Efficiency of Leaf Rust Resistance Genes in Martonvásár

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Abstract

The efficiency of leaf rust resistance genes in adult plants was studied on near-isogenic lines of *Thatcher* carrying known leaf rust resistance genes in the artificially inoculated leaf rust nursery of the Agricultural Research Institute of the Hungarian Academy of Sciences in Martonvásár over a five-year period (1997–2001). Eight of the wheat lines tested (*Lr9, Lr19, Lr23, Lr24, Lr25, Lr29, Lr35, Lr37*) exhibited little or no infection. Lines carrying genes *Lr13, Lr44* and *LrB* were resistant in two years and those carrying *Lr34, Lr38* and *LrW* in three years, after which they suffered moderate or heavy infection. Three lines *(Lr12, Lr17, Lr32*) proved to be moderately resistant. The majority of the wheat lines tested became heavily infected.

Keywords: *Puccinia recondita* f.sp. *tritici*; *Triticum aestivum*; resistance genes; efficiency

INTRODUCTION

Leaf rust (*Puccinia recondita* Rob. ex Desm. f.sp. *tritici*) is one of the major fungal diseases of wheat worldwide. In Hungary it has been observed regularly in recent years, causing local or national epidemics. The yield losses caused by the pathogen may amount to as much as 40% depending on the resistance of the variety and on the time and intensity of infection (BARABÁS & MATUZ 1983).

One environmentally sound, cost-saving means of disease control is the development and cultivation of resistant wheat varieties. More than fifty leaf rust resistance genes (*Lr* genes) with various degrees of efficiency have now been identified or hypothesised in wheat (MCINTOSH *et al*. 1995). Some provide satisfactory protection against the pathogen in both young and adult plants, while others are ineffective in the seedling stage, but provide various degrees of protection in the adult stage. Some *Lr* genes are now completely ineffective (KOLMER 1996).

The effect of leaf rust resistance genes is related to the physiological specialisation of the pathogen. Hundreds of physiological races of leaf rust are now known. Since the race composition changes, the resistance of the varieties is not a constant character. In the course of resistance breeding it is thus essential to regularly monitor the efficiency of the resistance genes (MANNINGER 1991; SZUNICS & SZUNICS 1995).

The efficiency of various known *Lr* genes in the adult stage is tested in Martonvásár each year. The results obtained over the last five years (1997–2001) will be given here.

MATERIALS AND METHODS

The adult leaf rust resistance of 35 near-isogenic lines of the Canadian spring wheat variety Thatcher carrying different *Lr* genes was evaluated in the artificially inoculated leaf rust nursery of the Agricultural Research Institute of the Hungarian Academy of Sciences, with Thatcher as a control. Plants of a susceptible variety sown in spreaders around the tested genotypes were artificially inoculated with a leaf rust uredospore mixture collected from varieties with different genetic backgrounds and multiplied in a greenhouse. A hypodermic syringe was used to inject 1 cm^3 of spore suspension (concentration: 1.25 g/dm^3) into one spreader plant per 20 cm when the plants were in the Zadoks 33–35 stage of development (ZADOKS *et al*. 1974). The pathogen spread naturally from these centres of infection to the tested

Table 1. Leaf rust resistance of near-isogenic wheat lines of *Thatcher* carrying different *Lr* genes (Martonvásár 1997–2001)

Genotype	*Lr* gene	Degree of infection (%) and reaction type (VR–VS)				
		1997	1998	1999	2000	2001
Tc*6/Centenario	*Lr1*	70VS	60S	70S	70S	80S
Tc*6/ Webster	*Lr2a*	80VS	70VS	90VS	60S	70S
Tc*6/Carina	*Lr2b*	50S	50S	90VS	70S	100VS
Tc*6/Loros	*Lr2c*	70S	40S	90VS	90S	100VS
Tc*6/Democrat	*Lr3*	70VS	50S	90VS	80VS	90VS
Bage/Tc*8	*Lr3bg*	80VS	80S	80S	70VS	80S
Tc*6/KleinAniversario	*Lr3ka*	60S	70S	80S	60S	60S
Transfer/Tc*6	*Lr9**	0VR	0VR	0VR	0	0
Tc*6/Exchange	*Lr10*	10MR	20S	60S	90VS	60MS
Tc*2/Hussar	*Lr11*	30MR	30S	40S	80VS	90VS
Exchange/Tc*6	*Lr12*	1VR(40S)	1R(40MS)	30MS	10MR	30M
Tc*6/Frontana	*Lr13*	1VR	0R	40MS	20MR	70S
Selkirk/Tc*6	*Lr14a*	10R	0R-50S	40MS	90VS	100VS
Tc*6/Mario Escobar	*Lr14b*	50S	15MS	60S	70VS	60S
Tc*6/W1483	*Lr15*	10MR-70S	1R-40S	50S	90VS	50MS
Tc*6/Exchange	*Lr16*	60S	50S	60S	80VS	80S
Klein Lucero/Tc*6	*Lr17*	5R	1R	30MR	10R	20MR
Tc*7/Translocation4	*Lr19**	1VR	0,1R	0VR	0	0
Tc*6/Jimmer	*Lr20*	5R-60S	0R-10MR	20MR	40M-70S	50M
Tc*6/RL5404	*Lr22**	30M	0R-30MR	30MS	60MS	50M
Lee310/Tc*6	*Lr23**	1VR	1R	0VR	0,1VR	10R
Tc*6/Agent	*Lr24**	1VR	0VR	0VR	0VR	0
Tc*6/Transec	*Lr25**	1VR	0R	1VR	0VR	0
Tc*6/ST-1-25	*Lr26**	70S	80S	60VS	80S	60S
Tc*6/Cs7D-Ag#11	*Lr29**	0VR	0R	0R	0VR	0VR
Tc*6/Terenzio	*Lr30*	50S	60S	80S	80VS	90S
Tc*6/3 *T. tauschii*	*Lr32**	10R	0R(50S)	5MR	30M	30MR
Tc*6/PI58548(+1 gene)	*Lr33*	40MS	30MS	40MS	60S	70S
Tc*6/PI58548(+2 genes)	*Lr34*	1VR	0R(5MR)	0R(20MS)	40M	60S
Tc*6/RL5711	*Lr35**	1VR	0-50R	1R-10MR	0,1VR	0
Tc*8/VPM	*Lr37**	1VR(10MR)	0R	0VR	5R	1R
Tc*6/TMR-514-12-24	*Lr38**	1VR	0R	10MR	70VS	80S
Tc*6/*T. speltoides*	*Lr44*	5R	3R	30MR	40MR	60MR
Tc*6/PI268316	*LrB*	5R	0R	40MR	90VS	70S
Tc*6/V336	*LrW*	10R	0R	1VR	50M	30MR
Thatcher	*Lr22a*	60VS	60VS	60VS	90VS	100VS

* = *Lr* genes originating from species other than bread wheat

VR = very resistant, R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible

genotypes. The degree of infection was evaluated in terms of the percentage of infected leaf area and the reaction type of the plants (VR–VS) to the pathogen (MACNEAL *et al*. 1971).

RESULTS

As can be seen from the data in Table 1, eight of the tested wheat lines exhibited little or no infection (*Lr9, Lr19, Lr23, Lr24, Lr25, Lr29, Lr35, Lr37*). Lines carrying the *Lr13, Lr44* and *LrB* genes were resistant in two years (1997, 1998), and those carrying *Lr34*, *Lr38* and *LrW* in three years (1997–1999), after which they became moderately or strongly infected. Three near-isogenic lines (*Lr12, Lr17, Lr32*) were moderately resistant, while the majority of the lines (*Lr1, Lr2a, Lr2b, Lr2c, Lr3, Lr3bg, Lr3ka, Lr10, Lr11, Lr14a, Lr14b, Lr15, Lr16, Lr20, Lr22, Lr26, Lr30, Lr33*) were severely infected in all five years.

DISCUSSION

As a consequence of the favourable weather and the artificial inoculation, intense leaf rust epidemics developed in the nursery in the experimental years (1997–2001), as indicated by the heavy infection of the susceptible variety Thatcher. The local leaf rust population was almost completely avirulent to genes *Lr9, Lr19, Lr23, Lr24, Lr25, Lr29, Lr35* and *Lr37* in all five years. Data from the literature indicate that these genes provide efficient protection all over the world, though *Lr23* has proved to be ineffective in several European countries in recent years (BARTOŠ & HUSZÁR 1996; BULOICHIK & VOULEVICH 1997; CASULLI 1998; BARTOŠ & STUCHLÍKOVÁ 1999). These genes are of value in resistance breeding even when used alone. Genes *Lr12, Lr17* and *Lr32*, which provide moderate resistance, can be used in resistance breeding if necessary, and may lead to long-term resistance when combined with other *Lr* genes.

The *Lr* genes which lost their effectiveness in the final years of the experiment or were ineffective in all five years (*Lr13, Lr44, LrB*, *Lr34*, *Lr38, LrW, Lr1, Lr2a, Lr2b, Lr2c, Lr3, Lr3bg, Lr3ka, Lr10, Lr11, Lr14a, Lr14b, Lr15, Lr16, Lr20, Lr22, Lr26, Lr30, Lr33*) no longer provide satisfactory protection alone.

With the help of these results it will be possible to select and apply efficient *Lr* genes in resistance breeding programmes. The *Lr* genes found to be efficient worldwide have not yet been exploited in Hungary, despite the fact that they provide satisfactory protection under Hungarian conditions. By developing and crossing new, agronomically valuable resistance sources with various genetic backgrounds the danger of genetic vulnerability could also be reduced.

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