

THREE YEARS OF EXPERIENCE WITH THE APPLE DISEASE CONTROL IN AN ORGANIC ORCHARD

Hanna BRYK, Agata BRONIAREK-NIEMIEC

Research Institute of Pomology and Floriculture
Pomologiczna 18, Skierniewice, Poland
E-mail: hbryk@insad.pl, abroniar@insad.pl

Abstract

In 2005–2007, thirteen apple cultivars planted in an orchard maintained in an organic system were evaluated. Of the studied cultivars, eight were scab-resistant and five were low susceptible to apple scab. The trees were planted in the spring of 2004. Every year two applications of a copper preparation before blossom and two applications of sulfur after blossom were made. Additionally, each spring, the tips of shoots with symptoms of powdery mildew were cut off. In all three years, no symptoms of apple scab were observed on the leaves of scab resistant cultivars. Among the low susceptible cultivars, the highest severity of apple scab was found on the leaves of 'Sampion' and 'Ligolina'. The incidence of powdery mildew on the leaves of all the cultivars was low. The most affected cultivars were 'Ligolina' and 'Sampion'. Evaluation of disease incidence on fruits, performed only in 2007, showed that apple scab was found only on 'Sampion', 'Ligolina', 'Piros' and 'Pinova'. Symptoms of brown rot of apples and bitter pit were also observed on the fruits of almost all the cultivars; they were of medium severity.

Key words: apple, cultivars, organic orchard, *Venturia inaequalis*, *Podosphaera leucotricha*, *Monilinia fructigena*.

Introduction

Organic production is subject to strict legal provisions. In the countries of the European Union its principles are governed by the European Regulation No. 2092/91 and national legislative acts. The most important principle of this kind of production is that the use of chemical plant protection products and chemical fertilisers is not allowed. In the protection of plants against pests and diseases great emphasis is put on prevention. Unfortunately, orchards constitute permanent crops and "tools" for controlling the occurrence of pests and diseases, such as appropriate crop rotation or companion planting, are of little use. For that reason, of great significance is the selection of a suitable cultivar that can be useful for such production. This cultivar should be resistant to pests and diseases, and produce a satisfactory yield of good quality fruit acceptable to consumers.

In the climatic conditions of Poland and other European countries the most dangerous disease of apple trees is apple scab (*Venturia inaequalis* Cke. Wint). It can cause a significant reduction in fruit yield and fruit quality. During rainy seasons, as many as a dozen or more treatments must be carried out to protect apple trees against the disease. Annex 2b to the European Regulation 2092/91 lists, for use in organic apple orchards, only those preparations that contain copper and sulfur as active ingredients.

Such preparations have a preventive mode of action and are less effective in the protection against apple scab than other chemical agents. The use of these preparations to protect apple cultivars susceptible to scab would not be very effective /Weibel et al., 2004/. That is why for ecological orchards apple cultivars resistant to apple scab or with low susceptibility to this disease should be selected /Granatstein, 2004/. Another important disease of apple trees is powdery mildew (*Podosphaera leucotricha* (Ellis et Everh.) Salm). This disease does not cause such great losses in fruit yield as apple scab does, but by occurring every year it weakens the trees and reduces their resistance to frost, and may cause russetting on fruit.

Thanks to the considerable progress in the breeding of apple cultivars, many new cultivars genetically resistant to apple scab have been obtained. Various research centres worldwide carry out assessments of their usefulness for organic cultivation in specific soil and climatic conditions, and of their susceptibility to other diseases /Roen et al., 2004; Tahir, 2005/.

The aim of the study was to assess, in the conditions of an organic orchard, the incidence of diseases on apple trees of thirteen cultivars resistant or low susceptible to apple scab.

Materials and Methods

The apple trees involved in the study included eight cultivars genetically resistant to apple scab: 'Gold Milenium', 'Free Redstar' and 'Melfree' bred in Poland; 'Rajka', 'Rubinola' and 'Topaz' bred in the Czech Republic; the American cultivar 'Enterprise', and the German 'Rewena'; and also five cultivars with low susceptibility to apple scab: 'Delbard Jubile', 'Ligolina', 'Pinova', 'Piros' and 'Sampion'. The trees, on the M.9 rootstock, were planted in the spring of 2004, at a spacing of 4.0 x 2.0 metres, in the organic orchard of the Institute of Pomology and Floriculture in Skieriewice. The orchard has been certified and is maintained according to the principles of organic agriculture (no herbicides, no chemical fertilisers). The programme for the protection of the apple trees against diseases involved each year 2 treatments with a copper preparation (Miedzian 50 WG – 50% copper oxychloride) carried out before flowering, and 2 treatments with a sulfur preparation (Siarkol Extra 80 WP – 80% sulfur) carried out in June. Every year in spring, the tips of shoots with the symptoms of powdery mildew were cut out. No insecticides were used, except for a non-proprietary preparation against aphids made from garlic.

The incidence of leaf diseases was assessed in 2005–2007. In 2007, the first year of more intense fruiting, the fruit diseases were also assessed. The severity of the symptoms of apple scab and powdery mildew was evaluated on 400 randomly chosen leaves of each cultivar (4 replications with 100 leaves each) during primary infections. The obtained results were processed statistically using the variance analysis method developed by R. A. Fischer. Differences between mean values were assessed with Newman-Keuls test at a significance level of 5%.

Results and Discussion

During the 3 years of observations there were no symptoms of apple scab on the leaves of any of the scab-resistant cultivars (Table 1). Among the cultivars with low susceptibility to scab, the highest severity of the disease, expressed in terms of both the number of the affected leaves (A) and the size of the lesion (B), occurred each year on the cultivar 'Sampion'. The severity of apple scab on the leaves of the other cultivars was at a lower but similar level. In 2007, there were no scab lesions on the fruits of scab-resistant cultivars, but among the remaining cultivars the most severely affected were the apples of the cultivars 'Sampion' (27%) and 'Ligolina' (31%), less so those of 'Piros' (18%) and 'Pinova' (5%).

Table 1. Incidence of apple scab (*Venturia inaequalis*) on the leaves of 13 apple cultivars in an organic orchard

cultivar	year		2005		2006		2007	
		A*	B*	A*	B*	A*	B*	
<u>scab-resistant</u>								
'Rubinola'		0	0	0	0	0	0	
'Topaz'		0	0	0	0	0	0	
'Melfree'		0	0	0	0	0	0	
'Free Redstar'		0	0	0	0	0	0	
'Gold Milenium'		0	0	0	0	0	0	
'Rajka'		0	0	0	0	0	0	
'Rewena'		0	0	0	0	0	0	
'Enterprise'		0	0	0	0	0	0	
<u>low susceptible to scab</u>								
'Sampion'		38.8 b	0.78 b	27.6 c	0.50 b	31.9 c	0.32 b	
'Ligolina'		26.0 a	0.31 a	15.6 b	0.05 a	11.6 a	0.09 a	
'Delbard Jubile'		13.5 a	0.12 a	15.7 b	0.20 a	17.7 b	0.16 a	
'Pinova'		—	—	7.1 a	0.07 a	12.8 ab	0.13 a	
'Piros'		—	—	19.6 b	0.22 a	10.2 a	0.09 a	

A* – % of leaves infected, B* – % of leaf surface area occupied by lesion

Means in columns followed by the same letter do not differ significantly according to Newman-Keuls test at a significance level of 5%.

It is thought that a minimum programme for the protection of apple trees of scab-resistant cultivars is necessary because of the risk of breaking their resistance. In the case of cultivars whose resistance is conditioned by a single scab resistance gene, the risk is very high /Parisi et al., 1993/. Most of the scab-resistant cultivars obtained by breeding have one resistance gene Vf that comes from the wild form of *Malus floribunda* clone 821 /Merwin et al., 1994/. Among the cultivars studied in the experiment, those that have this type of resistance are: 'Enterprise', 'Rajka', 'Rewena', 'Rubinola' and

'Topaz'. Only in a small number of cultivars scab resistance is conditioned by another gene (e. g. VA, VB, Vbj, Vm, Vr) or is polygenic. In the cultivars 'Gold Milenium', 'Free Redstar' and 'Melfree' this resistance is conditioned by two genes Vf + Vbj. Resistance-breaking occurs only when new races appear in the population of the fungus *Venturia inaequalis* /Parisi, Lespinasse, 1996/. Cases of resistance-breaking were found in Germany in the 1980s on the cultivars bred in the USA /Parisi et al., 1993/. In Denmark in 1997, the symptoms of apple scab were found on the leaves of the cultivars 'Rubinola' and 'Topaz', and in the year 2000 on the cultivar 'Rajka' /Kuhn, 2002/. In Poland, cases of apple scab on the scab-resistant cultivars with the Vf gene have not been found as yet.

The severity of powdery mildew on the leaves of all the scab-resistant cultivars was in 2005–2007 low, the percentage of affected leaves not exceeding 10% (Table 2). The opinion of other researchers that these cultivars have low susceptibility to powdery mildew /Kuhn, 2002/ have thus been confirmed, although it must be remembered that the trees are still young. On older trees, with bigger crowns, the severity of powdery mildew can be greater. Among the other cultivars in the study, the most affected were the leaves of the cultivar 'Ligolina' (a 3-year average of 10.0%) and 'Sampion' (5.6%), which also indicates low severity of the disease.

Table 2. Incidence of powdery mildew (*Podosphaera leucotricha*) on the leaves of 13 apple cultivars in an organic orchard

cultivar	year	2005		2006		2007	
		A*	B*	A*	B*	A*	B*
<u>scab-resistant</u>							
'Rubinola'		8.1 bc	0.49 ab	0.6 abc	0.04 a	0.7 a	0.05 a
'Topaz'		5.2 b	0.33 ab	0.1 ab	0.02 a	1.5 ab	0.10 ab
'Melfree'		6.9 b	0.35 ab	2.9 bc	0.18 a	1.7 ab	0.15 ab
'Free Redstar'		6.8 b	0.40 ab	1.0 abc	0.05 a	2.4 abc	0.15 ab
'Gold Milenium'		5.4 b	0.28 a	0.1 ab	0.02 a	7.1 c	0.50 d
'Rajka'		3.0 b	0.15 a	0.1 ab	0.02 a	3.2 abc	0.15 ab
'Rewena'		5.0 b	0.25 a	0.0 a	0.00 a	3.0 abc	0.15 ab
'Enterprise'		5.4 b	0.33 ab	0.3 ab	0.03 a	5.9 bc	0.45 cd
<u>low susceptible to scab</u>							
'Sampion'		7.9 bc	0.58 ab	1.6 abc	0.48 a	5.6 bc	0.35 bcd
'Ligolina'		14.0 c	0.85 b	4.4 c	0.24 a	10.0 c	0.25 abc
'Delbard Jubile'		1.5 a	0.08 a	0.9 abc	0.32 a	2.4 abc	0.15 ab
'Pinova'		—	—	0.3 ab	0.03 a	—	—
'Piros'		—	—	0.8 abc	0.30 a	0.9 a	0.05 a

A* – % of leaves infected, B* – % of leaf surface area occupied by lesion

Means in columns followed by the same letter do not differ significantly according to Newman-Keuls test at a significance level of 5%.

In 2007, apart from apple scab, the incidence of other diseases of fruit was also assessed. The symptoms of brown rot (*Monilinia fructigena* (Aderh. et Ruhl.) Honey) were found mostly (more than 30% of fruits infected) on the cultivars 'Free Redstar', 'Rewena', 'Delbard Jubile' and 'Melfree'. The occurrence of brown rot is related to the number of damage sites on fruits most often produced as a result of pests feeding on them. Due to the limited range of insecticides allowed for use in ecological orchards, pests that damage the skin of apples, such as the codling moth (*Cydia pomonella* L.), may present a problem /Weibel et al., 2004/.

In 2007, apples of many cultivars were also found to exhibit the symptoms of bitter pit – a physiological disorder. Apples of the cultivars 'Free Redstar', 'Rajka', 'Topaz' and 'Sampion' were the most affected (about 20% of fruits). The main cause of this disorder is calcium deficiency in apples; moreover, the disease often attacks fruits from young, poorly fruiting trees /Snowdon, 1990/, and that was the kind of trees under study.

From the literature on the diseases of apple trees in organic apple orchards it is known that there is a significant risk posed in those orchards by sooty blotch of apples (*Gloeodes pomigena* (Schw.) Colby) /Fuchs et al., 2002; Trapman, 2004/ and Nectria cancer (*Nectria galligena* Bres.) /Kuhn, 2002/. In the course of the study, no symptoms of these diseases were found on any of the apple tree cultivars involved.

Conclusions

1. No evidence of the breaking of resistance against apple scab (*Venturia inaequalis*) was found in the scab-resistant cultivars: 'Gold Milenium', 'Free Redstar', 'Melfree', 'Rajka', 'Rubinola', 'Topaz', 'Enterprise' and 'Rewena', during the 3 years of the experiment.
2. In the case of the cultivars with low susceptibility to apple scab: 'Delbard Jubile', 'Ligolina', 'Pinova', 'Piros' and 'Sampion', the severity of apple scab and powdery mildew, with a very limited protection programme, was low and at an acceptable level.
3. No incidence of sooty blotch of apples or nectria cancer was found on the trees of the studied cultivars.
4. Problems with brown rot (*Monilinia fructigena*) and bitter pit can be expected in organic apple orchards.

Received 2008-07-23

Accepted 2008-08-29

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