Characterization of new sources of resistance in some Palestinian barley landraces against *Blumeria graminis* f.sp. *hordei* under controlled and field conditions

Abstract

Eleven winter barley cultivars from Palestine screened for their resistance to powdery mildew in the field and under controlled conditions while, two types of resistance were identified. Three accessions showed low infection type (IT) at seedling stage with low disease severity (DS) in the mature plant. Six other lines showed low DS and low infection frequency (IF) with no macroscopically visible necrosis. These resistant accessions were selected and selfed for future studies.

Keywords: Barley, *Bluneria graminis* f.sp. *hordei*, Landraces, Powdery mildew.

توصيف مصادر مقاومة جديدة لبعض اصناف من الشعير البلدي الفلسطيني لمرض البياض الدقيقي (*Blumeria graminis* f.sp. *hordei*) تحت ظروف محكمة والحقل

أجريت دراسة على 11 صنف من أصناف الشعير البلدي من فلسطين لتحديد مدى مقاومتها لمرض البياض الدقيقي (*Blumeria graminis* f.sp. *hordei*) وذلك في كل من الحقل المفتوح و داخل الحاضنة في ظروف مثالية. وقد استخدمت سلالة واحدة من المرض تم عزلها من نفس منطقة إجراء التجربة. تم تحديد نوعين من المقاومة حيث أضهرت مجموعة من الاصناف مقاومة كاملة للمرض تحت الظروف المثالية مع إنخفاض شدة الاصابة في الحقل. واظهرت المجموعة الاخرى إنخفاض في شدة الاصابة ودرجتها.. إنتخبت الاصناف المقاومة للمرض وتم إكثارها بهدف إجراء مزيد من الدراسات عليها.

الكلمات الدالة: الشعير، *Blumeria graminis* f.sp. *hordei*، أصناف بلدية، البياض الدقيقي.

Introduction

Barley (*Hordeum vulgare* L.) is an important cereal crop in the Palestinian Territories. It is a nutritious and economical source of food. This importance comes from the fact that it is grown as landraces in nearly all marginal and drought-stressed environments mainly in the eastern slops of the West Bank (MOA, unpublished). Barley production is affected by many diseases which cause severe losses. On the global base, powdery mildew, caused by the fungus *Blumeria graminis* f. sp. *hordei*, is consistently been the most serious and important foliar disease in barley. The reduction due to the attack of such fungus reaches 20% in Europe and 30% in North Africa (FAO, 2007). Yield losses is highly affected by the growth stage when infection is occurred (Scott and Griffiths, 1980, Rasmusson, 1985, Jørgensen, 1994, Ceccarelli *et al.,* 1995).

Several methods are recommended for the control of powdery mildew in barley. Breeding for resistance is the most successful conventional method. Based on the gene-for-gene concept of Flor (1955), many race-specific powdery mildew resistance genes from different origins have been recognized in barley landraces and from wild relatives (Xu and Kasha, 1992, Jahoor and Fischbeck, 1993, Jørgensen and Jensen, 1997, Czembor and Czembor, 2000), but most of them have already been overcome by new virulent strains (Dreiseitl and Jorgensen, 2000, Dreiseitl and Bockelman, 2003). Therefore, it is necessary to look for new sources of resistance in barley grown in Palestinian Territories.

Several sources of resistance to powdery mildew in the cultivated varieties and in their wild types have been reported (Xu and Kasha 1992, Schonfeld *et al.,* 1996, Czembor and Johnson, 1999). A number of studies showed that the original area of cultivation of *H. vulgare* L. and its wild ancestor *Hordeum spontaneum* C. Koch. was the area of the Fertile Crescent (Willcox 1995). Taking this into account, barley landraces collected from the Palestinian territories may be a rich source of new genes for resistance to foliar diseases in general and to powdery mildew in particular. Since scanty studies on the genetics of powdery mildew in Palestinian lines and cultivars are available. The objective of the present investigation was planted to evaluate the level of resistance in some Palestinian barley landraces in growth chamber and in the open field, that to add more information which may be useful for barley breeders.

Materials and Methods

Plant material:

Seed samples of 11 *Hordeum vulgare* landraces from the West Bank, Palestine were kindly provided by the National Agricultural Research Centre (NARC), Jenin, Palestine.

Inoculum:

One isolate of *Blumeria graminis* f. sp. *hordei* collected at Tulkarm, Palestinian Territories and named as (TU-07) was used in the experiment. The pathogenicty test of the isolate was determined using a differential set of powdery mildew hosts (Kolster *et al.,* 1986). The virulence/avirulence spectrum of the isolate was:

Mla1,a3,a7,a8,a9,a10,a12,a22,a23,k,p,g,La,h/a6,a14,a13,at,o5. The isolate was maintained and increased on young seedlings of the susceptible cultivar Pallas.

Seedlings studies:

About 15 seeds per accession were sown in 6x6x7 cm pots. Eleven days after sowing leaf segments were inoculated according Shtaya *et al.,* (2006). After inoculation, Petri dishes were transferred to a growth chamber at 18-20 ºC and incubated in darkness for 12 h., then transferred to a growth chamber under 12 hours alternating cycles of cool white fluorescent light and darkness. Temperature was adjusted to be 18-20 °C (Edwards 1993).

Infection type (IT) was recorded five days after inoculation, following the 0-4 scale of Mains and Dietz (1930). This scale was broaden by including an additional symbol 0(4) for IT characterised by sparse small colonies originating from the stomatal subsidiary cells (Czembor, 2002). Plants scored 0 - 2 were included in the resistant group while plants with score 3 and 4 were included in the susceptible group. Infection frequency (IF) was calculated as number of powdery mildew colonies per cm^2.

Field experiment:

Field testing was performed at the experimental farm of the Faculty of Agriculture at Tulkarm, Palestine during the growing season 2006–2007. Accessions were sown in November 2006 in three complete randomized blocks. Each accession was represented by 25–30 seeds in a single row, 1 m long per replicate. A spreader row, of the very susceptible line Pallas, was sown in the alleyways, perpendicular to the tested accessions.

Powdery mildew infestation was initiated by artificial inoculation of the spreader rows at growth stage DC 43 (Zadoks et al., 1974) by shaking heavily infected Pallas plants over the spreader row. Disease severity (DS) was estimated three times during the growing season as the percentage of white mealy growth of powdery mildew occurred on the upper surface of the leaves.

Data analysis:

Analysis of variance (ANOVA) was calculated by using PROC GLM in an SAS program (SAS Institute, 1988). Comparisons between lines were made by the Duncan-test.

Results

Data on table 1 show the reaction of the 11 accessions under controlled conditions and in the open field. The collection showed reactions ranging from highly resistance to highly susceptible (IT 0 to 4). In seedling tests, 8 of the accessions (72.7%) displayed compatible interaction (IT ≥ 3) whereas, the remaining 3 accessions (27.3%) showed complete resistance (IT = 0 – 0(4)). Six accessions (54.5%) showed low disease severity incidence.

Under field conditions susceptibility to the disease was obvious. While, 45.5% of the accessions showed high levels of DS (as high as the check 'Pallas). The remaining ones represented 54.5% of the tested accessions showed reduction in DS.

Discussion

The results presented in this study demonstrate practical advantages of preserving the genetic diversity of barley landraces. Among 11 accessions tested in the present study, 3 were highly resistant to powdery mildew in growth chamber and they showed high levels of partial resistance in the field (Table 1).

The frequency of resistant landraces in this collection (27%) was higher than in other studies (Czembor, 1999, Czembor and Czembor, 1999&2000, Czembor, and Johnston, 1999, Czembor 2002; and Shtaya *et al.,* 2006). This variation in the level of resistance was most probably caused by using different isolates of powdery mildew and may be due to variation within and between landraces. The results presented here come from the tests performed on seedlings and mature plants in the field. However, determination of powdery mildew resistance genes based on tests performed on seedlings may be useful to the barley breeders and pathologist (Czembor and Czembor 1999).

The results of IT at seedling stage in growth chamber and also the DS in field were varied from the highly resistance to highly susceptible ones. This variation may be due to different degree of virulence of the mildew grown in growth chamber and in field, also to the differences in growth stage of barley (Masterbroek *et al.,* 1995). The presence of reaction type 0 and 0(4) in these lines may indicate that they may have the same alleles for resistance that can be postulated on the basis of the gene for gene concept (Flor 1955).

Conclusion

This study showed that barley landraces from Palestinian Territories have resistance genes to powdery mildew which may be useful for barley breeders. However, confirmation of resistance composition may be established by a test for allelism through crosses and backcrosses among appropriate hosts.

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Table 1: Visible symptoms of powdery mildew (*Blumeria graminis* f.sp. *hordei*) isolate TU-07 in selected accessions of barley landraces from the Palestinian Territories in seedling stage and in the field.

	Seedlings in growth chamber			Mature plants in the field
Cultivar	IT[1]	DS[2]	IF[3]	DS[2]
PAL001	3	25.0bc[4]	46. 7b	55.6ab
PAL002	4	73.7a	81.7a	50.3abc
PAL003	0(4)	0.10d	3.0c	9.8de
PAL004	3	21.7c	48.3b	40.3bc
PAL005	4	30.0bc	38.3b	45.8abc
PAL006	4	27.7bc	43.3b	41.7bc
PAL007	4	23.3bc	35.7b	31.4cd
PAL008	4	76.7a	77.3a	49.6abc
PAL009	4	31.7b	49.0b	46.9abc
PAL010	0(4)	0.10d	2.0c	12.3de
PAL011	0	0.0d	0.0c	5.2e
Pallas	4	75.0a	91.0a	67.8a

[1] Infection type (IT) on a scale of 0–4 (Mains & Dietz, 1930 and its modifications by Czembor, 2002).

[2] Estimated as leaf area covered by powdery mildew colonies.

[3] Infection frequency (IF) calculated as the number of uredia/cm^2.

[4] Data with the same letter per column are not statistically different (Duncan-test, $P \leq 0.05$). (Duncan, 1955).