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Screening for resistance to leaf rust (*Puccinia hordei*) in barley landraces from Spain and Fertile Crescent

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SUMMARY – A collection of 529 barley landraces from Spain and the Fertile Crescent was screened for resistance to leaf rust under field and controlled conditions. Large variation was observed for disease severity under field conditions. Landraces with high resistance due to hypersensitivity were identified. Also segregation was observed in some landraces with individual plants showing hypersensitive reaction (infection type ≤ 6), as well as partial resistance due to a reduction of disease severity in spite of a compatible interaction (infection type ≥ 7). Eighteen landraces displaying the lowest disease severity (DS) with no macroscopically visible necrosis were selected for further studies on components of resistance. Most of them showed a prolonged latency period, reduced infection frequency and colony size, and increased percentage of early aborted colonies not associated with host cell necrosis. In two of the studied landraces resistance seems to be mainly due to hypersensitivity. A high correlation was observed between the microscopic and macroscopic components of partial resistance.

Keywords: Barley, histology, partial resistance, *Puccinia hordei*.

Introduction

Leaf rust, caused by *Puccinia hordei* Otth, is one of the most important foliar diseases of barley (*Hordeum vulgare* L.). Nineteen major genes (*Rph*) for resistance against *Puccinia hordei* have been identified and mapped in barley landraces and wild barley (*H. spontaneum*) (Weerasena *et al*. 2004). The resistance caused by these genes is typically race-specific, expressed as a hypersensitive reaction, and of limited durability. The non-durability of this resistance has caused breeders to look for more durable types of resistance such as partial resistance (PR). PR has been identified in barley and is expressed as a reduced rate of epidemic development despite a compatible interaction (high infection type) (Parlevliet 1975).

The objectives of this work were to identify new sources of resistance against *P. hordei* in barley landraces from Spain and Fertile Crescent and to study the mechanisms of resistance.

Material and Methods

Field studies

A collection of 529 spring barley landraces, kindly provided by the INIA, Spain (BGE-numbers), ICARDA, Syria (IG-number), and USDA, USA (PI-number) was screened for rust resistance under field and controlled conditions. The collection was sown in November 2002 in a randomized complete block design with three replicates at the CIFA-IFAPA experimental station at Córdoba, Spain. An isolate of leaf rust (CO-01) was used across the experiments.

Seedling studies

Eighteen of the most resistant landraces (DS < 30%) were selected for further studies on components of resistance (Niks and Rubiales 1994). Seeds of the selected landraces were sown in soil in plastic trays (35 x 20 x 8 cm) with three replicates of three plants each. Eleven days after sowing, the first leaf of each plant was placed in a horizontal position and inoculated with isolate CO-01 of *P. hordei* inoculated as described by Shtaya *et al*. (2006).

Five days after inoculation a central leaf segment of 2 cm^2 per plant was collected. Leaves were fixed and cleared as described by Shtaya *et al*. (2006) and Niks (1982).

Results

Reaction in the field

DS ranged from very high to very low, and the frequently distribution was markedly skewed towards high DS. Eighteen landraces, with DS ≤ 30% (3.4% of the collection), were selected to study their reaction to leaf rust at seedling stage.

Macroscopic observations

Seventeen of selected landraces showed a significantly longer relative latency period (RLP) than L94 and were similar to Vada (Table 1). The relative infection frequency (RIF) of ten of the selected landraces was significantly lower than on L94 and was similar to Vada. The increase in the LP and reduction in IF was particularly marked in landraces BGE008930 and BGE011198 which showed a compatible interaction (IT ≥ 7), but with infection type slightly lower than in the remaining landraces, indicating that in these two landraces uredia were associated with some chlorosis.

Table 1. Macroscopic and microscopic components of resistance to leaf rust (*Puccinia hordei*) isolate CO-01 in selected barley landraces from Spain and Fertile Crescent

Landraces	IT	EA-	RLP	RIF	DS%
BGE007942	9	0.14ghij	112de	61bcde	15
BGE008930	7	0.12ghij	204a	6g	5
BGE009089	9	0.11hij	115d	58bcde	20
BGE009139	9	0.15fghij	121cd	75ab	27
BGE010359	9	0.18efghi	121cd	69abcd	27
BGE011198	8	0.08ij	160b	39cdef	8
IG31396	9	0.44abc	117d	46bcdef	14
IG32710	9	0.26defgh	118d	79ab	11
IG32733	9	0.33bcde	120cd	73abc	10
IG32747	9	0.33bcde	122cd	73abc	13
IG110863	9	0.58a	120cd	66abcd	13
IG110870	8	0.22cdefg	134c	24fg	12
IG110887	9	0.26defgh	126cd	58bcde	5
IG110906	8	0.37bcd	127cd	28efg	4
IG115774	9	0.25defgh	115d	70abcd	9
IG125768	9	0.31bcdef	117d	52bcdef	14
IG125775	9	0.28cdefg	118d	68abcd	10
PI186425	9	0.46ab	122cd	38def	8
Vada	9	0.36bcd	122cd	60bcde	12
L94	9	0.00j	100e	100a	87

Microscopic observations

The percentage of early aborted colonies not associated with plant cell necrosis (EA-) was higher in all tested landraces than in L94 and similar to the partially resistant ‘Vada’ although in IG110863 it was significantly higher than 'Vada'.

Discussion

Under field conditions, the reduction of the epidemic build-up of the disease was not common in the collection, which agrees with the results previously obtained by Martínez *et al.* (2001). The infection frequency was lower for the partially resistant landraces than for the susceptible L94 and was similar to the partially resistant 'Vada'. Parlevliet and Kuiper (1977) found a high correlation between infection frequency in the seedling stage and partial resistance in the field.

From this study we conclude that the components that best discriminate between susceptible and partially resistant cultivars in the seedling stage were differences in LP, the amount of early aborted colonies without host cell necrosis, and the infection frequency.

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