GROWTH AND INITIAL BEARING OF SCAB RESISTANT APPLE CULTIVARS UNDER CONDITIONS OF LIMITED FUNGICIDE USE

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Abstract

Growth, yield and fruit quality of seven apple cultivars resistant (V_f) to scab (*Venturia inaequalis*) on M.9 rootstock was evaluated in 2001–2004. Considering the cumulative two-year yield, three groups of cultivars were separated. ‘Selena’ was the most productive, ‘Sawa’, ‘Rajka’, ‘Topaz’, ‘Resista’ and ‘Wars’ were high yielding and ‘Rubinola’ gave moderate yield. ‘Sawa’ fruits were the largest and ‘Topaz’ the smallest. Fruits of all cultivars were covered with an intense surface red or orange red blush. Three chemical treatments per year, on average, were necessary for control of pests and only one or two against powdery mildew (*Podosphaera leucotricha*). During all study years no symptoms of scab and only sporadic symptoms of mildew have been observed.

Key words: apple cultivars, scab resistance, tree vigour, productivity, fruit quality

Introduction

Integrated and ecological (organic) apple production are becoming increasingly important (Fisher and Fisher 2004). In Switzerland 94% of apple acreage is managed according to integrated production, and 5% according to organic guidelines. Conventional production is practically over there (Bertschinger et al. 2004). Main factor limiting faster development of ecological apple production is the problem of disease control. Standard commercial cultivars can be widely grown in integrated fruit production. However, control methods, especially those against apple scab (*Venturia inaequalis*) employed in organic production are not effective enough, when susceptible cultivars are grown (Holb 2000). Holb et al. (2003) also showed that numerous lime sulphur treatments used against the disease, which have been
approved in organic apple production, exerted high phytotoxicity, reducing leaf size and showing a tendency to deteriorating fruit quality. An alternative solution is presented by resistant cultivars, which can be grown with considerably reduced pesticide use. However, scab resistant cultivars have some undesirable fruit quality parameters, which can delay their wide use. The aim of this study was a preliminary evaluation of five Czech and two Polish scab resistant cultivars and one scab resistant selection; some of them, like ‘Rubinola’ and particularly ‘Topaz’ have already gained consumer acceptance in Europe (Blažek 1996, Kühn and Thybo 2001, Kellerhals and Rapillard 2002, Czynczyk et al. 2004).

**Materials and methods**

In spring 2001 the experiment was established in the Warsaw-Wilanów Experimental Orchard of the Warsaw Agricultural University (WAU), at 505 mm average annual rainfall, on a fertile silty loam alluvial soil, rich in humus (ca 2–2.5%) and poor in potassium. The scab resistant (Vf) cultivars examined were: ‘Rajka’, ‘Resista’, ‘Selena’, ‘Rubinola’ and ‘Topaz’ of Czech origin, ‘Sawa’, ‘Wars’ (‘Fantazja’ × ‘Primula’) and a selection U 5656 (‘Šampion’ open pollinated), bred at the Department of Pomology WAU. ‘Sawa’ was used as a reference cultivar, because in earlier trials it has showed good fruit quality (Pitera 2000, Sosna 2001). The experiment was carried out in a randomized block design, in four replications, with three trees per plot. The trees on M.9 rootstocks were spaced at 3.5 × 1.5 m. Herbicide strips were maintained along tree rows and frequently mown sward in alleyways. Trees were trained as standard spindle. Three chemical insecticide treatments per year, on average, were necessary for control of the following pests: aphids using pirymikarb (Pirimor) or triazamat (Aztec), apple sawfly (Hoplacampa testudinea) using tiachlopryd (Calypso) and codling moth (Laspeyresia pomonella) using diflubenzuron (Dimilin). One or two fungicide treatments per year were applied only against powdery mildew (Podosphaera leucotricha) using bupirymat (Nimrod) at the beginning of blossom period or/and after petal fall. Chemical and hand thinning of fruitlets was applied.

Tree growth was estimated by the trunk cross-sectional area (TCSA), based on diameter measurements at 30 cm above the ground. The yield as a total for all trees per plot was recorded. Yield efficiency index was calculated as a ratio of two-year cumulative initial yield for the years 2003, 2004 to the TCSA in autumn 2004. Mean mass, fruit size and surface colour were determined as indices of fruit quality. Results were elaborated by analysis of variance. The significance of differences between treatment means was evaluated using the Newman-Keuls test.
Results

Four years after planting, trees of ‘Resista’, ‘Sawa’, ‘Rajka’ and U 5656 were significantly more vigorous than ‘Selena’, as assessed by the trunk cross-sectional area. The size of the other cultivars, in decreasing order (albeit not significantly different) was as follows: ‘Rubinola’, ‘Wars’ and ‘Topaz’ (Table 1). Trees started to bear fruit in 2003, i.e. in the third year after planting. In 2004, yield of all cultivars was high, varying from 10.7 to 19.1 kg per one tree. Considering the two-year cumulative initial yield, three groups of cultivars were separated. ‘Selena’ was the most productive (29.1 kg per tree (55.5 t/ha)), ‘Sawa’, ‘Rajka’, ‘Topaz’, ‘Resista’ and ‘Wars’ were high in cropping and ‘Rubinola’ gave moderate yield (13.0 kg per tree (24.7 t/ha)). ‘Selena’ had the highest yield efficiency index (2.9 kg/cm²) among the evaluated cultivars while ‘Resista’ and ‘Rubinola’ – the lowest (0.8 and 0.9, respectively; Tables 1 and 2). ‘Sawa’ fruits were the largest, with mean fruit weight 251 g, those of ‘Wars’, ‘Rubinola’, ‘Rajka’, ‘Resista’ and ‘Selena’ – medium (from 222 to 203 g) and those of ‘Topaz’ – the smallest (184 g). Fruits of all cultivars were covered with an intense surface red or orange red blush (Table 3). During the years of study no symptoms of scab (V. inaequalis) and only sporadic symptoms of mildew (P. leucotricha) infection have been observed.

Table 1

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Trunk cross-sectional area (cm²)</th>
<th>Yield per tree (kg)</th>
<th>Yield efficiency index (kg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawa’</td>
<td>12.3 b</td>
<td>16.5 b</td>
<td>4.1 b</td>
</tr>
<tr>
<td>Rajka’</td>
<td>10.1 ab</td>
<td>16.0 b</td>
<td>4.5 b</td>
</tr>
<tr>
<td>Resista’</td>
<td>12.8 b</td>
<td>20.5 b</td>
<td>3.9 b</td>
</tr>
<tr>
<td>Rubinola’</td>
<td>9.7 ab</td>
<td>15.1 ab</td>
<td>2.3 a</td>
</tr>
<tr>
<td>Selena’</td>
<td>7.6 a</td>
<td>10.1 a</td>
<td>11.1 c</td>
</tr>
<tr>
<td>Wars’</td>
<td>9.6 ab</td>
<td>13.5 ab</td>
<td>2.2 a</td>
</tr>
<tr>
<td>Topaz’</td>
<td>8.8 ab</td>
<td>12.6 ab</td>
<td>2.0 a</td>
</tr>
<tr>
<td>U 5656</td>
<td>12.7 b</td>
<td>18.0 b</td>
<td>4.3 b</td>
</tr>
</tbody>
</table>

Means within a column followed by the same letter do not differ significantly at α = 0.05.
Among cultivars evaluated on M.9 rootstock, only ‘Selena’ showed significantly weaker initial tree growth than ‘Sawa’, considered vigorous (Pitera 2000, Sosna 2001). This means that they need a dwarfing rootstock when planted on a fertile soil.

First scientific comparison of organic and integrated apple production under European conditions, carried out in Wädenswil, showed a considerable yield reduction in organic system (Bertschinger et al. 2004). From this point of view scab...
resistant cultivars for such an orchard, except for consumer acceptance, should show a genetically determined high productivity. In the present experiment all cultivars under study started to bear fruit early after planting and initial yield for the first two years of bearing ranged from very high (‘Selena’) to moderate (‘Rubinola’). This is, in general, in agreement with the report of Blažek (1996), who ranked the Czech scab resistant cultivars in three groups of yielding: high – ‘Melodie’, ‘Resista’, ‘Selena’ and ‘Topaz’, medium to high – ‘Rosana’ and medium yielding – ‘Rubinola’.

A vast number of scab resistant cultivars resulted from numerous apple breeding programs in the world (Janick et al. 1990, Laurens 1999). In Europe, only a few of them have some importance in commercial apple production. Main reason is lack of consumer and market acceptance of their fruits. However, essential traits of fruits are being progressively improved by breeders (Kühn and Thybo 2001). Among scab resistant cultivars evaluated in Switzerland the highest rank gained ‘Topaz’, thanks to good eating quality and storability of fruits. The acreage of this cultivar is slowly increasing. The second most important is ‘Rubinola’, but its storage ability is lower than that of ‘Topaz’ (Kellerhals and Rapillard 2002). Both cultivars are considered as having acceptable eating quality in Poland and have been included, among other, into experiments on sustainable fruit production (Czynczyk et al. 2004). Disadvantage of ‘Topaz’ fruits is the size – too small under Polish climatic conditions (Czynczyk et al. 2004), which was also confirmed in our experiment. ‘Wars’, a new cultivar from the Warsaw apple breeding program, showed very good eating quality and longer storage than the autumn cultivar ‘Sawa’; however, its storability was still lower than that of ‘Topaz’.

During all the years of study no symptoms of scab infection on scab Vf resistant cultivars have been noted, whereas in some European countries, during some years, many Vf resistant cultivars were infected by new races 6 and 7 of V. inaequalis (Parisi et al. 1993, Pedersen and Bertelsen 2002).

**Literature**


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