Evaluating Cereals for Aphid Resistance in Egypt

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Abstract

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Wheat and barley lines were screened in a laboratory in Giza, Egypt under controlled light and temperature. The progeny of crosses involving commercial Sakha and Giza wheat varieties and Bushland /Amigo lines from the USA were resistant to *Schizaphis graminum* Rond. Two *Hordeum vulgare* spp. *spontaneum* lines were also resistant to *S. graminum* while 2 others showed partial resistance. Two *H. spontaneum* lines were resistant to *Rhopalosiphum padi* L. One *Triticum timopheevi* var. *timopheevi* (Zhuk.)Zhuk. line and 2 *Aegilopes squarossa* L. lines possessed moderate resistance to *R. padi* as did 2 *Triticum aestivum* L. em. Thell. and 2 *Triticum turgidum* L. lines. These results, the product of over 10,000 separate tests performed over 2 years, are being verified in further laboratory and field tests. Cytogenetic manipulations and conventional crosses are envisioned in the future to fully exploit these sources of resistance. Future emphasis will be placed on examining primitive wheat and barley for aphid resistance.

Key words: aphids, barley, resistance, wheat, Egypt.

Introduction

Four species of aphids infest wheat and barley in Egypt. These are, in decreasing order of importance, *Rhopalosiphum padi* L. (bird cherry oat aphid), the major aphid pest of Egyptian wheat and barley which also occurs on sorghum and to a lesser extent on maize; *Schizaphis graminum* Rond. (greenbug), which occasionally exceeds *R. padi* in importance on wheat and also occurs on sorghum and on several wild grasses; *Rhopalosiphum maidis* Fitch (Corn leaf aphid), primarily a pest of maize, though also found on sorghum, barley, wheat, and various grasses; *Sitobium avenae* F. (English grain aphid), a minor pest of Egyptian wheat and barley.

Cereal aphids are most abundant in upper Egypt near Minya and Assyut, while Beni Suef and Sohag governorates usually have lower infestations. In the Nile Delta, wheat is seldom infested by aphids. *R. maidis,* however, may be abundant in lower and middle Egypt on late sown maize.

R. padi and *S. graminum* usually become apparent on wheat during the first week of February, while *R. maidis* appears later in the month and may intermix with colonies of *R. padi*. *S. avenae* populations appear near the beginning of April and may be present on wheat for about 4 weeks between heading and maturity. *R. padi* and *S. graminum* colonies, however, may be observed over an 11 week period that encompasses tillering, heading, emergence, and kernel formation.

In 1986 /87 field populations of *R. maidis* remained at relatively low densities, and were interspersed with *R. padi* colonies. This may have been due to higher fecundity of *R. padi* which allowed a more rapid population increase, or to a lower preference for wheat when maize and sorghum were available as alternate hosts.

Our observations indicate that *S. graminum* prefer the lower leaves of wheat. Apterae and nymphs are usually found clustered on the lower leaf surface near leaf apices and edges. We have not found *S. graminum* on the rachis. *R. padi* appears to prefer the mid-region of the plant including the rachis. *S. avenae* shows preference for feeding on the developing rachis.

Wheat in Egypt is normally sown in November. Populations of *S. graminum, R. padi,* and *R. maidis* reach their peak near the end of March in middle Egypt and near the first week of March in upper Egypt.

Materials and Methods

In 1984 screening cereals and legumes for aphid resistance on a controlled temperature facility began at the Agricultural Research Cooperation-Giza (ARC - Giza) . In 1985 /86 the first wheat and barley screenings were made against mixed biotype cultures of *R. padi* and *S. graminum*. *S. graminum* was easily reared on the barley variety Giza 121, while after some difficulty *R. padi* cultures were established on the wheat variety Giza 157. Host plants were grown in 12 cm diameter plastic pots at 20°C ± 2, 60% ±5 relative humidity, and 16:8 1 /d cycle. The two aphid species were kept in separate rearing rooms free from parasitoids and other aphid species.

Screening (5) was conducted by first sowing 15 seeds of each test line in soil filled metal trays in rows 30 cm long. Plants were later thinned to 10 seedlings /row. Three days after germination aphids were introduced from stock cultures by placing infested wheat or barley blades between the newly emergent seedlings. After 2 days plants were examined and if any plant had less than 2 aphids, additional aphids were placed on it. Two to three aphids per plant was considered the minimum initial density required for a valid test. Damage ratings for *S. graminum* were made 12 to 15 days after the aphids were placed on the plants. Plants with no apparent damage or with slight red spotting of the leaves were considered tolerant. Plants with extensive leaf chlorosis or with dead leaves were considered nontolerant. In rating for *R. padi* resistance the total number of aphids was recorded for each plant in each test line. Test lines with every plant having less than 10 aphids were considered resistant, test lines with plants having 10 – 15 aphids were considered moderately resistant, and plants with more than 15 aphids were designated susceptible.

A total of 3820 lines provided by ICARDA / CIMMYT breeders were screened in 1985 /86 against *S. graminum* (927 bread wheat, *Triticum aestivum* L., 1893 durum wheat, *Triticum turgidum* L., 1000 barley, *Hordeum vulgare* L.). Only 672 lines were screened against *R. padi* (444 bread wheat, 84 durum wheat, 144 barley) due to problems in establishing the *R. padi* culture.

In 1986 /87 approximately 5000 tests (including at least 2 retests of initially promising lines) were performed for each aphid species using the techniques previously described. Of note was the inclusion of 49 *Aegilopes* L. entries, the progeny of crosses and backcrosses between Egyptian wheat varieties and Bushand /Amigo derivatives (Table 2), and the testing of several accessions of *Hordeum vulgare* spp. *spontaneum* (referred to hereafter as *H. spontaneum)*.

Table 1. Some parent varieties and pedigrees of wheat used in aphid resistance tests in 1986 /87.

Parent Variety	Pedigree
1. Bushland / Amigo T 101	Bushland T X F 79518 – 2X 77A/ 5/ Amigo 11T – 101
2. Bushland/ Amigo T 105	Bushland T X 38924– 8 Amigo/ 27 – 105
3. Giza 157	G. 155 – P.I. 64 x IR. 64/ TEPP X KNOTT 11
4. Sakha 61	INIA – RL 4220 X 7C/ YR «S» CM 15430 – 2S – 6S
5. Sakha 69	INIA – RL 4220 X 7C/ YR «S» CM 15430 – 2S – 6S

Results and Discussion

No lines tested in 1985 /86 exhibited good resistance or tolerance.

Table 2 and 3 show results of screenings for *S. graminum* on Bushland /Amigo derivatives (adapted from Youssef et al., in press). These results indicate that *S. graminum* resistance may be due to 2 recessive genes, as earlier suggested by Dahms et al. (3) and Starks et al. (7). Others concluded

Table 2. Reaction of wheat parents and F_2 plants to *S. graminum* (modified from Youssef et al., in press).

Variety /F_2	Resistant	Susceptible	Total	Ratio	X^{2a}
Bushland / Amigo T105	10	0	10	—	—
Giza 157	0	50	50	—	—
Sakha 61	0	50	50	—	—
Sakha 69	0	50	50	—	—
Bushland/Amigo T105 × Giza 157	20	198	218	1:15	3.32
Bushland/Amigo T105 × Sakha 69	24	281	305	1:15	1.36
Bushland/Amigo T105 × Sakha 61	4	56	60	1:15	0.02

(a) X^2 0.05 (1) = 3.84

Table 3. Reaction of wheat parents and selfed BC_1 plants to *S. graminum* (modified from Youssef et al., in press).

Variety /BC_1	Resistant	Susceptible	Total	Ratio	X^{2a}
Bushland /Amigo T105	10	0	10	—	—
Bushland /Amigo T101	25	0	25	—	—
Giza 157	0	50	50	—	—
Sakha 61	0	50	50	—	—
Sakha 69	0	50	50	—	—
Bushland/Amigo T105 × Giza 157	10 (b)	83	93	1:15	3.22
	40 (c)	88	128	1:3	2.67
Bushland /Amigo T101 × Sakha 61	11 (b)	88	99	1:15	3.99
	29 (c)	87	116	1:3	0.31
Bushland /Amigo T 101 × Sakha 69	13 (b)	215	228	1:15	0.12
	4 (c)	10	14	1:3	0.10

(a) X^2 0.05 (1) = 3.84
(b) First cross
(c) Backcross

that resistance was imparted by a single gene pair (1, 2, 4, 5). Youssef et al. (8) concluded that these conflicting results may have resulted from differences among workers in classifying resistance / tolerance in plants and to variation in the aphid biotypes and densities employed in the screenings. A variable number of modifying genes may also have been involved.

More recently, tolerance to *S. graminum* was observed in 4 lines of *H. spontaneum*. Two lines exhibited no apparent damage (rating = 0) and *S. graminum* appeared to be slightly repelled by the plants when they attained about 8 days growth. Two other lines sustained moderate damage (rating = 1), but again aphids appeared to voluntarily leave the plant after about a week. Additional tests are still being

performed on these and other *H. spontaneum* accessions.

Resistance to *R. padi* has been more difficult to identify, and only recently have plants been identified as resistant. Two *H. spontaneum* lines have recently been shown to be resistant and subsequent tests are currently in progress. In addition, 1 *Triticum timopheevi* var. *timopheevi* (Zhuk.) Zhuk. and 2 *Aegilopes squarrosa* L. lines were shown to possess moderate *R. padi* resistance as were 2 *T. aestivum* and 2 *T. turgidum* lines. We surmise that pubesence, leaf toughness, and leaf shape confers resistance to *R. padi.*

Though relatively rare, it is apparent that resistance to *S. graminum* and *R. padi* is present and can be exploited in developing commercially acceptable wheat and barley varieties. For wheat the known *S. graminum* resistance characteristics of Bushland / Amigo derivatives make them the most likely candidates for parental material. Crosses between these varieties and lines possessing proper phenology, heat tolerance, and drought tolerance should do much to alleviate aphid problems in wheat grown in the Nile Valley, in North Africa, and in Ethiopia. Though little is known about biotype composition of aphids in the region, preliminary results from field studies suggest that wheats resistant to greenbug in Egypt are also resistant to green bug in Sudan.

Breeding wheat with *R. padi* resistance is likely to pose more problems as more complex cytogenetic manipulations must be made to transfer resistant genes into commercially acceptable varieties. Fewer problems are anticipated in crossing *H. vulgare* with *H. spontaneum.*

We anticipate that a greater percentage of the tests performed at the aphid screening laboratory at ARC – Giza in the future will involve material containing resistance / tolerance genes from the material previously described. These will be made available to national programs, researchers, and other collaborators through ICARDA's established distribution procedures. We also anticipate a more intensive examination of landraces and primitive forms as possible sources of aphid resistance. West Asia is a center of diversity and origin for wheat and barley, and the collaborative network for aphid resistance between national programs of the region and ICARDA will provide an efficient mechanism for exploiting these untapped genetic resources.

الملخص

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تمّ تقويم سلالات من القمح والشعير في أحد المختبرات بمركز البحوث الزراعية بالجيزة بمصر، وذلك تحت ظروف محكمة من الضوء والحرارة لتحديد مدى مقاومتها للمن. وقد كان نِتاج التهجينات التي شملت صنفي القمح جيزة وسخا التجاريين، وسلالات بوش لاند/ أميجو الامريكية، مقاومة لمنّ الحبوب الأخضر *Schizaphis graminum* Rond. كما أبدت سلالتان من الشعير *Hordeum vulgare* spp. *spontaneum* مقاومة لهذا النوع من المنّ، في حين أظهرت سلالتان أخريان مقاومة جزئية له. وأظهرت سلالتان من الشعير البري *H. spontaneum* مقاومة لمنّ النجيليات *Rhopalosiphum padi* واتسمت سلالة من *Triticum timopheevi* Var. *timopheevi* L. (Zhuk.) Zhuk. وسلالتان من *Aegilopes squarossa* L. بمقاومة متوسطة لمنّ النجيليات *Rhopalosiphum padi* على غرار سلالتين من قمح الخبز *Triticum aestivum* L. em. Thell، وسلالتين من القمح القاسي *Triticum turgidum* L.. وقد جرى التحقق من هذه النتائج والتي تمثل حصيلة أكثر من 10,000 اختبار منفصل نفذت على مدى سنتين؛ باختبارات حقلية ومخبرية إضافية. ويؤمّل استغلال مصادر المقاومة هذه على أكمل وجه في المستقبل بوساطة التأثيرات الخلوية الوراثية والتهجينات المألوفة. وسيتم التركيز مستقبلاً على اختبار السلالات المحلية والأشكال البدائية من الشعير والقمح كمصادر محتملة لمقاومة المنّ.

كلمات مفتاحية: منّ، شعير، مقاومة، قمح، مصر.

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