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SURVEILLANCE AND EVALUATION OF CLIMATIC FACTORS ON VARIETAL SCREENING AGAINST APHID POPULATION IN WHEAT

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ABSTRACT

Aphids, as notorious pests in wheat cultivation, pose a significant threat to crop yield and quality. The dynamics of aphid populations in wheat fields are intricately linked to various climatic factors, making it crucial to understand and manipulate these interactions for effective pest management. The study was conducted over growing seasons 2022-23, involving the systematic collection of data from wheat fields exposed to varying climatic conditions. These data were then analyzed to investigate the relationship between climatic factors, such as temperature, humidity, and rainfall, and aphid infestations. Additionally, varietal screening was performed to identify wheat cultivars with varying levels of resistance or susceptibility to aphids. The survey findings indicate that the aphid population on various wheat varieties exhibited a range of infestation levels. The findings of this study reveal the complex interplay between climatic factors and aphid population dynamics in wheat fields. Aphid population was maximum (1382.39/trap/week), when maximum and minimum temperature was 28.02 °C and 14.0 °C, respectively with relative humidity 80.83% and 49.62% at 8am and 5pm, respectively. However, for varietal screening of 14 wheat varieties and advance lines, the lowest aphid population was recorded on wheat varieties/lines viz., Arooj-22(4.311), HYT-74(4.378), Dilkash-21(4.433), V-19308(4.778) and HYT-76 (4.789), and these were statistically at par with each other. While maximum aphid population was observed on V-19532 (12.711) followed by V-19317(11.433), V-19559 (10.711), V-19317 (11.433), V-19347 (10.244), Akbar-19 (7.656), and Subhani-21 (6.044). Overall, this manuscript contributes to the body of knowledge on integrated pest management strategies in wheat farming, emphasizing the importance of both surveillance and varietal screening in mitigating aphid-related threats in the face of changing climate patterns.

Keywords: Aphid; environmental factors; Infestation; wheat

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a fundamental component of Pakistan's dietary consumption, constituting 10 percent of the agricultural value added and contributing over two percent to the nation's GDP. In the 2017-18 period, wheat was cultivated on more than nine million hectares, yielding 26.3 million tons of grains, with an average productivity of 2,893 kg per hectare. Notably, the average wheat yield falls below that of neighboring countries, such as India at 2,962 kg per hectare and Bangladesh at 4,357 kg per hectare (FAO, 2020). The subpar wheat yield in Pakistan can be attributed to various factors, including issues related to wheat varieties (Khan, Khan, Afzal, & Iqbal, 2012), suboptimal sowing timings, inadequate provision of essential inputs like water and fertilizers (Kibe, Singh, & Kalra, 2006), weed infestations (Memon, Bhatti, Khalid, Mallah, & Ahmed, 2013), variable rainfall patterns (Aheer, Ali, & Ahmad, 2008), diseases (Ahmed, Riaz, Zakria, &

Naz, 2013; Ali *et al.*, 2014), and insect pests (Aslam, Razaq, Akhter, Faheem, & Ahmad, 2005). Notably, among these insect pests, wheat aphids are progressively becoming a consistent threat in Pakistan.

Aphids, tiny insects that feed on plant sap, are significant pests in various crops, and their presence is greatly influenced by weather-related factors such as temperature, relative humidity, rainfall, wind speed, and sunlight duration. These pests have adapted to specific environmental and geographical conditions, particularly those related to the weather prevailing in the regions where crops are cultivated. When implementing environmentally friendly control methods, such as biological control, it is essential to have a thorough understanding of how their population dynamics are affected by the aforementioned weather parameters. This knowledge is of utmost importance for effective pest management (Ma &

Bechinski, 2009; Wei, Zhao, Liu, & Wu, 2009). Creating forecasting models or expert systems that incorporate weather parameters as essential variables, aiming to assess the influence of weather alongside other factors, is a complex endeavor. Incorporating numerous weather parameters as they relate to population changes presents a formidable challenge, and mathematical models designed to address this in the context of catastrophe theory have yet to be developed (Zhao et al., 2005; Rashid et al., 2009).

In a study conducted by Tomar (2010), the focus was on examining both the direct and indirect impacts of weather parameters on the population dynamics of cotton aphids. The findings indicated a positive correlation between temperature and relative humidity with aphid population growth, while rainfall was observed to exert a significant direct negative effect. Additionally, it was noted that certain parameters exhibited indirect effects on one another, although this was not always the case. In another research study, it was found that the influence of density-independent weather factors had a relatively minor impact when compared to the density-dependent mechanisms governing the growth of buckthorn, green peach, and potato aphids (Alyokhin et al., 2005).

MATERIALS AND METHODS

Survey of aphid population on wheat crop in different ecological zones of the Punjab: The survey was conducted in different climatic zones of the Punjab (Nankana, Sheikhpura, Lahore, Kasur and Faisalabad) to record aphid infestation on seven different wheat varieties i.e., Faisalabad-08, Ujala-16, Anaj-17, Akbar-19, Dilkash-21, Subhani-21 and MH-21). Aphid infestation was recorded on an average from 10 spots in each district on 28-02-2023, 02-03-2023, 20-03-2023, 22-03-2023 and 30-03-2023. Aphid population was recorded per tiller basis by selecting 10 tillers randomly from each variety/ line on each spot. The aphids were dislodged on white paper sheet with the help of camel hair brush and then counted.

Effect of different climatic factors on wheat aphid population: The experimental trial was conducted at the research area of wheat Research Institute, Faisalabad during 2022-23. Three Moericke Yellow water tray traps were installed at 60m apart from each other in three different fields of wheat crop at the height of 75cm from the ground level. Daily alate aphid population was recorded from these yellow water tray traps and later on data was transformed into weekly basis. The weekly counts of trapped alate aphids were correlated with a-biotic factors.

Varietal screening of wheat varieties/ advance lines against aphid: The trial was conducted at the research area of Wheat Research Institute, Faisalabad

during 2022-23. Fourteen (14) wheat varieties/Advanced Lines i.e, V1(Akbar-19), V2(Subhani-21), V3(Dilkash-21), V4(Arooj-22), V5(19347), V6(HYT-74), V7(19308), V8(HYT-76), V9(HYT-100-47), V10(20337), V11(19532), V12(20330), V13(19559), V14(19317) were screened out against aphid attack. The data of aphid population was recorded at 10 days interval during the month of February-March, 2023 from 10 randomly selected tillers of each line/ variety. The aphids were dislodged on white paper sheet with the help of camel hair brush and then counted.

Screening of wheat germplasm against aphids: Trial was conducted in the research area of Wheat Research Institute, Faisalabad. Three hundred and seventy five (375) wheat varieties/ lines of crossing block 2022-23 were screened out against aphid attack. The data of aphid population was recorded at 10 days interval during the month of February-March, 2023 from 10 randomly selected tillers of each variety/ line. The aphids were dislodged on white paper sheet with the help of camel hair brush and then counted.

RESULTS AND DISCUSSION

Survey of aphid population on wheat crop in different ecological zones of the Punjab: The survey revealed that aphid population on different wheat varieties ranged from 8.7-10.7, 7.2-11.3, 7.9-12.2, 7.7-9.2, 7.3-11.4, 7.9-11.5 and 8.8-10.6 aphids/tiller on Faisalabad-08, Ujala-16, Anaj-17, Akbar-19, Dilkash-21, Subhani-21 and MH-21, respectively. Aphid population was recorded more on Anaj-17 in Lahore and Sheikhpura districts and low on Ujala-16 and Dilkash-21 in Nankana, respectively. However on the whole wheat aphids population remained below economic threshold level (25-30 aphids/tiller) throughout the crop season in the Punjab (Table 1).

Effect of different climatic factors on wheat aphid population: The results showed that aphid population was started trapping on yellow water tray traps during 1st week of January, 2023 (5.6/trap/week) and then gradually increased during subsequent weeks and peak of aphid population was observed during 2nd week of March (1382.39/trap/week). Aphid population was started to decrease during 1st week of April-2023 (11.98/trap/week) due to rise of temperature and maturity of crop. Aphid population was maximum when maximum and minimum temperature was 28.02 °C and 14.0 °C, respectively with relative humidity 80.83% and 49.62% at 8am and 5pm, respectively (Table 2). Aphid population showed positive and non-significant correlation with maximum and minimum temperature. While aphid population had positive and negative effect and non-significantly correlated with relative humidity at 8am and 5pm, respectively. Rainfall had negative effect and non-significantly correlated with aphid population (Table 3).

Table 1. Average aphid population on different wheat varieties in different ecological zones (districts) of the Punjab.

District	Date	Fsd-08	Ujala-16	Anaj-17	Akbar-19	Dilkash-21	Subhani-21	MH-21	Av.pop./Tiller
Nankana	28/02/2023	8.7	7.2	9.8	9.2	7.3	9.4	9.6	8.74
Sheikhupura	2/3/2023	9.6	11.3	12.1	7.9	10.1	8.9	8.9	9.83
Lahore	20/3/2023	10.7	9.4	12.2	9.0	9.1	9.9	8.8	9.87
Kasur	22/3/2023	8.7	10.1	7.9	8.9	11.4	7.9	8.9	9.11
Faisalabad	30//3/2023	9.9	7.8	8.8	7.7	10.3	11.5	10.6	9.51
Average pop./tiller	-	9.41	8.88	9.88	8.67	9.64	9.52	9.36	-

Table 2. Effect of environmental factors on average wheat aphid population/trap/week.

Months / Year	Temperature °C		Humidity (%)		Rainfall/week	Av. Aphid population.
	Max °C	Min °C	8 am	5 pm	(mm)	/Trap/week
January, 2023						
1 st week	15.89	4.2	91.0	68.28	0	5.6
2 nd week	17.5	5.2	85.5	51.87	0	7.96
3 rd Month week	19.63	5.07	78.5	44.5	0	10.93
4 th week	20.31	4.71	84.37	52.5	30.6	15.27
February, 2023						
1 st week	21.86	8.36	79.43	41.0	0	45.31
2 nd week	23.25	8.96	66.43	36.86	0	133.28
3 rd week	27.86	11.9	82.0	48.43	0	444.86
4 th week	28.67	13.58	81.28	44.0	6.4	391.77
March, 2023						
1 st week	22.48	14.5	83.14	53.57	0	717.25
2 nd week	28.02	14.0	80.83	49.62	0	1382.39
3 rd week	24.34	15.94	81.62	63.5	15.8	414.29
4 th week	26.12	14.94	84.37	59.25	39.4	65.4
April, 2023						
1 st week	58	15.78	73.0	53.86	37.4	11.98

Table 3. Correlation of wheat aphid with climatic factors.

Aphid Population	Max °C	Min °C	R.H (%)	R.H (%)	Rainfall
			8.0 am	5.0 pm	(mm)
	0.0396	0.5133	0.0264	-0.0473	-0.3173
P Value	0.8977	0.0728	0.9318	0.8781	0.2908

Varietal screening of wheat varieties/ advance lines against aphid:

The results mentioned in table 4 of the three different dates showed the lowest aphid population was recorded on wheat varieties/lines viz., Arooj-22(4.311), HYT-74(4.378), Dilkash-21(4.433), V-19308(4.778) and HYT-76 (4.789), and these were statistically at par with each other. While maximum aphid population was observed on V-19532 (12.711) followed by V-19317 (11.433), V-19559 (10.711), V-19317 (11.433), V-19347 (10.244), Akbar-19 (7.656), and Subhani-21 (6.044) (Table 4). The above mentioned wheat varieties/lines were statistically different with each other regarding aphids population/tiller. However all the above mentioned varieties/lines behaved statistically different among each other.

Our study supports the earlier research conducted by scientists, affirming that Punjab 2011 exhibits resistance against aphids, resulting in lower

populations compared to other wheat varieties. It is noteworthy that, despite the use of different wheat varieties alongside Punjab 2011 (Painter, 1951).

Screening of wheat germplasm against aphids: The result showed that the aphid population ranged from 3.5 to 17 aphid/tiller. Out of three hundred and seventy five wheat varieties/ advanced lines, Only 154 varieties/ lines had up to 5 aphids per tiller and they showed tolerance/resistance against aphids attack (Table 5). These lines/ varieties from crossing Block 2022-2023 were had the lowest aphid population per tiller than others. The above mentioned varieties/lines were proposed for breeding program of variety development process. While the rest of the varieties / lines in Crossing Block 2022-2023 had more aphids per tiller and they were not recommended for using in crossing program.

Table 4. Average aphid population per tiller on different wheat varieties/lines.

Sr. No.	Varieties	15-02-2023	24-02-2023	08-03-2023	Av. Aphid pop./tiller
1	Akbar-19	7.8	8.3	6.867	7.656 D
2	Subhani-21	5.367	7.467	5.3	6.044 E
3	Dilkash-21	4.867	4.233	4.2	4.433 F
4	Arooj-22	4.8	4.533	3.6	4.311 F
5	V5-19347	8.833	13.0	8.9	10.244 C
6	HYT-74	4.333	4.567	4.233	4.378 F
7	V7-19308	4.5	5.0	4.833	4.778 F
8	HYT-76	5.233	5.3	3.833	4.789 F
9	HYT-100-47	8.133	9.3	4.8	7.411 D
10	V10-20337	13.533	14.133	6.867	11.511 B
11	V11-19532	15.933	13.3	8.9	12.711 A
12	V12-20330	10.167	13.2	8.633	10.667 BC
13	V13-19559	9.9	13.167	9.067	10.711 BC
14	V14-19317	11.4	13.4	9.5	11.433 B
Lsd value at 0.05%		1.991			

Table 5. Average aphid population/tiller on wheat germplasm.

Material	Total Entries	Average Aphid population (range) / Tiller on each variety/line (Mean values)			
		0-05	6-10	11-15	Above 16
Wheat	375				
		154	207	13	01

This investigation corroborates prior research conducted by Jarošík, Honěk, and Tichopad (2003), affirming the findings that *R. padi* and *S. avenae* are the most destructive species affecting winter wheat. According to Jarošík *et al.* (2003), *R. padi* primarily feeds on leaves and ears, while *S. avenae* infests ears. Their study highlighted the dominance of *R. padi* from mid-February to mid-March, with *S. graminum* prevailing in March and *S. avenae* becoming dominant from mid-March to the first week of April. Additionally, the current study aligns with the observations of Shahzad *et al.* (2013), who identified *R. padi* and *S. graminum* on wheat crops. Shahzad *et al.* (2013) noted the dominance of *S. graminum* over *R. padi* in the last week of March. These consistent findings contribute to a comprehensive understanding of the temporal dynamics and prevalence of aphid species on winter wheat, emphasizing the significance of specific time frames in which particular species exhibit heightened activity.

Continuous monitoring of temperature, humidity, and wind patterns is crucial for understanding the dynamic interplay between climate and aphid behavior. Utilizing advanced technologies such as remote sensing and weather stations aids in collecting real-time data, enabling researchers to identify correlations between climatic conditions and aphid population dynamics. Varietal screening plays a key role, focusing on the identification of wheat varieties that exhibit resistance or tolerance to aphids. Field trials across diverse regions help assess varietal performance under varying climatic circumstances, providing insights into the effectiveness of different wheat cultivars. The integration of data from multiple

sources facilitates a comprehensive understanding, allowing for the development of sustainable, integrated pest management approaches that consider genetic factors, climate change implications, and the broader goal of fostering resilient agricultural practices.

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