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EPIDEMIOLOGICAL EFFECTS OF COMBINING DIFFERENT SOURCES OF LEAF–RUST RESISTANCE IN WINTER RYE SYNTHETICS

SHORT CONTRIBUTION

ABSTRACT

Economically important rye (*Secale cereale* L.) cultivars are highly susceptible to leaf rust caused by *Puccinia recondita* f.sp. *secalis* in Germany. Presently, only race–specific resistances are available, which are likely to lose their effect after prolonged application. To study possibilities of increasing the durability of resistance, a three–year field experiment was initiated in 2000. Seventeen differential lines, three susceptible standards, 30 segregating populations with one to four resistance sources and two full–sib families were grown at six locations under a high level of natural infection. All segregating populations were significantly more resistant than the susceptible standards. The resistance level, however, was under these conditions moderate only. The two full–sib families from Russia showed high resistance. Strong genotype × location interactions were observed indicating different race compositions of the local leaf rust populations.

Key words: epidemiological effects, leaf rust, resistance, rye synthetics, *Secale*

INTRODUCTION

Leaf rust (*Puccinia recondita* f.sp. *secalis*) is the most frequent leaf disease of winter rye (*Secale cereale* L.) in Germany (Jörg und Krauthausen, 2001). In Russia yield reductions up to 40% are possible when the epidemic starts before flowering (Solodukhina, 1997). In practical breeding programmes, race–specific resistance genes are prevailing. Experiences in barley and wheat show that this kind of resistance is lasting for a limited number of seasons only (Wolfe and Finckh, 1996). To test possibilities of prolonging the effectiveness of resistance, we produced synthetic populations (*Syn–2*) of increasing host complexity, i.e.

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with one to four resistances of different origin. Additionally, a high host diversity was achieved because the synthetics were segregating for the resistances introduced.

MATERIAL AND METHODS

Five susceptible and eleven resistant self–fertile inbred lines were used. The latter harboured race–specific resistances that differed for their reaction on a differential set of 20–30 isolates in primary leaf–stage. With these inbred lines three single crosses without, 20 single crosses with one or two and ten double crosses with three or four resistances were produced. About 30 single F_1 (=*Syn–1*) plants per cross were multiplied by open pollination in isolation cabins. The resulting *Syn–2* progenies, two Russian full–sib families and a set of 17 differential lines were grown under natural infection at six locations in Germany (Hohenheim near Stuttgart, Eckartsweier near Kehl/Rhein, Bad Schönborn near Heidelberg, Petkus near Berlin, Bergen near Celle, Rieste near Lüneburg) in the 2000 season. Each entry was planted in a completely randomized block design with two replicates on 1.5 m^2 microplots regularly alternating with plots of a highly susceptible genotype in a chessboard layout to maximise natural infection and avoid plot–by–plot interference. Disease severity was estimated at the end of the epidemic from the leaf below the flag leaf (F–1) of one main tiller of 30 to 50 single plants per plot as percentage of leaf area affected using a 1–9 scale (Stephan 1978)

Degree of scale		Percentage of affected leaf area
1	=	0.0 – 0.5%;
2	=	0.6 – 2%;
3	=	2.1 – 4.5%;
4	=	4.6 – 8%;
5	=	8.1 – 15%;
6	=	15.1 – 28%;
7	=	29.0 – 42%;
8	=	43.0 – 65%;
9	>	65

RESULTS AND CONCLUSIONS

The susceptible synthetics reached a maximum (>65%) leaf–rust coverage at all locations (Fig. 1). Most experimental synthetics were significantly less diseased than the susceptible checks, and only the two full–sib families turned out to be resistant at almost all locations. The resistance

level of the synthetics varied greatly among locations. This indicates that the race composition also varied among the regional leaf–rust populations.

Type of entry / No. of resistance sources	Entry no.	HOH	EWE	BSB	PET	BER	RIE	Mean
Two-line synthetics	1	8,4	8,8	8,3	8,3	8,1	9,0	8,5
0	*Mean (N=3)*	*8,2*	*8,9*	*8,2*	*8,0*	*8,2*	*9,0*	*8,4*
	6	6,7	7,2	6,7	5,3	7,2	7,0	6,7
	8	5,2	6,3	6,5	5,6	6,8	6,4	6,1
1	11	3,4	5,8	5,2	4,6	6,0	5,5	5,1
	12	5,2	6,3	6,1	5,7	6,6	6,0	6,0
	Mean (N=10)	*5,3*	*6,6*	*6,3*	*5,7*	*6,8*	*6,2*	*6,1*
	17	3,7	6,3	4,3	5,1	5,6	4,8	5,0
	18	3,3	4,3	3,2	4,0	4,3	3,7	3,8
	19	3,4	4,6	2,9	4,2	5,5	3,1	3,9
2	20	3,1	5,4	4,4	4,4	6,6	4,7	4,8
	21	6,3	5,9	6,4	6,2	6,6	6,5	6,3
	22	3,8	4,9	4,7	4,9	6,4	5,2	5,0
	23	3,7	4,3	2,7	3,5	5,1	3,6	3,8
	Mean (N=10)	*3,6*	*5,0*	*4,2*	*4,7*	*5,7*	*4,4*	*4,6*
Four-line synthetics	27	3,5	6,1	4,4	4,1	5,9	4,9	4,8
3	28	3,3	6,6	4,5	4,9	5,1	5,1	4,9
	Mean (N=5)	*4,0*	*6,1*	*4,8*	*4,9*	*5,8*	*4,9*	*5,1*
	30	4,2	6,5	4,6	4,4	5,8	5,0	5,1
	31	2,7	5,3	3,7	3,5	5,2	3,6	4,0
4	32	6,0	6,8	6,2	6,1	7,0	6,1	6,4
	33	3,9	5,6	4,3	4,3	6,0	4,6	4,8
	Mean (N=5)	*4,1*	*5,8*	*4,9*	*4,7*	*6,1*	*4,8*	*5,1*
Full-sib families	FSF (N 9a/86)	1,7	2,9	1,8	1,6	3,0	2,4	2,2
unknown	FSF (N 75/81)	1,8	6,0	2,5	1,8	3,7	2,6	3,1
	Mean (N=2)	*1,7*	*4,4*	*2,2*	*1,7*	*3,4*	*2,5*	*2,6*
LSD5%		*1,2*	*1,5*	*0,6*	*0,7*	*0,7*	*0,8*	*0,9*

resistant
moderately resistant
susceptible

Fig. 1 Mean leaf rust ratings of 20 entries selected out of 35 with zero to four resistance sources and overall means of the groups with the same number of resistance sources at six locations 2000 (for abbreviations see text); grouping of resistance levels: 1–3 resistant, 4–6 moderately resistant, and 7–9 susceptible. (LSD5% = least significant difference at P = 5%)

Resistance levels of most entries were medium although they had race–specific resistances that have not yet been used in commercial varieties. On average, the resistance level of the two–line synthetics increased with increasing number of resistant parents (0,1 and 2, respectively) whereas no increase in resistance was observed in the four–line synthetics when using four instead of three resistant parents. Further, two– and four–line synthetics totally composed of resistant lines did not differ significantly from each other. Thus a higher resistance–gene complexity in a genetically diverse synthetic does not necessarily improve its resistance level. Even if each parent line of a synthetic contributes a different resistance source only a medium resistance level was achieved. To further increase the resistance level it seems necessary to use parent lines with resistance to a broader spectrum of leaf–rust races or those with race–non specific resistances.

In Fig. 2 the percentage of resistant, moderately resistant and susceptible plants at each of the six locations is illustrated for three entries greatly differing in their resistance level. Almost all plants of the sus–

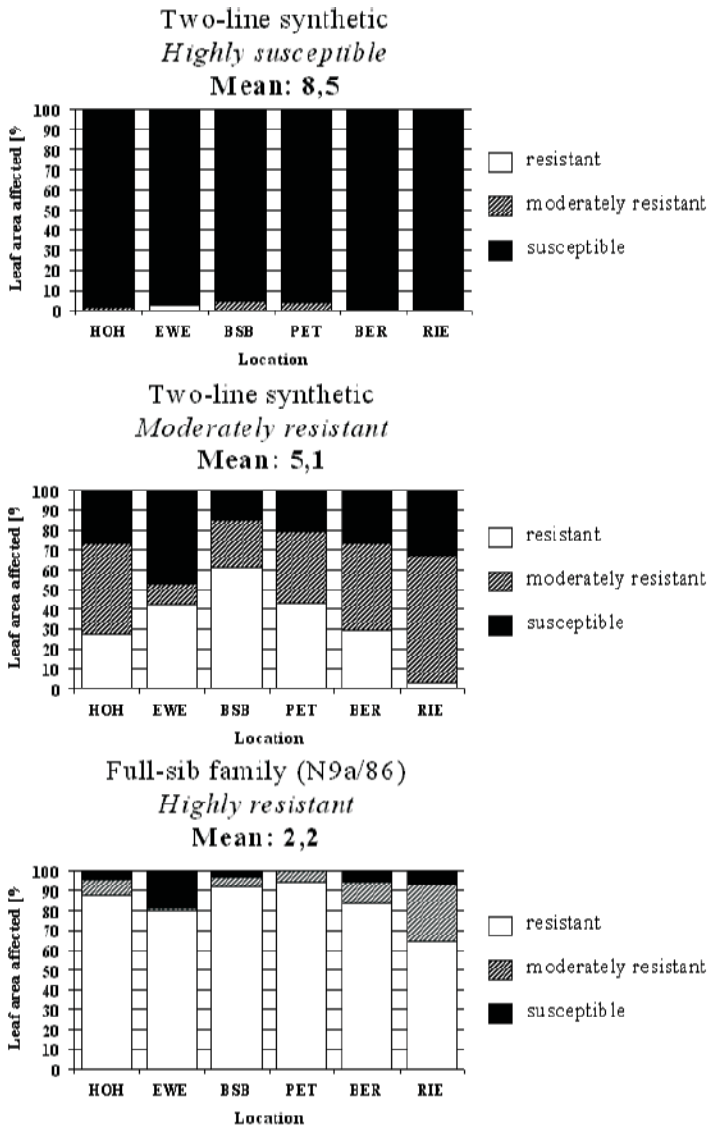

Fig. 2 Percentage of resistant, moderately resistant and susceptible single plants of three selected entries differing in resistance level at six locations. For abbreviations see text

ceptible entry (two–line synthetic, no resistant parent) were highly diseased. The proportion of such plants was reduced to 15–50% (depending on the location) in the moderately resistant entry (two–line synthetic, one resistant parent) and to 0–19% in the highly resistant Russian full–sib family. Although the occurrence of fully susceptible plants in a population might cause yield losses under heavy infection pressure it seems advantagous because it is expected to slow down the rapid dispersal of highly virulent leaf–rust races (Roelfs *et al.*, 1992).

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