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POPULATION DYNAMICS OF WHEAT APHID ON DIFFERENT LANDRACES OF WHEAT UNDER FIELD CONDITIONS

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ABSTRACT

Wheat (*Triticum aestivum* L.) is the leading food grain and staple diet in Pakistan. Cereal aphids are a severe problem in wheat growing areas. Among environmentally safe and economical methods for the control of aphids, the use of resistant wheat cultivars is one of the promising approach in pest management programs which can overcome the economic damage caused by aphid infestation. In the present study, the population dynamics of wheat aphid was observed on 114 landraces of wheat. The results showed that during March, nine landraces showed the highest population of *Rhopalosiphum padi* while the lowest *R. padi* population was recorded on fourteen different landraces with aphid populations ranging from 3.25 to 4.08. In the month of April, the highest population of *R. padi* was recorded on 81 landraces while the lowest population was recorded on 33 landraces with mean aphid numbers ranging from 2.91 to 6.9. The peak population was recorded during the month of May on 78 landraces of wheat and proved to be the susceptible while the remaining thirty eight landraces of wheat proved to be resistant with low aphid densities. The mean aphid population varied from 4.25 to 6.95. The results obtained from the month of March were non-significant while those obtained during the months of April and May were significant.

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INTRODUCTION

Wheat (*Triticum aestivum*) is a convenient nourishing and cost-effective source of food. Twenty percent of the world's food calories are supplied by wheat and it provides food to nearly 40% of the world's population. In several countries, wheat is preferably more consumed per capita than other food stuff (Wiese, 1987). Over 23% of global cultivated area is covered by wheat. It has gained more economic importance in bread, diet source, pharmaceutics and other industries. It is also a main produce in the international market worldwide (Anwar et al., 2009; Wiese, 1987). It has a major contribution towards increasing GDP of country's economy as a major cereal crop (Chowdhry et al., 1998). In agriculture as value added, its contribution is 18 percent while in GDP it contributes 4.2 percent (Anonymous, 2006). It is cultivated on the largest area in Pakistan as a major crop (Anwar et al., 2009). The cultivated area is 8414 million hectares with the production of 21749 million tons and the average yield was 2585 kg/hectare (Anonymous, 2009). There are different wheat producing countries viz. Pakistan, China, Russia, Australia, U.S.A., Canada, Turkey and India but the highest wheat producing country is Russia with 85,863,132 tons.

In wheat growing areas, aphids are a major trouble (Dixon, 1987). For the last few years, the attack of aphids on cereal crops has been increasing in Pakistan (Zia et al., 1999). This pest has large host preference of crops which include barley, wheat, corn and sorghum (Bowling et al., 1998; Kindler et al., 1984). Fourteen species of aphids have been reported attacking wheat crop. Among these, *Sitobion avenae*, *Rhopalosiphum maidis*, *R. Padi* and *Metopolophium dirhodum* are most common (Popov et al., 1988).

In Pakistan, five aphid species namely *Rhopalosiphum maidis* (Fitch), *R. padi* (L.), *Schizaphis graminum* (Rondani), *Diuraphis noxia* (Mordvilko) and *Sitobion miscanthi* (Takahashi) were observed on wheat. *R. padi* L., is one of the major pests on wheat. *S. graminum, R. padi, R. maidis* and *D. noxia* mostly infest wheat throughout the whole world including Pakistan causing serious losses to wheat crop (Inayatullah et al., 1993). Wheat production is severely affected by aphid population (Girma et al., 1993; Wratten and Redhead, 1976) which can cause 35-40% yield losses (Kieckhefer and Gellner, 1992) and 20-80% losses were reported by fungal and viral diseases (Marzocchi and Nicoli, 1991; Rossing et al., 1994; Trdan and Milevoj, 1999). Aphids' number 5, 15, 30 and 50 per ear/head can damage 13.3, 27.8, 38.1 and 47.7% of wheat production (Deol et al., 1987), however, a single aphid can cause 2.2% loss in grain yield (Aheer et al., 2007).

Many control methods have been used for the control of aphids. These contain cultural, physical, mechanical, biological, chemical and host plant resistance. The aphids, if present in large number, can cause severe losses and chemicals have to be used for their control (Hatchett et al., 1987). With positive interaction between natural enemies and host plant resistance, a population of *S. avenae* on wheat is often controlled by natural enemies in Europe successfully. Without harming the environment and disturbing the non-target organisms, a diverse control procedure may be used to control the aphid population lower than the economic threshold level. With these control measures, variation in date of sowing can prove effective for controlling aphids on wheat (Aslam et al., 2005). Susceptibility or resistance of plants is the consequence of a sequence of interactions between plants and insects, which affect the last level of settlement of insect populations on plants. In controlling aphid infestations, low levels of resistance can be proving important but stronger and more constant levels of resistance are required for a significant effect. Development of varieties with significant aphid resistance, good agronomic properties and yielding capacity is not possible (Ahmad and Nasir, 2001). An appropriate understanding of method of host plant resistance will also result in to breeding of long-term resistance varieties. Increased considerations of resistance factors will lead towards the way of managing of insects' behaviors for utilization in pest management programs. Thus there will be less use of chemicals with more economic benefits (Akhtar et al., 2006). Environmentally safe and economical method is the use of resistant varieties of wheat to control aphids and also to overcome the economic damage caused by aphid (Dong et al., 1994). For the management of aphids, host plant resistance is an essential part of IPM (Khan et al., 2011; Khattak et al., 2007; Zhou et al., 2011). It also reduces the probability of biotype development (Lowe, 1987; Riazuddin et al., 2004). Resistant varieties have higher concentrations of allelochemicals which control aphid development on plant, lessen fecundity and inherent rate of increase (Leszczynski et al., 1995). The derivation of analysis of population dynamics of cereal aphid is very complex due to the number of immigrant aphids, the time-span for population development and its rate is affected by host-plant cultivar and vigor, microclimate and natural enemies (Dixon, 1987). In the present study, population of aphid was monitored on 114 land races of wheat.

MATERIALS AND METHODS

Experimental locality: The population dynamics of wheat aphid, *R. padi*, was monitored on 114 land races of wheat in order to identify aphid resistant landraces. The present study was conducted in the experimental fields of the University of Poonch Rawalakot, AJ&K, Pakistan during the year 2013-2014. The landraces were sown in November 2013 using RCBD with three replications. Landraces were sown in straight rows maintaining row to row distance of 30 cm. Single row of each landrace was sown in each replication. All the cultural and standard agronomic practices were kept constant during the experiment. The entries were kept unsprayed to check the maximum population of aphids under natural conditions.

Aphid population dynamics: Wheat aphid's infestation was recorded on weekly basis. The population was observed after the appearance of aphid on wheat from

March to May until it started declining. For recording aphid population, three plants were randomly selected. Aphid population density was observed on stem, leaves and spikes and aphid population per tiller was calculated for each replication. Total number of leaves and spikes of landraces was observed and aphid population on them was counted. The aphid population was then divided with number of leaves to get number of aphid per leaf (Muhammad et al., 2013). The mean of aphids/plant for each landrace was calculated. The data on aphid population were recorded till crop maturity.

Statistical analysis: The data obtained was subjected to ANOVA and LSD tests at 5% level of significance (P<0.05) by using M Stat-C (Analytical Software) (Steel et al., 1997).

RESULTS

Population dynamics of *R. padi* during the month of March: During the month of March, the significant highest population of *R. padi* was recorded on 14130, 14540, 14112, 14942, 14545, 15325, 13511, 10336 and 15262 landraces with 10.0, 9.41, 9.33, 9.16, 8.83, 8.66, 8.58, 8.33 and 8.25 mean values respectively. The populations were found to be the lowest during the month on the landraces 14013, 12679, 10338, 15603, 10785, 12889, 10020, 14124, 13926, 13492, 15984, 10082, 14042 and 15692 which were 4.08, 4.00, 4.00, 3.91, 3.75, 3.75, 3.50, 3.33, 3.25 and 3.25 aphids per plant. The populations on the remaining landraces were found non-significant ranging from 7.50-4.16 aphids per plant (Table 1).

Table 1: Population dynamics of *Rhopalosiphum padi* on different wheat landraces during March 2014.

S. No.	Landrace	Mean	S. No	Landrace	Mean	S. No	Landrace	Mean
1	1403	7.00 a-j	39	14113	5.50 a-j	77	15645	4.83 a-j
2	12513	6.33 a-j	40	14116	5.41 a-j	78	15653	5.91 a-j
3	12619	6.00 a-j	41	14117	5.91 a-j	79	15692	2.33 j
4	12656	6.16 a-j	42	14118	7.33 a-j	80	15789	4.75 a-j
5	12679	4.00 d-j	43	14119	5.91 a-j	81	15984	3.25 h-j
6	12835	7.16 a-j	44	14124	3.33 a-j	82	16094	4.91 a-j
7	12889	3.75 e-j	45	14126	6.50 a-j	83	16108	5.08 a-j
8	13126	5.66 a-j	46	14130	10.00 a	84	16129	4.91 a-j
9	13242	4.25 b-j	47	14141	6.66 a-j	85	16148	5.33 a-j
10	13438	6.16 b-j	48	14144	7.50 a-j	86	10296	5.08 a-j
11	13477	6.83 a-j	49	14145	5.83 a-j	87	10297	5.50 a-j
12	13492	3.25 h-j	50	14148	4.66 b-j	88	10304	4.91 a-j
13	13511	8.58 a-g	51	14149	7.83 a-i	89	10311	5.75 a-j
14	13513	7.08 a-j	52	14171	5.83 a-j	90	10336	8.33 a-h
15	13526	6.08 a-j	53	14540	9.41 ab	91	10338	4.00 d-j
16	13564	6.41 a-j	54	14545	8.83 a-e	92	10340	5.50 a-j
17	13569	4.66 b-j	55	14547	7.75 a-i	93	10591	4.91 a-j
18	13570	5.33 a-j	56	14549	6.08 a-j	94	10593	5.58 a-j
19	13631	6.58 a-j	57	14551	6.75 a-j	95	10620	4.66 b-j
20	13633	4.41 b-j	58	14561	7.08 a-j	96	10625	6.08 a-j
21	13664	7.25 a-j	59	14919	6.58 a-j	97	10654	7.33 a-j
22	13831	4.83 a-j	60	14940	5.08 a-j	98	10686	6.16 a-j
23	13839	5.00 a-j	61	14942	9.16 a-d	99	10688	6.41 a-j
24	13842	4.41 b-j	62	14943	7.75 a-i	100	10692	6.00 a-j
25	13874	6.00 a-j	63	15262	8.25 a-i	101	10693	6.66 a-j
26	13881	7.16 a-j	64	15304	7.41 a-j	102	10697	7.00 a-j
27	13895	6.00 a-j	65	15310	4.25 b-j	103	10702	6.66 a-j
28	13925	4.50 b-j	66	15315	5.00 a-j	104	10703	5.25 a-j
29	13926	3.33 g-j	67	15325	8.66 a-f	105	10704	4.50 b-j
30	13929	6.83 a-j	68	15332	8.08 a-i	106	10705	6.16 a-j
31	13931	4.50 b-j	69	15333	7.50 a-j	107	10707	4.50 b-j
32	13955	5.58 a-j	70	15342	5.83 a-j	108	10709	4.91 a-j
33	14013	4.08 c-j	71	15357	7.75 a-i	109	10710	6.58 a-j
34	14041	5.58 a-j	72	15425	6.50 a-j	110	10780	6.08 a-j
35	14042	3.00 ij	73	15426	4.16 b-j	111	10781	5.91 a-j
36	14056	4.83 a-j	74	15438	6.25 a-j	112	10785	3.75 e-j
37	14081	5.91 a-j	75	15601	4.75 a-j	113	10020	3.50 f-j
38	14112	9.33 abc	76	15603	3.91 d-j	114	10082	3.08 h-j

Population dynamics of *R. padi* during the month of April: During the month of April, the significant highest populations of *R. padi* were recorded on 81 landraces. These all landraces were found to be more susceptible during April. However, 31 landraces were found resistant with the lowest populations. These landraces were 10710, 13492, 14141, 10340, 10785, 13633, 14561, 13569, 10688, 12835, 13842, 10709, 14940, 10620, 10692, 10593, 14124, 14013, 14119, 15984, 15310, 14149, 14042, 13874, 10697, 14116, 14117, 15426, 14549, 14041, 10625, 13925, 12679 with mean aphid populations of 6.9, 6.9, 6.87, 6.79, 6.79, 6.75, 6.75, 6.70, 6.66, 6.58, 6.50, 6.41, 6.33, 6.33, 6.29, 6.25, 6.20, 6.08, 6.00, 5.91, 5.91,5.75, 5.70, 5.62, 5.54, 5.50, 5.45,5.41, 5.33, 5.08, 4.20, 3.54, 2.91 respectively (Table 2).

Table 2: Population dynamics of *R. padi* on different wheat landraces during April 2014.

S. No.	Landrace	Mean	S. No	Landrace	Mean	S. No	Landrace	Mean
1	1403	7.00 a-j	39	14113	5.50 a-j	77	15645	4.83 a-j
2	12513	6.33 a-j	40	14116	5.41 a-j	78	15653	5.91 a-j
3	12619	6.00 a-j	41	14117	5.91 a-j	79	15692	2.33 j
4	12656	6.16 a-j	42	14118	7.33 a-j	80	15789	4.75 a-j
5	12679	4.00 d-j	43	14119	5.91 a-j	81	15984	3.25 h-j
6	12835	7.16 a-j	44	14124	3.33 a-j	82	16094	4.91 a-j
7	12889	3.75 e-j	45	14126	6.50 a-j	83	16108	5.08 a-j
8	13126	5.66 a-j	46	14130	10.00 a	84	16129	4.91 a-j
9	13242	4.25 b-j	47	14141	6.66 a-j	85	16148	5.33 a-j
10	13438	6.16 b-j	48	14144	7.50 a-j	86	10296	5.08 a-j
11	13477	6.83 a-j	49	14145	5.83 a-j	87	10297	5.50 a-j
12	13492	3.25 h-j	50	14148	4.66 b-j	88	10304	4.91 a-j
13	13511	8.58 a-g	51	14149	7.83 a-i	89	10311	5.75 a-j
14	13513	7.08 a-j	52	14171	5.83 a-j	90	10336	8.33 a-h
15	13526	6.08 a-j	53	14540	9.41 ab	91	10338	4.00 d-j
16	13564	6.41 a-j	54	14545	8.83 a-e	92	10340	5.50 a-j
17	13569	4.66 b-j	55	14547	7.75 a-i	93	10591	4.91 a-j
18	13570	5.33 a-j	56	14549	6.08 a-j	94	10593	5.58 a-j
19	13631	6.58 a-j	57	14551	6.75 a-j	95	10620	4.66 b-j
20	13633	4.41 b-j	58	14561	7.08 a-j	96	10625	6.08 a-j
21	13664	7.25 a-j	59	14919	6.58 a-j	97	10654	7.33 a-j
22	13831	4.83 a-j	60	14940	5.08 a-j	98	10686	6.16 a-j
23	13839	5.00 a-j	61	14942	9.16 a-d	99	10688	6.41 a-j
24	13842	4.41 b-j	62	14943	7.75 a-i	100	10692	6.00 a-j
25	13874	6.00 a-j	63	15262	8.25 a-i	101	10693	6.66 a-j
26	13881	7.16 a-j	64	15304	7.41 a-j	102	10697	7.00 a-j
27	13895	6.00 a-j	65	15310	4.25 b-j	103	10702	6.66 a-j
28	13925	4.50 b-j	66	15315	5.00 a-j	104	10703	5.25 a-j
29	13926	3.33 g-j	67	15325	8.66 a-f	105	10704	4.50 b-j
30	13929	6.83 a-j	68	15332	8.08 a-i	106	10705	6.16 a-j
31	13931	4.50 b-j	69	15333	7.50 a-j	107	10707	4.50 b-j
32	13955	5.58 a-j	70	15342	5.83 a-j	108	10709	4.91 a-j
33	14013	4.08 c-j	71	15357	7.75 a-i	109	10710	6.58 a-j
34	14041	5.58 a-j	72	15425	6.50 a-j	110	10780	6.08 a-j
35	14042	3.00 ij	73	15426	4.16 b-j	111	10781	5.91 a-j
36	14056	4.83 a-j	74	15438	6.25 a-j	112	10785	3.75 e-j
37	14081	5.91 a-j	75	15601	4.75 a-j	113	10020	3.50 f-j
38	14112	9.33 abc	76	15603	3.91 d-j	114	10082	3.08 h-j

Population dynamics of *R. padi* during the month of May: The peak populations were observed during the month of May on 78 landraces of wheat. These seventy eight landraces proved to be the most susceptible during this study while remaining thirty eight landraces were proved to be resistant with low aphid densities. The landraces with minimum populations during the month were 15310, 13895, 13931, 14042, 10297, 13570, 10781, 13511, 14081, 15426, 10593, 14124, 10692, 10704, 13842, 14113, 10296, 13831, 14041, 14117, 14148, 14116, 10704, 13526, 10697, 13631, 13126, 13874, 13881, 14056, 14149, 14940, 10304, 14119, 12679, 13925, 13926 and 13492 with mean aphid populations of 6.95, 6.91, 6.87,6.87, 6.79, 6.79, 6.75, 6.75, 6.755, 6.75, 6.75, 6.75, 6.70, 6.70, 6.58, 6.58, 6.54, 6.54, 6.50, 6.41, 6.29, 6.20, 6.16, 6.16, 6.16, 6.00, 5.87, 5.83, 5.54, 5.45, 5.41, 5.25, 4.95, 4.74 and 4.25 per plant respectively (Table 3).

Table 3: Population dynamics of *R. padi* on different wheat landraces during May 2014.

S. No.	Landrace	Mean	S. No	Landrace	Mean	S. No	Landrace	Mean
1	1403	8.45 b-n	39	14113	6.58 f-p	77	15645	7.16 e-p
2	12513	10.00 a-f	40	14116	6.29 g-p	78	15653	8.66 b-m
3	12619	9.95 a-f	41	14117	6.50 f-p	79	15692	8.04 b-o
4	12656	8.91 a-l	42	14118	8.29 b-o	80	15789	8.16 b-o
5	12679	5.25 m-p	43	14119	5.41 l-p	81	15984	7.62 d-p
6	12835	8.75 a-m	44	14124	6.75 e-p	82	16094	8.00 b-o
7	12889	8.41 b-n	45	14126	12.13 a	83	16108	8.91 a-l
8	13126	6.16 h-p	46	14130	10.75 a-d	84	16129	11.42 a-b
9	13242	7.37 d-p	47	14141	7.41 d-p	85	16148	8.45 b-n
10	13438	7.87 c-o	48	14144	9.25 a-i	86	10296	6.58 f-p
11	13477	7.91 b-o	49	14145	7.04 e-p	87	10297	6.79 e-p
12	13492	4.25 p	50	14148	6.41 f-p	88	10304	5.45 k-p
13	13511	6.75 e-p	51	14149	5.83 i-p	89	10311	7.45 d-p
14	13513	7.25 d-p	52	14171	7.20 d-p	90	10336	7.50 d-p
15	13526	6.29 g-p	53	14540	8.25 b-o	91	10338	7.33 d-p
16	13564	8.50 b-n	54	14545	8.62 b-m	92	10340	7.37 d-p
17	13569	7.83 c-o	55	14547	8.29 b-0	93	10591	8.79 a-m
18	13570	6.79 e-p	56	14549	7.45 d-p	94	10593	6.75 e-p
19	13631	6.16 h-p	57	14551	7.33 d-p	95	10620	8.83 a-m
20	13633	7.12 e-p	58	14561	7.16 e-p	96	10625	9.66 a-h
21	13664	9.33 a-i	59	14919	7.16 e-p	97	10654	8.29 b-o
22	13831	6.54 f-p	60	14940	5.54 j-p	98	10686	11.29 a-c
23	13839	7.41 d-p	61	14942	10.00 a-f	99	10688	8.79 a-m
24	13842	6.58 f-p	62	14943	7.66 d-p	100	10692	6.70 f-p
25	13874	6.16 h-p	63	15262	9.33 a-i	101	10693	9.12 a-j
26	13881	6.00 i-p	64	15304	8.00 b-o	102	10697	6.20 g-p
27	13895	6.91 e-p	65	15310	6.95 e-p	103	10702	8.83 a-m
28	13925	4.95 n-p	66	15315	7.20 d-p	104	10703	7.45 d-p
29	13926	4.75 op	67	15325	9.04 a-k	105	10704	6.70 f-p
30	13929	8.33 bo	68	15332	8.45 b-n	106	10705	8.83 a-m
31	13931	6.87 e-p	69	15333	7.04 e-p	107	10707	8.62 b-m
32	13955	7.04 e-p	70	15342	7.37 d-p	108	10709	7.70 d-p
33	14013	7.62 d-p	71	15357	10.33 a-e	109	10710	7.50 d-p
34	14041	6.54 f-p	72	15425	9.37 a-i	110	10780	7.75 d-p
35	14042	6.87 e-p	73	15426	6.75 e-p	111	10781	6.75 e-p
36	14056	5.87 i-p	74	15438	9.79 d-g	112	10785	7.00 e-p
37	14081	6.75 e-p	75	15601	7.54 d-p	113	10020	7.79 c-p
38	14112	9.08 a-j	76	15603	7.25 d-p	114	10082	7.66 d-p

DISCUSSION

During this study, the results obtained from March's observations were non-significant while those of April and May were significant. After this, a sudden decline in the aphid population was observed. During the month of April, the significant highest population was recorded on 81 landraces. All these landraces were found to be more susceptible during April. However, 33 landraces were found resistant with the lowest population. The peak populations were recorded during the month of May on seventy eight landraces of wheat and proved to be the most susceptible during this study while remaining thirty eight landraces were proved to be more resistant with low aphid density.

The present findings cannot be compared with those of Ahmad and Nasir (2001) due to different set of genotypes. The present findings are not in accordance with those of Zhang et al. (1989), Kindler et al. (1992), Aheer et al. (1993), Farid et al. (1998), Anonymous (2000) and Migui and Lamb (2003) due to differences in their materials and methods as well as ecological conditions. Similarly, according to Aheer et al. (1993) the highest grain yield was obtained with lowest aphid density. Changes in quality and quantity of the food occur with life of the plant and its growth stages, which ultimately affect the survival, longevity, distribution, reproduction and speed of development of insects (Yazdani and Agarwal, 1997).

The aphid population increased exponentially and did not reach its peak on 21st March. Our results did not confirm the results of earlier workers. Rios and Conde (1986) observed peak aphid population at milk stage, i.e. during the third week of March. Aphid reproduces rapidly and increases its population at heading or earing stage (Dyadechko and Ruban, 1975; Rustamani et al., 1999). This rapid growth in aphid population on all lines could be due to availability of good quality and surplus quantity of food (sap) present in the ears.

The sudden decline in the aphid population was observed in March. Our results are not in accordance with those of Aheer et al. (2006) who reported peak aphid population on 23rd March. Similarly, Aslam et al. (2004) observed peak aphid population on 16th March. Farooq and Nasir (2001) reported peak aphid population during the mid of March. We found that the aphid's population reduced till 6th April. Our results are not in confirmation with that of Suhail et al. (2001) who reported that the aphid's population was the highest on 2nd April. The aphid population almost diminished on 6th April on all wheat varieties/lines when crop was at dough stage. These results are not similar to those reported earlier (Ahmad and Nasir, 2001; Parvez and Ali, 1999). Aslam et al. (2004) observed that on all the wheat varieties tested against aphid, the aphid was completely destroyed on 6th of April while Suhail et al. (2001) reported pest population as zero. The sudden decline in population might be due to crop maturity, grain hardness, unavailability of sap due to senescence of the crop and high temperature. Wheat landraces behaved differently with regard to aphid population. This confirmed that these landraces have some inherent ability to cope with aphids up to a certain level. Hence, this study provided basis for further detailed study to investigate the population dynamics and its effect on yield losses.

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