Agronomy Research **7**(Special issue I), 536–541, 2009

Disease incidence on different cultivars of apple tree for organic growing

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Abstract. The incidence of diseases in fourteen apple cultivars and three hybrids planted in an orchard and managed under an organic system were examined in Lithuania in 2007–2008. Infection by leaf blotch (*Phyllosticta* spp.), apple scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*), bark diseases and physiological damage to fruit were evaluated. During experimental years apple trees cv. 'Aldas' were the most damaged by leaf blotch, the disease incidence and intensity was 42% and 13%, respectively. Cultivars 'Florina', 'Enterprise®', 'Roksana', 'Rajka' and hybrid No 20490 were damaged less than 10% by leaf blotch. The most damaged (39–55%) by scab on leaves were cvs. 'Pilot' and 'Pinova' apple trees; meanwhile, the fruits were slightly damaged. Powdery mildew was observed only in cv. 'Lodel', the incidence was 23%. Physiological damage was observed mostly on cvs. 'Goldstar' and 'Aldas' fruits. No bark diseases were observed on any apple tree cultivars and hybrids.

Key words: *Phyllosticta* spp., *Venturia inaequalis, Podosphaera leucotricha,* cultivars, organic growing

INTRODUCTION

Organic fruit production allows growers to produce apples with minimum contamination of the environment with chemicals. The availability of disease resistant cultivars is essential for successful organic fruit production (Gelvonauskienė & Bandaravičius, 1998; Godec, 2004; Ikase & Dumbravs, 2004).

The possibilities for control of pests and diseases in organic growing are limited; therefore, the availability of disease and pest resistant cultivars is essential for successful organic fruit production (Bryk & Broniarek-Niemiec, 2008). Cultivars with complex resistance to fungal diseases are important for ecological and economical considerations. Resistance to biotic and adaptation to abiotic factors of previously bred and newly introduced apple cultivars is being studied in Lithuania (Gelvonauskienė & Bandaravičius, 1998; Sasnauskas et al., 2006). Under the climatic conditions of Lithuania and other European countries, the most dangerous for apple trees is apple scab (*Venturia inaequalis* Cke. Wint). It can cause a significant reduction in fruit yield and fruit quality (MacHardy, 1996; Raudonis et al., 2007; Brun et al., 2008). 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 occurring every year it weakens trees and reduces their resistance to frost, and may cause russeting on fruit (Bryk & Broniarek-Niemiec, 2008). As MacHardy et

al. (2001) stated, all major resistances in apple such as *Vf, Vm, Vr* are ephemeral. It is therefore necessary to define alternative strategies for durable resistance. The aim of many breeding programs in the Baltic region is to obtain new apple cultivars well adapted to the Baltic climate and possessing multiple resistance to scab, mildew, different fruit rots and *Phyllosticta* leaf blotch (Ikase & Dumbravs, 2004; Sasnauskas et al., 2006). Apple blotch (*Phyllosticta mali* E. et E.) appears during epiphytoty in some years in Lithuania (Gelvonauskis & Gelvonauskienė, 2003).

The aim of the study was to assess the incidence of diseases on apple trees of different cultivars under the conditions of organic growing.

MATERIALS AND METHODS

The field trial was carried out at the Lithuanian Institute of Horticulture in 2007–2008. One-year-old nursery trees of tested apple cultivars and hybrids were planted in the orchard in the spring of 2005. Used rootstock – B.396, planting scheme – 4 x 2 m. Experiment was designed in 4 random blocks; each experimental plot consisted of 4 trees. Orchard floor was cultivated soil. Bioinsecticide 5 l ha^{-1} Bioshower (100 % biodegradable soap) against aphids was applied once a year, fungicides were not used.

The apple trees involved in the study included eleven cultivars and three hybrids genetically resistant to apple scab: 'Enterprise®', 'Goldrush®' and 'Freedom' bred in USA; 'Goldstar', 'Rajka', 'Rosana', 'Rubinola', 'Topaz' bred in Czech Republic; Polish cultivar 'Witos', French cultivar 'Florina', Lithuanian cultivar 'Aldas' and hybrids: No 18501, No 20490, No 22170; and also three cultivars with low susceptibility to apple scab: 'Lodel', 'Pilot' bred in Germany and Polish cultivar 'Pinova'.

Meteorological data (air temperature and amount of precipitation) were recorded using scab warning equipment Metos D. Meteorological conditions in 2007–2008 were favourable to fungal disease development and spread.

An infection of leaf blotch (*Phyllosticta* spp.), apple scab (*Venturia inaequalis*), powdery mildew (*Podosphaera leucotricha*), bark diseases and fruit physiological damages were evaluated. Injury to apple trees by fungal diseases was assessed in the second decade in July, and by bark diseases in November. Physiological damage to fruit was recorded during harvesting. Disease incidence was calculated: $P = n/N \cdot 100$. (P – disease incidence, %, n – number of attacked leaves, N – total number of investigated leaves). Disease intensity was calculated: $R = \sum ab \times 100/NK$; R – disease intensity; a – the number of leaves damaged the same level, b – score of the scale; $\sum$ – the sum numbers of damaged leaves or fruits of different scores; K – the highest score of the scale (5). Injury caused by fungal diseases were evaluated according to a 6 point scale: 0 – no disease symptoms detected on leaves or bark, 5 – injured more than 75% of leaf area, or, in the case of bark diseases, by area distorted.

Experimental data were subjected to analysis of variance. Data were analysed by 'ANOVA' statistical program. Specific differences were identified with Duncan's multiple range test.

RESULTS AND DISCUSSION

In two years of investigation, the susceptibility of the investigated cultivars to leaf blotch (*Phyllosticta* spp.) became evident. During the years of investigation, apple trees cv. 'Aldas' were the most damaged by leaf blotch, the disease incidence and intensity was 42% and 13%, respectively (Table 1). Cultivars 'Florina', 'Enterprise®', 'Roksana', 'Rajka' and hybrid No 20490 were damaged by leaf blotch less than 10%.

In different years apple tree damage by leaf blotch was very different: in 2007, the disease incidence of all the investigated cultivars was 6–72%, in 2008, seven cultivars were not diseased and nine were damaged from 1 to 9%. During the years of investigation two cultivars were distinguished: 'Aldas', which was most damaged by leaf blotch, and 'Florina', which was the least damaged in both years of investigation.

When scab resistant or tolerant varieties are planted and the fungicide program is minimized or set to zero, secondary diseases develop, and differences in susceptibility between cultivars become apparent. Sasnauskas et al. (2006) ascertained that apple hybrids No 20429 and No 20016 are characterized as complex-resistant to scab (*Venturia inaequalis*), apple blotch (*Phyllosticta mali* Pr.at Del.) and canker (*Nectria galligena* Bres.).

During the years of investigation, apple trees cvs. 'Pilot' and 'Pinova' were the most damaged (39–55%) by scab on leaves (Table 2); meanwhile, the fruits were only slightly damaged. For these cultivars with low susceptibility to apple scab there are necessary plant protection means permissible in ecological horticulture.

Table1. Leaf blotch (*Phyllosticta* spp.) incidence on different apple cultivars in organic orchard.

Cultivar	Leaf blotch, %					
	Incidence			Intensity		
	2007	2008	Average	2007	2008	Average
Aldas	38.0bcdef	46.0c	42.0	10.7ab	16.0b	13.4
Enterprise	15.0abcd	2.0ab	8.5	3.7ab	0.5a	2.1
Florina	6.0a	0a	3.0	1.5a	0a	0.8
Freedom	49.0fgh	9.0b	29.0	17.0b	2.3a	19.3
Goldrush	41.0def	2.0ab	21.5	11.5ab	0.5a	6.0
Goldstar	46.0efgh	0a	23.0	17.2b	0a	8.6
Lodel	31.0abcdef	4.0ab	17.5	8.0ab	1.0a	4.5
Pilot	72.0h	0a	36.0	38.0c	0a	19.0
Pinova	39.cdef	0a	19.5	11.0ab	0a	5.5
Rajka	12.0abc	2.0ab	7.0	4.0ab	0.5a	2.3
Rosana	12.0ab	0a	6.0	3.2a	0a	1.6
Rubinola	31.0abcdef	1.0ab	16.0	9.7ab	0.2a	4.9
Topaz	26.0abcdef	2.0ab	14.0	6.5ab	0.5a	3.5
Vitos	37.0bcdef	0a	18.5	12.7ab	0a	6.4
No 18501	22.0abcdef	0a	11.0	5.5ab	0a	2.8
No 20490	19.0abcde	1.0ab	10.0	5.0ab	0.2a	2.6
No 22170	42.0defg	3.0ab	23.5	10.5ab	0.3a	5.4

Note: Means followed by the same letter are not significantly different according to Duncan's multiple range test ($P = 0.05$)

Table 2. The incidence of leaf diseases on different apple cultivars in organic orchard.

Cultivar	Apple scab, %						*Powdery mildew, %		
	Incidence			Intensity			Incidence		
	2007	2008	Average	2007	2008	Average	2007	2008	Average
Aldas	0	0	0	0	0	0	0	0	0
Enterprise	0	0	0	0	0	0	0	0	0
Florina	0	0	0	0	0	0	0	0	0
Freedom	0	0	0	0	0	0	0	0	0
Goldrush	0	0	0	0	0	0	0	0	0
Goldstar	0	0	0	0	0	0	0	0	0
Lodel	0	0	0	0	0	0	10.0b	35.2b	22.6
Rajka	0	0	0	0	0	0	0	0	0
Rosana	0	0	0	0	0	0	0	0	0
Rubinola	0	0	0	0	0	0	0	0	0
Topaz	0	0	0	0	0	0	0	0	0
Witos	0	0	0	0	0	0	0	0	0
No 18501	0	0	0	0	0	0	0	0	0
No 20490	0	0	0	0	0	0	0	0	0
No 22170	0	0	0	0	0	0	0	0	0
Pilot	34.0b	44.0b	39.0	17.5b	19.3b	18.4	0	0	0
Pinova	49.0c	60.0c	54.5	20.7c	27.3c	23.9	0	0	0

Note: Means followed by the same letter are not significantly different according to Duncan's multiple range test ($P = 0.05$)

*The intensity of powdery mildew not assessed

According to the data of investigation it is seen that the infection by scab is increasing: in 2008, scab prevalence on leaves was approximately 10% bigger than in 2007. However, there were few incidences of scab on apples and the score of their damage was 1–2.

Brun, Didelot & Parisi (2008) observed the effects of cultivar susceptibility on the development of scab caused by *Venturia inaequalis* where no fungicide protection was used against scab. Whereas 95.2–100% of the fruits of susceptible cultivars had apple scab at harvest, low susceptible cultivars ('Reine des Reinettes', 'Gala') were relatively less scabbed – only 3.1–46.5% of scabbed fruits.

Powdery mildew was observed only in cv. 'Lodel', the incidence was 23%. This cultivar was distinguished for high susceptibility to powdery mildew. Other cultivars selected for investigations are less susceptible to powdery mildew and were not diseased during the years of investigation (Table 2). In Poland, most mildew symptoms on shoots were observed on cvs. 'Florina', 'Witos' and 'Topaz' trees (Sosna, 2002; Czynczyk et al., 2008).

Developing cultivars resistant to both scab and powder mildew is vitally important for organic fruit growing, where the use of synthetic fungicides is not allowed. In regions with lower temperatures and higher rainfall, scab is a major problem, and powdery mildew is less important. Therefore, cultivars grown in cold regions have to be resistant to scab to be grown without chemical protection. In regions where temperatures are higher and rainfall is lower, powdery mildew is a major problem, and scab is less important (Blažek & Hlušičková, 2003; Blažek, 2004). On

older trees, with bigger crowns, the severity of powdery mildew can be greater (Kühn, 2003).

Physiological damage problems can be expected in organic apple growing. Bryk & Broniarek-Niemiec (2008) found that apples of the cultivars 'Free Redstar', 'Rajka', 'Topaz' and 'Sampion' were the most affected by bitter pit – a physiological disorder. During our experimental years, physiological damage was observed most on cvs. 'Goldstar' and 'Aldas' fruits.

No bark diseases were observed on any apple trees cultivars or hybrids.

CONCLUSIONS

Under organic growing conditions no evidence of the breaking of resistance against *Venturia inaequalis* was found in the scab-resistant cultivars 'Aldas', 'Enterprise®', 'Florina', 'Freedom', 'Goldrush', 'Goldstar', 'Lodel', 'Rajka', 'Rosana', 'Rubinola', 'Topaz', 'Witos' and hybrids No 18501, No 20490, No 22170.

For the cultivars with low susceptibility to apple scab 'Pilot', 'Pinova' and the cultivars with low and medium susceptibility to powdery mildew there are necessary plant protection means permissible in ecological horticulture.

The highest incidence of leaf blotch occurred on cv. 'Aldas'. The leaf blotch damages were lesser on cultivars 'Florina', 'Enterprise®', 'Roksana', 'Rajka' and hybrid No 20490.

No bark diseases were observed on any of the apple tree cultivars or hybrids.

ACKNOWLEDGEMENT**.** The study was supported by Lithuanian Ministry of Agriculture.

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