

Apple Scab (*Venturia inaequalis* (Cooke) Wint.) Attacks on Cultivars and Genotypes Carrying Different Resistant Genes in Plantings with Breaking Through *Vf* - *Rvi6* Gene

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Abstract

The objective of this study was evaluation of pathogen *Venturia inaequalis* (Cooke) Wint. virulence in orchards with breaking through *Rvi6* (*Vf*) resistant gene. Virulence of pathogen was evaluated on *Rvi6* resistant cultivars, scab sensitive cultivars and genotypes carrying other resistance genes used in apple breeding programs. Diverse reactions were observed in relation host - pathogen in specific conditions of plantings. Stronger pathogen attacks were recorded in observed locations on cultivars Rubinola and Otava while cultivars Selena and Rajka were attacked fewer. Others tested genotypes carrying different resistant genes showed common resistant reactions or any symptoms indicated breaking only through *Rvi6* gene. Virulence knowledge of the pathogen is important for study of resistance resources and determination of the basic breeding material as well as to regionalization of scab resistant cultivars.

Keywords: apple scab, scab races, *Venturia inaequalis*, resistance, *Vf* cultivars, *Rvi6* gene

Introduction

Occurrence of apple scab symptoms on resistant cultivars are one of actual problems of apple growing. Plant breeding programs in numerous countries have attempted to develop resistant varieties to eliminate the most important disease in apple orchards caused by *Venturia inaequalis* (Cooke) Wint. Resistance to apple scab originating from *Malus floribunda* clone 821 is the most widely form of resistance used in apple breeding programs. According to ability to overcome resistance sources used by plant breeders several races were defined capable infecting different cultivars and species of apples. Two races virulent to the most-used type of resistance given by *Vf* - *Rvi6* gene were founded up recent time - race 6 in Germany in 1993 (Parisi, 1993) that can infect some progenies of *M. floribunda* 821 and race 7 in England in 1994 (Roberts, 1994) infecting all progenies of *M. floribunda* 821. According the new nomenclature of resistant genes is *Vf* gene named as *Rvi6* (Bus and col., 2009). The first appearance of apple scab on resistant *Vf* (*Rvi6*) cultivars was recorded in four locations in the Czech Republic in the year 2006. Totally eleven locations with occurrence of apple scab on resistant cultivars are recorded up to the year 2009.

Material and Methods

Cultivars and genotypes were evaluated in four locations with first appearance of apple scab on resistant cultivars in the year 2006: Břasy, Buková Lhota, Spálené Poříčí and Žernov). Cultivars Angold, Goldstar, Melodie, Otava, Rajka, Selena, Topaz and Vanda (Table 1) were evaluated in years 2006 – 2009. Genotypes Dolgo (gene *Vdolgo* - *Rvi9*),

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TSR33T239 (*Vh4 – Rvi4*), OR45T132 (*Vm - Rvi5*), Geneva (*Vh3 – Rvi3*), Priscilla (*Vf – Rvi6*) were grafted into the plantings (Table 2) and evaluated in four years. Gala was used as a control - an apple scab sensitive cultivar. Cultivars and genotypes were evaluated in randomized blocs excluded from fungicide treatments against apple scab. Herbicide treatments 1 to 2 per a year and mulching 4 to 5 times

seasonally were conducted. Symptoms were recorded after secondary infections on leaves using scale 1 – 9 (1: 0 %, 2: 1-5 %, 3: inter-grade, 4: ± 25 %, 5: inter-grade, 6: ± 50 %, 7: 75 %, 8: > 90 %, 9: over 90 %), (Lateur and Populer, 1994) for cultivars and scale 0 – 4, (Hough, 1944; Chevalier et al., 1991) for genotypes.

Results

Data collected from all cultivars are presented in Table 3 and genotypes in Table 2. The presence of scab only on cultivars Florina, Goldstar, Melodie, Otava, Rajka, Rubinola, Selena, Topaz and Vanda demonstrate the breakdown of *Vf (Rvi6)* gene in all four monitored locations. Cultivar Angold carrying *Va (Rvi10)* gene was without any symptoms or with weak sporulating lesions. The observation confirms differences of scab presence on genotypes carrying diverse resistant genes in those locations. Only Priscilla (*Vf - Rvi6* gene) was suffering with the same level of intensity as Gala cultivar susceptible to scab. Severe attacks of scab were observed on cultivars Rubinola and Otava while cultivars Selena and Rajka suffered less in all four observed locations. Cultivars Rajka and Rubinola were not evaluated in location Žernov in the year 2009 for reason of liquidation of the planting.

Table 1: Survey of tested resistant cultivars in locations with broken *Vf* resistance

Location	Cultivar	Rootstock	Year of planting	Spacing (m)	Number of trees/ha	Total acreage (ha)
Břasy	Angold	MM.106	1996	5x3	667	0.2
	Goldstar	MM.106	1996	5x3	667	0.2
	Melodie	MM.106	1996	5x3	667	15
	Otava	MM.106	1996	5x3	667	0.2
	Rosana	MM.106	1996	5x3	667	0.2
	Rubinola	MM.106	1996	5x3	667	0.2
	Selena	MM.106	1996	5x3	667	0.2
	Topaz	MM.106	1996	5x3	667	0.2
Žernov	Vanda	MM.106	1996	5x3	667	0.2
	Goldstar	M.9	2003	3.5x1.25	2286	1.9
Spálené Poříčí	Topaz	M.9	2003	3.5x1.25	2286	5.1
	Selena	M.9	1996	3.5x1	2857	0.8
	Rajka	M.9	1996	3.5x1	2857	0.4
	Rubinola	M.9	1996	3.5x1	2857	0.4
Buková Lhota	Topaz	M.9	1996	3.5x1	2857	0.4
	Angold	M.9	1997	3x1	3333	0.02
	Florina	M.9	1997	3x1	3333	0.02
	Goldstar	M.9	1997	3x1	3333	0.12
	Selena	M.9	1997	3x1	3333	0.12
	Rubinola	M.9	1997	3x1	3333	0.12
	Topaz	MM.106	1997	3x1	3333	0.12

Table 2: Survey of genotypes tested in plantings

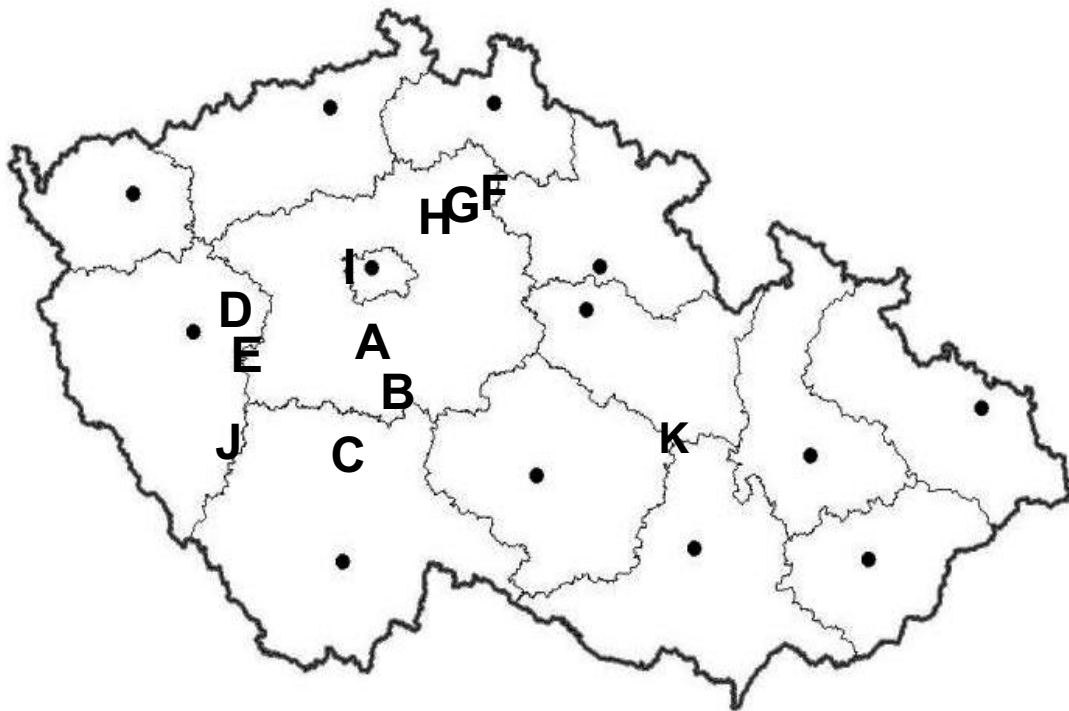
Genotype	Gene (locus)	
	Old nomenclature	New nomenclature
Geneva	<i>Vh3</i>	<i>Rvi3</i>
TSR33T239	<i>Vh4 (Vx, Vr1)</i>	<i>Rvi4</i>
OR 45T 132, 9AR2T196	<i>Vm</i>	<i>Rvi5</i>
Priscilla	<i>Vf</i>	<i>Rvi6</i>
Malus Dolgo	<i>Vdolgo</i>	<i>Rvi9</i>

Table 3: Evaluation of cultivars carrying different resistance genes (scale 1 – 9, Lateur and Populer, 1994)

Cultivar	Gene	Location	2006	2007	2008	2009
			Grade (1-9)			
Angold	<i>Va - Rvi10</i>	Břasy	1	1	1	1
		Buková Lhota	1	2	1	2
Florina	<i>Vf - Rvi6</i>	Buková Lhota	4	2	5	5
Gala	<i>0</i>	Břasy	8	5	8	8
		Buková Lhota	8	6	8	8
		Spálené Poříčí	8	5	8	8
		Žernov	7	4	7	8
Goldstar	<i>Vf - Rvi6</i>	Břasy	5	3	5	6
		Buková Lhota	6	4	7	7
		Žernov	7	4	7	7
Melodie	<i>Vf - Rvi6</i>	Břasy	2	2	7	7
Otava	<i>Vf - Rvi6</i>	Břasy	8	4	8	8
Rajka	<i>Vf - Rvi6</i>	Spálené Poříčí	6	4	6	6
		Žernov	2	2	2	0
Rosana	<i>Vf - Rvi6</i>	Břasy	5	3	6	6
Rubinola	<i>Vf - Rvi6</i>	Břasy	8	4	8	8
		Buková Lhota	7	4	8	8
		Spálené Poříčí	7	4	7	7
		Žernov	2	2	2	0
Selena	<i>Vf - Rvi6</i>	Břasy	6	4	6	6
		Buková Lhota	3	2	5	5
		Spálené Poříčí	3	2	4	4
Topaz	<i>Vf - Rvi6</i>	Břasy	7	4	7	7
		Buková Lhota	6	4	7	7
		Spálené Poříčí	6	4	6	6
		Žernov	7	4	7	7
Vanda	<i>Vf - Rvi6</i>	Břasy	6	3	6	6

Table 4: Evaluation of genotypes carrying different resistance genes (scale 0 – 4, Chevalier et al., 1991)

Genotype	Gene	Location	Grade of attack (0-4)			
			2006	2007	2008	2009
Gala	O	Břasy	4	3	4	4
		Buková Lhota	4	4	4	4
		Spálené Poříčí	4	3	4	4
		Žernov	4	3	4	4
Dolgo	<i>Vdolgo - Rvi9</i>	Břasy	1	1	1	0
		Buková Lhota	1	1	1	0
		Spálené Poříčí	0	0	1	0
		Žernov	1	1	1	0
TSR33T239	<i>Vh4 - Rvi4</i>	Břasy	0	1	0	1
		Buková Lhota	1	1	0	1
		Spálené Poříčí	1	1	0	0
		Žernov	1	1	1	0
Geneva	<i>Vh3 - Rvi3</i>	Břasy	0	1	2	1
		Buková Lhota	1	1	2	1
		Spálené Poříčí	1	1	2	0
		Žernov	1	1	2	0
OR45T132, 9AR2T196	<i>Vm - Rvi5</i>	Břasy	1	2	1	1
		Buková Lhota	1	1	1	0
		Spálené Poříčí	1	2	1	0
		Žernov	1	1	1	0
Priscilla	<i>Vf - Rvi6</i>	Břasy	4	4	4	4
		Buková Lhota	3	3	4	4
		Spálené Poříčí	3	3	4	4
		Žernov	3	3	4	4



Locations: A – Buková Lhota, B – Zvěstov, C – Branice, D – Břasy, E – Spálené Poříčí, F – Žernov, G – Střížovice, H – Mnichovo Hradiště, I – Ruzyně, J – Milčice, K – Rohozec

Figure 1: Locations with occurrence of apple scab on *Vf-Rvi6* resistant cultivars in years 2006 – 2009 in the Czech Republic

Discussion

Severity of attacks varied in observed years. Infections in the year 2007 were weaker than in others years. The reason was in weather conditions during growing season. Warm and dry spring in this year limited primary infections that occurred later resulted in lower intensity of scab. Two different scales to evaluate scab susceptibility that are used in this work showed needs to convert the observation to one basic scale showing greater consistency. Apple scab occurred in next locations on apple scab *Vf – Rvi6* resistant cultivars (Figure 1) in the Czech Republic in the year 2009 showing danger of spreading widely to other orchards. Under the heavy infection conditions in the Czech Republic the resistance of the variety 'Angold' (Va-gene) is more durable. The consequence for the grower is to plant varieties with a durable resistance or to combat at least the primary infections of apple scab also on resistant varieties. The evaluation of the scab symptoms on cultivars grown in observed plantings are not finish yet. More observation will serve to recognize severity of the scab races on cultivars and genotypes carrying different resistant genes. The conclusion for apple breeders is to combine different sources of resistance based on different genes.

Acknowledgements

This work is financed by the Ministry of Agriculture of the Czech Republic in the framework of the project NAZV QH71172 and QH81142.

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