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Effect of biotic and abiotic factors on the population dynamics of wheat aphids

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Abstract
Population dynamics of wheat aphids was observed on yellow water tray traps along the wheat field and also on wheat crop by using randomized completely block design on Entomological research area of Ayub agricultural research institute Faisalabad, Pakistan. In field also lady beetles, syrhpid fly and chrysopa were recorded. Experiment started from 23 November 2015 and end of data recorded on 6 March 2016 at harvesting stage. Population dynamics of aphids on yellow water tray traps showed strong positive ($r \leq 0.51$) relationship with temperature. While relative humidity having negative non-significant ($r \leq -0.2$) relationship with wheat aphids population. In wheat crop, aphids population showed positive and significant relationship ($r \geq 0.6$) with temperature and wind velocity while relative humidity showed negative significant relationship ($r \geq -0.8$). Soil temperature, and sunshine hours showed positive non-significant relationship ($r \leq 0.5$) with wheat aphids population. All biotic factors showed negative non-significant relationship ($r \leq -0.5$) with wheat aphids population.

Keywords: Wheat Aphids, Biotic factors, Abiotic factors, Population dynamics

1. Introduction
Aphids belong to order “Homoptera” and family “Aphididae” and also known as commonly plant lice and green flies [25]. Wheat aphids is a notorious and polyphagous pest feed on more than 60 plant species including barley, sorgum, corn and also on wheat [8]. Aphids having sucking type mouth parts and suck the cell sap from different horticultural, agronomical crops. Also inject toxic saliva into the plants and secrete honey dew that favors the growth of sooty mold fungus. This fungus covers the leaves and hinders the process of photosynthesis ultimately cause low yield [25]. In Pakistan from last few years their population increases due to climatic changes and gained the status of regular pest of different crops [4]. Aphid is very destructive Aheer *et al*., has been reported that can cause loss 2.20% in grain yield [4] while Kieckhefer *et al*., reported that 15 aphids per plant cause losses 30-40% [15]. Damage pattern of insect pests in crop depend upon fluctuation of population, if population increases then ultimately damage more and vice versa. This fluctuation mostly depends upon environmental factors like temperature, relative humidity, wind velocity etc [14]. A better understanding between environmental factors and insect pest relationship help them to manage the pest population before going to economic injury level and cause increase in yield [1]. Just like the infestation of mustard aphid is more on cloudy days [18]. While natural enemies also play a key role to manage the pest population below ETL level so, their augmentation and conservation having much importance in integrated pest management techniques [6, 19]. Many predators prey on the aphid species but most important is coccinellids and syrphid flies. Lady beetles mostly feed on soft bodied insects [21, 16] and aphids but females were more efficient [11]. Ali and Parvez, reported that these two predators shows positive correlation with mustard aphid *Lipaphis erysimi* (Kalt.) [7]. Chemical control is the most extensive, economical and easy method used to control the insect pest, which have adverse impact on beneficial insects like predators of insect pests [23]. Hence current study was carried out to check the impact of abiotic and biotic factors to aphids. So aphids were observed for soil temperature, wind velocity, sunshine, relative humidity and rain fall in terms of abiotic factors. While for biotic factors Lady bird beetle, syrphid flies and chysopa were observed against aphids.

2. Materials and Methods
Two types of experiment done side by side one on wheat crop and second on yellow water tray trap. Four yellow water tray traps installed along the wheat fields in entomological research

area of Ayub Agriculture Research Institute Faisalabad, Pakistan. In these yellow water tray traps aphid population recorded on daily basis. Glaxy 2013 variety was sown in lines by hand pulled drill on November 23, 2015 in plots by using Randomized Complete Block Design with three replicates. All the agronomical practices were applied uniformly in each replicates. Aphid population on wheat crop was recorded on weekly intervals by per tiller basis. Also count the syrphid fly, chrysopa and lady beetles per five plants from wheat crop till harvesting stage 16 march 2016. Meteorological data included maximum temperature, minimum temperature, relative humidity at 8am, relative humidity at 5pm, rain fall, sun shine hours and soil temperature. All these meteorological data were get from agronomy department Ayub Agriculture Research Institute Faisalabad.

2.1 Statistical analysis
At the end of the experiments data were analyzed by regression analysis and correlation analysis with the Analysis Tool Pak to find out the possible relationship between wheat aphids and their biotic and abiotic factors.

3. Results
Data revealed that (Fig-1) from the last week of December population of wheat aphid was observed in yellow water tray traps. Then significant gradual increases were observed with passage of time, i.e whole month of January and till first week of February. After first week of February aphid population fluctuation showed significant increased.

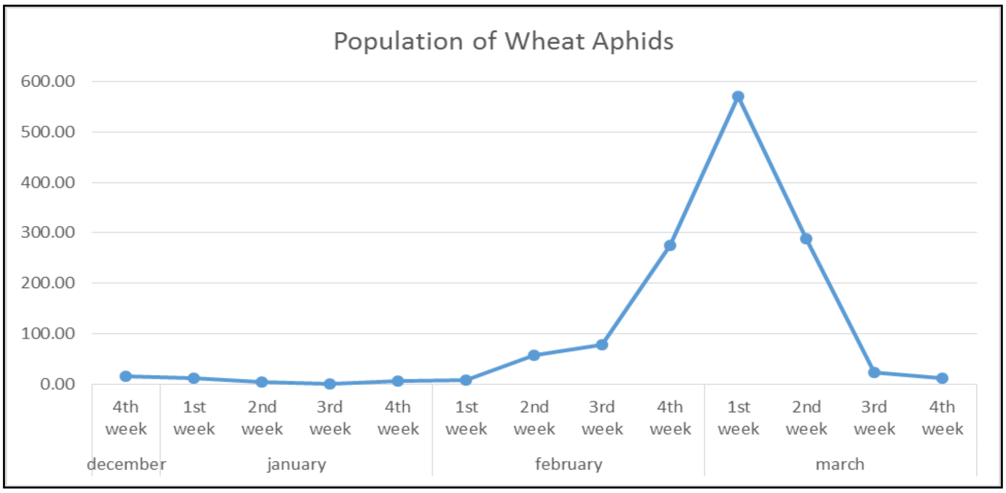

Fig-1: Wheat aphid's population on yellow water tray trap.

From the second week of February to third week of March peak period of population of wheat aphids was observed. Because during that time climatic conditions (mean maximum temperature in the month of February was 24.6 °C and in the month of March was 27.8 °C) favors the growth and development of aphid. Maximum aphid population (570.08 aphids per tray) was observed in first week of March after that again population of aphids sudden decline due to harvesting stage of wheat that become hard and not available for sucking cell sap (Fig.1).
Data (Fig.2) showed that same trend almost which was observed in yellow water tray traps. Peak periods started from second week of February to second week of March and maximum aphid (25 aphids per tiller) population was observed during last week of February. When peak period of aphid population was started then also predators of wheat aphids observed on wheat crop. Main predators that observed whole season was lady beetles, syrphid fly while chrysopa observed on last duration of peak period. Graph (Fig.2) clearly showed that when the predators populations increases then wheat aphid populations decreases this was also proved from regression analysis that showed that predators having negative non-significant relationship with aphids population (Table-2).

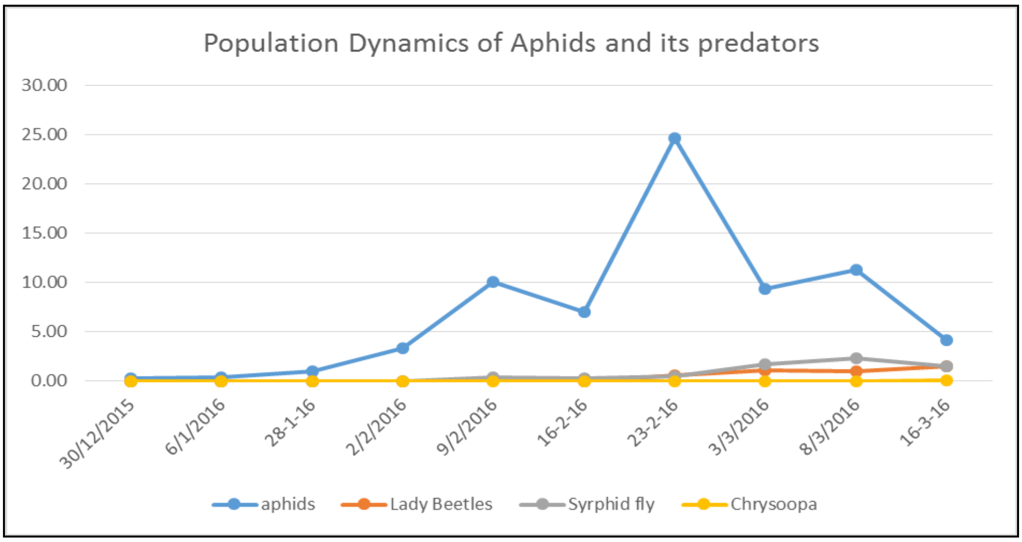

Fig 2: Wheat aphid's population, Lady Beetles, Syrphid fly and Chrysopa.

All biotic and abiotic factors affect the population dynamics of aphids during whole season. Population dynamics of yellow water tray traps showed significant positive relationship with maximum (R^2 =0.2) and minimum temperature (R^2 =0.3). While Relative Humidity (8am and 5pm) (R^2 =0.05, 0.004), Rain Fall (R^2 =4.09), wind velocity (8am) (R^2 =0.1) and Sunshine Hours (R^2 =0.007) showed non-significant positive relationship with yellow water tray wheat aphids population. But model 3, 4 showed that Relative Humidity (8am and 5pm) (R^2 =0.1, 0.2) having negative non-significant relationship with wheat aphids population (Table-1).

In wheat crop aphids population showed positive and significant relationship with Maximum Temperature (R^2=0.5) and wind velocity while (R^2=0.5) Relative Humidity at 8am showed (R^2=0.7) negative significant relationship. Relative Humidity at 5pm (R^2=0.4) showed negative non-significant relationship while Minimum Temperature (R^2=0.3), Soil Temperature (R^2=0.2), and Sunshine Hours (R^2=0.1) showed positive non-significant relationship with wheat aphid's population. All abiotic factors [(lady beetles (R^2=0.2), syrphid fly (R^2=0.2), chrysopa (R^2=0.4)] showed negative non-significant relationship with aphids population (Table-2).

Table 1: Correlation and Regression analysis of wheat aphid's population in yellow water tray traps with their abiotic factors.

Models	Parameters	Regression Equation	R Value	P Value
1	Maximum Temperature	y=-283.31+16.69938x	0.48	0.009
2	Minimum Temperature	y=-99.1266+21.10934x	0.51	0.006
3	Relative Humidity at 8am	y=540.1988-5.2465x	-0.2	0.45
4	Relative Humidity at 5pm	y=155.3348-0.94925x	-0.06	0.83
5	Rain Fall	y=103.4364+0.0787495x	0.006	0.98
6	Wind Velocity 8am	y=15.8609+85.58092x	0.34	0.25
7	Wind Velocity 5pm	y=-82.978+85.94725x	0.40	0.17
8	Soil Temperature	y=-431.527+30.39652x	0.5	0.05
9	Sunshine Hours	y=64.94469+6.749239x	0.08	0.77

Table 2: Correlation and Regression analysis of wheat aphid's population on wheat crop with their abiotic as well as abiotic factors.

Models	Parameters	Regression Equation	R Value	P Value
1	Maximum Temperature	y=-24.6519+1.246969x	0.69	0.02
2	Minimum Temperature	y=1.419055+0.602137x	0.36	0.3
3	Relative Humidity at 8am	y=54.0325-0.56986x	-0.84	0.002
4	Relative Humidity at 5pm	y=19.99661-0.27544x	-0.52	0.12
6	Wind Velocity 8am	y=3.132164+3.637427x	0.75	0.01
7	Wind Velocity 5pm	y=2.342029+2.661836x	0.63	0.05
8	Soil Temperature	y=-11.9767+1.100809x	0.42	0.22
9	Sunshine Hours	y=0.110928+1.068046x	0.49	0.14
10	Lady Beetles	y=15.63053-7.71919x	-0.5	0.19
11	Syrphid Fly	y=15.60125-5.09298x	-0.6	0.25
12	Chrysopa	y=11.26667-72.6667x	-0.9	0.45

4. Discussion

Planting dates having significant on wheat aphids attack on wheat crop. Early wheat sowing in November having low infestation as compared to late sowing [2]. Abiotic factors having much importance on development of aphid population [20], among this temperature is most important one affecting the reproduction rate, physiology of aphids [10] ultimately the population dynamics of wheat aphids [12]. During high temperature metabolism of insects increased so produce more generations and dispersed although their life cycle become short [26]. In 2010 reported that aphid having positive relationship with maximum and minimum temperature while negative association with relative humidity. Rain fall having positive but non-significant relationship with aphid population dynamics [24]. In 2001 sing found that during second week of January, 1999 peak population observed [22] while Hassan *et al.*, observed maximum aphid population during last week of February [13]. These results contradict with present findings due to climatic changes in all over the world also in Pakistan. Ahmed *et al.*, carried out experiments in Bahawalpur region and found that temperature and rainfall having positive and significant effect on aphid population dynamics in wheat crop while relative humidity having non-significant and negative association with aphid population [5]. Brosius *et al.*, found that predators of aphids having a great impact in lowering the aphid *(Aphis glycines)* population in soybean crop [9]. Kulkarni and Patel also found that predators of aphids having great impact on aphid's population and decrease the aphid population 30-80% [17].

5. Conclusion

From all abiotic factors maximum and minimum temperature and relative humidity having much greater impact on the population dynamics of wheat aphids population while remaining all factors also having non-significant impact. For biotic factors, Lady beetles; syrphid flies and chrysopa also having much greater impact on population dynamics of wheat aphids population so, if there population increases in the field timely by using trap crops or artificial releasing then we can manage the wheat aphid population without insecticide application or with reduced number of insecticide application.

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