

Inheritance of Vigour Tree in F₁ Apple Interspecific Hybrids

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Abstract

In ornamental apple breeding process, the vigour of the tree is an important characteristic, this trait being analyzed in selection of seminal descendants obtained by hybridization. The vigour of the apple trees was studied in 25 interspecific hybrids F₁ belonging to different *Malus* ornamental species, used as maternal or paternal genitors, crossed with several cultivars and selections. The seedling vigour was noted when hybrids were four to seven years old, in accordance with UPOV guideline standard: 3 - weak; 5 - medium; 7 - strong. The mean of marks for tree vigour of F₁ hybrids in the 25 combinations ranged between 4.00 and 6.13. Compared with the mean of experiment as control (5.20), the most vigorous seedlings were obtained in the families 'Cluj 218/2' x *M. niedzwetzkyana* and 'Reinette Baumann' x *M. prunifolia*, both with significant differences of growth versus the mean growth of all combinations. The weakest growth was noted in progenies belonging to 'Rosu de Cluj' x *M. coronaria*, 'Starkrimson' x *M. prunifolia*, 'Frumos de Voinesti' x *M. floribunda*, 'Cluj II-1-2' x *M. floribunda*, *M. zumi* x 'Reinette Baumann', *M. coronaria* x 'Reinette Baumann'. No significant differences were found between the mean of marks for tree vigour in the group of combinations in which the *Malus* species were used as maternal genitors (5.18) and paternal genitors (5.20). The coefficient of variability ranged in the experiment between 2.6% and 27.4%; in ten families a lower variability for seedlings vigour (under 10%) was identified, in 13 a medium one (between 10-20%) and in two a large one (more than 20%). Even if in some combinations the variability of tree vigour was not very large, there seems to be fair possibilities to identify by selection the seedlings with a desired vigour in each family.

Keywords: apple, hybridization, seedlings, species, growth, ornamental

Introduction

Ornamental apple cultivars derived from crabapple (*Malus* species), most of them from *Malus baccata* and *Malus floribunda*, are widely used in landscapes, botanic gardens and horticulture. They are valued not only for their beautiful flowers, fruits and foliage, but for their variations in growth habit and size of tree, crown or canopy.

There is a large variety of tree sizes and forms of ornamental apple, varying from vigorous to low vigour, even mounded and shrubby (Zion, 1994; Jackson, 2003; Juniper and Maberley, 2006; Shaughnessy and Polomski, 2007).

The big trees can find their place in large gardens and on estates where enough space is available. For new cultivars trees with slow to moderate growth rate are preferred; this allows many opportunities for use in home landscapes, as a specimen or patio tree, but also for street tree under utility

lines and urban use. There are large possibilities to use ornamental apples for design purposes: bonsai, as patio tree, sidewalk plants, container, espalier; parking lot islands; beautification of garden walks; backgrounds and as screens etc. (Fiala, 1994; Gilman and Watson, 2007).

If the vigorous trees have several disadvantages, it is because vigorous trees will require regular pruning to maintain their attractiveness and to remove their lower branches for pedestrian and vehicle clearance. Their selection for a specific vigour of trees (for street tree or other purposes) becomes more and more desirable, if one considers the numerous possibilities of using such trees in landscape design.

The study of the inheritance of apple tree vigour is difficult because several factors are involved (Janick et al., 1997), but as polygenic trait, except additive effects, dominance and epistasis ones are involved (Sestras, 2004).

Materials and methods

The vigour of growth of F₁ interspecific hybrids belonging to different apple ornamental species (crab-apple species), used as maternal or paternal genitors, crossed with several cultivars, was studied and evaluated as follows: 3 – weak; 5 – medium; 7 – strong. This scale was taken from the UPOV (International Union for the Protection of New Varieties of Plants) Guidelines, for Ornamental Apple (*Malus* Mill.), 2003.

The number of hybrids per family varied from eight to 127, depending on hybrid combination. The seedlings were noted for their vigour in four successive years; the average marks were computed as means of hybrid combinations.

The ANOVA (“t” test) statistic has been employed to identify the differences among hybrid families for vigour of the seedlings (Ardelean et al., 2006); also, the coefficients of variability for the analyzed trait were computed (Botez et al., 1995).

Results and discussion

The vigour of genitors used in experiment was different, and using the UPOV scale (3 – weak; 5 – medium; 7 – strong) both species and cultivars used as parental forms received marks from “3” to “7” (Tab. 1).

The mean of marks for tree vigour of F₁ hybrids in the 25 combinations was comprised between 4.00 and 6.13 (Tab. 2).

Compared with the mean of experiment as control (5.20), the most vigorous seedlings were obtained in the families ‘Cluj 218/2’ x *M. niedzwetzkyana* and ‘Reinette Baumann’ x *M. prunifolia*, both with significant differences in growth versus the mean growth of all combinations.

The weakest growth was noted in progenies belonging to ‘Rosu de Cluj’ x *M. coronaria*, ‘Starkrimson’ x *M. prunifolia*, ‘Frumos de Voinesti’ x *M. floribunda*, ‘Cluj II-1-2’ x *M. floribunda*, *M. zumi* x ‘Reinette Baumann’, *M. coronaria* x ‘Reinette Baumann’.

The coefficient of variability (CV%) varied in the experiment between 2.6% and 27.4%; in ten families it was identified a low variability for seedling vigour (under 10%), in 13 a medium one (between 10-20%) and in two a large one (more than 20%).

Vigour trees appeared under polygenic control, illustrated by CV% and continuous range of expression of growth in the seedlings when two genotypes were intercrossed. The range of variation was related to the expression of the characters in the parents and the progeny mean was quite related to the parental mean. Probably some exceptions were caused by triploidy of some genitors (eg. ‘Reinette Baumann’), which are vigorous, but as genitors could decrease the vigour of descendences because their aneuploidy) and dominance or epistasis genetic effects.

There was no significant difference between the mean of marks for trees vigour in the group of combinations in which the *Malus* species were used as maternal genitors (5.18) and paternal genitors (5.20).

Each species used as mother or father genitors transmitted certain vigour to descendants, but significant difference was registered only for *M. coronaria* (Fig. 1.).

Progenies belonging to this specie used as mother parent were more vigorous than progenies which had *M. coronaria* as father genitor (4.90, respectively 4.00).

Conclusions

The values of coefficient of variability for vigour trees and continuous range of expression of growth in the inter-

Tab. 1. Vigour of genitors used in interspecific hybridizations

Genotype used as genitor	Used as parent (♀-mother; ♂-father)	Vigour, appreciated by:	
		Phenotype expression	UPOV marks
<i>M. coronaria</i>	♀; ♂	Weak	3
<i>M. floribunda</i>	♀; ♂	Medium	5
<i>M. prunifolia</i>	♀; ♂	Medium to vigorous	7
<i>M. zumi</i>	♀; ♂	Medium	3
<i>M. niedzwetzkyana</i>	♂; ♂	Medium	3
‘Reinette Baumann’	♀; ♂	Vigorous	7
‘Rosu de Cluj’	♂; ♂	Very weak	3
‘Golden Delicious’	♂; ♂	Medium to vigorous	5
‘Jonathan’	♂	Medium	5
‘Ardelean’	♀	Medium	5
‘Cluj 218/2’	♀	Vigorous	7
‘Cluj II-1-2’	♀	Vigorous	7
‘Frumos de Voinesti’	♀	Vigorous	7
‘Starkrimson’	♀	Very weak (and spur)	3

Tab. 2. Mean rates of vigour (scale: 3 – weak; 5 – medium; 7 – strong) in F₁ hybrid populations when crab apple species were used as maternal genitor (differences between hybrid families compared to the mean of experiment, “t” value, significances of differences and coefficient of variability)

Hybrid combination	Mean of rates	Differ.	“t” value	Signif. of differ.	Coeff. Variab. (CV%)
<i>M. coronaria</i> x ‘Jonathan’	4.93	-0.27	-0.48	-	27.4
<i>M. coronaria</i> x ‘Reinette Baumann’	4.88	-0.32	-2.24	ooo	5.1
<i>M. floribunda</i> x ‘Reinette Baumann’	5.47	0.27	1.10	-	7.4
<i>M. prunifolia</i> x ‘Rosu de Cluj’	5.35	0.15	0.42	-	9.3
<i>M. zumi</i> x ‘Golden Delicious’	5.60	0.40	0.92	-	17.2
<i>M. zumi</i> x ‘Jonathan’	5.13	-0.07	-0.46	-	11.1
<i>M. zumi</i> x ‘Reinette Baumann’	4.93	-0.27	-2.68	ooo	4.5
‘Ardelean’ x <i>M. niedzwetzkyana</i>	5.52	0.32	1.42	-	11.8
‘Cluj 218/2’ x <i>M. floribunda</i>	5.18	-0.02	-0.13	-	6.8
‘Cluj 218/2’ x <i>M. niedzwetzkyana</i>	6.13	0.93	7.04	xxx	4.8
‘Cluj 218/2’ x <i>M. zumi</i>	5.40	0.20	1.06	-	10.3
‘Cluj II-1-2’ x <i>M. floribunda</i>	4.77	-0.43	-1.77	o	8.5
‘Cluj II-1-2’ x <i>M. niedzwetzkyana</i>	5.01	-0.19	-0.80	-	17.0
‘Frumos de Voinesti’ x <i>M. floribunda</i>	4.73	-0.47	-1.95	oo	15.3
‘Frumos de Voinesti’ x <i>M. niedzwetzkyana</i>	5.37	0.17	0.95	-	10.4
‘Frumos de Voinesti’ x <i>M. zumi</i>	5.18	-0.02	-0.13	-	6.8
‘Golden Delicious’ x <i>M. prunifolia</i>	5.08	-0.12	-0.54	-	13.8
‘Reinette Baumann’ x <i>M. floribunda</i>	5.37	0.17	0.69	-	11.8
‘Reinette Baumann’ x <i>M. niedzwetzkyana</i>	5.50	0.30	0.70	-	15.4
‘Reinette Baumann’ x <i>M. prunifolia</i>	5.92	0.72	4.09	xx	8.2
‘Reinette Baumann’ x <i>Malus zumi</i>	5.33	0.13	0.35	-	24.4
‘Rosu de Cluj’ x <i>M. coronaria</i>	4.00	-1.20	-5.54	ooo	10.2
‘Rosu de Cluj’ x <i>M. niedzwetzkyana</i>	5.38	0.18	0.97	-	12.9
‘Rosu de Cluj’ x <i>M. prunifolia</i>	5.39	0.19	0.97	-	13.5
‘Starkrimson’ x <i>M. prunifolia</i>	4.43	-0.77	-7.80	ooo	2.6
Mean of experiment (Control)	5.20	-	-	-	11.5

specific seedlings when two genotypes were intercrossed, illustrated polygenic control of the growth and respectively the vigour of the F₁ hybrids. The range of variation was related to the expression of the characters in the parents and the progeny mean was quite related to the parental mean.

Even if in some combinations the variability of tree vigour was not very large, there is a fair possibility to iden-

tify by selection the seedlings with a desired vigour in each family.

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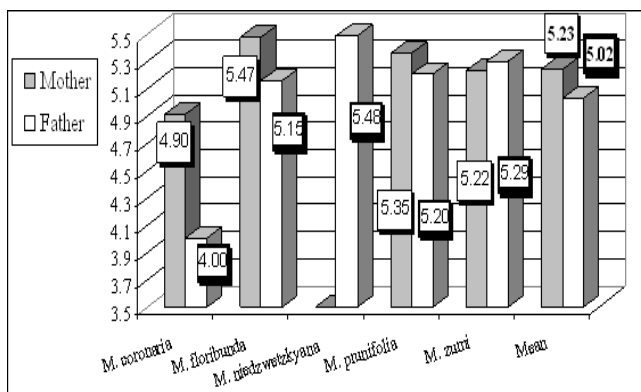


Fig. 1. The average marks of tree vigour in F₁ interspecific hybrids when *Malus* species were used as maternal or paternal genitors

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