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

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RESISTANCE TO ABIOTIC AND BIOTIC STRESSORS IN SWEET CHERRY ROOTSTOCKS AND CULTIVARS FROM THE CZECH REPUBLIC

Jitka Blažková

Research and Breeding Institute of Pomology Holovousy Ltd.
Holovousy 1, 508 01 Hořice, CZECH REPUBLIC
e-mail: blazkova@vsuo.cz

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A B S T R A C T

At the Research and Breeding Institute of Pomology Holovousy, six sweet cherry rootstocks and twelve sweet cherry cultivars from the Czech Republic were evaluated in terms of their resistance to abiotic and biotic stressors.

The rootstocks evaluated were the seedling rootstocks P-TU-1, P-TU-2 and P-TU-3, and the dwarf clonal rootstocks P-HL-A, P-HL-B and P-HL-C. The clonal rootstock 'Colt' was used as the standard. Rootstocks were evaluated in terms of winter hardiness, drought resistance, and resistance to crown gall, soil fungi, leaf spot, and *Prunus* Necrotic Ring Spot Virus. P-TU-2 was the most winter hardy of the seedling rootstocks. P-TU-1 was the least winter hardy of the seedling rootstocks. P-HL-A was the most winter hardy of the dwarf clonal rootstocks, although it was susceptible to soil fungi. P-HL-C was the overall best of the dwarf clonal rootstocks.

The cultivars evaluated were 'Aranka', 'Büttnerova kompakt', 'Granát', 'Halka', 'Horka', 'Karešova', 'Kordia', 'Marta', 'Sylvana', 'Těchlovan', 'Vanda' and 'Vilma'. 'Büttners Rote Knorpel' was used as the standard. Cultivars were evaluated in terms of winter hardiness and resistance to fruit cracking, brown rot, leaf spot and the Prune Dwarf Virus. 'Aranka' and 'Vanda' were the most winter hardy of the cultivars tested. 'Sylvana' was the least susceptible to flower bud damage by winter and late spring frosts. 'Aranka' and 'Kordia' were the most resistant to fruit cracking and also the most resistant to brown rot. 'Karešova' was moderately resistant to leaf spot. All of the other cultivars were susceptible to leaf spot. 'Aranka' was also resistant to Prune Dwarf Virus. Of all of the cultivars tested, 'Aranka' is overall the most promising for organic cultivation.

Key words: sweet cherry, cultivar, winter hardiness, leaf spot, brown rot, fruit cracking, resistance, breeding, Czech Republic

INTRODUCTION

Over the last fifty years, six sweet cherry rootstocks and twelve sweet cherry cultivars have been developed in the Czech Republic (Anonymous, 2003). These rootstocks and cultivars have been described in earlier reports (Blažková, 1993ab; Blažková and Hlušičková, 2001, 2002 and 2003abcdef; Kloutvor and Paprštein, 1999; Dokoupil et al., 2002). Most of these rootstocks and cultivars were developed at the Research and Breeding Institute of Pomology Holovousy (Blažková, 1996).

Several factors affect the success of sweet cherry cultivation in the Czech Republic. Winter and spring frosts can damage flower buds and reduce yields by up to 40% in some years (Blažek and Paprštein, 1988). Fruit cracking can also damage the crop, especially in rainy seasons. Crop loss due to fruit cracking varies widely from year to year and from cultivar to cultivar, and can run as high as 91% (Paprštein, 1986). Brown rot, caused by the fungus *Monilia fructicola* G. Wint. Honey, can cause significant crop losses, even though it can usually be controlled with fungicides (Hluchý et al., 1997). Leaf spot, caused by the fungus *Blumeriella jaapii* Rehm. V. Arx., indirectly reduces yields by causing early leaf shedding, which reduces winter hardiness and flower bud development the following year (Syrovátko and Blažková, 1986). In Europe, sweet cherry cultivars susceptible to leaf spot need to be chemically protected (Pedersen and Loschenkohl, 1997). Trees heavily infected with crown gall, caused by *Agrobacterium tumefaciens*, grow poorly and unequally after planting in the orchard.

The choice of rootstock affects the general health, productivity, winter hardiness and resistance to drought, pests and diseases of the trees in a sweet cherry orchard (Hluchý et al., 1997).

The aim of this trial was to evaluate six Czech sweet cherry rootstocks in terms of winter hardiness, drought resistance, and resistance to crown gall, soil fungi, leaf spot, and *Prunus* Necrotic Ring Spot Virus, and to evaluate twelve Czech sweet cherry cultivars in terms of winter hardiness and resistance to fruit cracking, brown rot, leaf spot and the Prune Dwarf Virus.

MATERIAL AND METHODS

From 1975 to 2003, a series of trials on six sweet cherry rootstocks developed in the Czech Republic was conducted at the experimental nursery and a several experimental orchards belonging to the Research and Breeding Institute of Pomology at Holovousy. The clonal rootstock Colt was used as a standard.

A brief survey of the six rootstocks evaluated in this study is outlined in Table 1. The seedling rootstocks P-TU-1, P-TU-2 and P-TU-3 have been propagated in the Czech Republic since the 1970s. Unfortunately, there have not yet been any studies comparing them to the standard, introduced Mazzard rootstocks. On the other hand, the dwarf clonal rootstocks P-HL-A, P-HL-B and P-HL-C have been the subject of numerous trials in the Czech Republic and elsewhere (Wertheim, 1998; Kloutvor and Paprštein, 1999; Blažková and Hlušičková, 2001).

Table 1. Sweet cherry rootstocks of Czech origin

Rootstock	Method of propagation	Previous designation	Parentage	Breeder	Year of registration
P-TU-1	seedling	PT 4	selected mazzard	Breeding station Turnov	1971
P-TU-2	seedling	PT 10	selected mazzard	Breeding station Turnov	1971
P-TU-3	seedling	PT 3	selected mazzard	Breeding station Turnov	1971
P-HL-A	clonal	HL 84	selected mazzard o.p.	RBIP Holovousy	1986
P-HL-B	clonal	HL 224	selected mazzard o.p.	RBIP Holovousy	1992
P-HL-C	clonal	HL 6	selected mazzard o.p.	RBIP Holovousy	2000

At the same time, a series of trials on twelve sweet cherry cultivars developed in the Czech Republic was also conducted at Holovousy. The cultivars were first grown on their own root systems. In 1983, 1992, and 1996, trials were started with the cultivars grafted on P-TU-2 rootstock. 'Büttners Rote Knorpel' was used as the standard. All trials were conducted without the use of fungicides.

'Karešova' and 'Kordia' were the first sweet cherry cultivars developed in the Czech Republic. They have been grown for several decades, and are already well known all over the world. Some of the newer cultivars, such as 'Těchlovan' and 'Vanda', have been widely grown in the Czech Republic and some other European countries. Others, such as 'Aranka', 'Halka', 'Horka', 'Marta', 'Sylvana' and 'Vilma', are still in the process of being introduced (Tab. 2).

Every year, the number of dead trees was recorded. The levels of infection by diseases were recorded on a scale from 1 to 9, where 1 equals severe infection, and 9 equals no detectable infection. In 1981, 1986, 2002 and 2003, years with very cold winters or severe spring frosts, the amount of frost damage to vegetative and reproductive organs was also recorded. The amount of damage caused by fruit cracking was recorded in years in which it caused significant crop losses. In some years, a more careful estimation of flower, fruitlet and fruit damage was carried out on random samples.

Table 2. Sweet cherry cultivars of Czech origin

Cultivar	Previous designation	Parentage	Breeder	Year of registration
Aranka	HL ST 4/2	Early Rivers x Moreau	RBIP Holovousy	2001
Büttnerova kompakt	N 24/4-5	mutant of Büttners R. K.	RBIP Holovousy	1991
Granát	Plavečský Granát	Chance seedling	Private person	1973
Halka	HL ST 12/6	Van x Stella	RBIP Holovousy	2001
Horka	HL ST 15/237	Van o.p.	RBIP Holovousy	2001
Karešova	Karešova raná	Chance seedling	Private person	1954
Kordia	Těchlovická II	Chance seedling	RBIP Holovousy	1981
Marta	HL 26/27	Kordia x Early Rivers	RBIP Holovousy	2001
Sylvana	HL 8/39	Kordia x Van	RBIP Holovousy	2001
Těchlovan	HL 18/21	Kordia x Van	RBIP Holovousy	1991
Vanda	HL 18/27	Kordia x Van	RBIP Holovousy	1991
Vilma	HL 7/63	Kordia x Vic	RBIP Holovousy	2001

From 2000 to 2002, a special series of freezing tests was conducted to evaluate winter frost resistance of the clonal rootstocks (Blažková and Hlušičková, 2002).

In the growing seasons of 2001 and 2003, long periods of drought occurred at Holovousy that resulted in extreme soil dryness. Drought resistance of rootstocks was estimated from the physiological state and total performance of the trees grafted on them.

Trees were regularly tested for viruses using ELISA. The resistance of the rootstocks and cultivars to viruses was estimated from the proportion of trees newly infected by the viruses.

RESULTS AND DISCUSSION

Results of the evaluation of the different rootstocks are presented in Table 3.

The rootstocks evaluated varied in terms of winter hardiness, based on the amount of root damage in several severe winters. Of the seedling rootstocks, P-

TU-2 was the most winter hardy, and P-TU-1 was the least winter hardy. Because P-TU-3 was especially susceptible to virus infection, only P-TU-2 can be recommended for commercial use. Of the dwarf clonal rootstocks, P-HL-A was the most winter hardy, and P-HL-B was the least winter hardy. However, P-HL-B seems to be more winter hardy when used for grafting in the orchard than when ungrafted in the nursery.

Table 3. Response of Czech sweet cherry rootstocks to some abiotic and biotic stressors

Rootstock	Winter frosts	Mean score after freezing tests 2000-2002 (1-9)	Soil dryness	Crown gall	Dieback caused by some soil fungi	Leaf spot	Prunus necrotic ring spot virus
P-TU-1	su		to	mre	re	msu	
P-TU-2	re		to	mre	re	msu	
P-TU-3	msu		to	mre	re	msu	su
P-HL-A	re	7.7	su	su	su	msu	
P-HL-B	su	4.8	msu	mre	msu	vsu	
P-HL-C	msu	6.4	msu	mre	re	mre	
Colt (control)	su	4.9	msu	su	to	mre	

Note: msu = medium susceptible; mre = medim resistant;
re = resistant; su = susceptible; to = tolerant; vsu = very susceptible

The rootstocks varied in terms of drought resistance, based on fruit size and new shoot growth in dry years. All of the seedling rootstocks were drought tolerant. Of the clonal rootstocks, P-HL-B and P-HL-C were moderately susceptible, and P-HL-A was susceptible to drought.

All of the seedling rootstocks were moderately resistant to crown gall. Of the clonal rootstocks, P-HL-B and P-HL-C are moderately resistant, and P-HL-A is susceptible.

All of the seedling rootstocks were resistant to die-back caused by soil fungi. Of the clonal rootstocks, P-HL-C was resistant, P-HL-B was moderately susceptible, and P-HL-A was susceptible. *Fusarium* sp. and *Cylindrocarpon destructans* were isolated from the dead trees, and are presumed to be the main causative agents of die-back. The occurrence of die-back was was sporadic. Some orchards were affected within a few years after planting, and other orchards remained unaffected for up to twenty-five years.

All of the seedling rootstocks were moderately susceptible to leaf spot. Of the clonal rootstocks, P-HL-C was moderately resistant, P-HL-A was moderately susceptible, and P-HL-B was very susceptible. Leaf spot is rarely a problem in the nursery, though, because it can be easily controlled with fungicides.

Results of the evaluation of the the different cultivars are presented in Table 4.

The most winter hardy cultivars were ‘Aranka’ and ‘Vanda’, and the least winter hardy cultivar was ‘Horka’.

The cultivars most resistant to flower bud damage by winter and spring frosts were ‘Sylvana’ and ‘Bütnerova kompakt’. The cultivars least resistant to flower bud damage by winter and spring frosts were ‘Marta’, ‘Horka’ and ‘Kordia’.

The cultivars most resistant to fruit cracking were ‘Aranka’ and ‘Kordia’. The cultivars least resistant to fruit cracking were ‘Marta’ and ‘Horka’.

The cultivars most resistant to brown rot were ‘Aranka’ and ‘Kordia’. The cultivars least resistant to brown rot are ‘Büttnerova kompakt’, ‘Horka’ and ‘Vilma’.

The only cultivar which is at all resistant to leaf spot is ‘Karešova’. All the other cultivars were susceptible, and need to be chemically protected in the orchard.

‘Aranka’ is resistant to Prune Dwarf Virus, and ‘Marta’ is susceptible to Prune Dwarf Virus.

Table 4. Response of Czech sweet cherry cultivars to some abiotic and biotic stressors

Cultivar	Winter frosts	Fruit bud injury by frosts	Mean share of damaged flowers [%]	Fruit cracking	Mean share of cracked fruit [%]	Brown rot	Leaf spot	Mean score of leaf spot (1-9)	Prune dwarf virus
Aranka	re*	mre	23	re	7	re	msu	5.9	re
Büttnerova kompakt	msu	re	19	vsu	51	vsu	msu	6.4	
Granát	msu	msu	48	mre	20	msu	su	4.5	
Halka	msu	mre	29	su	48	msu	su	4.3	
Horka	su	su	69	vsu	59	vsu	su	4.0	msu
Karešova	msu	mre	30	msu	35	msu	mre	7.8	
Kordia	msu	su	65	re	9	re	su	4.1	
Marta	msu	su	84	vsu	62	mre	msu	6.3	su
Sylvana	msu	re	10	su	53	su	msu	6.5	msu
Těchlovan	msu	msu	44	su	45	su	msu	5.4	
Vanda	re	mre	25	mru	16	msu	msu	5.4	
Vilma	msu	msu	53	msu	40	vsu	msu	6.5	msu
Büttners Rote Knorpel (Contro)	re	mre	15	vsu	77	vsu	msu	6.0	

* For explanatons, see Table 3

CONCLUSIONS

Based on this study of sweet cherry rootstocks and cultivars developed in the Czech Republic, the following recommendations can be made:

1. P-TU-2 is the best overall seedling rootstock for commercial production.
2. P-HL-C is the best overall clonal rootstock for commercial production.
3. P-HL-A is the most winter hardy clonal rootstock, but it needs to be monitored for and protected against soil fungi before being planted into the orchard and irrigated.
4. The new sweet cherry cultivar 'Aranka' seems to be the best for organic cultivation.
5. 'Vanda' seems to be the most reliable and the most resistant to diseases when grown in the Czech Republic.
6. 'Kordia' is highly resistant to fruit cracking and brown rot, but needs to be planted in an area protected from frosts, and needs to be treated to protect against leaf spot.
7. All the other cultivars either need to be planted in in an area protected from frosts, or need to be chemically treated to protect against diseases.

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WRAŻLIWOŚĆ LUB ODPORNOŚĆ NA CHOROBY I NIEKORZYSTNE WARUNKI ŚRODOWISKA ODMIAN I PODKŁADEK CZEREŚNI Z CZECH

Jitka Blažková

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

W pracy przedstawiono wyniki kilku doświadczeń przeprowadzonych w Holovousach z odmianami i podkładkami czereśni wyhodowanymi w Czechach. Spośród badanych podkładek generatywnych P-TU-2 wyróżniła się dużą wytrzymałością na mróz, natomiast P-TU-1 – była mało wytrzymała na mróz. P-HL-A okazała się najbardziej wytrzymała na mróz wśród wegetatywnych podkładek karłowych dla czereśni. Jednak część drzew na niej szczepionych zamierała z powodu zainfekowania systemu korzeniowego przez patogenny glebowe. Podkładka P-HL-C była pełna wigoru.

Warunki zimowych mrozów najlepiej znosiły drzewa odmian ‘Aranka’ i‘Vanda’, natomiast czereśnie odmiany ‘Sylvana’ były najmniej wrażliwe na uszkodzenia pąków kwiatowych zarówno w okresie zimy, jak i podczas przymrozków wiosennych. Pod względem podatności na pękanie owoce czereśni odmiany ‘Aranka’ były podobne do odmiany ‘Kordia’, uważanej za jedną z najbardziej odpornych na pękanie owoców w czasie deszczu. Drzewa odmian ‘Aranka’ i ‘Kordia’ okazały się całkowicie odporne na brunatną zgniliznę drzew pestkowych. Tylko odmiana ‘Karešova’ była częściowo tolerancyjna. Na podstawie przeprowadzonych badań wydaje się, że odmiana ‘Aranka’ jest najbardziej odpowiednia do uprawy ekologicznej.

Słowa kluczowe: czereśnia, odmiana, wytrzymałość na mróz, plamistość liści, brunatna zgnilizna, pękanie owoców, odporność, hodowla, Czechy