

SCAB RESISTANCE IN APPLE CULTIVARS FROM THE LITHUANIAN GERMPLASM COLLECTION AND SELECTION OF DONORS FOR BREEDING

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(Received August 16, 2004/Accepted November 25, 2004)

A B S T R A C T

228 *Malus* accessions from the Lithuanian Institute of Horticulture were evaluated in terms of scab resistance. The accessions included old, local cultivars as well as introduced cultivars. 170 of the cultivars were grafted on M.26 rootstock, and 58 of the cultivars were grafted on 54-118 rootstock. Trees were planted 3 x 5 meters apart in the orchard. Damage to leaves due to scab was graded on a scale from 0 to 5, where 0 equals no damage, and 5 equals extensive damage. Thirty-seven cultivars showed no sign of leaf damage due to scab. Twenty-eight of these highly resistant cultivars carried the Vf gene. Another 107 cultivars showed only slight leaf damage due to scab. From 1995 to 2004, ten of the cultivars which carry the Vf gene were used to breed hybrids which possessed not only resistance to scab, but also winter-hardiness, good tree architecture and attractive, storable fruits. Of the resulting 47 hybrids, seven were selected for further testing and propagated using various rootstocks.

Key words: scab resistance, *Malus* accessions, breed hybrids

INTRODUCTION

Apple scab is the most important disease in apple growing regions. It is caused by the fungus *Venturia inaequalis* (Cooke). Depending on region and weather conditions, up to fifteen fungicide treatments may be needed to control apple scab in commercial orchards in a single season. One way to avoid or reduce the use of fungicides is to plant scab resistant cultivars. Scab resistance occurs in some wild apple species and is coded for by several genes

(Williams and Kuc, 1969; Büttner et al., 2000). In commercial apple breeding, the main focus has been on the Vf gene (Fischer et al., 1994; Laurens, 1999). New strains of *V. inaequalis* have been identified which can infect apple cultivars carrying the Vf gene (Parisi et al., 1993). Incorporating several different scab resistance genes into a single apple cultivar should confer more consistent and reliable scab resistance. Therefore, it is important to identify and characterize all genes which contribute to scab resistance, even if they only confer partial resistance to scab.

MATERIAL AND METHODS

There are more than eight-hundred accessions in the apple collection at the Lithuanian Institute of Horticulture. 228 of them were evaluated in terms of scab resistance. The accessions included old, local cultivars as well as introduced cultivars. 170 of the cultivars were grafted on M.26 rootstock, and 58 of the cultivars were grafted on 54-118 rootstock. Trees were planted 3 x 5 meters apart in the orchard.

Damage to leaves due to scab was assessed at the beginning of August and was graded on a scale from 0 to 5, where 0 equals no damage, and 5 equals extensive damage. Scab resistance was inferred from leaf damage due according to the following scheme:

Leaf damage score	Leaf damage proportion	Level of resistance to scab
0	no leaf damage	highly resistant
1	1 to 10%	moderately resistant
2	11 to 25%	slightly resistant
3	26 to 50%	slightly susceptible
4	51 to 75%	moderately susceptible
5	76 to 100%	highly susceptible

RESULTS

Of the 228 cultivars tested, 37 were highly resistant to apple scab, 107 were moderately resistant, 52 were slightly resistant, 27 were slightly susceptible, and 5 were moderately susceptible (Fig. 1). Of the 37 highly resistant cultivars, 27 carried the Vf gene, and one carried the Vm gene. In the other nine highly resistant cultivars, the gene responsible for scab resistance was not identified. *M. consuensis*, *M. hartvigii*, H12, H105, 'Raudoniai', 'George Karpenter' did not show scab symptoms at all. The old, local Latvian cultivars 'Rigas rožabele', 'Jalgavas vasara' and 'Cesu sipolinš' had very few

necrotic lesions without sporulation. H12 and H105 had been collected from an old orchard planted by Prof. A. Hrebnicki at the beginning of twentieth century.

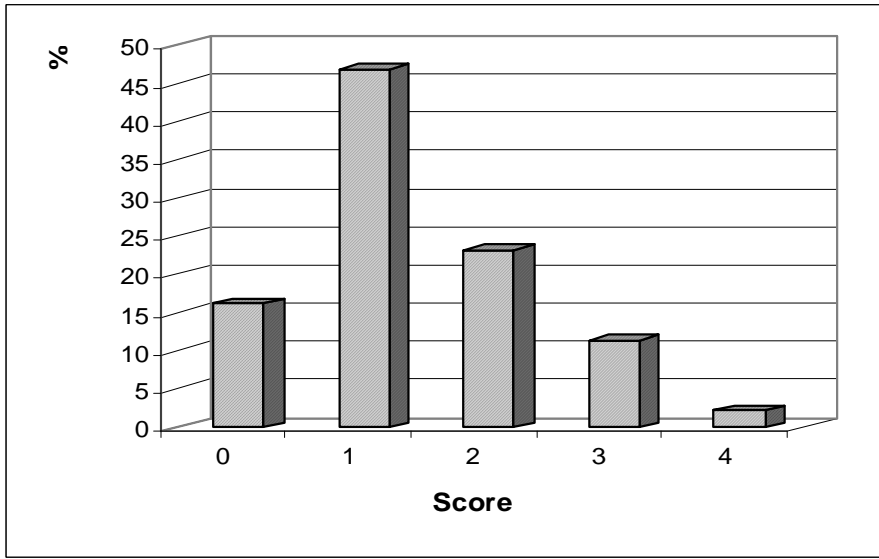


Figure 1. Frequency distribution of the level of scab resistance in the apple cultivars tested

For the past ten years, a breeding program has been underway which has yielded 308 new hybrids. In 176 of these hybrids, one or both parents carried either the Vf or the Vm gene (Tab. 1). 'Florina' was used in 25 crosses, 'Priam' in 23, 'Antonovka' in 21, 'Arbat' in 18 and 'Shtaris' in 18.

Ten of the cultivars which carry the Vf gene were used to breed hybrids which possessed not only resistance to scab, but also winter-hardiness, good tree architecture and attractive, storable fruits. Of the resulting 47 hybrids, seven were selected for further testing and propagated using various rootstocks. All seven had 'Prima' as one of the parent cultivars.

Leaf damage due to scab for some crosses is shown in Table 2. 'Florina', 'Priam', 'Arbat', 'Priscilla' and 'Prima' carry the Vf gene. The proportion of highly resistant seedlings resulting from these crosses ranged from 27.8% with 'Priam' x 'Papirovka' to 85.7% with 'Priscilla' x 'Arbat'. In comparison, a cross of two susceptible cultivars, 'Noris' and 'Papirovka', yielded only 1.2% highly resistant seedlings.

Table 1. Apple cultivars involved in crosses in 1995-2004

Cultivar	Used as female	Used as male	Total
Aldas	6	2	8
Angold	1	3	4
Antonovka	17	4	21
Arbat	7	11	18
BM 41497	1		1
Dayton	1		1
Discovery	1		1
Florina	8	17	25
Freedom	2	11	13
Gold Rush			1
KB47	3	2	5
Liberty		7	7
MacFree		2	2
Murray (Vm)		4	4
No. 18011		1	1
No. 18422		6	6
No. 18429	1	3	4
No. 18451	2		2
No. 20978		1	1
No. 25061		2	2
No. 25657		3	3
No. 25865	3	1	4
Nowamac	1		1
NY18491		1	1
OR33T90		2	2
Orlovim (Vm)	2	5	7
PO 54-140-9		4	4
Priam	15	8	23
Prima		2	2
Priscilla	5		5
Pristine		1	1
Realka		1	1
Redfree	2		2
Reglindis		1	1
Resi	1		1
Retina		2	2
Sawa	1	1	2
Sir Prize		2	2
SR 0523 (Vm)		8	8
Shtaris	13	5	18
Williams Pride	1	1	2
Witos	1		1
Total	95	125	220

Table 2. The inheritance of resistance to apple scab in crosses involving resistant cultivars

Cross	Number of plants	Percentage of plants with a given level of leaf damage due to scab				
		0	1	2	3	4
Tellissaare x Florina	113	54.9	10.6	20.4	14.2	-
Mantet x Florina	58	62.1	13.8	10.3	13.8	-
Florina x 'Mantet	243	52.7	12.3	19.3	11.9	3.7
Priam x 'Auksis	76	63.8	13.4	16.4	6.0	0.4
Priam x Papirovka	72	27.8	30.6	34.7	6.9	-
Aktiubinskoye x Arbat	93	47.3	16.1	22.6	11.8	2.2
Priscilla x Arbat	56	85.7	7.1	3.6	3.6	-
Antonovka x Prima	76	35.5	31.6	22.4	10.5	-
Antonovka x Auksis	130	40.8	43.8	14.6	0.8	-
Antonovka x Delikates	196	36.2	41.3	18.9	3.6	-
Shtaris x Papirovka	133	46.6	37.6	14.3	1.5	-
Noris x Papirovka	84	1.2	15.5	34.5	40.5	8.3

DISCUSSION

In order to obtain apple cultivars which are consistently and reliably highly resistant to scab, it is necessary to incorporate as many different resistance genes as possible into new hybrids. That way, the hybrids will be resistant to scab by a number of different mechanisms. It is therefore important to identify and characterize all genes which contribute to scab resistance, even if they only confer partial resistance to scab.

H12 and H15 are probably hybrids of *M. baccata* or *M. prunifolia*. Whereas they are good donors of scab resistance, they have rather small fruits. Thus, when used in a breeding program, they should be combined with cultivars with large fruits.

The breeding potential of the Latvian cultivars can be inferred from the level of scab resistance among their progeny.

Various scab resistance genes from various sources can be used to improve currently existing commercial cultivars using modern advanced molecular methods (Baldi et al., 2004; Belfanti et al., 2004).

The proportion of resistant seedlings depends not only on dominant resistance genes, but also on minor genes which modify and magnify the action of the dominant genes (Gessler, 1992). Crosses involving resistant cultivars such as 'Auksis' had a higher proportion of resistant seedlings than crosses involving susceptible cultivars such as 'Papirovka' (Fig. 1). However, some crosses involving susceptible cultivars, such as 'Mantet' x 'Florina', had a high

proportion of resistant cultivars, which agrees with earlier reports (Kellerhals et al., 1993; Gelvonauskis and Gelvonauskienė, 2002).

'Shtaris' is moderately resistant to scab and is a good donor of scab resistance. One of its ancestors is *M. prunifolia*, which is the probable source of its resistance genes.

The fact that 'Priscilla' x 'Arbat' yielded such a high proportion of resistant seedlings is probably because both parents carry the Vf gene.

Identifying new sources of scab resistance genes and prudently using them in breeding programs should result in new, genetically improved apple cultivars which possess not only a consistent and reliable high level of resistance to scab, but also winter-hardiness, good tree architecture, attractive, storable fruits, and a whole host of other desirable traits.

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ODPORNOŚĆ NA PARCHA ODMIAN JABŁONI W ZASOBACH KOLEKCYJNYCH ORAZ WYBÓR NAJLEPSZYCH ODMIAN DO HODOWLI TWÓRCZEJ

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S T R E S Z C Z E N I E

Grupa 228 taksonów z rodzaju *Malus* zgromadzonych w kolekcji Litewskiego Instytutu Ogrodnictwa została poddana szczegółowej charakterystyce pod względem ich odporności na parcha jabłoni. W grupie tej były stare, lokalne odmiany, odmiany wprowadzone do uprawy towarowej oraz mieszańce hodowlane. Objawy parcha na liściach drzew rosnących w sadzie oceniano według 5-stopniowej skali bonitacyjnej. Drzewa 170 taksonów zaszczerpiono na podkładce M.26, a pozostałych 58 taksonów na podkładce 54-118 i posadzono w jednakowej rozstawie 3 x 5 m. Stwierdzono, że 37 taksonów nie miało żadnych objawów parcha. Bardzo wysoką tolerancyjność na parcha jabłoni miało 28 odmian, o których wiadomo, że posiadały gen odporności Vf. Liście na drzewach 107 taksonów były nieznacznie porażone przez parcha jabłoni, natomiast liście na pozostałych drzewach miały wyższy stopień uszkodzeń. W latach 1995-2004 odmiany jabłoni posiadające gen odporności Vf były włączone do krzyżowań z odmianami charakteryzującymi się atrakcyjnymi owocami, długo wiszącymi na drzewie, odpowiednim pokrojem drzewa i innymi cechami. W ten sposób uzyskano 47 mieszańców, z których wyselekcjonowano 7 wartościowych siewek. Zostały one rozmnożone na różnych podkładkach wegetatywnych i poddane ocenie sadowniczej.

Słowa kluczowe: odporność na parcha, taksony z rodzaju *Malus*, hodowla twórcza