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POPULATION DYNAMICS OF MUSTARD APHID, *LIPAPHIS ERYSIMI* (KALT.) IN RELATION TO ABIOTIC STRESSORS

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ABSTRACT

Mustard aphid (*Lipaphis erysimi*) is a significant pest of mustard and other cruciferous plants. An experiment was conducted to study the population dynamics of *Lipaphis erysimi* on mustard variety Pusa Vijay at the Crop Research Centre (CRC) of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, during the Rabi season of 2020-21. The aphid population first appeared in the 51st Standard Week and persisted until the 9th Standard Week. Results revealed that the aphid population peaked during the 5th Standard Week. Correlation studies showed a significant negative correlation between aphid population and both maximum and minimum temperatures (r = -0.584 and r = -0.378, respectively), while a significant positive correlation was observed with relative humidity (r = 0.602) and rainfall (r = 0.041).
***Keywords*:** *Lipaphis erysimi*, population dynamics, Temperature, relative humidity and rainfall.

Introduction

In Indian agriculture, oilseed crops play a critical role in the nation's economy, with mustard (*Brassica* spp.), a self-pollinated cruciferous plant, being the most important among them. Mustard stands as the second most significant oilseed crop after groundnut, serving dual purposes: as an edible oil source and as animal feed in the form of oilseed cakes. Various species of mustard are utilized for oil production, as vegetables, and for fodder. Globally, India ranks fourth in rapeseed-mustard production, following Canada, China, and the European Union, contributing 72.41 million tonnes to global oilseed production. India accounts for 17% of the world's rapeseed-mustard output, with 17.19% of the global area under cultivation and 8.54% of global production during 2018-19. In India, rapeseed-mustard covers an area of 6.52 million hectares, producing 9.26 million tonnes, with a productivity of 1511 kg/ha. The major rapeseed-mustard-producing states, including Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, West Bengal, and Assam, together account for 86.29% of the cultivated area and 88.46% of national production. Rajasthan alone contributes 40.74% of the total area and 44.97% of the production, while Uttar Pradesh accounts for 11.20% of the area and 10.60% of the production (Anonymous, 2020).

The mustard plant is susceptible to a wide range of insect pests. Several species, including the mustard sawfly (*Athalia lugens proxima* Klug), painted bug (*Bagrada cruciferarum* Kirk), mustard aphid (*Lipaphis erysimi* Kalt.), cabbage leaf webber (*Crocidolomia binotalis* Zeller), flea beetle (*Phyllotreta cruciferae* Geoze), and leaf miner (*Phytomyza horticola* Meign), pose significant threats to mustard cultivation. Among these, the mustard aphid (*Lipaphis erysimi* Kaltenbach) from the Homoptera (Aphididae) family has emerged as the most critical insect-pest, causing substantial crop losses ranging from 9% to 96% by sucking plant sap. The extent of damage caused by this pest varies based on the agroclimatic conditions of the region (Singh and Sharma, 2002; Bakhetia, 1984; Chorbandi and Bakhetia, 1987; Singh and Sachan, 1994; Singh and Sachan, 1995). Both the upper and lower surfaces of leaves of mustard plants are susceptible to attack by mustard aphids (Yadav *et al*., 1998). These aphids feed on the crop's foliage and flowers (Singh *et al*., 1965), with both nymphs and adults sucking sap from various plant parts, including petioles, leaves, tender stems, inflorescences, and pods. Heavy infestations lead to stunted growth, leaf curling, and desiccation, resulting in a lack of pod formation. Additionally, the aphid's secretion of honeydew fosters the growth of sooty mold, further hindering photosynthesis. Given its economic importance, the mustard aphid is considered a key pest in mustard production (Mishra *et al*., 2018; Ali, and Rizvi,2008). Understanding the population dynamics of *Lipaphis erysimi* in relation to abiotic stressors is crucial for developing sustainable pest management strategies. By integrating this knowledge with predictive models, it becomes possible to mitigate aphid infestations more effectively, optimizing control measures while understanding the environmental impact (Ansari *et al*., 2007).

Material and Methods

A field experiment was conducted during the Rabi season of 2020-21 at the Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India (29.0850311°N 77.6974459°E). The plot size for each treatment was maintained at 180 m², with row-to-row and plant-to-plant spacing set at 45 × 15 cm. All recommended agronomic practices were followed to ensure optimal crop growth. The mustard crop was sown on November 7, 2020. A recommended fertilizer dosage of nitrogen, phosphorus, and potassium (@100:40:20 kg/ha) was applied to enhance crop production. Half of the nitrogen was applied as a basal dose, along with the total quantity of phosphorus and potassium, at the time of final field preparation. The remaining nitrogen was top-dressed 40 days after sowing.

Observations on the population of mustard aphids were recorded by randomly selecting 10 plants from the untreated plot, specifically examining 10 cm of the twig from the selected plants (Singh and Lal, 1999) (Figure 1). These observations began with the appearance of mustard aphids and continued until the crop reached maturity. Additionally, meteorological data was collected throughout the entire growth period, starting from the initial appearance of mustard aphids until crop maturity, to facilitate correlation calculations. Weekly meteorological data on temperature, relative humidity, and rainfall were obtained from the university's meteorological observatory.

Statistical analysis

To assess the influence of abiotic factors on the population dynamics of mustard aphids, weekly mean meteorological data, including maximum and minimum temperatures, relative humidity, and rainfall (mm), were obtained from the meteorological observatory at the College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The relationship between aphid population fluctuations and these abiotic factors was quantified using correlation analysis, with computations performed in XLSTAT software (Lumivero) at a 5% significance threshold.

Results and Discussion

The observation of aphid populations began during the 51st Standard Week (SW), recording an initial density of 22.33 aphids per 10 plants. Activity persisted until the 9th SW, at which point the population had decreased to 5.9 aphids per 10 plants. Aphid activity was noted from the vegetative stage through to the podding stage, spanning from December 2020 to March 2021. The highest population density of mustard aphids was recorded during the 5th SW, with a remarkable value of 182.03 aphids per 10 plants. Conversely, the lowest population was documented in the 9th SW, registering only 5.9 aphids per 10 plants. The highest and lowest temperatures during this period were recorded at 21.61°C and 7.13°C, respectively, accompanied by a relative atmospheric humidity of 70.85% and Rainfall of 1.1 mm (Table 1; Figure2).

A simple correlation coefficient analysis between aphid populations and various weather parameters revealed that the population of *Lipaphis erysimi* exhibited a negative correlation with both maximum and minimum temperatures (-0.584 and -0.378, respectively). In contrast, a positive correlation was identified with relative humidity (0.562) and rainfall (0.041), indicating that higher humidity and rainfall may favor aphid populations (Table 2; Figure3). Following this peak, a declining trend in aphid numbers was observed, culminating in the lowest population level recorded in the 9th SW (5.9 aphids per 10 cm central terminal twig per plant). These findings align with previous studies, such as those conducted by Lal *et al*. (2018), Choudhury *et al*. (2009), Dwivedi *et al*. (2018), and Rana Jyoti (2018), which also reported similar patterns of mustard aphid populations from December to March. This consistency in results supports the current study's findings and emphasizes the influence of weather conditions on aphid dynamics in mustard crops.

Conclusion

The overall findings of this investigation indicate that the occurrence of aphids is influenced by several factors, with weather conditions specifically temperature, relative humidity, rainfall, and sunshine hours identified as the primary determinants. In addition to these meteorological influences, various crop growth stages and agronomic practices also significantly contributed to the incidence of aphid populations. During these studied aphids were first observed during the 51st Standard Week (SW) and remained active until the 9th SW. Notably, during the 5th SW, when the maximum and minimum temperatures reached 21.61°C and 7.13°C, respectively, and with relative humidity at 70.85% and rainfall measuring 1.1 mm, the aphid population peaked at 182.03 aphids per 10 plants. These findings underscore the complex interplay between environmental factors and pest dynamics, highlighting the importance of integrated pest management strategies that consider these variables for effective control of mustard aphids.

Table 1 : Population of *Lipaphis erysimi* in relation to abiotic factor during *Rabi* season 2020-21

(SW)	Period	Mean of aphid population/10cm main apical shoot	Weather parameter			
			Temperature °C		Relative humidity (%)	Rainfall (mm)
			Max	Min.		
47	16-22 November	0	25	9.5	68.55	1.4
48	23-30 November	0	25.8	8.4	64.68	0
49	1-7 December	0	26.3	7.9	65	0
50	8-15 December	0	22.9	6.4	67.55	5.9
51	16-23 December	22.33	20.3	6	69.35	0
52	24-31 December	35.33	18.7	4.9	73.35	0.2
1	1-7January	68.06	19.01	6.17	80.14	24
2	8-15 January	97.63	18.84	5.7	79.215	0
3	16-23 January	130.9	18.13	7.2	77.79	0
4	24-30 January	153.13	18.8	6.46	73.64	0
5	31 Jan. - 6 Feb.	182.03	21.61	7.13	70.85	1.1
6	7-13 February	102.4	23.94	7.73	70.64	5.6
7	14-20 February	41.4	26.56	9.8	63.64	0
8	21-27 February	17.1	29.44	12.04	61.86	0
9	28 Feb.–6 Mar	5.9	30.47	14.11	58.93	0.2

Table 2 : Correlation(r) coefficient matrix of Mustard aphid with abiotic factors during *Rabi* season 2020-21

Variables	Mean of aphid population/10cm main apical shoot	Max. Temp. (*C)	Min. Temp (*C)	Relative humidity (%)	Rainfall (mm)
Mean of aphid population/10cm main apical shoot	**1**	-0.584	-0.378	0.602	0.041
Max. Temp. (*C)	-0.584	**1**	0.896	-0.924	-0.254
Min. Temp(*C)	-0.378	0.896	**1**	-0.780	-0.236
Relative humidity (%)	0.602	-0.924	-0.780	**1**	0.436
Rainfall (mm)	0.041	-0.254	-0.236	0.436	**1**

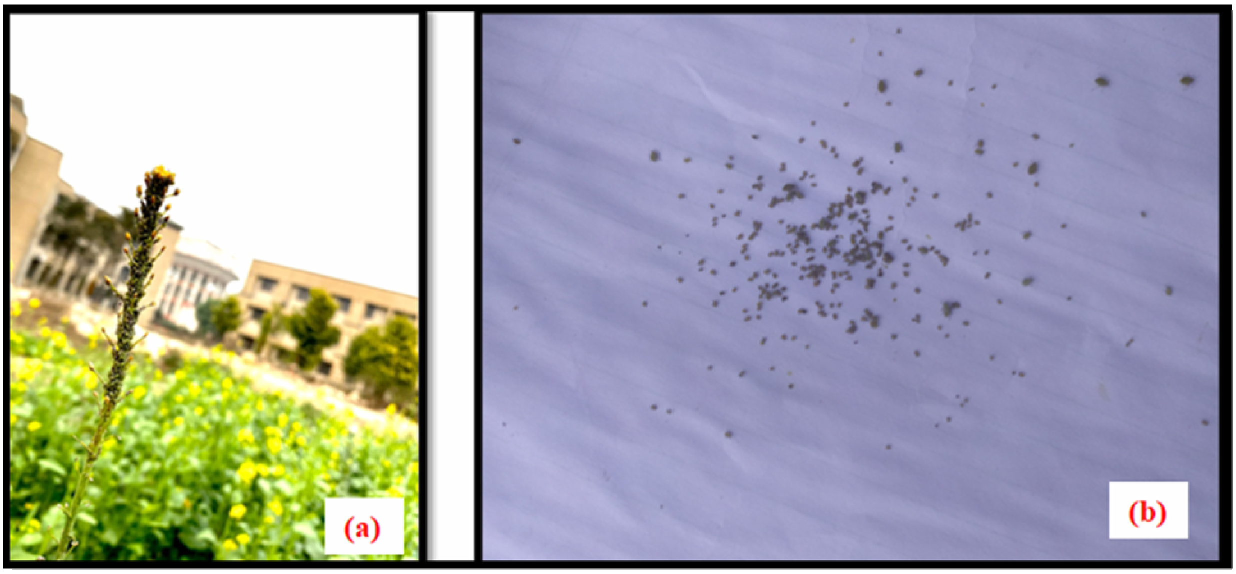

Fig.1 (a) 10 cm of the twig from the selected plant
(b) Counting the number of aphid population from selected twig

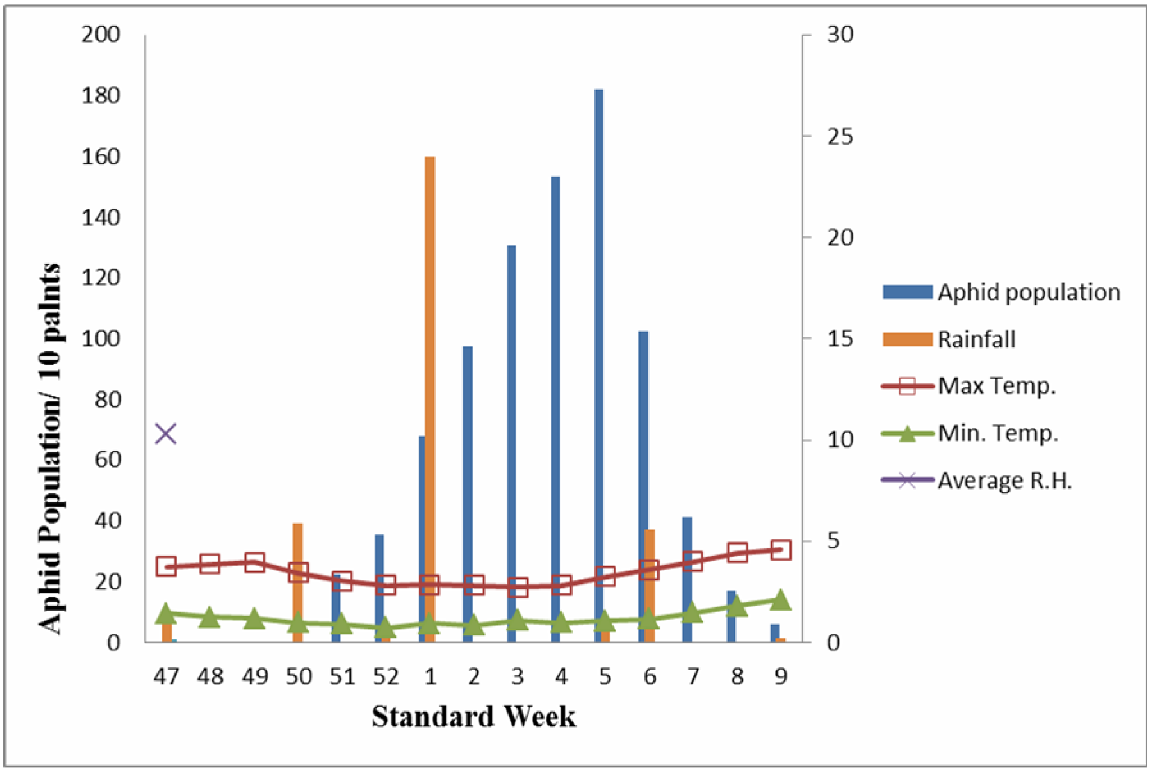

Fig. 2 : Population of mustard aphid (*L. erysimi*) with the relation of abiotic stressors during *Rabi*, 2020-21.

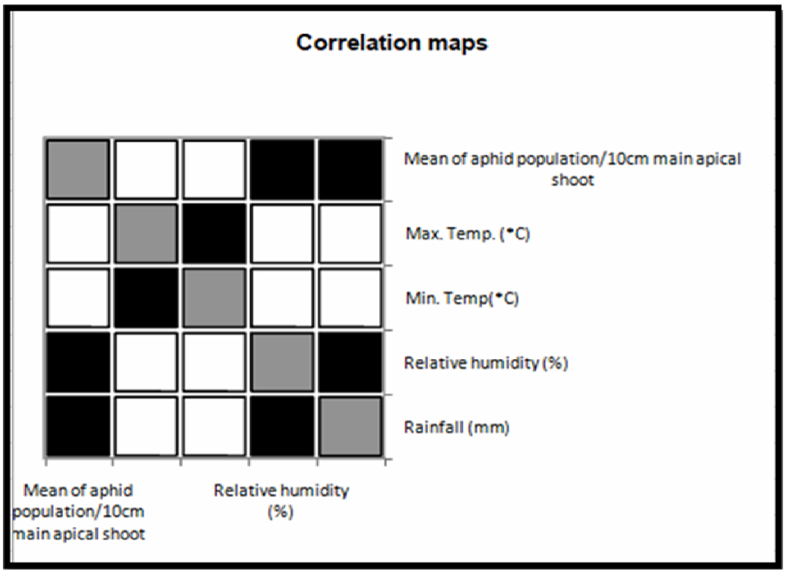

Fig. 3 : Correlation coefficient maps of Mustard aphid with abiotic factors

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Authors Contribution

SS carried out the field experiments and data collection, while **HS** conceptualized, designed, and supervised the research and drafted the manuscript. **MR** contributed through critical review and manuscript editing. **SS** also performed data curation and formal analysis. All authors thoroughly reviewed and approved the final version of the manuscript.

Conflict of Interest- None

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