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Patterns of Resistance Against *Schizaphis graminum* (Rondani) in Rain Fed Wheat Varieties

NAHEED AKHTAR AND MUHAMMAD YAQOOB MUJAHID
Insect Pest Management Programme (NA) and Wheat Programme (MYM)
National Agricultural Research Centre, Islamabad

Abstract.- Sixteen rain fed wheat, *Triticum aestivum* cultivars were screened under laboratory conditions for resistance to the aphid species, *Schizaphis graminum* (Rond.) in Pakistan. Comparison of investigations by seedling bulk tests and components of resistance like antixenosis, antibiosis and tolerance were evaluated. MAW-I, BARS-I, Kt-2000 and Faisalabad were found to be resistant varieties. DN-18 was least preferred variety, PR-77 was least fecund, DN-18, PR-77 and Faisalabad were least tolerant. The resistance mechanism against green bug appeared to be partially independent, while antibiosis appeared to be determined by affecting development time and other by reducing fecundity and longevity. According to these studies, V98C017 was highly preferred and NR-206 was the least tolerant variety. It is concluded that varieties with high level of resistance, least preference, least fecundity and high level of tolerance should be recommended for breeders and farmers.

Key words: Wheat, *Schizaphis graminum* (Rond.), greenbug, aphids, *Triticum aestivum,* host plant resistance, insect pest resistance.

INTRODUCTION

Many of the major insect pests on wheat world wide have their origin in the rain fed grass land of West and Central Asia and along the Mediterranean rim, or at least are related to species that originated there. This region has been considered home to the wild progenitors of wheat. Numerous insect pests of wheat in almost all of the major wheat-producing areas of world can be traced back to the centre of origin of their host plants (Miller *et al.,* 1992). Insect pests are frequently considered secondary to other biotic stresses, such as disease. *Schizaphis graminum* (Rond.), a green bug, is commonly observed on wheat throughout world and may attain significant high densities to cause the same type of direct feeding damage as *R. padi* does (Sharaf EI Din, 1992). Direct damage in wheat by *S. graminum* may result in upto 30% yield losses in unsprayed field (Kannan, 1992). Neither country however, has sufficient natural enemies to retain aphid populations below thresholds because of heavy pesticide use in cotton field which reduces hymenopteran parasitoids and predators, although natural enemies even in low number could exert suppression of aphid populations. Since the potential for biological control appears low due to high pesticide use in adjacent crops and phonology of aphid parasitoids, efforts have to be made to identify wheat germplasm possessing resistance to *R. padi* and *S. graminum* and for other cereal aphids (Miller *et al.,* 1992).

Resistance to green bug was observed in National Uniform Wheat Yield Trials and National Uniform Barley Yield Trials (NUWYT) obtained from Wheat Programme and also to several germplasm lines/accessions showed that use of aphid resistant varieties is one of the foundations of IPM. Adequate aphid resistance against aphid pests could be achieved by implementing resistant varieties (Akhtar and Hashmi, 1992), Thirteen wheat varieties were tested to determine loss in grain yield caused by aphids *(Sitobion avenae* F. and *Rhtopalosiphum rujiabdominalis* Sasaki). On an average, 7.19 aphids per tiller reduced 16.38% yield. Kohinoor83 was relatively susceptible with 22.53% grain yield loss. Where as, 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).

Wheat is severely attacked by the wheat aphids which effect the produce adversely. Infestation rates and populations were highest during September, and were higher at Naran (510 aphids with 57% infested plants) than at Kaghan

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(352 aphids with 40% infested plants) (Hamid, 1983). Losses due to this insect pest on wheat have been estimated at US$ 400 million annually. Aphids suck the cell sap from leaves and stems. Some inject toxic secretions when they infest the plant in the form of barley yellow dwarf virus (BYDV), which destroy the tissues and interfere the processes of photosynthesis. Host plant resistance is the important part of IPM of aphids (Porter *et al.,* 1997).

Diuraphis noxia (Kurdjumov), Russian wheat aphid (RWA) became established as a major aphid pest of wheat in Europe, Africa, Asia and North and South America (Hughes and Maywald, 1990) where it has caused crop losses of up to 80 percent in heavily infested areas. The cryptic behavior of RWA makes it difficult to control using conventional insecticides, that has systemic action such as immidaloprid, or that which are passed through intestinal spaces, such as primicarb (Bayoun *et al.,* 1995; Hill *et al.,* 1996). Resistant wheat lines have been examined and released for use against RAW (Martin and Harvey, 1994; Rafi *et al.,* 1996). When combined with biological and cultural control, these varieties offer an acceptable alternative to chemical insecticides for aphid control. Aphids remain a serious threat to rainfed wheat in many developing countries other than sporadic drought. Resistant varieties adapted from breeding programmes in North America, South Africa (IACR) and by International Agricultural Research Centre and national programmes are being developed for use in most of the countries (Rechmany *et al.,* 1993).

Host plant resistance is an important part of IPM of aphids. In Pakistan, there are several commercial wheat varieties available which need screening for resistance to aphids (Webster *et al.,* 1991). Use of host plants resistance component of IPM will help us to get better crop of wheat with low economic input. The over all cost of some IPM techniques, such as biological control and the use of pest resistant varieties need low economic input. Initial investment costs for research and technology transfer should be considered for the entire life of the natural enemy population or resistant variety and not for just for the year of its release.

MATERIALS AND METHODS

Sixteen NUWYT (RF) cultivars of wheat during 2002-03, were obtained from Wheat Programme of National Agricultural Research Centre for evaluation. For mass rearing of aphids, twenty seeds of susceptible wheat cultivar Chakwal-97 were sown in a plastic pot and were kept in a rearing cage. The environmental conditions maintained in the rearing room were 25±3°C, 40-60% R.H. and 16:8 hr photo phase. Dead plants were replaced with new healthy plants daily. Under seedling bulk test, one row of each test entry was sown in a metal flat. Mature aphids were released on the seedlings and the intensity of damage on each entry was rated at 0 to 9 scale (Naheed *et al.,* 1991).

In order to study the components of resistance, antixenosis (non-preference), antibiosis and tolerance tests, sixteen varieties and twelve replications of wheat varieties NR 192, 98 C0l7, Wafaq-2001, NR 206, NRL 9912, 2KC 050, KT 2000, Bars-I, V 00146, V-6, 97 B2333, SN-7, MAW-I, DN-18, PR-77 and Faisalabad were used.

For antixenosis tests, cultivars were planted in a circular pattern in a pot. When the plants were about 5 cm tall, 10 adult aphids per plant were released in the centre of the pot. The plants and 'aphids were covered with plastic cages having cloth covered tops and 2 ventilation holes on the sides. The aphids were allowed 24 hours to select the plant of their own choice. The data was recorded for number of aphids per plant in order to know the preference of pest for host plants.

In antibiosis tests, number of nymphs laid the life cycle of female per plant was noted on above mentioned sixteen varieties. Two seeds of each variety were sown in pots and were thinned to one seedling per pot. Individual plants in the first leaf stage were infested with one adult aphid from laboratory reared colonies. Each plant was covered with a plastic cage 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 from each plantlet and one nymph on each plantlet was left. When nymph became mature and began to reproduce then the number of nymphs reproduced were on each plant were counted daily and were removed from the

plants daily, until the adults stop reproducing.

For tolerance tests, same sixteen wheat cultivar seeds were sown. At the seedling stage, laboratory-reared ten adult aphids were released per plant. All the seedlings were covered with plastic cage. The plants were checked daily, nymph and extra adults were removed daily in order to maintain stress of ten mature aphids per plant. Two weeks later, the infested plants were rated for damage (Inayatullah *et al.,* 1993).

RESULTS AND DISCUSSION

Table I shows results of seedling bulk tests for evaluation of resistance in NUWYT (RF), wheat cultivars, NR-192, 98 C0l7, Wafaq-200l, NR 206, NRL 9912, 2KC 050, KT 2000, Bars-I, V 00146, V-6, 97 B2333, SN-7, MAW-I, DN-18, PR-77 and Faisalabad against Bird Cheery Oat Aphid (BCOA). Four varieties KT 2000, Bars-I, MA W-l and Faisalabad were resistant (R) with damage rating (DR)-3. Four varieties NRL 9912, 2KC050, V-6 and 97B2333 were moderately resistant (MR) with DR-4. Four varieties NR 206, V 00146, DN-18, and PR-77 were moderately resistant (MR) with DR-5. NR 192, 98C017, Wafaq 2001 and SN-7 were moderately susceptible (MS) with DR- 6 and no variety was susceptible with DR 7-9. 11.50, 12.25, 13.28, 14.55, 14.62 and 15.12, respectively. Four varieties PR-77, V-6, BARS-1 and NR-206 were highly fecund (HF) with average no. of nymphs laid 19.25, 17.37, 17.00 and 17.00, respectively.

Table II shows results of tolerance studies. Four wheat varieties Faisalabad, DN-18, PR-77 and MAW-1 were resistant (R) with average DR 4.00, 4.00, 4.08 and 4.08l, respectively, seven varieties Bars-I, 92B2333, 2KC050, KT2000, VOO146, NRL9912 and V-6 were moderately resistant (MR) with average DR 5.00, 5.25, 5.58, 5.91, 6.16,6.16 and 6.5, respectively. Five susceptible (S) cultivars were SN-7, 98C017, NR-192, NR-206 and wafaq-2001 with average DR of 6.91, 7.00, 7.16, 7.33 and 7.41, respectively. Most highly damaged variety was wafaq-2001 among all varieties, so it was most susceptible.

In seedling bulk test four varieties KT 2000, BARS-I, MAW-1 and Faisalabad were resistant (R) with DR-3 and moderately susceptible (MS) with DR-6 were NR 192, 98C017, Wafaq 2001 and SN-7. In antixenosis studies three varieties DN-18, MAW-l and Faisalabad were least preferred (LP), while five varieties V-6, NRL-9912, Bars-I, VOO146 and 98C017 were highly preferred (HP). In antibiosis studies, three varieties SN-7, Faisalabad and MAW-l were least fecund (LF), four varieties PR-77, V-6, BARS-l and NR-266 were highly fecund (HF). Tolerance studies showed four wheat varieties Faisalabad, DN-18, PR-77 and MAW-l were resistant (R). Five susceptible (S) cultivars were SN-7, 98C017, NR-192, NR-206 and wafaq-2001. Over all resistance varieties were Faisalabad and MAW-1 and most susceptible (S) variety was 98 C017.

Table I.- Seedling bulk test of rainfed wheat varieties against *Schizaphis graminum* (Rondani).

NUWYT RF wheat varieties	No. of aphids per seedling	Damage rating (DR)	Resistance type
NR-192	10	6	MS
98 C017	10	6	MS
Wafaq-2001	10	6	MS
NR 206	10	5	MRI
NRL 9912	10	4	MR
2KC 050	10	4	MR
KT 2000	10	3	R
Bars-l	10	3	R
V 00146	10	5	MRI
V-6	10	4	MR
97 B2333	10	4	MR
SN-7	10	6	MS
MA W-l	10	3	R
DN-18	10	5	MRI
PR-77	10	5	MRI
Faisalabad	10	3	R

DR, damage rating; R, resistant, DR 2-3; MR, moderately resistant DR 4; MRI, moderately resistant DR 5; MS, moderately susceptible, DR 6.

The results of this study also confirm the conclusion of Meyer *et al.* (1989) that the resistance in susceptible wheat variety conferred by resistant wheat variety includes a major tolerance component. As the absence of leaf rolling in Halt wheat variety should expose Russian wheat aphid to chemical and biological controls, suggesting that cultivars with Dn4 resistance should be compatible with other integrated pest management components.

Table II.- Two components of resistance showing nature of resistance in rainfed (NUWYT) wheat against *S. gramlnum* (Rond.)

Wheat varieties	Antixenosis Av. # of aphids/plant	Nature of resistance	Antibiosis Av. No. of nymphs laid	Nature of resistance	Tolerance Av. DR	Nature of tolerance
NR-192	3.00 abc	MP	11.25 ab	MF	7.16 a	S
98 C017	5.00 a	HP	14.62 ab	MF	7.00 ab	S
Wafaq2001	2.58 abc	MP	12.25 ab	MF	7041 a	S
NR-206	3.00 abc	MP	17.00 a	HF	7.33 a	S
NRL-9912	4.33 ab	MP	11.25 ab	MF	6.16 abc	MR
2KC 050	3.16 abc	MP	10.50 ab	MF	5.58 abc	MR
KT-2000	3.00 abc	MP	11.50 abc	MF	5.91 abc	MR
BARS-1	4.66 a	HP	17.00 a	HF	5.00 abc	MR
V-000146	5.00 a	HP	13.27 abc	MF	6.16 abc	MR
V-6	4.25 ab	HP	17.37 a	HF	6.50 abc	MR
97 B2333	3.25 abc	MP	13.87 ab	MF	5.25 abc	MR
SN-7	3.16 abc	MP	8.37 bc	LF	6.91 ab	S
MA W-1	1.58 bc	LP	8.69 bc	LF	4.08 c	R
DN-18	1.25 c	LP	15.12 a	MF	4.00c	R
PR-77	2041 abc	MP	19.25 a	HF	4.08 c	R
Faisalabad	1.66 bc	LP	8045 bc	LF	4.00c	R

Antixenosis: LP, Least preferred; MP, Moderately preferred; HP, highly preferred. *LSD=2.337 at 0.050 (means with same letters do not show significant difference).
Antibiosis: LF, Least fecund; MF, Moderately fecund; HF, Highly fecund. *LSD, 12.89 at 0.050.
Tolerance: R, Resistant; MR, Moderately resistant; S, Highly susceptible. *LSD, 182 at 0.050 (means with same letters do not show significant difference).

Our results are similar to Burd *et al.* (1998) as they mentioned that the level of resistance contained in Halt wheat makes it a good choice for growers who historically have high wheat aphid populations. However, Halt wheat variety contains various levels of antibiosis and tolerance and it lacks leaf rolling, which may serve to protect the aphid. These factors could put some selective pressure on wheat aphid because it is not able to feed on and colonize Halt wheat variety at a level similar to TAM-I 07. Therefore, to avoid the potential of biotypes being produced, it would be beneficial to use polygenics, inserting more than one resistant gene into a wheat, which is considered to be more stable and longer lasting than plants containing only one resistant gene (Gallun and Khush, 1989).

Laboratory studies on life table of greenbug *Schizaaphis graminum* (Rondani) were conducted on Kohinoor, Mehran-89 and Sarsabz wheat varieties. The results indicated that adult longevity was the highest in Mehran (41 days) followed by Kohinoor (31 days) and Sarsabz (22 days). Similarly the total number of offspring per female was the lowest in Sarsabz (2.37) and the highest in Mehran-89 (23.49). The innate capacities of increase (r) values were lowest for Sarsabz and highest for Mehran-89. The mortality in all the cultivars was high initially but later gradually decreased (Buriro *et al.*, 1997).

Results of antixenosis wheat varieties as indicated in (Table II) showed that three varieties DN-18, MAW-1 and Faisalabad were least preferred (LP) with least average number of aphids per plant, 1.25, 1.58 and 1.66 respectively. Eight varieties PR-77, Wafaq-2001, NR 192, NR 206, KT 2000, SN-7, 2KC050, 97B2333 were moderately preferred (MP) with average number of aphids per plant 2.41,2.58,3.00, 3.00, 3.000, 3.16, 3.16 and 3.25, respectively, while five varieties V-6, NRL-9912, Bars-I, V00146 and 98C0170 were highly preferred (HP) with average number aphids per plant 4.25, 4.66, 5.00 and 5.00, respectively.

Results of antibiosis studies (Table II) showed that out of sixteen NUWYT (RF), wheat varieties, three varieties SN-7, Faisalabad and MAW-1 were least fecund (LF), with 8.37, 8.45 and 8.69 average number of nymphs laid. Eight varieties 2KC 050, NRL-9912, KT-2000, Wafaq-2001, 92B2333, 98C017, NR-192 and DN-18 were moderately fecund (MF) with average number of

nymphs laid, 10.95, 11.25.

According to our results, there was a significant difference in antixenosis and tolerance tests. Among sixteen wheat varieties Faisalabad and MAW-1 varieties has antixenosis, antibiosis and tolerance type of resistance and the varieties 98C017 and NR 206 showed susceptibility. These data can be added to the wealth of information available about these varieties so that wheat with good agronomic qualities and multiple pest resistance can be used in further wheat variety breeding and development.

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