Journal of Scientific Research and Reports

Volume 31, Issue 1, Page 76-84, 2025; Article no.JSRR.129379
ISSN: 2320-0227

Screening of Rapeseed-Mustard Genotypes for Resistance to Mustard Aphid Infestation

Arvind [a++], Dalip Kumar [a#], Ankit Saini [a++], Deepak [a†], Lovepreet Kaur [a++] and Kaushik Kumar Das [a‡*]

[a] *Department of Entomology, Chaudhary Charan Singh Haryana Agricultural University, Hisar- 125004, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2025/v31i12747

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/129379

Original Research Article

Received: 05/11/2024
Accepted: 07/01/2025
Published: 08/01/2025

ABSTRACT

Rapeseed-mustard, a key oilseed crop in India, faces significant yield losses due to insect pests, particularly the mustard aphid (*Lipaphis erysimi*). This study evaluated the resistance of 79 rapeseed-mustard genotypes to aphid infestation across three growth stages (aphid appearance, full flowering, and full siliqua formation) during the 2022-23 *Rabi* season. Results revealed significant variability in aphid resistance among genotypes and across growth stages. At the aphid appearance stage, 41 genotypes exhibited resistance (Aphid Resistance Index = 1), while 38 were moderately resistant. As the crop matured, aphid populations increased, and resistance levels

---

[++] *Ph.D. Scholar;*
[#] *Assistant Scientist;*
[†] *Undergraduate;*
[‡] *M.Sc. Scholar;*
**Corresponding author: E-mail: kaushikkumardas2000@gmail.com;*

Cite as: *Arvind, Dalip Kumar, Ankit Saini, Deepak, Lovepreet Kaur, and Kaushik Kumar Das. 2025. "Screening of Rapeseed-Mustard Genotypes for Resistance to Mustard Aphid Infestation". Journal of Scientific Research and Reports 31 (1):76-84. https://doi.org/10.9734/jsrr/2025/v31i12747.*

declined. At the full flowering stage, 31 genotypes remained resistant, with 46 moderately resistant. At the full siliqua formation stage, only six genotypes were resistant, with 69 moderately resistant and four tolerant. No genotypes were categorized as susceptible or highly susceptible throughout the study, indicating a baseline level of resistance in the evaluated germplasm. Aphid populations ranged from 1.2 to 24.6 (aphid appearance), 3.2 to 59.0 (full flowering), and 2.6 to 173.4 (full siliqua formation) aphids per 10 cm twig. These findings emphasize the dynamic nature of host-aphid interactions and the crucial need for growth-stage-specific resistance evaluations in breeding programs. Identifying and utilizing resistant genotypes can significantly reduce reliance on chemical insecticides, promoting sustainable and eco-friendly aphid management strategies in rapeseed-mustard production.

Keywords: Rapeseed-mustard; aphid; screening; genotypes; resistance.

1. INTRODUCTION

Rapeseed-mustard, a significant oilseed crop in India, consists of four *Brassica species*: *Brassica campestris* (rape), *B. juncea* (Indian mustard), *B. napus*, and *B. carinata* (Ethiopian mustard). Indian mustard (*B. juncea*), also known as Mohari, rai, or raya, produces siliqua-type fruits. Grown during the *Rabi* season, *B. juncea* and *B. rapa* thrive in a variety of agro-climatic conditions, including irrigated, rainfed, and mixed cropping systems. Worldwide, rapeseed and mustard are cultivated in 53 countries, particularly in rainfed regions, due to their low water requirement (80–240 mm) (Rani et al., 2024). Rapeseed-mustard accounts for 28.6% of India's total oilseed production, making it the second-largest contributor after groundnut. Globally, it ranks third, contributing 12% to the world's vegetable oil production (Qian & Kede, 2022) valued for its polyunsaturated fats and antioxidants (Aakanksha et al., 2023). India holds the top position in the area under rapeseed-mustard cultivation and ranks second in production, trailing only China (Khavse et al., 2014). Primarily cultivated during the Rabi season, rapeseed-mustard occupies 7.99 million hectares in India, with a production of 11.96 million tonnes and a productivity rate of 1,497 kg/ha (Anonymous, 2024a). Haryana exceeds the national average productivity of rapeseed-mustard with 1,914 kg/ha. The state cultivates 0.714 million hectares, producing 1.366 million tonnes (Anonymous, 2024a). Mustard is the leading oilseed crop in India, with a production of 13.161 million tonnes, contributing 33.24% to the country's total oilseed output (Anonymous, 2024b). The yield potential of rapeseed-mustard in India is constrained by various challenges, such as poor soil fertility, water stress, insect pests, climate change, and limited access to high-quality seeds and advanced farming practices.

Of the 38 insect pests affecting rapeseed-mustard in India, ten are of major economic importance, leading to an estimated 30% yield loss (Dhaliwal et al., 2004). Among these, mustard aphid (*Lipaphis erysimi*) is the most damaging, leading to yield losses ranging from 9% to 95% (Bakhetia, 1987; Bakhetia & Sekhon, 1986; Das, 2002; Rai, 1976) and proved to be most significant pest of rapeseed mustard specially in late grown crop (Arvind et al., 2024). Nymphs and adults of mustard aphid suck sap from tender leaves, buds, and pods, causing wilting, yellowing, and stunted growth. The honeydew they excrete encourages sooty mold development, which hampers photosynthesis and significantly reduces yield (Awasthi, 2002; Khan et al., 2015). Mustard aphid remains active throughout the year, with its peak activity observed between December and March (ICAR, 2018). Although various methods are available for managing agricultural pests, each comes with its own set of advantages and disadvantages. These methods often present trade-offs, where certain benefits are accompanied by specific limitations. In real-world scenarios, the economic and ecological aspects of pest management can sometimes be in conflict. For example, chemical control, while being one of the most preferred and effective pest management methods, poses significant environmental and health risks. These include toxicity hazards to individuals involved, residue contamination in food and the environment, resistance development in pests, and a negative impact on the long-term sustainability of agricultural production systems (Harjindra et al., 2017; Sachan & Purwar, 2007). However, adopting seed treatments can reduce the quantity and exposure of pesticides in the environment, while also minimizing yield loss due to mustard aphid and limiting insect infestation (Arvind. et al., 2023). The use of chemical pesticides in seed treatments is not completely risk-free, as it reduces but does not eliminate pesticide exposure, with their residues in soil and plant matter remaining a significant concern. Recent global research has shifted focus toward eco-friendly alternatives to insecticides, such as host plant resistance. Host plant resistance provides an economical and sustainable solution to reduce aphid infestations in Brassica crops, integrating seamlessly into Integrated Pest Management (IPM) systems. Resistant germplasm is particularly valuable as it eliminates the need for additional chemical inputs or separate pest management practices, while ensuring stabilized yields over time. Even moderately resistant varieties can support other strategies to reduce pesticide use. The development of insect-resistant cultivars begins with identifying sources of resistance and systematically screening them (Stoner & Shelton, 1988). Extensive efforts have been made to evaluate resistance in Brassica species' primary gene pools (Amjad & Peters, 1992; Brar & Sandhu, 1978; Saxena et al., 1995; Sekhon & Åhman, 1993). Understanding the dynamics of aphid populations across different Brassica genotypes is crucial for predicting the intensity and timing of infestations. Resistant genotypes provide an ecological approach to pest management, ensuring sustained agricultural production while safeguarding environmental health. Considering these factors, the current screening experiment entitiled "screening of rapeseed-mustard genotypes for resistance to mustard aphid infestation".

2. MATERIALS AND METHODS

The experiment was carried out over two consecutive years, from 2022-23 to 2023-24, at the Oilseed Section of the Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, involving 50 rapeseed-mustard genotypes. Hisar, located at 29°08' N, 75°42' E and at an elevation of 215 m, lies within Agroclimatic Zone-II (southwestern zone) characterized by arid conditions. Sowing took place in the second half of November, with a spacing of 30 × 15 cm and two replications, to align crop growth with the peak activity of aphids (*Lipaphis erysimi*). All recommended practices from CCSHAU, except for pest protection, were followed to ensure optimal crop health.

2.1 Observation Recorded

Observations on the mustard aphid population were recorded on ten randomly selected plants per entry at three different crop stages: the first appearance of aphids, full flowering stage, and full siliqua formation stage, following the method described by Dhillon et al., (2018) on 50 rapeseed-mustard genotypes and were categorized into different classes.

3. RESULTS

During the *Rabi* season of 2022–23, 79 rapeseed-mustard genotypes were screened for their resistance to mustard aphid infestation using the index proposed by (Dhillon et al., 2018). Aphid populations were counted on the top 10 cm twig across three crop growth stages: aphid appearance, full flowering, and full siliqua formation.

3.1 Aphid Appearance Stage

At the aphid appearance stage, the genotypes with the lowest infestation were RH 2199 (1.2 aphids, ARI 1), HUJM-21-4 (1.4 aphids, ARI 1), and DRMRHT-17-2 (1.6 aphids, ARI 1), RHH 2201 (2.8 aphids, ARI 1.1) etc. all were classified based on the index (Table 2). Conversely, the varieties DRMRCI-160 (24.6 aphids, ARI 1.2), NPJ265 (19.0aphids, ARI 1.2), SVJH73 (17.0 aphids, ARI 1.3), BAUM117 (16.8 aphids, ARI 1.4) etc. had the highest infestations and were categorized as moderately resistant. Of the 79 genotypes, 41 were classified as resistant (ARI = 1), while 38 were moderately resistant (ARI 1–2). Other resistance categories, such as tolerant, susceptible, and highly susceptible, were not reported, likely due to mild aphid infestations attributed to favorable climatological conditions that limited migration and population buildup. Mean aphid population across all the screened genotypes at this stage was 8.18 aphids per 10cm twig while, mean aphid resistance index was 1.08. At the aphid appearance stage aphid ranged between 1.2 to 24.6 aphids per 10cm twig across all the genotypes.

3.2 Full Flowering Stage

During the full flowering stage, the genotypes with the least aphid infestation were RH2199 (3.2 aphids, ARI 1), DRMRHT 17-2 (4.8 aphids, ARI 1), and DRMRQ2920 (4.8 aphids, ARI 1), JM15-6 (5 aphids, ARI 1), etc. all classified based on the index. In contrast, the highest infestations occurred in PHR4284 (59.0 aphids, ARI 1.7), RB113 (48.2 aphids, ARI 1.7), and SVJH73 (47.7 aphids, ARI 1.5), RMM19-12 (40.4 aphids, ARI

1.6), etc. Among these, RH 2220 was classified as "tolerant," while the others were moderately resistant. Of the 79 genotypes screened, 31 were resistant (ARI = 1), 46 were moderately resistant (ARI 1–2). Other resistance categories, such as tolerant, susceptible, and highly susceptible, were absent, likely due to mild aphid infestations. Mean aphid population across all the screened genotypes at this stage was 17.80 aphids per 10cm twig while, mean aphid resistance index was 1.19. At the full flowering stage aphid ranged between 3.2 to 59.0 aphids per 10cm twig across all the genotypes.

3.3 Full Siliqua Formation Stage

At the full siliqua formation stage, the least aphid infestation was observed in BAUM-2022-2 (0.6 aphids, ARI 1), JKJH12 (0.8 aphids, ARI 1), KMR(E) 22-2 (0.8 aphids, ARI 1), TM258 (1 aphids, ARI 1),etc. each with, ARI=1 were classified as resistant. The highest infestations were recorded in KMR (E) 22-1 (173.4 aphids, ARI 1.8), RHH 2203 (60.8 aphids, ARI 2.4), JH2102 (24.6 aphids, ARI 2.1). Out of the 79 genotypes, 06 were resistant (ARI = 1), 69 were moderately resistant (ARI 1–2), four were tolerant, and no genotype, was categorized as "susceptible" or "highly susceptible". At the full siliqua formation stage aphid ranged between 2.6 to 173.4 aphids per 10cm twig across all the genotypes.

4. DISCUSSION

The study offers an in-depth assessment of aphid resistance in 79 rapeseed-mustard genotypes during the Rabi season of 2022–23, highlighting differences in infestation levels and resistance at three distinct growth stages. The study highlights significant variability in aphid resistance across different growth stages and genotypes, emphasizing the importance of stage-specific evaluations. At the aphid appearance stage, 41 genotypes were resistant (ARI = 1), while 38 were moderately resistant (ARI 1–2), with no susceptible categories due to mild pest infestation attributed to crop-favorable climatic conditions. During the full flowering stage, as infestation increased from 8.18 (at aphid appearance stage) to 17.80 mean aphid population resistance decreased, with only 31 genotypes remaining resistant and 46 moderately resistant, as aphid populations

Table 1. Aphid infestation index for screening rapeseed-mustard genotypes for resistance

S. No.	Aphid population index (API)	Aphid damage index (ADI)	Aphid resistance index (ARI)	Resistance category
1	1 = No or less than 20 aphids on the inflorescences of test plants	1 = Normal plant growth, no symptoms of injury, no curling or yellowing of leaves	0.1-1.0 (API+ADI/2)	0.0-1.0 = Resistant
2	2 = upto 25% inflorescences have 21- 100 aphids on the test plants	2 = Average plant growth, curling and yellowing of few leaves, flowering and fruiting	1.1-2.0 (API+ADI/2)	1.1-2.0 = Moderately resistant
3	3 = upto 50% of inflorescences have 101- 250 aphids across test plants	3 = Poor plant growth, curling and yellowing of leaves on some branches, drying of few flowers and poor pod setting	2.1-3.0 (API+ADI/2)	2.1-2.5 = Tolerant
4	4 = upto 75% inflorescences have 251- 500 aphids across test plants	4 = Stunted plant growth, heavy curling and yellowing of leaves all through the plant, drying and curling of almost half the inflorescence with poor flowering and rare pod setting	3.1-4.0 (API+ADI/2)	2.6-3.5 = Susceptible
5	5 = 100% of inflorescences have more than 500 aphids across test plants	5 = Severe stunting and ragged plant appearance, yellowing and curling of almost all the leaves, complete drying of inflorescence without any flower and immature drying of pods if any	4.1-5.0 (API+ADI/2)	3.6-5.0 = Highly susceptible

Table 2. Aphid infestation on rapeseed-mustard genotypes at different crop stages

		At aphid initiation			At full flowering			At full siliqua formation		
S. No.	**Genotypes**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**
1	RH 2199	6.8	1	R	8	1	R	4.6	1.2	MR
2	HUJM-21-4	3	1	R	9	1	R	5.2	1.3	MR
3	DRMRHT- 17-2	8.4	1.1	MR	11.6	1.1	MR	4.6	1.3	MR
4	RHH 2201	6.6	1	R	12.4	1	R	4.6	1.2	MR
5	DRMRRIL 21-1	4	1	R	6.4	1	R	3.4	1.1	MR
6	DRMR 2020-8	6.8	1	R	8.8	1	R	4.6	1.2	MR
7	BAUM-2022-2	6.4	1	R	7.2	1	R	6.2	1.3	MR
8	RB- 110	10.4	1.1	MR	14.8	1.1	MR	3.4	1.1	MR
9	Pusa MH 111	3.8	1	R	7.6	1	R	5.6	1.2	MR
10	BMH19011	8.2	1.1	MR	20.6	1.2	MR	7.8	1.3	MR
11	DRMRHJ 1419	3.6	1	R	7.6	1	R	8.6	1.3	MR
12	JM-15-8	14.4	1.2	MR	59	1.7	MR	7.6	1.8	MR
13	Radhika	5.4	1	R	9.6	1	R	5.2	1.1	MR
14	DRMRHJ 310	7.4	1	R	13.4	1	R	5.6	1.2	MR
15	RH 2199-6	4.8	1	R	9.4	1	R	9	1.6	MR
16	DRMRQ 29-20	8.4	1	R	13	1	R	8.2	1.3	MR
17	DRMRHT 18-141	9.8	1.1	MR	20.4	1.4	MR	4	1.1	MR
18	PR-2019-1	9.4	1.2	MR	48.2	1.7	MR	6.6	1.3	MR
19	DM 2020-3	9	1.1	MR	23.4	1.4	MR	4.6	1.2	MR
20	JKJH12	11.2	1.1	MR	15.6	1.1	MR	3.2	1.1	MR
21	PDZ 18	7.4	1	R	9.8	1	R	5.8	1.2	MR
22	Pusa QMH 1	12.6	1.1	MR	18.6	1.1	MR	6.2	1.2	MR
23	DRMRCI- 155	5.4	1	R	16.2	1	R	6	1.2	MR
24	DRMRSJ 294	10.2	1.2	MR	21.4	1.5	MR	7	1.2	MR
25	JH21002	6	1	R	10.2	1	R	2.2	1.1	MR
26	DRMRIJ 21-51	11	1.1	R	19.2	1.2	MR	3	1.1	MR
27	PYS 2018-1	9	1	R	14	1.3	MR	173.4	1.8	MR
28	DRMRCI- 154	7	1.1	MR	15.2	1.2	MR	5.4	1.2	MR

		At aphid initiation			At full flowering			At full siliqua formation		
S. No.	**Genotypes**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**
29	NRCYS 05-02	11	1.2	MR	27.4	1.5	MR	9.4	1.5	MR
30	KMR 22-4	12.8	1.2	MR	24.8	1.8	MR	17.6	2.1	T
31	KMR 22-3	3	1	R	5.4	1	R	5.2	1.2	MR
32	KRANTI	5	1	R	7.4	1	R	2.8	1.1	MR
33	RAURD 18-1	3.8	1	R	5	1	R	2.4	1.1	MR
34	KMR(E) 22-2	12.6	1.3	MR	40.4	1.6	MR	22.8	2.1	T
35	NPJ 264	2.8	1.1	MR	7	1.2	MR	7	1.3	MR
36	RHH 2203	7	1	R	15.8	1.5	MR	12	1.6	MR
37	KMR(L) 22-6	6	1.2	MR	15.8	1.3	MR	24.6	2.1	T
38	JKJH11	12	1.1	MR	37.2	1.4	MR	7.2	1.4	MR
39	TM260	1.6	1	R	4.8	1	R	3.6	1.2	MR
40	TM258	3.4	1	R	5	1	R	0.6	1	MR
41	RHH 2202	9	1	R	28	1.2	MR	7	1.5	MR
42	PDZ 19	10.6	1.2	MR	36.8	1.5	MR	8.4	1.6	MR
43	RH 2187	9.2	1.1	MR	18.6	1.2	MR	3.4	1.2	MR
44	DTM- 341	6.2	1	R	13.6	1.1	MR	3	1.2	MR
45	RH(OE) 1806	11	1.2	MR	26	1.4	MR	7.2	1.4	MR
46	4205A252-01	4.4	1	R	4.8	1	R	1.8	1.2	MR
47	RGN 526	1.4	1	R	5	1	R	2.8	1.1	MR
48	NPJ 259	4	1	R	8.2	1	R	2.4	1.1	MR
49	RH 2148	13.8	1.3	MR	35.4	1.5	MR	7.2	1.4	MR
50	RH 1999-22	7.4	1	R	16.6	1.1	MR	3.8	1.1	MR
51	KMR(E) 22-1	6.8	1.1	MR	14	1.1	MR	6.2	1.3	MR
52	LES 67	8	1	R	16.8	1.1	MR	1.8	1.1	MR
53	HUJM-21-1	4.2	1	R	11.6	1.1	MR	5.2	1.3	MR
54	RB- 113	4.6	1	R	14.4	1	R	3.4	1.1	MR
55	DRMR 2020-3	8.2	1.1	MR	17.6	1.2	MR	9.6	1.6	MR
56	KMR(L) 22-5	6	1.1	MR	18.6	1.2	MR	11	1.5	MR
57	SKM 1924	5	1	R	7.4	1	R	0.8	1	R
58	ANDM 14-09	12.8	1.2	R	30.2	1.4	MR	17.6	1.6	MR

		At aphid initiation			At full flowering			At full siliqua formation		
S. No.	**Genotypes**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**	**Aphid/ 10 cm top twig**	**ARI**	**Resistant category**
59	NMH90M01	13	1.2	MR	38	1.2	MR	10	1.5	MR
60	KBH5207	3.4	1	R	8.6	1	R	1.4	1.1	MR
61	SKM 2012	6.2	1.1	MR	11.6	1.1	MR	7	1.3	MR
62	RGN 534	1.2	1	R	3.2	1	R	1.4	1	R
63	KGMH- 9783	16.6	1.2	MR	33.6	1.4	MR	7.6	1.4	MR
64	NAMJH21-04	24.6	1.2	MR	38.2	1.4	MR	8.2	1.4	R
65	PR-2020-14	6.8	1	R	9.4	1	R	0.8	1	R
66	LES 66	6.8	1.1	MR	12.4	1.1	MR	6.8	1.3	MR
67	NPJ 261	7.2	1	R	9.6	1	R	1	1	R
68	RMM-19-12	19	1.2	MR	31.8	1.2	MR	6.2	1.3	MR
69	DRMRIJ 21-37	8	1	R	17.4	1.1	MR	8.4	1.4	R
70	PRL-2020-5	16.8	1.4	MR	27.6	1.4	MR	6.8	1.4	MR
71	PRL-2020-8	11	1.1	MR	21.6	1.4	MR	6.8	1.4	MR
72	DRMRHJ319	12.2	1.2	MR	24.8	1.4	MR	4	1.2	MR
73	ACNMM- 3	7	1	R	12.4	1	R	3	1.1	MR
74	PHR 4284	17	1.3	MR	47.5	1.5	MR	9.8	1.5	MR
75	TM316	11.4	1.1	MR	16.4	1.1	MR	4	1.1	MR
76	BAUM- 17	5	1.1	MR	13.2	1.2	MR	5.8	1.2	MR
77	SVJH- 73	13	1.1	MR	19.8	1.1	MR	3.4	1.1	MR
78	NPJ 265	3.4	1	R	7.8	1	R	2.4	1.1	MR
79	DRMRCI- 160	6.8	1.1	MR	31.4	1.8	MR	60.8	2.4	T
Mean		8.18	1.08	41R+38MR	17.80	1.19	31R+48MR	8.92	1.31	6R+69MR+4T

R is Resistant; MR is moderately resistant; T is tolerant, S is susceptible.Mean aphid population= Number of aphid/ 10 plants increased to a mean of 17.80 per 10 cm twig (ARI 1.19). These findings are in accordance with the finding of a behavioral study on mustard aphids conducted by (Mamun et al., 2010), who reported that response od phid vary at different crop stages as well as different genotypes of rapeseed-mustard. At the siliqua formation stage, aphid infestations peaked, reducing the resistant genotypes to six, with 69 moderately resistant and four tolerant, reflecting declining resistance at later growth stages. Aphid populations across genotypes ranged from 1.2–24.6 (aphid appearance stage), 3.2–59.0 (full flowering stage), and 2.6–173.4 (full siliqua formation stage) aphids per 10 cm twig. These results are partially supported by (Maurya et al., 2018) who evaluated 20 *Brassica* types, recording aphid populations ranging from 9.13 to 100.84 per plant, with the highest in RLM 619 and the lowest in Pusa Jagnath. Despite higher infestation levels, no genotypes were categorized as susceptible or highly susceptible, indicating baseline resistance across the screened varieties. These findings underscore the dynamic nature of host-aphid interactions, the need for growth-stage-specific resistance evaluations, and the importance of developing genotypes with sustained resistance for effective aphid management.

5. CONCLUSION

This study demonstrates significant variability in aphid resistance among 79 rapeseed-mustard genotypes across three key growth stages. While a baseline level of resistance was observed throughout the study, with no genotypes categorized as highly susceptible, the observed decline in resistance as the crop matured highlights the dynamic nature of host-aphid interactions. These findings underscore the critical need for growth-stage-specific evaluation of aphid resistance in breeding programs. Identifying and utilizing resistant genotypes can significantly reduce reliance on chemical insecticides, promoting sustainable and eco-friendly aphid management strategies in rapeseed-mustard production.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Aakanksha, Y.B.G., Mathur, S., Yadava, S. K., & Ramchiary, N. (2023). Genomic Designing for Nutraceuticals in Brassica juncea. In *Compendium of Crop Genome Designing for Nutraceuticals* (pp. 1–52).

Amjad, M., & Peters, D. C. (1992). Survival, development, and reproduction of turnip aphids (Homoptera: Aphididae) on oilseed brassica. *Journal of Economic Entomology*, *85*(5), 2003–2007. https://academic.oup.com/jee/article-abstract/85/5/2003/880097

Anonymous. (2024a). *Area, Production and Productivity of Rapeseed and Mustard in India*. 2024. https://www.indiastat.com/data/agriculture/rapeseed-mustard

Anonymous. (2024b). *First advance estimate of food grains*. First Advance Estimate of Food Grains.

Arvind, Jat, B. L., Chand, A., Kumar, S., Yadav, M. S., & Redhu, M. (2024). Population dynamics of mustard aphid and its natural enemies. *Indian Journal of Entomology*, e24478.

Arvind., Choudhary, S., Jat, B. L., Chand, A., Kadawla, K., Kumawat, S., & Redhu, M. (2023). Bio-efficacy of Chemical Insecticides against Major Insect Pests of Mustard Applied through Seed Treatment. *International Journal of Environment and Climate Change*, *13*(9), 1119–1127.

Awasthi, V. B. (2002). *Introduction to General and Applied Entomology*. Scientific Publisher.

Bakhetia, D. R. C. (1987). Insect pests of rapeseed-mustard and their management. *Plant Protection in Field Crops*, *27*, 249–259.

Bakhetia, D. R. C., & Sekhon, B. S. (1986). Pest management in rapeseed and mustard. *Pesticides*, *20*, 32–38.

Brar, K. S., & Sandhu, G. S. (1978). Comparative resistance of different brassica species/varieties to the mustard aphid (Lipaphis erysimi Kalt.) under natural and artificial condition. *Indian Journal of Agricultural Research*, *12*(3), 198–200.

Das, B. C. (2002). Ecology and diversity of agricultural crop infesting aphids

(Homoptera: Aphididae). *Bangladesh Journal of Aphidology*, *16*, 51–57.

Dhaliwal, G. S., Arora, R., & Dhawan, A. K. (2004). Crop losses due to insect-pests in Indian agriculture. *Indian Journal of Ecology*, *31*, 1–7.

Dhillon, M. K., Singh, N., Tanwar, A. K., Yadava, D., & Vasudeva, S. (2018). Standardization of screening techniques for resistance to Lipaphis erysimi (Kalt.) in rapeseed-mustard under field conditions. *Indian Journal of Experimental Biology*, *56*, 674–685.

Harjindra, S., Deshwal, H., Haldhar, S., & Veer, S. (2017). Bio-efficacy of some insecticides and botanicals against mustard aphid, Lipaphis erysimi Kalt.(Hemiptera: Aphididae) on Indian mustard. *Journal of Experimental Zoology*, *20*(1), 249–253.

ICAR, D. (2018). *ICAR-Directorate of Rapeseed-Mustard Research*. http://www.drmr.res.in/aphidforecast/aphid_lifecycle.html

Khan, I. A., Ahmad, M., Akbar, R., Hussain, S., Saeed, M., Farid, A., Shah, R. A., Fayaz, W., Shah, B., Manzar, M., Din, U., Imtiaz, C., Khan, A., & Shah, A. (2015). Study on Aphids density and yield components of 12 brassica genotypes under field conditions in Peshawar, Pakistan. *Journal of Enotomology and Zoology Studies*, *3*(6), 11–15.

Khavse, R., Singh, R., Manikandan, N., & Chaudhary, J. L. (2014). Influence of temperature on rapeseed-mustard yield at selected locations in Chhattisgarh state. *Current World Environment, 9*(3), 1034–1036.

Mamun, M. S. A., Ali, M. H., Ferdous, M. M., Rahman, M. A., & Hossain, M. A. (2010). Assessment of several mustard varieties resistance to mustard aphid, Lipaphis erysimi (Kalt.). *J. Soil Nature*, *4*(1), 34–38.

Maurya, N. K., Singh, R., Singh, J., Nigam, R., Husan, W., & Kumar, A. (2018). Screening of rapeseed-mustard varieties against mustard aphid (Lipaphis erysimi). *South Asian Journal of Food Technology and Environment*, *4*(2), 709–716.

Qian, Z., & Kede, L. (2022). Worldwide rapeseed (Brassica napus L.) research: A bibliometric analysis during 2011–2021. *Oil Crop Science*, *7*(4), 157–165.

Rai, B. K. (1976). *Pests of oilseed crops in India and their control.* (B. K. Rai (ed.)). Indian Council of Agricultural Research.

Rani, P., Rani, J., Mittal, A., & Sheoran, N. (2024). Assessment of Drought Tolerance of Two Cultivars of Indian Mustard (Brassica juncea) Using Morphological and Physiological Parameters. *Archives of Current Research International*, *24*(5), 437–450.

Sachan, G. C., & Purwar, J. P. (2007). Integrated insect pest management in rapeseed and mustard. In *Novel approaches* (Vol. 7, pp. 399–423).

Saxena, A. K., Bhadoria, S. S., Gadewadikar, P. N., Barteria, A. M., Tomar, S. S., & Dixit, S. C. (1995). Yield losses in some improved varieties of mustard by aphid, Lipaphis erysimi Kalt. *Agric Sci Dig*, *15*, 235–237.

Sekhon, B. S., & Åhman, I. (1993). Insect Resistance with Special Reference to Mustard Aphid. In *Monographs on Theoretical and Applied Genetics* (pp. 206–221). https://doi.org/10.1007/978-3-662-06166-4_13

Stoner, K. A., & Shelton, A. M. (1988). Role of nonpreference in the resistance of cabbage varieties to the onion thrips (Thysanoptera: Thripidae). *Journal of Economic Entomology*, *81*(4), 1062–1067.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/129379