PRODUCTIVE VALUE OF SEVEN APPLE CULTIVARS WITH DIFFERENT SUSCEPTIBILITY TO APPLE SCAB (*Venturia inaequalis* Che.)

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A B S T R A C T

One-year-old trees without feathers of seven apple cultivars with different susceptibility to scab on M.26 rootstock, were planted in the spring 1998 in Przybroda near Poznań. Six cultivars were genetically resistant to scab: 'Goldstar', 'Topaz', 'Rajka', 'Rubinola', 'Rosana' and 'Odra' whereas 'Šampion' was low susceptible to the disease. Trees were spaced 4.0 x 1.5 m (1667 trees ha^{-1}). There was no chemical protection against apple scab. Cultivation of 'Goldstar', 'Topaz', 'Rajka', 'Rubinola', 'Rosana' and 'Odra' was possible without chemical protection against scab while fruit and leaves of 'Šampion' without scab protection were totally infected. The most vigorous cultivars were 'Rajka', 'Rubinola' and 'Topaz', and the least were 'Šampion' and 'Odra'. The highest total fruit yield was obtained from 'Rajka', 'Goldstar', 'Rosana' and 'Topaz' and the lowest from 'Šampion'. 'Goldstar' had the heaviest fruit and 'Odra' the lightest. The biggest fruit had 'Goldstar' and the smallest had 'Rajka'. The best coloured were 'Odra' fruit and the worst coloured were fruit of 'Goldstar'.

Key words: apple, cultivar, growth, yielding, scab resistance

INTRODUCTION

One of the major problems in apple cultivation is apple scab disease caused by fungus *Venturia inaequalis* (Mac Hardy, 1996). The main goal of breeders is to obtain cultivars with good productive value and scab resistance (Krüger, 1989; Kellerhals, 1994; Sansavini et al., 2004). In some countries, including Poland, breeding programs are carried for many years to obtain new scab-resistant apple cultivars (Rouselle et

al., 1974; Pitera, 1992, Meszka and Masny, 2006). Till now many genetically scab resistant apple cultivars were bred, but it should be objecttively said that most of them didn't meet growers' and consumers' expectations because of low yielding and low fruit quality, especially taste. The new scab-resistant cultivars were well estimated recently in public sensory evaluations (Paprštein et al., 2006). There are also apple cultivars highly tolerant, but not genetically resistant (Blažek, 2004). The cultivation of these cultivars with low susceptibility to scab is possible with reduced protection programme and in some years with no chemical protection at all.

The aim of experiment presented was to estimate growth, yielding, fruit quality and susceptibility to apple scab of seven apple cultivars with different levels of scab resistance, grown without protection against apple scab in Wielkopolska region (western Poland).

MATERIAL AND METHODS

The experiment was conducted in the orchard of Experimental Station at Przybroda, belonging to Pomology Department of Poznań University of Life Sciences. One-year-old trees without feathers of seven apple cultivars with different susceptibility to scab on M.26 rootstock were planted in the spring of 1998. Six cultivars tested were genetically resistant to scab: 'Goldstar', 'Topaz', 'Rajka', 'Rubinola', 'Rosana' and 'Odra' whereas 'Šampion' was a cultivar with low susceptibility to this disease. The trial was established on heavy brown podzolic soil developed from post-glacial clay of IIIa class. Trees were spaced in rows at 1.5 m, whereas a distance between rows was 4.0 m (1667 trees ha^{-1}). Apple tree canopies were formed as a spindle. Agronomical practices followed commercial guidelines; chemical protection was carried out according to the current recommendations of Orchard Protection Programme, but there was no chemical protection against scab. Each combination consisted of 12 trees; each planted in 4 replications with 3 trees per a plot.

In accordance with the method proposed by the Centre for Cultivar Testing in Słupia Wielka, the level of infection by apple scab was recorded on a scale from 1 to 9, where 1 equals heavy infection and 9 equals minimal infection (Tab. 1).

Following measurements were taken: trunk cross-sectional area (TCSA) (cm^2), yield per tree (kg), fruit weight (g), fruits having > 7.0 cm in diameter (%), fruits having > ½ surface red (%). Using these parameters calculated were: total fruit yield (kg/tree), total fruit yield (t/ha) productivity index of total yield (kg cm^{-2} TCSA).

The results were statistically elaborated by an analysis of variance. The significance of differences between means was evaluated by Duncan's multiple range t-test at $p = 0.05$. Data expressed as percentages were transformed by the method of Bliss.

Table 1. Scale for evaluating infection of fruit and leaves by apple scab

Grade	Scab infection	
	fruits [%]	leaves [%]
1	30.0 and more	75.0 and more
3	15.0 to 29.9	35.0 to 74.9
5	7.5 to 14.9	12.0 to 34.9
7	3.0 to 7.4	3.0 to 11.9
9	0.5 to 2.9	0.5 to 2.9

RESULTS AND DISCUSSION

In 2007 there were no scab symptoms on apples and leaves of cultivars: 'Goldstar', 'Topaz', 'Rajka', 'Rubinola', 'Rosana' and 'Odra'. Therefore cultivation of these six cultivars was possible without scab protection. However, heavy scab infection symptoms were observed on fruits and leaves of cultivar 'Šampion'; thus cultivation of this cultivar without scab protection is non advisable (Tab. 2).

Vegetative growth measured by final trunk cross-sectional area varied and depended on a cultivar (Szklarz, 2004). The most vigorous cultivars after 10 years from planting were 'Rajka', 'Rubinola' and 'Topaz'. Significantly smallest TCSA had 'Šampion' (Tab. 3).

Cropping started in the third year after planting with only single fruits but in next years yielding increased. The highest cumulative fruit yield for the period 2000-2007 was obtained for 'Rajka' (118.8 kg tree^{-1}; 198.0 t/ha). According to Kruczyńska (1998; 2002) 'Rajka' is a very good yielding cultivar. The lowest yields were obtained from 'Šampion' (Tab. 3, 4).

Rejman (1994) maintained that cultivar's productivity depends not only on a genetic set up but also on cultivation site specificity and agronomic treatments. The productivity index, expressed as total yield in kg per cm^2 of TCSA, was the highest for cultivars 'Goldstar' (3.0 kg cm^{-2}) and 'Rosana' (2.8 kg cm^{-2}). In Czynczyk's et al. (2005) experiment, 'Goldstar' was also a cultivar with high productivity index. Productivity index was the lowest for 'Rubinola', 'Rajka' and 'Topaz' (Tab. 3).

The weight of fruit varied significantly for cultivars. 'Goldstar' had the heaviest fruits – 181.7 g. The lightest apples had 'Odra' (142.9 g). The biggest fruit had 'Goldstar' (97.7%), and the smallest had 'Rajka' (62.3%). The best coloured fruit had 'Odra' (100.0%), which agrees with earlier reports (Szklarz, 2004 and 2006), and the worst coloured had 'Goldstar' (5.1%) (Tab. 5).

Table 2. Scab occurrence on fruits of apple cultivars

Cultivar	Scab occurrence 2007 [1-9* scale]	
	fruits	Leaves
Goldstar	9	9
Rajka	9	9
Rosana	9	9
Odra	9	9
Topaz	9	9
Rubinola	9	9
Šampion	1	1

*scale from 1 to 9, where 1 equals heavy infection, and 9 equals minimal infection (Table 1)

Table 3. Vigour, yield and productivity of apple cultivars

Cultivar	TCSA autumn 2007 [cm^2]	Cumulative yield 2000-2007 [kg $tree^{-1}$]	Productivity index of cumulative yield 2000-2007 [kg cm^{-2}]
Goldstar	36.0 bc*	105.9 cd	2.9 b
Topaz	47.3 cd	103.4 cd	2.2 a
Rajka	58.3 d	118.8 d	2.0 a
Rubinola	51.7 d	88.9 bc	1.7 a
Rosana	36.5 bc	104.0 cd	2.8 b
Odra	32.3 ab	75.1 b	2.4 ab
Šampion	22.4 a	50.6 a	2.3 ab

*Means followed by the same letter do not differ significantly at p = 0.05 level according to Duncan's multiple range test. Analysis of variance was made separately for each variable

Table 5. Fruit quality of apple cultivars tested

Cultivar	Fruit weight 2000-2007 average [g]	Fruit having > 7.0 cm in diameter, 2007 [%]	Fruit having > ½ surface red, 2007 [%]
Goldstar	181.7 c*	97.7 d	5.1 a
Topaz	170.3 bc	94.6 cd	94.3 bc
Rajka	168.3 bc	62.3 a	92.3 b
Rubinola	164.1 b	87.3 bcd	94.9 bc
Rosana	173.4 bc	91.3 cd	93.6 b
Odra	142.9 a	66.9 ab	100.0 d
Šampion	173.7 bc	77.5 abc	99.8 cd

*Explanations, see Table 3

CONCLUSIONS

1. Cultivation of 'Goldstar', 'Topaz', 'Rajka', 'Rubinola', 'Rosana' and 'Odra' was possible without chemical protection against scab whereas fruit and leaves of 'Šampion' were totally infected with no scab protection.
2. The most vigorous cultivars were 'Rajka', 'Rubinola' and 'Topaz', and the least vigorous were 'Šampion' and 'Odra'.
3. The highest total fruit yield was obtained from 'Rajka', 'Goldstar', 'Rosana' and 'Topaz', and the lowest yield had 'Šampion'.
4. 'Goldstar' had the heaviest fruit and 'Odra' the lightest.
5. The biggest fruit had 'Goldstar', and the smallest had 'Rajka'.
6. The best coloured fruit had 'Odra', and the worst coloured had 'Goldstar'.
7. 'Goldstar', 'Topaz', 'Rubinola' and 'Rosana' are most suitable for fruit production in modern orchards.

Table 4. Yielding of apple cultivars

Cultivar	Fruit yield [kg tree^{-1}]								Cumulative yield 2000-2007 [t ha^{-1}]
	2000	2001	2002	2003	2004	2005	2006	2007	
Goldstar	2.7 bc*	3.7 a	14.5 bcd	19.0 c	8.4 a	23.3 bc	19.7 c	14.6 ab	176.5 cd
Topaz	3.4 c	2.7 a	16.2 cde	20.7 c	6.5 a	29.1 c	15.7 bc	9.1 ab	172.4 cd
Rajka	3.1 c	0.8 a	20.1 e	7.8 a	27.9 c	23.7 bc	32.9 d	2.5 a	198.0 d
Rubinola	1.4 ab	2.2 a	17.6 de	9.5 ab	6.1 a	21.8 abc	21.0 c	9.3 ab	148.2 bc
Rosana	2.7 bc	3.3 a	12.9 bc	17.1 bc	9.6 a	18.6 ab	18.4 c	21.4 b	173.4 cd
Odra	2.4 abc	2.1 a	12.1 b	6.3 a	18.7 b	15.1 a	9.6 b	11.2 ab	125.2 b
Šampion	1.2 a	0.8 a	1.4 a	10.6 ab	4.0 a	14.1 a	2.4 a	16.1 b	84.4 a

*Means followed by the same letter do not differ significantly at p = 0.05 level. Analysis of variance was made separately for each year of yielding, Duncan's multiply range test

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WARTOŚĆ PRODUKCYJNA ODMIAN JABŁONI O RÓŻNEJ WRAŻLIWOŚCI NA PARCHA JABŁONI (*Venturia inaequalis* Che.)

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

Jednoroczne okulanty siedmiu odmian jabłoni o różnej wrażliwości na parcha jabłoni zaokulizowane na podkładce M.26 posadzono wiosną 1998 w Przybrodzie pod Poznaniem. Sześć odmian było genetycznie odpornych na parcha: 'Goldstar', 'Topaz', 'Rajka', 'Rubinola', 'Rosana' i 'Odra', a 'Šampion' to odmiana mało podatna na tę chorobę. Dla drzew zastosowano rozstawę 4.0 x 1.5 m (1667 drzew ha^{-1}). Pominięto ochronę chemiczną przeciwko parchowi jabłoni. Uprawa odmian: 'Goldstar', 'Topaz', 'Rajka', 'Rubinola', 'Rosana' i 'Odra' była możliwa bez chemicznej ochrony przeciwko parchowi, natomiast owoce i liście odmiany 'Šampion' były w takich warunkach całkowicie porażone przez tę chorobę. Najsilniej rosnącymi odmianami okazały się 'Rajka', 'Rubinola' i 'Topaz', a najsłabiej rosnącą 'Šampion'. Najwyższy sumaryczny plon jabłek uzyskano z drzew odmian 'Rajka', 'Goldstar', 'Rosana' i 'Topaz', a najmniejszy z odmiany 'Šampion'. Najcięższe owoce miała odmiana 'Goldstar', a najlżejsze 'Odra'. Największe jabłka stwierdzono u odmiany 'Goldstar', a najmniejsze u 'Rajki'. Najlepiej wybarwione jabłka miała odmiana 'Odra', a najgorzej 'Goldstar'.

Słowa kluczowe: jabłoń, odmiana, wzrost, plonowanie, odporność na parcha