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Resistance to fungal diseases of apple cultivars and hybrids in Lithuania

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Abstract. Thirty apple (*Malus domestica* Mill.) cultivars and hybrids were evaluated for resistance to scab (*Venturia inaequalis* (Cke.) Wint.), apple blotch (*Phyllosticta mali* Pr.at Del.) and canker (*Nectria galligena* Bres.). Resistance to scab and apple blotch were studied in 2003–2005 and to canker in 2005. Injuries caused by fungal diseases were evaluated according to a 6 point scale: 0 – no disease symptoms detected on leaves or branches, 5 – injured more than 75% of leaf area or, in the case of canker, the branch is girdled by distorted area. Meteorological conditions were favourable or moderately favourable for the development of pathogens. It was ascertained that apple hybrids No 20429 and No 20016 are characterized as complex-resistant to scab, apple blotch and canker. Cultivar 'Kurnakovskoe' and hybrids No 19399, No 19707, No 19646, No 19942, No 20235, No 20239, No 20978 and No 24-40-52 are characterized as complex-resistant to scab and apple blotch. Cultivars 'Delikates', 'Anteĭ', hybrids No 25-50-126 and No 25-50-132 were the most sensitive to scab; 'Pamyat' Syubarovoĭ' and No 25-51-122, to apple blotch, and 'Katja', 'Yubilyar', 'Pamyat' Syubarovoĭ', 'Bolotovskoe' and No 19942, to canker.

Key words: apple, apple blotch, cultivar, european cancer, hybrid, resistance, scab

INTRODUCTION

Meteorological conditions are favourable for the development and spreading of pathogens in the Baltic states. Apple trees are damaged by scab *Venturia inaequalis* (Cke.) Wint., apple blotch *Phyllosticta mali* Pr. at Del. and European canker *Nectria galigena* Bres. (Kozlovskaya, 2001). One of the main objectives of the apple breeding programme is to develop immune or resistant cultivars. Apple breeding was started in 1952 in Lithuania. Apple cultivars immune to scab began to be used in crosses from 1978. Several commercially grown cultivars: 'Auksis', 'Noris', 'Staris' and 'Aldas' were developed. 'Skaistis' and 'Rudenis' – scab immune apple cultivars - were achieved in 2005 (Sasnauskas et al., 2005).

Artificial infection settings in greenhouses were used in many countries to evaluate and select scab-resistant individuals and to increase the speed of an apple breeding cycle (Pitera, 2000); *in vitro* screening is used as well to achieve the above noted results (Gelvonauskienė & Stanys, 2001).

Races of pathogens change rather fast and new aggressive fungicide-resistant races develop. Cultivars with complex resistance to fungal diseases are important for ecological and economical considerations.. Resistance to biotic and adaptation to

abiotic factors of previously bred and newly introduced apple cultivars is being studied in Lithuania. (Gelvonauskienė & Bandaravičius, 1998).

Objectives of the work were to study newly developed apple cultivars and hybrids and, in Lithuania, hybrids which achieved resistance to scab, apple blotch and European canker .

MATERIALS AND METHODS

Resistance of apple cultivars and hybrids to scab (*Venturia inaequalis* (Cke.) Wint.), apple blotch (*Phyllosticta mali* Pr. at Del.) and European canker (*Nectria galligena* Bres.) were studied at the Lithuanian Institute of Horticulture in 2003–2005. Ten introduced cultivars: 'Katja', 'Delikates', 'Anteĭ', 'Yubilyar', 'Svezhast', 'Verbnoe', 'Kurnakovskoe', 'Kovalenkovskoe', 'Pamiat' Syubarovoĭ', 'Bolotovskoe'; 4 hybrids – donors of resistance to powdery mildew *Podosphaera leucotricha* Salm: No 25-50-126, No 25-50-132, No 25-51-122, No 24-40-52 (Russia) and 16 promising hybrids were achieved at the Lithuanian Institute of Horticulture: No 19399, No 21118 ('Prima' x 'Idared'), No 19436, No 19707, No 19709, No 19646 ('Katja' x 'Prima'), No 19942, No 20235, No 20239, No 20242, No 20427, No 20429, No 22170 ('Noris' x 'Prima'), No 20490 ('Auksis' x 'Prima'), No 20978 ('Tellissaare' x 'Prima'), No 20016 ('Prima' x 'Idared').

Cultivars and hybrids were planted in spring 1999. Trees were grafted on rootstock M26. Trees were spaced at 4 x 2.5 m in the orchard. Orchard management, pest, disease and weed control were performed as recommended for commercial orchards. Meteorological conditions in 2003–2005 were favourable to fungal disease development and spread. Resistance to scab and apple blotch was studied in 2003–2005, and resistance to canker in 2005 (in the 6^{th} year of apple tree growth in the orchard). Injuries of apple trees by scab and apple blotch were registered in the first decade in August, and injuries of apple trees by canker in November. Five fruit trees of every cultivar or hybrid investigated were evaluated. Injuries caused by fungal diseases were evaluated according to a 6 point scale: 0 – no disease symptoms detected on leaves or branches, 5 – injured more than 75% of leaf area, or, in the case of canker, the branch is girdled by a distorted area.

All data were subjected to analysis of variance. The significance of differences between the cultivars and hybrids was evaluated using LSD test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Resistance of cultivars to disease is determined genetically and, obviously, a composition of the population of pathogens strains in certain climate conditions influence incidence of disease. A maximum score demonstrates a potential level of plant resistance to disease. Scab and European canker cause more severe injuries than apple blotch. The score for scab sensitivity varied from 0 to 4, for European canker from 0 to 5 and for apple blotch from 0 to 1 (Table 1). Obtained results showed that cultivar 'Kurnakovskoye' and hybrids No 19399, No 19707, No 19646, No 19942, No 20235, No 20239, No 20016 have no symptoms of scab and apple blotch, and cultivars 'Yubilyar', 'Svezhest', 'Bolotovskoye' and hybrids No 19436, No 19709, No 20242, No 20427, No 20429, No 20490, No 20978, No 21118, No 22170, No 24-40-52 were

immune to scab. During the entire period of study, cultivars 'Verbnoye', 'Katja', 'Kovalenkovskoye', 'Pamiat Syubarovoi' and hybrid No 25-51-122 were characterized as cultivars having a stable resistance to scab. 'Verbnoje' was particularly distinguished among investigated cultivars.

None of the scab-immune apple cultivars carrying gene Vf and immune hybrids (gene Vf) which were introduced have scab symptoms. Scab strain composition had never been investigated in Lithuania. According to our results it can be stated that we have no strain 6 in the population of pathogens in Lithuania.

This strain damages apple cultivars; scab resistance is determined by the gene Vf (Parisi & Lespinasse, 1996). Cultivars 'Antei', 'Delikates' and powdery mildew donors No 25–50–126 and No 25–50–132 were the most sensitive to scab.

Table 1. Apple tree sensitivity to scab, apple blotch and european cancer.

Cultivars and hybrids	Scab		Apple blotch	European cancer		
	Average score of injury	Min.-max	Min.-max.	Average number of lesions	Average score of injury	Min.-max.
Katja	0.8	0.1–2	0	3	1.5	1–3
Delikates	2.4	1–4	0–1	0.2	0.7	1–2
Anteĭ	1.5	1–3	0.1–1	1.2	0.4	1–5
Yubilyar	0	0	0–0.1	1.4	1.8	1–5
Svezhest	0	0	0–1	0	0	0
Verbnoye	1	1	0	1.2	0.7	1–2
Kurnakovskoye	0	0	0	0.4	0.4	1–3
Kovalenkovskoye	0.9	0.1–1	0	0.8	0.5	1–2
Pamiat' Syubarovoi	1.1	1–2	0–1	1.6	2.1	2–4
Bolotovskoe	0	0	0–1	1.2	2.6	3–4
No 19399	0	0	0	1.8	0.4	1–3
No 19436	0	0	0–1	0	0	0
No 19707	0	0	0	1	0.6	1–3
No 19709	0	0	0–0.1	1.2	1.2	1–3
No 19646	0	0	0	1.5	1.5	1–4
No 19942	0	0	0	5.8	3.2	1–5
No 20235	0	0	0	1	0.8	1–2
No 20239	0	0	0	2.8	1.4	1–3
No 20242	0	0	0–0.1	1.4	1.0	1–3
No 20427	0	0	0–1	0.8	0.3	1
No 20429	0	0	0	0	0	0
No 20490	0	0	0–0.1	1.8	0.7	1–3
No 20978	0	0	0	1.2	0.8	1–2
No 21118	0	0	0–0.1	2	0.4	1–3
No 22170	0	0	0–0.1	1.2	1.3	1–3
No 20016	0	0	0	0	0	0
No 25–50–126	2.7	1–4	0	2.2	1.4	1–2
No 25–50–132	2.6	1–4	0–1	0.2	0.1	1
No 25–51–122	1.1	1–2	1–2	0.6	0.2	1–2
No 24–40–52	0	0	0	0.4	0.2	1
LSD_{05}	0.8	-	-	1.1	0.79	-

The data of the investigation show that the most of cultivars and hybrids studied were not injured by scab. In most cases resistance determined by the gene Vf. No 25–51–122 was the most resistant to apple blotch. We suppose that high resistance to apple blotch of cultivars and hybrids is either determined genetically, or we have do not have avirulent and non-aggressive strains of the pathogen in Lithuania.

Most most of the investigated apple cultivars and hybrids were injured by European canker (Table 1). Hybrids No 19436, No 20429, No 20016 have no European canker symptoms. 'Bolotovskoye', 'Pamiat Syubarovoĭ', 'Yubilyar', 'Katja' and hybrids No 19942, No 19646, No 20239, No 22170, No 25–50–126 were assessed as sensitive to European canker. Other cultivars and hybrids were moderately sensitive to canker. It was ascertained that apple hybrids No 20429 and No 20016 are characterized as resistant to scab, apple blotch and canker. Cultivar 'Kurnakovskoye' and apple hybrids achieved at the Lithuanian Institute of Horticulture No 19399, No 19707, No 19646, No 19942, No 20235, No 20239, and No 20978 are characterized as resistant to scab and apple blotch. Apple resistance to several diseases and pests has a different genetic control. It creates the possibility for combining resistance to several pathogens and pests into one genotype (Fischer, 2000). Horticulture promoted by cultivars with complex resistance to diseases and pests can ensure high ecological and economical levels.

CONCLUSIONS

1. Reaction of investigated apple cultivars and hybrids to the high pressure of pathogens differs in Lithuania. Hybrids No 20429 and No 20016 achieved at the Lithuanian Institute of Horticulture are characterized as complex-resistant to scab, apple blotch and canker.

2. Growth of disease-resistant cultivars is important for both the ecology and economy. Cultivar 'Svezhest' and hybrids No 19436, No 20427, No 20429, 20016, No 24–40–52 are important for ecological horticulture or as parent cultivars for use in breeding programs for achieving complex- resistant cultivars.

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