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RESISTANCE OF SOME EGYPTIAN BARLEY GENOTYPES TO LEAF RUST CAUSED BY *Puccinia hordei Otth.*

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ABSTRACT

One hundred and twenty barley lines as well as three commercial cultivars belonging to the Egyptian breeding program (A , B , D & E trials) were tested for resistance to barley leaf rust (*Puccinia hordei Otth.*) at seedling stage and at adult stage in 2005/2006 season. Under green-house conditions, a total of 55 lines showed resistant response (low infection type). These lines comprise 45.83 %, comparing with the check commercial varieties which were susceptible (high infection types). Of these lines, 20 were highly resistant. At adult stage, the evaluation was carried out at four locations differed in climatic conditions i.e. Sakha, Gemmeiza, Nubaria and Ismalyia. Rust Severity(RS), Average Coefficient of Infection (ACI) and Relative Resistance Index (RRI) were calculated. Also ,the desirable / acceptable levels of relative resistance index (RRI) were estimated. The stability parameters using the regression coefficient of the performance of each genotype under different environments (b) and the mean square deviation from linear regression (S^2d) were calculated. Most of the tested lines showed susceptible responses to leaf rust. The susceptibility to leaf rust of the tested lines was the least in Isma;lia. The line No. 29 was the best one for both resistance and stability to leaf rust disease at the four locations as it had the lowest value of ACI (5.00) and the highest value of RRI (8.38) , followed by lines No. 88, 28 and 12 where the ACI ranged between (12.50 – 14.00) and the RRI ranged between (7.45 – 7.26).These materials can be used as parents in barley breeding programs for developing new disease resistant cultivars.

Keywords: Rust Severity (RS) , Average Coefficient of Infection (ACI), Relative Resistance Index (RRI), Genotypes Stability.

INTRODUCTION

Leaf rust caused by *Puccinia hordei Otth*. is the most important disease of barley and is widely distributed wherever the crop is grown(Clifford 1985).The disease is one of the major barley diseases in Egypt as it occurs yearly causing a considerable loss in grain yield specially in the Northern areas of Delta where environmental conditions, particularly high relative humidity, is favorable for disease development.(Ghobrial *et al.*, 1984).The use of disease – resistant barley cultivars has been an efficient method for controlling the disease and preventing yield losses. Barley yield losses may reach 30 % in susceptible cultivars due to infection by *P. hordei* (Griffey *et al.*, 1994 and Whelan *et al.*, 1997). The development of Stable barley varieties that are tolerant to different environmental stress is the ultimate goal of the national barley program . Genotype environment interaction is often described as a consistent differences among genotypes from an environment to another .Multi –location tests would test abiotic and biotic stress against existing pathogen populations . Several attempts has been made to evaluate genotype x environmental conditions (Mirza *et* *al.*,2000 and Akhtar *et al.*,2001).

Regression analysis is the most widely used method proposed by Finaly and Wilkinson (1963) to estimate stability and adaptability parameters for several genotypes of barley. However, the modified model of Eberhart and Russel (1966) was widely used by various investigators in many plant species. They suggested the use of an environmental index to measure environments instead of the actual yield and supposed that any deviation from the average response (regression coefficient , b = 1) can be considered a genotype environment interaction. Thus predictable response by a variety to environment would be either good or poor. In addition to regression coefficient, the mean square for deviation from regression (S^2d) was suggested as a useful measure of specific genotype x environment interaction .

The main objective of this study was to asses the response of various barley advancing genotypes to leaf rust at seedling stage and at adult stage in four different locations in order to use those exhibiting stable resistance in the Egyptian barley breeding program.

MATERIALS AND METHODS

One hundred and twenty advanced barley genotypes were obtained from the National Breeding Program of barley, Field Crops Research Institute, (ARC), Giza, Egypt. These genotypes comprises 4 trials: A(64 lines), B(32 lines), D(16 lines) and E(8 lines). Three highly susceptible barley varieties i.e. Giza 123 , Giza 126 and Giza 2000 were used as checks in each trial, (Table 1). These genotypes were evaluated for their stable resistance to leaf rust.

Green-house test

All the barley genotypes were tested in the controlled greenhouse of the Barley Diseases Research Section. Plant Pathology Research Institute , ARC, Giza in 2005/2006 season. Five seedlings of each line / cultivar were grown in 7 cm plastic pots and inoculated by a mixture of 10 mg freshly collected uredinospores and talc powder at the rate of 1:25 according to Tarvet and Cassell,(1951). After 24 hr. of incubation in dew chamber (100% relative humidity) the inoculated plants were transferred to a greenhouse benches (20 – 24 °C). Three pots were used for each line / cultivar. Plants were investigated daily for pustules eruption until pustules establishment. Infection type was recorded following the scale of 0 - 4 according to Stakman *et al.,* (1962) which, 0, 0; , 1 and 2 infection types are resistant while 3 and 4 infection types are considered as susceptible .

Field test

Trials were conducted at four locations representing different climatic conditions i.e. Sakha (North Delta), Gemmeiza (Middle Delta), Nubaria (West Delta) and Ismailia (East Delta). Severe natural infection with leaf rust of barley were relied upon in the mentioned locations.

At all the four locations, the barley materials were planted in two rows of 2m. long with a row distance of 25 cm between rows. A spreader rows of highly susceptible varieties were planted around the experiment and left to natural infection with leaf rust. A randomized complete block design with three replicates was used.

Disease parameters assessment

Disease severity of leaf rust was estimated visually as a percent of leaf area covered with leaf rust pustules according to the modified Cobb's scale 0 – 100 adopted by Peterson *et al.* (1948).

Average coefficient of infection (ACI) for each entry was calculated by multiplying the following factors by disease severity percentage according to Saari and Wilcoxson (1974),

Resistant (R) = 0.2 Moderately resistant (Mr) = 0.4
Mesothetic (X) =0.6 Moderately susceptible(Ms)= 0.8
Susceptible (S)= 1.00

To calculate the Country Average Relative Percentage Attack(CARPA) ,the highest ACI line is set as 100 and other lines are adjusted accordingly. From CARPA values , Relative Resistance Index (RRI) is calculated according the scale (0 to 9) where, " 0 " denote most susceptible and "9" as highly resistant (Akhtar *et al.*, 2002):

$$RRI = \frac{(100 - CARPA)}{100} \times 9$$

The desirable and acceptable indexs for leaf rust were estimated according to Aslam (1982), where desirable index was RRI 7 and above, while acceptable index was RRI 6 or 5.

All the obtained data were subjected to analysis of variance for each of the four locations with combined analysis of variance , Snedecor and Cochran , (1967).

Stability parameters

The stability parameters namely (b) which refer to the regression coefficient of the performance of each genotype under different environments on the environmental means overall genotypes and (S^2d) which refers to the mean square deviation from linear regression were calculated (Eberhart and Russel , 1966) .

Table (1): List of evaluated barley genotypes for resistance to leaf rust disease, program 2005/2006.

A- Trial

No.	Pedigree and Cross Name	Source [a]
1.	G. 123	
2.	G. 126	
3.	G. 2000	
4.	Aths/Lignee686//Giza117	Scr.1 Skh 2-2004/05
5.	MR25-84/Att/3/Mari/Aths//Bc/7/Aramir/Arabi Abiad/6/Man/Huiz//M69/3/Apm/RI//H272/4/CP/Bra/5/Joso"S"	Scr.1 Skh 3-2004/05
6.	Post/Copal//Gloria-BAR/Come-B/3/…/4/Giza117	Scr.1 Skh 9-2004/05
7.	Barberusse/PI382696//Gloria-BAR/Come-B/3/…./3/G124	Scr.1 Skh 10-2004/05
8.	M66-69-1/M65-94//70-221109/3/Apm/IB65/4/Glda"S"/5/CM67/Centeno//Cam/6/Api/CM67//Aths*3/7/Aths/Lignee686/4/Rhn-03/3/Bc/Rhn//Ky63-1294	Scr.1 Skh 14-2004/05
9.	M66-69-1/M65-94//70-22109/3/Apm/IB65/4/Gida"S"/5/CM67/Centeno//Cam/6/Api/CM67//Athe*3/7/Lignee527/NK1272//Alanda	Scr.1 Skh 17-2004/05
10.	M66-69-1/M65-94//70-22109/3/Apm/IB65/4/Gida"S"/5/M67/Centeno//Cam/6/Api/CM67//Athe*3/7/Lignee527/NK1272//Alanda	Scr.1 Skh 18-2004/05
11.	M66-69-1/M65-94//70-22109/3/Apm/IB65/4/Gida"S"/5/M67/Centeno//Cam/6/Api/CM67//Athe*3/7/Lignee527/NK1272//Alanda	Scr.1 Skh 19-2004/05
12.	M66-69-1/M65-94//70-22109/3/Apm/IB65/4/Gida"S"/5/M67/Centeno//Cam/6/Api/CM67//Athe*3/7/Lignee527/NK1272//Alanda	Scr.1 Skh 20-2004/05
13.	Gloria 'S'/Copal 'S'//As46/Aths/3/Rhn-03	Scr.1 Skh 24-2004/05
14.	BSH-/5/Alanda/4/Lignee527//Bahtim/DL71/3/Api/CM67//Mzq	Scr.1 Skh 25-2004/05
15.	As46/Th.Unk.27//Lignee527/NK1272	Scr.1 Skh 29-2004/05
16.	As46//DeirAlla106/Strain2055/3/Cabro/Harma	Scr.1 Skh 30-2004/05
17.	Man/4/Ball6/Pro//APDM/Dwil/ly/3/Api/CM6715/Comper229//As46/Pro/6/Salda	Scr.1 Skh 37-2004/05
18.	Carbo/Gustoe	Scr.1 Skh 38-2004/05
19.	N-Acc4000-301-80/FB974//Allanda-01	Scr.1 Skh 39-2004/05
20.	Giza117/7/Aranir/Arabi Abiad/6/Man/Huiz/M69-69/3/Apm/R1//H272/9/CP/Bra/5/Joso 'S'	Scr.2 Skh 3-2004/05
21.	Avt/Attiki/3/Giza121/Pue/4/Giza117 4,5B	Scr.2 Skh 5-2004/05
22.	SLB09-85/4/Baca 'S'/3/AC253//CI08887/C105761	Scr.2 Skh 11-2004/05
23.	SLB09-85/4/Baca 'S'/3/AC253//CI08887/C105761	Scr.2 Skh 12-2004/05
24.	Arizona5908/Aths/Lignee640/6/Giza121/CI06248/4/Apm/IB65//11012-2/3/Api/CM67//Ds/Apro/5/Aths	Scr.2 Skh 13-2004/05
25.	Arizona5908/Aths/Lignee640/6/Giza121/CI06248/4/Apm/IB65//11012-2/3/Api/CM67//Ds/Apro/5/Aths	Scr.2 Skh 14-2004/05
26.	Barberousse/PI382696//Gloria-BAR/Come-B…./3/Giza117	Scr.2 Skh 16-2004/05
27.	M126/CM67//As/Pro/3/Lignee527/Arar/4/Giza124	Scr.2 Skh 17-2004/05

Cont. Table (1)

28.	M66-69-1/M65-94//70-22109/3/Apm/IB65/4/Glda 'S'/5/CM67/ Centeno//Cam/6/Api/CM67Aths*3/7/Lignee527/NK1272//Aanda	Scr.2 Skh 22-2004/05
29.	M66-69-1/M65-94//70-22109/3/Apm/IB65/4/Glda 'S'/5/CM67/ Centeno//Cam/6/Api/CM67Aths*3/7/Lignee527/NK1272//Aanda	Scr.2 Skh 24-2004/05
30.	M66-69-1/M65-94//70-22109/3/Apm/IB65/4/Glda 'S'/5/CM67/ Centeno//Cam/6/Api/CM67Aths*3/7/Lignee527/NK1272//Alanda	Scr.2 Skh 27-2004/05
31.	ACSAD68/3/Arr/Esp//Alger/Ceres362-1-1	Scr.2 Skh 36-2004/05
32.	Alanda-01//Gerbel/Hma/3/Gloria 'S'/Colo 'S'//Teran78	Sha.BYTM-13-2004/05
33.	Alanda-01/4/W12291/3/Api/CM67//L2966-69	Sha.BYTM-19-2004/05
34.	U.Sask.1766/Api//Cel/3/Weeah/4/Gaiza121/Pue	Sha.BYTM-20-2004/05
35.	Sen 'S'/Lignee527	Sha.BYTM-23-2004/05
36.	CABUYA/PETUNIA1//CIRU	Sha.CIMMYT-3 2004/05
37.	PETUNIAI/CALI92//BLLU	Sha.CIMMYT-15 2004/05
38.	BLLU/PETUNIA1//CABUYA	Sha.CIMMYT-16 2004/05
39.	Lignee527//Bahtim/DL71/3/Api/CM67//Mzq/5/Ager//Api/CM67/3/Cel/WI 2269//Ore/4/Hamra01	Sha.BYTL-2 2004/05
40.	Moroc9-75//W12291/W12269	BON-L 37 2004/05
41.	Alanda/Zafraa//Gloria 'S'/Copal 'S'	Sha.BYTL-21 2004/05
42.	Deir Alla106//DL71/Strain205/3/zDL529/4/Arar/Lignee527	Sha.BYT.L-69 2004/05
43.	Rhn-03//Lignee527/NK1272/3/Lignee527/Chn-01//Alanda/4/Giza121/ Pue//79An/Mn	Sha.BYT.L-81 2004/05
44.	Harmal	Sha.BYT.L-90
45.	Rihane-01/3/As46/Aths*2//Aths/Lignee686	Sha.BYT.L-96
46.	As46/Aths/3/Giza121/Pue//79n/Mn/5/Khafour/4/Rhn.03/Lignee527/NK12 7 2/Lignee527/Chn-01//Alndra	Early 17-2004/05
47.	AwBlack/Aths//Arar/3/9C1279-07/Roho/7/F6-4-Kf/6/Man/Huz//M69-69/3/Apm/RI/H272/4/CP/Bra/5/Josos	Early 23-2004/05
48.	Alndra//Lignee527/Arar/4/TunLB923137//Arar19-3/W12291	Early 26-2004/05
49.	Giza121/C106248/4/Apm/IB65//11012-2/3/api/Cm67// DS/Apro/5/Srs-04/6/Cen/Bglos	Early 38-2004/05
50.	MR25-84/Att*2//Mari/Aths*2-02 (Sel. A-22)	Early 47-2004/05
51.	National Check	Heat.t 1-2004/05
52.	U.Sask.1766/Api//Cel/3/Weeah/4/Arar/5/As46//Deir Alla106/Strain205	Heat.t 6-2004/05
53.	BKFMaguelone1604/Atem//ER/Apm/3/Lignee640/Lignee686/4/Nainaa	Heat.t 55-2004/05
54.	Rihane-03//Lignee527/Aths	Heat.t 59-2004/05
55.	ACSAD1182/5/Arizona5908/Avt/Attiki/3/S.T.Barley/4/Aths/Lignee686	ACSAD -10 -2004/05
56.	Manal/3/Lignee527/NK1272//JLB70-63/4/Barjouj	Segr. 3 -2004/05
57.	Barjouj/5/AwBlack/Aths//Arar/3/9Cr279-07/Roho/4/Aths	Segr. 7 -2004/05

Cont. Table (1)

58.	Aths/Lignee686//Orge905/Cr289-53-2/3/UC566/Arbayan-01//M83-194Ras*32	Segr. 11 2004/05
59.	UC566/Arbayan-01//M83-194Ras*32/5/AwBlack/Aths//Arar/3/9Cr279-07/Roho/4/DD-14/Ran-03	Segr. 12 2004/05
60.	Arizona5908/Aths//Avt/Attiki/3/S.T.Barley/4/Aths/Lignee686/5/AwBlack/Aths//Arar/3/9Cr279-07/Roho/4/Aths	Segr. 13 2004/05
61.	Arizona5908/Aths//Avt/Attiki/3/S.T.Barley/4/Aths/Lignee686/5/AwBlack/Aths//Arar/3/9Cr279-07/Roho/4/Aths	Segr. 14 2004/05
62.	Arizona5908/Aths//Avt/Attiki/3/S.T.Barley/4/Aths/Lignee686/5/Giza126	Segr. 19 2004/05
63.	Arizona5908/Aths//Avt/Attiki/3/S.T.Barley/4/Aths/Lignee686/5/Katara	Segr. 25 2004/05
64.	Arizona5908/Aths//Avt/Attiki/3/S.T.Barley/4/Aths/Lignee686/5/CaiMr	Segr. 27 2004/05

Table, 1(cont.) **B- Trial, 2005/2006**

No.	Pedigree and Cross Name	Source[a]
65.	G. 123	
66.	G. 126	
67.	G. 2000	
68.	Avt/Attiki//Aths/3/Giza121/Pue/4/Line366-13-2	A-11 2004/05
69.	Avt/Attiki//Aths/3/Giza121/Pue/4/Line366-13-2	A-12 2004/05
70.	Ssn/Bda//Arar/3/C.C89	A-13 2004/05
71.	Ssn/Bda//Arar/3/C.C89	A-14 2004/05
72.	CAPA-BAR/3/API/BM67-B//MZQ/4/C114032/5/…./6/Sawsan/Lignee640	A-16 2004/05
73.	Monroe/Esperanza//Quina/3/Orge905/Cr.289-53-2	A-16 2004/05
74.	Ssn/Silo/3/Amapa/Cota//Glori-BAR-/Copal/4/Orge905/Cr.289-53-2	A-20 2004/05
75.	Ssn/Silo/3/Amapa/Cota//Glori-BAR-/Copal/4/Orge905/Cr.289-53-2	A-21 2004/05
76.	Aths/Lignee686/ACSAD618	A-27 2004/05
77.	Aths/Lignee686/5/Apm/RL/4/Api/EB489-8-2-15-4//por/U.Sask1766/3/Cel/C1	A-28 2004/05
78.	Aths/Lignee686///Asse/Jaidr	A-30 2004/05
79.	Alnda//Lignee527/Arar/4/Coho/zy//Masurka/3/Alanda/5/TunLB-932137/Noor17	A-31 2004/05
80.	Enir/Nacta//Ast907/3/Avt (9-9)	A-32 2004/05
81.	kenyaResearch/Belle//As46/Aths*2/3/Arar/19-3//W12291	A-33 2004/05
82.	Enir/Nacta//Ast907/3/Avt (9-9)	A-35 2004/05
83.	Rhn-03//Lignee527/As45	A-38 2004/05
84.	National Check	A-42 2004/05
85.	80-5145/Hma-01/3/Arar/19-83/W12291	A-43 2004/05
86.	Agir8//Alnada/Zafraa	A-44 2004/05
87.	Arar/Lignee527//Arar/Rhn-03	A-45 2004/05
88.	Alnada//Lignee527/Arar	A-47 2004/05
89.	Alnada-01/4/W12291/3/Api/CM67//L2966-69/5/Rhn-08/3/DeirAlla106//DL71/Strain205	A-49 2004/05
90.	Arar//Hr/Nopal/3/Alnada-01/Alnada01	A-51 2004/05
91.	Cen/Bglo '5'/Baca 'S'/3/AC253//C108887/C105761/4/Mari/Aths*2//M-Att-73-337-1	A-55 2004/05
92.	CopmCr229//As46/Pro/3/Srs/4/RWA-M47	A-56 2004/05
93.	Alnada/Hamra//Alnada-01	A-59 2004/05
94.	Arbayan/NK1272/4/Arar/3/Mari/Aths*2//M-Att-73-337-1	A-61 2004/05
95.	QB813-2/4/Hma-02//11012-2/CM67/3/Arar	A-62 2004/05
96.	QB813-2/3/Alnada-01//Ssn/Lignee640	A-63 2004/05

Table 1 (cont) **D- Trial, 2005/2006**

No.	Pedigree and Cross Name	Source[a]
97.	G. 123	
98.	G. 126	
99.	G. 2000	
100.	Alnada/Hamra//Alnada01	B-5 2004/05
101.	Rihane/Giza123 (1925)	B-8 2004/05
102.	Rihane/Giza123 (1925)	B-9 2004/05
103.	Aths/Lignee86//ACSAD68	B-10 2004/05
104.	AthLignee86//ACSAD410	B-12 2004/05
105.	Nigrate/5/W12198/4/Attiki//Avt/Toi/82/Vt (Sel.2.2)	B-15 2004/05
106.	80-5145/Hma-01/3/Arar/19-3//W12291	B-19 2004/05
107.	Malouk//Aths/Lignee686	B-20 2004/05
108.	Alanda/3/C108887/C105761//Lignee640/4/Alnada/Lossalka	B-22 2004/05
109.	Alanda-02/4/Arizona5908/Aths//Asse/3/F208-74/5/Alanda/3/C108887/C105761//Lignee640	B-23 2004/05
110.	Lignee527/NK1272//Alanda	B-24 2004/05
111.	CL10114/Attiki//NK1272/3/Mzq/C103909-2//Aths	B-26 2004/05
112.	Giza124/7/Man/Huiz//M-69/3/Apm/RI//H272/4/CP/Bra/5/Joso 'S'/6/Chn-01/W12291	B-27 2004/05

Table 1 (cont) **E- Trial, 2005/2006**

No.	Pedigree and Cross Name	Source[a]
113.	G. 123	
114.	G. 126	
115.	G. 2000	
116.	Aths/Rihane-01//Sawsan/Lignee640	D-3 2004/05
117.	Sawsan/Badia//Arar/3/M84-76 Bon//Jo/Yrk/3/Galt//As46/4/ Hj34*80/Astrix/5/Aths	D-6 2004/05
118.	Giza117/3/W12197/Cl 13450//Arar	D-7 2004/05
119.	Arizona5908/Aths//Lignee640/4/WI 2291/3/Api/CM67//L2966-69 /6/M64-76/Bon//Jo/York/3/MS/Galt//AS46/4/Hij34-80/Astrix/5/Aths	D-10 2004/05
120.	Arrivat/3/Arizona 5908/Aths//Lignee640	D-11 2004/05

[a]Barley Research Section . FCRI, ARC , Giza , Egypt

RESULTS AND DISCUSSION

A total of 120 advanced barley genotypes as well as three commercial cultivars i.e. Giza 123, Giza 126 & Giza 2000 were tested against leaf rust pathogen (*Puccinia hordei*) at seedling stage under greenhouse conditions , as well as under four locations representing different climatic conditions.

Seedling test

This evaluation was conducted using artificial inoculation with uredinospores mixture of the pathogen races identified in 2005/ 2006 (Table 3). Out of 120 lines/ cultivar , 55 were resistant showing infection types ranged between 0 to type 2 comparing with the three commercial checks which showed susceptible infection types (3 and 4). These lines comprised 45.83% of the total barley lines. The lines No. 4, 10, 15,28, 43, 48, 58, 61, 62, 64, 78, 86, 87, 90, 91,94, 101, 103, 104 and 109 were highly resistant lines because they showed zero infection types. Seedling tests against barley leaf rust isolates can give preliminary information about the level of resistance in the breeding germplasms. Similar results were obtained on other barley genotypes by El Sayed *et al.* (1991) Nooman *et al.* (1992) and Czembor and Bladenopoulos (2007).

Field test

Analysis of variance.

To assess the resistance of the tested genotypes, the combination of the four locations was used to carry out analysis of the studied barley genotypes. Data in Table (2) reveal analysis of variance of the tested genotypes across different environments. The four locations differed considerably concerning average coefficient of infection (ACI). Analysis of variance (Table,2) showed that there were highly significant differences between environments and significant genotype x location interactions. Highly significant differences among genotypes were detected, indicating the presence of genetic variability among these genotypes. A number of genotypes showed a genotype x location interactions for qualitative resistance, indicating that these entries may carry race-specific resistance genes. Park,(2003) reported that *Puccina hordei* is characterized by large genetic variability and the pathogen is able to overcome any R-gene rapidly. Based on this fact, the best strategy for barley breeders to control this pathogen is to increase the level of partial resistance or different other sources of resistance (Niks *et al.*, 2000). El- Marakby *et al.* (1986) found that all the studied characters of cotton genotypes showed highly significant mean squares for environments , varieties and genotype environment interaction.

Table (2): Combined analysis of variance over locations for average coefficient of infection (ACI) of barley genotypes to leaf rust.

Sources of variation	Degrees of freedom	Mean Square	F value [a]
Rep.(Location)	8	18.8438	
Location (L)	3	117972.500	20947.57**
Variety (V)	119	1525.4940	270.87**
L × V	357	633.3670	112.46**
Error	952	5.6318	

[a]F value is significant at P < 0.01

Regarding to the data in Table (3) ,the average coefficient of infection revealed that the tested genotypes showed different levels of (ACI) ranged between 5.00 to 72.50. On contrast of seedling reactions, most of the evaluated genotypes showed susceptibility to leaf rust under all locations which exhibited the greatest values of ACI. However, some of them showed reactions ranged between moderate resistance in some locations especially in Ismalyia location and susceptible reactions in others. Leaf rust severity was lower at Ismalyia than the other Locations. Also, relative resistance index (RRI) has been considered a good criterion, since the highest values of RRI were associated with disease resistance. The genotype No. 29 exhibited the lowest value of ACI (5.00) consequently the highest value of relative resistance index (8.38).However, the genotype No. 88 occupied the second rank which showed ACI value 12.50 and RRI value 7.45, followed by lines No,s 28 and 12 (ACI, 13.50 & 14.00 and RRI,7.32 & 7.26 respectively). The genotypes No,s 9, 13 and 101 showed susceptibility up-to 17 (ACI). While the others showed high ACI. Martinez *et al.* (2001) reported that disease severity describes the amount of rust disease and the amount of damage on the infected plants, and that it can be used as a proper parameter for evaluating the resistance of genotypes. Prescott and Saari (1975) reported that genotypes with average coefficient of infection less than 5 suggested the presence of adequate resistance, while genotypes having values between 5 and 10 suggested reasonable level of resistance. Also, genotypes having values greater than 10 suggested that genotypes in this class have less adequate resistance and should be improved or discarded. As the obtained results indicated the lack of resistant genotypes, so it is recommended to search for new sources of resistance through another host-pathogen interactions tests. These findings are in agree with Nabila, Mostafa , and Ahmed (2005).

Table (3): Reaction of barley genotypes to leaf rust in seedling stage (artificial infection) and adult stage (natural infection) during 2005 / 2006 growing season.

No.	Seedling reaction*	Adult plant reaction**								
		Location / Leaf rust severity %				(1) ACI	(2) CARPA	(3)RRI	(4) B	(5) S^2d
		Gemmeiza	Sakha	Nubaria	Ismaylia					
1	4	70 S	60 S	60 S	15 S	51.25	70.68	2.63	1.078	157966
2	3	80 S	80 S	70 S	40 S	67.50	63.79	3.26	0.908	27.715
3	4	50 S	50 S	70 S	15 S	46.25	63.79	3.26	0.640	435.860
4	0	60 S	80 S	60 S	20 S	55.00	75.86	2.17	1.239	9.651
5	2	30 Ms	60 S	40 S	10 Mr	32.00	44.14	5.03	1.048	190.100
6	4	40 S	50 S	40 S	10 Mr	33.50	46.21	4.84	1.003	16.521
7	4	40 S	50 S	30 S	20 S	35.00	48.27	4.65	0.612	16.497
8	3	40 S	70 S	50 S	5 Mr	40.50	55.86	3.97	1.379	69.413
9	1	20 Ms	30 S	30 S	10 Mr	20.00	27.58	6.51	0.514	78.527
10	0	10 Mr	50 S	30 S	30 S	28.50	39.31	5.46	0.432	305.326
11	2	50 S	50 S	30 S	20 Mr	34.50	47.58	4.71	0.823	46.282
12	1	15 Mr	20Ms	30 S	10 Mr	14.00	19.31	7.26	0.195	156.233
13	3	30 Mr	30Ms	40 S	10 Mr	20.00	27.58	6.51	0.341	251.364
14	4	15 Mr	50 S	40 S	10 Mr	25.00	34.48	5.89	0.798	280.621
15	0	15 Mr	60 S	30 S	10 Mr	25.00	34.48	5.89	0.952	410.589
16	4	30 Mr	40 S	40 S	20 Ms	27.00	37.24	5.64	0.494	107.306
17	3	30 S	50 S	50 S	15 Mr	34.00	46.89	4.78	0.915	140.689
18	1	80 S	70 S	50 S	30 S	57.50	79.31	1.86	0.958	144.197
19	1	70 S	60 S	70 S	20 Ms	54.00	74.48	2.29	1.137	253.169
20	1	20 Ms	50 S	20 S	5 Mr	22.00	30.34	6.27	0.873	143.003
21	4	30 S	40 S	30 S	5 Mr	25.50	35.17	5.83	0.787	8.623
22	3	30 S	60 S	40 S	10 Mr	33.50	46.20	4.84	1.046	189.335
23	4	30 S	60 S	40 S	10 Mr	33.50	46.20	4.84	1.048	190.100
24	3	40 S	60 S	50 S	5 Mr	38.00	52.41	4.28	1.217	66.753
25	2	40 S	60 S	60 S	5 Mr	40.50	55.86	3.97	1.226	184.903
26	1	30 Ms	40 S	40 S	10 Mr	27.00	37.24	5.64	0.724	121.750
27	1	40 S	40 S	30 S	10 Ms	29.50	40.68	5.34	0.908	27.716
28	0	15 Mr	20Ms	30 S	5 Mr	13.50	18.62	7.32	0.238	166.761

Cont. Table (3)

No.	Seedling response	Adult plant reaction: Location / Leaf rust severity % Gemmeiza	Sakha	Nubaria	Ismaylia	ACI	CARPA	RRI	b	S^2d
29	3	15 Mr	10 Mr	10 Ms	5 Mr	5.00	6.89	8.38	0.604	20.976
30	3	40s	70 S	40 S	10Mr	38.50	53.10	4.22	1.327	36.416
31	3	50 S	70 S	30 S	5 Mr	38.00	52.41	4.28	1.420	46.530
32	4	50 S	70 S	30 S	10 Mr	38.50	53.10	4.22	1.377	51.471
33	3	80 S	50 S	30 S	15 Mr	41.50	57.24	3.85	1.191	507.312
34	3	80 S	60 S	40 S	5 Mr	45.50	62.76	3.35	1.442	341.261
35	3	80 S	70 S	40 S	5 Mr	48.00	66.20	3.04	1.604	247.334
36	-	20 Ms	80 S	40 S	20 S	39.00	53.79	4.16	0.951	646.416
37	4	30 S	80 S	50 S	20 S	40.50	55.86	3.97	1.057	298.615
38	2	40 S	70 S	60 S	10 Mr	43.00	59.31	3.66	1.345	161.638
39	2	70 S	60 S	60 S	10 Mr	48.00	66.20	3.04	1.358	212.095
40	3	90 S	60 S	40 S	20 S	52.50	72.41	2.48	1.133	784.233
41	1	10 Mr	50 S	40 S	5 Mr	24.00	33.10	6.02	0.832	413.926
42	1	40 S	70 S	40 S	10 Mr	38.50	53.10	4.22	1.327	36.46
43	0	50 S	50 S	50 S	50 Mr	42.50	58.62	3.72	1.113	104.687
44	2	30 Ms	60 S	20 S	10 Mr	27.00	37.24	5.64	1.030	181.243
45	3	30s	40 S	70 S	10 Mr	36.00	49.82	4.51	0.808	597.892
46	3	60 S	60 S	30 S	10 Mr	38.50	53.28	4.20	1.273	105.699
47	1	30 Ms	60 S	20 S	40 S	37.00	51.21	4.39	0.190	425.919
48	0	80 S	60 S	60 S	20 S	55.00	76.12	2.14	1.034	241.935
49	3	40 S	40 S	40 S	10 Mr	31.00	42.90	5.13	0.840	58.911
50	2	30 S	60 S	60 S	5 Mr	38.00	52.59	4.26	1.167	286.912
51	1	40 S	60 S	40 S	10 Mr	36.00	49.82	4.51	1.088	9.360
52	3	80 S	70 S	30 S	30 S	52.50	72.66	2.46	0.940	403.594
53	3	60 S	60 S	30 S	30 S	55.00	76.12	2.15	0.661	147.438
54	4	80 S	60 S	60 S	20 S	55.00	76.12	2.15	1.034	241.935
55	1	50 S	80 S	40 S	5 Mr	43.00	59.51	3.64	1.591	30.569
56	3	40 S	50 S	40 S	30 S	40.00	55.36	4.02	0.393	4.227
57	1	30 Ms	70 S	40 S	20 S	38.50	53.29	4.20	0.828	339.151
58	0	40 S	70 S	40 S	5 Mr	38.00	52.59	4.26	1.370	33.588
59	2	50 S	60 S	30 S	30 S	42.50	58.82	3.70	0.603	92.620
60	4	60 S	70 S	50 S	10 Mr	48.50	67.13	2.96	1.453	16.681
61	0	80 S	80 S	50 S	30 S	60.00	83.04	1.52	1.120	110.109
62	0	60 S	70 S	50 S	10 Ms	47.00	65.05	3.14	1.376	11.644
63	1	60 S	70 S	40 S	20 S	47.50	65.74	3.08	1.062	41.121
64	0	80 S	70 S	50 S	10 Ms	54.50	75.43	2.21	1.493	184.406
65	4	60 S	60 S	50 S	30 S	50.00	69.20	2.77	0.667	16.487
66	3	60 S	60 S	40 S	50 S	52.50	72.66	2.46	0.211	87.496
67	4	90 S	70 S	30 S	40 S	57.50	79.58	1.83	0.828	876.099
68	4	50 S	60 S	10 MR	40 S	38.50	53.29	4.20	0.350	680.265
69	-	70 S	70 S	20 S	20 S	45.00	62.28	3.39	1.102	412.808
70	-	90 S	80 S	40 S	10 Mr	53.50	74.04	2.33	1.840	578.325
71	2	90 S	70 S	30 S	10 Mr	48.50	67.12	2.95	1.669	846.222

Cont. Table (3)

No.	Seedling response	Adult plant reaction								
		Location / Leaf rust severity %				ACI	CARPA	RRI	b	S^2d
		Gemmeiza	Sakha	Nubaria	Ismaylia					
72	4	40 S	60 S	40 S	5 Mr	35.50	49.13	4.57	1.203	9.231
73	-	30 Ms	70 S	50 S	30 S	43.50	60.20	3.58	0.607	413.887
74	3	60 S	60 S	40 S	10 Mr	41.00	56.74	3.89	1.283	55.935
75	-	90 S	80 S	40 S	30 S	60.00	83.04	1.52	1.228	528.803
76	2	30 Ms	70 S	30 S	15 Mr	32.50	44.98	4.95	1.163	271.573
77	3	80 S	70 S	30 S	20 S	50.00	69.20	2.77	1.170	378.263
78	0	40 S	70 S	40 S	10 Ms	39.50	54.67	4.07	1.251	42.193
79	2	90 S	80 S	30 S	20 s	55.00	76.12	2.15	1.448	778.518
80	3	70 S	80 S	70 S	10 Mr	56.00	77.51	2.02	2.015	29.607
81	1	90 S	90 S	30 S	15 Mr	54.00	74.74	2.27	2.117	677.513
82	4	90 S	90 S	70 S	40 S	72.50	100.00	0.00	1.328	70.131
83	4	40 S	60 S	40 S	15 Mr	36.50	50.34	4.46	0.292	634.586
84	3	30 S	70 S	30 S	40 S	42.50	58.62	3.72	0.419	347.090
85	-	40 S	70 S	30 S	10 Mr	36.00	49.65	4.53	1.318	64.716
86	0	60 S	60 S	40 S	15 Ms	41.50	57.24	3.84	1.129	49.772
87	0	60 S	50 S	40 S	30 S	47.50	65.51	3.10	0.508	73.662
88	2	30 Ms	15Mr	20 Ms	10 Mr	12.50	17.24	7.45	0.133	62.301
89	1	40 S	60 S	40 S	20 S	40.00	55.17	4.03	0.783	20.748
90	0	50 S	50 S	30 S	40 S	42.50	58.62	3.72	0.211	87.496
91	0	40 S	60 S	30 S	10 Mr	33.50	46.20	4.84	1.156	15.673
92	3	40 S	70 S	40 S	30 S	45.00	62.06	3.41	0.715	110.741
93	3	30 Ms	50 S	40 S	10 Mr	29.50	40.68	5.33	0.886	138.48
94	0	30 Ms	80 S	40 S	30 S	43.50	60.00	3.60	0.761	553.642
95	2	60 S	70 S	40 S	30 S	50.00	68.96	2.79	0.832	62.352
96	3	70 S	70 S	40 S	20 S	50.00	68.96	2.79	1.120	110.11
97	3	40 S	70 S	60 S	40 S	52.50	72.41	2.48	0.504	146.624
98	3	90 S	80 S	50 S	40 S	65.00	89.65	0.93	1.007	420.259
99	3	70 S	60 S	40 S	30 S	50.00	68.96	2.79	0.728	142.025
100	1	70 S	70 S	40 S	5 Mr	45.50	62.75	3.35	1.540	107.643
101	0	30 Ms	30 Ms	20 Ms	10 Mr	17.00	23.44	6.89	1.187	376.221
102	1	30 Ms	90 S	50 S	10 Mr	42.00	57.93	3.78	1.706	754.424
103	0	60 S	70 S	10 Mr	15 Mr	35.00	48.27	4.65	1.373	589.975
104	0	40 S	50 S	20 S	10 Mr	28.50	39.31	5.46	0.985	47.194
105	3	80 S	70 S	80 S	20 S	62.50	86.20	1.24	1.213	276.174
106	3	60 S	70 S	60 S	30 S	55.00	75.86	2.17	0.850	7.320
107	3	30 S	50 S	60 S	40 S	45.00	62.06	3.41	0.121	193.428
108	3	30 Ms	40 S	80 S	10 Mr	37.00	51.03	4.40	0.743	1131.124
109	0	70 S	70 S	70 S	30 S	52.50	72.41	2.48	0.917	70.456
110	1	90 S	80 S	80 S	15 Mr	64.00	88.27	1.05	1.836	473.381
111	2	40 S	40 S	40 S	10 Mr	31.00	42.75	5.15	0.840	58.911
112	4	30 S	70 S	60 S	30 S	47.50	65.51	3.10	0.675	290.526
113	3	40 S	70 S	70 S	20 S	50.00	68.96	2.79	0.971	263.136
114	3	50 S	70 S	60 S	5 Mr	45.50	62.75	3.35	1.441	91.089
115	-	50 S	90 S	30 S	10 Mr	43.50	60.00	3.60	1.863	319.270
116	4	60 S	70 S	60 S	5 Mr	48.00	66.20	3.04	1.500	73.846
117	2	30 Ms	70 S	60 S	20 S	43.50	60.00	3.60	0.846	486.692
118	3	80 S	50 S	60 S	5 Mr	48.00	66.20	3.04	1.292	521.120
119	1	50 S	40 S	70 S	10 Mr	41.00	56.55	3.91	0.925	525.325
120	4	60 S	50 S	70 S	10 Mr	46.00	63.45	3.29	1.146	408.680

(-)absent General mean : ACI = 37.47 b = 1.00 S^2d = 239.042

Accordingly, the genotype No.29, have the highest level of resistance to leaf rust and could be considered as a good source of resistance, while the genotype No.88, 28 and 12 could be scored as reasonable resistant lines. It could be noticed that the lines No. 9, 13 and 101 showed ACI values up to 17 (20.00 , 20.00, 17.00, as well as RRI values 6.51, 6.51 and 6.89 ,respectively). These lines could be improved through crossing with other resistant lines. Dubin and Rajaram (1981) reported that low average of coefficient of infection indicated the presence of broadly-based resistance. Similar results were obtained by Ghobrial *et al.* (1984); Hussain (1997); Rizk *et al.* (1997) and Akhtar, *et al.* (2002) on other barley genotypes.

On the other hand, the desirable / acceptable relative resistance index (RRI) were assessed. Data presented in (Table 4) showed that the desirable barley germplasms with relative resistance index (RRI 7 and above) to leaf rust during 2005 / 2006 season are as follows :

A-Yield trial No. 12, 28 and 29 .

B-Yield trial No. 88

Also, the acceptable barley germplasms with relative resistance index (RRI 6 or 5) are as follows:

A-Yield trial No. 5, 9, 10, 13, 14, 15, 16, 20, 21, 26, 27, 41, 44 and 49 .

B-Yield trial No. 93

D- Yield trial No. 101, 104 and 111

Similar results which were obtained on other barley genotypes by Akhtar *et al.* (2002) supported this study on barley leaf rust disease.

Table (4): Barley genotypes with desirable/acceptable relative resistance index (RRI) against leaf rust during 2005 / 2006 season.

Genotype No.	Desirable (RRI 7 and above)	Acceptable (RRI 6 or 5)
5	-	5.03
9	-	6.51
10	-	5.46
12	7.26	-
13	-	6.51
14	-	5.89
15	-	5.89
16	-	5.64
20	-	6.27
21	-	5.83
26	-	5.64
27	-	5.34
28	7.32	-
29	8.38	-
41	-	6.02
44	-	5.64
49	-	5.13
88	7.45	-
93	-	5.33
101	-	6.89
104	-	5.46
111	-	5.15

The stability of these one hundred and twenty genotypes against barley leaf rust were evaluated by calculating the stability statistics namely (b) which refer to the regression coefficient of the performance of each of the genotypes under different environments and (S^2d) which refer to the mean square deviation from linear regression were calculated.

The ideal genotype must be characterized by the following characteristics:

1- Regression coefficient should be significantly different from zero ($b \neq 0$) and not significantly different from unity ($b = 1$).

2- Minimum value of the deviation from linear regression $S^2d = 0$.

3- Low disease severity within a reasonable range of environmental variations.

According to the previous criteria, data in (Table 5) reveal that nine genotypes i.e. (9, 20, 21, 26, 27, 29, 44, 93 & 104) showed the highest stability for resistance to barley leaf rust.

Table (5): Selective barley genotypes expressed by average coefficient of infection (ACI) and stability parameters for resistance to leaf rust disease.

Genotype No.	ACI	b	S^2d
9	20.00	0.514	78.527
20	22.00	0.873	143.003
21	25.50	0.787	8.623
26	27.00	0.724	121.750
27	29.50	0.908	27.716
29	5.00	0.604	20.976
44	27.00	1.030	181.243
93	29.50	0.886	138.48
104	28.50	0.985	47.194

Finally , it can be concluded that :

The genotype No. 29 followed by lines No. 88 , 28 & 12 have the highest level of resistance to barley leaf rust and could be considered as a good source of resistance. The lines which showed desirable / acceptable relative resistance index (RRI) in this study are sufficient to be used as parents in breeding programs for developing new disease resistant cultivars.

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مقاومة بعض التراكيب الوراثية لمرض صدأ الأوراق فى الشعير المتسبب عن الفطر بكسينيا هوردياي

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تم تقييم ١٢٠ تركيب وراثى (سلالة) من الشعير ضد مرض صدأ الأوراق تمثل اربع تجارب محصولية وهى (أ – ب – ج – د) و ذلك فى طور البادرة تحت ظروف العدوى الصناعية بالصوبة و طور النبات البالغ فى أربعة مواقع خلال موسم ٢٠٠٥ – ٢٠٠٦ . اظهر عدد ٥٥ تركيب وراثى درجة من المقاومة (طراز إصابة منخفض) فى طور البادرة تمثل ٤٥,٨٣ % من إجمالى التراكيب المختبرة و ذلك مقارنة بالأصناف التجارية الثلاثة القابلة للإصابة فى كل مجموعة (طراز الإصابة مرتفع) . من بين هذه التراكيب الوراثية وجد ٢٠ سلالة عالية المقاومة حيث اظهرت طراز إصابة منخفض . ايضاً تم تقييم هذه التراكيب الوراثية فى أربعة مواقع متباينة فى الظروف البيئية وهى سخا – الجميزة – النوبارية – و الإسماعيلية حيث تم حساب شدة الإصابة و متوسط معدل الإصابة و المقياس النسبى للمقاومة بالإضافة إلى انه امكن تحديد التراكيب الوراثية المرغوبة و المقبولة بالنسبة للمقاومة لمرض صدأ الأوراق . من خلال التحليل الإحصائى بإستخدام معامل الإنحدار للتراكيب الوراثية المستخدمة تحت الظروف المتباينة تم حساب درجة ثباتها للمقاومة . اظهرت معظم التراكيب الوراثية درجة من القابلية للإصابة بمرض الصدأ و كان متوسط شدة الإصابة بالإسماعيلية أقل منها من المواقع الاخرى و تبين أن سلالة الشعير رقم ٢٩ من أفضل السلالات من حيث المقاومة و الثبات الوراثى على مستوى المواقع الأربعة حيث كان متوسط معدل الإصابة (٥,٠٠) و المقياس النسبى للمقاومة (٨,٣٨) يليها السلالات رقم ٨٨ ، ٢٨ ، ١٢ من حيث المقاومة حيث وجد أن متوسط معدل الإصابة بين (١٢,٥ – ١٤,٠٠) و المقياس النسبى للمقاومة (٧,٤٥ – ٧,٢٦). و هذه التراكيب الوراثية يمكن استخدامها كآباء فى برنامج تربية أصناف جديدة من الشعير مقاومة لمرض صدأ الأوراق .