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Wheat Crop Yield Losses Caused by the Aphids Infestation

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Abstract

Present study was planned to determine the yield loss in wheat crop at different dates of observation for the population of aphids. The wheat cultivar BK-2002 was sown at Arid Zone Research Institute, Bhakkar. For two different treatments viz. sprayed and un-sprayed wheat crop was compared, sprayed crop was observed with minimum aphid's population whereas un-sprayed appeared comparatively susceptible with maximum population of aphids. Thiamethoxam (Actara®) was used as insecticide for sprayed treatment @ 25 gm/acre as recommended commercially. Last week of February was found to be very favourable for aphids in wheat fields in the study area. Third week of February was found to be the most suitable period for the bio-control agents i.e. *Coccinellids* in wheat crop. Positive correlation was found to exist between the population of aphids and *Coccinellids* among different wheat cultivars.

Keywords: Aphids; Wheat crop; Yield loss

Introduction

Wheat (*Triticum aestivum* L.) is a major crop with largest area under cultivation in Pakistan and plays a significant role in economic stability of the country [1]. Low yield of wheat per hectare in Pakistan compared to the other advanced countries is due to several abiotic and biotic factors, such as traditional methods of cultivation, varieties, lack of irrigation facilities, barani areas, soil fertility and incidence of insect pests and diseases.

Although many insect pests attack wheat (*Triticum aestivum* L.) in Pakistan, severe damage is caused by aphids. Aphids cause yield losses either directly (35-40%) by sucking the sap of the plants or indirectly (20-80%) by transmitting viral and fungal diseases [2]. Population density of aphids also depends on the abiotic factors [3-5]. During spring season (February-March) aphid population increases, at the same time biocontrol agents like *coccinellids* also increase as natural check on this pest [6].

Several control methods have been evolved for the control of aphids. These include cultural, physical, mechanical, biological, chemical and host plant resistance. Mostly, the aphid populations are maintained below the economic injury level by combination of naturally occurring population regulating factors. But sometimes, the aphids can be extremely injurious if present in large number and chemicals have to be used for control [7].

The wheat crop is generally infested with aphids during the growth stages when both the adults and nymphs take a heavy toll by sucking cell sap which reduces the vitality of the plants. The infested leaves turn pale, wilt and wear a silky appearance. Some species also have toxins in their saliva and dense infestation may kill young shoots. Honey dew excretion is often prolific and sooty moulds usually accompany aphids infestation which eventually affects the rate of photosynthesis in plants. The poor yield of wheat crop is mainly attributed to its instability to aphids attack. The aphids are considered as serious pest of wheat crop. They can multiply very rapidly under favourable conditions on leaves, stems and inflorescence. The infestation causes severe distortion of leaves and inflorescence, and can significantly decrease the yield through direct feeding. Decline in the yield in wheat crop is attributed to several abiotic factors, traditional methods of cultivation, low yielding varieties, lack of proper irrigation facilities in most of the areas, relatively low level of soil fertility and a higher incidence of insect pests and diseases. The present study was conducted to evaluate the yield losses in wheat crop due to the infestation of aphids. The investigations were projected to manage this serious pest and to boost up the wheat production keeping in view the quality and quantity of the production.

Materials and Methods

Present experiment was performed at Arid Zone Research Institute (AZRI), Bhakkar, Pakistan during 2004-05 to see yield losses in wheat crop infested by green aphid. The data of aphids and its yield losses was recorded during the whole experimental period (from January 2005 to April 2005). The wheat cultivar BK-2002 obtained from Punjab Seed Corporation Bhakkar was used as cultivar. The crop was sown in lines on 15th of November, 2004. Two treatments viz. sprayed and un-sprayed were distributed in 16 plots, 8 for each, the plot size was 2 m^2. Thiamethoxam (Actara®) was used as insecticide for sprayed treatment @ 25 gm/acre as recommended commercially. Polyethylene sheet was hanged at the height of 4 ft between treatments, the drift of aphid population from sprayed to unsprayed plots was prevented. The experiment was replicated four times by using Complete Randomized Block Design. Treatment plan is given in the Figure 1.

Data was collected after every ten days from 01-01-2005 to 15-04-2005. During each sampling date, five wheat plants from each plot were randomly selected and the number of aphids per tiller of each plant was counted. At harvest, the yield of both sprayed and unsprayed plots was compared to assess yield losses. To see the grain weight of

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sprayed and unsprayed plots, 1000 grains of every plot were counted and their weights were compared. Data regarding abiotic factors (RH% and °C) was recorded from observatory of AZRI, Bhakkar. ANOVA was made to compare the yield losses and thousand grain weight losses, after counting percentage yield losses (LSD P ≤ 0.05). Minitab 13.3, a statistical software package was used for statistical analyses.

Results

First detection of aphids on the wheat crop was observed on 11th of January 2005 (Table 1); at this time, the population was 0.18 aphid/plant, afterwards a gradual increase in the population was observed that reached to its peak in the mid of March (51.55 aphid/plant). After mid of March, the population started declining and 1.56 aphid/plant were observed in the mid of April and gradually no aphids were seen in the wheat fields. The aphid infestation was scattered on leaves, spikes and in mid of March also observed on stem.

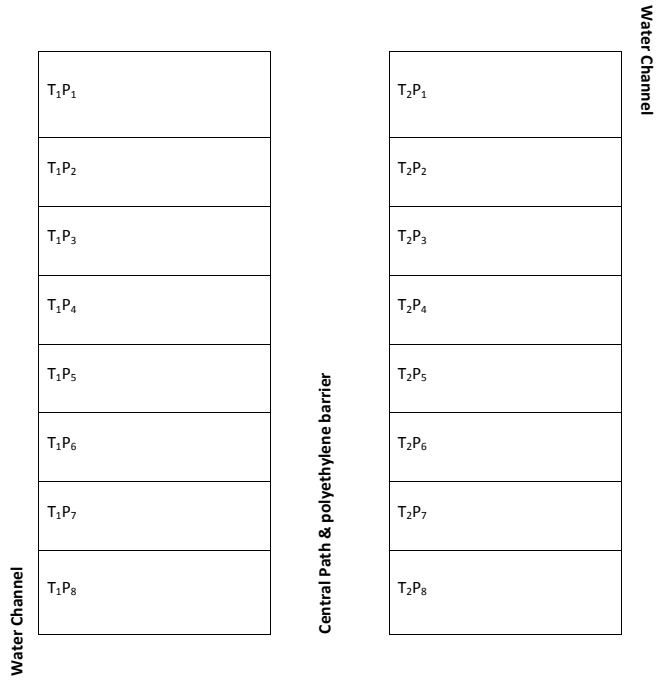

Figure 1: Sowing plan for treatments in the study area.

Dates		Population/Plant
1.	01/01/2005	0.00
2.	11/01/2005	0.18
3.	21/01/2005	0.26
4.	31/01/2005	0.52
5.	11/02/2005	1.57
6.	21/02/2005	8.64
7.	04/03/2005	39.67
8.	15/03/2005	51.55
9.	26/03/2005	21.74
10.	05/04/2005	11.34
11.	15/04/2005	1.56

Table 1: Population Dynamics of Wheat Aphids.

Effect of temperature and relative humidity on aphid population dynamics

Aphid infestation started in 2nd week of January mostly on the leaves. At this time, the relative humidity was 72% and the temperature ranged from 17.5°C to 8.5°C, maximum and minimum respectively. Up to the end of the February, the increase in the population was gradually slow while a slight fluctuation in the relative humidity and temperature were recorded. Sharp increase of aphid population in 1st week of March was recorded which remained till mid of March (Table 1). At this time, 71% relative humidity, 26.5°C maximum temperature and 15°C minimum temperature were recorded. Afterwards, aphids population started declining and on 26th of March 2005, 21.74 aphids/plant were recorded (Figure 2). During the month of April, the RH ranged from 73% to 88% and temperature from 26.5°C to 32.0°C maximum and from 16.5°C to 13.0°C minimum respectively. RH reached to 74% and minimum temperature also increased in the mid of April and aphid population dropped down to 1.56 aphids/plant while at the end of April, no counts were observed in field.

Yield losses assessment and thousand-grain weight comparison

The results showed that the yield per plot ranged from 17.40 kg to 24.10 kg with an average of 19.79 kg in treated plots as compared to 16.00 kg to 24.00 kg with an average of 18.93 kg in untreated plots (Table 2). Further results revealed that 4.57% more yield was recorded in plots where thiamethoxam (Actara®) was sprayed. However, the statistical analysis shows that the means are not significantly different

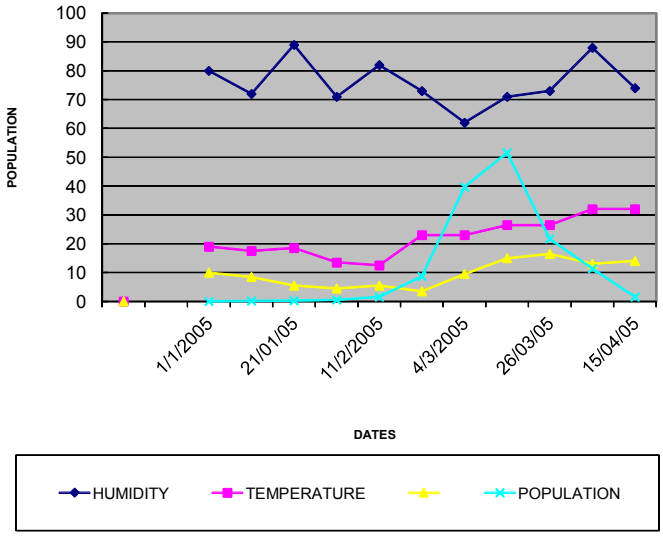

Figure 2: The Effect of Relative Humidity and Temperature on the Population Dynamics of wheat Aphids.

Source	Degree of Freedom	Mean Squares for Yield loss assessment (Kg/plot)	Mean Squares for 1000-grain weight Comparison
Replications	3	21.226	30.216
Treatments	1	1.496ns	182.787**
Error	3	0.454	106.267
LSD		1.517	23.198

P ≤ 0.05

Table 3: Analysis of Variance for Yield Losses Assessment and 1000-Grain Weight.

	Treatments	Range	Average	% differences	LSD
Yield losses assessment (kg/plot)	T1	17.4-24.1	19.79	4.57	1.517
	T2	16.0-24.0	18.93		
Thousand Grain Weight Comparison	T1	329.02-377.90	339.52	5.92	23.198
	T2	320.01-336.32	329.96		

$P \leq 0.05$ T_1 = Sprayed T_2 = Unsprayed

Table 2: Yield Losses Assessment.

for each treatment. The 1000-grain weight per plot ranged from 329.00 to 377.90 with an average of 339.52 gm in treated plots as compared to 320.01 to 336.32 with an average of 329.96 gm in untreated plots, 5.92% increase occurred in 1000-grain weight in plot where insecticide was sprayed (Table 3).

Discussion

The aphids infestation started in the mid of January and gradually increased during the vegetative growth of wheat crop. The population reached to its peak in the mid of March during the heading stage of the wheat and gradually declined when the crop reached to maturity with 1.56 aphids/plant in the mid of April. Similar results were shown by Karimullah and Ahmad [8]; they observed that aphids infestation started in the 1st week of February and peaked in the latter half of March with fluctuations in population size thereafter up to mid of April. Our results are in conformity with Xiong [9], and Nawaz [10]; who observed that population of aphids in the field increased with the development of the wheat and peaked at the heading stage.

Graphical presentation (Figure 2) shows that the aphid infestation started in the 4th week of January up to the mid of February, the increase in the population remained very slow, where maximum temperature range was 12.5–19°C and the minimum temperature ranged from 3.5-8.5°C and the RH ranged 72-82%. In start of 3rd week of February, the gradual increase in temperature occurred and sharp increase in population was recorded up to the mid of March. The temperature in which the population increased was in the range of 9.5-26.5°C and RH 62-71% was recorded. After the mid of March, the temperature and RH again increased but a sharp decrease in the aphid population was recorded. After the mid of April, no aphids were observed in the field. Our results agreed with Yang [11] who reported that at low temperature, the developmental period was delayed, whereas high temperature decreases the reproductive capacity. The author also concluded that a temperature of 25°C is favorable for population growth. In the present experiment, the highest population was recorded on 15th March that was 51.55 aphids/plant at 26.5°C. Similarly, Kostyukovskii and Kushneuk [12] observed that the number of aphids increased at 15-18°C during earing and flowering of wheat. The highest population density was recorded during grain development and initiation of wax ripening. The decline in the aphid population could also be the result of the crop maturity as stated by Riedell [13]; that infestation of aphids on wheat crop is abundant during the heading and flowering stages and is reduced during the maturity stage of the crop. In the present study, reduction of 4.57% in the yield and 5.92% in the thousand-grain weight was recorded due to aphid infestation. Here, our results agree with Khan [14], while Gair et al. [15] and Oakley et al. [16] observed a reduction in yield and thousand-grain weight as 12% and 39% respectively which are more as in our study. Since the experimental plots were normally fertilized with NPK, the non-significant yield losses could be due to proper nutrition of the crop, as stated by Riedell [13].

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