

THE RESULTS OF A COMPARISON TRIAL OF APPLE SCAB RESISTANT CULTIVARS IN ESTONIA

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Abstract. A comparison trial of 23 apple scab resistant cultivars was started in spring 2009. The trial was located in southern Estonia at the Polli Horticultural Research Center (58°07'N, 25°32'E). Trees were grafted on dwarfing rootstock B396 and planted in an orchard with the distance 2x4 m (1250 trees/ha). The comparison trial lasted six years (from 2009 to 2014) and provides data for drawing conclusions on disease resistance, winter hardiness, fruit bearing age, and yield of trees as well as the size of fruit. The following cultivars proved to be better suited to Estonian climatic conditions: Belorusskoye Sladkoye, Dace, Elena, and Pamyat Kovalenko. Antei, Dace, and Pamyat Kovalenko stood out with their large yield. The following cultivars produced large fruit: Roberts, Sügisjoonik, Yubilar, Pospekh, Dace, and Antei.

Key words: apple, clonal rootstock, fruit quality, growth, yield.

INTRODUCTION

Climatic and soil conditions as well as consumer expectations about the quality of fruit in an increasingly competitive market are key factors in the selection of species and cultivars in horticulture. Commercial apple orchards in Estonia prefer apple cultivars that are suited for growing during a 170 to 180-day vegetation period and winters that are characterized by intermittent periods of extremely low temperatures (less than 30°C) and above-freezing temperatures. Furthermore, contemporary environment-friendly growing technology is increasingly aiming for minimal use of pesticides. That is why disease-resistant cultivars and, in case of apple trees, scab-resistant cultivars are preferred. Estonia's neighboring countries have had some success in breeding disease-resistant apple cultivars: e.g., Latvia [1], Lithuania [2]-[4], Byelorussia [5],[6], and Poland [7],[8]. In Estonia, a comparison trial was initiated in 2009 to determine scab-resistant or scab-tolerant cultivars suited for growing in Estonian climatic conditions. For that purpose, new apple cultivars bred in Estonia's neighboring countries were collected for a comparison trial aimed at evaluating their performance in the Estonian agroclimatic conditions with minimal use of pesticides.

MATERIALS AND METHODS

The comparison trial included 23 cultivars that were planted in southern Estonia at the Polli Horticultural Research Center (58°07'N, 25°32'E) in spring 2009. Of the total of 23 cultivars, seven were from Byelorussia (Belorusskoye Sladkoye, Darunak, Elena, Imant, Nadzeina, Pamyat Kovalenko, and Pospekh); six were from Poland (Egeria, Ligolina, Lodel, Medea, Odra, and Wars); four were from Latvia (Dace, Edite, Gita, and Roberts); one from the Czech Republic (Rubinola); one from Russia (Yubilar), and two other cultivars (Liberty and Priam). The new cultivars were compared to two cultivars that have been included in the list of cultivars recommended for growing in Estonia: Antei and Sügisjoonik. The trial was carried out in one repetition, with 5 to 10 trees per cultivar. Planting scheme was 2x4 m (1250 trees/ha). The cultivars included in the trial were grafted on a dwarfing rootstock B396. The trees planted in the orchard were two years old. The parameters obtained in the study included yield per tree (kg), average fruit weight (g), the winter resistance of the trees and the extent that the fruit was infected with apple scab (*Venturia inaequalis*). The following measurements were taken to characterize the growth of the trees: trunk diameter 30 cm from the ground (mm) and the length of the leader branch (cm).

The soil type was medium sandy clay, with a pH of 5.5 and a content of K 134 mg/kg, P 156 mg/kg and C org 2.1%. Soil was mechanically clean-cultivated for three years after planting, then grass rows were established between the rows, mowing several times during summer in alleyways grass sward. Herbicide strips were maintained along tree rows and grass sward. The trial orchard was not treated against apple scab.

Climatic conditions were unfavorable in two years out of six (2009/2010 and 2010/2011), when air temperature fell below -30°C, causing winter damage to trees.

RESULTS AND DISCUSSION

Breeding apple scab resistant cultivars started as a joint project of three US universities already before the Second World War. They found a scab-resistant parent *Malus floribunda* 841. After repeated cross-pollinations they obtained a fifth-generation cultivar Prima. The donors used to obtain the cultivars included in the present trial are Liberty, BM 41497, and SR 0523. The latest releases of the Latvia State Institute of Fruit-Growing include scab resistant (*Rvi6*) cultivars ‘Dace’, ‘Edite’, ‘Gita’, ‘Ligita’, ‘Roberts’ and columnar apples ‘Inese’ (*Rvi6*), ‘Duets’, ‘Baiba’, ‘Uldis’ and ‘Zane’ [9]. DNA markers confirmed that BM41497 was the source of the gene Vf present in modern cultivars of Belarusian breeding. The cultivars ‘Belorusskoye Sladkoye’, ‘Darunak’, ‘Nadzeiny’, ‘Pamyat Kovalenko’, and ‘Pospkeh’, which were obtained from BM41497, formed a separate cluster [10]. These cultivars proved to be apple scab resistant in Estonia as well. The cultivars Elena, Egeria, Lodel, and Medea are polygenous to apple scab [7],[8],[11]. Of these cultivars, only Elena exhibited some scab spots on a limited number of apples in a year when conditions were especially favorable for apple scab (2014).

Table 1

The number of winter hardy apple trees in years 2009, 2011, 2014 and tree measurements in 2012

Variety	Number of apple trees			Tree measurements, 2012	
	2009	2011	2014	Ø, mm	Leader branch, cm
Antei	5	5	4	36 b	27 cd
Belorusskoye Sladkoye	10	10	10	27 e	33 b
Dace	10	10	10	30 d	30 bc
Darunak	10	6	0	14 f	22 e
Edite	10	9	8	32 c	32 bc
Egeria	10	9	9	32 c	29 c
Elena	10	10	10	31 cd	38 a
Gita	10	6	6	26 e	25 de
Imant	10	9	9	28 e	40 a
Liberty	5	2	0	18 f	32 bc
Ligolina	10	5	5	33 c	28 c
Lodel	10	5	5	30 d	29 c
Medea	10	3	3	31 cd	27 cd
Nadzeina	5+1	3	2	35 bc	38 a
Odra	10	9	9	37 b	33 b
Pamyat Kovalenko	10	10	10	31 cd	29 c
Pospkeh	10	8	8	34 bc	22 e
Priam	10	9	1	17 f	23 de
Roberts	10	5	3	27 e	22 e
Rubinola	10	9	9	43 a	31 bc
SügisjooNIK	10	10	8	32 c	23 de
Wars	10	5	5	36 b	27 cd
Yubilar	10	5	2	35 bc	26 d

Winter hardiness is an important characteristic in selecting cultivars. The harsh winter of 2009/2010 damaged the trunks of young trees. A similarly harsh winter in 2010/2011 damaged the already weakened trees to such a degree that the trees of several cultivars had to be cut back severely or were destroyed (Table 1). In the part of the orchard where trees had grown two years, at least 50% of trees were lost in case of cultivars Yubilar,

Ligolina, Gita, and Medea. Trees were cut back severely in case of cultivars Darunak (70%), Priam (70%), Liberty (80%), Lodel (50%), Roberts and Wars (30%), and Rubinola (20%). By 2014, when the orchard was six years old, all trees had survived in case of the following cultivars: Belorusskoye Sladkoye, Dace, Elena, and Pamyat Kovalenko. Insufficiently winter-hardy cultivars had been Liberty, Priam, Yubilar, Medea, Roberts, and Nadzeina. More than 50% of trees were destroyed in case of these cultivars. In case of cultivars Ligolina, Lodel, and Wars, 50% of the trees planted in the orchard were lost. Egeria, Imant, Odra, Antei, Sügisjoonik, and Edite could be considered satisfactorily winter resistant.

Vegetative growth characteristics of trees (trunk diameter and length of leader branch) were measured in the fourth year after planting in the orchard. Trunk diameter of cultivars Darunak, Priam, and Liberty was less than 20 mm (Table 1). These cultivars were severely pruned back due to winter damage. The trees of cultivars Rubinola, Odra, and Wars had the largest trunk diameter (36 to 42 mm). The length of leader branch shows a tree's growth vigor during the vegetative period. Cultivars Imant, Elena, and Nadzeina were most vigorous. The leader branches of cultivars Roberts, Pospekh, Darunak, Yubilar, Gita, and Sügisjoonik had shortest leader branches (22 to 26 cm).

Table 2

The average of yield kg/tree of apple varieties in years 2009 to 2014

Cultivar	Yield, kg/tree						Average yield, kg/tree
	2009	2010	2011	2012	2013	2014	
Antei	3.2	1.0	9.0	10.6	7.9	6.8	6.4 a
Belorusskoye Sladkoe	2.8	0.1	2.4	3.1	6.3	1.7	2.7 c
Dace	1.8	0.6	3.3	5.7	7.2	18.6	6.2 ab
Darunak	0.7	1.6	1.7	0.3	0	-	0.7 d
Edite	0.3	0.2	0.7	1.8	1.9	4.6	1.6 c
Egeria	0.7	0.1	1.3	2.3	4.8	6.4	2.6 c
Elena	2.1	2.0	3.8	5.3	5.5	4.8	3.9 bc
Gita	0.8	1.0	1.8	2.2	8.1	5.6	3.3 c
Imant	0.2	0.1	1.6	3.9	4.5	2.6	2.2 c
Liberty	1.0	0.8	1.5	0	0	-	0.6 d
Ligolina	1.3	0.3	1.8	3.0	1.2	2.8	1.7 c
Lodel	0.5	0.5	2.5	2.2	2.1	4.8	2.1 c
Medea	0.3	0.2	2.7	0.7	1.0	0.5	0.9 d
Nadzeina	1.7	1.2	1.1	2.8	2.7		1.9 c
Odra	0.3	0.2	4.8	2.3	10.6	3.9	3.7 bc
Pamyat Kovalenko	1.9	0.5	6.0	5.4	8.4	4.9	4.5 ab
Pospekh	0.8	0.9	3.0	4.8	5.9	5.3	3.5 bc
Priam	0.9	1.1	2.1	0.1	0.6	1.0	1.0 d
Roberts	0.8	1.1	0.5	3.9	0.1	2.8	1.5 c
Rubinola	0.2	0.2	2.7	4.7	3.2	11.9	3.8 bc
Sügisjoonik	0.5	1.1	1.4	3.8	1.3	2.2	1.7 c
Wars	0.8	0.4	3.3	1.2	4.9	5.7	2.7 c
Yubilar	1.2	0.4	2.1	7.4	9.1	1.0	3.5 bc
Average	1.1 A	0.7 A	2.7 B	3.4 C	4.2 D	4.3 D	

Early fruiting cultivars are preferred in planting commercial orchards. Among control cultivars, Sügisjoonik starts to bear fruits late [12] and Antei is very early fruiting cultivar [11]. Young trees grafted on dwarfing rootstock B396 blossomed during their first year in the orchard. The average yield of the trial cultivars was 1.1 kg/tree in the first year, 0.7 kg/tree in the second year, and 2.7 kg/tree (Table 2). Based on the total yield of the first three years, early fruiting cultivars were Antei (13.2 kg/tree), Pamyat Kovalenko (8.4 kg/tree), and Elena (7.9 kg/tree). The yield of the young trees of most cultivars was between 3.0 and 5.7 kg/tree. However,

the yield of cultivars Edite, Imant, Egeria and Roberts was below that level. These differences were explained by biological characteristics of cultivars – the cultivar’s genetic potential for formation of flower buds – and the impact of winter damage to the health of young trees.

The yield of the trees increased year by year. The average yield per tree was 3.4 kg/tree in the fourth year and over 4 kg/tree in the fifth and sixth year. Based on the average of six fruit-bearing years, cultivars Antei, Dace, and Pamyat Kovalenko were most productive. The yield of cultivars Roberts, Edite, Ligolina, Nadzeina, Lodel, Imant, Egeria, Wars, and Byelorusskoye sladkoye did not exceed the yield of one of the control cultivars, Sügisjoonik. The yield was the lowest for cultivars Darunak, Liberty, Medea, and Priam. The yield of high-yielding cultivars in the six years exceeded 33 tons/ha. In comparison, in Lithuania, high-yielding apple cultivars on rootstock M26 reached this level already in the fifth year [13].

The largest apples were on cultivars Roberts and Sügisjoonik, accordingly 191 g and 179 g (Table 3). The fruit of the cultivars Yubilar, Pospekh, Dace, Antei, and Nadzeina was larger than the average (134 g) of the cultivars included in the trial. The fruit of cultivars Elena, Lodel, Medea, Ligolina, and Odra was smaller than the average.

Table 3

Average fruit weight (g) in years 2009-2014

Cultivar	Fruit weight, g						Average weight, g
	2009	2010	2011	2012	2013	2014	
Antei	226	181	142	122	140	137	158 abc
Belorusskoye Sladkoye	178	155	150	97	104	112	133 bcd
Dace	186	213	130	131	184	150	166 ab
Darunak	171	129	125	120	-	-	136 bcd
Edite	160	138	134	118	146	132	138 bc
Egeria	144	116	111	120	128	110	122 cde
Elena	100	80	65	69	74	76	77 e
Gita	133	125	132	113	140	147	132 bcd
Imant	124	200	145	116	142	117	141 bc
Liberty	141	119	114	-	-	-	125 cde
Ligolina	96	114	110	101	111	100	105 de
Lodel	93	103	91	106	110	100	101 de
Medea	89	120	115	87	98	100	102 de
Nadzeina	196	142	124	135	191	-	158 abc
Odra	108	113	109	169	90	113	117 cde
Pamyat Kovalenko	146	163	158	109	113	131	137 bc
Pospekh	196	182	178	180	157	127	170 ab
Priam	160	100	100	-	112	108	116 cde
Roberts	236	256	190	162	-	109	191 a
Rubinola	135	105	188	104	111	117	127 cde
Sügisjoonik	240	208	137	178	173	136	179 a
Wars	126	136	131	100	106	113	119 cde
Yubilar	201	275	195	122	120	130	174 ab

CONCLUSIONS

The comparison trial of 23 apple cultivars that lasted for six years (2009 to 2014) allows to draw some conclusions on disease resistance, winter hardiness, early cropping, productivity and size of fruit. The cultivars that proved to be best adapted to the Estonian climatic conditions were Belorusskoye Sladkoye, Dace, Elena, and Pamyat Kovalenko. Early cropping cultivars were Antei, Pamyat Kovalenko, and Elena. The cultivars

with highest yield were Antei, Dace, and Paymat Kovalenko. The cultivars with largest fruit were Roberts, Sügisjoonik, Yubilar, Pospekh, Dace, and Antei.

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