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POPULATION DYNAMICS OF APHID PESTS OF WHEAT AND THEIR NATURAL ENEMIES

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ABSTRACT

Four aphid species (*Schizaphis graminum, Sitobion avenae, Rhopalosiphum padi* and *Diuraphis noxia*) were observed when the population dynamics of aphids in four wheat varieties were analysed. Maximum population abundance (104± 1.79 aphids/ plant) was observed during middle of March. *Rhopalosiphum padi* and *D. noxia* were predominant throughout (52.86.1± 0.21 and 56.10± 0.24 aphids/ plant, respectively). The variety ANAJ-2017 showed the least incidence (26.28± 0.27 aphids/ plant) being more resistant. Aphid parasitism was also more in ANAJ-2017 with the parasites *Aphidius ervi* (15.35± 0.13) and *Praon volucre* (12.45± 0.12). Abundance of predators (ladybird beetle, green lace wing, syrphid fly and spiders) was observed with the highly infested varieties UJALA-2016 and FSD-2008. With incidence of aphids, temperature showed positive correlation while relative humidity (RH) and rainfall did not show any significant effect. The yield varied significantly among the tested varieties and it was found positively correlated with aphid incidence with ANAJ-2017 exhibiting the maximum 1000 grain weight (55 g).

Key words: Wheat varieties, *Schizaphis graminum*, *Sitobion avenae*, *Rhopalosiphum padi*, *Diuraphis noxia*, predators, parasitoids, population dynamics, yield, grain weight

Wheat (*Triticum aestivum*) is considered as the staple food in many countries. Among 121 wheat-producing countries Pakistan is ranked 9th and 29th in area and yield, respectively. Numerous biotic and abiotic factors have an impact on wheat productivity. Several insect pests attack wheat at different stages of the crop, causing damage and eventually lowering the yield (Abbas et al., 2018). Aphids are sap sucking insects causing winding, yellowing and bending of leaves, lowering chlorophyll concentrations and eventually affecting productivity and profitability causing 35-40% yield loss (Ali et al., 2018; Zeb et al., 2020). They include *Schizaphis graminum, Sitobion avenae, Rhopalosiphum padi* and *Diuraphis noxia* (Zeb et al., 2016). Aphidicides are employed for aphid management in cereal crops, particularly wheat (Tanguy and Dedryver 2009; Kirkland et al., 2018). Insecticide resistance development has been reported which ultimately results in lower wheat production (Carvalho 2006; Pickett 2013; Foster et al., 2014). In addition, as increase in aphid infestation has been predicted due to climate change leading to negative impact on wheat production and ultimately affecting global economy (Simon Amma et al., 2021). Abiotic factors assume a huge function in population development, increment in their action, collaborations among host and irritation, and interspecific connections (Piyaratne et al., 2013). Increase in temperature shows escalation of aphid's population while relative humidity responsible for decreasing the population of aphids. Natural enemies assume a fundamental job in aphid control (Saeed et al., 2018). Furthermore, genotypes of wheat also impacts aphid density significantly (Zeb, 2016a; Hafeez et al., 2021). Considering the importance of wheat and aphid species current study has been planned for sustainable management of different aphid species. The experiments were conducted to assess the ecological and varietal implications on population dynamics of aphid species and their natural enemies. The correlation of aphid population was also assessed with abiotic factors (temperature, rainfall and humidity). Additionally, aphid infestation was correlated with different yield-related traits. Conclusively, the current outcomes would help to select the aphid resistant varieties and to enhance the wheat production without using toxic chemicals.

MATERIALS AND METHODS

Field trials were carried out at the Entomological Research Farm, University of Agriculture, Faisalabad (31.4278°N,73.0758°E) in wheat season 2021-22. Four wheat varieties recommended for irrigated areas including UJALA-2016, ANAJ-2017, FAISALABAD-2008 and JAUHAR-2016 were grown in plots with randomized complete block design with three replications. Seeds were purchased from wheat section of Ayub Agriculture Research Institute, Faisalabad. The experiment was laid out on 0.5 ha divided into 12 experimental units with sowing completed on December 01, 2021 by broadcast sowing method at seed rate of 125 kg ha^{-1}. Seeds were treated with Topsin-M® (thiophanate methyl 70 WP) @ 2.5 g kg^{-1} before sowing, and plant to plant distance of 10 cm was maintained with all agronomic practices followed as per standard practice except pest control. Analysis was done to assess the impact of varietal characters, as well as, of natural elements on population dynamics of all aphid species. The incidence of winged and wingless aphids were recorded by shaking three tillers from each replication. The morphological characters were used to identify aphid species, with weekly observations made until harvesting. Naturally occurring parasitoids were also sampled on weekly basis. Three parameters of yield were recorded including plant height (cm), spike length (cm) and thousand grain weight (g) following standard methods, and after threshing, 1000 grains weight measured, The data on temperature (°C), humidity (%) and rainfall (mm) were obtained from the Meteorological Department, University of Agriculture, Faisalabad, Punjab (Pakistan).The data on incidence of aphids, parasitoids, predators, plant height, spike length and 1000-grain weight were subjected to ANOVA and all pairwise comparison of means was conducted by LSD test using Statistics software 8.1 version. Correlation and regression analysis was also performed along with scatter diagrams.

RESULTS AND DISCUSSION

The winged aphids were observed from end of December which remained stagnant till January 2022 of which counts were made from February and continuing till maturity. Significant differences were observed with the varieties (Fig. 1); winged aphids appeared in December and remained dormant till February, with maximum incidence during March which is in agreement with earlier results (Hassan, 2017; Giraldo et al., 2019). All the varieties were infested with *R. padi*, *D. Noxia*, *S. graminum* and *S. avenae* with varying degree of infestation- *R. padi*, *D. noxia* and *S. graminum* were significantly more than *S. avenae*. The 2nd week of March showed peak incidence as observed earlier by Zeb et al. (2011), Fievet et al. (2007), Asghar and Chughtai (2012) and Hameed (2013). Peak incidence (56.10± 0.24 aphids/ plant) of *R. padi* was on UJALA-2016 and the least (20.67± 0.19/ turner) with ANAJ-2017. Shereen et al. (2017) observed that *R. padi* incidence varied with varieties significantly. Ajmal et al. (2018) observed that most critical period for *R. padi* began from 2nd week of March. *Sitobion avenae* showed significant incidence (34.83± 0.31 aphids/ plant) in FSD-2008. Abbas et al. (2018) observed maximum incidence (24.98± 0.21/ plant) of *S. avenae*. Aslam et al. (2004) observed most extreme incidence (160.3 aphids/ plant) showing that as temperature increased above 19.6°C, aphid density increased. With *D. noxia* peak incidence (56.1± 0.14 aphids/ plant) was on the variety UJALA-2016. Temperature fluctuation was the primary factor in increased incidence- 2nd week of March showed peak period (82.10± 1.73 aphids/ plant). Abbas and Niaz (2019) observed that incidence of aphids began in early February and increased by mid-March. Akhtar and Parveen (2002) observed increase in *D. noxia* (8.2 aphids/ leaf). The variety UJALA-2016 harboured more (41.87± 0.41aphids/ plant) of *S. graminum*; and it was high (55.87± 0.34 aphids/ tiller) on all the varieties

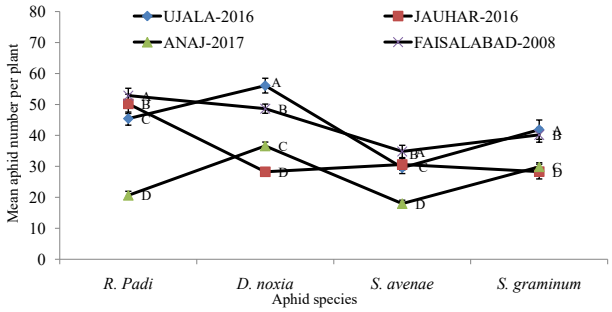

Fig. 1. The population dynamics of aphid species against four wheat verities

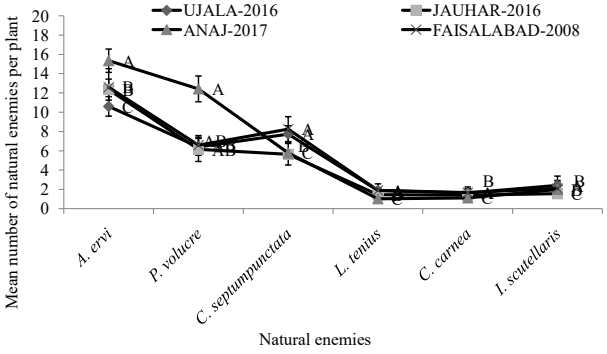

Fig. 2. The abundance patterns of aphids' natural enemies among four wheat varieties

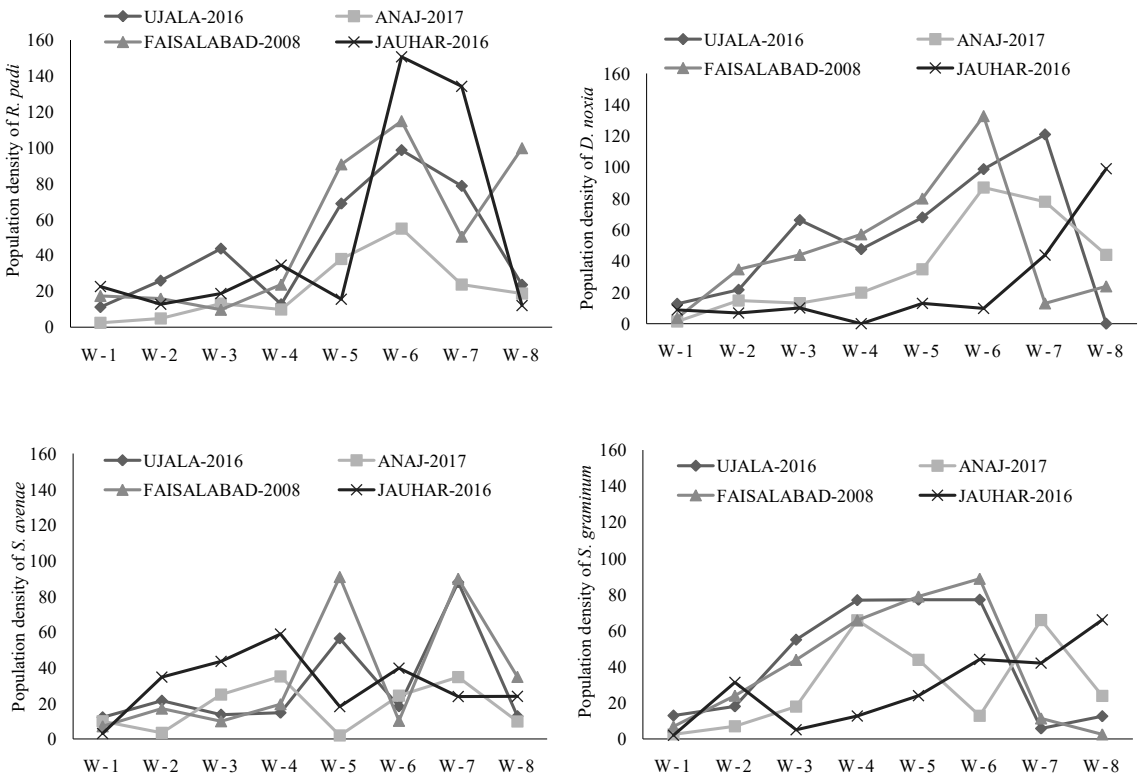

Fig. 3. Population fluctuation of aphid species among four wheat cultivars (1st week of Feb- 4th week of March), A: *R. padi*, B: *D. noxia*, C: *S. avenae*, D: *S. graminum*

from 4th week of February to 2nd week of March; and less parasitism rate was seen during this period. Ahmad et al. (2015) observed similar results with *S. graminum.* Shereen et al. (2017) also observed more aphid mummies during 2nd week of March.

Lee et al. (2005) demonstrated low mortality (<0.05%) of aphids, and concluded that parasitoids were insignificant sources of mortality. Nyaanga et al. (2012) reported that coccinellids feed more on *D. noxia* and *S. graminum* than others. Gavish-Regev et al. (2009) reported 50% reduction of *R. padi* density due to the presence of spider's web in wheat. Revealed that *Chrysoperla carnea* density continuously increased from February till March 3rd week. Observed more syrphids during March 3rd week. Maximum aphid density (104.45± 0.45/ plant) was seen between 10°C-24°C which is in agreement with previous study (Zeb et al. 2011). Weather factors revealed non-significant impact on the population dynamics of aphids (Fig. 5). Aphid species showed significant incidence variation from 4th to 8th week of study and *R. padi* showed maximum incidence (104.78 aphids/ plant) in 6th week. The natural enemies showed positive correlation with aphid incidence and remained significantly less than aphid incidence. Aheer et al. (2008) reported that RH played a significant role. The 1000 grain weight ranged from 41.3g (UJALA-2016) to 55.0g (ANAJ-2011), which might be attributed to the reason that the variety ANAJ-2011 was least infested with aphids. Li et al. (2013) reported 11-43.45g 1000 grain weight, and concluded that aphid number and wheat yield had converse relationship, as observed by others (Ahmad et al., 2015; Abbas and Niaz, 2019). Plant height significantly varied between varieties- ANAJ-2017 (44.673± 0.25^{A}), and it was non-significant in UJALA-2016(39.673± 0.23^{B}) and JAUHAR-2016 (41.673± 0.24^{B}) but significantly higher than FSD-2008 (35.673± 0.22^{C}). The 1000 grain weight was varying significantly- ANAJ-2017 (55.000±0.48^{A}) showed significantly higher 1000 grain weight. Overall, *R. padi* and *D. noxia* were more abundant; parasitization was more on less infested varieties while predators were abundant on most infested varieties.

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CONFLICT OF INTEREST

No conflict of interest.

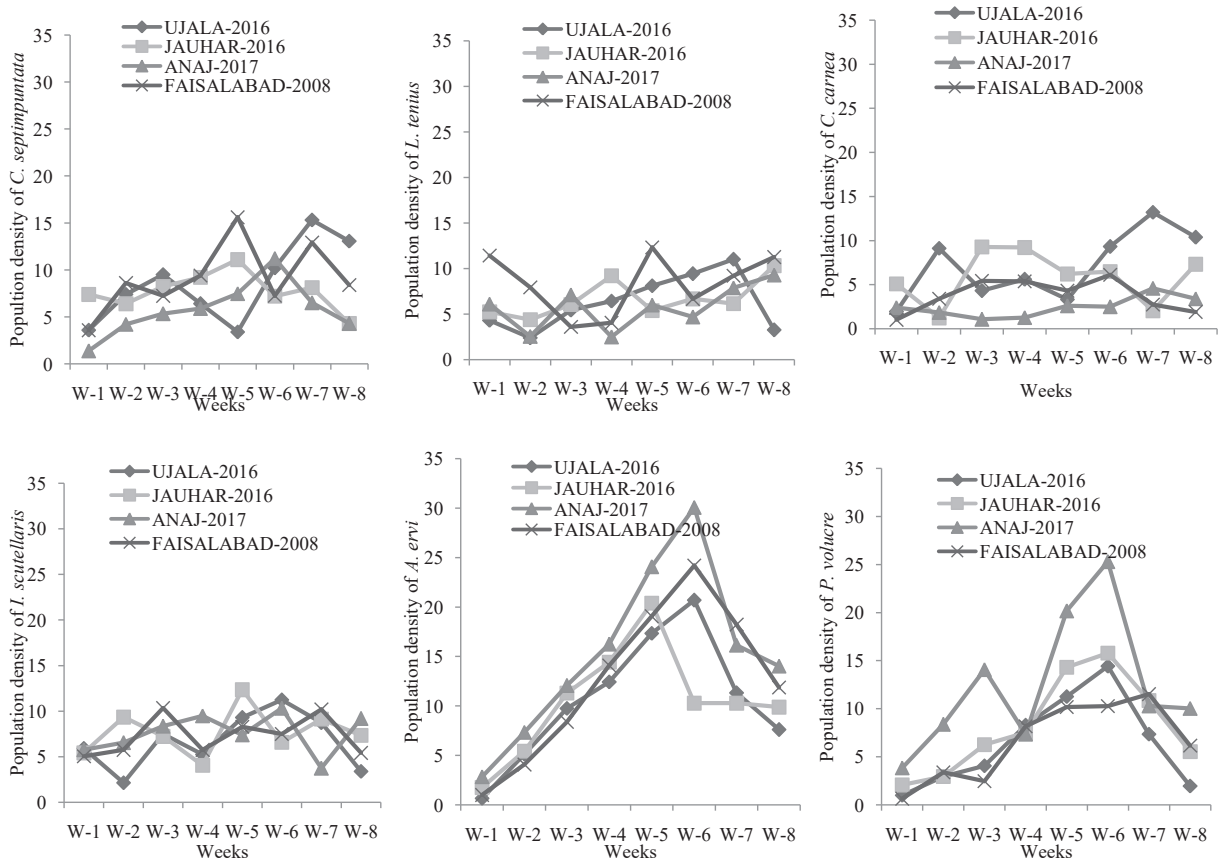

Fig. 4. Population fluctuation of parasitoids and predators among four wheat cultivars (1st week of Feb- 4th week of March), A: *C. septimpuntata*, B: *L. tenius*, C: *C. carnea*, D: *I. scutellaris*, E: *C. carnea*, F: *A. ervi*, GP. volucre

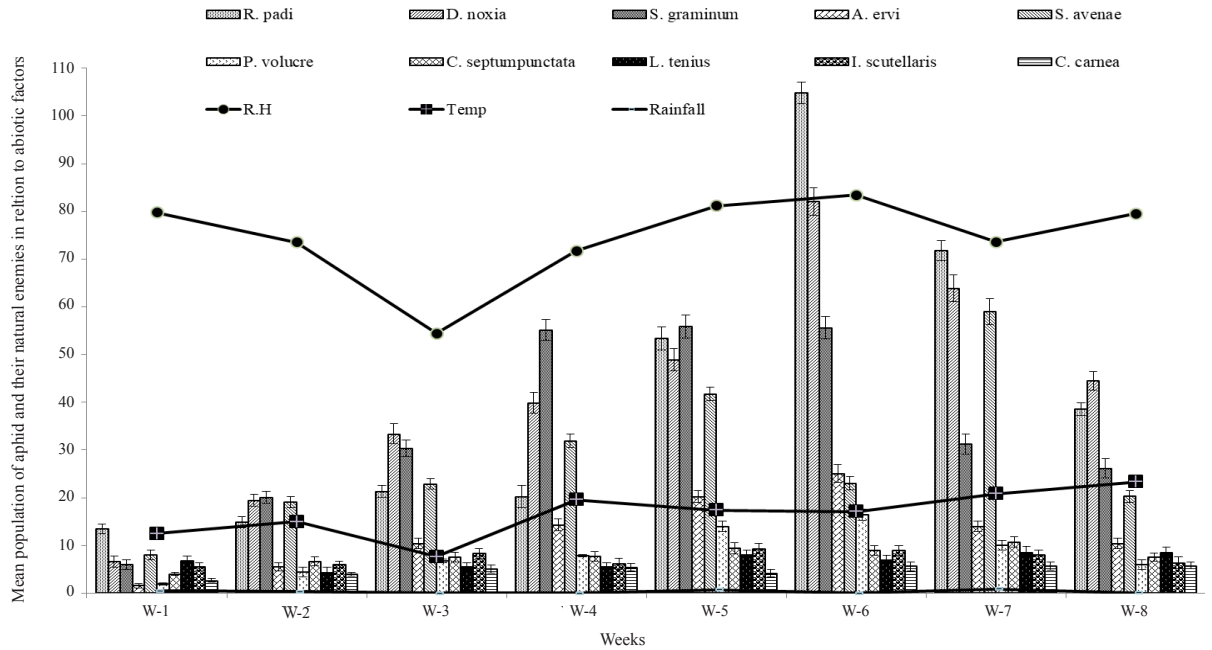

Fig. 5. Impacts of host plant characteristics and abiotic factors (temperature, relative humidity and rainfall) on seasonal abundance of aphids and their associated natural enemies

AUTHOR CONTRIBUTION STATMENT

UR and AN planned, designed and execute the research experiments. UR, AE, AS and AK complete the write up of article. MDG, AA and AM reviewed the article and helped in the statistical analysis. MA and MJA reviewed the manuscript before submission. All authors have read and approved the manuscript.

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