Wheat Leaf Rust Races/Pathotypes in Slovakia in 1999–2000

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Abstract

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Virulence of the wheat leaf rust populations of 1999 and 2000 from Slovakia was studied on Thatcher near-isogenic lines (NILs) with genes *Lr1*, *Lr2a*, *Lr2b*, *Lr2c*, *Lr3a*, *Lr9*, *Lr10* (only in 2000), *Lr11*, *Lr15*, *Lr17*, *Lr19*, *Lr21*, *Lr23*, *Lr24*, *Lr26* and *Lr28*. Seven pathotypes were determined from 36 rust samples in 1999, and 17 pathotypes from 45 rust samples in 2000. The frequency of virulence on *Lr1*, *Lr2*a and *Lr2b* was relatively low, and there was no virulence on *Lr9*, *Lr19*, *Lr24* and *Lr28*. The frequency of virulence on *Lr2c*, *Lr15*, *Lr23* and *Lr26* varied between 53.0 and 97.8%. All isolates were virulent on *Lr3*, *Lr11*, *Lr17* and *Lr21*. The identified pathotypes conformed with races 61SaBa, 57SaBa, 12SaBa, 6SaBa, 77SaBa, 6, 61 and 2SaBa. In 1999 races 61SaBa, 77SaBa and 57SaBa prevailed, in 2000 races 61SaBa, 57SaBa, 12SaBa, 6SaBa and 77SaBa were prevalent. Data on the reactions of 18 cultivars and advanced lines to six rust isolates of 2000 representing different pathotypes and to one isolate from the collection (race 14) are presented.

Key words: *Puccinia persistens* subsp. *triticina*, syn. *Puccinia recondita* f.sp. *tritici*; pathotypes; races; *Lr* genes; winter wheat; variety resistance; Slovak Republic

Wheat leaf rust belongs to important wheat diseases causing considerable yield losses particularly when the pathogen appears early and the weather during ripening is hot and dry. Growing rust resistant cultivars is the most economic way to reduce such losses. Due to the genetic variability of the pathogen and to selection in the population of the pathogen, new races of the pathogen virulent on hitherto resistant cultivars develop and spread in the rust population. Monitoring of these changes in the population is important for wheat growers so that cultivars that lost resistance can be avoided and thus reduce yield losses. The data on virulence in the rust population are used also by wheat breeders for the selection of effective sources in resistance breeding. This contribution presents data on physiologic races/pathotypes identified in Slovakia in 1999–2000 and reactions of selected wheat cultivars and advanced lines to seven rust isolates.

MATERIAL AND METHODS

Samples of wheat leaf rust *Puccinia persistens* Plow. subsp. *triticina* (Eriks.) Urban et Marková (syn. *Puccinia recondita* Rob. ex Desm. f.sp. *tritici* Eriks.) originated from different parts of Slovakia. For testing, near isogenic Thatcher lines (NILs) possessing the *Lr* genes listed in Tables 2 and 3 were used as differentials (15 in 1999 and 16 in 2000). Field samples of rust were increased on the susceptible cultivar Diana. Inoculation of cv. Diana, the differentials and tested cultivars or lines was carried out by rubbing the first leaf with a suspension of urediospores. Inoculated plants were kept in closed glass cylinders to provide a high air humidity for 24–48 h, and then in open glass cylinders at 18–22°C in the greenhouse with supplemental (18 h/d) illumination with fluorescent tubes. Infection types were evaluated 14 d after inoculation according to STAKMAN *et al.* (1962). Race numbers were assigned according to JOHNSTON and BROWDER (1966). Virulence on *Lr26* (cv. Salzmünder Bartweizen) is designated by the suffix SaBa. Of the samples that displayed mixed reactions on any of the differentials one to three single pustule isolates were taken, increased on cv. Diana and tested again. The term race was used when determined isolates were designated with numbers, the term pathotype in relation to reactions on the NILs.

Seed of the tested cultivars and advanced lines originated from the Central Institute for Supervision and Testing in Agriculture, Variety Testing Station, Želiezovce. When testing them, the four NILs with *Lr3*, *Lr10*, *Lr13* and *Lr26* were included. As inoculates, isolate 600B (race 14) and the following isolates of the 2000 survey were used: 9031SPB from Rimavská Sobota, cv. Ilona, race 6SaBa; 9042SPB from Jakubovany, cv. Rada, race 6; 9033 from •eliezovce, cv. Blava, race 12SaBa; 9034SPB from Velký Meder, cv. Brea, race 57SaBa; 9045SP from Michalovce, cv. Ilona, race 61SaBa; 9047SPB from Velké Ripňany, cv. Brea, race 77SaBa.

RESULTS AND DISCUSSION

In both 1999 and 2000 race 61SaBa prevailed, representing 78% in 1999 and 47% in 2000 of the analyzed rust samples. In 1999, races 77SaBa (8%), 57SaBa (5%), 12SaBa, 6SaBa and 61 (each 3%) were also determined (Table 1). In 2000 the following races were identified in addition to

Table 1. Leaf rust races determined in 1999 and 2000

Race	1999				2000			
	number of samples	%	number of localities	%	number of samples	%	number of localities	%
61 SaBa	28	78	11	100	21	47	10	62
57 SaBa	2	5	1	9	8	18	5	31
12 SaBa	1	3	1	9	5	11	5	31
6 SaBa	1	3	1	9	5	11	5	31
77 SaBa	3	8	3	27	3	7	2	12
61	1	3	1	9	–	–	–	
6	–	–	–	–	2	4	2	12
2 SaBa	–	–	–	–	1	2	1	6
Total	36	100	11	–	45	100	16	–

Table 2. Reactions of *Lr* NILs to leaf rust isolates (1999)

NIL	Leaf rust pathotypes							Virulence (%)
	a	b	c	d	e	f	g	
Lr1	R	R	S	R	R	R	S	11.4
Lr2a	R	R	S	R	R	S	R	14.2
Lr2b	R	R	S	S	R	S	R	17.1
Lr2c	S	S	S	S	S	S	S	100
Lr3	S	S	S	S	S	S	S	100
Lr9	R	R	R	R	R	R	R	0
Lr11	S	S	S	S	S	S	S	100
Lr15	S	S	S	S	S	S	S	100
Lr17	S	S	S	S	S	S	S	100
Lr19	R	R	R	R	R	R	R	0
Lr21	S	S	S	S	S	S	S	100
Lr23	S	R	S	S	S	R	S	80
Lr24	R	R	R	R	R	R	R	0
Lr26	S	S	S	S	R	S	S	97.1
Lr28	R	R	R	R	R	R	R	0
Number of isolates	22	6	3	1	1	2	1	Total 36
Conformed to races	61 SaBa		77 SaBa	12 SaBa	61	57 SaBa	6 SaBa	

61SaBa: 57SaBa (18%), 12SaBa, 6SaBa (both 11%), 77SaBa (7%), 6 (4%) and 2SaBa (2%).

No virulence on *Lr9*, *Lr19*, *Lr24* and *Lr28* was found, and a low frequency of virulence on *Lr1*, *Lr2a* and *Lr2b*. The frequency of virulence on other *Lr* genes varied from 53% to 100%, with the relatively lowest on *Lr23* (80% in 1999 and 53% in 2000) (Tables 2 and 3).

In 1999 the rust samples originated from 11 locations, in 2000 from 16 locations (Table 1). In 1999 the most common race 61SaBa was found at all locations, in 2000 at 10 locations. In 1999 race 77SaBa was found at three locations, in 2000 at two locations. The other four races determined in 1999 originated each from only one location, in 2000 races 57SaBa, 12SaBa and 6SaBa from five locations, race 6 from two locations and race 2SaBa only from one location.

The results regarding races and virulence on the NILs do not differ much from the data of 1997 and 1998, when race 61SaBa also prevailed and no virulence on *Lr9*, *Lr19*, *Lr24* and *Lr28* was found. Race 77SaBa was also rather widespread, but in 2000 its frequency declined to 7%. In 2000 race 57 was more frequent than race 77SaBa. Race 57SaBa differs from race 77SaBa only by avirulence on *Lr1*, and sometimes intermediate reactions are observed. The frequency of races 77SaBa and 57SaBa combined reached 13% in 1999 and 25% in 2000, while it was 37% in 1997 and 20% in 1998. With the exception of race 61, all other races determined in 1999 and 2000 were also found in the previous two years (BARTOŠ *et al.* 1999).

The geographic distribution of the determined races (Table 4) does not indicate any concentration of certain races to specific regions. The most widespread race 61SaBa was found in 1999 at all localities and in 2000 at the majority of localities in various parts of Slovakia.

If we compare the data on leaf rust races from Slovakia with those from the neighbouring countries Hungary and the Czech Republic we find many similarities. For 1999, MANNINGER (2000) lists races 12, 61 and 77 as predominant in Hungary. In the Czech Republic, race 61SaBa predominated in 1999–2000, and races 57SaBa, 12SaBa and 77SaBa also belonged to relatively frequently determined races. Neither in Slovakia nor in the Czech Republic in 1999–2000 (BARTOŠ *et al.* 2000) and Hungary in 1999 (MANNINGER 2000) was virulence on *Lr9*, *Lr19*, *Lr24* and *Lr28* detected. In the European part of Russia (GULTYAEVA *et al.* 2000) in 1996–1999 no virulence on *Lr9*, *Lr19*, *Lr24* was found, whereas the frequency of virulence on *Lr28* was 65% in 1998 and 10% in 1999.

Of 18 tested cultivars and advanced lines, 16 displayed reactions indicating the presence of specific genes for leaf rust resistance. Only the cv. Ilona and line PS-39/96 did not show a distinct resistant reaction to any of the rust

Table 3. Reactions of *Lr* NILs to leaf rust isolates (2000)

NIL	Leaf rust pathotypes																	Virulence (%)
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	
Lr1	R	R	R	R	R	R	R	R	R	R	S	S	S	S	S	S	R	22.2
Lr2a	R	R	R	R	S	S	R	R	R	R	R	R	S	S	R	R	R	24.4
Lr2b	R	R	R	R	S	S	S	S	S	S	R	R	S	S	R	R	R	35.5
Lr2c	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	R	97.8
Lr3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	100
Lr9	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	0
Lr10	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	100
Lr11	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	100
Lr15	S	S	R	R	S	R	R	S	R	S	S	R	S	S	R	R	S	64.4
Lr17	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	100
Lr19	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	0
Lr21	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	100
Lr23	R	S	S	R	R	S	R	R	S	S	S	S	S	R	S	R	S	53
Lr24	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	0
Lr26	S	S	S	S	S	S	S	S	S	S	S	S	S	S	R	R	S	95.5
Lr28	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	0
Number of isolates	8	7	5	1	7	1	1	1	2	1	1	4	1	2	1	1	1	Total 45
Conform to race	61 SaBa				57 SaBa		12 SaBa				6 SaBa		77 SaBa		6		2 SaBa	

Table 4. Geographic origin of leaf rust samples in 1999 and 2000 (districts listed in alphabetic order)

1999				2000			
District	Locality	Cultivar	Race	District	Locality	Cultivar	Race
Bratislava	Báhoň	BU-54	12 SaBa	Bratislava	Vrakuňa	Boka	61 SaBa
		RA-60	61 SaBa			Viginta	61 SaBa
		HE-3625	61 SaBa	Dunajská Streda	Solary	unknown	6 SaBa
		Compass	61 SaBa		V. Meder	Brea	61 SaBa, 57 SaBa
		MO-633	61 SaBa	Galanta	Sládkovičovo	unknown	77 SaBa
	Vrakuňa	SG-RU-488	61 SaBa, 57 SaBa	Levice	Želiezovce	Blava	12 SaBa
		BR-458	61 SaBa			Hana	57 SaBa
		Hana	77 SaBa, 57 SaBa, 6 SaBa	Martin	Bodorová	Astella	61 SaBa
		Torysa	61 SaBa			unknown	61 SaBa
Dunajská Streda	Veľký Meder	Alana	61 SaBa	Michalovce	Michalovce	Hana	61 SaBa
		Hana	61 SaBa			Ilona	61 SaBa, 6 SaBa
Košice	Haniska	Compass	77 SaBa	Piešťany	Borovce	unknown	61 SaBa, 57 SaBa
		Brea	61 SaBa	Poprad	Spiš. Belá	Hana	61 SaBa
		Torysa	61 SaBa			PS 19/94	57 SaBa
Levice	Želiezovce	Blava	77 SaBa	Prešov	Malý Šariš	unknown	12 SaBa
		Hana	61 SaBa	Rim. Sobota	Rim. Sobota	Torysa	61 SaBa
		Malvina	61 SaBa			Ilona	6, 6 SaBa
Michalovce	Michalovce	Košútka	61 SaBa	Sabinov	Jakubovany	Brea	61 SaBa
		Bruta	61 SaBa			Malvina	61 SaBa
Nitra	Nitra	Malanta//TC6/Loros	61 SaBa			Rada	61 SaBa, 6, 6 SaBa
Piešťany	Piešťany	unknown	61 SaBa	Spišská Nová Ves	Spišské Vlachy	Hana	12 SaBa
		Torysa	61 SaBa	Topoľčany	V. Ripňany	unknown	57 SaBa
		Brea	61 SaBa			unknown	61 SaBa
		Hana/Amila	61 SaBa			Hana	77 SaBa
		AM 45/97	61 SaBa			Brea	61 SaBa, 6 SaBa, 77 SaBa
Poprad	Spiš. Belá	PS-19/94	61 SaBa		Radošina	unknown	12 SaBa
		PLH 6336	61 SaBa	Zvolen	Víglaš	Brea	61 SaBa
		Malvina	61 SaBa			Hana	2 SaBa
Považská Bystrica	Beluša	unknown	61 SaBa			unknown	12 SaBa
Rim. Sobota	Rim. Sobota	Samanta	61 SaBa				

isolates. A postulation of resistance genes based on reaction patterns has limited value due to the limited number of rust isolates applied. Judged by susceptibility to all isolates virulent on *Lr3* and by resistance to the only isolate avirulent on *Lr3*, about half of the entries may possess this gene (Table 5). In three of them (Astella, Rada and Brea) this gene was postulated already earlier (BARTOŠ *et al.* 1998, 1999). One cultivar, Malvina, showed reactions characteristic for *Lr26*, postulated for this cultivar also earlier (BARTOŠ *et al.* 1999). The same gene and an additional gene can be postulated for cv. Balada. Reactions of cv. Alka are similar to those of NILs *Lr10* and *Lr13* if we consider the possible additive/complementary effect of genes *Lr10* and *Lr13* on expression of resistance. This confirms our previous results on the presence of these two genes in cv. Alka. Presence of *Lr10* was proved by a molecular marker (BLAŽKOVÁ *et al.* 2001). Postulation of *Lr* genes in other cultivars according to reaction patterns is difficult.

None of the cultivars and lines showed high resistance to all tested isolates at the seedling stage. The effectiveness of the described genes under field conditions will depend especially on the presence and frequency of virulence at individual locations, on the spread of virulence and on environmental factors affecting both the pathogen and the host.

Data on leaf rust severity observed on entries of the State Variety Trials (Table 5) enable at least a partial evaluation of the effect of the determined genes on disease severity in the field. The lowest average disease severity

Table 5. Reactions of selected cultivars and advanced lines in the State Variety Trials to seven rust isolates and disease severity

Cultivar-line	Isolate-race							Disease severity*	Postulated *Lr* gene	Year of registration
	9031 SPB 6 SaBa	9042 SPB 6	9033 12 SaBa	9034 SPB 57 SaBa	9045 SP 61 SaBa	9047 SPB 77 SaBa	600 B 14			
Astella	3	3	3	3	3	3-	0	5.9	*Lr3*	1995
Zerda	4	4	4	3	3	3	0;	7.1	*Lr3*	1995
SO-16	4	3	3	3	3	3	0;	5.5	*Lr3*	–
SO-550	3	3	3	3	3	3	0	6.6	*Lr3*	–
Klea	3-	3-	3	3	3	3	0;	6.2	*Lr3*	1998
BU-54	3	4	3	3	3	3	0;	6.3	*Lr3*	–
Brea	3	3	3	3	3	3	;	4.9	*Lr3*	1998
MS-944	4	3	3	3	3	3	0	5.6	*Lr3*	–
Rada	3	3-	3	3	3	3	0;	6.1	*Lr3*	1995
Malvina	3	0	3	3	3	3	;1	5.3	*Lr26*	1998
PS-39/96	3-	3-	3	3	3	3	3-	4.9	–	–
Ilona	3	3	3	3	3	3	3	5.0	–	1989
Solara	3	3(;)	;1	;1,2	3	;	3	6.6	*Lr* u	1998
Balada	3	0	;1	3	3	;1,2	0;	7.0	*Lr26*, *Lr* u	1999
Torysa	2+	2+	1,2	3-	2+	3	1,2+	4.9	*Lr* u	1992
Bety	2,3	2,3(;)	2,3(;)	3-	3(;)	3-	3-	7.0	*Lr* u	1999
Alka	;1	;	1,2+	;1	2,3	;1,2	2,3	5.5	*Lr10*, *Lr13*	1997
Šárka	;1,2+	;1,2	;1	2,3	;1,2	3	;1	5.8	*Lr* u	2000
Tc - *Lr 3*	3	3	3	3	3	3	;1	–	*Lr3*	–
Tc - *Lr 10*	;1,2	;1,2	2,3-	;1,2	3	3-(;)	3	–	*Lr10*	–
Tc - *Lr 13*	3	3-	3-	3-	3	3	2,3	–	*Lr13*	–
Tc - *Lr 26*	3	0	3	3	3	3	0	–	*Lr26*	–

* 1 – high severity (susceptibility)
9 – low disease severity/no disease symptoms (resistance)
Data from the State Variety Trials
u – undetermined

was observed in cvs. Zerda, Balada and Bety. In the group of cultivars postulated to possess *Lr3* the differences in their rust reaction can be due to genes for adult plant or partial resistance. In this group the advanced line SO-550 showed a low disease severity, whereas that of the other line from Solary, SO-16, was higher. Cv. Brea with *Lr3*, line PS-39/96 without any *Lr* gene and cv. Torysa with undetermined *Lr* gene(s) displayed the highest disease severity. The field data have to be considered with caution as the observed disease severity may be influenced by the incidence of other diseases, by earliness of the cultivar and by ranking of the cultivars in variety trials.

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Souhrn

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V letech 1999–2000 jsme studovali virulenci rzi pšeničné na téměř izogenních liniích odrůdy Thatcher s geny rezistence *Lr1*, *Lr2a*, *Lr2b*, *Lr2c*, *Lr3*, *Lr9*, *Lr10* (jen v roce 2000), *Lr11*, *Lr15*, *Lr17*, *Lr19*, *Lr21*, *Lr23*, *Lr24*, *Lr26* a *Lr28*. Na těchto liniích bylo určeno 7 patotypů ze 36 vzorků rzi v roce 1999 a 17 patotypů ze 45 vzorků v roce 2000. Relativně nízká četnost virulence byla zjištěna ke genům rezistence *Lr1*, *Lr2a*, *Lr2b*; virulence nebyla zjištěna ke genům *Lr9*, *Lr19*, *Lr24* a *Lr28*. Četnost virulence ke genům rezistence *Lr2c*, *Lr15*, *Lr23* a *Lr26* se pohybovala mezi 53.0 a 97.8%. Všechny izoláty byly virulentní ke genům rezistence *Lr3*, *Lr11*, *Lr17* a *Lr21*. Zjištěné patotypy se shodovaly s rasami 61SaBa, 57SaBa, 12SaBa, 6SaBa, 77SaBa, 6, 61 a 2SaBa. V roce 1999 převládaly rasy 61SaBa, 77SaBa a 57SaBa, v roce 2000 rasy 61SaBa, 57SaBa, 12SaBa, 6SaBa a 77SaBa. Jsou uvedeny údaje o reakcích 18 odrůd a novošlechtění k šesti izolátům rzi z roku 2000 a jednomu staršímu izolátu rzi ze sbírky (rasa 14).

Klíčová slova: *Puccinia persistens* subsp. *triticina*; syn. *Puccinia recondita* f.sp. *tritici*; patotypy; rasy; *Lr* geny; pšenice; odrůdová rezistence; Slovensko

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