Pakistan J. Zool., vol. 38(2), pp. 167-171, 2006.

Categories of Resistance in National Uniform Wheat Yield Trials Against *Schizaphis graminum* (Rondani) (Homoptera: Aphididae)

NAHEED AKHTAR, EHSAN-UL-HAQ AND M. ASIF MASOOD
Insect Pest Management Programme (NA, EH) and Biometric Programme (MAM), National Agricultural Research Centre, Islamabad

Abstract.- An effort was made to evaluate the categories of resistance in National uniform wheat yield trials (NUWYT) Normal (N) 2002-03 against green bug *Schizaphis graminum,* under controlled conditions. Aphids were collected from grasses and wheat field of National Agricultural Research Centre and their culture was established. Out of twenty NUWYT wheat cultivars six cultivars, MAW-I, SKD-I, V-99022, PR-76, 99-B-2237 and TD-l, were resistant. In seedling bulk test, twelve cultivars proved to be moderately resistant and two were susceptible. Components of resistance like antixenosis, antibiosis and tolerance were conducted to determine the nature of resistance in NUWYT (N) cultivars. In antixenosis test 99B2460, MAW-I, D-98627 and V-5 were least preferred cultivars. In antibiosis three cultivars SD-66, Local Check (Wafaq-2001) and D 98627 sustained high fecundity and three cultivars 99B24460, SKD-l and 99B2237 showed high tolerance.

Key words: *Schizaphis graminum,* greenbug, aphids, wheat, antixenosis, Antibiosis, tolerance, seedling bulk test, host plant resistance, Pakistan.

INTRODUCTION

Wheat *(Triticum aestivum* L.) is the most widely grown cereal grain in the world. It is the staple food for 35% of the world's population and is becoming increasingly important in developing world. A number of aphid species attack cereals causing damage by (i) sucking plant sap (ii) injecting toxic secretion while feeding and (iii) transmitting viral diseases (Webster and Inayatullah, 1984). Aphid feeding results in destruction of plant chloroplasts that ultimately leads to reduced chlorophyll levels and photosynthetic activity (Burd and Elliott, 1996). Significant reduction in yield occur when aphids inject salivary enzymes into the plant during feeding and subsequently remove the plant nutrients. Wheat leaves and aphid saliva react to cause physiological reactions (through transmission of viral diseases) that leads to leaf chlorosis and necrosis (Ryan *et al.,* 1990). The green bug, *S. graminum* (Rondani), bird cherry oat aphid, *Rhopalosiphum padi* L., corn leaf aphid, *R maidias* (L.) and Russian wheat aphid *(Diurapis noxia)* commonly attack wheat throughout the world including Pakistan causing severe damage to wheat crop (Hamid, 1983). Green bug, S. *graminum* Rondani found all over the world, is one of the most serious insect pests of wheat, but also infests other small-grain cereals and sorghum *Sorghum bicolor* (L.) Moench (Inayatullah *et al*., 1993).

Direct and indirect costs as a result of the Russian wheat aphid damage in wheat *(Triticum aestivum* L.) and barley *(Hordeum vulgare* L.) in America has been estimated at $ 893 million. The green bug causes severe damage to winter wheat in Oklahoma, with estimates of economic loses> $ 100 million in some years (Webster, 1995). Thirteen wheat varieties were tested to determine loss in grain yield caused by aphids *(Sitobion avenae* F. and *Rhtopalosiphum ruftabdominalis* Sasaki). On an average, 7.19 aphids per tiller reduced yield 16.38%. Kohinoor 83 was relatively susceptible with 22.53% grain yield loss, whereas, variety V 7061 was resistant with 10.76% yield loss. Wheat lines behaved differently with regard to aphid population and loss in grain yield (Aheer *et al.,* 1993). It is not known, however, whether the aphid injects a phytotoxin during feeding that degrades chloroplasts or if the damage results from the plant's response to mechanical injury (Royer *et al.,* 1998).

The use of aphid resistant varieties is an

0030-9923/2006/0002-0167 $ 8.00/0

effective control measure. Since the recognition of aphids as a damaging pest, resistant varieties of both small grains and sorghum have been released. There is a need of continuous search for resistance sources against aphid. There is a good chance that research in Pakistan may lead to the discovery of new resistance sources against aphid which can be exploited to use in aphids host plant resistance program in Pakistan, or elsewhere in the world. Sixteen cultivars of NUWYT Rain Fed (RF) have been tested in the laboratory for resistance against *S. graminum* (Rond.) species of aphid.

MATERIALS AND METHODS

Green bug, *S. graminum* were collected from wheat, barley and grasses from Wheat Fields of National Agricultural Research Centre (NARC), Islamabad, Their culture was established on a susceptible host (Cakwal-97), under growth room conditions. Twenty seeds of susceptible wheat cultivar per plot were sown in plastic pots (11.5 cm.dia.) and were kept in rearing cages. The environmental conditions maintained in the rearing room were 27±3°C temperature, 60±2% RH. and 16:8 h daylight photophase. After every three days pots with dead plants were replaced with new healthy plants and aphids were automatically shifted to the healthy plants.

Seedling Bulk-test was conducted on twenty wheat cultivars, 99 B2460, SD-66, MAW-1, SKD-1, Wafaq-2001, CT-0023I, V-98069, D-98627, V-5, V 99022,93 T-347, PR-76, 99 B2237, V-1076, V-9, TD-I, PR-74, V-9189, V-00813 and SN-122, of National Uniform Wheat Yield Trials (NUWYT) Normal (N), year 2002-2003 obtained from Wheat Programme, NARC. One row of each test entry was sown in a metal flat (51x35x9 cm). When seedlings attained height of 5.8 cm ten aphids per seedling were released and were observed daily. When senescence of leaves and logging of seedlings started after aphid infestation for fifteen days the damage done to each variety was recorded on damage rating (DR) scale of 0 to 9, where 2-3 damage rating stands for resistant (R), 4-6 damage rating stands for moderately resistant (MR) and 7-9 damage rating stands for susceptible (S) varieties (Inayatullah *et al.,* 1993).

Varieties were subjected to further experimentation to determine the components of resistance (Painter and Peters, 1956). For antixenosis test wheat varieties 99 B2460, SD-66, MAW-I, SKD-1, Wafaq-2001, CT-00231, V-98069, D-98627, V-5, V 99022, 93 T-347, PR-76, 99 B2237, V-I076, V-9, TD-l, PR-74, V-9189, V-00813 and SN-122 with twelve replicates were used. Seeds of varieties were planted in a circular pattern about 3 cm from the edge of a 30.5 cm-diameter pot. When the plants were about 5 cm tall, 10 adults green bug aphid per plant were released on the soil in the centre of the pot. There were 10 replicates and twenty cultivars. The plants and aphids were covered with plastic cages (28 cm diameter by 50 cm high) having cloth covered tops and 2 ventilation holes on the sides. The first data was recorded after twenty four hours and second data was recorded after forty eight hours as reported by Webster and Inayatullah (1984). When the aphids had selected plants of their choice the data was recorded for number of aphids per plant in order to know the preference of pest for host plants.

For antibiosis test wheat varieties 99 B2460, SD-66, MAW-I, SKD-l, Wafaq-2001, CT00231, V-98069, D-98627, V-5, V 99022, 93 T-347, PR-76, 99 B2237, V-I076, V-9, TD-l, PR-74, V-9189, V-00813 and SN-122, with twelve replicates were tested for number of nymphs laid in the life cycle of female aphid per plant. Seeds of entries were planted in 7.6 cm -diameter pots and were thinned to one seedling per pot. Individual plants in the first-leaf stage were infested with one aphid adults from laboratory colonies. Each plant was then covered with a plastic cage (6 cm in diameter by 30 cm high) with a cloth top and cloth-covered ventilation holes on the sides. The plants and aphids were observed daily. When reproduction began, adult was removed, and one nymph on each plant was left. Nymphs were allowed to grow on the test plant until mature and began to reproduce. Nymphs reproduced were counted and removed from the plants daily until the adults stopped reproducing. The plants were clipped periodically to facilitate handling (Inayatullah *et al.,* 1993).

For tolerance test, twenty wheat varieties, 99 B2460, SD-66, MAW-1, SKD-l, Wafaq-2001, CT-00231, V-98069, D-98627, V-5, V 99022, 93 T-347,

PR-76, 99 B2237, V-I076, V-9, TD-l, PR-74, V-9189, V-00813 and SN-122, were tested in twelve replicates. Two seeds of each variety were sown which were thinned to one seed. When the seedlings attained a height of 5 to 6 cm, laboratory reared ten green bug adult aphids were released per plant. There were ten replicates and twenty cultivars. All the seedlings were covered with plastic cages as described in the antixenosis test. The plants were checked daily to remove or add aphids as needed to maintain 10 mature aphids/plants. when senescence of leaves and logging of seedling started, the damage done to each variety was recorded on damage rating (DR) scale of 0 to 9, where 0 stand for healthy and 9 stands for dead (Starks and Burton, 1977).

RESULTS AND DISCUSSION

The damage done to each of the twenty cultivars by *S. graminum* is shown in Table I. Results showed that seven cultivars MAW-I, SKD-l, V-99022, PR-76, 99B2237, V-9 and TD-l were resistant. Eleven cultivars 93 T-347, V-1076, V-5, PR-74, V-00813, SD-66, Wafaq-2001(L. Check), V-9189 CT-00231, V-98069 and D-98627 were found to be moderately resistant (MR) with DR 4-6. Two cultivars 99 B2460 and SN-122 were susceptible (S), with DR 7-9. Results of our studies agree with those of Youssef (1997) who conducted field and laboratory studies during 1990-95 in Egypt to evaluate 200 wheat lines for resistance against S. *graminum* and *Rhopalosiphum padi.* A greenhouse study of 1042 showed that 15 lines were resistant and 12 lines were tolerant at the seedling stage. Results were reported by Hafez *et al.* (1994) that they screened ten local and exotic wheat genotypes for aphid infestation in the field the aphid species were *Sitobion avenae, S. graminum* and *R. padi.* Resistant wheat genotypes found were Pick, Hatri E 16 and Seren with 23-41% infestation.

Results of antixenosis experiments with twelve replications as indicated in (Table II) showed that four cultivars V-5, Wafiq-2001 (L. Check), MAW-I, and 99B2460 were least [referred (LP), with 4.16,4.58, 4.58 and 5.08 average aphids per plant, respectively. Three cultivars CT-00231, V-99022 and PR-74 were highly preferred (HP) with 10.83, 10.75 and 9.25 average aphids per plant, respectively. However, thirteen cultivars SKD-1, D-98627, SN-122, PR-76, 99B-2237, SD-66, V-98059, 93T347, V-1076, V-9, TD-1, V-9189 and V-00183 were moderately preferred (MF) with 7.08, 6.41, 6.83, 6.08, 6.33, 6.41, 8.75, 7.41, 7.50, 7.08,6.50, 7.75, 7.91 average number of aphids per plant respectively.

Table I.- Seedling bulk test of NUWYT normal (N) wheat cultivars against *S. graminum.*

Cultivars	Damage rating	Level of resistance*
99 B2460	7	S
SD-66	5	MR
MAW-l	3	R
SKD-l	3	R
Wafaq-2001 (L. Check)	5	MR
CT -00231	6	MR
V -98069	6	MR
SN-122	8	S
V -99022	3	R
93 T-347	4	MR
PR-76	3	R
99 B-2237	3	R
V-107 6	4	MR
D-98627	5	MR
V-5	4	MR
V-9	3	R
TD-l	3	R
PR-74	4	MR
V-9189	6	MR
V -00813	4	MR

*R (resistant), DR, 2-3; MR (moderately resistant), DR, 4-6; S (susceptible), DR, 7-9.

Nasir (2001) evaluated ten wheat varieties Pitic-62, Pak-81, Barani-83, Kohinoor-83, FSD-85, Punjab-85, Rawal-87, Chakwal-86, Pasban-90 and FDS-83 for various physio-morphic and chemical characters imparting resistance against wheat aphid *Sitobion avenae* and studied the effect of abiotic factors on aphid population. The data indicated that some wheat varieties were comparatively resistant and others were moderately resistant except one that was moderately susceptible to wheat aphid, *Sitobion avenae.* The most resistant wheat varieties to wheat aphid were proved to be Pitic-62 and Punjab-85. However, the variety most victimized by wheat aphid was observed to be FDS-83.

Table II shows the results of antibiosis test which measured the fecundity of the aphid on the twenty cultivars of NUWYT (N) 99 B2460, SD-66, MAW-I, SKD-1, Wafaq2001, CT-00231, V-98069, D-98627, V-5, V 99022, 93 T-347, PR-76, 99 B2237, V-1076, V-9, TD-1, PR-74, V-9189, V-00813 and SN-122, for year 2002-2003, with twelve replications. Three cultivars (D-98627, Wafaq-2001 and SD-66) supported least fecundity (LF) with average number of 2.42, 3.71 and 4.85 nymphs, respectively. Six cultivars V-99022, V-1076, 99B2460, CT-00231, V-9189 and 93T347 had 12.75, 11.50, 10.71, 10.50, 10.25 and 10.00 average number of nymphs, respectively were the cultivars with high fecundity (HF), while eleven cultivars MAW-I, PR-76, V-9, TD-1, V-98059 V-00183, V5, PR-74, SKD-1, SN-122 and 99B2237 sustained moderate fecundity (MR) with average number of 9.71, 9.71, 9.50, 9.50, 9.25, 9.25, 8.00, 7.75, 7.00, 6.71, 6.71 nymphs per plant, respectively.

Table II.- Antixenosis antibiosis and tolerance tests of NUWYT (N) cultivars of wheat showing nature of resistance.

Wheat	Antixenosis[1]	Antibiosis[2]	Tolerance[3]
99B2460	5.08 bc	10.71	2.58 bc
SKD-1	7.08 abc	7.00	2.33 c
D-98627	6.41 abc	2.42*	4.00 abc
SN-122	6.83 abc	6.71	3.66 abc
Wafaq-2001	4.58 bc	3.71*	3.33 ab
MAW-1	4.58 bc	9.71	3.41 abc
PR-76	6.08 abc	9.71	4.33 ab
99B-2237	6.33 abc	6.71	2.66 bc
V-5	4.16 c	8.00	3.58 abc
SD-66	6.41 abc	4.85*	3.41 abc
CT -00231	10.83 a	10.50	3.91 abc
V -98059	8.75 abc	9.25	4.75 a
93T347	7.41 abc	10.00	5.00 a
V-1076	7.50 abc	11.50	3.75 abc
V-9	7.08 abc	9.50	4.12 abc
TD-1	6.50 abc	9.50	4.25 ab
PR-74	9.25 ab	7.75	3.41 abc
V-9189	7.75 abc	10.25	4.33 ab
V-00183	7.91 abc	9.25	4.37 ab
V-99022	10.75 a	12.75	3.62 abc
	S	N.S.	N

[1]a, highly preferred, highly susceptible; abc, moderately preferred and moderately resistant; c, least preferred and highly resistant; LSD, 4.043 at 0.05 for antixenosis test; S, significant. Means with same letters do not show significant difference.

[2]N.S. (Results showed not significant differences), *, Cultivars supporting/sustaining the least fecundity.

[3]Tolerance: LSD = 1.518 at 0.05 for tolerance test; S, significant. Means with same letters do not show significant difference.

Zia *et al.* (1999) studied resistance/ susceptibility of sixteen wheat advanced lines varieties *viz.* 93032, 93105, 93108, 93111, 94234, 92R10, 93C066,92B2535, 93BT 022, 6544-6, D-93620, D-93640, T93705, Pasban-90 and Inqilab-91 to *Sitobion avenae* (F) and *S. graminum* (Rond.), which was evaluated on the basis of number of aphids per tiller in replicated field trials. After 104 days, aphid population was low in Pasban-90 (1.78/ tiller) followed in ascending order by 93BT022 (1.89/tiller) 94234 (2.04), 93C066 (2.49), 93032 (2.82), T-93705 (2.93), 93105 (3.49), T-93640 (3.80), 93111 (3.89), 93108 (4.79), (5.55) and 92B2535 (7.89). All of these lines/varieties were statistically at par with one another. Durum-93620 having 17.62 aphids / tiller proved susceptible and was statistically equal to 93104 (10.98/tiller). Aphid population showed a decline after 104 days of crop sowing.

Table II shows the results of tolerance test of twenty cultivars of NUWYT (N) for the year 2002-2003. There were twelve replications. The results indicated that the average damage rating (DR), after 10 to 15 days of infestation as it was the required period when damage occurred to seedlings was obvious after aphid infestation (Starks and Burton, 1977). In this test, the lowest damage was recorded on three cultivars SKD-1, 99B2460, and 99B2237 with average DR of 2.33, 2.66 and 2.58, respectively, at DR scale of 2-3. Eleven varieties Wafaq-2001, SD-66, MAW-I, PR-74, V-5, V-99022, SN-122, V-1076, CT-00231, D-98627 and V-9 were moderately resistant (MR), with average DR 3.33, 3.41, 3.41, 3.41, 3.58, 3.62, 3.66, 3.75, 3.91, 4.00, 4.12, respectively at DR scale of 4-5, Four varieties TD-1, V-9I89, PR-76, V-00183 were moderately susceptible (MS) with average DR 4.25, 4.33, 4.33, 4.37, respectively, at DR scale of 6. Two varieties V-98059 and 93T347 were highly susceptible (HS) with average DR 4.75, and 5.06, respectively, at DR scale of 7-9 (Inayatullah *et al.,* 1993).

Lazar *et al.* (1995) investigated the reproductive and developmental parameters of

biotypes C and E of *S. graminum,* restricted to feeding on host wheat genotypes. The antibiotic factors contributing to resistance to both biotypes were generally more related to effects on reproduction than to developmental effects. Significant effects of pest resistance were observed on reproduction of green bug.

The results of present investigation indicate that NUWYT (N) wheat cultivars had high level of tolerance and antixenosis type of resistance to green bug. Resistant cultivars are important for breeding wheat against this pest. These data can be added to the wealth of information available about these lines, so that resistant wheat lines with good agronomic qualities and multiple pest resistance can be used in future wheat variety breeding and development programmes.

REFERENCES

AHEER, G.M., RASHID, A., AFZAL, M. AND ALI, A., 1993. Varietal resistance/susceptibility of wheat to aphids, *Sitobion avenae* F. and *Rhopalosiphum rufiabdominalis* Sasaki. *Pakistan J. agric. Res*., **31**: 307-311.

BURD, L. D. AND ELLIOTT. N. C., 1996. Changes in chlorophyll a fluorescence induction kinetics in cereals infested with Russian wheat aphid (Homoptera: Aphididae). *J. econ. Ent.,* **89**: 1332-133

HAFEZ, A.A., EL-KHAYAT, E.F. AND BAKHEAT-MMM., 1994. Screening of some local and exotic wheat genotypes for aphid infestation and some plant characters in Egypt. *AnnIs. Agric. Sci.,* **32**: 523535.

HAMID, S., 1983. Natural balance of hraminicolous aphids in Pakistan. Survey of population. *Rev. appl. Ent. Absts.,* **72**: 409.

HORBER, E., 1980. Types and classification of insect resistance. In: *Breeding plants resistant to insects* (eds. F.G. Maxwell and R. Jennings), pp. 15-21. Wiley, New York.

INAYATULLAH, C., NAHEED, M., EHSAN-UI-HAQ AND FAYYAZ, C., 1993. Incidence of green bug, *Schizaphis graminum* (Rondani) (Homoptera:Aphididae) in Pakistan and resistance in wheat against it. *Insect Sci. Appl.,* **14**: 247-254.

LAZAR, M.D., MICHEL, G.J.J.R. AND BOOKER, J.D., 1995. Reproductive and developmental rates of two green bug biotypes in relation to two wheat host resistance genes. *Southw. Entomol.,* **20**: 467-482.

NASIR, S., 2001. *Varietal resistance of wheat germplasm againist aphid* Sitobion avenae *(F.), with special reference to physico-morphic and chemical characters of different varieties.* M.Sc. (Hons.) thesis, University of Agriculture, Faisalabad, Pakistan, 80 pp.

PAINTER, R.H. AND PETERS, D.C., 1956. Screening wheat varieties and hybrids for resistance to the greenbug. *J. econ. Ent.,* **49**: 546-548.

ROYER, T.A., GILES, K.L. AND ELLIOTT, N.C., 1998. *Small grains aphids in Oklahoma,* Oklahoma Cooperative Extension Service, Oklahoma State University Extension Facts, F-7183, Stillwater, OK

RYAN, J.D., MORGHAM, A.T., RICHARDSON, P.E., JOHNSON, R.C., MORT A.J. AND EIKENBARY, R.D., 1990. Green bugs and wheat: a model system for the study of phytotoxic Homoptera. In: *Aphid/plant genotype interactions (*eds. R. K. Campbell and R. D. Eikenbary), pp. 171-186. Elsevier, Amsterdam, Netherlands.

STARKS, K.J. AND BURTON, R.L., 1977. Green bugs: determining biotypes, culturing, and screening for plant resistance, with notes on rearing parasitoids. *US. Dept. Agric. ARS. Tech. Bull.* 1556, pp. 12.

WEBSTER, J.A. AND INAYATULLAH, C., 1984. Greenbug (Homoptera: Aphididae) resistance in triticale. *Environ. Ent.,* **13:** 444-447

WEBSTER, J.A., 1995. Economic impact of the green bug in the western United States: 1992-1993. *Rep. Vol. Pub. No.* 155

YOUSSEF, G.S., 1997. Screening for resistance to *Schizaphis* (Rondani.) and *Rhopalosiphum padi* in cereal crops. *Egyptian J. agric. Res.,* **75**: 587-599.

ZIA, M.A., AHEER, G.M., MUMTAZ, M.K. AND AHMAD, K.J., 1999. Field screening of sixteen advanced line of wheat for resistance to aphids (Homoptera: Aphididae). *Pakistan Entomol.,* **21**: 95-97

(Received 12 September 2004, revised 17 May 2006)