PROTECTION OF GENETIC RESOURCES OF POMOLOGICAL PLANTS AND SELECTION OF GENITORS WITH TRAITS VALUABLE FOR SUSTAINABLE FRUIT PRODUCTION

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RESPONSE TO DISEASES IN NEW APPLE CULTIVARS FROM THE CZECH REPUBLIC

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ABSTRACT

In the Czech Republic, fifty-seven new apple varieties have been bred and registered in the State Variety Book since 1977. Twenty-eight are resistant or tolerant to scab. Only eight were tolerant to powdery mildew, and none were completely resistant. Only four were tolerant to fire blight, and almost three-quarters of the cultivars were susceptible or very susceptible to fire blight. Only seven cultivars were resistant or tolerant to both scab and powdery mildew, and can be grown without any fungicide protection. On the basis of disease incidence and climatic conditions, seventeen cultivars are recommended for colder regions of the country, and thirteen cultivars are recommended for warmer regions of the country. These cultivars are briefly described in terms of their susceptibility or tolerance to other diseases.

Key words: apple, cultivar, scab, mildew, fire blight, canker, resistance, breeding, Czech Republic

INTRODUCTION

Thanks to three extensive, well-promoted breeding programs from the 1960s to the 1980s, as well as to the efforts of several amateur breeders, fifty-seven new apple varieties have been bred and registered in the State Variety Book of the Czech Republic since 1977 (Blažek, 1995). Twenty-seven other apple cultivars of foreign origin that can be propagated and grown in the Czech Republic have also been registered (Anonymous, 2003). The first remarkable cultivar registered was ‘Šampion’, which has become an important cultivar

throughout Europe. Several new varieties are added almost every year. Their significance will depend on the results of long-term tests and trials, as well as on the market's willingness to accept the newcomers.

Commercial apple production in the Czech Republic is still dominated by well-known international cultivars such as 'Idared', 'Golden Delicious', 'Spartan' and 'Jonagold'. In orchards established within the past ten years, there has been a large increase in the proportion of new Czech cultivars such as 'Rubín', 'Bohemia', 'Šampion' and, most recently, 'Topaz', 'Melodie' and 'Julia' (Buchtová, 2001).

The burgeoning number of registered cultivars available to Czech growers has begun to cause problems over the last few years. Suppliers of cultivars for the market are frequently disappointed by what is not in demand or what is not convenient especially for big supermarket chains. Therefore, the Fruit Union of the Czech Republic currently recommends eleven primary apple cultivars for commercial orchards, and another twenty as secondary cultivars for less extensive planting. The other fifty-three cultivars are recommended only for amateur growing or for research purposes (Čepička et al., 2000).

For the foreseeable future, new additions to the list will have to have better fruit quality and be more disease resistant than the varieties currently grown. The aim of this study was to evaluate apple cultivars bred in the Czech Republic in terms of their susceptibility or tolerance to the main apple diseases encountered in the Czech Republic, such as scab, powdery mildew, and fire blight.

MATERIAL AND METHODS

The evaluation is based on several trials from 1985 to 2003 in different commercial orchards with different soil and climate conditions. Most of this research was carried out at the Research and Breeding Institute of Pomology at Holovousy.

The station trials usually consisted of five discarded seedlings per cultivar grafted on M 9 rootstock with no replications. The susceptible cultivars 'Golden Delicious' and 'Idared' served as controls. Experimental orchards were usually managed for several years without any fungicide treatments (Blažek, 1999). The natural occurrence of scab and mildew was evaluated every year in the middle of the growing season on a scale from 1 to 9, where 9 equals no visible signs of infection. Canker and storage diseases were evaluated either at harvest or after several months of cold storage.

Many cultivars were also evaluated between 1996 and 2001 in thirty-five commercial orchards located in different climatic regions of the Czech Republic (Blažek, 2000; Blažek and Hlušičková, 2003). In most of these orchards, the

occurrence of diseases was monitored as part of the standard plant protection management program, whereas in some, very limited spraying was carried out in compliance with organic growing guidelines.

A third source of data was testing performed at the Central Institute for Supervising and Testing in Agriculture, which is responsible for registering new cultivars in the Czech Republic (Dokoupil et al., 2002). These tests yielded clear results pertaining to some very new cultivars. Five trees of each cultivar grafted on M 9 or MM 106 rootstock were managed in the orchard as recommended by the breeder. If a cultivar had been declared to be resistant to diseases, no fungicide was used for plant protection.

Each cultivar in this study was finally classified in terms of its resistance to both scab and powdery mildew on the basis of the average of the three worst infections recorded according to the following scale:

Score	Classification
9	A – completely resistant
8	B – field resistant
7	C – tolerant
5 or 6	D – slightly susceptible
3 or 4	E – susceptible
1 or 2	F – very susceptible

Only plants which are completely resistant, field resistant, or tolerant can be safely grown without any chemical protection from the disease in question.

Evaluation in terms of resistance to fire blight was based on three-year inoculation tests that were carried out at one station in the Czech Republic and at one institute in Germany (Kůdela et al., 2002; Fischer et al., 2004).

RESULTS AND DISCUSSION

About half of the fifty-seven apple cultivars listed in the State Variety Book are resistant or tolerant to scab, which is caused by *Venturia inaequalis* Cke. Wint. (Fig. 1). Only four cultivars are very susceptible to this disease, which reflects recent advances in domestic apple breeding programs. Most cultivars which are scab resistant carry the V_f gene derived from *Malus floribunda*. In the Czech Republic, resistance to scab has been a reliable trait of these cultivars, and there have been no reports of new races of *Venturia inaequalis* that can overcome this resistance (Blažek et al., 2003).

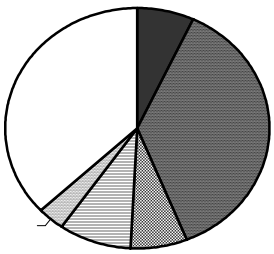

Figure 1. Response to scab in Czech apple cultivars

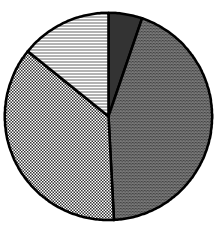

Figure 2. Response to mildew in Czech apple cultivars

None of the cultivars are resistant, and only eight were tolerant to powdery mildew, which is caused by *Podosphaera leucotricha* Ell. et Ev./Salm. (Fig. 2). Most cultivars are susceptible and require good chemical protection against powdery mildew.

None of the cultivars are resistant, and only four were tolerant to fire blight, which is caused by *Erwinia amylovora*. Three-quarters of the cultivars were susceptible or very susceptible (Fig. 3). When these cultivars were being selected and bred, fire blight was not yet known to occur in the Czech Republic.

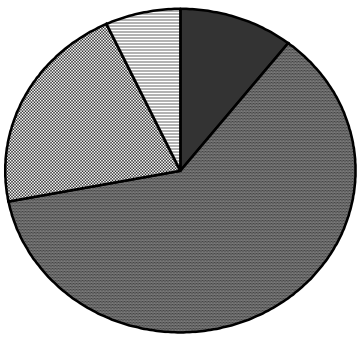

Figure 3. Response to fire blight in Czech apple cultivars

Developing cultivars resistant to both scab and powdery mildew is vitally important for organic fruit growing, where the use of synthetic fungicides is not allowed. As can be seen in Table 1, only seven of the fifty-seven cultivars listed in the State Variety Book are resistant to both scab and powdery mildew. Another nine are only slightly susceptible to either scab or powdery mildew, and might be acceptable for planting in organic orchards, because complete resistance both to scab and mildew is not necessary in all apple-growing regions in the Czech Republic.

Table 1. Resistance to scab versus resistance to powdery mildew in the fifty-seven apple cultivars listed in the Czech State Variety Book

Scoring of the response		Powdery mildew				
		very susceptible	susceptible	slightly susceptible	tolerant	total
Scab	very susceptible		1	3		4
	susceptible	2	9	10		21
	slightly susceptible	1	2		1	4
	tolerant		2	2	1	5
	field resistant			1	1	2
	resistant		11	5	5	21
	total	3	25	21	8	57

In regions with lower temperatures and higher rainfall, scab is a major problem, and powdery mildew is less important. Therefore, the cultivars grown in cold regions have to be resistant to scab to be grown without chemical protection. Cultivars which are slightly susceptible to powdery mildew can be safely grown without chemical protection. In colder regions of the country, apples ripen later and are easier to store. Early-ripening cultivars can also successfully be grown in colder regions.

In regions where temperatures are higher and rainfall is lower, powdery mildew is a major problem, and scab is less important. Therefore, the cultivars grown in warmer regions should be tolerant to powdery mildew to be grown without chemical protection. Cultivars which are slightly susceptible to scab can be safely grown without chemical protection. In warmer regions of the country, apples ripen earlier and are more difficult to store.

On the basis of resistance to scan and powdery mildew, seventeen cultivars are recommended for commercial growing in colder regions of the Czech Republic, and thirteen are recommended chosen for warmer regions (Tabs 2 and 3).

Among the cultivars recommended for colder regions are ‘Topaz’, ‘Rubinola’, ‘Julia’, ‘Melodie’, ‘Selena’, ‘Rajka’, and ‘Angold’ (Čepička et al., 2000).

‘Topaz’ is currently the most widely grown scab-resistant cultivar in the Czech Republic. It is very productive and bears high quality fruits. ‘Topaz’ is only slightly susceptible to powdery mildew, but very susceptible to fire blight, canker, and *Gloeosporium* rot, which may figure into to the choice of orchard site and orchard management techniques.

Table 2. Cultivars recommended for colder regions

Cultivar	Resistance to selected diseases				
	A – completely resistant		D – slightly susceptible		
	B – field resistant		E – susceptible		
	C – tolerant		F – very susceptible		
	scab	powdery mildew	canker	fire blight	*Gloeosporium* rot
'Angold'*	C	E	C	E	C
'Biogolden'	A	D	D	D	D
'Dolores'	A	E	D	D	E
'Julia'*	B	C	D	C	D
'Karmína'	A	C	D	D	D
'Klára'	C	D	D	D	D
'Melodie'*	A	E	E	D	D
'Nabella'	C	C	D	C	E
'Nela'	A	E	E	D	E
'Otava'	A	E	D	E	E
'Rajka'*	A	C	E	E	E
'Rubinola'*	A	C	C	E	D
'Rubinstep'	C	D	E	E	D
'Selena'*	A	D	D	C	D
'Topaz' *	A	D	E	F	E
'Viktoria'	A	C	D	E	D
'Zuzana'	C	E	D	D	D

*presently recommended for commercial orchards

'Rubinola' is probably the second most widely grown scab-resistant cultivar in the Czech Republic. Though it is also susceptible to fire blight, it is one of the few cultivars which are resistant to canker.

'Julia' is the only cultivar with broad tolerance to all the major apple diseases. The only reason that it is not more widely grown is that it is a summer variety. There is not a very big demand for summer apples on the Czech market.

'Melodie' was the first scab-resistant cultivar commercially grown in the Czech Republic. Unfortunately, there is not a very big demand for its very tart fruits on the Czech market. 'Melodie' is susceptible to powdery mildew when grown in warmer regions of the country.

Table 3. Cultivars recommended for warmer regions

Cultivar	Resistance to selected diseases				
	A – completely resistant		D – slightly susceptible		
	B – field resistant		E – susceptible		
	C – tolerant		F – very susceptible		
	scab	powdery mildew	canker	fire blight	*Gloeosporium* rot
'Biogolden'	A	D	D	D	D
'Durit'	A	D	D	D	E
'Goldstar'*	A	D	E	E	D
'Julia'*	B	C	D	C	D
'Karmína'	A	C	D	D	D
'Klára'	C	D	D	D	D
'Produkta'*	B	D	D	E	D
'Rajka'*	A	C	E	E	E
'Rubinola'*	A	C	C	E	D
'Rubinstep'	C	D	C	E	D
'Selena'*	A	D	D	C	E
'Svatava'*	A	D	D	E	E
'Viktoria'	A	C	D	E	D

*presently recommended for commercial orchards

'Selena' was scab resistant as well as somewhat tolerant to all the major apple diseases. It was by far the most tolerant to fire blight of all the cultivars tested (Fischer et al., 2004). Unfortunately, 'Selena' doesn't store well, and is considered by the apple industry to be an autumn variety.

'Rajka' was resistant to scab, only slightly susceptible to powdery mildew, but susceptible to the other major apple diseases, which may figure into to the choice of orchard site and orchard management techniques. 'Rajka' did not store very well, particularly in warmer areas of the country.

'Angold' was susceptible to both powdery mildew and fire blight, but moderately resistant to canker and storage diseases.

Among the cultivars recommended for warmer regions are 'Rubinola', 'Julia', 'Selena', and 'Rajka', as well as 'Goldstar', 'Produkta', and 'Svatava' (Čepička et al., 2000).

'Goldstar' is a scab resistant cultivar closely related to 'Topaz', but with better storage potential. It is susceptible to canker, fire blight, and bitter pit.

'Produkta' was somewhat tolerant to all the major diseases except fire blight. It needs to be grown in a warm region to have acceptable fruit quality.

'Svatava' was resistant to scab, but susceptible to fire blight and *Gloeosporium* rot. It also needs to be grown in a warm region to have acceptable fruit quality.

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WRAŻLIWOŚĆ NA CHOROBY NOWYCH ODMIAN JABŁONI WYHODOWANYCH W CZECHACH

Jan Blažek

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

Od 1977 roku wyhodowano w Czechach 57 odmian jabłoni, które zostały wpisane do Narodowej Księgi Odmian. Około połowy z nich jest odpornych lub tolerancyjnych na parcha jabłoni. W przypadku mączniaka jabłoni tylko 14% z nich było sklasyfikowanych jako tolerancyjne, ale żadna z tych odmian nie okazała się kompletnie odporna na tę chorobę. Z drugiej strony, prawie trzy czwarte z tych odmian zostało ocenionych jako wrażliwe lub bardzo wrażliwe na zarazę ogniową, jednakże tylko 7% z nich zakwalifikowano do grupy tolerancyjnych na tę chorobę. Tylko 7 odmian posiadających łączną odporność lub tolerancyjność na parcha i mączniaka jabłoni może być uprawianych beż żadnej ochrony chemicznej. Biorąc pod uwagę podatność na choroby oraz inne wymagania związane z warunkami klimatycznymi, 17 odmian odpornych lub tolerancyjnych na parcha jabłoni zostało wytypowanych do uprawy w chłodniejszych rejonach, a 13 z tych odmian wytypowano dla cieplejszych rejonów Czech. Ich krótka charakterystyka dotycząca wrażliwości czy też tolerancyjności na inne choroby została również przedstawiona w pracy.

Słowa kluczowe: jabłoń, odmiana, parch jabłoni, mączniak, zaraza ogniowa, odporność, hodowla, Republika Czeska