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Breeding of columnar apple-trees in Latvia

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In 1991–1993, at the Iedzeni breeding station crosses were made between columnar apple-tree selections obtained by V. Kichina (Russia) and the apple-tree varieties having commercial value in Latvia. The seedlings were selected in nursery for columnar habit (gene *Co*), and 239 seedlings of 11 hybrid families were grown at Dobele in a field unsprayed with fungicides. The first yield was obtained in 1999. The seedlings were evaluated for their growth habit, vigour, fruit quality, flowering and yield, resistance to scab, mildew, leaf spot, *Nectria*, fruit rots and spring frost, and general ornamental value. We found that not all seedlings maintained a good columnar habit after seven years of growth: bare wood, excessive branching and fruit bearing on long shoots appeared in 9.5–31.8% of seedlings, depressive growth was observed in 0–32.7% depending on cross combination. The average fruit yield in hybrid families was low, the most productive were the combinations 'Arbat' × 'Forele', KV-3A × 'Forele', KV-35 × 'Doch Melbi'. The largest fruits with best flavour were observed in families KV-35 × 'Doch Melbi', KV-3A × 'Talvenauding'. The highest resistance to diseases was found in the combinations 'Arbat' × 'Forele' (mean scab injury 3.5, mildew 1.8 on a 9-point scale), KV-3A × × 'Forele' (scab 3.5, mildew 1.3), KV-3A × 'Talvenauding' (scab 3.8, mildew 2.5, no *Nectria* or leaf spot). At present, 29 best seedlings have been selected for further trials.

Key words: *Malus*, gene *Co*, disease resistance

INTRODUCTION

Columnar apple-tree breeding after their discovery and the first investigations of gene *Co* by Lapins [1] has started in several countries. The first columnar varieties obtained at East Malling and described by Tobutt [2] were used in crosses with hardy Russian varieties by V. Kichina in Moscow [3]. As the introduced columnar apple-trees showed a low hardiness and susceptibility to scab and canker in the Baltic climate, hybridisation to obtain columnar apple-trees suitable for the Latvian climate was started by R. Dumbravs in 1989 and the first hybrids were evaluated by I. Drudze at Pure HRS; he named the variety 'Duets' and selected several promising hybrids [4, 5].

Studies of columnar habit inheritance by Lapins [5] showed that it is controlled by the dominant *Co* gene, possibly together with the modifying genes, as the columnar trait is inherited close to 1:1, but not exactly. Further research, reviewed by Kelsey and Brown [6], as well as the recent study by De Wit et al. [7] showed that the gene works through apical dominance regulated by growth hormones, but the tree habit in hybrid progeny is influenced by both parents [7].

The aim of our work was to obtain columnar apple-tree varieties for the Baltic climate, combining fruit quality and attractive trees with hardiness and resistance to diseases.

MATERIALS AND METHODS

Crosses using columnar apple-tree hybrids were made at the Iedzeni breeding station in 1991 (2 crossing combinations) and 1993 (9 combinations). The crosses were selected for columnar habit at Iedzeni. The resulting 239 seedlings were transferred to Dobele and planted in spring 1995. The columnar hybrids used in crosses were obtained by V. Kichina: variety 'Arbat', hybrids KV-3A, KV-11, KV-16, KV-26, KV-35. Commercial varieties were used as pollen parents. Scab immune hybrid BM 41497 (Sweden) and the AMD-27-10-1 hybrid from Iedzeni ('Lawfam' × 'Iedzenu') were also used in 1991. The seedlings were grown in field, unsprayed with fungicides.

The evaluation of hybrid seedlings was done according to generally accepted methods [3, 8]. During the first years of growth, the trees were evaluated for their growth habit, vigour, resistance to scab *Venturia inaequalis*, mildew *Podosphaera leucot-*

richa and leaf spot *Phyllosticta mali*, and physiological disorders. Seedlings with depressive growth and non-columnar ones were discarded before the start of fruiting. Fruiting columnar seedlings were evaluated for their fruit quality (size, shape, colour, flavour, firmness, storage), flowering and yield (season and abundance), regularity of production, resistance to canker *Nectria galligena*, fruit rot diseases caused by *Monilia* and *Gloeosporium* fungi, injuries of spring frost (–4 °C at full bloom for two years), and the general ornamental value. Injuries by diseases and frost, flowering and yield were evaluated on a 9-point scale. Seedlings injured by over 4 points were ranged as susceptible. Fruit quality was first screened as acceptable/unacceptable, then the best hybrids were evaluated by a taste panel. The tree morphology was described, and tree vigour and branching evaluated.

The characteristics used to discard non-columnar trees were: branching at angles over 30°, numerous branches, fruit bearing on long shoots, development of bare wood (constantly dormant buds in the lower part of branches).

The characteristics used to discard trees with depressive growth were: small, thick and curled leaves, very short new growth, failure to produce fruits and flowers, physiological disorders, *e.g.* chlorosis.

The evaluation of ornamental value was based on flower size, colour and shape; flowering and fruiting abundance and regularity; fruit attractivity and persistence on tree; tree habit; leaf colour and size; resistance to leaf, fruit and bark diseases.

RESULTS AND DISCUSSION

Although the seedlings were selected for columnar growth already in the first year of growth, it was observed that not all seedlings maintained a good columnar habit after 7 years of growth: bare wood, excessive branching and fruit bearing on long shoots appeared in 9.5–31.8% of seedlings and depressive growth in 0–32.7% depending on a cross combination (Table 1). Our results comply with those of De Wit et al. [7] that the non-columnar male parent may have a significant influence on tree habit. The number of seedlings was too low for a thorough statistical analysis, but the differences among the hybrid families look striking. The highest percentage of non-columnar progeny was observed in crosses with tip-bearing varieties 'Forele' and 'Iedzenu'; yet another tip-bearing variety, 'Doch Melbi', gave only 19% of non-columnar seedlings. It may be supposed that, like in other cases of crossing heterozygous plants, latent genes of parent varieties will show up in the next generation, especially as the genetic variability of commercial apple varieties is limited.

The columnar tree size (after discarding non-columnar and depressive plants) in the hybrid families varied from very vigorous to very weak. Smaller trees were observed in crosses with KV-3A and ' Forele' as parents, while crosses with the vigorous varieties 'Iedzenu' and 'Doch Melbi' produced only vigorous or medium-size trees (Table 2). Such small-size trees present interest, even if they are not truly columnar, and one spur-type tree was selected in the family KV-3A × 'Forele'.

The first yield was obtained in 1999, and by 2002 the majority of seedlings started fruiting. The average

Table 1. **Segregation by tree types in columnar apple hybrid families**

Crossing combination	Number of seedlings	Non-columnar trees, %	Depressive trees, %	Columnar trees, %
'Arbat' × 'Forele'	66	31.8	4.5	63.7
KV-11 × 'Melba'	52	15.4	32.7	51.9
KV-16 × 'Antonovka'	23	26.1	30.4	43.5
KV-26 × 'Auksis'	25	28.0	24.0	48.0
KV-26 × 'Iedzenu'	13	30.8	7.7	61.5
KV-3A × 'Talvenauding'	21	9.5	None	90.5
KV-3A × 'Forele'	8	12.5	37.5	50.0
KV-35 × 'Doch Melbi'	21	19.0	19.0	62.0
KV-35 × 'Antonovka'	3	None	100.0	None

Table 2. **Tree vigour of columnar apple hybrid seedlings**

Crossing combination	Number of columnar seedlings	Vigorous trees, %	Medium trees, %	Small trees, %
'Arbat' × 'Forele'	37	51.4	37.8	10.8
KV-11 × 'Melba'	18	38.9	44.4	16.7
KV-16 × 'Antonovka'	6	16.7	83.3	None
KV-26 × 'Auksis'	10	60.0	30.0	10.0
KV-26 × 'Iedzenu'	6	83.3	16.7	None
KV-3A × 'Talvenauding'	16	56.3	12.5	31.3
KV-3A × 'Forele'	5	20.0	40.0	40.0
KV-35 × 'Doch Melbi'	12	50.0	50.0	None
KV-35 × 'Antonovka'	1	100.0	None	None
KV-35 × BM 41497	2	None	100.0	None
KV-16 × AMD-27-10-1	5	40.0	60.0	None

Table 3. **Disease resistance in columnar apple hybrid families**

Crossing combination	Number of seedlings	Mean scab injury, points 1–9	Mean mildew injury, points 1–9	Seedlings susceptible to leaf spot, %	Seedlings susceptible to canker, %
'Arbat' × 'Forele'	66	3.5	1.8	3.0	10.6
KV-11 × 'Melba'	52	4.7	2.4	1.9	9.6
KV-16 × 'Antonovka'	23	4.5	2.3	17.4	None
KV-26 × 'Auksis'	25	4.7	3.3	20.0	8.0
KV-26 × 'Iedzenu'	13	4.6	2.0	7.7	None
KV-3A × 'Talvenauding'	21	3.8	2.5	None	None
KV-3A × 'Forele'	8	3.5	1.3	None	12.5
KV-35 × 'Doch Melbi'	21	4.7	2.9	9.5	None
KV-35 × 'Antonovka'	3	3.0	2.0	None	None

Table 4. **Fruiting and ornamental value of columnar apple hybrid seedlings**

Crossing combination	Number of columnar seedlings	Mean yield, points 1–9	Attractive flowers, %	Attractive fruits, %	Good fruit flavour, %
'Arbat' × 'Forele'	37	4.0	7.6	6.1	7.6
KV-11 × 'Melba'	18	2.4	3.8	7.7	3.5
KV-16 × 'Antonovka'	6	1.6	None	None	None
KV-26 × 'Auksis'	10	2.8	16.0	4.0	4.0
KV-26 × 'Iedzenu'	6	2.8	None	23.1	23.1
KV-3A × 'Talvenauding'	16	1.6	None	19.0	42.9
KV-3A × 'Forele'	5	4.0	60.0	12.5	25.0
KV-35 × 'Doch Melbi'	12	3.8	23.8	14.3	42.9
KV-35 × Antonovka	1	0.3	None	33.3	33.3
KV-35 × BM 41497	2	0.5	None	None	None
KV-16 × AMD-27-10-1	5	4.0	12.5	None	12.5

fruit yield in the hybrid families was low; the most productive were combinations 'Arbat' × 'Forele', KV-3A × 'Forele', KV-3A × 'Doch Melbi' (Table 3). As observed by the author (unpublished), the productivity of columnar apple seedlings may increase, if they are grafted on dwarfing rootstocks such as B9.

The largest fruit with best flavour were observed in families KV-35 × 'Doch Melbi', KV-3A × 'Talvenauding', while 'Arbat × 'Forele' produced only small-fruited seedlings, yet made attractive trees.

The highest resistance to diseases was found in the combinations 'Arbat' × 'Forele' (mean scab injury 3.5, mildew 1.8 on 9-point scale), KV-3A × 'Forele' (scab 3.5, mildew 1.3), KV-35 × 'Talvenauding' (scab 3.8, mildew 2.5, no *Nectria* or leaf spot). The crosses 'Arbat' × 'Forele' and KV-11 × 'Melba' had most canker-injured trees (Table 4).

Twenty-nine best seedlings which combine good ornamental value, resistance and fruit quality have been selected for further trials.

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KOLONINIŲ OBELŲ AUGINIMAS LATVIJOJE

S a n t r a u k a

1991–1993 metais V. Kičinos (Rusija) išaugintos kolonin̄s obelys buvo sukryžmintos su komercinę vertę Latvijoje turinčiomis obelų rūšimis.

Pirmasis derlius gautas 1999 m. Buvo įvertintas sodinukų augimas, patvarumas, vaisių kokybė, žydėjimas ir derlingumas, atsparumas kenkėjams – miltligei, lapų dėmėtumui, nektrijai, vaisių puviniui, taip pat atsparumas šalnoms ir bendroji dekoratyvinė vertė. Nustatytas žemas vidutinis sodinukų derlingumas. Tolimesniems tyrimams atrinkti 29 sodinukai (iš 239).