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POPULATION DYNAMICS OF *SITOBION AVENAE* (HEMIPTERA: APHIDIDAE) AND THEIR MUMMIFIED APHIDS ON WHEAT CROP

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ABSTRACT

Wheat (*Triticum aestivum* L.) is one of the major nutritional bases of mankind and animals worldwide; however, infestations by aphids are the main cause that severely affects wheat production in Pakistan and around the world. In 2021-22 the population densities of *Sitobion avenae* and their mummified aphids were studied on wheat crop under field conditions at University Research Farm, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi. About eight quadrats were taken on each day from the whole field on weekly basis and numbers of aphids were counted visually on each plant part (stems, leaves, and spikes) individually. Seasonal weekly mean population of aphid morphs on wheat crop revealed that population densities were found significantly different among winged, adults, nymphs, and mummies ($F_{5, 551}$ = 8.38, P = 0.000; $F_{5, 551}$ = 14.80, P = 0.000; $F_{5, 551}$ = 24.13, P = 0.000; $F_{5, 551}$ = 18.30, P = 0.000 respectively). Significantly greater numbers of aphids were recorded on the spikes (29.23 ± 1.14) as compared to those on leaves (8.46 ± 0.68) and stems (0.37 ± 0.05). The overall combined mean population comparison was observed non-significant between aphids morphs winged, adult, nymph, and mummified ($F_{7, 551}$ = 0.20, P = 0.984; $F_{7, 551}$ = 0.07, P = 0.999; $F_{7, 551}$ = 0.08, P = 0.999; $F_{7, 551}$ = 0.50, P = 0.829 respectively) on the wheat crop. Therefore, the *S. avenae* peak population timing reported in this study will be helpful as a critical infestation period for scheduling their management practices.

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INTRODUCTION

Wheat (*Triticum* spp.), being the most important and major cereal crop, belongs to the family Poaceae (Giraldo et al., 2019). Therefore, it is a staple source of nutrients that provides about 13% of the proteins and 20% of the calories to the world's population, primarily used as a food for approximately 40% of the world's population (Ullah et al., 2020). It is consumed in many forms by mankind and is also used for the feed of animals and the manufacturing of many industrial products. As a cereal crop, wheat has many advantages, being a nutritious diet that is easily stored, transported, and processed (Muhammad et al., 2005). In Pakistan, wheat is considered a major crop and the mainstay of their economy. It contributes 10% value-added in agriculture and more than two percent to the Gross Domestic Production (Faheem et al., 2019). Wheat crop is attacked by so many insect pests; particularly cereal aphid's attack is responsible for the major economic damage (Hussain et al., 2021).

Aphids (Hemiptera: Aphididae) commonly called blackflies or greenflies are the most familiar and destructive insect pests of crops, fruit trees, vegetables, and ornamental plants (Giraldo et al., 2019). They are

easily recognizable by their characteristics, small size that measures between 0.7-7.0 mm in length, sap-sucking, soft-bodied and pear-shaped insect (Hafeez et al., 2021). There is no plant part of the terrestrial ecosystem that is not attacked by this persistent and destructive insect pest, even they feed on the bark and some aphids go underground to feed on the roots (Guerrieri and Digilio, 2008). The majority of the aphids take their nutrition from the plant by sucking the sap of leaves, shoots, and inflorescences, inject toxic saliva into the plant tissues and transmit numerous diseases (Yano et al., 1983). They also secrete honeydew which results in causing stunted plant growth, distortion, and premature leaves fall (Akhtar and Javed, 2004). Aphids reproduce both sexually and asexually hence; due to this tremendous ability they are capable of rapidly increasing population growth (Tanguy and Dedryver, 2009).

The cereal aphid population on wheat has been increasing from the past several years and attaining the status of severe pest in Pakistan. The reported cereal aphid species in Pakistan include *Sitobion avenae* (F.), *Metapolophum dirhodum* (W.), *Schizaphius graminum* (R.), *Rhopalosiphum padi* (L.), *R. maidis* (F.), *R. rufiabdominalis* (S.), *Macrosiphum granarium* (F.), *Sipha maydis* (P) (Akhtar and Javed, 2004).

Population dynamics and phenological study of a pest can have a significant impact on their pest status. For example, phenological study of aphids on wheat shows at which growing stages the wheat is likely to be invaded by the aphid; similarly population dynamics refers how the populations of this pest change in size and structure over time. Studies on the population densities of *Sitobion avenae* over wheat in arid region of Punjab are relatively rare. Therefore, present study was planned to provide information about the seasonal abundance and phenological study of *S. avenae* on wheat crop under field conditions.

MATERIALS AND METHODS

The present field work was carried out at University Research Farm, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi. Main objectives of the research were to study the population dynamics of *S. avenae* and their mummified aphids on wheat crop under field conditions. The wheat variety Fakhar-e-bhakkar was sown during the winter wheat season of 2021-2022.

Sampling Methods

Random based sampling technique was followed for the whole wheat crop research period. For population sampling analysis different sampling techniques were adopted.

Quadrat-based sampling

A total of eight quadrates (1 square foot) were randomly taken from the whole field in a zig-zag form. Spots selected for sampling were not closer than 10 feet from the border of the field. In quadrat basis sampling, two different sampling techniques were followed.

Whole plant-based sampling

Whole wheat plants were selected and aphids were counted visually on each plant part (whole leaves, stems and spikes) individually.

Aphid morphs-based sampling

Different aphid morphs (nymphs, adults, winged and mummified) were sampled and counted individually. Counting and sampling of aphids initiated at the time of immigration to the wheat crop and continued until the collapse of the populations. Data were recorded visually at weekly intervals. The collected cereal aphids were preserved in 70% alcohol in glass vials and were later identified up to species level based on taxonomic characters using the keys (Olsan et al., 1993: Blackman and Eastop, 2000).

Statistical analysis

Descriptive statistical data (sum, mean, standard error, and standard deviation) and ANOVA were calculated for the interpretation of the results using the statistical softwares (Microsoft office excel and SPSS 16) and Micro origin graph 6.0 for graphical representation.

RESULTS

Aphid population

A total of 20131 aphid individuals were recorded on wheat crop in overall sampling methods. Over 99% of the total recorded specimens were identified as *S. avenae*. Among them, 4558 were winged, 6073 were adult, and 9500 were nymphs. The percentage population of nymphal stage (47.19%) were recorded more frequently as compared to adults (32.63%) and winged (20.17%) aphids in the whole cropping season.

Aphid mummies

A total of 487 numbers of mummified aphids were counted in overall sampling methods during the whole cropping season. The overall percentage parasitism rate was 2.19%, estimated by including the nymph, adult, and winged stages. The maximum rate of parasitism was

recorded in the 14th and 12th weeks during the whole cropping season (Table. 1).

Table 1: Population (mean ± SEM) of *Sitobion avenae* nymphs, adults, winged, and mummies recorded on the wheat crop at weekly intervals.

Weeks	Population of			
	Nymph	Adult	Winged	Mummified
11th	24.09 ± 2.49	0.70 ± 0.10	5.33 ± 0.56	0.95 ± 0.12
12th	33.90 ± 3.80	14.75 ± 2.23	8.24 ± 0.97	1.97 ± 0.22
13th	15.47 ± 1.48	20.78 ± 2.70	12.88 ± 1.50	4.18 ± 0.38
14th	5.70 ± 0.69	12.61 ± 1.54	9.69 ± 1.13	4.49 ± 0.43
15th	4.0 ± 1.41	4.25 ± 1.58	2.66 ± 0.91	2.62 ± 0.88
16th	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

Aphid phenologies observed on the wheat crop

The population densities for *S. avenae* were monitored on weekly basis during 2021. *S. avenae* remains the consistent pest of the wheat crop with different population densities throughout the whole growing season. The aphids were first observed on the wheat crop during mid of January and reached their peak by the 12th week during the end of March. This peak population was observed to be consistent among adult and winged aphids, whereas the peak population of nymphs was observed in the 12th week during the mid of March (Table 1). After peak population, a sharp decline in population was observed and eventually disappeared by the mid of April. Weekly mean population was significantly different among winged, adult, nymph and mummified aphids ($F_{5, 551}$ = 8.38, P= 0.00; $F_{5, 551}$ = 14.80, P= 0.00; $F_{5, 551}$ = 24.13, P= 0.00; $F_{5, 551}$ = 18.30, P= 0.000 respectively) during the wheat crop season. During the start and the end, the mean population densities of aphid morphs were recorded minimum. Peak population densities of nymph/week (33.9 ± 3.80) were recorded in the 12th week, while adult/week (20.78 ± 2.70) and winged/week (12.88 ± 1.50) were recorded in the 13th week. Mummified aphids were first recorded in early March and per week peak population densities (5.35 ± 0.43) were recorded in the end of March (Table 1) when the aphid population was at their peak.

Distribution of *S. avenae* on the wheat plants

The data regarding distribution of *S. avenae* on different parts of wheat plant (stems, leaves, and spkies) wererecorded. Aphids morphs were scattered differently over the leaes, stems, and spikes. Data were recorded for the distribution pattern of *S. avenae* morphs on each plant part individually. The distribution pattern changed on each part with time until the heading started. The distribution of population patterns of all the aphid morphs were found significantly different among stems, leaves, and spikes ($F_{2, 528}$ = 7.17, P= 0.001; $F_{2, 528}$ = 79.91, P= 0.000; $F_{2, 528}$ = 14.91, P= 0.000) (Figure 1). The observed overall mean population of *S. avenae* winged, adults, nymphs, and mummified aphids were always found higher on the spikes, however the mean population densities of all the morphs of *S. avenae* were found lower on the stems followed by leaves. On stems, leaves, and spikes, the populations of nymphs of aphids were recorded maximum, whereas the population winged aphids was recorded minimum (Figure 1). The mummified aphids were also increased with increase in aphids number. Analysis of aphid mummies showed that their population was found higher on the spikes followed by leaves and stems.

Comparison of aphid morphs on wheat crop

The overall combined numbers of aphids were also observed on the whole plant (leaf, stem, and spike) which showed high population trends in aphid nymphs during the whole crop season. The results showed that overall mean population observed was non-significant between winged, adult, nymph and mummified aphids ($F_{7, 551}$ = 0.20, P= 0.984; $F_{7,551}$ = 0.07, P= 0.999; $F_{7,551}$ = 0.08, P= 0.999; $F_{7,551}$ = 0.50, P= 0.829, respectively) on the wheat crop (Figure 2). The mean population of nymph 17.99 ± 1.19 was observed higher in overall quadrat basis sampling followed by adult 11.5 ± 0.91, winged 8.63 ± 0.53 and mummified aphid 2.97 ± 0.18.

DISCUSSION

The current research carried out was focused on the response of *S. avenae* to the wheat crop. The mean population densities of the aphids and their morphs were investigated under field conditions. Over 99% of

the total recorded specimens were identified as *S. avenae*. It was found that the *S. avenae* attack started during mid-January and the population increased as the vegetative growth proceeded.

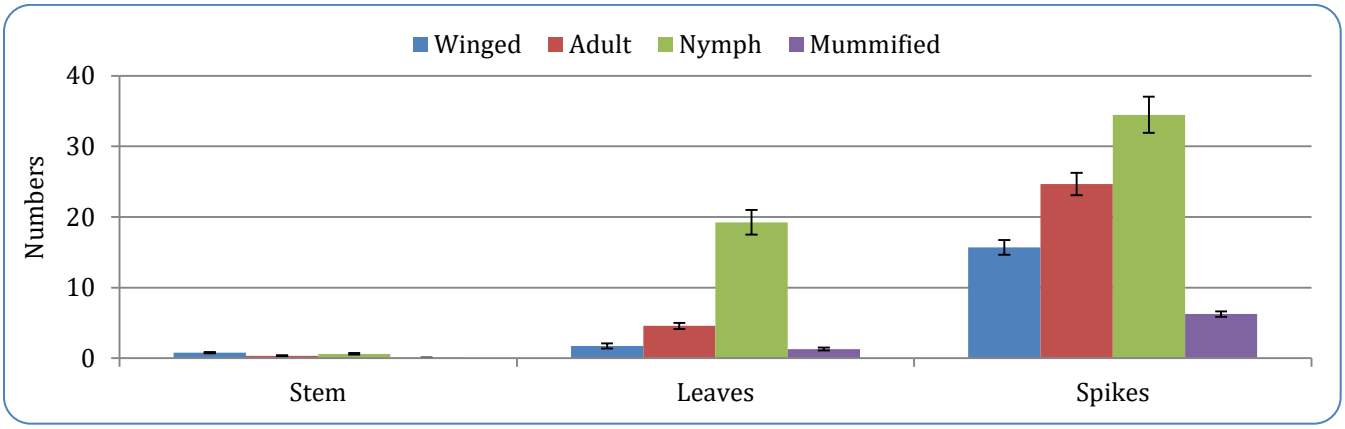

Figure 1: Numbers of *Sitobion avenae* (mean ± SEM) on stem, leaves and spikes.

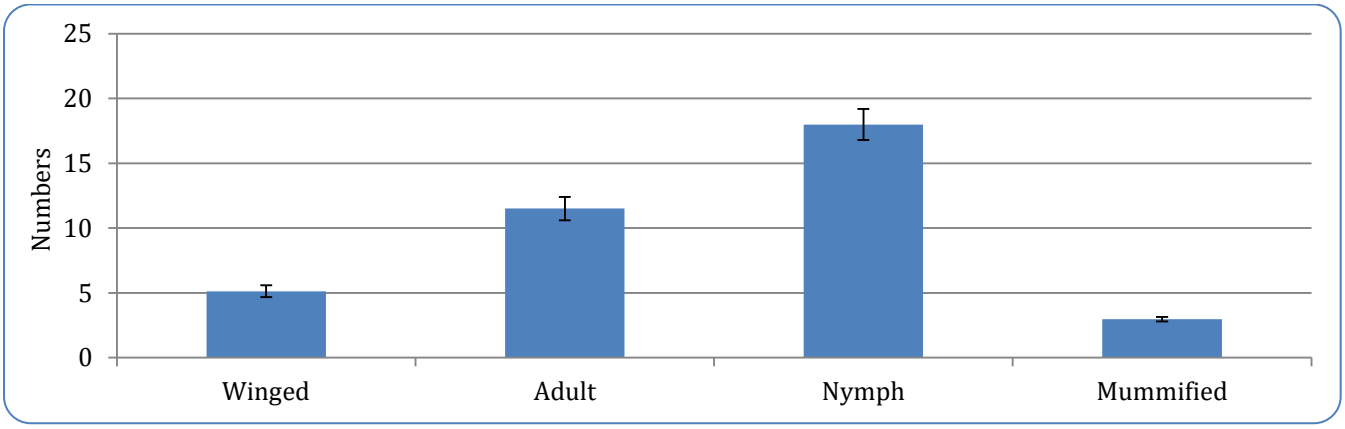

Figure 2: Overall combined *Sitobion avenae* morphs population (mean ± SEM) recorded on wheat crop.

The population increased steadily to its peak in 12th week during the end of March with a rapid decrease in population after peak till mid-April. The population distribution of aphids was influenced by the temperature. (Muhammad et al., 2005) observed that aphid reproduction and development rate increased with the rise in temperature. During the start of the season, the temperature was very low, and the population recorded was also minimum. Ullah et al. (2020) found the same population trend of *S. avenae* during his study. An increased rate of parasitism was observed with the increase in the number of aphids, which highlights the importance of parasitoids in the wheat ecosystem. Under favorable conditions, aphids multiply at a faster rate to form dense colonies of nymphs and adults (Faheem et al., 2019). The mean population of aphid nymphs was observed higher in numbers as compared to adults and winged in the whole plant which showed that the aphid population can increase with great speed. *S. avenae* was most abundantly found on the ears as compared to leaves and stem (Shahid et al., 2012). The current findings over *S. avenae* agree very well with the literature which showed that greater numbers of aphids were found on the spikes as compared to those of leaves and stem. It showed that aphids prefer to attack the soft terminal parts of the plant because more food is supplied towards that part.

CONCLUSION

Based on current study, it is concluded that the population density S. *avenae* could be controlled by early sowing of wheat crops. Additionally, the indiscriminate use of insecticide influence the population growth of natural enemies, and due to the decrease population of

natural enemies in wheat crops, aphids' outbreak occurs and cause severe destruction to the wheat crops.

AUTHORS' CONTRIBUTION

UA and MN designed the study, US conducted the research trial, collected, arranged and analyzed the data, MN and MAA helped in data analysis, US wrote the manuscript; MAA guided in data recording, MN supervised the work and helped in identification, All the authors proofread the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Akhtar, I.H., Javed, H., Shakoor, A., 2004. Microclimatic morphs and plant distribution analysis of cereal aphids on wheat. Asian Journal of Plant Sciences (Pakistan) 3(5), 516-521.

Blackman, R.L., Eastop, V.F., 2000. Aphids on the World's Crops—An Identification and Information Guide. The Natural History Museum. John Wiley and Sons, Ltd., New York.

Faheem, M., Saeed, S., Sajjad, A., Wang, S., Ali, A., 2019. Spatio-temporal variations in wheat aphid populations and their natural enemies in four agro-ecological zones of Pakistan. PLOS One 14(9), 26-35.

Giraldo, P., Benavente, E., Agugliaro, F. M., Gimenez, E., 2019. Worldwide research trends on wheat and barley. A bibliometric comparative analysis. Agronomy 9, 352.

Gong, P., Chen, D., Wang, C., Li. M., Zhang, Y., Li, X., Zhu, X., 2021. Susceptibility of four species of aphids in wheat to seven insecticides and its relationship to detoxifying enzymes. Frontiers in Physiology 11, 623612.

Guerrieri, E., Digilio, M.C., 2008. Aphid-plant interactions: a review. Journal of Plant Interactions 3(4), 223-232.

Hafeez, F., Abbas, M., Abbas, K., Zia, S., Ali, M., Farooq, M., Arshad, A., Iftikhar, M.J., Saleem, Zuan, A.T., Zuan, K., Li, Y., 2021. Prevalence and management of aphids (Hemiptera: Aphididae) in different wheat genotypes and their impact on yield and related traits. PLOS One 16(10), 0257952.

Hussain, D., Asrar, H., Khalid, B., Hafeez, F., Saleem, M., Akhtar, M., Ahmed, M., Ali, I., Hamid, K., 2021. Insect pests of economic importance attacking wheat crop (*Triticum aestivum* L.) in Punjab, Pakistan. International Journal of Tropical Insect Science 42, 9-20.

Muhammad, N., Compton, S., Incoll, L., Akram, W., Lee, J.J., 2005. Interaction of English grain aphid, *Sitobion avenae* (F.) and their natural enemies to an agro-forestry environment. Journal of Asia-Pacific Entomology 8, 175-183.

Olsen, C.E., Pike, K.S., Boydston, L., Allison, D., 1993. Keys for identification of apterous viviparae and immatures of six small grain aphids (Homoptera: Aphididae). Journal of Economic Entomology 86(1), 137-148.

Shahid, S., Zia, A., Naeem, M., Naz, F., 2012. Bionomics of aphids and their parasitoid in selected wheat varieties grown under homologous ecological conditions. Pakistan Journal of Zoology 44(5), 1423-1430.

Tanguy, S., Dedryver, C.A., 2009. Reduced BYDV–PAV transmission by the grain aphid in a *Triticum monococcum* line. European Journal of Plant Pathology 123, 281-289.

Ullah, F., Gul, H., Said, F., Ali, A., Tariq, K., Zaman, M., Song, D., 2020. Population dynamics of wheat aphids *Rhopalosiphum padi* (Linnaeus) and *Sitobion avenae* (Fabricius) at district Mardan, Khyber Pakhtunkhwa Pakistan. Pure and Applied Biology 9, 27-35.

Wakeil, N.E., Gaafar, N., Sallam, A., Volkmar, C., 2013. Insecticides development of safer and more effective technologies: Intechopen, London.

Yano, K., Miyake, T., Eastop, V.F., 1983. The biology and economic importance of rice aphids (Hemiptera: Aphididae): a review. Bulletin of Entomological Research 73, 539-566.