

Wheat Leaf Rust Races/Pathotypes in the Czech Republic in 1997–1998*

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Abstract

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In 1997–1998 virulence of the wheat leaf rust population was studied on Thatcher near isogenic lines with *Lr1*, *Lr2a*, *Lr2b*, *Lr2c*, *Lr3*, *Lr9*, *Lr11*, *Lr15*, *Lr17*, *Lr19*, *Lr21*, *Lr23*, *Lr24*, *Lr26* and *Lr28*. On these NILs 11 pathotypes were determined in 1997, and 8 in 1998. All rust samples were avirulent on *Lr9*, *Lr19*, *Lr24* and *Lr28*. There was a relatively low frequency of virulence on *Lr1*, *Lr2a* and *Lr2b*. Most rust samples were virulent on *Lr2c*, *Lr11*, *Lr15*, *Lr17*, *Lr23* and *Lr26*. All samples were virulent on *Lr3* and *Lr21*. The identified pathotypes conformed with races 61SaBa*, 77SaBa, 2SaBa, 12SaBa, 57SaBa, 6SaBa, 61*, 77 and 6. Races 61SaBa*, 77SaBa and 2SaBa prevailed in 1997, races 61SaBa*, 77SaBa and 12SaBa were prevalent in 1998. Races 6 and 6SaBa were found for the first time. Data on *Lr* genes in recently registered winter wheat cultivars are presented.

Key words: *Puccinia persistens* subsp. *tritricina*, syn. *Puccinia recondita* f. sp. *tritici*; pathotypes; physiologic races; *Lr*-genes; wheat; registered cultivars; Czech Republic

Control of wheat leaf rust is usually based on genetic resistance that is transferred from sources of resistance lacking other agronomically important traits into commercially grown cultivars. For the selection of suitable genes for resistance breeding, their effectiveness against virulence genes occurring in the rust population has to be considered. Therefore, virulence in the leaf rust population is studied annually in race/pathotype surveys. This contribution presents data from the years 1997–1998.

MATERIAL AND METHODS

Collections of wheat leaf rust *Puccinia persistens* Plow. subsp. *tritricina* (Eriks.) Urban et Marková, syn. *Puccinia recondita* f. sp. *tritici* were obtained mainly from the trials of the Central Institute for Agricultural Supervision and Testing and of plant breeding companies located in different areas of the Czech Republic. Field samples of rust were increased on the susceptible cv. Diana. Inoculation of the cv. Diana as well as of the differentials was carried out by rubbing the first leaf with a suspension of urediospores. For testing 15 near-isogenic lines (NILs) of the cv. Thatcher possessing *Lr* genes listed in Tables 3 and 6 were used. These NILs were agreed upon for the

differentiation of pathotypes within the framework of COST 817 project "Population studies of airborne pathogens on cereals as a means of improving strategies for disease control". Inoculated plants were kept in closed glass cylinders to keep a high air humidity for 48 h. Infection types were evaluated 14 d after inoculation according to STAKMAN *et al.* (1962). Race numbers were assigned according to JOHNSTON and BROWDER (1966). Since races 61(SaBa) cannot be distinguished from 62(SaBa) on the used NILs, an asterisk * was added to races 61 and 61SaBa to indicate that races 62 and 62SaBa, respectively, may be involved. Virulence on *Lr26* (cv. Salzmünder Bartweizen) is designated by the suffix SaBa.

RESULTS AND DISCUSSION

Half of the leaf rust samples analyzed in 1997 (Table 1) belonged to race 61SaBa*, followed by races 77SaBa and 2SaBa. The same races prevailed in the previous year (BARTOŠ *et al.* 1998). Races 61SaBa* and 77SaBa predominated also in 1998 (Table 2), the third most widespread race being 12SaBa. Other races, 77/57SaBa, 77, 61* in 1997, and 61*, 57SaBa, 6SaBa and 6 in 1998, were represented only by one or two samples. Races 6 and

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Table 1. Wheat leaf rust races determined in 1997

Race	Number of samples	%	Number of localities	%
61SaBa*	22	50	18	86
77SaBa	11	25	9	43
2SaBa	8	18	5	24
77/57SaBa	1	2	1	5
77	1	2	1	5
61*	1	2	1	5
Total	44	99	21	–

Table 2. Wheat leaf rust races determined in 1998

Race	Number of samples	%	Number of localities	%
61SaBa*	16	53	14	70
77SaBa	5	17	4	20
12SaBa	3	10	3	15
61*	2	7	2	10
57SaBa	2	7	2	10
6SaBa	1	3	1	5
6	1	3	1	5
Total	30	100	20	–

Table 3. Virulence spectra of wheat leaf rust samples on *Lr* NILs* (1997)

NILs	Leaf rust pathotypes											Frequency of virulence [%]
	a	b	c	d	e	f	g	h	i	j	k	
Lr 1	R	R	R	R	R	R	R	S	S	S	S	29
Lr 2a	R	R	R	R	R	R	R	S	S	S	S	29
Lr 2b	R	R	R	R	R	R	R	S	S	S	S	29
Lr 2c	S	S	S	S	S	R	R	S	S	S	S	82
Lr 3	S	S	S	S	S	S	S	S	S	S	S	100
Lr 9	R	R	R	R	R	R	R	R	R	R	R	0
Lr 11	S	S	R	S	S	S	S	S	S	S	S	95
Lr 15	R	S	R	S	R	S	R	S	R	S	S	66
Lr 17	S	S	R	S	S	S	S	S	S	S	S	95
Lr 19	R	R	R	R	R	R	R	R	R	R	R	0
Lr 21	S	S	S	S	S	S	S	S	S	S	S	100
Lr 23	S	S	S	R	S	S	R	R	S	S	S	82
Lr 24	R	R	R	R	R	R	R	R	R	R	R	0
Lr 26	S	S	S	S	R	S	S	S	S	S	R	95
Lr 28	R	R	R	R	R	R	R	R	R	R	R	0
Number of isolates	9	7	2	4	1	7	1	3	2	7	1	Σ 44
Conformed with race	61SaBa*			61*	2SaBa	77/57SaBa			77			

*NILs – near isogenic lines

6SaBa were determined as new races. They differ from races 61* and 61 SaBa* by their virulence on *Lr1*. It is interesting that both biotypes of race 6 were found, namely with or without virulence on *Lr26*. The same situation was observed earlier in most races and seems to indicate a high mutability at the locus for (a)virulence on *Lr26*.

Data on the occurrence of race 61SaBa* in the last 5 years indicate slightly declining trend, from 97%, 86%, 62%, 50% to 53%. Rather the opposite is true for race 77SaBa with virulence on all eight standard differentials Malakoff, Carina, Brevit, Webster, Loros, Mediterranean, Hussar, Democrat and the supplemental differential Salzmünder Bartweizen. Its occurrence in the last 5 years was 0%, 7%, 8%, 26% and 17% (BARTOŠ *et al.* 1966, 1998).

On the 15 near-isogenic *Lr* lines 11 pathotypes were differentiated in 1997 (Table 3), and 8 pathotypes in 1998 (Table 4). In 1997 race 61SaBa* could be further differentiated according to reactions on *Lr15* and *Lr17*, and race 77SaBa according to reactions on *Lr15* and *Lr23*. In 1998 differentiation of race 61SaBa* was possible on *Lr15*. Most samples were also virulent on *Lr2c*, *Lr11*, *Lr15*, *Lr17* and *Lr23*. Low virulence was found in both years on *Lr1*, *Lr2a* and *Lr2b*.

The geographic distribution of the identified races (Tables 5 and 6) does not show a distinct prevalence of certain races in certain geographic areas. In 1997 the most

Table 4. Virulence spectra of wheat leaf rust samples on *Lr* NILs* (1998)

NILs	Leaf rust pathotypes								Frequency of virulence [%]
	a	b	c	d	e	f	g	h	
<i>Lr 1</i>	R	R	R	R	R	S	S	S	23
<i>Lr 2a</i>	R	R	R	R	S	R	S	R	23
<i>Lr 2b</i>	R	R	S	R	S	R	S	R	33
<i>Lr 2c</i>	S	S	S	S	S	S	S	S	100
<i>Lr 3</i>	S	S	S	S	S	S	S	S	100
<i>Lr 9</i>	R	R	R	R	R	R	R	R	0
<i>Lr 11</i>	S	S	S	S	S	S	S	S	100
<i>Lr 15</i>	S	R	S	R	S	S	S	R	77
<i>Lr 17</i>	S	S	S	S	S	S	S	S	100
<i>Lr 19</i>	R	R	R	R	R	R	R	R	0
<i>Lr 21</i>	S	S	S	S	S	S	S	S	100
<i>Lr 23</i>	S	S	S	S	S	S	S	S	100
<i>Lr 24</i>	R	R	R	R	R	R	R	R	0
<i>Lr 26</i>	S	S	S	R	S	S	S	R	90
<i>Lr 28</i>	R	R	R	R	R	R	R	R	0
Number of isolates	12	4	3	2	2	1	5	1	Σ 30
Conformed with race	61 SaBa*	12 SaBa	61*	57 SaBa	6 SaBa	77 SaBa	6		

*NILs – near isogenic lines

widespread races 61 SaBa* and 77SaBa occurred in most parts of the Czech Republic from which the rust samples originated. In 1998 race 77SaBa was found only in samples from the eastern part of the Czech Republic, but in that year the majority of samples originated from that area. In neighbouring Slovakia race 77SaBa formed 20% of the rust population in 1998 (BARTOŠ *et al.* unpublished), i.e., about the same proportion as in the samples from the eastern part of the Czech Republic.

Of the *Lr* genes included in the set of near isogenic lines used for the differentiation of the pathotypes, only *Lr1*, *Lr3* and *Lr26* were postulated to be present in the cultivars registered in the Czech Republic. Most cultivars with postulated genes *Lr3* and *Lr26* have already been listed earlier (BARTOŠ *et al.* 1998).

Several cultivars registered in the Czech Republic and mentioned below were tested by Dr. R. Park in Australia (personal communication). He postulated *Lr1* and *Lr3* in the cv. Vlada. These results are in agreement with our tests (BARTOŠ *et al.* 1998), and with earlier published genetic analyses (BARTOŠ & STUHLÍKOVÁ 1993). In the genetic study two dominant genes were postulated on the base of a segregation 15R : 1S of the F₂ population of crosses of Vlada with the susceptible cvs. Zdar and Regina after

inoculation with a race avirulent on *Lr1* and *Lr3*. In the cv. Siria genes *Lr10* and *Lr13* were postulated by Park. Monosomic analysis of the leaf rust resistance of Siria (KOŠNER *et al.* 1998) revealed chromosome 1A as the critical one, i. e., carrying the resistance gene. Till now only *Lr10* has been located on chromosome 1A (MC INTOSH *et al.* 1998). However, this gene is not effective against our races avirulent on cv. Siria. Further studies are necessary to elucidate whether gene *Lr13* for adult plant resistance, postulated by Park in addition to *Lr10*, may be also involved in seedling resistance of cv. Siria. Enhancement of resistance has been described by KOLMER (1992) when gene *Lr13* was combined with other *Lr* genes. Unfortunately, he did not test the combination of *Lr13* with *Lr10*. Presence in cv. Siria of a gene other than those given above cannot be excluded either. Similarly, Park's postulation of *Lr3ka* in the cv. Blava does not completely agree with our results. Resistance of Blava to race 14 (isolate 333) and 14 SaBa (isolate 600) avirulent on *Lr3ka* is in agreement with postulation of *Lr3ka*; however, resistance to race 61 (isolate 1887) virulent on *Lr3ka* (BARTOŠ & HUSZÁR 1996) suggests presence of an additional gene or of another resistance gene effective against isolates 333, 600 and 1887.

Table 5. Geographic origin of the analyzed wheat leaf rust samples in 1997

District	Locality	Cultivar	Race
Strakonice	Libějovice	Hana	61SaBa*
Příbram	Příbram	Hana	61SaBa*
Praha	Praha-Ruzyně	Astella	61SaBa*
		Siria, Boka	2SaBa
Praha-východ	Stupice	Sparta, Sida	61SaBa*
		Hana	2SaBa, 77SaBa
	Sedlec	Alana	2SaBa
Trutnov	Vlčice	unknown	61SaBa*, 77SaBa
Litoměřice	Židovice-Hrobce	Saxana	61SaBa*
Chrudim	Uhřetice	Sparta	2SaBa, 77SaBa
Svitavy	Hradec nad Svitavou	Ebi	61SaBa*
	Mladějov	Samanta	61SaBa*
Hradec Králové	Nechanice	Saxana	61SaBa*, 77SaBa
Opava	Lipina	Samara	61SaBa*
Havlíčkův Brod	Lípa	Brea	61SaBa*
		Ebi	61SaBa*, 77/57SaBa
Brno	Chrlice	Saxana	77
Olomouc	Věrovany	Maja	61SaBa*, 77SaBa
		Sandra	61*
Kroměříž	Kroměříž	Ina	61SaBa*, 77SaBa
Znojmo	Branišovice	Samara, Bruta	2SaBa
		Siria	61SaBa*
		Ina	61SaBa*, 77SaBa
Břeclav	Lednice	Rexia	2SaBa, 77SaBa
		Boka, Hana	77SaBa
Uherské Hradiště	Uherský Ostroh	Hana	61SaBa*
Vsetín	Lešná	Bruta	61SaBa*, 77SaBa
	Janová	Regina	61SaBa*

In 1997 and 1998, ten winter wheat cultivars were listed as newly registered in the Czech Republic (Table 7). Specific leaf rust resistance was found in cvs. Alana, Šárka, Saskia, Tower, Elpa and Contra. Cv. Solara (SO 1269) showed a variable reaction only to one rust isolate. It was susceptible to all other isolates listed in Table 7, and to all six Slovak isolates used in earlier tests (BARTOŠ & HUSZÁR 1998). It is questionable whether cv. Solara possesses a gene for specific resistance. The results shown in Table 7 indicate that the cv. Saskia has *Lr3*, which has to be expected also from its pedigree (Hana/Viginta) as both parents possess *Lr3*. Reactions of the cv. Contra are similar to those conditioned by the combination of *Lr3* and *Lr26*. However, gene *Pm8* that is linked with *Lr26* has not been listed among *Pm* genes in cv. Contra (ANONYM 1992). Similarly, analysis of gliadins in the cv. Contra (ŠAŠEK, personal communication) has not confirmed the presence of Gld1B3 which is characteristic for the trans-

location 1BL/1RS that carries *Lr26*. PARK (personal communication) postulates *Lr13* (i.e., a gene for adult plant resistance) in cv. Contra. Additional experiments are needed for reliable conclusions on the genes for leaf rust resistance in this cultivar.

Among the registered cultivars the resistance of cv. Tower seems to be the most promising for the protection against our present population of leaf rust. However, field resistance of some cultivars also plays an important role in the protection against leaf rust.

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Table 6. Geographic origin of the analyzed wheat leaf rust samples in 1998

District	Locality	Cultivar	Race
Strakonice	Libějovice	Hana	61SaBa*
Chrudim	Uhřetice	Regina	6SaBa
		Bruta, Hana	61SaBa*
Třebíč	Jaroměřice	Alana, Šárka	77SaBa
Hradec Králové	Nechanice	Brea, Siria	61SaBa*
Trutnov	Trutnov	Ebi	61*
		Brea, Ebi	12SaBa
Svitavy	Svitavy	Samanta	61SaBa*
	Víska u Jevíčka	Bruta	61SaBa*
Bruntál	Rýmařov	Nela	61SaBa*
Opava	Třebom	Samanta	57SaBa
	Pusté Jakartice	unknown	61SaBa*
Prostějov	Hrubčice	Nela	77SaBa
		Alka	12SaBa
Přerov	Přerov	Brea	61SaBa*
Olomouc	Věrovany	Hana	77SaBa
		Bruta	61SaBa*
Kroměříž	Kroměříž	Hana	61SaBa*
	Ivanovice	Regina	61*
Znojmo	Braňšovice	Siria	61SaBa*
	Týn nad Bečvou	Vlada	57SaBa
Vsetín	Jablunka	Siria	61SaBa*
	Lešná	Hana	61*
Uherské Hradiště	Uherský Ostroh	Saskia, Bruta	61SaBa*
Břeclav	Lednice	Bruneta	77SaBa

Table 7. Reactions (infection types) of winter wheat cultivars registered in 1997 and 1998 to seven wheat leaf rust races / isolates

Isolate Race	14 333	14SaBa 600	57SaBa 4332	61 1887	61SaBa 628	77 347	77SaBa 1947
Alana	4	4	4	1-2	4	4	4
Ebi	4	4	4	4	4	4	4
Šárka	;1N	;N	3-	;	3	4	4
Versailles	3	3	3	3	4	4	3-
Saskia*	0	0;	4	4	4	4	4
Nela	3	3	3	4	4	3	3
Tower	0	0	;	;1-2	;1N	1-2	;1-2
Elpa	3(;1)	3	3-	;1(3)	3	3	3
Solara	4	3	3	4	3	;1-2-3	3
Contra	;1	0	3	;1-2	3	0	3

*registered in 1996, first listed in the List of registered cultivars in 1997

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Souhrn

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V letech 1997 a 1998 byla studována virulence v populaci rzi pšeničné na téměř izogenních liniích odrůdy Thatcher s geny *Lr1*, *Lr2a*, *Lr2b*, *Lr2c*, *Lr3*, *Lr9*, *Lr11*, *Lr15*, *Lr17*, *Lr19*, *Lr21*, *Lr23*, *Lr24*, *Lr26* a *Lr28*. Na těchto liniích bylo v roce 1997 rozlišeno jedenáct a v roce 1998 osm patotypů. Všechny vzorky rzi byly avirulentní na *Lr9*, *Lr19*, *Lr24* a *Lr28*. Jen menší počet vzorků byl virulentní na *Lr1*, *Lr2a* a *Lr2b*. Většina vzorků byla virulentní na *Lr2c*, *Lr11*, *Lr15*, *Lr17*, *Lr23* a *Lr26*. Všechny vzorky byly virulentní na *Lr3* a *Lr21*. Identifikované vzorky odpovídaly rasám 61SaBa*, 77SaBa, 2SaBa, 12SaBa, 57SaBa, 6SaBa, 61*, 77 a 6. V roce 1997 převažovaly rasy 61SaBa*, 77SaBa a 2SaBa a v roce 1998 rasy 61SaBa*, 77SaBa a 12SaBa. Rasy 6 a 6SaBa byly zjištěny poprvé. Jsou uváděny údaje o *Lr* genech v nově registrovaných odrůdách pšenice ozimé.

Klíčová slova: *Puccinia persistens* var. *tritici*, syn. *Puccinia recondita* f. sp. *tritici*; patotypy; fyziologické rasy; *Lr*-geny; pšenice ozimá; registrované odrůdy; Česká republika

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