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Grain Yield Losses in Wheat by Russian Wheat Aphid *Diuraphis noxia* (Mordvilko)

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Abstract. Eight wheat cultivars were sown at the Regional Agricultural Research Institute, Bahawalpur, Pakistan, to evaluate their response to Russian wheat aphid (RWA) *Diuraphis noxia* (Mordvilko). Significant variability was observed among cultivars with respect to aphid infestation and yield losses. Cultivar V-2707 was the least infested with the aphid (6.3 aphids/tiller) giving maximum grain yield (4638 kg/ha), with cultivar V-2047 the second best with 6.43 aphids/ tiller infestation and grain yield of 4206 kg/ha. Commercial cultivars (Inqlab-91 and Punjab-96) were heavily infested with 14.4 and 12.6 aphids/tiller, respectively, and yielded 2245 and 2490 kg/ha harvest, respectively. Aphid population increased upto the fourth week of March and then declined. Aphid infestation resulted in 3.96 to 7.36% yield loss. The cultivar V-2707 was later released for general cultivation, under the name of Punjab-1.

Keywords: *Triticum aestivum*, aphid, yield loss, *Diuraphis noxia*

Introduction

Pakistan, with a population of 160.9 million by mid-2008 is the sixth most populous country in the world. The country's population is estimated to double by the year 2045 if population growth continues at 1.8% per annum (Economic Survey of Pakistan, 2008). Wheat is the most widely grown crop in the world. In Pakistan, wheat is a staple crop and is cultivated on some 8.459 million hectares giving production of 22.5 million tons during 2006-2007. It shares 13.7% of the value of Pakistan agricultural produce and 3.0% to GDP (Economic Survey of Pakistan, 2008).

Wheat crop suffers from a number of biotic and abiotic stresses from sowing to harvesting, including heat, drought, diseases and insect damage. One of the most recent and important pests of small grains is the Russian wheat aphid (RWA) *Diuraphis noxia* (Mordvilko). It spends its entire life cycle on the grains and grasses and is a serious pest of wheat. Russian wheat aphid prefers to live in leaf whorls and emerging tightly rolled leaves feeding on them. Infestation on leaves, stems, awns and heads result in necrosis and blackening of these plant parts, affecting grain yield. Aphid attack results in curling of leaves, delayed head emergence causing improper maturity of grains. Therefore, the early detection of pest infestation is important for its timely and proper control. Each 1% infestation level results in 0.5% yield loss at harvest (Karren and Reeve, 1989). Aphid attack starts from emergence and continues upto maturity (Shea *et al*., 2000; Karren and Reeve, 1989).

The aphid incidence level differs in different cultivars of wheat (Wratten and Redhead, 1976). Advanced lines of wheat differ significantly with respect to population of aphids and grain yield. The aphid population attains peak level in mid March (Chen *et al*., 1994; Aheer *et al*., 1993). Aphid population varies on test cultivars of wheat during February-April 2001 and peak level of aphids was noted during the third week of March (Parvez and Ali, 1999). Aheer *et al.* (2006) reported mean densities of wheat aphids to be 2.29, 2.07, 2.41, 2.23 and 2.22/tiller on wheat cultivars, Inqlab-91, Pasban-90, Pak-81, Uqab-2000 and Iqbal-2000, respectively, and found that infestation of aphids mainly concentrated on leaves, on heads (spikes) and stem of wheat plant. The present studies were aimed at determining the effect of aphid populations on different wheat cultivars under field conditions.

Materials and Methods

The field experiment, to evaluate the response of different wheat cultivars to Russian wheat aphid (RWA), was conducted at Regional Agricultural Research Institute, Bahawalpur, Pakistan. Bahawalpur is located at an altitude of 112 meters, latitude 29° 23' 60 N and longitude of 71° 40' 60 E. Eight wheat cultivars, including two checks (Inqlab-91, Punjab-96, V-2047, V-2236, V-2239, V-2251, V-2707 and V-7222), were sown in two

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sets (sprayed and unsprayed). In the sprayed set, Furathiocarb was sprayed at 625 ml/ha during February (1st and 3rd weeks) and March (1st and 3rd weeks) in order to control aphid population. The experiment was laid out in a randomized complete block design with three replications of each set. Plot size was 5 m × 1.2 m in both the sets. N and P_2O_5 fertilizers were applied at the rate of 160 and 110 kg/ha, respectively. The experiment was sown on November 30, 2001. Four irrigations were applied to the crop at crown root, tillering, milky and grain filling stages. Weeds were controlled chemically with Bromoxynil. Aphid infestation was recorded at weekly intervals from the first week of February to the 3rd week of April, 2000. Fifteen tillers were selected randomly from each plot. Each tiller was clipped with a pair of scissors, brought to the laboratory and the aphids were separated from the stem and spikes with the help of a camel hairbrush, placed on a white paper and counted. At maturity, the yield data were recorded and percent loss was determined by using the following formula:

$$\text{Yield loss (\%)} = \frac{\text{Yield in sprayed set-Yield in unsprayed set}}{\text{Yield in unsprayed set}} \times 100$$

The yield and aphid data were subjected to analysis of variance by using computer package MSTATC and means were compared by calculating LSD (Steel and Torrie, 1980).

Results and Discussion

Aphid infestation. The highest aphid population was found on Inqlab-91 (14.4 aphids/tiller) followed by Punjab-96 (12.6 aphids/ tiller). The lowest mean aphid population (6.3 aphids/ tiller) was found on cultivar V-2707 (Table 1). Cultivars differed significantly with respect to aphid population ($P<0.01$). Aphids were first observed at the beginning of February (Aheer *et al*., 2006; Shea *et al*., 2000). The maximum infestation (8.92 to 18.36 aphids/ tiller) was recorded during the month of March (Table 2). Minimum infestation (3.20 to 10.24 aphids/tiller) was observed during April. Aphid infestation gradually increased up to the 4th week of March and then decreased down to the 3rd week of April. The population peak from middle to the 4th week of March is consistent with the reported observations (Aheer *et al*., 2006; Ahmad and Nasir, 2001; Rios and Conde, 1986). Decline in aphid population during April may be attributed to high minimum (21.5 °C) and maximum (37.2 °C) temperatures (Table 2). According to Aheer *et al*. (2007) and Kieckhefer and Elliotte (1989), the gross and net reproductive rates of both morphs were greater at low temperature regimes and decreased with an increase in the temperature. Thus aphid population decreased when maximum and minimum temperatures were 28.3-30.6 °C and 9.57-10.0 °C, respectively. Present results are in line with these findings.

Table 1. Average Russian wheat aphid populations on different wheat cultivars during various months during the year 2000

Varieties	Russian wheat aphid population per tiller			
	February	March	April	Average
V-2047	6.23	8.92	4.14	6.43
V-2236	7.58	9.58	6.54	7.90
V-2239	6.02	12.75	4.12	7.63
V-2251	5.44	10.74	3.65	6.61
V-2707	4.98	10.72	3.20	6.30
V-7222	5.94	11.29	4.07	7.10
Inqlab-91	14.76	18.20	10.24	14.4
Punjab-96	12.89	18.38	6.53	12.6
Average	7.98	12.57	5.31	

Table 2. Maximum and minimum temperature recorded at Bahawalpur, during the year 2000

Months	Temperature (°C)	
	Maximum	Minimum
January	20.1	6.5
February	21.1	6.7
March	27.4	11.1
April	37.2	21.5

Aphids were found on each tiller, head, leaf and stem. During the present study, aphid infestation was observed to result in the rolling of the flag leaf and trapping of the emerging heads and awns. This phenomenon may have caused reduction in pollination resulting in improper maturity and low grain yield in the tested cultivars (Aheer *et al*., 2006; Shea *et al*., 2000; Parvez and Ali, 1999).

Grain yield. The data of grain yield subjected to analysis of variance revealed significant differences between sprayed and unsprayed sets ($P<0.01$). Significant differences were also observed among cultivars with respect to grain yield ($P<0.01$). Cultivar V-2707 produced the highest yield (4638 kg/ha) followed by V-2047 (4206 kg/ha). Cultivar V-2707 had the lowest aphid population among all other cultivars. The cultivar with the lowest yield was Inqlab-91 (2245 kg/ha). Perusal of the data (Table 3) reveals that genotypes having maximum attack of aphids had the lowest yield and *vice versa*, suggesting direct relationship between mean aphid population and reduction in yield. The average loss in grain yield due to a single aphid/ tiller was 0.51% to 0.66%. Kieckhefer and Kantack (1980) reported substantial yield losses as the

Table 3. Yield, aphid infestation and loss in yield in various wheat genotypes

Genotypes	Yield (kg/ha)		Loss in grain yield over unsprayed set (%)	Aphid population/tiller (average of 12 weeks)	Average loss/aphid
	Sprayed	Unsprayed			
V-2047	4206	4026	4.47	6.43	0.70
V-2236	2965	2838	4.47	7.90	0.57
V-2239	3217	3077	4.55	7.63	0.60
V-2251	3927	3758	4.50	6.61	0.68
V-2707	4638	4454	4.13	6.30	0.66
V-7222	3664	3508	4.47	7.10	0.63
Inqlab-91	2245	2080	7.93	14.4	0.55
Punjab-96	2490	2333	6.73	12.6	0.53
LSD (5%)	256	312	-	2.67	1.87

direct effect of aphid feeding (Blackman and Eastop, 1984). The present results also get support from the findings of Kuroli and Nemeth (1987) who found 50 and 70% loss in grain weight in winter and spring wheat, respectively. Kieckhefer and Gellner (1992) also reported 35-40% losses at 15 aphids/plant (2.3-2.7% per aphid). Aheer *et al*. (1993) observed that 7.2 aphids/tiller caused a 16.4 % loss in grain yield (2.3% per aphid). Kortyukovski (1984) reported 30-80% losses with 100-200 aphids/stem (0.3-0.4% aphid). Aphid infestation at the level of 1% causes 0.50% yield loss at harvest (Karren, 1989).

Conclusion

The wheat genotype V-2707 was found to be the least infested with RWA, producing the highest grain yield (4638 kg/ha) with 6.30 aphids/tiller. The wheat variety Inqlab-91 with 14.4 aphids/tiller had the highest infestation with a yield of 2245 kg/ha. The aphid infestation gradually increased upto the 4th week of March and then decreased upto the 3rd week of April and was affected by an increase in maximum and minimum temperatures. Genotypes responded differently to aphid infestation. There was a loss in grain yield in various genotypes ranging from 3.96 to 7.36% with increasing infestation of aphid. The genotype V-2707 was later on released for general cultivation based on its better performance in the name of Punjnad-I. It is concluded that aphid infestation causes significant loss to grain yield in wheat. The check varieties had higher infestation rate and greater loss in grain yield as compared with the new strains. The loss in grain yield, specially in the checks, demands plant protection measures but wheat being a staple food, the use of insecticides on wheat is not advisable. Therefore, the studies on RWA occurrence in the area and identification of resistant cultivars should be encouraged. Area sown to wheat cultivars with low levels of resistance should be decreased.

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