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Understanding mustard aphid (*Lipaphis erysimi*) infestation under agro-climatic variability: Evidence from NICRA demonstration on temperature, humidity, and farmer awareness

[1]Rohit Kumar Mishra, [2]Hemant Kumar Sinha, [3]Dr. Kamlesh Ahirwar, [4]Dr. RK Singh and [5]Dr. Veena Pani Shrivastava

[1]Senior Research Fellow, ICAR - Krishi Vigyan Kendra, JNKVV, Chhatarpur, Madhya Pradesh, India

[2]Subject Matter Specialist (Agromet), ICAR - Krishi Vigyan Kendra, JNKVV, Chhatarpur, Madhya Pradesh, India

[3]Scientist, Department of Horticulture, ICAR - Krishi Vigyan Kendra, JNKVV, Chhatarpur, Madhya Pradesh, India

[4]Scientist, Department of Agronomy, ICAR - Krishi Vigyan Kendra, JNKVV, Chhatarpur, Madhya Pradesh, India

[5]Principal Scientist & Head, ICAR - Krishi Vigyan Kendra, JNKVV, Chhatarpur, Madhya Pradesh, India

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Corresponding Author: Rohit Kumar Mishra

Abstract

Mustard aphid (*Lipaphis erysimi*) infestation in Chhatarpur is significantly influenced by climatic factors, particularly during the flowering stage. The study revealed that peak aphid incidence occurs in January due to low temperatures, high humidity, and increased cloud cover, creating a favorable environment for pest proliferation. Integrating meteorological data with pest management strategies is essential to reducing yield losses. Regular aphid monitoring should commence in December using weather-based forecasting models for early detection. Targeted application of eco-friendly insecticides and neem-based formulations at the flowering stage can effectively suppress aphid populations. Climate-smart Integrated Pest Management (IPM) approaches, combining weather predictions with pest control measures, enhance resource optimization and crop protection. Strengthening farmer training and extension services will facilitate the adoption of bio-control agents and sustainable pest control techniques. Additionally, refining predictive models through multi-season research will improve aphid forecasting accuracy, ensuring proactive management. Implementing these climate-responsive strategies will enhance mustard production resilience, safeguard yields, and promote sustainable agricultural practices.

Keywords: *Lipaphis erysimi*, sustainable agriculture, yield security

Introduction

Mustard (*Brassica juncea* L.), a vital rabi oilseed crop of the Cruciferae family, enhances agricultural profitability and soil fertility while thriving under residual moisture with minimal irrigation (Pathan *et al*., 2025) [15]. In 2021, global mustard seed production stood at 532,769 tonnes, marking a 1.45% decline from 2020 and a 10.6% reduction over the past decade, with Nepal leading at 220,250 tonnes (41.3%), followed by Russia and Canada (FAO, 2021). India's total oilseed production for 2023-24 is estimated at 396.69 LMT, with rapeseed and mustard reaching a record 132.59 LMT (PIB, 2024). As the second-largest oilseed crop after groundnut, rapeseed-mustard (*Brassica* spp.) is predominantly grown in Rajasthan, Uttar Pradesh, and Madhya Pradesh. However, yield remains suboptimal due to delayed sowing, pest infestations, and inefficient crop management, with aphids being a major global constraint (Das *et al*., 2019) [1]. Several studies have documented varying plant damage severity caused by the mustard aphid, *L. erysimi*, ranging from 10% to 90%, with yield losses between 65% and 96% in different *Brassica* species, influenced by crop growth stage, population escalation rate, and agro-climatic factors (Dhillon *et al*., 2022) [2]. Our study aims to assess aphid infestation duration in mustard crops within Chhatarpur district and evaluate farmers' awareness regarding timely aphid management. The research focuses on sustainable oilseed production by identifying the peak infestation period and analyzing farmers' adoption of control measures within the optimal time frame.

Table 1: Economic Threshold Levels of *L. erysimi* Across Various Crops/Varieties

Crop/Variety	Economic Threshold	Reference
B. campestris	9-19 aphids per central shoot or 20% plant infestation	Singh *et al*., 1982 [9]
B. napus (GSL-1)	4 aphids per central shoot or 10% plant infestation	Rohilla *et al*., 1990 [7]
B. juncea (RL 1359)	9 aphids per central shoot or 20% plant infestation	
Mustard	9-13 aphids per 15 cm topmost terminal shoot	Suri *et al*., 1986 [10]
Brown sarson	4 mm shoot area showing infestation	

Materials and Methods

The study was conducted in the Nowgong block of Chhatarpur district, Madhya Pradesh, India, during the rabi season of 2020-21, focusing on NICRA village, particularly Singrawankala (25.0594° N, 79.4743° E). The research aimed to assess the aphid (*Lipaphis erysimi*) infestation in the mustard variety 'Rukmani,' a high-yielding cultivar developed by the Mustard Research Institute, Bharatpur, Rajasthan, and procured from the State Seed Corporation, Chhatarpur. Five NICRA farmers were selected for the study, all following similar agronomic practices. The experimental plots were arranged in a randomized pattern to minimize spatial variations, and five plants from each plot were randomly selected to record aphid infestation at different growth stages.

Meteorological parameters, including maximum and minimum temperature (°C), rainfall (mm), relative humidity (%), wind speed (kmph), and cloud cover (measured in octa units), were recorded throughout the cropping season, with data obtained from the DAMU meteorological observatory for accuracy. Statistical analysis was performed to determine the relationship between aphid infestation and meteorological parameters through available data.

Results and Discussion

Aphid Infestation in January: Our observations involved continuous monitoring of the selected field from September to March on a regular basis. Before the sowing of the mustard crop, no aphid infestation was detected based on our field observations. However, after sowing, systematic monitoring was conducted at three-day intervals on randomly tagged plants. During October, November, and December, no mustard plants showed signs of aphid infestation. However, a severe outbreak was observed in January. A similar finding was reported by Dinda *et al.* (2015) [3], where the highest mustard aphid infestation was recorded during the first and second weeks of January in West Bengal.

Our meteorological data is presented in Table 2, detailing month-wise climatic parameters from September to December, including temperature, relative humidity, and cloud cover. During this period, the average maximum temperature was recorded at 30.0 °C, while the minimum temperature averaged 12.45 °C. Relative humidity remained high, with RH I at 85.2% and RH II at 60.6%, indicating favorable moisture conditions. Cloud cover was relatively low, averaging 1.25 octas. A correlation was observed between low temperatures and high humidity levels (>90%), which played a crucial role in influencing environmental conditions.

In January, the maximum and minimum temperatures dropped to 24.0 °C and 8.4 °C, respectively. This month recorded the highest relative humidity, with RH I at 93.3% and RH II at 64.0%. Additionally, cloud cover significantly increased to 7 octas, resulting in an overcast atmosphere. These meteorological conditions-low temperature, high humidity, and dense cloud cover-created an ideal environment for the maximum outbreak of mustard aphids. Our field observations confirmed that January was the most critical period for aphid infestation, with significantly higher infection levels compared to other months.

Table 2: Monthly Variation in Mustard Aphid Incidence and Weather Parameters

Month	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Tmax (°C)	Tmin (°C)	Rainfall (mm)	RH I (%)	RH II (%)	Cloud Cover (Octa)
September	0	0	0	0	0	35.7	18.8	0	75.3	55.8	2
October	0	0	0	0	0	26.8	8.7	0	90.8	62.8	1
November	0	0	0	0	0	30.4	13.5	0	84.1	61.1	1
December	0	0	0	0	0	26.9	8.8	0.4	90.6	62.7	1
January	3	8	12	38	4	24.0	8.4	0	93.3	64.0	7
February	0	0	0	0	0	30.0	10.6	0	81.1	36.0	5
March	0	0	0	0	0	35.2	15.1	0	63.8	26.3	2

In contrast, during October, November, December, February, and March, aphid infestation remained insignificant. The climatic conditions during these months were less favorable for aphid multiplication, with either higher temperatures, lower humidity, or reduced cloud cover limiting their survival and spread. As temperatures began to rise after January, aphid populations naturally declined. During this time, farmers in the region implemented various pesticide control measures, effectively managing the infestation. As a result, after this period, no mustard aphids were observed in the mustard fields.

Flowering Stage Susceptibility: Figure 1 illustrates the variations in mustard aphid incidence in relation to weather parameters, including temperature trends, relative humidity, rainfall, and cloud cover across different plants. The data indicate that aphid infestation peaks in January, coinciding with the flowering stage of mustard. This suggests that the flowering phase is highly conducive to mustard aphid infestation. A similar observation was reported by Singh and Sinhal (2011) [8], highlighting that during the mustard flowering stage, aphid infestation leads to a significant reduction in lipid, carbohydrate, nitrogen, and protein content. This decline underscores the adverse impact of aphid infestation on the physiological composition of mustard plants.

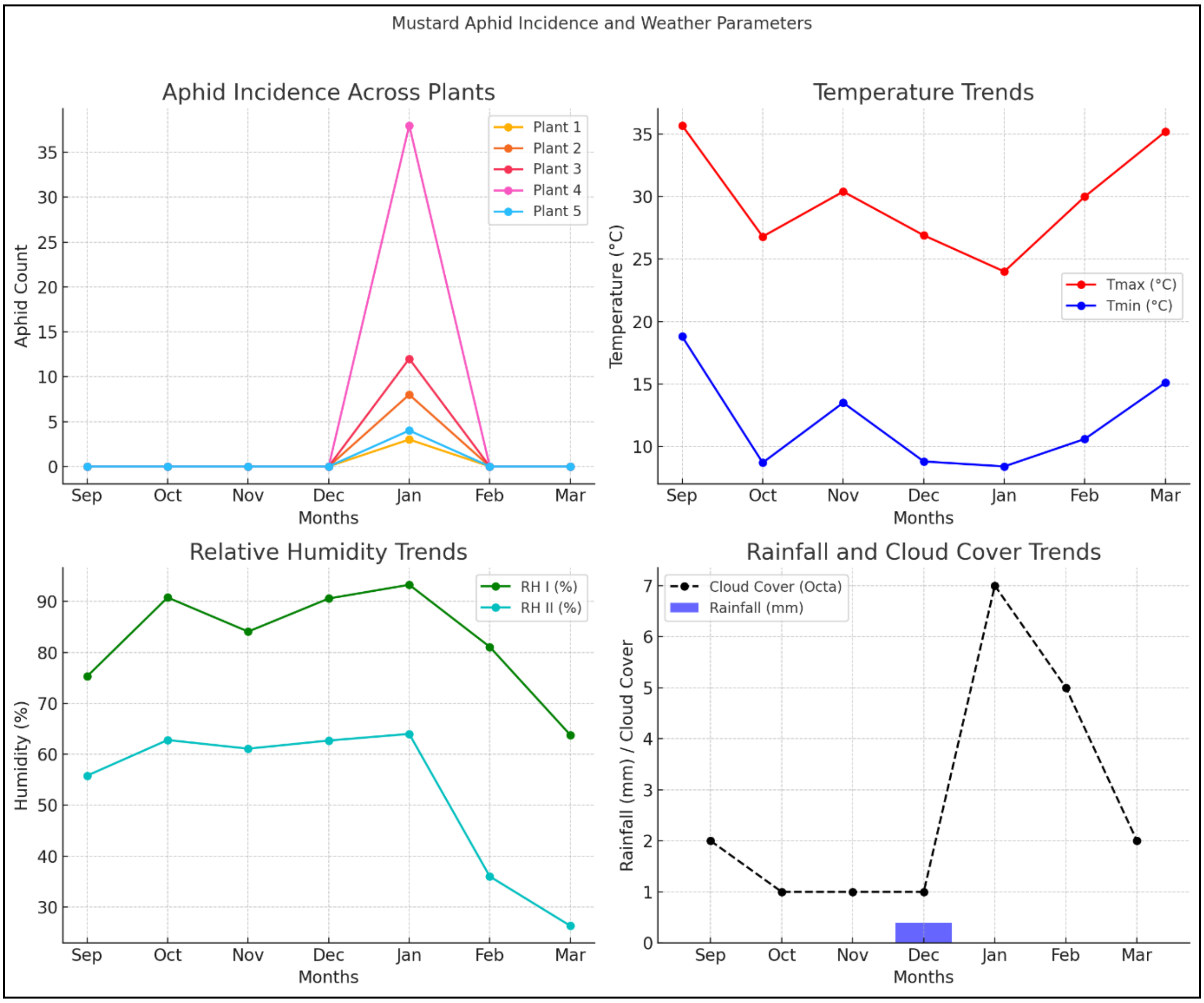

Fig 1: Mustard aphid incidence in relation to weather parameters, including temperature trends, relative humidity trends, rainfall, and cloud cover. The data illustrate the aphid infestation across different plants, highlighting a peak incidence in January during the mustard flowering stage. The figure also depicts variations in maximum and minimum temperature, morning and afternoon relative humidity, rainfall, and cloud cover, demonstrating their influence on aphid infestation dynamics

Conclusion and Recommendations

The study confirms that mustard aphid incidence in Chhatarpur is closely linked to weather conditions, with peak infestations occurring in January due to low temperatures, high humidity, and dense cloud cover. Integrating meteorological data with pest control strategies is crucial to minimizing aphid-induced yield losses. To achieve this, real-time aphid monitoring should begin in December, utilizing weather-based forecasting models for early warning. Eco-friendly insecticides and neem-based formulations should be applied at the flowering stage for effective pest suppression. Climate-smart Integrated Pest Management (IPM) must be implemented by synchronizing weather predictions with targeted interventions to optimize resource use. Strengthening farmer training and extension services will enhance the adoption of bio-control agents and sustainable pest control measures. Additionally, refining predictive models through multi-season research will further improve forecasting accuracy, ensuring proactive aphid management. By integrating scientific advancements with farmer-centric strategies, mustard growers can achieve improved pest resilience, higher yields, and long-term agricultural sustainability.

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