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Impact of wheat-rapeseed perimeter crop and environmental factors on the occurrence and population abundance of wheat aphid species

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Key words: Perimeter crop, *Rhopalosiphum padi*, *Myzus persicae*, Natural enemies, Temperature, Relative humidity

Abstract

The wheat aphid species individually and collectively cause severe damage to the wheat crop qualitatively and quantitatively. The incidence of these aphids is influenced by a number of biotic factors such as host plant resistance, availability of the natural enemies and the major abiotic factors such as temperature, humidity and rainfall. In the present investigation, the incidence and abundance of wheat aphid species were recorded with rapeseed as a perimeter crop. The results showed that wheat was infested by two major aphid species, bird cherry oat aphid, *Rhopalosiphum padi* and green peach aphid, *Myzus persicae* with rapeseed as a perimeter crop. The results further suggested that the level of infestation in wheat with perimeter crop remained low compared to check, influenced by the presence of natural enemies, however, the level of infestation of *M. persicae* remained highly influenced by the high level of infestation in rapeseed. In light of the above experimental results we concluded that the rapeseed influenced the population of *R. padi* and deterred *S. avenae*, however, encouraged *M. persicae* to infest wheat crop.

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Introduction

Wheat (*Triticum* spp.) is consumed by more than half of the world's population as an important staple diet source and its consumption is expected to rise much faster compared to other cereals (Johnson *et al.,* 1978; Kearney, 2010). It supplies food to about 40% population of the world. An estimated of 23% area of the world is under wheat cultivation and an important component of international trade (Istvan, 2006). It is a principal source of food with the protein contents of 13% (Ahmad and Shaikh, 2003).

In Pakistan, a number of factors such as outdated seed bed preparation, late sowing, contaminated seed, inappropriate use of fertilizer, drought, pathological diseases and insect pests are responsible for the major losses in wheat production (El-Gizawy, 2009). Insect pests are regarded as a major limiting factor which reduces per hectare yield (Khattak *et al.,* 2007). Among the major insect pests, aphids as sucking pests infest various fruits, vegetables and field crops, including wheat (Aheer *et al.,* 2008). Aphids as a pest have been recorded to reduce yield by 10-90%, depending upon the infestation level (Aheer *et al.,* 1993). A total of 15 aphids per plant cause a grain yield loss of 30 to 40% (Kieckhefer & Gallner, 1992).

In Pakistan, different aphid species, including *Rhopalosiphum padi* L (Aphididae: Homoptera) infest wheat crop (Shah *et al.,* 2006). It is normally observed on stems and leaves of the wheat plant (Wains *et al.,* 2008). The infested leaves consequently become pale and wilted (Khan *et al.,* 2012). *Myzus persicae* S (Aphididae: Homoptera) commonly known as the green peach aphid, infest large number of plant species, suck phloem sap from the plants (Malone *et al.,* 1999). In case of its attack on rapeseed with prolonged infestation cause greater yield losses (Chattopadhyay *et al.,* 2005). Out of a total six species infesting rapeseed, *Myzus persicae* was found the most abundant after *Brevicoryne brassicae,* L (Aphididae: Homoptera) (Mushtaq *et al.,* 2013).

A number of management practices have been employed such as chemical, biological, cultural and host plant resistance to counter aphid attack (Scholler *et al.,* 1997).

Early season cultivation and chemical control of aphids has been reported to increase the grain yield of wheat crop (Shahzad *et al.,* 2007). Among the cultural practices many researchers have validated the use of wheat-oilseed rape intercropping as beneficial for the wheat crop and keeping the aphid population low due to the encouragement of natural enemies by the availability of floral nectaries and enhance their fitness (Landis *et al.,* 2000; Irvin & Hoddle, 2007).

The present studies were designed to see the effects of rapeseed as a perimeter crop in wheat. Aphid species infesting rapeseed and wheat were identified and their incidence and abundance was also plotted against environmental factors such as maximum, minimum temperature and relative humidity.

Materials and methods

Location and Experimental Layout

The experiment was carried out in the experimental farm area at the Nuclear Institute for Agriculture & Biology (NIAB), Faisalabad. The experiment was laid out on an area of 300×100-foot. The wheat variety, Galaxy-2013 was cultivated in the second week of December, 2017 with a tractor drill in the central area of the experimental field. Afterwards the rapeseed variety, Punjab Sarsoon was sown as a perimeter crop on a 5 feet wide path all along the four sides of the wheat field with a hand drill. The row to row distance in wheat was 6 inches, whereas, in rapeseed it was 1.5 feet.

The rapeseed strip was separated from wheat by 2.5 feet path. The wheat was sown in 10 homogeneous size bed of 25x80-foot. The bed to bed distance was 2.5 feet.

Agronomic Practices

Weeds in the wheat crop were controlled by the application of stomp 330 EC as pre-emergence weedicide. The fertilizers, DAP and urea, were used in recommended rates to all the plots. No insecticides were applied in the experiment.

Identification and Population trend of wheat Aphid species

All the aphid species collected during pest scouting from the field as soon as their incidence started and were identified in the laboratory under the stereo microscope using an aphid identification key.

The population trend of the aphid infesting wheat crop was recorded after 4 day intervals. The data were recorded by counting of aphids per tiller on three randomly selected plants per replicate from five different randomly distributed plots.

Environmental Factors

Environmental data viz., minimum, maximum temperatures and relative humidity were recorded by mini weather station with data logger, installed at the NIAB experimental area.

Analysis of the Data

The data were pooled and means were calculated. The data were further subjected to ANOVA using (Statistix 8.1, Tallahassee, Florida, USA) and the separation of means was carried out by LSD at 0.05 confidence level. The graphs showing aphid peaks corresponding to temperature and relative humidity were drawn by Microsoft Excel, 2013.

Results

In the present studies, wheat crop protected by the perimeter rapeseed crop was infested by two major species of aphids, cherry oat aphid, *R. padi* and green peach aphid, *M. persicae*, identified in the laboratory in NIAB. The incidence of *R. padi* in wheat started in the third week of February with the mean population density of 4.93/tiller. The population keep on increasing and reached its seasonal peak of 40.73/tiller in the fourth week of February. Afterwards, the population of the aphid started to decline with the change in temperature and maturity level, reaching to 3.25 at its minimum level in the second week of March. As far as the population of green peach aphid, *M. persicae* is concerned its incidence started on the third week of February, with the population density of 0.73/tiller. The mean population of this aphid reached to its seasonal peak level in the second week of March, with a population density of 35.60/tiller. Afterwards, the population of the aphid started to decline and reached 3.80/tiller, lowest in the season (Table 1).

Table 1. Incidence and abundance of aphid species on wheat and rapeseed, with rapeseed as a perimeter crop.

Dates (dd-mm-yy)	Mean number of aphids per tiller					
	Wheat (Galaxy)		Rapeseed (Punjab Sarsoon)		Check (Galaxy)	
	R. padi	*M. persicae*	*B. brassicae*	*M. persicae*	*R. padi*	*S. avinea*
12/02/18	--	--	--	6.50^{GH}	--	0.86G
15/02/18	4.93^{E}	--	--	14.38^{EFGH}	5.80^{E}	1.20^{FG}
18/02/18	13.73^{D}	--	4.06^{G}	28.81^{DE}	16.40^{D}	4.53^{E}
21/02/18	15.13^{D}	0.73^{G}	27.93^{F}	21.81^{DEFG}	19.53^{D}	7.06^{D}
24/02/18	24.73^{C}	0.33^{G}	43.37^{DE}	19.63^{DEFG}	28.20^{C}	16.60^{A}
27/02/18	40.73^{A}	6.73^{E}	28.25^{F}	27.69^{DE}	45.46^{A}	15.40^{AB}
03/03/18	31.60^{B}	15.20^{C}	53.87^{CD}	32.75^{CD}	36.73^{B}	13.66^{B}
06/03/18	24.50^{C}	23.06^{B}	70.81^{B}	48.56^{C}	28.13^{B}	10.00^{C}
09/03/18	3.25^{E}	35.60^{A}	90.75^{A}	130.25^{A}	5.13^{E}	3.13^{EF}
12/03/18	--	14.66^{C}	56.68^{C}	79.50^{B}	--	--
15/03/18	--	10.66^{D}	33.81^{EF}	23.50^{DEF}	--	--
18/03/18	--	3.80^{F}	12.87^{G}	8.38^{FGH}	--	--
21/03/18	--	--	5.69^{G}	2.80^{H}	--	--
LSD Value	5.56	2.12	11.97	16	4.19	1.94

The rapeseed crop as perimeter crop was infested by two major aphid species, cabbage aphid, *B. brassicae* and green peach aphid, *M. persicae*. The infestation of *B. brassicae* was recorded in the third week of February and after increasing trend with some fluctuation reached its peak level of 90.75/tiller in the second week of March. A steady decline was seen afterwards and the mean population reached to its lowest seasonal level of 5.69/tiller.

The incidence of *M. persicae* on rapeseed started in the second week of February, with a population density of 6.50/tiller.

The population keep on increasing at a variable increase rate and reached a peak seasonal population density of 130/tiller in the second week of March. A steady decline was seen afterwards and lowest population was recorded in the third week of March (Table 1).

The share of infestation in wheat protected by rapeseed as a perimeter crop, by *R. padi* and *M. persicae* remained 59 and 41%, respectively, whereas the total share of infestation in rapeseed by *B. brassicae* and *M. persicae* remained 52 and 48%, respectively (Fig. 1).

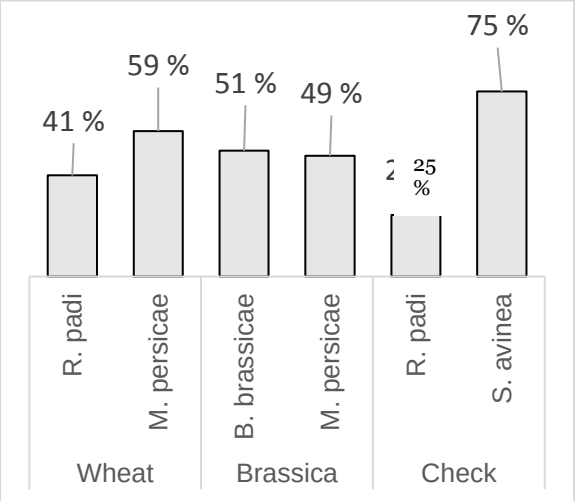

Fig. 1. Percentage share of aphid infestation in wheat with or without rapeseed as a perimeter crop

The infestation level of the aphids was also influenced by the environmental factors such as temperature and relative humidity. The data revealed that the temperature range of 20-25°C was optimum for the population build-up of aphids such as *R. padi, B. brassicae and M. persicae* in both wheat and rapeseed (Fig. 2, 3).

The relative humidity range of 50-80% corresponded to the peak aphid population for all the aforementioned aphid species (Fig.4, 5).

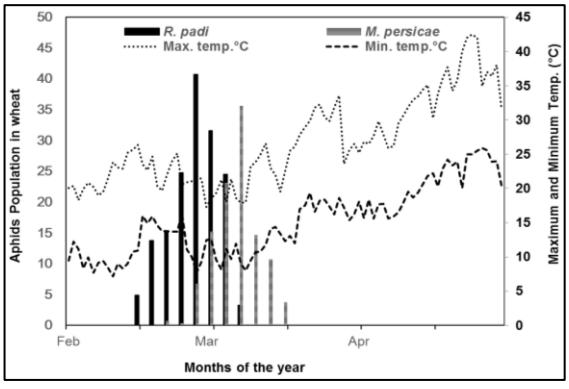

Fig. 2. Incidence of aphids on wheat crop in comparison with minimum and maximum temperatures.

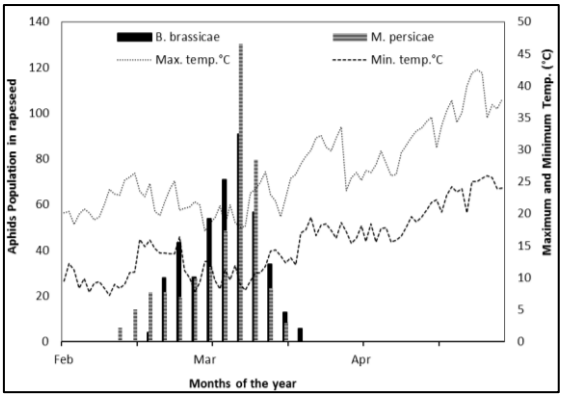

Fig. 3. Incidence of aphids on rapeseed crop in comparison with minimum and maximum temperatures.

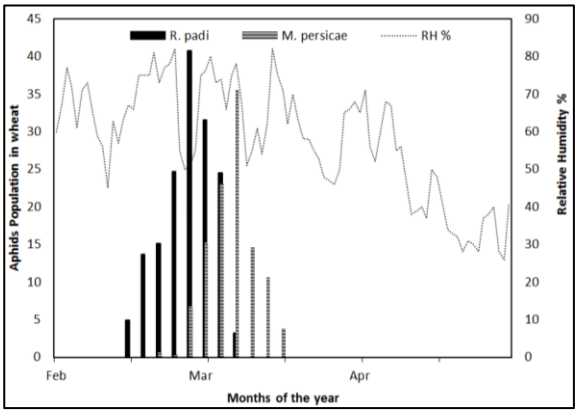

Fig. 4. Incidence of aphids on wheat crop in comparison with relative humidity.

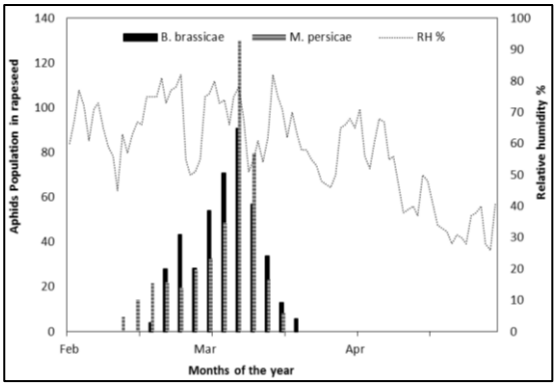

Fig. 5. Incidence of aphids on rapeseed crop in comparison with relative humidity.

Discussion

In Pakistan wheat is attacked by a number of aphid species, namely, *Rhopalosiphum padi*, *Sitobion avenae*, *Schizaphis graminum* (Shah *et al.,* 2006) and *Myzus persicae* (Mushtaq *et al.,* 2013).

In an investigation *M. persicae* was found the most abundant aphid with 34% infestation followed by *B. brassicae* with 33% infestation (Mushtaq *et al.,* 2013). In the present studies, we recorded *R. padi* and *M. persicae* on wheat, whereas the incidence of *B. brassicae* and *M. persicae* on rape seed which is in partial and full agreement with the earlier researchers respectively.

In our studies the incidence of aphids started in February which is in agreement with (Muhammad *et al.,* 2013; Pervez & Ali, 2000). Our data further revealed that the peak population of aphids, *Rhopalosiphum padi, B. brassicae* and *M. persicae* in wheat and rapeseed attained peak level in March which is in complete agreement with (Abbas *et al.,* 2014; Muhammad *et al.,* 2013; Akhter *et al.,* 2010; Wains *et al.,* 2010) who also recorded peak aphid population in the month of March. The decline in aphid population was observed in the second week of March which is in agreement with (Muhammad *et al.,* 2013; Khan *et al.,* 2012; Tabassum *et al.,* 2012).

We also noticed that population of *R. padi* in wheat with rapeseed as a perimeter crop remained comparatively low. This low population may have been influenced by the presence of natural enemies encouraged by the availability of floral resources of perimeter crop which provide nectars and pollens for better fitness of natural enemies (Landis *et al.,* 2000; Irvin and Hoddle, 2007). In addition, *Sitobian avenae* was not recorded in the wheat-oil seed rape. These results are in total agreement with Nassab *et al.,* 2013. However, it was also noticed that population of *M. persicae* also developed in the wheat crop compared to the check where the negligible aphid population was noticed. The presence of *M. persicae* may have shifted from the heavily infested perimeter crop.

Temperature and humidity are other important factors which affect the population dynamics of aphids. In the current study aphid population started to decline in the second week of March and reached negligible number or disappeared from the wheat field. Similar to our studies (Khan *et al.,* 2012) reported a downward trend in aphid population with an increase in temperature and maturity of wheat crop.

Conclusion

After analysis of the data we reached the conclusion that rapeseed perimeter crop kept population of *R. padi* comparatively low and barred S*itobian avenae* from the field, however, at the same time it also provided *M. persicae* an opportunity to shift to wheat as an alternate host which was not noticed in check.

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Conflict of interest

The authors declare no conflict of interest.

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