Comprehensive Assessment of Aphid (*Lipaphis erysimi* (Kalt.)) Resistance in Mustard Cultivars

ABSTRACT

The study focuses on mustard (Brassica spp.) crops, crucial rabi oilseed crops in India. This study aimed to assess the susceptibility of 45 mustard crop cultivars to *Lipaphis erysimi* Kaltenbach, commonly known as the mustard aphid, a significant biotic stressor affecting Indian mustard (*Brassica juncea*).The necessity of this study lies in the importance of identifying aphid-resistant cultivars to enhance pest management strategies and improve mustard crop yields.Field experiments were conducted at Jawaharlal Nehru Krishi Vishwavidyalaya in Jabalpur, Madhya Pradesh,India during the rabi season, using a Randomized Block Design. The study utilized a mean aphid index-based scoring scheme to categorize the cultivars into different susceptibility levels, ranging from highly resistant to highly susceptible. The classification was determined based on normal distribution values, including highly resistant (HR), resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S), and highly susceptible (HS).The results revealed that none of the cultivars fell into the highly resistant category, but five cultivars demonstrated resistance, with mean aphid index values below 0.34. Thirty cultivars were classified as moderately resistant, displaying mean aphid index values between 0.34 and 0.66. Six cultivars exhibited moderate susceptibility (mean aphid index between 0.66 and 0.82), while four cultivars were categorized as susceptible (mean aphid index between 0.82 and 0.98). Notably, none of the cultivars were highly susceptible.The study underscores the importance of identifying aphid-resistant cultivars to enhance pest management strategies and improve mustard crop yields. The results provide valuable insights into the susceptibility levels of different cultivars, guiding farmers in selecting appropriate varieties for cultivation. The research also emphasizes the significance of environmentally friendly pest management options, considering the potential risks associated with pesticide use. Overall, this study contributes to the development of sustainable Integrated Pest Management (IPM) techniques for Indian mustard cultivation.

KEYWORDS: Cultivars, *Lipaphis erysimi*, Mustard, Mean aphid index value, Screening

INTRODUCTION

Indian mustard, scientifically known as *Brassica juncea* (L.) Czern. & Coss., belongs to the Brassicaceae (Cruciferae) family and is a significant oilseed crop cultivated globally. According to Sharaya *et al*. (2023), in addition to its role as a valuable oil source, Indian mustard can serve multiple purposes, including use as a vegetable and as raw material for feed and sauces. With a high content of bioactive substances, this adaptable crop provides a cheap and healthy nutritional choice. These include large amounts of dietary fiber, chlorophylls, β-carotene, and ascorbic acid, as well as glucosinolates and their breakdown products, polyphenols such as flavonoids and anthocyanins. Furthermore, mustard is a well-rounded supply of different nutritional elements since it includes volatile components and vital minerals (Tian & Deng, 2020).The mustard crop holds the largest cropping area among oilseed crops cultivated in India. This significant cultivation spans across 6.8 million hectares, resulting in a production output of 9.1 million metric tons. The average yield of the mustard crop is reported to be 1331 kilograms per hectare (GOI, 2020).

Numerous biotic stressors pose serious problems for the Indian mustard crop, with the mustard aphid (*Lipaphis erysimi* Kaltenbach) emerging as a key cause of production fluctuations(Kumar*et al*., 2013).This insect, which mostly affects the crop's above-ground sections, is a major contributor to the reported yield gap between potential and realized. Notably, as reported by Sahoo, 2012 and Yadav *et al*., 2019, the mustard aphid is a common pest in all of the nation's mustard-growing regions.The severity of *L. erysimi* infestation ranges from 10% to 90%, influenced by climatic conditions and the specific growth stages of the crop, as highlighted by Dhillon *et al.* in 2018. This pest poses a substantial threat to both the quality and quantity of mustard seeds. Predicting the onset, spread, and development of aphid infestation presents a considerable challenge, underscoring the need for effective strategies to mitigate the adverse impact of this harmful organism on mustard crops(Rao *et al*.,2014).

The mustard aphid, *Lipaphis erysimi* Kaltenbach, has unique feeding habits and is difficult to control because of its reproductive traits, which include parthenogenesis, a short generation time, viviparity for establishment and multiplication, and oviparity during migration and host finding. These characteristics make managing this pest more difficult.When the infestation is severe, the mustard crop exhibits certain signs, such as leaf curling. Since it is unable to generate pods, the effect on plant development is obvious. Even when new pods do develop, they frequently do not mature and produce harmful seeds as a result. Bakhetia (1983) and Malik and Anand (1984) have documented these deleterious impacts on plant development and seed quality.

Although there are several approaches to managing aphids that have been considered, including changing the date of sowing, using yellow sticky traps, and using biological control, the most common strategy that is currently being used is using pesticides. However, there is an urgent need for environmentally benign and sustainable pest management options given the health and environmental risks connected to the usage of insecticides. Therefore, it is necessary to manage the production system by making soil interventions and applying foliar seed to seed to protect the standing crop from aphids. By overcoming biotic stress, biopesticides may increase financial gains and assist producers in producing robust harvests of Indian mustard. Given their excellent effectiveness and safety to non-target species, new compounds are now emerging as a feasible part of Integrated Pest Management (IPM) techniques for managing mustard aphids (Yadav *et al.,* 2019). Numerous screenings of Brassica germplasm have not shown any sources of aphid resistance in India (Aslam *et al.,* 2011). Therefore, the goal of the current study is to determine the origins of aphid resistance in several cultivars of mustard that might be used.

MATERIAL AND METHODS

Field experiments were conducted to assess the average aphid index across 45 mustard crop cultivars at Jawaharlal Nehru Krishi Vishwavidyalaya in Jabalpur, Madhya Pradesh,India during the rabi season. The seeds utilized in the study were sourced from the Directorate of Rapeseed-Mustard Research (DRMR) in Bharatpur, Rajasthan, and the Zonal Agriculture Research Station in Morena, Madhya Pradesh, India. Employing a Randomized Block Design (RBD), the seeds were sown in the second week of November.

organized into two rows each measuring 5 meters in length. The spacing between rows and individual plants was set at 30 cm and 10 cm, respectively.

Table 1: Aphid index mean-based scoring scheme According to the approach outlined by Patel *et al.,* 1995,

Sr.. No	Description	Grading
1	Plants are completely free from aphids.	0
2	Plants have 1-12 aphids per twig but no symptoms of damage	1
3	Plants with 10-25 aphids on a few twigs but no curling of shoots or leaves.	2
4	Plants have aphid colonies on almost all twigs, leaves start yellowing and drying, and pods are curled.	3
5	Every branch of the plant is fully covered with aphids and some of the branches start drying.	4
6	The plant is completely dry immaturely due to aphid infestation.	5

The mean aphid index was worked out by using the following equation:

Mean aphid index= $\frac{0N + 1N + 2N + 3N + 4N + 5N}{Total\ number\ of\ aphid\ observed}$

Where 0, 1, 2, 3, 4 and 5 are the grading numbers

N= Number of plants showing respective grading number

Statistical analysis

Construction of categorization of aphid index

The classification of the aphid index was determined based on the normal distribution's points of inflexion, which were designated as μ, μ+, μ+, μ+, μ-, μ-, and μ-, respectively. The five categories were displayed as follows:

μ - < HR< μ-,μ - < R< μ-, μ - < MR< μ, μ < MS< μ+, μ + < S < μ+, μ + < HS < μ+

In the context of the study, the symbols represent various categories related to the mean aphid index value:

μ: Represents the mean aphid index value, σ: Denotes the standard deviation of the mean aphid index value, HR: Signifies high resistance, R: Indicates Resistance, MR: Represents moderate resistance, MS: Stands for moderately susceptible, S: Represents Susceptible, HS: Denotes Highly Susceptible.

Conversely, when the categories fall on the higher end of the normal distribution with one point below it, it suggests a tendency for our aphid index to exhibit a positively skewed direction. To assess and compare various cultivars, the mean aphid index values underwent analysis of variance at a significance level of 5%.

RESULT AND DISCUSSION

Based on the combined data from the two years, the classification of different cultivars was conducted, considering both damage symptoms and mean aphid index values. None of the cultivars met the criteria for the highly resistant category (defined by mean aphid index values less than 0.18). Five cultivars, namely RH-406 (0.32), RVM-2 (0.30), RP-9 (0.28), Aravali (0.28), and Durgamani (0.24), exhibited the lowest aphid index values, placing them in the resistant category. Although these cultivars had mean aphid index values exceeding 0.18, they were below 0.34.

Thirty cultivars, including NRCDR-2 (0.64), Basanti (0.65), RGN-73 (0.59), RH-749 (0.59), NRCHB-101 (0.60), GSC-7 (0.57), Shradda (0.54), JM-2 (0.56), Jawahar mustard-1 (0.49), Jawahar mustard-2 (0.53), China Kovind (0.52), SEJ-2 (0.50), Kranti (0.52), Kiran (0.50), IJ-31 (0.49), Gujarat mustard-1 (0.47), JM-3 (0.48), BR-40 (0.49), Ashirwad (0.48), Gujarat mustard-2 (0.47), GSL-1 (0.49), Maya (0.47), PC-5 (0.46), Bhagirathi (0.46), JTC-1 (0.44), Jaganath (0.43), RVM-3 (0.43), DRMRIJ-31

(0.44), RVM-1 (0.44), and Geeta (0.39), displayed were identified as moderately resistant. These cultivars exhibited mean aphid index values ranging from more than 0.34 to less than 0.66.

Table 2: Mean aphid index value of mustard cultivars under field condition

Sr. No	Cultivar	Mean Aphid Index Value		Pooled
		2018-2019	2019-2020	
1	Aravali	0.31* (0.90)	0.25 (0.86)	0.28(.88)
2	SEJ-2	0.42 (0.95)	0.57 (1.03)	0.50(1.00)
3	Swarn Jyoti	0.68 (1.08)	0.75 (1.11)	0.72(1.10)
4	Rohini	0.79 (1.13)	0.93 (1.19)	0.86(1.16)
5	RP-9	0.29 (0.88)	0.26 (0.87)	0.28(0.88)
6	Kranti	0.47 (0.98)	0.56 (1.02)	0.52(1.00)
7	Jawahar mustard-1	0.52 ()1.00	0.56 (1.02)	0.54(1.01)
8	Maya	0.43 (0.96)	0.50 (1.00)	0.47(.98)
9	Jaganath	0.44 (0.96)	0.42 (0.95)	0.43(0.96)
10	RGN-73	0.53 (1.01)	0.65 (1.07)	0.59(1.04)
11	BR-40	0.44 (0.96)	0.53 (1.01)	0.49(0.99)
12	Ashirwad	0.45 (0.97)	0.51 (1.00)	0.48(0.98)
13	Durgamani	0.23 (0.85)	0.25 (0.86)	0.24(0.86)
14	Gujarat mustard-1	0.48 (0.98)	0.49 (0.99)	0.49(0.99)
15	China Kovind	0.53 (1.01)	0.51 (1.00)	0.52(1.00)
16	Bhagirathi	0.39 (0.94)	0.52 (1.00)	0.46(0.97)
17	DRMRIJ-31	0.41(0.95)	0.47 (0.98)	0.44(0.96)
18	NRC-HB-506	0.73 (1.10)	0.80 (1.14)	0.77(1.12)
19	Pusa Bold	0.94 (1.20)	1.02 (1.23)	0.98(1.21)
20	Kiran	0.44 (0.96)	0.56 (1.02)	0.50(1.00)
21	JM-2	0.53 (1.01)	0.58 (1.03)	0.56(1.02)

22	Lakshmi	0.73 (1.10)	0.69 (1.09)	0.71(1.10)
23	YSH-406	0.75 (1.11)	0.89 (1.17)	0.82(1.14)
24	RVM-3	0.39 (0.94)	0.46 (0.97)	0.43(0.96)
25	Varuna	0.73 (1.10)	0.74 (1.11)	0.74(1.11)
26	NRCDR-2	0.59 (1.04)	0.69 (1.09)	0.64(1.06)
27	NRCHB-101	0.57 (1.03)	0.62 (1.05)	0.60(1.04)
28	JTC-1	0.40 (0.94)	0.47 (0.98)	0.44(0.96)
29	GSL-1	0.45 (0.97)	0.52 (1.00)	0.49(0.99)
30	Krishna	0.75 (1.11)	0.77 (1.12)	0.76(1.12)
31	IJ-31	0.45 (0.97)	0.53 (1.01)	0.49(0.99)
32	RH-749	0.53 (1.01 ())	0.64 (1.06)	0.59(1.04)
33	RVM-1	0.39 (0.94)	0.49 (0.99)	0.44(0.96)
34	PC-5	0.43 (0.96)	0.48 (0.98)	0.46(0.97)
35	NC-1	0.84 (1.15)	0.90 (1.18)	0.87(1.17)
36	RH-406	0.30 (0.89)	0.34 (0.91)	0.32(0.90)
37	RVM-2	0.29 (0.88)	0.30 (0.89)	0.30(0.89)
38	Shradda	0.52 (1.00)	0.56 (1.02)	0.54(1.01)
39	JM-3	0.44 (0.96)	0.52 (1.00)	0.48(0.95)
40	Jawahar mustard-2	0.54 (1.01)	0.51 (1.00)	0.53(1.01)
41	Gujarat mustard-2	0.42 (0.95)	0.52 (1.00)	0.47(0.98)
42	Geeta	0.34 (0.91)	0.44 (0.96)	0.39(0.94)
43	GSC-7	0.56 (1.02)	0.57 (1.03)	0.57(1.03)
44	BSH-1	0.76 (1.12)	0.84 (1.15)	0.80(1.14)
45	Basanti	0.64 (1.06)	0.66 (1.07)	0.65(1.07)
	SE(m)±	0.078	0.073	0.075
	C.D. at 5%	0.220	0.204	0.21

*Mean three replications

**Figures in parentheses are square root ($\sqrt{x+0.5}$) transformed values

Six cultivars, including BSH-1 (0.80), NRC-HB-506 (0.77), Krishna (0.76), Varuna (0.74), Swarn Jyoti (0.72), and Lakshmi (0.71), exhibited moderate susceptibility, manifesting mean aphid index values surpassing 0.66 but falling below 0.82. Additionally, Pusa Bold (0.98), NC-1 (0.87), Rohini (0.86), and YSH-401 (0.82) were categorized as susceptible, displaying values less than 0.82 but greater than 0.98. Notably, none of the cultivars were classified as highly susceptible, as none recorded a scale exceeding 0.98.

Table 3: Classification of Mustard Cultivars Based on Susceptibility to *L. erysimi*infestation

S. No	Cultivars	MAIV*Scale and SD** (based on normal distribution values)	Category
1		<0.18	Highly resistant
2	RH-406, RVM-2, Aravali, RP-9, Durgamani	>0.18 but<0.34	Resistant
3	GSC-7, Gujarat mustard-1, JM-3, Ashirwad, Rh-749, NRCHB-101, Bhagirathi, RVM-1, Jaganath, NRCDR-2, China Kovind, Maya, JM-2, Kiran, Jawahar mustard-2, SEJ-2, Rohini, RVM-3, NC-1, JTC-1, BR-40, PC-5, Krishna, GSL-1, Basanti, IJ-31, Jawahar mustard-1, YSH-401, Shradda		Moderately resistant
4	Swarn Jyoti, Varuna, BSH-1, Krishna, Lakshmi, NRC-HB-506	>0.34 but<0.66	Moderately susceptible
5	NC-1, Pusa Bold, Rohini, YSH-401	>0.66 but<0.82	Susceptible
6		>0.82 but<0.98	Highly susceptible

*Meanaphidindexvalue(MAIV)=0.50(μ)

**Standarddeviation(SD)=0.16(σ)

Several researchers have employed the mean aphid index calculation method to categorize mustard cultivars based on their resistance to mustard aphids. In a similar study, Khedkar *et al*. 2011 screened seventeen mustard genotypes/varieties (*Brassica juncea* L.), with GM-2, GM-1, and GM-3 exhibiting low aphid index values (1.18, 1.26, and 1.34) and classified as highly resistant. Conversely, the highest aphid index (2.61) was recorded in genotype BIO-902, comparable to varieties Pusa bold (2.52) and Krishna (2.46), with PM-67, Varuna, and PCR-7 (2.25) following closely. Furthermore, Yadav *et al.* 2017 evaluated 240 *B. juncea* accessions for resistance/tolerance against mustard aphids, categorizing 16 accessions as resistant, 83 as moderately resistant, and 102 as susceptible, while some were identified as highly susceptible. For instance, in a study by Chaudhary and Patel, 2016, 60 Indian mustard lines (*Brassica juncea* L.) were screened for resistance to *Lipaphis erysimi* (Kaltenbach) using the aphid infestation index (A.I.I.). Cultivars NRCM 120, NRCM 353, and Rayad 9602 exhibited the lowest aphid index values (1.22, 1.22, and 1.23, respectively) and were classified as highly resistant (HR). Similarly, Kumari *et al*. (2018) evaluated seventy-seven mustard germplasms against *Lipaphis erysimi*. IC491089 demonstrated tolerance with the least aphid population (21.3-30.7 aphids/top 10 m of the central shoot/plant), while IC385703 was highly susceptible, recording 87.0-195.3 aphids/top 10 cm of the central shoot/plant. Accessions were categorized as tolerant, moderately tolerant, susceptible, and highly susceptible based on the aphid infestation index.In line with these findings, Bavisa *et al*., 2018 reported that aphid populations persisted from the first week of December throughout the crop period, with an aphid index ranging from 0.14 to 4.9 per plant. The infestation gradually increased, reaching its peak in the third week of February, with a recorded aphid index of 4.9 per plant.

CONCLUSION

The findings underscore the importance of breeding and selecting mustard cultivars with enhanced resistance to aphids. The study provides a foundation for future research and cultivar development aimed at mitigating the impact of Lipaphis erysimi on mustard crops. Sustainable and environmentally friendly pest management practices, including the identification of resistant cultivars, are crucial for ensuring the productivity and quality of Indian mustard crops. Continued efforts in this direction can contribute significantly to the development of resilient agricultural systems.

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