Wheat Leaf Rust Races/Pathotypes in the Czech Republic in 1999–2000

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Abstract

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In 1999–2000 virulence of the wheat leaf rust population was studied on Thatcher near isogenic lines (NILs) with *Lr1*, *Lr2a*, *Lr2b*, *Lr2c*, *Lr3*, *Lr9*, *Lr10* (only in 2000), *Lr11*, *Lr15*, *Lr17*, *Lr19*, *Lr21*, *Lr23*, *Lr24*, *Lr26* and *Lr28*. On these NILs 11 pathotypes were determined in 1999, and 18 in 2000. 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*, *Lr21*, *Lr23* and *Lr26*. The identified pathotypes conformed with races 61SaBa, 77SaBa, 2SaBa, 12SaBa, 57SaBa, 6SaBa, 28SaBa, 61and 6. Races 61SaBa, 2SaBa and 77SaBa prevailed in 1999, races 61SaBa and 12SaBa were prevalent in 2000. Race 28SaBa was found for the first time. Data of the reactions to 15 leaf rust isolates of the recently registered winter wheat cultivars Niagara, Vlasta, Sulamit, Record, Ludwig, Apache, Semper, Drifter, Complet, Corsaire, Sepstra and Rialto are presented.

Keywords: *Puccinia persistens* subsp. *triticina*, syn. *Puccinia recondita* f. sp. *tritici*; pathotypes; physiologic races (races); *Lr*-genes; wheat; registered cultivars; Czech Republic

Breeding for leaf rust resistance is the most common and economic way to reduce losses caused by this fungus. Genetic variability of the pathogen leads to the development of new virulences matching the hitherto effective resistance genes. For this reason, resistance breeding is a continuous process. For successful breeding for resistance, the monitoring of changes of virulence in the pathogen population is of importance. In the Czech Republic the virulence carried by the leaf rust population is studied annually in (physiologic) race/pathotype surveys. This contribution presents data from the years 1999 and 2000.

MATERIAL AND METHODS

Collections of wheat leaf rust, caused by *Puccinia persistens* Plow. subsp. *triticina* (Eriks.) Urban et Marková, syn. *Puccinia recondita* f. sp. *tritici*, were obtained mainly from the trials of the Central Institute for Supervision and Testing in Agriculture and of plant breeding companies located in different areas of the Czech Republic. The field samples were increased on the susceptible cv. Diana. It, the recently registered cultivars, and the differentials were inoculated by rubbing the first leaf with a suspension of urediospores. Fifteen (16 in 2000) near-isogenic lines (NILs) of the cv. Thatcher possessing *Lr* genes listed in Tables 2 and 3 were used as differentials. Of samples that displayed mixed reactions on any of the differential, one to three single pustule isolates were taken, increased on Diana and tested again.

Inoculated plants were kept in closed glass cylinders for 24–48 h to provide high air humidity. Then, the plants were kept in open glass cylinders in the greenhouse at 18–22°C with supplemental (18 h) illumination by 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.

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The term race (= physiologic race) was used when determined isolates were designated with numbers according to JOHNSTON and BROWDER (1966), the term pathotype in relation to reactions on NILs.

Seed of winter wheat cultivars registered in 1999–2000 originated from the Central Institute for Supervision and Testing in Agriculture. Near-isogenic Thatcher Lr-lines with *Lr3*, *Lr10*, *Lr13* and *Lr26* were added to one set of the tested cultivars. For the tests old isolates from the leaf rust collection and new isolates from the survey of 2000 were used: 9021SPB from Rokytnice, distr. Přerov, cv. unknown, race 61SaBa; 9018SP from Křenovice, distr. Přerov, cv. unknown, race 61; 9016SPB from Bohutice, distr. Znojmo, cv. Boka, race 57SaBa; 9002SPB from Pusté Jakartice, distr. Opava, cv. Saskia, race 2SaBa; 9009SPB from Uherský Ostroh, distr. Uherské Hradiště, cv. Saskia, race 61SaBa; 9017SP from Kroměříž, distr. Kroměříž, cv. unknown, race 61SaBa; 9016SP from Bohutice, distr. Znojmo, cv. Boka, race 6SaBa; 9017SPB from Kroměříž, distr. Kroměříž, cv. unknown, race 77SaBa.

RESULTS

Almost half of the leaf rust samples analyzed in 1999 belonged to race 61SaBa, followed by races 2SaBa and 77SaBa. In 2000, races 61SaBa and 12SaBa predominated (Table 1). Other races, such as 57SaBa, 6SaBa, 6, 61 and 28SaBa, were represented only by one to four samples. Race 28SaBa was identified for the first time.

In 1999, 11 pathotypes were differentiated on the 15 NILs (Table 2), and in 2000 the 16 NILs differentiated 18 pathotypes (Table 3). In 1999 three, in 2000 six pathotypes belonged to race 61SaBa. In 2000 five pathotypes belonged to race 12SaBa and two pathotypes to race 57SaBa. In 1999 three pathotypes represented race 2SaBa.

No virulence on *Lr9*, *Lr19*, *Lr24* and *Lr28* was found, there was low frequency of virulence on *Lr1*, *Lr2a* (9–18%) and a higher frequency on *Lr2b* (21–34%). In 1999, all isolates were virulent on *Lr3*, *Lr11*, *Lr15* and *Lr17*, and in 2000 on *Lr3* and *Lr21*. In 1999, only one isolate, and in 2000 two isolates avirulent on *Lr26* were determined.

In 1999 the rust samples originated from 25 locations, in 2000 from 23 locations. At about half of the locations (46% in 1999 and 57% in 2000) race 61SaBa was found. Isolates of race 77SaBa and related race 57SaBa originated from Moravia, except one from central Bohemia (Table 4).

Tests of the recently registered winter wheat cultivars showed that all cultivars, except Sulamit and probably also Record and Vlasta, carry specific genes for leaf rust resistance. Inoculation with old pathotypes that represented seven races from the collection (Table 5) enabled a more detailed differentiation of the cultivars according to their reaction pattern than inoculation with new isolates of 2000 (Table 6), although the latter also represented seven pathotypes (at least): isolate 9021SPB (race 61SaBa) gave different reactions than isolates 9009SPB and 9017SP (both race 61SaBa). The old isolates revealed 10 patterns of virulence, while the new isolates gave only four to five virulence patterns on the tested cultivars. The cvs Semper, Drifter and Complet displayed similar reaction patterns in both tests. In the tests with new isolates the cvs Niagara, Record, Vlasta, Sulamit and Ludwig were susceptible to all of them. In the test with old isolates only cv. Sulamit was susceptible to all of them, Record showed an intermediate reaction to one isolate, Vlasta had a small proportion of plants with a resistant reaction to two isolates, and cv. Ludwig showed 2N and 2–3 infection type to two pathotypes. Cv. Apache showed resistance to three old isolates, but only to one new isolate. Corsaire was resistant to four old, but only to one new isolate, and cv. Rialto gave a resistant or intermediate reaction to six old, but only to three new isolates.

Table 1. Wheat leaf rust races determined in 1999 and 2000

Race	1999				2000			
	Number of samples	%	Number of localities	%	Number of samples	%	Number of localities	%
61SaBa	15	45	15	46	19	54	13	57
12SaBa	1	3	1	3	8	23	8	35
57SaBa	1	3	1	3	3	9	3	13
2SaBa	9	27	9	28	1	3	1	4
77SaBa	5	15	4	12	1	3	1	4
6SaBa	–	–	–	–	1	3	1	4
28SaBa	1	3	1	3	–	–	–	–
6	–	–	–	–	1	3	1	4
61	1	3	1	3	1	3	1	4
Total	33		25	–	35		23	–

Table 2. Virulence spectra of wheat leaf rust samples on Lr-near isogenic lines (NILs) in 1999

NIL	Leaf rust pathotypes											Frequency of virulence %
	a	b	c	d	e	f	g	h	i	j	k	
Lr1	R	R	R	R	R	R	R	S	R	R	S	18
Lr2a	R	R	R	R	R	R	R	S	R	S	R	12
Lr2b	R	R	R	R	R	R	R	S	S	S	R	21
Lr2c	S	S	S	S	R	R	R	S	S	S	R	70
Lr3a	S	S	S	S	S	S	S	S	S	S	S	100
Lr9	R	R	R	R	R	R	R	R	R	R	R	0
Lr11	S	S	S	S	S	S	S	S	S	S	S	100
Lr15	S	S	S	S	S	S	S	S	S	S	S	100
Lr17	S	S	S	S	S	S	S	S	S	S	S	100
Lr19	R	R	R	R	R	R	R	R	R	R	R	0
Lr21	S	S	R	S	S	S	R	S	S	S	R	85
Lr23	S	R	S	R	R	S	R	S	S	R	S	67
Lr24	R	R	R	R	R	R	R	R	R	R	R	0
Lr26	S	S	S	R	S	S	S	S	S	S	S	97
Lr28	R	R	R	R	R	R	R	R	R	R	R	0
Number of isolates	10	4	1	1	2	4	3	5	1	1	1	Total 33
Conformed with race	61SaBa			61	2SaBa			77SaBa	12SaBa	57SaBa	28SaBa	

Table 3. Virulence spectra of wheat leaf rust samples on Lr-near isogenic lines (NILs) in 2000

NIL	Leaf rust pathotypes																		Frequency of virulence (%)
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	
Lr1	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	S	S	9
Lr2a	R	R	R	R	R	R	R	R	R	R	R	R	S	S	S	R	R	R	11
Lr2b	R	R	R	R	R	R	R	S	S	S	S	S	S	S	S	R	R	R	34
Lr2c	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	R	S	S	97
Lr3a	S	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	R	0
Lr10	S	S	S	R	S	S	R	S	S	S	S	S	R	S	S	S	R	S	86
Lr11	S	S	S	S	S	S	S	S	S	S	S	S	R	S	S	S	S	S	97
Lr15	S	S	R	R	S	R	R	S	R	S	R	R	S	S	S	S	R	S	71
Lr17	S	S	S	S	R	S	S	S	R	S	S	S	S	S	S	S	S	S	94
Lr19	R	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	S	100
Lr23	S	R	R	S	R	S	S	S	S	R	R	R	R	R	R	R	S	R	51
Lr24	R	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	R	S	S	S	S	S	S	S	S	S	R	S	94
Lr28	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	0
Number of isolates	1	4	3	1	1	1	1	4	1	1	1	1	2	1	1	1	1	1	Total 35
Conformed with race	61 SaBa						61	12 SaBa					57 SaBa		77 SaBa	2 SaBa	6	6 SaBa	–

Table 4. Geographic origin of leaf rust samples in 1999–2000 (Districts arranged in alphabetic order)

District	Locality	Cultivar	Race
1999			
Břeclav	Lednice	Brea	57SaBa
Bruntál	Rýmařov	Linda	77SaBa
Havl. Brod	Lípa	unknown	2SaBa
Chrudim	Úhřetice	unknovn	2SaBa
Kolín	Velim	Vega	2SaBa
Kroměříž	Kroměříž	Siria	2SaBa
Kroměříž	Kroměříž	Astella	61SaBa
Kroměříž	Vlčí Doly	Ilona	61SaBa
Mikulov	Lednice	unknown	2SaBa
Plzeň	Plzeň	Samanta	2SaBa
Praha	Praha 6-Ruzyně	Samara	61
Praha	Praha 6-Ruzyně	Siria	61SaBa
Praha-východ	Stupice	Sulamit	61SaBa
Praha-východ	Stupice	Saxana	28SaBa
Praha-západ	Kněževes	Samanta	2SaBa
Rakovník	Branov	unknown	77SaBa
Rychnov n. Kn.	Rychnov n. Kn.	Trane	61SaBa
Svitavy	Vidlatá Seč	Siria	61SaBa
Třebíč	Jaroměřice n. Rok.	unknown	61SaBa
Trutnov	Trutnov	unknown	2SaBa
Trutnov	Trutnov	Alka	61SaBa
Uherské Hradiště	Uherský Ostroh	Brea	2SaBa,77SaBa
Uherské Hradiště	Uherský Ostroh	Samanta	12SaBa
Ústí n. Orlicí	Ústí n/Orlicí	unknown	61SaBa
Ústí n. Orlicí	Demoradice	Siria	61SaBa
Vsetín	Střelná	Nela	61SaBa
Vsetín	Horní Lideč	Nela	77SaBa
Znojmo	Olbramovice	Niagara	61SaBa
Znojmo	Olbramovice	Nela	77SaBa
Znojmo	Branišovice	Šárka	61SaBa
Znojmo	Branišovice	Vlasta	61SaBa
Žďár n. S.	Rodkov	Sandra	61SaBa
2000			
Břeclav	Lednice	unknown	61SaBa, 12SaBa
Chrudim	Vestec	unknown	61SaBa
Chrudim	Hlinsko	unknown	12SaBa
Kladno	Podkozí	unknown	61 SaBa
Kroměříž	Kroměříž	unknown	61SaBa, 77SaBa
Kutná Hora	Kutná Hora	unknown	61SaBa
Nový Jičín	Loučka	Versailles	61SaBa
Olomouc	Věrovany	Alka	12SaBa
Opava	Pusté Jakartice	unknown	61SaBa, 2SaBa
Pelhřimov	Humpolec	Ritmo	61SaBa
Plzeň-sever	Krukanice	unknown	12SaBa
Praha-východ	Stupice	unknown	61SaBa
Prostějov	Hrubčice	Hana	12SaBa
Přerov	Rokytnice	unknown	61SaBa, 57SaBa
Přerov	Křenovice	unknown	61, 6
Přerov	Žákovice	unknown	12SaBa
Tachov	Pernolec	unknown	12SaBa
Trutnov	Trutnov	Elpa	12SaBa
Uherské Hradiště	Uherský Ostroh	Saskia	61SaBa
Znojmo	Branišovice	unknown	57SaBa
Znojmo	Znojmo	Contra	61SaBa
Znojmo	Bohutice	Boka	6SaBa, 57SaBa
Žďár n. Sázavou	Lísek	unknown	61SaBa
Žďár n. Sázavou	Žákovice	unknown	12SaBa

DISCUSSION

Race spectra in the foregoing years 1997–1998 (BARTOŠ & STUCHLÍKOVÁ 1999) were very similar to those found in 1999–2000. In both periods the most widespread race was 61SaBa; its occurrence in 1997 was 50%, in 1998 it was 53%, in 1999 it was 45%, and in 2000 54%. Of other and less frequent races determined in 1999–2000 all except 28SaBa were also found at least in one of the two previous years. Whereas race 2SaBa was represented by eight samples in 1997, it was not found in 1998, but nine samples were identified as 2SaBa in 1999 and one sample in 2000. The frequency of race 77SaBa was 25% in 1997 and 17% in 1998, was lower in 1999 (15%) and much so in 2000 (only 3%). No virulence on *Lr9*, *Lr19*, *Lr24* and *Lr28* was found in 1999–2000, nor in the earlier period of 1997–1998 (BARTOŠ & STUCHLÍKOVÁ 1999).

The origin of the races determined by us can be explained by single step mutations in two groups of races. One group is represented by races 2, 61, 12, 28 and 6, the other by races 57 and 77. From race 61 race 2 differs by avirulence on *Lr2c* (Loros), race 6 by virulence on *Lr1* (Malakof), and race 12 by virulence on *Lr2b* (Carina). Race 28 differs from race 2 by virulence on *Lr1* (Malakof). Race 57 differs from race 77 by avirulence on *Lr1* (Malakof). The development of new pathotypes by mutations was reported e.g. for Australia (PARK *et al.* 1995).

In most surveys, rust samples are taken at random with the intention to cover the whole studied region instead of all grown cultivars. We did likewise and did not select the cultivars from which rust samples were taken. It can be assumed that they were chosen because of considerable incidence of leaf rust on them. Often the cultivar was not known.

Table 5. Reactions of winter wheat cultivars registered in 1999–2000 to seven leaf rust isolates representing different races

Cultivar	333 B 14	4332 57 SaBa	628 61 SaBa	1887 61	600 14 SaBa	347 77	1947 77 SaBa
Niagara	0;	3–	3	3	0;	3	3–
Record	3	3	3	2–3	3	3	3
Vlasta	3[;]	3	3	3	3[;]	3	3
Sulamit	3	3	3	3	3	3	3
Ludwig	2N	3	2–3	3	3	3	3
Apache	;1N	3	;1N	3-	;1–2+	3	3
Semper	;1	3	;1N	3+	3	3	3–
Drifter	;1	3	1-2	3	3	3	3–
Complet	;1	0;	1-2	3	3	3	3–
Corsaire	;1–2N	3;	;1	1-2	;1–2+	3	3
Sepstra	;1–2	0;	;1	2	3–	2+	;1
Rialto	0	0;	2–3	0	3–	0	;

Table 6. Reaction of winter wheat cultivars registered in 1999–2000 to eight leaf rust isolates from the 2000 survey

Cultivar	9021 SPB	9018 SP	9016 SPB	9002 SPB	9009 SPB	9017 SP	9016 SP	9017 SPB
Niagara	3	3	3	3	3	3	3	3
Record	3	3	3	3	3	3	3	3
Vlasta	3	3	3	3	3	3	3	3
Sulamit	3	3	3	3	3	3	3	3
Ludwig	3	3	3	3	3	3	3	3
Apache	;1	3	3	3-	3	3-	3	3–
Semper	1–2	3	3	3-	3	3-	3	3
Drifter	1–2	3	3	3	3	3	3	3
Complet	1–2	3-	3	3	3	3	3	3–
Corsaire	2+	3	3	3	3	3	3	3
Sepstra	3–	;1	;	3-	3	3	;1	3–
Rialto	3–	0	;1	3	3	3	1–2	3–
NIL Lr10	3–	;1	;1	3	3–	3	2	3
NIL Lr13	;1–2	3	3–	3–	3–	3–	3	3–
NIL Lr26	3	0	3	3	3	3	3	3
NIL Lr3	3	3	3	3	3	3	3	3

Our results conform relatively well with results of other race surveys as far as the number of determined pathotypes is concerned. E.g. in Hungary, MANNINGER (2000) determined 32 pathotypes from 133 analysed isolates on 15 Lr NILs. On the same set of NILs we determined in the same year 1999 11 pathotypes from 33 samples, in 2000 on the same set with addition of Lr10 NIL 18 pathotypes from 35 samples. In France, GOYEAU (2000) determined 32 pathotypes from 123 samples taken from 100 plants on 17 NILs in one evaluation. In another evaluation carried out on the same field she determined 30 pathotypes from 129 samples taken from only five plants.

There is also relatively good agreement with the results from Hungary in the proportion of the most important races to other races. In our surveys the three prevailing races were represented by 87% of the samples in 1999 and 86% in 2000; in the experiments carried out by MANNINGER (2000) the three dominant races formed 83.4% of the analysed samples in 1999.

A comparison of results from different countries with our data on virulence in the leaf rust population are important for resistance breeding in wheat, as well as for the study of leaf rust epidemiology. Our results on the determined pathotypes and frequency of their occurrence are similar to the results from Hungary where races 12, 61 and 77 predominated in 1999 (MANNINGER 2000). These races (virulent on *Lr26*) prevailed in the Czech Republic in 1998 (BARTOŠ & STUCHLÍKOVÁ 1999). In 1999, race 12SaBa

was determined only from one rust sample, whereas in 2000 race 12SaBa was again among the most widespread races, together with races 61SaBa and 57SaBa. The latter was also found in Hungary in 1999 (frequency 4.5%). A comparison of virulence frequency on Lr NILs shows a similar trend on all of them except Lr23, where we found a higher frequency of virulence. A race survey from Slovakia (BARTOŠ *et al.* unpublished) also shows significant similarities. In all three countries, NILs possessing *Lr9*, *Lr19*, *Lr24* and *Lr28* were resistant to all leaf rust isolates.

GULTYAEVA *et al.* (2000) presented results from Germany and the European part of Russia for the years 1996–1999. In 1999, in the European part of Russia, virulence on *Lr9*, *Lr19* and *Lr24* was not found, but 10% of the isolates were virulent on *Lr28*. Virulence on *Lr1* and *Lr2a* was found in 54% of the isolates; less than 50% of them (49%, 37% and 11%) were virulent on *Lr15*, *Lr23* and *Lr26*, respectively. If we consider the large area and different cultivars from which the samples originated, the differences between the results from the European part of Russia and the Czech Republic are relatively small. More significant differences appear if we compare our results with those from Germany where isolates with virulence on *Lr19* (5.2%), *Lr24* (10.3%) and *Lr28* (46.6%) were found in 1999 (GULTYAEVA *et al.* 2000). Less than 50% of the isolates were virulent on *Lr23*.

MESTERHÁZY *et al.* (2000) summarized the results from the international trials (COST action 817) and concluded that in 1998, when the most comprehensive data were obtained from France, Germany, Italy, Spain, Hungary, Poland, Bulgaria, Rumania, Slovakia and the Czech Republic, the countries had very few pathotypes in common. In the year 1995 PARK and FELSENSTEIN (1998) found four predominant and widespread pathotypes in western Europe. These pathotypes were similar to those present in former Czechoslovakia for up to 20 years. Conclusions on similarities or dissimilarities in virulence patterns largely depend on the number and choice of resistance genes on which the reaction patterns are compared.

The comparison of molecular and virulence polymorphism of leaf rust isolates, as it was carried out e.g. in Canada (KOLMER 2000) and on a smaller scale also in Europe (PARK *et al.* 2001a,b), could substantially contribute to the study on relations between rust populations of different European countries.

Data from virulence surveys are also important for estimating the potential losses due to the leaf rust pathotypes that overcome genes for resistance in the registered cultivars. For this reason, knowledge of resistance genes in the cultivars is of importance. Our tests allowed us to postulate the presence of resistance genes or at least similarity of resistance genes according to the reactions to 15 leaf rust isolates. The reaction patterns of the cv. Sepstra may indicate presence of *Lr10*. Gene *Lr10* was determined earlier in cv. Rialto by a molecular marker (BLAŽKOVÁ *et al.* 2001); genes *Lr13* and *Lr26* were postulated in this cultivar by its reactions. In our tests, cv. Sepstra had reactions similar to Rialto to most isolates except 628. However, reactions of cv. Sepstra to all isolates avirulent on *Lr26* were higher than of cv. Rialto that displayed 0IT, typical for *Lr26*. This suggests that, unlike Rialto, Sepstra does not carry *Lr26*. In cv. Corsaire resistance gene *Lr37* may govern leaf rust resistance as it has cv. Rendezvous possessing *Lr37* in its pedigree. In our tests, cv. Corsaire was resistant to 5 of 15 isolates. Cv. Niagara, as well as a small part of plants of cv. Vlasta, were resistant only to two isolates avirulent on *Lr3* (333B and 600). In the pedigree of cv. Niagara (Danubia/Viginta//Ilona), the cv. Viginta possesses *Lr3*. In the pedigree of Vlasta (Brimstone/Š13//Hana) it is Hana that has *Lr3*. This supports our postulation of *Lr3* in cv. Niagara and in some plants of Vlasta. Genes for leaf rust resistance in cvs Semper, Drifter and Complet are probably identical. The resistance of cv. Apache may be governed by the same gene(s) and an additional one; its reaction differed from cvs Semper, Drifter and Complet only by resistance to one isolate.

Of the postulated genes in the recently registered winter wheat cultivars, the most important one may be *Lr37*, particularly as an adult plant resistance gene and because virulence for *Lr37* has not been recorded in Europe to date (WINZELER *et al.* 2000). It is derived from *Aegilops ventricosa* and is linked to *Sr38* and *Yr 17*. Resistance gene *Lr10* may contribute to relatively good resistance, even more so in combination with *Lr13* in certain genetic backgrounds as e.g. in cvs Siria and Alka.

Besides specific resistance that is effective in all growth stages, partial and adult plant resistance that mostly cannot be revealed in seedling tests, could play an important role in the resistance of wheat to leaf rust under field conditions. It is more widespread than generally assumed. E.g. WINZELER *et al.* (1995) examined 250 European winter wheat cultivars and found that 86% of the entries had a component of adult plant resistance to leaf rust. In recent international trials in 10 European countries, WINZELER *et al.* (2000) tested 72 cultivars and breeding lines under field conditions and postulated adult plant resistance or partial resistance in combination with *Lr* genes in 50 entries. More experimental work is needed to clarify the role of genetic components of resistance as manifested in the field, and future resistance breeding and wheat production can benefit greatly from such research programmes.

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References

BARTOŠ P., STUCHLÍKOVÁ E. (1999): Wheat leaf rust races/pathotypes in the Czech Republic in 1997–1998. Plant Protect. Sci., **35**: 51–56.

BLAŽKOVA V., BARTOŠ P., PARK R.F., GOYEAU H. (2001): Verifying the presence of leaf rust resistance gene *Lr10* in sixteen wheat cultivars by use of a PCR-based STS marker. Cereal Res. Commun. (submitted).

GOYEAU H. (2000): Spatial organisation of diversity for virulence in wheat leaf rust in France. Consequences on sampling of populations. Acta Phytopathol. Entomol. Hung., **35**: 279–285.

GULTYAEVA E., WALTHER U., KOPAHNKE D., MIKHAILOVA L. (2000): Virulence of *Puccinia recondita* Rob. ex Desm. f. sp. *tritici* in Germany and European part of Russia in 1996–1999. Acta Phytopathol. Entomol. Hung., **35**: 409–412.

JOHNSTON C.O., BROWDER L.E. (1966): Seventh revision of the international register of physiologic races of *Puccinia recondita* f. sp. *tritici*. Plant. Dis. Reptr., **50**: 756–760.

MANNINGER K. (2000): Virulence survey of wheat leaf rust in Hungary: Races/pathotypes in 1999. Acta Phytopathol. Entomol. Hung., **35**: 421–428.

MESTERHÁZY A., BARTOŠ P., GOYEAU H., NIKS R.E., CSÖSZ M., ANDERSEN O., CASULLI F., ITTU M., JONES E., MANISTERSKI J., MANNINGER K., PASQUINI M., RUBIALES D., SCHACHERMAYR G., STRZEMBICKA A., SZUNICS L., TODOROVA M., UNGER O., VANČO B., VIDA G., WALTHER U. (2000): European virulence survey for leaf rust in wheat. Agronomie, **20**: 793–804.

KOLMER J.A. (2000): Molecular and virulence polymorphism in clonal lineages of the wheat leaf rust fungus, *Puccinia triticina*, in Canada. Acta Phytopathol. Entomol. Hung., **35**: 201–207.

PARK R.F., BURDON J.J., MCINTOSH R.A. (1995): Studies on the origin, spread and evolution of an important group of *Puccinia recondita* f. sp. *tritici* pathotypes in Australasia. Eur. J. Plant Pathol., **101**: 613–622.

PARK R.F., FELSENSTEIN F.G. (1998): Physiological specialization and pathotype distribution of *Puccinia recondita* in western Europe, 1995. Plant Pathol., **47**: 157–164.

PARK R.F., GOYEAU H., FELSENSTEIN F.G., BARTOŠ P., ZELLER F.J. (2001a): Regional phenotypic diversity of *Puccinia recondita* f. sp. *tritici* and host resistance in western Europe, 1995. (submitted).

PARK R.F., JAHOOR A., FELSENSTEIN R.G. (2001b): Population structure of *Puccinia recondita* in western Europe during 1995, as assessed by variability in pathogenicity and molecular markers. J. Phytopathol. (submitted).

STAKMAN E.C., STEWART P.M., LOEGERING W.Q. (1962): Identification of physiologic races of *Puccinia graminis* var. *tritici*. Minn. Agric. Exp. Sci. J. Ser. Paper: 4691.

WINZELER M., WINZELER H., KELLER B., STRECKEISEN PH., HITZ S., MESSMER M., SCHACHERMAYR G., FEUILLET C. (1995): Strategien der Züchtung auf Braunrostresistenz bei Weizen. Bericht 46. Arb.-Tag. Arb.-Gem. Saatzuchtl., Verein. österr. Pfl.-Zücht., BAL Gumpenstein, **46**: 83–88.

WINZELER M., MESTERHÁZY A., PARK R.F., BARTOŠ P., CSÖSZ M., GOYEAU H., ITTU M., JONES E., LÖSCHENBERGER F., MANNINGER K., PASQUINI M., RICHTER K., RUBIALES D., SCHACHERMAYR G., STRZEMBICKA A., TROTTET M., UNGER O., VIDA G., WALTHER U. (2000): Resistance of European winter wheat germplasm to leaf rust. Agronomie, **20**: 783–792.

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Souhrn

BARTOŠ P., HANZALOVÁ A., STUCHLÍKOVÁ E. (2001): **Rasy/patotypy rzi pšeničné v České republice v letech 1999 až 2000**. Plant Protect. Sci., **37**: 10–16.

V letech 1999–2000 jsme studovali virulenci rzi pšeničné na téměř izogenních liniích odrůdy Thatcher s geny *Lr1*, *Lr2a*, *Lr2b*, *Lr2c*, *Lr3*, *Lr9*, *Lr10* (jen rok 2000), *Lr11*, *Lr15*, *Lr17*, *Lr19*, *Lr21*, *Lr23*, *Lr24*, *Lr26* a *Lr28*. Na těchto liniích bylo v roce 1999 určeno 11 patotypů a v roce 2000 18 patotypů. Všechny analyzované vzorky rzi byly avirulentní na *Lr9*, *Lr19*, *Lr24* a *Lr28*. Relativně nízká četnost virulence byla zjištěna na *Lr1*, *Lr2a* a *Lr2b*. Většina vzorků rzi byla virulentní na *Lr2c*, *Lr11*, *Lr15*, *Lr17*, *Lr21*, *Lr23* a *Lr26*. Identifikované patotypy byly shodné s rasami 61SaBa, 77SaBa, 2SaBa, 12SaBa, 57SaBa, 6SaBa, 28SaBa, 61 a 6. Rasy 61SaBa, 2SaBa a 77SaBa převládaly v roce 1999, rasy 61SaBa a 12SaBa v roce 2000. Rasa 28SaBa byla zjištěna poprvé. Jsou uvedeny reakce odrůd registrovaných v letech 1999–2000 (Niagara, Vlasta, Sulamit, Record, Ludwig, Apache, Semper, Drifter, Complet, Corsaire, Sepstra a Rialto) k 15 izolátům rzi pšeničné.

Klíčová slova: *Puccinia persistens* subsp. *triticina* (Eriks.) Urban et Marková, syn. *Puccinia recondita* f. sp. *tritici*; (fyziologické) rasy; patotypy, pšenice; zapsané odrůdy; Česká republika

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