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LOSSES IN GRAIN YIELD CAUSED BY RUSSIAN WHEAT APHID *Diuraphis noxia* (Mordvilko)

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ABSTRACT

A field experiment was conducted to evaluate the response of different wheat genotypes to Russian wheat aphid (RWA) Diuraphis noxia (Mordvilko). For this purpose, seven wheat cultivars were sown in a randomized complete block design with three replications at Regional Agricultural Research Institute Bahawalpur. A significant genotypic variability existed with respect to aphid infestation and yield losses. Aphid infestation resulted in 7.9 to 34.2% yield losses. The wheat genotype V-4012 was found to be the least infested with aphid giving a maximum grain yield (3754 kg ha^{-1}) with 1.57 aphids per tiller. The strain V-2237 was second best with 1.72 aphids per tiller and a grain yield of 3458 kg ha^{-1}. The commercial wheat variety Punjnad-1 was heavily infested (2.85 aphids per tiller) with a grain yield of 2470 kg ha^{-1}. Aphid population increased up to 4th week of March and then started declining. The genotype V-4012 was later on released for general cultivation based on its better performance as Fareed-06.

Key Words: ***Triticum aestivum*, variety, aphid, grain yield, loss of harvest**

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INTRODUCTION

Pakistan, with a population of 160.9 million in mid 2008 is the 6th most populous country in the world. The country's population is estimated to double in the year 2045 if it continues to grow at 1.8% (Anonymous, 2008). In this scenario, the government is facing the challenge of feeding the ever increasing population. Wheat is the most widely grown crop in the world. In Pakistan, wheat being the staple diet is the most important crop and is cultivated on the largest acreage of 8.459 million hectares with a production of 22.5 million tons during 2006-07 in almost every part of the country. It contributes 13.7% to the value added in agriculture and 3.0 percent to GDP (Anonymous, 2008).

The wheat crop suffers from a number of biotic and biotic stresses from sowing to harvesting, including heat, drought, disease, and insects. One of the most recent and important pests of small grains is the Russian wheat aphid (RWA). Russian wheat aphid is a serious pest of wheat (Shea *et al.* 2000). This species i.e. *Diuraphis noxia* (Mordvilko) spends its entire life cycle on grains and grasses (Karren, 1989). It is also stated that Russian wheat aphids prefer to live in leaf whorls and tightly rolled leaves shortly after they begin feeding. Wheat is one of the preferred hosts of RWA. Infestations on leaves, stems, awns and heads have been severe, causing necrosis and blackening of these parts during the last few years. Necrosis and blackening affect grain yield. The production of chlorophyll (green color) is prevented by the attack of aphid resulting in curling of leaves and delayed head emergence causing improper maturity of grains. Therefore, the early detection is important (Karren, 1989). It was also reported that each 1% infestation level will result in a 0.5% yield loss at harvest (Karren, 1989). Shea *et al*. (2000) pointed out that the flag leaf is rolled and the emerging heads and awns are trapped by aphid attack resulting in poor pollination. Aphid attack starts from emergence and continues up to maturity (Shea *et al*., 2000).

The aphid incidence level differed in different cultivars of wheat (Wratten and Redhead, 1976). Aheer *et al*., (1993) reported that advanced lines of wheat differed significantly with respect to population of aphids and grain yield. The aphid population attained peak level in the mid of March (Aheer *et al*., 1993; Chen *et al*., 1994). Amjad and Ali (1999) narrated that aphid population varied on test cultivars of wheat during the months of February to April 2001 and peak level of aphids was noted during third week of March. 50 and 76 percent losses in grain weight per year in winter and spring wheat, respectively, have been reported (Kuroli and Nemeth, 1987). Kiechkhefer and Gellner (1992) reported losses ranging from 35 to 40 percent at 15 aphids per plant (2.3-2.7% per aphid). Aheer *et al*. (2006) reported mean densities of the wheat aphids to be 2.29, 2.07, 2.41, 2.23 and 2.22 per tiller on wheat

cultivars i.e. Inqlab-91, Pasban-90, Pak-81, Uqab-2000 and Iqbal-2000, respectively. They also found that infestation of aphids mainly concentrated on leaves, on heads (spikes) and stem of wheat plant. Aheer *et al*. (1993) observed that 7.2 aphids per tiller caused a 16.4 % loss in grain yield (2.28% per aphid). Kortyukovski (1984) reported 30-80% losses with 100-200 aphids per stem (0.3-0.4% per aphid). Aphid infestation at the level of 1% causes 0.50% yield loss at harvest (Karren, 1989).

In Pakistan, attacks by aphids are increasing on the wheat crop, especially in cotton zones of Multan, D.G. Khan, and Bahawalpur. Bahawalpur is characterized by low humidity with drought stress. Russian wheat aphid is most often found in low humidity areas with moderate drought stress (Anonymous, 1992). In the present study, the response of various wheat genotypes to RWA attack was investigated under field conditions.

MATERIALS AND METHODS

A field experiment was conducted to evaluate the response of different wheat genotypes to Russian wheat aphid (RWA) at Regional Agricultural Research Institute, Bahawalpur, Pakistan. Bahawalpur is located at an altitude of 112 meters, latitude of 29° 23' 60N and longitude of 71° 40' 60E. The trial consisted of two approved cultivars (Manthar-03 and Punjnad-I) and five advanced wheat lines (V-2237, V-2460, V-2278, V-4012 and V-2333). The experiment was laid out in a randomized complete block design with three replications. Plot size was 6 m^2. N and P_2O_5 fertilizers were applied at the rate of 160 and 110 kg ha^{-1}, respectively. The experiment was sown on 30th November, 2002. Four irrigations were applied to the crop. Weeds were controlled chemically with Bromoxynil. RWA population was recorded from 10 tillers selected at random from each plot at weekly intervals starting from 3rd February up to 20th April at 8-9 am (Aheer *et al*. 2007). The selected tillers were clipped off with a pair of scissors. The aphids were counted by dropping them on white paper using a camel hair brush. Harvesting was completed by 26th April, 2003 and yield data were recorded and % losses in yield were determined taking V-4012 as check which had minimum aphid infestation and maximum yield. Analysis of variance was performed following the method described by Steel and Torrie (1980), and means were compared using a Duncan's Multiple Range test.

RESULTS AND DISCUSSION

Aphid Infestation

Significant differences in RWA populations were observed ($P<0.01$). Maximum aphid populations were found on Punjnad-I (2.85 aphids per tiller) followed by V-2460 (2.64 aphids per tiller) and Manthar-03 (2.01 aphids per tiller). The lowest aphid population (1.57 aphids per tiller) was found on genotype V-4012. Statistical analysis of the data revealed that the genotypes differed significantly from one another with respect to aphid attack in all weeks. The appearance of aphid was observed from the start of February ranging from 0.96 to 1.62 aphids per tiller. Similar results were obtained by earlier workers (Shea *et al*., 2000; Aheer *et al*. 2006). The maximum infestation was recorded during the 4th weeks of March (3.20 to 6.12 aphids per tiller) (Table II).

Table I ***Maximum and minimum temperature (°C) recorded at Bahawalpur, during the year 2003***

Months	Temperature (°C)	
	Maximum	Minimum
January	19.5	7.0
February	20.2	7.4
March	28.6	12.6
April	36.4	25.4

Table II ***Weekly average Russian wheat aphid populations on different wheat cultivars during 2003***

Varieties	Russian wheat aphid population per tiller					
	03.02.2003	10.02.2003	17.02.2003	24.02.2003	02.03.2008	09.03.2008
V-4012	1.08	1.12	1.18	1.29	2.00	2.15
V-2237	1.18	1.28	1.94	2.00	2.49	2.53
V-2333	1.20	1.49	1.85	1.99	2.60	2.77
V-2460	1.27	1.90	2.09	2.37	2.94	2.97
V-2278	0.96	1.15	1.93	2.42	2.97	3.47
Manthar-3	1.10	1.96	2.21	3.05	3.87	4.29
Punjnad-I	1.62	2.16	2.52	3.13	3.88	4.37
Average	**1.20**	**1.58**	**1.96**	**2.32**	**2.96**	**3.22**
LSD (5%)	**0.35**	**0.54**	**0.41**	**0.46**	**0.65**	**0.74**

Varieties	Russian wheat aphid population per tiller						Average of 12 weeks
	16.03.2008	23.03.2008	30.03.2008	06.04.2003	13.04.2003	20.04.2003	
V-4012	2.68	3.2	2.45	1.31	1.11	0.75	**1.69**
V-2237	2.92	3.22	1.82	1.22	1.00	0.63	**1.85**
V-2333	2.99	3.27	1.92	1.22	1.01	0.75	**1.92**
V-2460	3.08	3.45	2.07	1.68	1.06	0.91	**2.15**
V-2278	4.21	3.52	2.06	1.85	1.03	0.52	**2.17**
Manthar-3	4.75	5.14	3.49	2.00	1.56	1.08	**2.88**
Punjnad-I	5.52	6.12	3.05	1.92	1.86	1.05	**3.10**
Average	**3.74**	**3.99**	**2.41**	**1.60**	**1.23**	**0.81**	
LSD (5%)	**0.51**	**0.69**	**0.82**	**0.34**	**0.39**	**0.22**	

The aphid infestation gradually increased up to 4th week of March and then decreased up to 3rd week of April. The results further revealed peak aphid population during 4th week of March which is in conformity with those of Rios and Conde (1986), Aheer *et al.* (2006) and Farooq and Nasir (2001). Significant differences were found among average aphid population during different months (P<0.01). Highest infestation was noted for March followed by February. April had the minimum aphid infestation (Table III). Aheer *et al*. (2006) reported cultivar differences with respect to aphid infestation and concluded that aphid infestation was at peak during March followed by February. Decline in aphid population during April may be attributed to high temperature (Table I). Aheer *et al.* (2007) and Kieckhefer and Elliotte (1989) reported that the gross and net reproductive rates of both morphs were greater at low temperature regimes and decreased with an increase in temperature. Aheer *et al*. (2007) concluded that aphid population decreased when maximum and minimum temperatures to the optimum limits i.e. 28.3-30.6°C and 9.57-10.0°C, respectively. Present results are in line with these findings.

Aphids were found on each tiller, heads, leaves, and stems. During the present study period, the aphids were observed to roll the flag leaf and trapping the emerging heads and awns. This phenomenon may have caused reduction in pollination (Shea *et al.,* 2000) resulting in low grain yield in low yielding genotypes. The attack of aphid on stem, leaves, awns and heads has also been reported by Aheer *et al.* (2006), Amjad and Ali (1999) and Shea *et al*. (2000).

Table III ***Average Russian wheat aphid populations on different wheat cultivars during various months of 2003***

Varieties	Russian wheat aphid population per tiller			
	February	**March**	**April**	**Average**
V-4012	1.17	2.50	1.06	**1.57**
V-2237	1.60	2.60	0.95	**1.72**
V-2333	1.63	2.71	0.99	**1.78**
V-2278	1.62	3.25	1.13	**2.00**
V-2460	1.91	2.90	1.22	**2.01**
Manthar-3	2.08	4.31	1.55	**2.64**
Punjnad-I	2.36	4.59	1.61	**2.85**
Average	**1.77**	**3.26**	**1.22**	

Grain Yield

Significant differences were observed among genotypes with respect to grain yield (P<0.01). V-4012 produced highest yield (3754 kg ha^{-1}) followed by V-2237 (3458 kg ha^{-1}). V-4012 had better resistance to aphid than all other genotypes. The lowest yielding genotype was Punjnad-1 (2470 kg ha^{-1}). The perusal of the data (Table II - IV) revealed that genotypes having maximum attack of aphid had lower yield and vice versa. Considering the least infested genotype (V-4012) as check which was least infested by aphid, it was revealed that there was a decline in grain yield in various genotypes ranging from 7.9 to 34.2% with increasing infestation of aphid (Table-IV). Kieckhefer and Kantack (1980) reported substantial yield losses by direct effect of aphid feeding and as a vector of several plant viruses (Blackman and Eastop, 1984). The present results also get support from the finding of Kuroli and Nemeth (1987) who found 50 and 70% loss in grain weight per year in winter and spring wheat, respectively.

Kieckhefer and Gellner (1992) also reported 35-40% losses at 15 aphids per plant (2.3 to 2.7 per aphid). Aphid infestation at the level of 1% causes 0.50% yield loss at harvest (Karren, 1989). Aheer *et al*. (1993) observed that 7.2 aphids/tiller caused a 16.4 % loss in grain yield (2.3% per aphid). Kostyukovski (1984) reported 30-80% losses with 100-200 aphids per stem (0.3-0.4% per aphid).

Table IV *Grain yield data (kg ha^{-1}) for different wheat cultivars and lines infested with Russian wheat aphids in 2002-03*

Cultivars/lines	Grain yield (kg ha^{-1})	% decrease of yield over least infested strain V-4012
V-4012	3754	
V-2237	3458	34.2
V-2333	3359	21.0
V-2278	3260	18.4
V-2460	3063	13.2
Manthar-3	2964	10.2
Punjnad-I	2470	07.9
LSD (5%)	285	

CONCLUSION AND RECOMMENDATIONS

Wheat genotype V-4012 was found to be the least infested with RWA, producing the highest grain yield (3754 kg ha^{-1}) with 1.57 aphids per tiller. The wheat strain Punjnad-I with 2.85 aphids per tiller had the highest infestation with a yield of 2470 kg ha^{-1}. The aphid infestation gradually increased up to 4th week of March and then decreased up to 3rd week of April. Aphid population was affected with an increase in maximum and minimum temperatures. There was a decline in grain yield in various genotypes ranging from 7.9 to 34.2% with increasing infestation of aphid. It is concluded that aphid infestation causes a significant loss to grain yield in wheat.

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