Original Research Article

Variation in Mustard Aphid (*Lipaphiserysimi*) Infestation and Resistance Levels across Diverse Rapeseed-MustardGenotypes

ABSTRACT

The present study evaluated 89 rapeseed-mustard genotypes for their resistance against mustard aphid during the *Rabi* season of 2023–24 at CCSHAU, Hisar, Haryana to understand the role of phenological and genotypic variations influencing aphid resistance. Screening targeted three key crop stages: aphid appearance, full flowering, and siliqua formation to measure aphid infestation levels using standardized indices. Aphid infestation was consistently higher in *B. juncea* (7.81 aphids/10 cm twig) compared to *B. napus* (1.88 aphids) during early stages of crop growth. At the aphid appearance stage, 60 genotypes were resistant (ARI = 1), 28 moderately resistant (ARI 1–2), and one tolerant. During the full flowering stage, resistant genotypes number declined slightly to 54 while, 32 remained moderately resistant. At full flowering, infestation in *Brassicajuncea* (17.08 aphids/10 cm twig) remained higher than in *B. napus* (1.88 aphids/10 cm twig). The full siliqua formation stage saw higher aphid infestations, with four genotypes categorized as susceptible and eight as tolerant. However, by the full siliqua formation stage, the infestation levels between the *B. juncea* and *B. napus* (30.12 and 27.63 aphids) were nearly equal, indicating either a convergence in susceptibility at later crop stages or some sort of developmental asynchrony. The differential response of *B. napus* and *B. juncea* genotypes across crop growth stages, points to potential avenues for breeding programs to improve resistance in rapeseed-mustard crops.

Keywords:Lipaphis erysimi, oilseed, rapeseed-mustard, resistance, screening

1. INTRODUCTION

Rapeseed-mustard, an important oilseed crop in India, comprises four Brassica species: *Brassica campestris* (rape), *B. juncea* (Indian mustard), *B. napus*, and *B. carinata* (Ethiopian mustard). It is cultivated during the *Rabi* season, *B. juncea* and *B. rapa* adapt well to diverse agro-climatic conditions, including irrigated, rainfed, and mixed cropping systems. Globally, rapeseed and mustard are grown across 53 countries, generally favoured in rainfed areas for 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 limited by several challenges, including poor soil fertility, water stress, insect pests, climate change, and restricted access to high-quality seeds and advanced farming techniques.

Among the 38 insect pests affecting rapeseed-mustard in India, ten are economically significant, causing an estimated 30% yield loss (Dhaliwal et al., 2004). Among these, mustard aphid (*Lipaphiserysimi*) is the most damaging insect pest, 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, which encourages sooty mold development, hampers photosynthesis and significantly reduces yield (Awasthi, 2002; Khan et al., 2015). Mustard aphid remains active throughout the year, with its peak activity is observed between the months of December and March (ICAR (DRMR), 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). Seed treatments reduce pesticide quantity and exposure, limit yield loss from mustard aphids, and control infestations (Arvind. et al., 2023). However, they don't eliminate risks, as pesticide residues in soil and plants remain a concern.

Recent research emphasizes eco-friendly alternatives like host plant resistance, offering a sustainable solution to aphid infestations in *Brassica* crops. Resistant germplasm reduces the need for chemical inputs, stabilizes yields, and can be integrated into IPM systems. Even moderately resistant varieties help reduce pesticide use. The development of insect-resistant cultivars begins with identifying sources of resistance and systematically screening them (Arvind et al., 2025; 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 entitled "Variation in mustard aphid, *L.erysimi* infestation levels across diverse rapeseed-mustard genotypes" was carried out.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

The experiment was carried out over *Rabi*, 2023-24, at research farm, Department of Genetics and Plant Breeding, CCSHAU, Hisar, Haryana involving 89 rapeseed-mustard genotypes. Hisar, lies within Agroclimatic Zone-II (southwestern zone) characterized by arid conditions, hot summers and very cold winters. The Directorate of Rapeseed-Mustard Research (DRMR, Bharatpur) provided various germplasm and advanced genotypes under the All India Coordinated Research Project for rapeseed-mustard to screen for resistance against mustard aphid. The sowing of crop was carried out in the second half of November, with a spacing of 30 × 15 cm and three replications, to align the crop growth with the peak activity of aphid (*L.erysimi*) infestation. All recommended practices for optimal crop production and health were followed from the package and practices of CCSHAU, except for pest protection.

2.1 Observation recorded

Observations on the mustard aphid population were recorded on ten randomly selected plants per entry at three different crop stages *viz.*, the first appearance of aphids, full flowering stage, and full siliqua formation stage. The observation was taken on 50 rapeseed-mustard genotypes. The methodological procedure for taking observations and further categorization of the genotypes on the basis of resistance or infestation level against aphids along with aphid population index, aphid damage index, aphid resistance index (table2) were followed from Dhillon et al., (2018).

3. RESULTS AND DISCUSSION

During the *Rabi* season of 2023–24, 89 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. Most of the genotypes belonged to *B. juncea* group while 08 genotypes viz., PGSH 1711, AKGS 20-9, AKMS 8141,GSL-1,JGS-16-9,GSC-6, GSC-64 and AKGS 2461 belonged to *B. napus* group.

3.1 Aphid appearance stage

At the aphid appearance stage, the genotypes with the lowest infestation were KMR (E), AKMS18-89-1, DRMRHT17-23, RB114 each having 0.0 aphid and aphid resistance index, ARI (1) all were classified as "resistant" based on the index (Table 1). Conversely, the varieties *Radhika* (70.2 aphids, ARI 2.1), LES68 (54.0 aphids, ARI 1.5), NPJ259 (47.6 aphids, ARI 1.8), KBH51.6 (46 aphids, ARI 1.7) etc. had the highest infestations and were categorized as moderately resistant except Radhika which was categorised as "tolerant". Of the 89 genotypes, 60 were classified as resistant (ARI = 1), while 28 were moderately resistant (ARI 1–2) while only one genotype i.e. *Radhika* was categorised as "tolerant" at this stage. Other resistance categories, such as susceptible, and highly susceptible, were not reported at this stage, likely due to mild aphid infestations attributed to favourable climatological conditions that limited migration and population build up. Mean aphid population across all the screened genotypes at this stage was 7.27 aphids per 10cm twig while, mean aphid resistance index was 1.11 (Fig.1). Mean aphid infestation in *B. juncea* group (7.81 aphids/ 10cm twig) remained significantly higher than that in *B. napus* group (1.88 aphids/ 10cm twig) while, mean ARI in two group's genotype was 1.12 and 1.01, respectively. At the stage when aphids appeared, the number of aphids ranged from 0.0 to 70.7 per 10 cm twig across all genotypes. . The screening revealed clear differences between the *B. juncea* and *B. napus* groups, with *B. napus* consistently exhibiting lower aphid infestations, particularly during the early stages. These findings are corroborating with the findings of (Mamun et al., 2010) who observed that *B. campestris* was the most favoured plant species, whereas *B. napus* was notably less preferred in comparison to the other two species, and (Vekaria & Patel, 2000) concluded that mustard genotypes belonging to the *B. campestris* group were more susceptible to aphid infestations compared to those in the *B. juncea* group. At the aphid appearance stage, favourable climatic conditions likely limited aphid population build up, resulting in most genotypes being classified as resistant (ARI = 1) or moderately resistant (ARI 1–2), with a solitary tolerant genotype (Radhika). Mean infestations in *B. napus* genotypes were significantly lower, suggesting inherent resistance in this group compared to *B. juncea*. However, finding of present study partially contradicted with that of (Farooq & Tasawar, 2007) who reported that field screening in 2000–2001 of 23 *Brassica* cultivars found *B. napus* (var. Bulbul-98) most susceptible (70.66 aphids/10 cm inflorescence) and *B. campestris* (var. PeeliSarson) most tolerant (41.74 aphids/10 cm). *L. erysimi* dominated over *Brevicorynebrassicae*.

3.2 Full flowering stage

During the full flowering stage, the genotypes with the least aphid infestation were KMR (E)22-2, RGN563, PYS2018-1, NRCYS05-02 each having 0.0 aphid and ARI (1) all were classified as "resistant" based on the index (Table 1). In contrast, the highest infestations occurred in KMRL23-5 (106.0 aphids, ARI 1.2), RMM19-07 (104.0 aphids, ARI 2.1), DRMRCI-175 (101.0 aphids, ARI 1.9), HUJM (E) 22-1 (100.0 aphids, ARI 2.1), etc. Among these, Radhika, HUJM (E) 22-1 and RMM19-07 were classified as "tolerant," while the others were moderately resistant. Of the 89 genotypes screened, 54 were resistant (ARI = 1), 32 were moderately resistant (ARI 1–2) and 3 were categorised as "tolerant" at full flowering stage. Other resistance categories, such as susceptible, and highly susceptible, were at full flowering stage, likely due to mild aphid infestations. Mean aphid population across all the screened genotypes at this stage was 15.72 aphids per 10cm twig while, mean aphid resistance index was 1.16 (Fig.1). Mean aphid infestation in *B. juncea* group (17.08 aphids/ 10cm twig) remained significantly higher than that in *B. napus* group (1.88 aphids/ 10cm twig) while, mean ARI in two group's genotype was 1.17 and 1.01, respectively. At the full flowering stage, the number of aphids ranged from 0.0 to 106.0 per 10 cm twig across all genotypes. As the plants progressed to the full flowering stage, a general increase in aphid populations was observed, with a corresponding shift in resistance categorization. While most genotypes in the *B. napus* group maintained their resistance, a larger proportion of *B. juncea* genotypes moved into moderately resistant or tolerant categories. This stage highlighted the importance of genotypic variations in aphid response under increasing pest pressure.

3.3 Full siliqua formation stage

At the full siliqua formation stage, the least aphid infestation was observed in RH2299-63, KMR(E)22-2, DRMRHT17-23, HUJM (E) 22-1 each having 0.0 aphid and ARI (1) all were classified as "resistant" based on the index (Table 1). The highest infestations were recorded in DRMRCI-175 (245.8 aphids, ARI 2.6), RHOE1618 (242.4 aphids, ARI 2.6), PMAS08 (177.2 aphids, ARI 2.6), DRMRCIQ179 (146.0 aphids, ARI 2.7). Out of the 89 genotypes, 41 were resistant (ARI = 1), 35 were moderately resistant (ARI 1–2), 08 were tolerant and four were categorised as susceptible, and no genotype, was categorized as "highly susceptible". At the full siliqua formation stage, the number of aphids ranged from 0.0 to 245.8 per 10 cm twig across all genotypes (Fig.1).

Mean aphid infestation in *B. juncea* group (30.12 aphids/ 10cm twig) remained almost at par with than that in *B. napus* group (27.63 aphids/ 10cm twig) while, mean ARI in two group's genotype was 1.32 and 1.15, respectively. *B. napus* group genotypes which outperformed *B. juncea* group at aphid appearance and full flowering stage were reported to be similar in their aphid resistance at full siliqua formation stage. This particular similarity in aphid infestation between *B. napus* and *B. juncea* group genotypes may be due to their phenological differences or developmental asynchrony otherwise.

At the full siliqua formation stage, aphid infestations peaked, with the highest infestations recorded in DRMRCI-175, RHOE1618, and PMAS08. Although *B. napus* genotypes demonstrated superior resistance during earlier stages, their resistance was comparable to that of *B. juncea* at this stage, possibly due to phenological differences or developmental asynchrony. This finding of present study is partially supported by the finding of (Rana, 2005) who reported that rapeseed (*B. campestris* var. BSH 1 and YSPB 9) and mustard (*B. juncea* RH 30) served as more favourable hosts for aphids compared to other *Brassica species*, including *B. napus*, *B. nigra*, *Erucasativa*, and *B. carinata*. This convergence underscores the influence of crop stage and environmental factors on resistance expression. The absence of highly susceptible genotypes across all stages and the limited number of susceptible genotypes at the siliqua stage suggest that the screened genotypes possess a baseline level of aphid resistance. Aphid numbers ranged from 0.0 to 70.7 per 10 cm twig at the aphid appearance stage, 0.0 to 106.0 at full flowering, and 0.0 to 245.8 at full siliqua formation across all genotypes. These results are partially supported by Mauryaet. al., 2018 (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 *PusaJagnath*. While conducting the experiment, unseasonal and unusual weather conditions such as untimely rains were observed which affected the aphid population during the study period. Due to the aforementioned variables, the observation on the population showed high variations and may not be indicative of the true resistance or susceptibility of the genotype and categorised of the plants was carried on the basis of the available data in to resistant, tolerant, susceptible, etc.

These findings highlight the dynamic nature of aphid infestations and resistance across growth stages and underscore the significance of considering both genotypic and phenological factors when evaluating resistance to pests like mustard aphids. The differential response of *B. napus* and *B. juncea* genotypes across stages points to potential avenues for breeding programs to improve resistance in rapeseed-mustard crops.

Table 1. Aphid infestation on rapeseed-mustard genotypes at different crop stages

Sl. No.	Genotypes	At aphid initiation			At full flowering			At full siliqua formation		
		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	KMR(E) 23-1	6.2	1.0	R	28.4	1.2	MR	21.0	1.2	MR
2	KBH 5106	46.0	1.7	MR	85.0	1.6	MR	39.0	2.2	T
3	DRMRHT-17-3-3	8.4	1.1	MR	31.4	1.3	MR	35.8	1.5	MR
4	HUJM(E) 22-1	17.8	1.5	MR	100.0	2.1	T	19.6	1.2	MR
5	RH 1999-16	6.8	1.1	MR	49.8	1.4	MR	6.8	1.0	R
6	PBR 788-1	4.4	1.0	R	29.8	1.2	MR	31.8	1.5	MR
7	HUJM-22-13	9.6	1.1	MR	23.6	1.2	MR	24.4	1.2	MR
8	DRMRCI-175	27.4	1.5	MR	101	1.9	MR	245.8	2.6	S
9	DRMRIJ 21-31	1.6	1.0	R	11.2	1.0	R	4.8	1.0	R
10	KMR 23-4	1.4	1.0	R	3	1.0	R	3.4	1.0	R
11	DRMR 2021-30	3.0	1.0	R	12.4	1.1	MR	10	1.1	MR
12	TM 182	6.4	1.0	R	20	1.2	MR	19.4	1.1	MR
13	JM-17-8	1.6	1.0	R	5.4	1.0	R	0.4	1.0	R
14	RH 2299-63	1.0	1.0	R	2.0	1.0	R	0.0	1.0	R
15	KMR (E) 22-2	0.0	1.0	R	0.0	1.0	R	0.0	1.0	R
16	RKM 544	33.8	1.3	MR	69.6	1.6	MR	76.8	2.1	T
17	RMM 19-07	33.4	1.4	MR	104.0	2.1	T	86.0	2.1	T
18	NPJ 270	25.4	1.3	MR	70.0	1.5	MR	49.6	1.6	MR
19	PR-2019-19	7.4	1.1	MR	64.0	1.5	MR	56.0	2.1	T
20	AKMS 18-89-1	0.0	1.0	R	24.8	1.2	MR	20.4	1.2	MR
21	DRMRHT-17-23	0.0	1.0	R	2.4	1.0	R	0.0	1.0	R
22	RB 114	0.0	1.0	R	7.0	1.0	R	8.4	1.0	R
23	DRMRIJ 20-197	0.0	1.0	R	21.6	1.1	MR	12.4	1.2	MR
24	RH 2217	0.6	1.0	R	7.8	1.0	R	5.8	1.0	R
25	RKM 597	0.6	1.0	R	11.2	1.0	R	4.2	1.0	R
26	RGN 563	0.0	1.0	R	0.0	1.0	R	29.6	1.3	MR
27	PYS-2018-1	0.0	1.0	R	0.0	1.0	R	5.2	1.1	MR
28	NRCYS 05-02	0.0	1.0	R	0.0	1.0	R	4.0	1.0	R
29	NPJ 272	0.0	1.0	R	0.0	1.0	R	4.0	1.0	R
30	RH 2263	0.6	1.0	R	0.6	1.0	R	22.0	1.3	MR
31	HUJM-22-1	0.0	1.0	R	0.0	1.0	R	0.0	1.0	R
32	RKM 594	0.0	1.0	R	0.0	1.0	R	23.4	1.6	MR
33	DRMR 2018-1	1.0	1.0	R	1.0	1.0	R	83.0	2.1	T
34	KMR(L) 23-6	0.0	1.0	R	0.0	1.0	R	26.6	1.4	MR
35	NPJ 267	1.6	1.0	R	1.6	1.0	R	25.0	1.3	MR

36	PRL 2020-6	8.6	1.2	MR	8.6	1.2	MR	1.0	1.0	R
37	DRMRHT-17-4-5	4.4	1.1	MR	4.4	1.1	MR	1.4	1.0	R
38	DRMRIJ 20-126	25.2	1.4	MR	25.2	1.4	MR	60.4	1.5	MR
39	KMR (L) 23-5	10.6	1.2	MR	106.0	1.2	MR	20	1.6	MR
40	Kranti	10.2	1.2	MR	10.2	1.2	MR	25.6	1.4	MR
41	RGN 570	1.4	1.0	R	1.4	1.0	R	7	1.0	R
42	RH 2299-108	0.0	1.0	R	0.0	1.0	R	1.8	1.1	MR
43	RH 2299-106	0.0	1.0	R	0.0	1.0	R	2	1.0	R
44	RGN 572	0.0	1.0	R	0.0	1.0	R	0	1.0	R
45	PRL 2020-20	2.2	1.0	MR	2.2	1.0	R	0.6	1.0	R
46	PHR 5169	0.0	1.0	R	0.0	1.0	R	1.6	1.0	R
47	TM 305-1	0.6	1.0	R	0.6	1.0	R	2	1.0	R
48	NPJ 268	0.0	1.0	R	0.0	1.0	R	2.4	1.0	R
49	KGMH-9297	0.0	1.0	R	0.0	1.0	R	2	1.0	R
50	Pusa MH 150	0.0	1.0	R	0.0	1.0	R	0.0	1.0	R
51	SKMH 1809	2.0	1.0	R	1.0	1.0	R	2.4	1.0	R
52	HRH 191290	0.0	1.0	R	0.0	1.0	R	4.8	1.0	R
53	NAM 9204	0.0	1.0	R	0.0	1.0	R	8.4	1.1	MR
54	RHH 2318	0.0	1.0	R	0.0	1.0	R	2.8	1.0	R
55	RHH 2301	0.6	1.0	R	0.6	1.0	R	4.0	1.0	R
56	Q90033	1.0	1.0	R	1	1.0	R	5.8	1.0	R
57	US 8787	0.0	1.0	R	0.0	1.0	R	4.0	1.0	R
58	SVJH 76	0.0	1.0	R	0.0	1.0	R	3.6	1.0	R
59	BMH 20011	0.0	1.0	R	0.0	1.0	R	3.6	1.1	MR
60	DRMRHJ 1517	0.0	1.0	R	0.0	1.0	R	0.0	1.0	R
61	RHH 2302	0.0	1.0	R	0.0	1.0	R	3.4	1.0	R
62	DRMRHJ 25018	0.6	1.0	R	0.6	1.0	R	1.8	1.0	R
63	KBH 5252	14.4	1.1	MR	14.4	1.1	MR	7.2	1.1	MR
64	Pusa MH 145	1.4	1.0	R	1.4	1.0	R	0.4	1.0	R
65	PHR 3278B	0.0	1.0	R	0.0	1.0	R	89.0	2.1	T
66	DRMRHJ 1170	0.0	1.0	R	0.0	1.0	R	29.0	1.3	MR
67	4205B284-01	9.4	1.2	MR	9.4	1.2	MR	0.6	1.0	R
68	NMH 90M03	0.0	1.0	R	0.0	1.0	R	0.0	1.0	R
69	PA 5232	10.6	1.2	MR	10.6	1.2	MR	24.2	1.5	MR
70	PHR 1293	0.0	1.0	R	0.0	1.0	R	45.0	1.4	MR
71	RH(OE) 1618	8.4	1.2	MR	8.4	1.2	MR	242.4	2.6	S
72	RH(OE) 1710	1.6	1.3	MR	16.0	1.3	MR	3.2	1.0	R
73	DRMRCI(Q) 181	15.6	1.4	MR	15.6	1.4	MR	135.6	2.2	T
74	DRMRCI(Q) 180	15.4	1.3	MR	15.4	1.3	MR	99.2	2.1	T
75	NPJ 259	47.6	1.8	MR	47.6	1.8	MR	27.0	1.2	MR
76	PMAS 8	32.0	1.7	MR	32.0	1.7	MR	177.2	2.6	S
77	DRMRCI(Q) 179	3.8	1.0	R	3.8	1.0	R	146.0	2.7	S
78	LES 69	11.2	1.1	R	11.2	1.1	MR	134.0	2.6	S
79	PDZ 21	23.4	1.5	MR	23.4	1.5	MR	36.0	1.3	MR
80	LES 68	54.0	1.5	MR	54.0	1.5	MR	64.0	1.7	MR
81	**Radhika**	70.2	2.1	T	70.2	2.1	T	7.6	1.1	MR
82	PGSH 1711	0.0	1.0	R	0.0	1.0	R	97.4	1.1	MR
83	AKGS 20-9	0.0	1.0	R	0.0	1.0	R	88.6	1.6	MR
84	AKMS 8141	0.0	1.0	R	0.0	1.0	R	14.6	1.2	MR
85	**GSL-1**	0.0	1.0	R	0.0	1.0	R	1.0	1.0	R

86	JGS-16-9	0.0	1.0	R	0.0	1.0	R	2.2	1.0	R
87	**GSC-6**	0.0	1.0	R	0.0	1.0	R	6.0	1.2	MR
88	GSC-64	0.6	1.0	R	0.6	1.0	R	3.6	1.1	MR
89	AKGS 2461	14.4	1.1	MR	14.4	1.1	MR	7.6	1.0	R
Mean		7.27	1.11	**60R+28 MR+1T**	15.72	1.16	**54R+32 MR+3T**	29.95	1.31	**41R+35 MR+8T+ 5S**

*ARI is aphid resistance index; *R is Resistant*(ARI=1); *MR is moderately resistant (1.0-2.0); T is tolerant (2.1-2.5), S is susceptible (2.6-3.5). Mean aphid population= Number of aphid/ 10 plants*

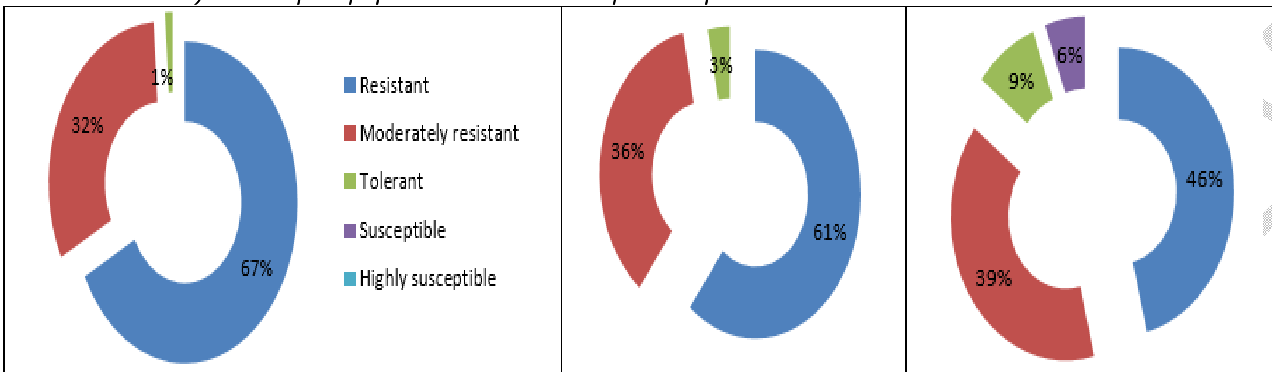

Fig. 1. Resistance categorisation of genotypes (a) at first appearance of aphid, (b) at full flowering stage, and (c) at full siliqua formation stage (Left to right)

Table2. Aphid infestation index used for varietal screening

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 ifany	4.1-5.0 (API+ADI/2)	3.6-5.0 = Highly susceptible

4. CONCLUSION

Mustard aphid poses significant challenges to rapeseed-mustard production globally. While various strategies have been used, finding effective IPM practices that are both ecological and economical remains challenging. Resistant genotypes can reduce reliance on chemical pesticides, promoting sustainable pest management. This study evaluated 89 rapeseed-mustard genotypes for resistance to mustard aphid (*L.erysimi*) during the *Rabi* season of 2023–24, showing genotypic and phenological variations in infestation across three growth stages: aphid appearance, full flowering, and siliqua formation. *Brassica napus* demonstrated superior early-stage resistance compared to *B. juncea*, with lower aphid infestations (1.88 vs. 7.81 aphids/10 cm twig. At the aphid appearance stage, 60 genotypes were resistant, and one was tolerant (*Radhika*). By full flowering, resistance decreased slightly, with 54 genotypes remaining resistant and mean infestation rising to 15.72 aphids/10 cm twig. Peak infestation at the siliqua formation stage identified four susceptible and eight tolerant genotypes. No highly susceptible genotypes were found, indicating a general resistance baseline. The study highlights *B. napus* as a valuable resource for breeding pest-resistant crops and underscores the importance of understanding dynamic aphid resistance across growth stages. However,later stages saw a convergence in resistance between species due to developmental asynchrony and environmental factors. Future research should explore genetic markers for resistance, integrate resistant genotypes into breeding, and investigate environmental factors affecting resistance to improve IPM strategies.

CONSENT (WHEREEVER APPLICABLE)

Not applicable

ETHICAL APPROVAL (WHEREEVER APPLICABLE)

Not applicable

Disclaimer (Artificial intelligence)

Authors 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.

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DEFINITIONS, ACRONYMS, ABBREVIATIONS

R is Resistant; MR is moderately resistant; T is tolerant, S is susceptible.