www.czasopisma.pan.pl PAN www.journals.pan.pl

JOURNAL OF PLANT PROTECTION RESEARCH Vol. 50, No. 3 (2010)

DOI: 10.2478/v10045-010-0065-6

APHID DYNAMICS IN RELATION TO METEOROLOGICAL FACTORS AND VARIOUS MANAGEMENT PRACTICES IN BREAD WHEAT

Muhmmad Saleem Wains, Muhammad Amjad Ali, Makhdoom Hussain, Javed Anwar, M. Zulkiffal, Waseem Sabir*

Wheat Research Institute, Ayub Agricultural Research Institute, 38070 Faisalabad, Pakistan

Received: October 28, 2009
Accepted: August 13, 2010

Abstract: The infestation of aphids in wheat is becoming a serious problem nowadays and it might become a threat to the future wheat crop in Pakistan. With this problem in mind we did a study pertaining to aphid dynamics in relation to meteorological factors and various management practices in bread wheat. The study was carried out at the Wheat Research Institute, Faisalabad, Pakistan. The aim of this study was to investigate how meteorological factors play a role in the fluctuating aphid population and how different management practices could be effective in combating aphids. The results revealed that a peak aphid population was recorded during the beginning of the third week of March for both of the study year periods of 2007–2008 and 2008–2009. Aphid density was positively associated with maximum as well as minimum temperature while it showed a negative correlation with relative humidity. However aphid population was positively but not significantly affected by rainfall. Early sowing on 1st November produced the least aphid infestation hence early sowing was encouraged as a cultural practice for keeping aphids below damaging levels. The recently developed wheat varieties like: SHAFAQ-06, SEHER-06, FSD-08 and LASANI-08, revealed aphid resistance and performed better against aphids. On the other hand the genotypes V-05003, BARS-09 and 0BT006, revealed maximum vulnerability to aphids. Number of aphids per tiller was positive correlated with loss in grain yield. Application of insecticide significantly controlled the aphid population which suggested that a combination of host plant resistance with chemical control could restrain the aphid infestation in wheat.

Key words: aphids, environment, sowing date, host plant resistance, chemical control

INTRODUCTION

Aphids (Aphididae: Homoptera), often called plant lice and green flies have a wide host range. Aphids significantly affect various field crops, fruits and vegetables as sucking pests (Aheer *et al.* 2008). The first wheat aphid species [*Diuraphis noxia* (Mordvilko)] was reported by Grossheim around 1900 in the Mediterranean Sea region and in southern Russia (Jones *et al.* 1989; Elsidaig and Zwer 1993). It is assumed that this aphid species spread from West Asia to the USA and Canada via South Africa and Mexico (Saidi and Quick 1996). The aphid has since spread to most of the wheat producing regions of the world including Pakistan.

Bread wheat (*Triticum aestivum* L.) is the main crop with the largest area under cultivation in Pakistan (Anwar *et al.* 2009). Aphids of cereal crops are a dangerous problem for wheat (Dixon 1987). Aphid populations stay on wheat for a short, distinct time period during which they multiply rapidly (Jarosik *et al.* 2003). Aphids cause substantial yield losses by the direct effect of their feeding (Keickhefer and Kantack 1980) and as a vector of several plant viruses (Blackman and Eastop 1984). Kindler *et al.* (1995) observed chlorosis and curling of leaves caused by feeding aphids. Aheer *et al.* (1994) found that one aphid caused 2.20 percent loss in grain yield. Losses range from 30 to 40 percent at 15 aphids per plant have also been reported by Kiechkhefer and Gellner (1992).

The investigation of aphid population dynamics on wheat is complex and depends on the numbers of immigrant aphids, and the length of time required for population growth (Jarosik *et al.* 2003). The growth rate and migration are affected by host-plant variety and crop vigor, microclimate and natural enemies (Dixon 1987). Various workers (Aheer *et al.* 1994; Geza 2000; Nasir and Ahmad 2001; Aheer *et al.* 2007; Ashfaq *et al.* 2007; Aheer *et al.* 2008; Wains *et al.* 2008) reported that abiotic factors severely affect the population build-up of wheat aphids. Aheer *et al.* (2007) and Wains *et al.* (2008) found that peak population of aphids is during March when the air temperature ranged from 7.7 to 25.02°C. Nasir and Ahmad (2001) as well as Aheer *et al.* (2007, 2008) reported that temperature had a significant and positive role in fluctuating aphid density. On the other hand, relative humidity revealed negative and significant correlation with aphid population. They also reported not significant correlation of aphid density with rainfall. But Wains *et al.* (2008) reported significant negative correlation between aphid density and rainfall during 2005. Moreover, Nasir and

*Corresponding address:
Amjad.Ali2001@gmail.com

Ahmad (2001) observed that most favorable conditions for the growth of aphid populations were 30.3°C maximum temperature, 13.7°C minimum temperature and 45.3% relative humidity.

Similarly, Smatas *et al.* (2008) reviewing the trends in aphid occurrence in spring barley from 1976 to 2007, found that the occurrence of aphids was more frequent due to increasing trend in air temperature during the last decade.

Different control measures might be used to check the aphid population below the economic threshold level without disturbing the environment and affecting the nontarget organisms. Among these control strategies, fluctuation in sowing date can be supportive for controlling aphids on wheat (Aslam *et al.* 2005). Delayed sowing might be detrimental for a wheat crop if cool and sometimes cloudy weather prevails up to the end of March. The potential for aphid infestation can be reduced by early sowing of wheat (Acreman and Dixon 1985) because aphid infestation rises on late sown crop and reduces grain yield as compared to normal sowing (Aheer *et al.* 1993 a). Similarly, host plant resistance is one of the most vital factors which can handle aphid infestation well below the economic threshold level. Host plant resistance also lessens the chances of biotype development (Lowe 1987; Riazuddin *et al.* 2004). Leszczynski *et al.* (1995) reported that resistant varieties have higher concentrations of allelochemicals which restrain aphid development on plants, reduced fecundity and inherent rate of increase. Interestingly, Wiwart and Sądej (2008) demonstrated some correlation between the colour of field bean leaves and infestation of these plants by black bean aphid (*Aphis fabae* Scop.). However, in the case of high aphid populations resulting in heavy yield loss, chemicals are to be used for their immediate knock down effect (Riazuddin *et al.* 2004). Many studies demonstrated that use of various insecticides can be helpful in managing aphids on wheat (Ahmed *et al.* 2001; Iqbal *et al.* 2005). Moreover, Jansen (2000) concluded aphid management with insecticides, fenvalerate and fluvalinate was safe to natural enemies of aphids in wheat.

This experiment was designed to study aphid dynamics in relation to various meteorological factors and to investigate the usefulness of various management practices.

MATERIALS AND METHODS

Aphid dynamics in relation to meteorological factors

Wheat crop (cv. SEHER 2006) was sown at the Wheat Research Institute (WRI), Faisalabad, Punjab, Pakistan (31°24´N and 73°02´E). Plot size was 5x1.62 meter with three repeats. To conduct the trial, three Moericke yellow water traps (59x46x75 cm) were placed at the height of 75 cm from the ground level on wooden stands in three different wheat fields (300 feet distant) containing the cultivar Seher-06. Data on alate (winged) aphids (*Sitobian avenae* F.) trapped in trays were recorded daily from 9–11 a.m. A daily record of alate aphids trapped was maintained and later on transformed on a weekly basis. The weekly count of trapped alate aphids was correlated with biotic meteorological factors. The data regarding weather factors were taken from Meteorological Department of Ayub Agricultural Research Institute, Faisalabad. Regression models were also developed to forecast aphid population.

Implication of agricultural control against aphids

The experiment was aimed at finding an agricultural method for controlling wheat aphids. The experiment was conducted to observe the effect of different dates of sowing wheat on aphid density at the farm of WRI, Faisalabad. The cultivar Seher-2006 was sown on six different dates i.e., 1st Nov, 10th Nov, 20th Nov, 30th Nov, 10th Dec and 20th Dec in both years 2007–2008 and 2008–2009 at an interval of 10 days. The layout was split factorial design with three replications. The plot size was 5 m x 1.62 m. The data regarding aphid counts were recorded at weekly interval by cutting ten tillers selected randomly. The cutting was done efficiently with a pair of scissors to avoid dislodging aphids. Then the aphids were brushed off from the tillers onto a white sheet of paper to count them. These sowing dates were also used to determine the aphid population dynamics during the seasons.

Integration of chemical control and host plant resistance

A set of twelve genotypes: Shafaq-2006, V-04022, V-04178, Seher-2006, 0BT006, 0BT034, FSD-2008, LASANI-2008, BARS-2009, V-05066, V-05082 and V-05003, was used to study the integration of chemical control and host plant resistance with two check varieties Shafaq-2006 and Seher-2006. The advanced lines 0BT006 and 0BT034 were taken from Agricultural Biotechnology Research Institute, Faisalabad while BARS-2009 was taken from Barani Agricultural Research Station, Fatehjang, Pakistan. The rest of the genotype/advance lines were developed at WRI, Faisalabad. Genotypes from different sources were used to create some sort of diversity in the experiment. The studies were conducted during the 2007–2008 and 2008–2009 crop seasons in two sets: sprayed and unsprayed. The insecticide Confidor 25WP (Imidacloprid) @ 500 ml/ha was sprayed on four dates (February 18, 28 and March 10, 20) during both the periods of 2007–2008 and 2008–2009. The layout system was RCBD replicated thrice with plot size of 5 m x 1.62 m. Observations of aphid populations were recorded from treated set just before and then 24 hours after spray, at ten day intervals from February 18 to March 19 of both seasons. Ten tillers were selected randomly from each plot. Each tiller was clipped off gently with scissors. Aphids were counted by dropping them on a white paper with the help of a camel hair brush. The yield data were also taken at the end of the experiment. The percentage losses were calculated.

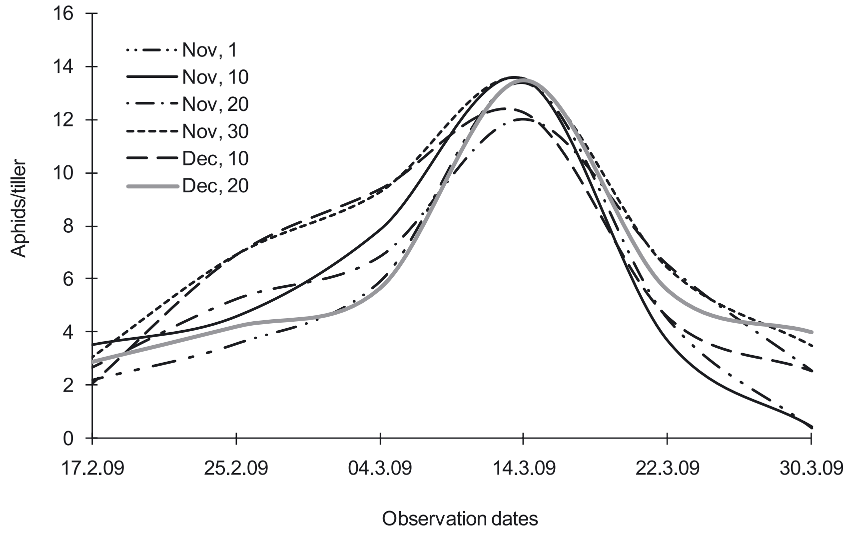
Statistical analysis

The data thus recorded were analyzed for split plot factorial design according to Steel *et al.* (1997) and differences among various means were determined using Duncan's multiple range (DMR) test according to Duncan (1955).

RESULTS AND DISCUSSION

Aphid dynamics in relation to meteorological factors

The results of the aphid population observed in various sowing dates (Fig. 1) revealed that peak population of aphids was recorded during the third week of March in both years 2007–2008 and 2008–2009. Aheer *et al.* (2007), Wains *et al.* (2008) and Iqbal *et al.* (2008) found the highest



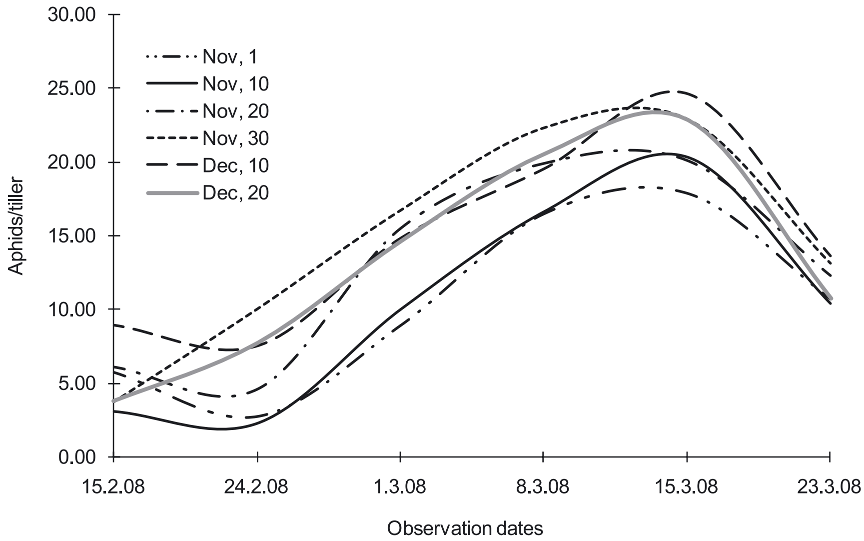


Fig. 1. Aphid population dynamics in relation to sowing dates for 2007–2008 (above) and 2008–2009 (below) crop seasons. The aphid population was found to be the highest during mid March for various sowing dates for both years

aphid population during March. However, the present findings are in contradiction with those of Singh *et al.* (2001) who found peak population of aphid during 2nd week of January, 1999 and this was due to change in climatic conditions. Likewise, the study of Hassan *et al.* (2004) concluded that population of aphids was maximum in the 4th week of February during the 2001–2002 crop season. Figure 1 demonstrated a gradual increase in aphid density from the 3rd week of February to the beginning of the 3rd week of March during the growing season of both years. The aphid population declined vertically after the 16th during 2007–2008, while it was less affected after the 16th of March during 2008–2009. The data from table 1 and figure 1 shows that maximum temperature of 30°C, minimum temperature of about 13°C, and relative humidity ranging from 60–70% were the most favorable environmental conditions for building up the aphid population beyond the economic threshold level. However, according to Nasir and Ahmad (2001) the most conducive conditions for aphid growth were 30.3°C maximum temperature, 13.7°C minimum temperature and 45.3% RH.

The data of the various environmental factors for the two year periods are given in table 1. The average meteorological data of environmental factors was taken from the two crop seasons of 2007–2008 and 2008–2009 for an estimation of the correlated response of these factors with aphid density. The results exhibited by figure 2 revealed that the maximum and minimum temperatures showed significant and positive effect on the population of aphids (Nasir and Ahmad 2001), whereas relative humidity exerted a significant and negative role. Elevated maximum temperature displayed an increasing trend in aphid population (R^2 = 0.5708) along with statistically significant correlation coefficient (r = 0.755). Minimum temperature also displayed a significant and positive correlation (r = 0.646) on aphid population with an increasing tendency (R^2 = 0.4176). On the other hand, relative humidity revealed a very strong opposite trend to aphid population (R^2 = 0.6905) which was soundly confirmed by a significant correlation coefficient (r = 0.83). Similar to our findings, Nasir and Ahmad (2001) and Aheer *et al.* (2007, 2008) reported that minimum and maximum tem-

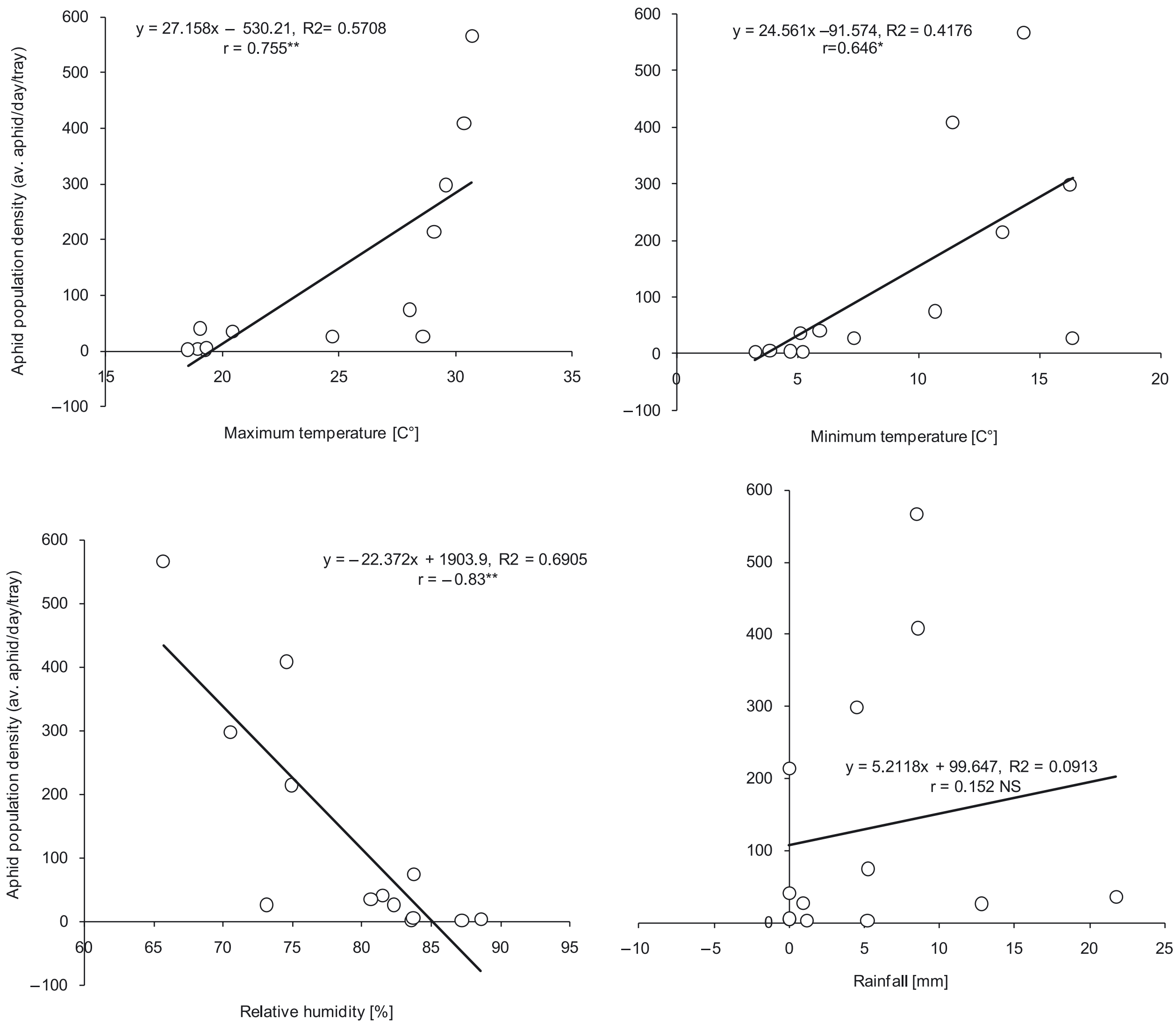


Fig. 2. Correlated response of aphid density with various abiotic factors for bread wheat. This figure demonstrates the trend of increase or decrease in aphid population in relation to various meteorological factors in the growing season (from 1st week of January to 1st week of April). The meteorological data is the average of two years

peratures had a significant and positive role in causing fluctuation in the aphid population. However, they demonstrated that relative humidity revealed a negative and significant correlation with aphid population (Wains *et al.* 2008). The present findings are also comparable with those of Geza (2000) who reported that abiotic factors seriously affected the population build-up of wheat aphids.

Our study demonstrated that the effect of rainfall was found to be not significant on the population of aphids (Aheer *et al.* 2007). However, the response was observed to be positive. These findings cannot be compared with those of Singh *et al.* (2001) who reported that winter showers resulted in a decline of the aphid population. Srivastava *et al.* (1995) concluded that a high rainfall during January to mid February was favorable but in the last week of February or the first week of March rainfall was detrimental to aphid population.

Implication of agricultural control against aphids

It has been suggested that early sowing as well as maturity would avoid outbreaks of aphids on wheat crop (Barabas and Benovsky 1985). Our study revealed a gradual increase in aphid population from early February to mid March in both years (Fig. 1). The results displayed that sowing dates significantly affected aphid density (Table 2). The year x dates (Y x D) was also significant suggesting that aphid population was also influenced by both years and sowing dates simultaneously, however, years individually showed non-significant affects on aphid infestation. A look at figure 1 and table 1 reveals that aphid population was the least during the early sowing date (1st November) and timely sowing (November, 10) in both years. Aphid population was the highest for the fourth sowing date (November, 30). Aphid infestation increased gradually from the first sowing date to the fourth one and after that it continued to decrease up to the last date (December, 20). These results suggest that early sowing results in reduced aphid population. This might be due to the fact that crops escape the most damage which is done by aphid instars during their succulent stage. Early sowing resulting in reduced aphid population may also be due to very low temperature at

Table 1. Meteorological data throughout growing seasons both the years

Period/month	Week	Temperature [°C]		Relative humidity [%]	Rainfall [mm]	Aphid pop./ day/tray
		maximum	minimum			
2007–2008						
January	1st	19.04	1.74	79.1	0	0.43
	2nd	17.34	5.51	88.3	0	0.04
	3rd	16.8	3.1	86.75	0	0.96
	4th	17.15	-0.3	79.89	0	1.03
February	1st	15.26	4.17	81.6	0	0.59
	2nd	19.2	2.59	73.7	35	0.98
	3rd	25.5	6.5	77.7	1.5	5.6
	4th	29.9	10.87	86.1	10.5	25.4
March	1st	29.35	14.8	78.12	0	208
	2nd	30.75	13.8	74.1	17.1	584
	3rd	30.9	13.86	59.75	15	911
	4th	33.3	17.46	61.3	0	513
April	1st	27.5	16.36	75.6	0	35.3
2008–2009						
January	1st	19.46	4.8	88	2.4	5
	2nd	20.55	3.94	88.87	0	9
	3rd	20.26	7.36	87.62	10.4	4
	4th	21.5	8.03	87.5	0	10
February	1st	22.83	7.67	81.43	0	81
	2nd	21.7	7.64	87.57	8.5	70
	3rd	23.96	8.21	86.86	0.4	48
	4th	26.2	10.5	81.43	0	124
March	1st	28.81	12.13	71.71	0	221
	2nd	30	9	75	0	233
	3rd	30.5	14.85	71.62	2	222
	4th	25.9	15.04	79.75	9.0	84
April	1st	29.71	16.36	70.62	25.6	18

Table 2. Analysis of variance in split plot for variety SEHER-06 in different years and sowing dates

SOV	df	Sum of squares	Mean sum of squares	F- ratio
Replications	2	1262.123	631.061	2.880 ns
Years (Y)	1	594.531	594.531	2.714 ns
Error	2	438.181	219.091	
Dates (D)	5	88.524	17.705	9.200*
Y× D	5	38.073	7.615	3.957*
Error	44	84.675	1.924	
Total	59	2506.107		

ns – not significant; SOV – source of variance; df – degree of freedom; * significant at 1% probability level

Table 3. Effect of different sowing dates on aphid density in bread wheat

Sowing dates	Aphid data observation dates						Av. aphid population
	2007–2008						
	15.2.08	24.2.08	1.3.08	8.3.08	15.3.08	23.3.08	
Oct. 25	5.70	2.70	8.90	16.50	17.90	10.70	9.60 de
Nov. 10	3.10	2.30	10.00	16.60	20.30	10.40	10.47 d
Nov. 25	6.10	4.60	15.50	19.90	20.10	12.30	13.09 bc
Dec. 10	3.70	10.00	16.70	22.30	22.90	13.10	15.72 a
Dec. 25	8.90	7.50	14.80	19.50	24.60	13.60	14.83 ab
Jan. 10	3.80	7.80	14.70	20.60	22.90	10.80	13.43 bc
2008–2009							
	17.2.09	25.2.09	04.3.09	14.3.09	22.3.09	30.3.09	
Oct. 25	2.20	3.56	5.90	13.38	4.52	0.4	4.99 cd
Nov. 10	3.50	4.56	7.82	13.50	3.65	0.42	5.58 c
Nov. 25	2.68	5.25	6.85	12.02	6.54	2.56	5.98 bc
Dec. 10	3.04	6.89	9.25	13.52	6.40	3.48	7.10 a
Dec. 25	2.05	6.88	9.36	12.24	4.56	2.54	6.27 ab
Jan. 10	2.91	4.23	5.67	13.50	5.60	4.02	5.99 bc

The values carrying different alphabets are statistically different this time reducing aphid attack on the crop (Wains *et al.* 2008). However, the crop sown on the 10th of December was the most affected by aphids. Aphid infestation was three times more on late sown crop as compared to early and timely sown crop. These results were in agreement with those of (Aslam *et al.* 2005) and Wains *et al.* (2008). The month of February is very crucial for multiplication of aphids. In February environmental factors, such as the slightly increasing maximum and minimum temperatures along with declining RH% contribute towards this process (Aslam *et al.* 2005; Aheer *et al.* 2007).

Integration of chemical control and host plant resistance

The application of insecticides in addition to host plant resistance has been proven to be better for controlling aphids on wheat (Iqbal *et al.* 2005). The results revealed that differences among various genotypes were significant for aphid population/tiller, grain yield (in both sprayed and unsprayed treatments), losses in grain yield due to aphids and number of aphids causing yield losses were significant for both years (Table 4). The variety BARS-09 (13.18) showed maximum aphids per tiller in unsprayed block. BARS-09 (13.18) was narrowly followed by 0BT034 (12.44) and V-05003 (12.27), respectively, which demonstrated the susceptibility of these genotypes to aphids in 2007–2008 while V-05003 (12.94), BARS-09 (9.19) and V-04178 (7.95) displayed susceptibility in 2008–2009. On the other hand, resistant genotypes SHAFAQ-06, SEHER-06, FSD-08 and LASANI-08 showed a comparatively lower population of aphids as compared to susceptible genotype during both the crop seasons. In sprayed block, genotypes V-05003 and 0BT006 scored the highest aphids per tiller which demonstrated complete vulnerability to aphids. Ahmad and Nasir (2001) reported that the variety FSD-83 having 10.30 aphids/tiller proved to be highly susceptible while PITIC-62 (4.98 aphids/tiller) proved to be comparatively resistant and was statistically at par with PUNJAB-85 (5.01 aphids/tiller).

The results revealed that maximum losses in grain yield were displayed by the genotype V-05003 in both years (10.88 and 15.47%, respectively) with a higher number of aphids causing these losses followed by BARS-09 (Table 4). This suggested that these genotypes were fully susceptible to aphid even when the blocks were treated with insecticide. However, on the average the recently developed varieties at Wheat Research Institute, Faisalabad viz; SHAFAQ-06, SEHER-06, FSD-08 and LASANI-08 showed small losses in grain yield with lower number of

Table 4. The effect of an integrated use of chemical control and host plant resistance to combat aphids in bread wheat

Genotypes	Aphid population/tiller		Grain yield [kg/ha]		Losses in grain yield [%]	Aphid caused yield losses
	sprayed	unsprayed	sprayed	unsprayed		
2007–2008						
SHAFAQ-06	0.01 d	9.32 d	4 122 c	3 862 bcde	6.78 cd	9.31 d
V-04022	0.01 d	10.48 cd	3 654 de	3 439 fg	6.25 cd	10.46 cd
V-04178	0.07 ab	11.42 bc	3 849 d	3 638 ef	5.79 cd	11.36 bc
SEHER-06	0.05 bc	9.63 d	4 140 c	3 900 abcd	6.13 cd	9.59 d
0BT006	0.10 a	9.55 d	3 416 e	3 170 h	7.73 bc	9.45 d
0BT034	0.05 bc	12.44 ab	3 514 e	3 209 gh	9.51 ab	12.39 ab
FSD-08	0.05 bc	10.06 cd	3 662 de	3 429 fg	6.84 cd	10.01 cd
LASANI-8	0.01 d	9.51 d	4 217 bc	4 021 abc	4.88 d	9.51 d
BARS-09	0.04b cd	13.18 a	4 140 c	3 838 cde	7.84 bc	13.14 a
V-05066	0.01 d	10.48 cd	4 518 a	4 108 a	9.98 ab	10.47 cd
V-05082	0.01 d	10.84 bcd	4 471 ab	4 080 ab	9.59 ab	10.83 bcd
V-05003	0.08 ab	12.27 ab	4 155 c	3 748 de	10.88 a	12.19 ab
2008–2009						
SHAFAQ-06	0.01 e	3.21 f	3 173 cd	3 100 c	2.36 e	4.86 f
V-04022	0.02 e	6.05 e	3 111 cde	2 926 e	6.32 cde	6.03 e
V-04178	0.03 e	7.95 bc	3 387 b	3 086 c	9.76 bc	7.92 c
SEHER-06	0.91 b	5.99 e	3 765 a	3 595 a	4.73 de	5.08 f
0BT006	1.01 ab	7.43 cd	3 185 c	2 988 d	6.61 cd	6.42 d
0BT034	0.13 de	7.85 bc	3 025 ef	2 763 f	9.50 bc	7.72 d
FSD-08	0.30 c	5.99 e	3 148 cd	3 000 d	4.99 de	5.69 e
LASANI-8	0.02 e	6.41 de	2 778 g	2 595 h	7.04 cd	6.39 d
BARS-09	0.15 de	9.19 b	3 086 de	2 750 f	12.25 ab	9.04 b
V-05066	0.11 de	6.69 cde	3 457 b	3 185 b	8.54 bcd	6.58 d
V-05082	0.21 cd	6.95 cde	2 938 f	2 676 g	9.79 bc	6.74 d
V-05003	1.10 a	12.94 a	3 136 cd	2 716 fg	15.47 a	11.84 a

The values carrying different alphabets are statistically different

Table 5. Correlated response of aphid population with yield loss and grain yield/ hectare

Population	Season	Grain yield [kg/ha]	Losses in grain yield [%]
No. of aphids causing yield losses	2007–2008	–0.092 ns	0.514*
	2008–2009	–0.510*	0.954**

* significant at 5% probability level; ** significant of 1% probability level; ns – not significant

aphids per tiller causing these losses. This confirmed that these varieties have some inherent ability to cope with aphids up to a certain level.

The application of insecticide Confidor 25WP @ 500 ml/ha significantly controlled aphids as shown on table 4; aphid density per tiller had been reduced to nearly a zero level. The efficiency of aphid control through insecticide was nearly 99% in the sprayed block as compared to the unsprayed block. However, the genotypes V-05003 and 0BT006 were less affected by insecticide in sprayed block revealing higher aphids per tiller as compared to other genotypes. Most of the genotypes exhibited lower aphids in treated block suggesting that integration of chemical control and host plant resistance could be the answer to coping with aphid infestation in wheat. However, the application of commonly used insecticides results in health hazards, environmental pollution and development of resistance in the insects against the insecticides; hence, the best solution is the exploitation of host plant resistance (Iqbal *et al.* 2008). The present findings cannot be compared with those of Jansen (2000), Ahmed *et al.* (2001) and Iqbal *et al.* (2008) because control of the aphid population by applying different insecticides other than those used in the present studies could be the one reason for aphid control.

The results revealed that percent loss in grain yield was significantly associated with aphid population (Table 5). However there was negative correlation between grain yield per hectare and aphid population which revealed that high infestation of aphids might cause great yield losses in wheat. These findings are in agreement with those of Aheer *et al.* (1993 b) who found a positive correlation between yield loss and aphid density and a negative correlation between grain yield per hectare and aphid population.

CONCLUSION

The results concluded that peak aphid population was recorded during the beginning of the third week of March in both years 2007–2008 and 2008–2009. Aphid dynamics were largely dependent on temperature and relative humidity, however, aphid population was not significantly correlated with rainfall. Early sowing was a supportive agricultural practice for controlling aphids below threshold levels. The study suggested that the combination of host plant resistance with chemical control could restrain aphid infestation in wheat. The recently evolved cultivars i.e. SHAFAQ-06, SEHER-06, FSD-08 and LASANI-08 showed resistance against aphids, so these varieties could be further exploited for improving aphid resistant in wheat.

REFERENCES

Acreman T.M., Dixon A.F. 1985. Developmental patterns in the wheat and resistant to cereal aphids. Crop Protect. 4 (3): 322–328.

Aheer G.M., Ali A., Munir M. 2008. Abiotic factors effect on population fluctuation of alate aphids in wheat. J. Agric. Res. 46 (4): 367–371.

Aheer G.M., Munir M., Ali A. 2007. Impact of weather factors on population of wheat aphids at Mandi Baha-ud-Din district. J. Agric. Res. 45 (1): 61–66.

Aheer G.M., Haq I., Ulfat M., Ahmad K.J., Ali A. 1993 a. Effects of swoing dates on aphids and grain yield in wheat. J. Agric. Res. 31: 75–79.

Aheer G.M., Rashid A., Afzal M., Ali A. 1993 b. Varietal resistance/susceptibility of wheat to aphids, *Sitobion avenae* F. and *Rhopalosiphum rufiabdominalis* Sasaki. J. Agric. Res. 31 (3): 307–311.

Aheer G.M., Ahmad K.J., Ali A. 1994. Role of weather in fluctuating aphid density in wheat crop. J. Agric. Res. 32 (3): 295–301.

Ahmad K.J., Malik N.A., Akhtar A.S., Hamza M. 2006. Varietal resistance in wheat varieties/lines and sowing date effect on aphid population. J. Agric. Res. 44 (3): 215–218.

Ahmed N.E., Kanan H.O., Inanaga S., Ma W.Q., Sugimoto Y. 2001. Impact of pesticide seed treatment on aphid cona trol and yield of wheat in the Sudan. Crop Protect. 20 (10): 929–934.

Anwar J., Ali M.A., Hussain M., Sabir W., Khan M.A., Zulkiffal M., Abdullah M. 2009. Assessment of yield criteria in bread wheat through correlation and path analysis. J. Anim. Plant Sci. 19 (4): 185–188.

Ashfaq M, Iqbal J., Ali A., Farooq U. 2007. Role of abiotic factors in population fluctuation of aphids on wheat. Pak. Entomol. 29 (2): 117–122.

Aslam M., Razaq M., Akhter W., Faheem M., Ahmad F. 2005. Effect of sowing date of wheat on aphid (*Schizaphis gramium* RONDANI) population. Pak. Entomol. 27 (1): 79–82.

Barabas, L., Benovsky J. 1985. The effect of winter wheat cultivars on the intensity of occurrence of the grain aphid (*Sitobion avenae* F). Ochrona Rostlin 21 (3): 195–199.

Blackman R.L., Eastop V.F. 1984. Aphids of world's crops, an identification and information guide. J. Econ. Entomol. 81 (5): 1383–1388.

Dixon A.F.G. 1987. Cereal aphids as an applied problem. Agric. Zool. Rev. 2: 1–57.

Duncan D.B. 1955. Multiple range and Multiple F. test. Biometrics 11: 1–42.

Elsidaig A.A., Zwer P.K. 1993. Genes for resistance to Russian wheat aphid in PI 294994. Crop Sci. 33 (5): 998–1001.

Hassan M.M., Nisar G., Ali A., Aheer G.M. 2004. Impact of predi ators on aphids in normal sown wheat advanced lines/varieties. J. Nat. Sci. 2 (1): 41–49.

Iqbal J., Ashfaq M., Ali A. 2005. Integration of chemical control and host plant resistance against aphids on wheat. Pak. Entomol. 27 (1): 3–5.

Iqbal J., Ashfaq M., Ali A. 2008. Screening of wheat varieties/advanced lines against aphids. Pak. Entomol. 30 (1): 77–81.

Jansen J.P. 2000. A three-year field study on the short-term effects of insecticides used to control cereal aphid on plant-dwelling aphid predators in winter wheat. Pest Manage. Sci. 56 (6): 533–539.

Jarosik V., Honek A., Tichopad A. 2003. Comparison of field population growths of three cereal aphid species on winter wheat. Plant Protect. Sci. 39 (2): 61–64

Jones J.W., Byers J.R., Butts R.A., Harris J.L. 1989. A new pest in Canada: Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (*Homoptera: Aphididae*). Can. Entomol. 82: 1779–1781.

Keickhefer R.W., Kantack B.H. 1980. Losses in yield in spring wheat in South Dakota. J. Econ. Entomol. 73 (4): 582–585.

Kindler S.D., Springer T. L., Jensen K.B.L. 1995. Detection and characterization of the mechanisms of resistance to Russian wheat aphid (Homoptera: Aphididae) in tall wheat grass. J. Econ. Entomol. 88 (5): 1503–1509.

Kuroli G. 2000. Aphid flight and change in abundance of winter wheat pests. Arch. Phytopathol. Plant Protect. 33 (4): 361–373.

Leszczynski B., Dixon A.F.G., Bakowski T., Matok H. 1995. Cereal allelochemicals in grain aphid control. Allelopathy J. 2 (1): 31–36.

Lowe H.J.B. 1987. Breeding for Resistance to Insect. Wheat Breeding. (F.G.H. Lupton, ed.). Chapman and Hall Ltd., UK: 423–454.

Nasir S., Ahmad F. 2001. Correlation between wheat aphid population and abiotic factors. Pak. Entomol. 23 (1): 23–25.

Panda D., Thakur B.S., Patro B. 2000. Population dynamics of *Lipaphis erysimi* Kalt. on *Brassica juncea* L. at Raipur, Madhya Pradesh, India. Plant Potect. Bull. 52 (1): 28–30.

Riazuddin, Anayatullah M., Khattak M.K. 2004. Screening resistant wheat lines against aphids. Pak. Entomol. 26 (1): 13–18

Saidi A., Quick J.S. 1996. Inheritance and allelic relationships among RWA resistance genes in winter wheat. Crop Sci. 36 (2): 256–258.

Singh V.S., Sekhar S.M.V., Sharma R.P. 2001. Root aphid infestation in wheat at Delhi and its control. Indian J. Enotomol. 63 (2): 197–201.

Smatas R., Tamosiunas K., Semaskiene R., Dabkevicius Z., Lazauskas S. 2008. Trends in aphid occurrence in spring barley in 1976–2007. J. Plant Protec. Res. 48(3): 275–282.

Srivastava A., Singh H., Thakur H.L. 1995. Impact of abiotic factors on the population dynamics of mustard aphid, *Lipaphis erysimi* (Kalt.) (*Homotera: Aphididae*). J. Oilseed Res. 12: 197–202.

Steel R. G. D., Torrie J. H., Deekey D. A. 1997. Principles and Procedures of Statistics: A Biometrical Approach. 3rd ed. McGraw Hill Book Co., New York.

Wains M.S., Aziz-ur-Rehman, Latif M., Hussain M. 2008. Aphid dynamics in wheat as affected by weather and crop planting time. J. Agric. Res. 46 (4): 361–366.

Wiwart M., Sądej W. 2008. The effect of leaf colour of selected field bean cultivars which differ in attracting black bean aphid (*Aphis fabae* Scop.). J. Plant Protection Res. 48(2): 195–200.

POLISH SUMMARY

DYNAMIKA MSZYC W ASPEKCIE CZYNNIKÓW METEOROLOGICZNYCH I RÓŻNYCH SPOSOBÓW UPRAWY PRZENICY CHLEBOWEJ

Opanowanie pszenicy przez mszyce staje się obecnie poważnym problemem i może stać się w przyszłości zagrożeniem dla pszenicy w Pakistanie. W pracy przedstawiono badania dotyczące dynamiki mszyc w aspekcie czynników uprawy pszenicy chlebowej. Badania wykonano w Instytucie Badawczym Pszenicy, Faisalabad, Pakistan. Celem pracy było stwierdzenie, jaką rolę odgrywają czynniki meteorologiczne w wahaniah, w populacji mszyc i jak różne zabiegi uprawowe mogłyby wpływać na skuteczność ich zwalczania. Wyniki badań wykazały, że szczytowa wartość populacji mszyc występowała w obydwóch latach prowadzonych badań: 2007–2008 i 2008–2009, w początkach trzeciego tygodnia marca. Gęstość zasiedlenia przez mszyce była pozytywnie związana z maksymalną oraz minimalną temperaturą, podczas gdy wystąpiła korelacja negatywna z wilgotnością względną. Ale populacja mszyc była pozytywnie, lecz nieistotnie związana z opadami. Wczesny siew, 1 listopada, sprzyjał najniższemu zasiedleniu przez mszyce, więc jest on zalecany jako zabieg agrotechniczny stosowany w celu utrzymania populacji mszyc poniżej poziomu szkodliwości. Wyhodowane ostatnio odmiany pszenicy, takie jak: SHAFAQ-06, SEHER-06, FSD-08 i LASANI-08, wykazywały odporność na mszyce i były przeciwko nim skuteczne. Z drugiej strony, genotypy: V-05003, BARS-09 i OBT006, wykazywały maksymalną podatność na mszyce. Liczba mszyc na źdźbło była skorelowana pozytywnie ze stratami plonu ziarna. Zastosowanie insektycydu istotnie zwalczało populację mszyc, co sugerowało, że połączenie odporności rośliny żywicielskiej z ochroną chemiczną mogłoby ograniczyć zasiedlenie pszenicy przez mszyce.