expanding and spreading. For twig thickness thin or medium cathegories were used. The size of mature leaves on the middle of shoots can be small, medium and large, while the leaf shape can be divided into elliptic or elongated cathegories.

Examination of frowerdensity vigor and flowers took place in full bloom. For evaluation of flowerdensity vigor, the following classes were used: 0: no flowers, 1: some pieces (1–5), 2: 5–20 pieces, 3: more than 20 flowers on the tree. We recorded flower colours (in bud and in full blossom), the average size of totally opened flowers, and the adventitious full-flowers.

For evaluating the fruit setting of the certain *Malus* taxon or hybrid, the four cathegories used at flowerdensity (0–3) were applied. Average size, ground colour, cover colour, and shape of fruits, as well as average pedicel length were determined by measuring 20–30 fruits.

Results

1. Growing, morphological and pomological characteristics of selected *Malus* taxa

Table 1 shows the growing characteristics and leaf features of *Malus* taxa selected in Hungary on the base of their disease resistance. Their canopy is mostly expanding or spreading, their vigor is medium strong. The SBG-6 type of *Malus baccata* is an exception, because it is characterized by an upright habit. Twigs of selected taxa are thin or medium thick, their leaves are mostly medium sized and elliptic shaped except *Malus floribunda* BA-1.

Selected taxa are featured by a rich flowering *(Table 2)*. The size of their pink flowers are characteristic of species, variety. Their fruit setting is different, mostly good, though their fruits are small (10–15 mm in diameter). Individuals of *Malus fusca*, *Malus spectabilis* and *Malus baccata* selected by us and indicated by code numbers in the table, are distinguished by their relatively large fruits in the species.

2. Growing, morphological and pomological characteristics of progenies selected from *Malus floribunda* generations

Hybrid families 'All Red Jonathan' x *M. floribunda* (3–106), 'Jonathan M41' x *M. floribunda* (462) and 'Gloster' x *M. floribunda* (465) proved to be the most valuable among examined *Malus* progenies. *Tables 3* and *4* indicate the data of the 9 most promising *Malus floribunda* progenies. Selected hybrids are not only resistant to apple scab and powdery mildew, but according to their following characteristics, they can be used well in further modified back-crossings: their canopy is expanding, their growth is mostly medium strong, their fruit setting vigor is medium or good, their fruits are relatively large (20–25 mm in diameter) and decorative.

The hybrid with 46584 code number ('Gloster' x *M. floribunda*) has born the largest fruit among examined hybrids. However, the productivity of this highly vigorous hybrid with thick twigs and medium leaves falls behind that of others. Other hybrids bearing large fruits are code number 46246 ('Jonathan M41' x *M. floribunda*) with weak-medium growth vigor and medium fruit setting, as well as code number 4658 ('Gloster' x *M. floribunda*) with weak growth vigor and medium fruit setting.

Table 1 Growing features and morphological characteristics of Hungarian types of *Malus* species

Malus taxa	Canopy form	Growth vigor	Twig thickness	Leaf	
				size	shape
Malus baccata Borkh. (SBG 6)	upright	medium strong	medium	medium large	elliptic
Malus floribunda Sieb. (BA 1)	expanding	medium strong	thin	small-medium large	elongated
Malus fusca Schneid. (SBG 1)	spreading	medium strong	medium	medium large	elliptic
Malus spectabilis (Ait.) Borkh. (SBG 1)	expanding	medium strong	medium	medium large	elliptic
Malus x zumi Rehder (BA 1)	expanding	medium strong-strong	thin-medium	medium large	elliptic (some leaves are lobed)

Table 2 Flower and fruit characteristics of Hungarian types of *Malus* species

Malus taxa	Flower				Fruit					
	flower-density (0–3)	colour (in bud-in blossom)	size (mm diameter)	setting (0–3)	size (mm diameter)	shape	ground colour	cover colour		length of pedicel (mm)
								intensity	character	
Malus baccata Borkh. (SBG 6)	2	light pink-white	30	0–1	20–25 medium	rounded oblate	yellow	light red 10%	tinged	5 very short
Malus floribunda Sieb. (BA 1)	3	dark pink-white	30–35	3	8–10 very small	rounded elongated	yellow	none	none	35 long
Malus fusca Schneid. (SBG 1)	3	light pink-white	30–35	2–3	15–18 small-medium	rounded elongated	yellow	light red 20–30%	tinged	20–25 medium
Malus spectabilis (Ait.) Borkh. (SBG 1)	2–3	light pink-white	40–45	2	15–20 small-medium	rounded elongated	yellow	light red 40–50 %	tinged	25 medium
Malus x zumi Rehder (BA 1)	3	light pink-white	25	3	10-12 small	rounded elongated	yellow	red 80–90%	tinged	25 medium

Table 3 Growing features and morphological characteristics of progenies selected from first generation of *Malus* species

Code number*	Canopy form	Growth vigor	Twig thickness	Leaf	
				size	shape
3-106-22	expanding	medium strong-strong	thin-medium	small-medium	elliptic
3-106-5	expanding	medium strong-strong	medium	small	elliptic
4-62-22	expanding	medium	thin	small	elongated
4-62-46	expanding	weak-medium	thin-medium	medium	elongated
4-62-48	expanding	weak-medium	thin	small	elongated
4-62-65	expanding	weak	thin	small	elongated
4-65-58	expanding	medium strong-strong	thin	medium	elongated
4-65-8	expanding	weak	thin	small-medium	elongated
4-65-84	expanding	strong	thick	medium-great	elongated

*The male variety is BA-1 individual of *Malus floribunda* in all cases, name of female varieties according to hybrid families: 3106: All Red Jonathan, 462: Jonathan M41, 465: Gloster.

Discussion

Malus taxa selected previously on the base of their resistance to apple scab and powdery mildew, have optimal tree habit, suitable productivity and good fruit quality. Their morphological features generally correspond to literature data (*Fiala* 1994; *Krüssmann* 1977). Hungarian types differed from original species only in fruit size.

Malus fusca is a promising new gene source for resistance breeding. Beside its optimal canopy form, growth vigor and good fruit characteristics, it has the advantage of being in distant relationship with *Malus* x *domestica* (subsection *Kansuenses*) according to *Büttner* et al. (1999), and can supplement well the genetic basis of breeding by its resistance based on different genetic grounds.

Besides, the range of present gene sources can be widened by *Malus fusca, Malus spectabilis* (SBG 1) and *Malus floribunda* (BA 1), *Malus x zumi* (BA) and *Malus baccata* (SBG 6) types selected by us.

Similarly to other breeding centers, we also used frequently in our program the species *Malus floribunda* carrying gene Vf as crossing partner. *Since* 1984 several evidences were demonstrated about the fact, that new races of the pathogen exceeded the resistance of progenies derived from clone 821 of *Malus floribunda* (*Parisi* and *Lespinasse* 1996). We also experienced susceptibility at Hungarian individuals of the species (*Kovács & G. Tóth* 2002), but the individual presented in this article and hybrids selected from its progenies have not shown susceptibility after artificial infections either.

Though, from crossings made by other *Malus* taxa (eg. *Malus baccata, Malus* x *purpurea, Malus robusta*) the *Malus floribunda* combinations proved to be the most secure. Selected individuals of combinations 'All Red Jonathan' x *M. floribunda* (3-106-), 'Jonathan M41' x *M. floribunda* (4-62-) and 'Gloster' x *M. floribunda* (4-65-) can be utilized well in further resistance breeding. Beside the high rate of scab resistance and good powdery mildew resistance, an optimal tree habit and a relatively large fruit size increase their value.

While using *Malus* taxa in crossings, we have to carry out four or often more back-crossings to reach the optimal fruit size. However, repeated back-crossings can result in failure of the modifying genes partly providing resistance (*Krüger* 1988; *Kellerhals* 1991). With the further utilization of F1 progenies selected by us, having relatively large fruit and other favourable features, the aimed breeding result can be reached by less back-crossings.

However, first generation hybrids deriving from *Malus* taxa cannot only be used as gene sources, but as ornamental

Table 4 Flower and fruit characteristics of progenies selected from first generation of *Malus* species

Code number*	Flower			Fruit						
	flower-density (0–3)	colour (in bud - in blossom)	size (mm diameter)	setting (0–3)	size (mm diameter)	shape	ground colour	cover colour		length of pedicel (mm)
								intensity	character	
3–106–22	2–3	dark pink–light pink	35–40	2–3	20–25	rounded oblate	yellow	red 60–80%	overlaid	15–20
3–106–5	3	dark pink–light pink	35	2–3	20–25	roundde elongate	greenish-yellow	red 40–80%	overlaid	15–20
4–62–22	3	dark pink–light pink	30	2–3	20–25	rounded elongated	yellow	dark red 80–90%	overlaid	12–15
4–62–46	3	pink–white	30	2	26–30	rounded oblate	yellow	dark red 70–80%	overlaid	10–15
4–62–48	2	dark pink–light pink	30	1–2	20	rounded oblate	yellow	dark red 70–80%	overlaid	10
4–62–65	2	dark pink–light pink	25	1	23–25	rounded elongated	greenish-yellow	red 13–15	90–100%	overlaid
4–65–58	2–3	dark pink–light pink	25	2	22–29	rounded elongated	yellow red	dark 90–100%	overlaid	10
4–65–8	1–2	dark pink–light pink	30	1–2	26–30	conic	yellow	dark red 60–90%	overlaid	15–17
4–65–84	2	dark pink–light pink	30	1	30–35	rounded oblate	greenish-yellow	orange	overlaid	15

*Note: see Table 3

trees as well, because their flowering is relatively rich, and their flower colour is more intensive than that of wild species. They require less plant protection, the larger and more decorative fruits ornament not only in the trees, but can finely be used in inside decorations and flower arrangements (eg. decorating pine trees). *Nyéki* et al. (1982) and *Botzner* (1992) propose their utilization in orchards as pollenizers, because they require no additional taking care of plant protection and harvest.

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