

Physiological Specialization of *Puccinia triticina* on Wheat and Triticale in Hungary in 2004

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Isolates of *Puccinia triticina* were obtained from wheat and triticale nurseries and fields in Hungary. Pathotypes were determined on 15 Thatcher wheat lines that are near-isogenic for leaf rust resistance. Thirteen pathotypes were identified from 70 *Puccinia triticina* isolates collected from infected wheat plants, and 2 pathotypes were identified from 12 *Puccinia triticina* isolates obtained from infected triticale leaves.

Most pathotypes identified in Hungary were virulent to resistance genes Lr2b, Lr2c, Lr3, Lr11, Lr17, Lr21, Lr26, but pathotypes from triticale were virulent only to Lr2b, Lr2c and Lr11. Among the examined 15 Lr genes Lr2a, Lr9, Lr19, Lr23, Lr24 and Lr28 were highly effective. The most common pathotypes were 43522, 43722 and 53522 on wheat plants, among them 53522 was new in rust populations. Pathotypes 41000 and 41100 obtained from infected triticale plants were identified for the first time in the Hungarian *Puccinia triticina* populations.

The number of pathotypes with virulence to Lr1, Lr2b and Lr21 increased from 1999 to 2004. Virulence to other Lr genes declined, because a lot of susceptible cultivars were removed from production during the past five years. In 2004, most predominant cultivars grown in Hungary were resistant or moderately resistant to leaf rust.

Keywords: wheat, triticale, leaf rust, *Puccinia triticina*, pathotypes.

Leaf rust caused by *Puccinia triticina* is an important disease worldwide. *Triticum* species and the man-made crop triticale (cereal hybrid by crossing wheat with rye) are the main hosts of this fungi (Park et al., 2000). Severe early infections can cause significant yield losses, mainly by reducing the number of kernel per spike, test weights and kernel quality (Park et al., 2000). The stable grain production depends highly on the successful protection against leaf rust in many growing regions. The use of resistant cultivars as an alternative approach to chemical control is environmentally safe and economically more effective. More than 45 resistance genes against wheat leaf rust (Lr genes) have been described and used in wheat breeding (Mc Intosh et al., 1995). Each of these resistance genes will provide excellent resistance against some pathotypes, but none of them can be expected to work against all pathotypes. Genetic studies with rust fungi have shown that every resistance gene in the host plant can be matched by a corresponding virulence gene in the rust fungus that will allow the fungus to overcome that resistance.

Adaptation of rust fungi populations to their wheat host cultivars has been widely documented (Kolmer, 1999). Novel leaf rust pathotypes constantly appear in rust populations, therefore new resistant wheat varieties must be developed and plant breeders must be informed about the appearance of new pathotypes in their growing areas (Winzeler et al., 2000.; Mesterházy et al., 2000; Kolmer et al., 2004, 2005).

National surveys for leaf rust provide valuable information for breeders on the distribution and frequency of pathotypes. Determination of resistance of winter wheat cultivars to leaf rust helps farmers to make successful cultivar policies.

The aim of this study was to detect new pathotypes of *Puccinia triticina* and to determine the leaf rust resistance of predominant cultivars grown in Hungary.

Materials and Methods

Leaf rust sample collection, inoculations and wheat differential set

Rusted leaf samples were collected in June 2004 from a national trial network on unsprayed wheat and triticale plots and fields in Hungary. Single pustule isolates were established from leaf rust samples (70 from wheat, 12 from triticale), which were then individually applied to isogenic Thatcher wheat differential sets. Infected seedlings were set in dew chamber at 80–100% relative humidity at 15–18 °C for 20 hours. After the incubation the infected plants were transferred to climate chambers at 20 °C with 16/8 h light (1000 W)-dark photoperiods. Infection types on isogenic wheat lines were evaluated at 10 to 14 days after inoculation using the infection type nomenclature of Stakman et al. (1962). Virulence of leaf rust isolates were characterized with infection types 3 to 4, while avirulence of isolates with 0 to 2+ at seedling stage.

Pathotypes and distribution frequency of pathotypes were identified on a differential set of 15 near isogenic wheat lines with resistance genes Lr1, Lr2a, Lr2b, Lr2c, Lr3, Lr9, Lr11, Lr15, Lr17, Lr19, Lr21, Lr23, Lr24, Lr26 and Lr28. The differential set and nomenclature of pathotype was recommended by members of Working Group of Cost Action 817 (Ostergard and Coudert, 1997; Manninger, 2000).

Cultivar experiments

The experiments were conducted under field conditions at Bóly, Kecskemét, Mosonmagyaróvár and Táplánszentkereszt (Hungary) in 1999 and in 2004. Resistance against leaf rust of 21 Hungarian winter wheat and 8 winter triticale cultivars were tested at adult stage. Natural infection symptoms were evaluated by the modified Cobb's scale (Király et al., 1974).

Eleven winter wheat and eight winter triticale cultivars were tested at seedling stage. The inoculation method was identical to that described in the inoculation procedure.

Results and Discussion

Survey results

In 2004 the population of *Puccinia triticina* in Hungary was highly diverse for virulence pathotypes (races). From all collected samples 82 were selected and single pustule isolates were established (70 from wheat and 12 from triticale). From 70 isolates 11 pathotypes, from 12 isolates 2 pathotypes were identified (Table 1).

Table 1

Pathotypes of *Puccinia triticina* in Hungary, 2004

Pathotype	Origin	Number of isolates	Frequency %	Virulent on wheat isogenic lines with Lr genes
03502	wheat	2	2.4	Lr2c, Lr3, Lr11, Lr17, Lr26
03722	wheat	1	1.2	Lr2c, Lr3, Lr11, Lr17, Lr21, Lr26
13422	wheat	1	1.2	Lr1, Lr2c, Lr3, Lr17, Lr21, Lr26
13622	wheat	1	1.2	Lr1, Lr2c, Lr3, Lr15, Lr17, Lr21, Lr26
43502	wheat	6	7.3	Lr2b, Lr2c, Lr3, Lr11, Lr17, Lr26
43522	wheat	19	23.2	Lr2b, Lr2c, Lr3, Lr11, Lr17, Lr21, Lr26
43702	wheat	1	1.2	Lr2b, Lr2c, Lr3, Lr11, Lr15, Lr17, Lr26
43722	wheat	18	22	Lr2b, Lr2c, Lr3, Lr11, Lr15, Lr17, Lr21, Lr26
53502	wheat	1	1.2	Lr1, Lr2b, Lr2c, Lr3, Lr11, Lr17, Lr26
53522	wheat	16	19.5	Lr1, Lr2b, Lr2c, Lr3, Lr11, Lr17, Lr26
53722	wheat	4	4.9	Lr1, Lr2b, Lr2c, Lr3, Lr11, Lr17, Lr21, Lr26
41000	triticale	9	11	Lr2b, Lr2c
41100	triticale	3	3.7	Lr2b, Lr2c, Lr11
Sum		82	100	

Marked differences between the pathotypes were observed on isogenic wheat lines Lr1, Lr2b, Lr11, Lr15 and Lr21. More than 50% of pathotypes were virulent to Lr2b, Lr2c, Lr3, Lr11, Lr17, Lr21 and Lr26. Pathotypes collected from infected triticale plants were virulent on Lr2b, Lr2c and Lr11 only.

Seven novel pathotypes were detected for the first time in Hungary in 2004 among the 13 pathotypes investigated. Virulence pathotypes 43522, 43722 and 53522 were found in all regions of Hungary from the rust samples collected. The most common pathotypes were 43522 and 43722, which accounted for 20–25% of the leaf rust population. Pathotype 43722 was detected with very low frequency in Hungary in 1990, but later the frequency increased and reached 65.4% in 1999. Interestingly, the frequency of the new pathotype 53522 was unusually high (19.5%) among the new pathotypes.

All isolates were virulent on the Lr2c isogenic line. Virulence to Lr1, Lr2b and Lr21 has increased, although virulence to most other Lr genes has decreased from 1999 to 2004 (Fig. 1). In 2004 the resistance genes Lr2a, Lr9, Lr19, Lr23, Lr24 and Lr28 were highly effective among the tested Lr genes, and provided good protection against leaf rust.

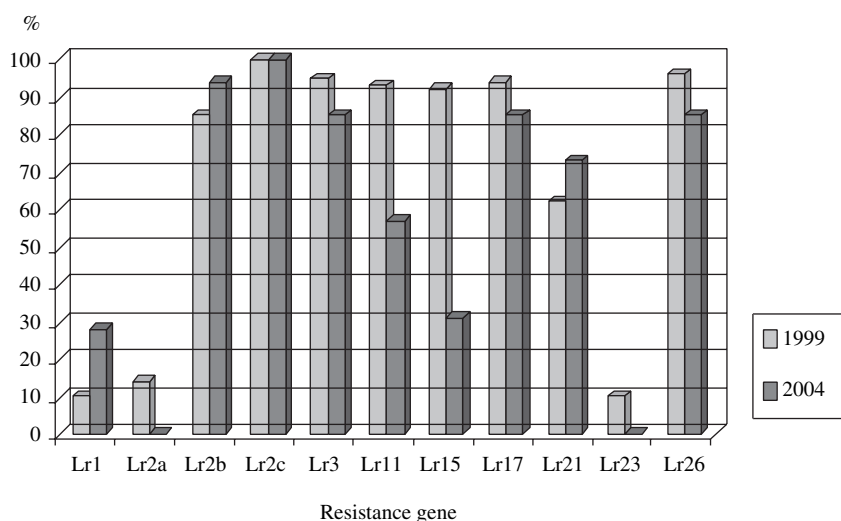


Fig. 1. Alterations in the virulence of leaf rust population evaluated on Lr isogenic wheat lines in Hungary from 1999 to 2004

Resistance of winter wheat cultivars to leaf rust

Resistance of Hungarian winter wheat cultivars against leaf rust was tested at adult stage in the field in 1999 and 2004 (Tables 2 and 3). Under natural infection conditions the disease severity differed highly between these years. In 1999 the predominant Hungarian cul-

Table 2

Leaf rust resistance of wheat cultivars bred at Martonvásár and produced on significant growing areas in Hungary in 1999 and 2004

Cultivar	Year of registration	Postulated Lr gene	Year		Year	
			1998	2003	1999	2004
			Area of seed grain production %		Infection type*	
Mv 23	1991	Lr26	4	—	70S	—
Fatima-2	1992	Lr26+	9.8	—	60S	—
Mv Optima	1993	Lr26	6.5	—	100S	—
Mv Emma	1994	Lr26	3.4	—	80S	—
Mv Vilma	1994	Lr26	4.6	—	70MS-S	—
Mv Pálma	1994	Lr26	7.5	—	90S	—
Mv Magdaléna	1996	?	—	12	—	t
Mv Magvas	1998	?	—	7.6	—	5-30MR/MS
Mv Csárdás	1999	?	—	13.6	—	t
Mv Palotás	2000	?	—	6.7	—	t
Mv Verbunkos	2001	?	—	2.4	—	R
Mv Marsall	2001	?	—	1.2	—	R
Mv Suba	2002	?	—	0.3	—	R

*Scoring was made using the modified Cobb's scale, S=susceptible, MS=moderately susceptible, MR=moderately resistant, R= resistant, t= traces

Table 3

Leaf rust resistance of wheat cultivars bred at Szeged
and produced on significant growing areas in Hungary in 1999 and 2004

Cultivar	Year of registration	Postulated Lr gene	Year		Year	
			1998	2003	1999	2004
			Area of seed grain production %		Infection type*	
Jubileynaya	1970	Lr3, Lr34	4	6.2	70S	70-100S
GK Öthalom	1985	Lr3, Lr34	9.8	–	40S	–
GK Góbé	1992	?	6.5	–	R	–
GK Zugoly	1993	Lr26+	3.4	–	5-10MS-S	–
GK Csörnóc	1994	Lr26	4.6	–	70-80S	–
GK Kalász	1996	?	–	5	–	t-30MS
GK Garaboly	1998	?	–	3	–	t-30MR/MS
GK Ati	2001	?	–	1.4	–	t-5MR/MS

*Scoring was made using the modified Cobb's scale, S=susceptible, MS=moderately susceptible, R=resistant, t=traces

tivars such as Mv23, Mv Emma, Fatima-2, Mv Optima, Mv Pálma, Mv Vilma, GK Csörnóc, GK Öthalom, and GK Zugoly were highly susceptible to leaf rust in the field and potentially at risk to leaf rust disease. Therefore these cultivars were removed from production and new cultivars were introduced during 1999–2004. The new cultivars with significant growing areas in Hungary were resistant or moderately resistant to leaf rust in 2004 (*Fig. 2*).

The cultivars Mv Magdalena, Mv Magvas, Mv Csárdás, Mv Verbunkos and Mv Suba were susceptible at seedling stage, but resistant, moderately resistant at adult stage (*Table 4*). These results suggest that these cultivars may carry adult plant resistance

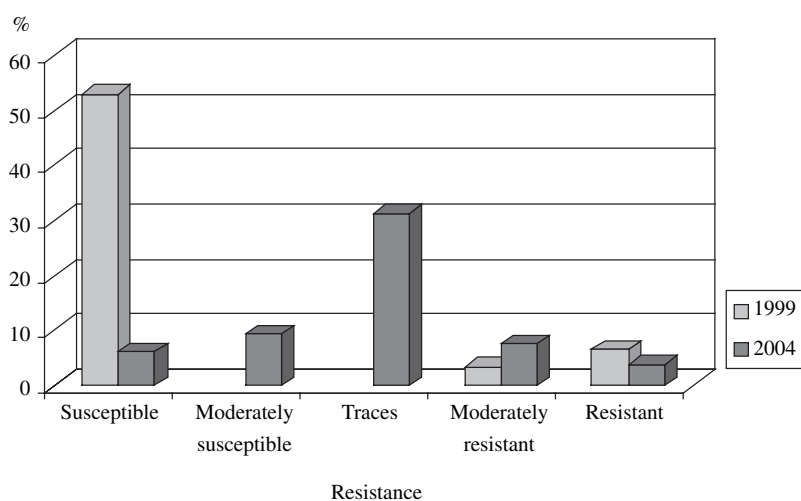


Fig. 2. Distribution of wheat cultivars on the base of leaf rust resistance in 1999 and 2004

Table 4

Resistance to leaf rust in Hungarian winter wheat cultivars
at seedling stage and adult stage in 2004

Cultivar	Resistance				
	At seedling stage		At adult stage		
	Pathotype		Locality		
	43722	73722	Bóly	Kecskemét	Táplán-Szentkereszt
			28.06.2004	25.06.2004	05.07.2004
Infection type					
Mv Magdaléna	3*	3	t**	t	t
Mv Magvas	3	3	5MR/MS	30MR/MS	R
Mv Csárdás	3	3	R	t	t
Mv Palotás	–	0;1	R	R	30MS
Mv Verbunkos	3	3	t	R	R
Mv Marsall	0;	0;	R	R	R
Mv Suba	3	3	R	R	R
Yubileynaya	3	3	80S	70S	100S
GK Kalász	3	3	t/MS	t/MS	30MS
GK Garaboly	3+	3	t/MS	30MR/MS	10MS
GK Ati	0;	0;	5MR	5MR/MS	t

* Scoring was made on a 0-4 scale (Stackman et al., 1962), 3, 4=susceptible, 0, 0; 1, 2=resistant

** Scoring was made using the modified Cobb's scale, S=susceptible, MS=moderately susceptible, MR=moderately resistant, R=resistant, t=traces

Table 5

Leaf rust resistance of winter triticale cultivars at seedling stage and adult stage in 2004

Cultivar	Origin	Year of registration	Resistance					
			At seedling stage				At adult stage	
			Pathotype				Locality	
			41000	43722	53522	73722	Kecskemét	Magyaróvár
							25. 06. 2004.	01. 07. 2004.
Infection type								
Presto	PL	1990	4	0;	0;	0;	R	R
Tricolor	FR	2002	4	0;	0;	0;	R	R
Disco	PL	2001	4	0;	0;1	0	30S	100S
GK Bogo	PL	1998	4	0;	0;1	0;	100S	100S
Kitaro	PL	1998	4	0;	0	0;1	100S	100S
Pongo	AT	1998	4	0;1	0;1	0;	100S	100S
Lupus	DE	2000	4	3	0;1,3	3	10-20S	100S
GK Márko	PL	2000	4	3	0;1,3	3	40S	100S

* Scoring was made on a 0-4 scale (Stackman et al., 1962), 3, 4=susceptible, 0, 0; 1, 2=resistant

** Scoring was made using the modified Cobb's scale, S=susceptible, MS=moderately susceptible, MR=moderately resistant, R=resistant, t=traces

genes and their resistance may be durable. But, we still do not know exactly which adult resistance genes provide resistance to leaf rust for these cultivars.

Resistance of triticale cultivars to leaf rust

Triticale cultivars Disco, GK Bogo, Kitaro, Pongo, Lupus and GK Márko were susceptible at seedling and adult stage in 2004 (*Table 5*). Lupus and GK Márko were infected by wheat leaf rust pathotypes at seedling stage, too. In 2004, Cultivars Presto and Tricolor were resistant against leaf rust in Hungary.

Conclusion

Seven new pathotypes were identified in the Hungarian rust population in 2004. The frequency of the pathotype 43722, which was predominant in 1999, markedly decreased. During the last five years all susceptible cultivars were removed from production and resistant cultivars having highly efficient, but still unknown resistance genes were introduced. The introduction of these new, highly resistant cultivars into large-scale production strongly influenced the diversity of virulence in rust population.

In the past, triticale was known as a highly resistant crop, particularly against leaf diseases. However, our present data show that leaf rust has recently become a disease threat also in triticale cultivation in Hungary. In the future, breeders should pay more attention to the resistance of triticale cultivars against leaf rust.

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