

GROWTH AND YIELDING IN SIX SCAB-RESISTANT APPLE CULTIVARS GRAFTED ON THREE DWARFING ROOTSTOCKS IN INTEGRATED FRUIT PRODUCTION

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(Received September 26, 2005/Accepted November 9, 2005)

A B S T R A C T

During three years (2002-2004) 6 apple cultivars resistant or partially resistant to apple scab: 'Bohemia', 'Topaz', 'Rubinola', 'Goldstar', 'Pinova' and 'Redkroft' grafted on 3 dwarfing rootstocks: M.9, P 22 and P 60 were tested at the Experimental Orchard at Dąbrowice with integrated fruit production. The susceptibility to scab and powdery mildew as well as growth, yielding and fruit quality were observed. All cultivars grafted on P 60 rootstocks formed the largest trees whereas on P 22 the smallest. Cropping efficiency index was the highest for 'Pinova', 'Topaz', 'Bohemia' and 'Rubinola' on P 22. The cultivars: 'Goldstar' and 'Redkroft' had the highest cropping efficiency on M.9. In the third year after planting (2004) effect of rootstocks on quality of fruits was minimal and not significant. Primary observations show that cultivars having small fruits: 'Pinova' and 'Goldstar' should be not recommended to grow on light soil in integrated fruit production. In the first three years after planting very little infection of apple scab was observed on 'Bohemia' and 'Pinova' cultivars. Apple mildew was controlled by cutting infected shoots.

Key words: apple, scab resistant cultivars, rootstock, integrated fruit production

INTRODUCTION

When growing apples in accordance with the guidelines of Integrated Fruit Production, the cultivars chosen for planting should be

resistant to apple scab (Czynczyk, 1996; Czynczyk et al., 2004; Krućczyńska, 1999). Planting scab-resistant cultivars minimalizes environmental damage by reducing the need for chemical spraying (Niem-

czyk, 2000; Kühn et al., 2003; Sansavini, 2004; Godec, 2004). The number of scab-resistant cultivars currently available is still limited. Nonetheless, some of these cultivars have generated interest among apple growers in Poland. Among them are 'Rubinola', 'Topaz', 'Early Freegold' and 'Redkroft', which are scab-resistant, and 'Bohemia' and 'Pinova', which are partially scab resistant (Kruczyńska et al., 2000; Szklarz, 2004; Czynczyk et al., 2004).

The aim of this study was to select the best dwarfing rootstock for use with scab resistant cultivars in integrated apple orchards planted on light soils

MATERIAL AND METHODS

In the spring of 2002, two-year-old scab-resistant or partially scab-resistant apple cultivars with one-year-old crowns grafted on dwarfing rootstocks were planted in a podsolic soil overlaying heavy clay in the Experimental Orchard at Dąbrowice, near Skierniewice in central Poland. Six cultivars were chosen for the study: 'Bohemia', 'Rubinola', 'Topaz', 'Goldstar', 'Pinova', and 'Redkroft'. Three dwarfing rootstocks were evaluated: M.9, P 22 and P 60. M.9 is commonly used in Poland and Western Europe, and served as the standard.

The trial was set up in a randomized block design with four replicates of three trees per plot. Trees on M.9 were planted 3.40 x 1.25 meters apart, trees on P 22 were planted 3.40

x 0.80 meters apart, and trees on P 60 were planted 3.40 x 1.45 meters apart.

All trees were trained as slender spindles. Fertilization, soil management and pest control were carried out in accordance with the Integrated Fruit Production guidelines. Infection of apple scab were noted using scale recommended by Borecki and Mrozowska (1961). Mildew was controlled by cutting away infected shoots in early spring and during the vegetative period. All trees were drip irrigated from the time of planting.

Every year, tree trunk diameter was measured 30 cm above ground level and converted to trunk cross-sectional area. Yield and fruit quality parameters were also recorded for each year.

Data were statistically elaborated using bifactorial analysis of variance, followed by Duncan's multiple range t-test at $P=0.05$.

RESULTS AND DISCUSSION

In the course of the three-year observation period, only four trees were lost due to trunk infection by apple canker: two of 'Topaz' on M.9, one of 'Goldstar' on P 22, and one of 'Rubinola' on P 22. This rate of tree loss (1.85%) was much lower than in an earlier experiment with standard cultivars grown on the same dwarfing rootstocks (Czynczyk et al., 1999).

Of the rootstocks tested, P 22 was the most dwarfing and P 60 was the least dwarfing. On P 22, 'Bohemia', 'Rubinola' and 'Goldstar' grew sig-

nificantly smaller than on M.9. On P 60, 'Topaz', 'Goldstar', 'Pinova', and 'Redkroft' grew significantly larger than on M.9 (Tab. 1). This compares well with previously reported data (Czynczyk et al., 2004).

The highest cumulative yields for the three-year study period were observed in 'Pinova' on P 60 and 'Topaz' on P 22. The lowest cumulative yields were seen in 'Bohemia', 'Rubinola', and 'Topaz' grafted on P 60. 'Bohemia' and 'Topaz' had significantly higher cumulative yields when grafted on P 22 than when grafted on M.9. Scab-resistant cultivars grafted on M.9 yielded early, which agrees with previously reported data (Czynczyk et al., 2004).

The cropping efficiency coefficient was calculated by dividing the three year cumulative yield by the trunk cross-sectional area. 'Bohemia', 'Rubinola', 'Topaz' and 'Pinova' had higher cropping efficiency coefficients when grafted on P 22 than on the other rootstocks. 'Goldstar' and 'Redkroft' had higher cropping efficiency coefficients when grafted on M.9 than on the other rootstocks.

In this study, the scab-resistant cultivars yielded early, which agrees well with previous reports (Kruczyńska et al., 2000; Jönsson and Tahir, 2004; Szklarz, 2004).

The choice of rootstock had only a minimal effect on fruit weight. Only 'Pinova' on P 22 and 'Bohemia' had significantly smaller fruits when grafted on P 60 than when grafted on M.9. The choice of rootstock also had only a minimal effect on the percentage of fruits greater than 7 cm in diameter.

Only 'Pinova' had significantly fewer fruits greater than 7 cm in diameter when grafted on P 22 than when grafted on M.9. The choice of rootstock also had only a minimal effect on the percentage of fruits with more than 50% of their surface covered by red blushing. Only 'Goldstar' and 'Pinova' had significantly less blushing when grafted on P 22 and P 60 than when grafted on M.9 (Tab. 1).

'Goldstar' and 'Pinova' were the cultivars with the smallest fruits of the cultivars tested, and therefore cannot be recommended for orchards established on light podsolic soils.

During the three year observation period, apple scab caused only negligible damage to the fruits and leaves of 'Bohemia' and 'Pinova'. Mildew was easily controlled by cutting off infected shoots.

Even though this trial lasted only three growing seasons and any conclusions drawn from should be treated as preliminary, our results give some early indications of which combinations of scab-resistant apple cultivars and dwarfing rootstocks are best suited for Integrated Fruit Production.

'Rubinola', 'Bohemia', 'Topaz' and 'Redkroft' can be recommended for planting in integrated orchards. This agrees well with earlier studies (Jönsson and Tahir, 2004; Sansavini, 2004; Czynczyk et al., 2004). Vigorously growing cultivars like 'Rubinola', 'Bohemia', and 'Topaz' should be grafted on P 22, the most dwarfing rootstock, to ensure early yielding.

Table 1. Trunk cross-sectional area (TCSA), three year cumulative yield, cropping efficiency coefficient (CEC) and fruit quality parameters in six scab-resistant apple cultivars grafted on three dwarfing rootstocks

Cultivar	Root-stock	TCSA [cm ²]	Cumulative yield per tree (2002-04)	CEC [kg cm ⁻²]	Mass of 100 fruits [kg]	Percentage of fruits >7 cm in diameter	Percentage of fruits with >50% of surface blushing
Bohemia	M.9	13.7 g-i	2.7 a	0.28 a	24.8 g	96.8 e	100.0 d
	P 22	9.5 b-e	7.0 b-d	0.82 c-e	23.8 g	94.8 de	99.8 d
	P 60	14.7 hi	1.9 a	0.15 a	20.3 f	75.3 c-e	100.0 d
Rubinola	M.9	14.0 g-i	4.8 ab	0.36 ab	19.0 d-f	98.0 e	100.0 d
	P 22	10.5 d-f	7.2 b-d	0.84 c-e	19.0 d-f	88.8 c-e	100.0 d
	P 60	16.2 i	2.5 a	0.18 a	19.8 d-f	99.3 e	100.0 d
Topaz	M.9	9.5 b-e	10.0 de	1.07 d-g	16.3 b-e	86.9 c-e	96.2 d
	P 22	10.8 ef	13.5 f	1.29 fg	14.3 bc	86.1 c-e	93.1 d
	P 60	12.7 f-h	7.8 b-d	0.66 bc	16.8 c-f	90.7 c-e	98.7 d
Goldstar	M.9	5.2 a	5.9 b	1.21 e-g	16.0 b-d	70.1 cd	14.5 b
	P 22	8.1 b-d	7.4 b-d	0.97 c-f	14.5 bc	67.3 bc	2.7 a
	P 60	11.9 e-g	7.8 b-d	0.69 b-d	16.3 b-e	83.7 c-e	6.0 a
Pinova	M.9	9.8 c-e	12.3 ef	1.30 fg	13.5 bc	47.3 b	90.7 d
	P 22	7.5 a-c	12.5 ef	1.71 h	9.8 a	20.2 a	69.8 c
	P 60	13.5 gh	14.9 f	1.12 e-g	12.5 ab	45.3 b	73.4 c
Redkroft	M.9	7.0 ab	10.2 de	1.45 gh	14.0 bc	86.0 c-e	100.0 d
	P 22	7.5 a-c	6.6 bc	0.94 c-f	15.5 b-d	94.1 de	100.0 d
	P 60	10.1 c-f	9.8 c-e	0.97 c-f	15.8 b-d	86.2 c-e	100.0 d

Means followed by the same letter do not differ significantly according to Duncan's multiple range t-test at P=0.05

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WPLYW TRZECH SŁABO ROSNĄCYCH PODKŁADEK: M.9, P 22 i P 60 NA WZROST I OWOCOWANIE SZEŚCIU PARCHOODPORNÝCH ODMIAN JABŁONI W SADZIE Z INTEGROWANĄ PRODUKCJĄ OWOCÓW

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

Jabłonie odporne lub częściowo odporne na parcha jabłoni ('Bohemia', 'Topaz', 'Rubinola', 'Goldstar', 'Pinova' i 'Redkroft') szczepione na podkładkach: M.9, P 22, P 60 posadzono wiosną 2002 roku w sadzie z produkcją integrowaną w Dąbrowicach w celu porównania podkładek i odmian. Po trzech latach badań (2002-2004) stwierdzono najsilniejszy wzrost drzew na podkładce P 60, a najsłabszy na P 22. Drzewa na M.9 miały wzrost pośredni w stosunku do pozostałych podkładek. Najobficiej owocowały drzewa na P 22 i miały najwyższy wskaźnik plenności. Podkładki nie miały wpływu na jakość owoców. Odmiany drobnoowocowe 'Pinova' i 'Goldstar' miały owoce zbyt drobne i nie powinny być sadzone na glebach lżejszych. Porażenie drzew odmian 'Bohemia' i 'Pinova' przez parcha jabłoni było znikome. Mączniak był skutecznie zwalczany przez wycinanie pędów porażonych.

Słowa kluczowe: jabłka, parchoodporne odmiany jabłoni, integrowana produkcja owoców