FIELD AND LABORATORY SCREENING OF BARLEY GENOTYPES FOR APHID RESISTANCE IN EGYPT*

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Abstract

Barley breeding lines and cultivars have been evaluated for their levels of sensitivity to aphid infestation under laboratory and natural infestation conditions in the field. In 1992/93 barley season, laboratory screening of 80 barley genotypes revealed 9 resistant and 8 moderately resistant entries to the corn leaf aphid Rhopalosiphum maidis. The criterion for resistance was based on the average daily reproduction rate of the female aphids. Field screening of 80 genotypes in two localities revealed the existence of 5 entries in Mallawi and 15 in Giza that harboured the lowest aphid population (0-25 aphids per plant) on the least percentage of infested plants per plot. In 1993/94 growing season, laboratory screening revealed 2 resistant and four moderately resistant genotypes to R. Maidis out of 60 entries.

Field screening of the same 60 genotypes grown at Giza Research Station revealed 4 entries that were resistant to aphid build-up. Field screening of 80 barley genotypes (92/93 group) grown at Mallawi Research Station for the second season revealed 8 resistant entries. Five of these were found resistant in the previous season either at Giza or at Mallawi.

Key Words : Barley, Resistance to aphids, Rhopalosiphum maidis, Egypt.

INTRODUCTION

Aphids are the principal insect problem of barley in Egypt. Barley fields have been found to be more liable to aphid attack than the adjacent wheat fields in Middle Egypt (Bishara, 1987). The dominant species are Rhopalosiphum padi and R.maidis, and to a lesser extent Schizaphis graminum and Sitobion avenae (El-Hariry, 1979 and Tantawi, 1985). In the "Barley Belt" located on the northwestern coast of Egypt, however, survey studies revealed that R.maidis was the most dominant species of aphids (El-Sayed *et al.*, in press and Noaman *et al.*, 1992).

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Breeding for resistance to aphids has been one of the main components in the barley program since 1988. The present work included field and laboratory screening of barley genotypes aiming at finding sources of resistance to aphids to serve as a useful tool in an integrated pest management (IPM) program. Painter (1951) has emphasized the importance of plant resistance to insects as a major factor which should be incorporated in any breeding program of main crops.

MATERIALS AND METHODS

Laboratory screening (standard method)

A colony of R.maidis was raised in the laboratory on local barley variety Giza 121, grown in 12 cm plastic pots, under nearly constant conditions of temperature 22 ± 2°C, relative humidity 65 ± 5 % and illumination 14/10 light/dark cycle.

The tested barley genotypes were grown in groups of 5 seedlings per pot, with 4 replicates for each entry.

Three days after seedling emergence, 5 viviparous female aphids were introduced into each pot at the rate of one female per seedling, which were covered by a lantern glass with muslin top for confining the aphids and their progeny inside each pot. Six days after initial infestation, the total number of aphids per pot was counted. The criterion for resistance was based on the average daily repoduction rate of the female aphids, as not exceeding one nymph per female per day, i.e. 30 aphids per 5 females per six days. Barley genotypes harbouring 40 aphids/5 females/6 days were considered moderately resistant.

Field screening

Sixty barley genotypes (93/94 breeding material) also tested in the laboratory, were evaluated for their levels of resistance to aphid under natural infestation conditions in the field at Giza Research station.

Two criteria for evaluation were measured :

(i) Level of infestation of plants with aphids was estimated according to a scale of 5 scores :

1 = 0-25; 2 = 26-50; 3 = 51-100; 4 = 101-500, and 5 = more than 500 aphids/plant.

(ii) Percentage of infested plants per plot.

Barley genotypes harbouring the least numbers of aphids (score 1) and lowest percentage of infested plants per plot were considered resistant.

At Mallawi Research Station, 80 genotypes of barley (92/93 breeding material) were re-evaluated in 93/94 growing season for confirmation of previous year results. The same barley material were tested at Giza in 92 /93 season only.

Field observations were recorded in February and March during peak aphid activity, which coincides with very sensitive stages of plant growth.

RESULTS AND DISCUSSION

Laboratory screening

Eighty and sixty barley breeding lines, representing 1992/93 and 1993/94 material, respectively, were tested in the laboratory for estimating their levels of sensitivity to infestation with the corn leaf aphid Rhopalosiphum maidis. The maximum number of aphids and their progenies produced by 5 females per 6 days was 127 aphids in case of the breeding line M64-76/bon/Jo/york/3/M5/Galt//As46/4/ Hj 34-80/Astrix/5/CN 12/CI. The average daily reproduction rate being 4.23 individuals/female/day.

In the pesent work, the genotypes allowing for a reporduction rate less than one aphid per female per day, i.e. 30 individuals/5 females/6 days were considered as promising sources of resistance. By adopting this criterion, 9 entries were resistant and 8 were moderately resistant, Table 1.

Out of 60 barley genotypes (93/94 breeding material) only 2 entries exhibited resistance to build-up of R.maidis aphids, and 4 entries were moderately resistant as shown in Table 2. Four of these genotypes are land-races (LBEG).

It is worthy of mentioning that the newly released barley variety Giza 126 adapted to rainfed areas in Egypt, being drought tolerant, showed reasonable resistance to aphids, Tables 1 and 2. Among the 1993/94 group, Table 2, entries No. 16

Table 1. Laboratory-screened barley genotypes for resistance to R.maidis aphids (80 genotypes, 1992/93)

Entry No.	Name/Pedigree or source	No. of aphids/5 females/6 days
	Resistant Genotypes :	
71	6 F5 Sakha/NWC 91/92	18.50
74	DL 541	20.75
36	Coala's/Apm/IB65//11012-12-2/3/Api/CM67//Ds/Pro/4/Jet/Cp ICB84-0655-4AP-0AP-13APH-OAP	21.75
45	Arar/PI 386540 ICB 84-1739-OAP-3 APH-PAP	24.50
72	L 91/10	25.75
77	L 91/8	26.00
73	L 91/9	29.25
12	80-5013/5/Cr-115/PRO//Bc/3/APi/CM 674/Giza 20 ICB 88-1696-OAP	29.25
43	CEN/Bg LO'S' ICB 84-0548-IAB-OAP-IIAPH-OAP	29.50
	Moderately resistant Genotypes :	
44	N-ACC-4000-301-80/IFB 974 ICB 84-1423-4 AP-OAP-17APH-OAP	32.00
42	Deir Alla 106//APi/EB 89-8-2-15-4/3/Chzo's'/Prn. ICB 84-0163-6AP-OAP-20 APH-PAP	35.25
33	Lignee 527/NK 1272 ICB 84-0323-8 AP-OAP-14 AP-PTR	36.25
4	Giza 126	36.50
53	WI 2269/Lignee 131 ICB 83-0800-5 AP-OAP	37.25
28	Arar//com. cr. 29/C6 ICB 85-1594-5 AP-2 AP-OAP	38.25
29	Arar/PI 386540 IcB 84-1739-11 AP-2 AP-OAP-OAP	38.50
41	Deir Alla 106//APi/EB 89-8-2-15-4/3/Chzo's'	35.50

Table 2. Resistance levels of 60 barley genotypes to R.maidis, 1993/94 group (Laboratory screening).

Entry No.	Name/Pedigree or source	No. of aphids/5 females/6 days
	Resistant Genotypes :	
16	116132 89023-20 51 LBEG 92/93	22.75
18	116134 89032-18 75 LBEG 92/93	24.50
	Moderatly Resistant Genotypes :	
19	116134 89032-21 79 LBEG 92/93	32.00
13	116131 89013-44 39 LBEG 92/93	35.25
4	Giza 126	38.50
25	Arar/Lignee 527 ICB 85-0625-6 AP-OAP-18 APH-OAP	40.00

19, 13, and 25 are early maturing, while No. 18 is very early maturing. Entries No. 16, 4 and 25 are drought tolerant, whereas Nos. 16 and 25 are high yielding.

Field screening

The dominant aphid species on barley in the experimental plots at Giza and Mallawi in 1992/93 season was Rhopalosiphum maidis, since the previous crop in the two areas was maize.

a- Giza Research Station

Aphid infestation of barley was very low in the spring of 1993 at Giza region. The rate of infestation (R.I.) among the 80 tested barley genotypes ranged between score 1 and 2 on the infestation scale. Aphids were always clustering at the basal part of the flag leaf at low density infestations.

On the other hand, percentage of plants harbouring aphids per plot, ranged between 1 and 80%. The barley entries which gained score 1 (R.I.) and exhibited the lowest percentage of infested plants per plot (1 %) reached 15 in number as shown in Table 3. Four entries (36, 41, 42 and 74) were also resistant in laboratory tests Table 1.

The fact that some entries have not been attacked by aphids, does not necessarily mean that they are resistant, because at such low aphid population, many barley genotypes may escape infestation.

Table 3. Field-screened barley genotypes showing lowest infestation rate (R.I. = 1) and the least percentage of infested plants per plot (= 1%) Giza locality (92/93).

Entry No.	Name/Pedigree
24	Nopal's/4/Makner/Aths//CI14122/3/Ager//Api/CM 67ICB 97-1509-OAP
25	Coala's'/Attki CYB-3996-AP-IAP-OAP.
26	Aths/Lignee 686 ICB 82-0979-5 AP-OAP-OAP-12 AP-OTR
27	Aths/Lignee 686 ICB 82-0979-5 AP-OAP-24 AP-OTR
34	Arar//1762/BC-2L-2Y ICB 83-0687-7AP-OTR-OAP-IAP-OTR
36	Coala's'/Apm/IB 65//11012-2/3/Api/CM 6'///Ds/Pro/4/Jet/CP OCB 84-0655-4AP-OAP-13 APH-OAP
37	ArAr//2762/BC-2L-2Y ICB 83-0687-7 AP-OTR-OAP-1 AP-IAPH-OAP
38	Mari/Aths* 2/M-Att-73-337-1 CYB-3574-CAP
39	Baca's'/3/AC 253//CI 08887/CI 25761 ICB 84-0674 OAP-15 AP-1 APH-OAP
40	Baca's'/3/AC 253//CI 08887/CI 25761 ICB 84-0674 OAP-18 AP-1 APH-OAP
41	Deir Alla 106//Api/EB 89-8-2-15-4/3/chzo's'/Prn ICB 84-0163-3 AP-0AP-16 APH-OAP
42	Deir Alla 106//Api/EB 89-8-2-15-4/3/chzo's'/Prn ICB 84-0163-6 AP-OAP-20 APH-OAP
48	Aths/Lignee 686 ICB 82-0979-5 AP-OAPO-OAP-5 AP-OTR
74	DL 541
76	L 91/7

b- Mallawi Research Station (Middle Egypt)

Aphid infestation of barley in this locality is normally high but in 92/93 season it was comparatively lower than the previous seasons. However, screening was

successful as the rate of infestation (R.I.) of plants ranged between score 1 and 3 on the scale.

Honeydew was few in score 2 but abundant in score 3. On the other hand, the percentage of infested plants per plot ranged between 20 and 80%.

The genotypes that showed score I (R.I.) and the lowest percentage of infested plants per plot (20-30 %) were five in number as presented in Table 4. As far as the interrelationship between laboratory and field screening it can be noticed that entry No. 74 was found resistant in the laboratory and under field conditions at Giza and Mallawi localities. Entry No. 36 which was found resistant in the laboratory exhibited the desired character at Giza field conditions.

Table 4. Field-screened genotypes showing lowest infestation rate (R.I. = 1) and the least percentage of infested plants per plot (20-30%) at Mallawi locality (92/93).

Entry No.	Name/Pedigree
56	Baca's'/3/Ac 253//CI//08887/CI 05761 ICB 84-0674-0AP-22 AP-1APH-OAP
70	CI 7273
74	DL 541
79	W 2291/WI 2269
80	Giza 123

In 1993/94 season infestation of barley at Giza was generally moderate to high. The rate of infestation (R.I.) ranged between 1 and 4 on the scale, while percentage infested plants per plot ranged between 20 and 90%. The dominant aphid species was R.maidis, most probably because the previous crop was maize.

Evaluation of 60 barley genotypes (1993/94 breeding material) for their levels of resistance to aphids carried out at Giza Research Station revealed 4 resistant and 5 moderately resistant genotypes as shown in Table 5.

As can be concluded from the results obtained in Tables 2 and 5, laboratory screening was confirmed by field evaluations at Giza.

At Mallawi region, on the other hand, aphid infestation of barley was moderate in the spring of 1994, and aphid species available were R.padi, R.maidis and S.graminum.

Table 5. Rate of infestation with aphids (R.I.) and percentage of infested barley plants per plot (93/94 material) at Giza.

Entry No.	Name/Pedigree	R.I.	%
	Resistant :		
4	Giza 126	I	20
16	116132 89023-20 51 LBEG 92/93	I	20
18	116134 89032-18 78 LBEG 92/93	I	20
19	116134 89032-21 79 LBEG 92/93	I	20
	Moderately Resistant :		
13	116131 89013-44 39 92/93	I	30
17	116134 89032-16 76 LBEG 92/93	I	30
25	Arar/Lignee 527 ICB 85-0625-6 AP-OAP-18 APH-OAP	I	30
26	Haram-02//11012-2/Mzq/3/Arar/4/Harma-02//11012-2/Mzq/3/ Lingee 527 ICB 85-1152-2 AP-4AP-OTR-2AP-OTR-OAP	I	30
52	WI 2197/CI 1354/Arar	I	30

Evaluation of 80 barley genotypes (92/93 breeding material) for their levels of sensitivity to aphids build-up was conducted at Mallawi Research Station in 93/94 for the second consecutive season. Field observations revealed the existence of 8 highly resistant genotypes which were free of aphids, as shown in Table 6.

It is worthy of mentioning that entries Nos. 26, 27, 48, 56, and 74 proved resistant in the previous season either at Giza or at Mallawi. This confirms the desired character of resistance to aphids.

The present laboratory screening technique has several advantages (a) the accuracy in evaluating the aphid reproduction on each genotype through standardization of the initial infestation at the rate of 5 female aphids per 5 seedlings as the unit of testing, i.e. one female per seedling, for a limited period of six days only to

avoid over crowding of aphids and wilting of the host plant on which they fed, and (b) rapid screening of hundreds of genotypes can be carried out all the year round in the laboratory held at favourable conditions of temperature, relative humidity and light.

Table 6. Resistant barley genotypes to aphids under field conditions at Mallawi (92/93 breeding material) in the spring of 1994.

Entry No.	Name/Pedigree
15	Deir Alla 106/Cel/3/Bco. Mr/Mzq//Apm/5106
	ICB 83-0215-4 Ao-OTR-OAP
26	Aths/Lignee 686
	ICB 82-0979-5 AP-0AP - 12 AP -OTR
27	Aths/Lignee 686
	ICB 82-0979-5 AP -OAP-24 AP-OTR
33	Lignee 527/NK 1272
	ICB 84-0323-8 AP-OAP-14 AP-OTR
48	Aths/Lignee 686
	ICB 52-0979-AP-OAP-OAP-OAP-5 AP-OTR
54	Early Arar/PI 386540-1739-2 AP-OAP
	ICB 84-1739-2 AP-3 APH-AP
56	Baca's'/s/AC 253//CI 0761
	ICB 84-0674-OAP-22 AP-1 APH-OAP
74	DL 541

Another method of screening cereals for aphid resistance offered by Starks and Burton (1977) was more suitable for the greenbug Schizaphis graminum, in which unknown numbers of aphids were left to crawl freely from source plants to the test seedlings, grown in rows inside flat trays left uncovered, and no count of aphids was recorded but only damage rating. For this reason, this technique was not adopted in the present studies.

Serveral authors dealt with screening barley genotypes for aphid resistance. Hormchong and Wood (1963) suggested that the gene-pair responsible for Schizaphis graminum resistance in barley was apparently different from the pair that impact

resistance to R.maidis. Webster and Starks (1984) stated that greater resistance in an R-strain of barley to S.graminum occurred when antibiosis, non-preference and tolerance were considered together.

Resistance to aphids in barley has been attributed to either physical factors, e.g. thickness of schlerenchyma cells and number of vascular bundles (El-Serwiy *et al.*, 1985), or surface wax on the leaves (Tsumuki *et al.*, 1987); or to the chemical composition of the leaves as has been discussed by some authors. Todd *et al.* (1971) concluded that resistance of barley genotypes to S.graminum might be due to the presence of phenolic and flavonoid compounds in the leaves, while Juneja *et al.* (1972) identified benzyl alcohol as possible cause of resistance.

Another chemical causing resistance to cereal aphids in barley was the existence of gramine in the leaves (Salas, 1991). For this reason, biochemical investigations seem essential in the future plan of work in order to identify resistance factors in the breeding material available.

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غربلة بعض مواد التربية للشعير بالنسبة للمقاومة لحشرة المن بالحقل والمعمل فى مصر*

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أختبرت مجموعة من الأصناف والتراكيب الوراثية للشعير من حيث حساسيتها للإصابة بحشرة المن تحت الظروف الحقلية والمعملية بمصر. ففى موسم ١٩٩٢ / ٩٣ تم إختبار ثمانون تركيبا وراثيا بالمعمل ، وإظهرت نتائجها أن تسعة منها كانت مقاومة، وثمانية منها متوسطة المقاومة لحشرة من الذرة وأعتمدت صفات المقاومة على متوسط معدل التناسل اليومى لكل أنثى واحدة ومن جهة أخرى أختبرت نفس مواد التربية تحت ظروف الإصابة الطبيعية بالحقل بكل من محطة بحوث ملوى ومحطة بحوث الجيزة. وأظهرت النتائج وجود خمسة تراكيب وراثيه ذات مقاومة عاليه نسبيا بمحطة بحوث ملوي وخمسة عشر تركيبا وراثيا ذات مقاومة عالية أيضا بمحافظة الجيزة. وأعتبرت النباتات ذات المقاومة النسبية العالية هى التى تأوى عددا من الحشرات تتراوح ما بين صفر الى ٢٥ حشرة .وفى موسم ١٩٩٣ / ٩٤ أجرى اختبار معملى لستين تركيبا وراثيا أخرى للشعير، وأظهرت النتائج وجود تركيبين وراثيين لهما صفة المقاومة لحشرة من الذرة وأربعة تراكيب وراثية متوسطة المقاومة للحشرة نفسها .

وعندما أختبرت نفس السلالات تحت ظروف الحقل فى محطة بحوث الجيزة وجدت أربعة منها مقاومة لتكاثر المن .

كما أجريت بمحطة بحوث ملوى بمصر الوسطى تجربة لتقييم ٨٠ تركيبا وراثيا من مجموعة الشعير (٩٢ / ٩٣) للسنة الثانية على التوالى ، وظهر من النتائج أن ثمانية تراكيب وراثية لها صفة المقاومة لحشرة من الذرة منها خمسة سلالات سبق أن أظهرت نفس الصفة فى العام السابق فى محطة بحوث الجيزة أو محطة بحوث ملوى.

* استخلص هذا البحث من البرنامج الاقليمي لوادي النيل الممول من السوق الأوربية المشتركة.