

Adapted from:

A North American System of Nomenclature for *Puccinia triticina*

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Phytopathology 79:525-529

A nomenclature system for designating virulence combinations of cultures of *Puccinia triticina* (formerly *Puccinia recondita* f. sp. *tritici* - (see Taxonomic Change page)) in North America was accepted by the North American Wheat Leaf Rust Research Workers Committee in 1986. Host seedling resistance genes *Lr1*, *Lr2a*, *Lr2c*, *Lr3a*, *Lr3ka*, *Lr9*, *Lr11*, *Lr16*, *Lr17*, *Lr24*, *Lr26*, and *Lr30* occur singly in each of the primary differentials. Host lines are grouped into sets of four (Table 1), and infection types (Tables 2, 3) are recorded for each line. Avirulence and virulence of cultures are determined by low (L) and high (H) infection types, respectively. Recently a fourth set of lines with genes *LrB*, *Lr10*, *Lr14a*, and *Lr18* was added to the North American set of differentials. Virulence combinations are designated by a four-letter code followed by a hyphen and a listing of ineffective host genes in any supplemental differential host set (Wheat Leaf Rust Resistance Gene page contains a complete list of Lr genes). This system is by design similar to the nomenclatural system described for *P. graminis* (Pers.) f. sp. *tritici* (Phytopathology 78:526-533). If additional differentials are used, the four-letter code can be followed by a hyphen and a listing of ineffective host genes in any supplemental differential used in the host set. In North America, lines from the resistant series listed in Table 4 have been used as supplemental differentials. See the Wheat Leaf Rust Resistance Gene page for a complete list of Lr genes.

Depending on the leaf rust races present, other differential lines may be more useful in some other regions of the world. The Wheat Leaf Rust Resistance Gene page contains information on the sources of leaf rust resistance genes, their low infection types, and wheat lines that can be used as sources of Lr genes that may be used to develop new sets of differential lines. Of course, an ideal set of differentials should be made up of lines with single genes for resistance backcrossed into a common genetic background such as the Thatcher near-isolines used in the North American set of differentials.

In many parts of the world and in North America prior to 1986 the International Register of Physiologic Races and the Unified Numeration system were used to designate races of *Puccinia triticina*. Differential hosts and Lr genes used in these systems can be found in Table 5.

For color pictures of typical phenotypes associated with most wheat rust resistance genes see:

McIntosh, R. A., Wellings, C. R., and Park, R. F. 1995. Wheat Rusts: An Atlas of Resistance Genes. Plant Breeding Institute, University of Sydney, CSIRO, Australia. Published by CSIRO Australia in conjunction with Kluwer Academic Publishers, PO Box 17, 3300 AA Dordrecht, The Netherlands.

Table 1. Code (Pt) for the 16 North American differential hosts for *Puccinia triticina* in ordered sets of four and an additional set four

Pt code ^a	Host set	Infection type ^b produced on near isogenic <i>Lr</i> lines:			
		1	2a	2c	3a
	Host set 1:	1	2a	2c	3a
	Host set 2:	9	16	24	26
	Host set 3:	3ka	11	17	30
	Host set 4:	B	10	14a	18
B		Low	Low	Low	Low
C		Low	Low	Low	H
D		Low	Low	High	Low
F		Low	Low	High	High
G		Low	High	Low	Low
H		Low	High	Low	High
J		Low	High	High	Low
K		Low	High	High	High
L		High	Low	Low	Low
M		High	Low	Low	High
N		High	Low	High	Low
P		High	Low	High	High
Q		High	High	Low	Low
R		High	High	Low	High
S		High	High	High	Low
T		High	High	High	High

^aPt code consists of the designation for set I followed by that for set 2, etc. For example, race MGB: set 1 (M) - virulent to Lr1, 3a; set 2 (G) - virulent to Lr16; set 3 (B) - avirulent.

^bLow infection type (avirulent pathogen); Hgh infection type (virulent pathogen), see Table 2.

Table 2. Description of infection types and symptoms

Infection type		Symptoms
0	Low	No uredinia or other macroscopic sign of infectiton
0;	Low	Few faint flecks
;	Low	No uredinia, but hypersensitive necrotic or chlorotic flecks present
1	Low	Small uredinia often surrounded by a necrosis
2	Low	Small to medium uredinia often surrounded by chlorosis
Y	Low	Ordered distibution of variable-sized uredinia with largest at leaf tip
X	Low	Random distibution of variable-sized uredinia
3	High	Medium-sized uredinia without chlorosis or necrosis
4	High	Large uredinia without chlorosis or necrosis

The infection types are often refined by modifying characters as follows:

- =, uredinia at the lower size limit for the infection type
- , uredinia somewhat smaller than normal for the infection type
- +, uredinia somewhat larger than normal for the infection type
- ++, uredinia at the upper size limit for the infection type
- C, more chlorosis than normal for the infection type
- N, more necrosis than normal for the infection type

Discrete infection types on a single leaf when infected by a single race are separated by a comma (e.g., 4,; or 2-, 2+ or 1, 2). A range of variation between infection types is recorded by indicating the range, with the most prevalent infection type listed first.

Table 3. Range of low infection types produced when wheat cultivar Thatcher lines with *Lr* genes used in the *Puccinia triticina* (Pt) differential set were inoculated with cultures of *P. triticina* that are avirulent with respect to these genes

<i>Lr</i> gene	Source	Low infection types ^a	Test line	Comments
B	Brevit	2,;	TcLrB, RL6051	
1	Centenario	0;	TcLr1, RL6003	
2a	Webster	;	TcLr2a, RL6000, RL6016	
2c	Brevit	;1	TcLr2c, RL6047	
3a	Democrat	;C	TcLr3a, RL6002	Often called Lr3
3ka	Klein Aniversario	12	TcLr3ka, RL6007	
9	<i>T. umbellulatum</i>	0;	TcLr9, RL6010	
10	Lee	;,2	TcLr10, RL6004	
11	Hussar	2; (Y)	TcLr11, RL6053	
14a	Hope	X	TcLr14a, RL6006	
16	Exchange	;1N	TcLr16, RL6005	Linked to Sr23
17	Klein Lucero	;12	TcLr17, RL6008	
18	<i>T. timopheevi</i>	2+2-	TcLr18, RL6040	
24	<i>Elytrigia elongatum</i>	;	TcLr24, RL6064	Linked to Sr24
26	<i>Secalis cereale</i>	;	TcLr26, RL6078	Linked to Sr31, Yr9
30	Terenzio	2	TcLr30, RL6049	

^aExpected low infection type at 20 C. Infection types vary depending on the entire host or pathogen genotype and environment. 0 = no uredia or other macroscopic signs of infection; ; = no uredia, but hypersensitive necrotic or chlorotic flecks of varying size present; 1 = small uredia often surrounded by necrosis; 2 = small to medium uredia often surrounded by chlorosis or necrosis; C = more chlorosis than normal for infection type; N = more necrosis than normal for infection type (Phytopathology 78:526-533).

Table 4. Source of the leaf resistance genes, the expressed low infection type, and the host lines used in the North American resistant series

<i>Lr</i> gene	Source	Low infection type ^a	Test line	Comments
19	<i>Elytrigia elongatum</i>	0	TcLr19, RL6040	Linked to Sr25
21	<i>Aegilops squarrosa</i>	0	TcLr21, RL6043	
25	<i>Secale cereale</i>	;N	Transec, RL6084	
29	<i>Elytrigia elongatum</i>	0;	TcLr29, RL6080	
32	<i>Aegilops squarrosa</i>	;1+	TcLr32, RL5494-1	
33 + 34	P158548	0;	RL6059	Effective combination

^aLow infection type expressed may depend on the pathogen phenotype as well as changes in environment. 0 = no uredia or other macroscopic sign of infection; ; = no uredia, but hypersensitive necrotic or chlorotic flecks of varying size present; 1 = small uredia often surrounded by a necrosis; N = more necrosis than normal for infection type; + = uredia somewhat larger than normal for infection type (Phytopathology 78:526-533).

Table 5. Differential hosts and *Lr* genes used in the International Register of Physiologic Races (International) and the Unified Numeration (UN) nomenclature systems for *Puccinia triticina*

Cultivar	<i>Lr</i> gene(s)	Differential hosts for system			Pt set ^c	Comments
		International ^a	UN ^b			
Malakof	1	+	+	Lr1		
Webster	2a	+	+	Lr2a		
Carina	2b	+			Temperature sensitive	
Brevit	2c, B	+			Temperature sensitive	
Loros	2c	+	+	Lr2c		
Mediterranean	3a	+	+			
Hussar	11	+		Lr11	Temperature sensitive	
Democrat	3a	+	+	Lr3a	Same as Mediterranean in North America	

^aInternational race nomenclature system, Plant Dis. Rep. 50:756-760.

^bUnified Numeration nomenclature system, Plant Dis. Rep. 41:508-511.

^cNorth American System of Nomenclature for *Puccinia triticina*, Phytopathology 79:525-529.

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