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The evaluation of scab resistant apple cultivars in Estonia

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Abstract. At Polli Horticultural Research Centre currently over 400 apple accessions are being maintained, including 47 local cultivars and 14 scab resistant cultivars. Cultivars 'Imrus', 'Chistotel', 'Orlovim', 'Pamyat Issayeva', 'Pervinka', 'Pioner Orlovski' and 'Slavyanin' were introduced from the All-Russian Research Institute of Breeding of Horticultural Crops at Orel. Cultivars were assessed for tree phenology stage, weight of the fruit, yield per tree, occurrence of apple scab and the biochemical content of the fruit. No scab infections were found on these cultivars during the evaluation years at Polli. 'Orlovim' was the earliest and 'Pioner Orlovski' the latest bloomer. 'Chistotel' and 'Slavyanin' achieved the highest yield per tree. 'Pamyat Issayeva' and 'Pervinka' gave the largest fruits. All 7 cultivars possessed relatively high levels of acidity and because of that they are not best suited for fresh consumption.

Key words: disease resistance, *Malus domestica*, *Venturia inaequalis*

INTRODUCTION

About one third of the thirty-three apple cultivars listed in the "List of cultivars recommended for growing in Estonia" are susceptible to scab, which is caused by *Venturia inaequalis*, and only one cultivar in the list ('Imrus') is scab immune. In commercial apple orchards established within the past ten years, scab susceptible cultivars ('Lobo', 'Koit', 'Melba' and 'Cortland') constitute about 20% of planted apple trees (data of Statistics Estonia). In the Estonian commercial apple orchards, fungicide sprays are applied no more than 3–5 times because of limited financial means. During the years of high disease pressure, poor disease control causes a large proportion of scabby fruits and apple yield that is suitable only for processing. An alternative solution to spraying is the cultivation of resistant cultivars, which can be grown with no fungicide application (Crosby et al., 1992; Janick, 2002). Integrated and ecological (organic) apple production is becoming increasingly important (Fisher & Fisher, 2004). The cultivation of scab resistant apples is important for both producers and consumers in terms of economy, ecology and toxicology (Zimmer, 1999). However, scab resistant cultivars have some undesirable fruit quality parameters, which can delay their wider use. One such parameter is the acid taste still present in the final cultivar.

At the All-Russian Research Institute of Breeding of Horticultural Crops at Orel, breeding for scab resistance started in 1978, and the first cultivars were released for cultivar testing in 1989 (Sedov & Serova, 2005). In 1991, the seven scab resistant cultivars 'Imrus', 'Chistotel', 'Orlovim', 'Pamyat Issayeva', 'Pervinka', 'Pioner

Orlovski' and 'Slavyanin' were introduced in Estonia. The objective of this study was to observe the phenological stages and evaluate the productivity and quality of these scab resistant cultivars.

MATERIAL AND METHODS

The experiment was established at the Polli Horticultural Research Centre of the Estonian University of Life Sciences, at 450–500 mm average annual rain fall, on a moderate fertile medium loamy clay sod podzolic soil. Between 2001 and 2006, seven scab resistant apple cultivars were evaluated: 'Chistotel', 'Imrus', 'Orlovim', 'Orlovski Pioner', 'Pamyat Issayeva', 'Pervinka' and 'Slavyanin', all bred at the All-Russian Institute of Fruit Crop Breeding, Orel. Trees grafted on MM106 rootstocks were planted in the apple collection orchard in 1994, with 2–7 trees per cultivar, without replication. The planting scheme was 4 × 7 m. 2–3 chemical insecticide treatments were necessary to control pests and 1–2 fungicide treatments per year were applied against apple scab in the apple collection orchard.

In this study we observed the phenological stages and fruit quality characteristics (fruit weight, total soluble solids, acidity, total sugars, and ascorbic acid content). Yield was recorded. Resistance to apple scab was assessed in the beginning of August. The results were expressed as mean ± standard deviation.

Table 1. Scab resistant cultivars tested in the experiment.

Cultivar	Parentage	Resistance gene	Year of release
Chistotel	'Antonovka' × SR 0523	Vm	1989
Imrus	'Antonovka' × OR18T13	Vf	1989
Orlovim	'Antonovka' × SR 0523	Vm	1989
Orlovski Pioner	'Antonovka Krasnobochka' × SR 0523	Vm	1989
Pamyat Issayeva	'Antonovka Krasnobochka' × SR 0523	Vm	1992
Pervinka	'Antonovka Krasnobochka' × SR 0523	Vm	1989
Slavyanin	'Antonovka Krasnobochka' × SR 0523	Vm	1992

RESULTS AND DISCUSSION

During the experiment no scab infections were found on the fruits of the evaluated cultivars. This means that Vm and Vf resistance was not conquered in the Estonian conditions. Nevertheless, a limited crop protection programme is recommended for commercial practice. Trapman (2006) reported that a small scab protection routine is still essential to avoid a selection of resistant scab and powdery mildew populations.

Phenology is the most important attribute involved in the adaptation of apple, as for other crops, to its growing environment and to climatic changes. The timing of phenological phases depends on numerous environmental conditions: temperature, precipitation, soil type, soil moisture. However, air temperature has the greatest influence on phenology, especially for spring phenological phases. The bud burst of the observed cultivars ranged from April 26 to May 2 over a six year average (Table 1).

Table 2. Data of the phenological phases of apple cultivars, 2001–2006.

Cultivar	No of trees	Bud burst	Flowering		Leaf fall
			First flowers open	Petal fall	
Chistotel	7	30.April ± 4	20.May ± 5	30.May ± 8	23.Oct. ± 5
Imrus	6	30.April ± 6	22.May ± 7	01.June ± 10	17.Oct. ± 6
Orlovim	2	26.April ± 6	19.May ± 7	31.May ± 8	26.Oct. ± 5
Orlovski Pioner	2	29.April ± 6	27.May ± 4	03.June ± 9	27.Oct. ± 6
Pamyat Issayeva	4	02.May ± 8	24.May ± 7	02.June ± 9	23.Oct. ± 4
Pervinka	4	01.May ± 6	21.May ± 7	31.May ± 7	26.Oct. ± 5
Slavyanin	3	28.May ± 9	23.May ± 9	01.June ± 9	26.Oct. ± 5

Table 3. The average yield of apple cultivars in 2001–2006.

Cultivar	Average yield (kg per tree)					Cumulative yield (kg per tree)
	2001	2002	2003	2005	2006	
Chistotel	12.2	0.0	46.0	47.1	16.8	122.1
Imrus	12.0	6.0	10.0	13.0	7.2	48.2
Orlovim	18.0	20.5	10.0	34.0	10.5	93.0
Orlovski Pioner	7.0	0.0	16.5	50.5	1.5	75.5
Pamyat Issayeva	6.0	17.5	25.0	36.3	16.5	101.3
Pervinka	0.0	7.7	14.0	69.3	0.0	91.0
Slavyanin	0.0	50.7	7.0	55.0	49.0	161.7

Table 4. Fruit quality characteristics of scab resistant cultivars.

Cultivar	Fruit weight (g)	Years of analyses	Soluble solids (Brix %)	Titratable acids (%)	Total sugars (%)	Vitamin C (mg $100g^{-1}$)
Chistotel	94 ± 20	6	11.4 ± 0.7	0.8 ± 0.09	9.0 ± 1.4	13 ± 1
Imrus	105 ± 15	5	12.2 ± 0.7	0.8 ±0.06	9.5 ± 0.8	10 ± 2
Orlovim	114 ± 20	1	11.0	0.9	9.5	10
Orlovski Pioner	150 ± 32	2	11.0 ± 1.7	0.9 ± 0.00	10.5 ± 3.7	11 ± 1
Pamyat Issayeva	132 ± 39	4	10.7 ± 0.7	0.7 ± 0.04	8.9 ± 1.7	6 ± 1
Pervinka	164 ± 10	1	11.9	0.6	7.6	9
Slavyanin	131 ± 33	4	12.1 ± 0.4	0.9 ± 0.16	10.4 ±1.0	9 ± 1

The earliest bud burst was observed on ‘Orlovim’ and the latest on ‘Pamyat Issayeva’. The average duration of blooming was 10 days. ‘Orlovim’ was the earliest and ‘Orlovski Pioner’ the latest bloomer. The leaves of all seven cultivars had fallen by the end of October.The leaves of ‘Imrus’ were the first and the leaves of ‘Orlovski Pioner’ the last ones to fall. According to phenology data, it can be concluded that all seven cultivars adapt well to the Estonian climate.

There was no yield in 2004, because of the severe frosts (–4.5°C) that occurred during the flowering time and killed most flowers. In 2005, the average yield of all cultivars was high (43.6 kg per tree), varying from 13.0 to 69.3 kg per tree (Table 3). The five-year cumulative yield of cultivars ‘Slavyanin’, ‘Chistotel’ and ‘Pamyat Issayeva’ exceeded 100 kg per tree. The lowest cumulative yield was recorded on cv. ‘Imrus’ (48.2 kg).

The fruits of ‘Chistotel’ were the smallest, whereas ‘Pervinka’ produced the largest ones (Table 4). Moreover, the fruits of ‘Pervinka’ were the most uniform in size. The content of soluble solids varied between 11.0 and 12.2%. All analyzed cultivars possessed a relatively high acid content. The apples of ‘Orlovim’, ‘Orlovski Pioner’ and ‘Slavyanin’ had the highest and those of ‘Pervinka’ the lowest titratable acidity. Total sugar content ranged from 7.6 to 10.5%. The sugar–acid ratio is responsible for the taste and flavor of the apple fruit. All tested cultivars were characterized by a low (under 13) sugar-acid ratio. Vitamin C content was the highest in the apples of ‘Chistotel’ and the lowest in ‘Pamyat Issayeva’. A similar biochemical composition of these scab resistant cultivars has been reported by Sedov et al. (1992).

Low sugar-acid ratio means that the fruits of these seven scab-resistant cultivars are not best suited for fresh consumption. Besides fresh consumption, apples are suitable for processing. The fruits of scab resistant cultivars are suitable for different products. According to Levgerova (2004), the overall rating of apple compote on a 5 point scale was as follows: ‘Imrus’ 4.0, ‘Pervinka’ 4.1, ‘Chistotel’ and ‘Slavyanin’ 4.2, ‘Orlovim’ 4.3, ‘Orlovski Pioner’ 4.4 and ‘Antonovka’ (control) 4.2. The overall rating of apple jam made from scab resistant cultivars ranged from 4.4 to 4.5, equal to the jam of ‘Antonovka’ apples (4.4 points).

CONCLUSIONS

All evaluated scab resistant cultivars possessed a relatively high level of acidity, and because of that they are not suitable for fresh consumption. But among them cultivars ‘Chistotel’, ‘Slavyanin’ and ‘Pamyat Issayeva’ excel in a high yielding potential, and cultivars ‘Pervinka’ and ‘Orlovski Pioner’ in good fruit size. All evaluated cultivars can be used in the apple breeding program since they are donors of resistance to apple scab.

REFERENCES

Crosby, J. A., Janick, J., Pecknold, P.C., Korban, S.S., O'Connor, P.A., Ries, S.M., Goffreda, J. & Voordeckers, A. 1992. Breeding apples for scab resistance: 1945 – 1990. *Acta Hort.* **317**, 43–70.

Fisher, M. & Fhisher, Ch. 2004. Genetic resources as a basic for new resistant apple cultivars. *J. Fruit Ornam. Plant Res.* **12**, 63–76.

Janick, J. 2002. History of the PRI Apple Breeding Program. *Acta Hort.* **595**, 55–60.

Levgerova, N. S. 2004. What products are possible to make from apples and pears. In *Apple and pear cultivars*, pp. 170–182. GNU VNIISPK Orel (in Russian).

Sedov, E. N, Serova, Z. M., Zhdanov, V. V. & Habarov, Yu. I. 1992. New apple varieties high resistant to apple scab. In Stroev, E.S. (ed.): *Selection and horticultural breeding*, pp. 36–45. Orel (in Russian).

Sedov, E. N. & Serova, Z. M. 2005. Apple breeding history, results and prospects. In Kuznetsov, M.N. (ed.): *Status and prospects of fruit breeding and variety investigation* pp. 13–40 Orel (in Russian).

Trapman, M. 2006. Resistance management in Vf resistant organic apple orchards. *Pome Fruit Diseases (IOBC/wprs)* **29**(1), 253–258.

Zimmer, J. 1999. Testing of scab resistant apple cultivars at the Ahrweiler experimental station. *Erwerobstbau* **41**(6), 185–191.