ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(7): 91-94
www.agriculturaljournals.com
Received: 13-04-2026
Accepted: 15-05-2026

Ram Avtar
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Neeraj Kumar
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Dalip Kumar
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Rakesh Punia
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Nisha Kumari
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Uma Devi
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Rajbir Singh Khedwal
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Mahavir Bishnoi
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Aakash
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

Corresponding Author:
Neeraj Kumar
Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana, India

RH 1975: An Indian mustard (*Brassica juncea*) variety suitable for timely-sown conditions

Ram Avtar, Neeraj Kumar, Dalip Kumar, Rakesh Punia, Nisha Kumari, Uma Devi, Rajbir Singh Khedwal, Mahavir Bishnoi and Aakash

DOI: https://www.doi.org/10.33545/2664844X.2026.v8.i7b.1653

Abstract
CCS HAU, Hisar, has developed the Indian mustard (*Brassica juncea*) (L.) Czern and Coss.) variety "RH 1975" specifically for timely sown and irrigated conditions. This variety was identified for release in the 30th Annual Group Meeting of the All India Coordinated Research Project (AICRP) on Rapeseed-Mustard, held at SKUAST-Jammu on 3–4 August, 2023. It is now gazette notified for cultivation across Zone-II, which covers Haryana, Punjab, Delhi, Jammu, and northern Rajasthan. Across 23 environments, RH 1975 recorded an average seed yield of 2,720 kg/ha. This demonstrated seed-yield increase over the latest-release check Giriraj by 13.6%, the zonal check RH 749 by 11.8%, and the national check Kranti by 19.7%. The variety featured among the top five performing entries in 73.91% (17/23) of the 23 pooled environments, a consistency rate that easily exceeded Giriraj (26.08% [6/23]), RH 749 (30.43% [7/23]), and Kranti (13.04% [3/23]). Separate agronomy trials across five diverse locations confirmed a mean seed yield of 2,480 kg/ha, outperforming the best commercial check, Giriraj (2,220 kg/ha), by 11.7%. Alongside high yields, RH 1975 showed less susceptibility against major foliar diseases like Alternaria blight, white rust, and Sclerotinia stem rot and aphid damage compared to standard susceptible checks in trials.

Keywords: Indian mustard, RH 1975, seed yield, rapeseed-mustard, disease resistance

1. Introduction

Indian mustard (*Brassica juncea* (*L.*) Czern. & Coss.) is a major oilseed crop of the Indian subcontinent, largely because of its high oil content, wide environmental adaptability, and reliable performance under moisture stress ((Chauhan *et al.*, 2020) [4]). Compared to other species in the Brassicaceae family, *B. juncea* exhibits greater yield stability and production reliability under Indian agro-ecological conditions. This makes it a key crop for achieving self-sufficiency in edible oils (Singh *et al.*, 2021) [10]. North Indian farmers prefer cultivating it in every soil type under both irrigated and rainfed conditions. The well-drained nature of these soils facilitates root growth and nutrient uptake, thereby contributing to higher crop productivity and yield potential.

A major challenge in plant breeding is to develop high-yielding varieties that fully exploit the genetic potential of a crop while maintaining stable performance across diverse agro-ecological environments. For a variety to gain widespread acceptance across diverse regions, high seed yield must be complemented by desirable agronomic traits such as appropriate flowering and maturity duration, manageable plant height, bold seed size and high oil content (Yadav *et al.*, 2018) [11]. Evaluation of these traits in segregating populations enables breeders to identify stable, adaptable, and high-yielding genotypes.

The pedigree method offers clear advantages over other conventional breeding methods (Allard 1999) [2]. As a hybridization-based approach, it allows freedom for the selection of diverse parents and subsequently generation and selection of superior transgressive segregants. Selection begins in the F_2 population and continues until the lines reach genetic uniformity (homozygosity). Ultimately, the performance of transgressive progenies in the pedigree program largely depends on the selection of parents and the extent of variability generated through hybridization of parents.

2. Materials and Methods

Two genetically diverse lines, RH 1140 (bold seed and long siliquae) and RH 1378 (a good combiner parent with basal branches and long main shoot) were crossed to generate transgressive segregants. The resulting segregating population was handled through the pedigree method from the F_2 to F_5 generations, with selection of desirable plants in each generation. Selection was focused on plant types characterised by early-to-medium flowering, early-maturity, medium-to-high plant biomass, manageable plant-height, more branching, high siliqua density, long main shoot, more seeds per siliqua, bold seed size, and high oil-content. Up to the F_5 generation, selected individual plants were harvested and threshed separately.

Final selection was based on desirable seed characteristics and progeny performance, whereby lines exhibiting smaller seed size and lower oil content were systematically eliminated. By the F_5 generation, most lines had achieved desirable homozygosity, and heritable variation diminished within these lines; at this stage, these promising individual lines were harvested in bulk for further evaluation in subsequent yield trials. The systematic breeding pathway from the initial cross to advanced Multi-environment Coordinated Trials is mapped out below (Figure 1).

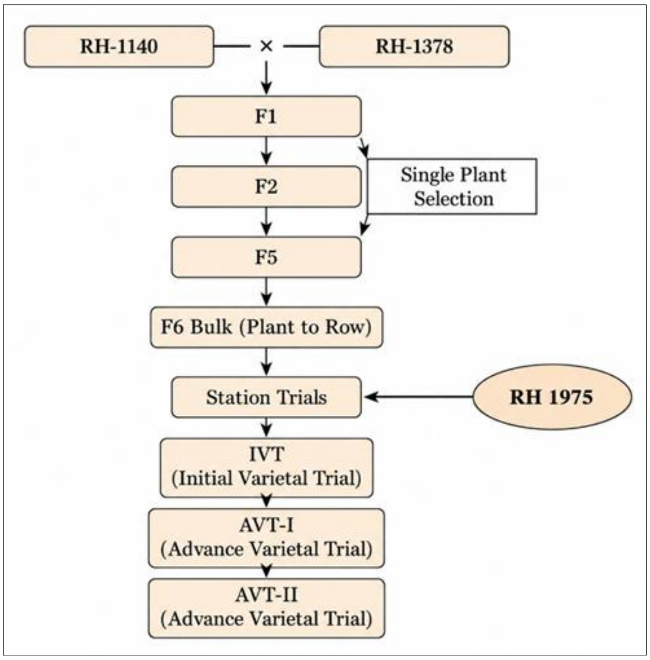

Fig 1: Breeding procedure employed in development of Indian mustard variety RH 1975.

For the evaluation of these promising homozygous bulks, small-scale trials under irrigated, timely-sown conditions against standard checks were constituted. Promising entries were further promoted to large-scale and final yield trials. To be officially released and notified at the national level, promising entries were contributed to the All India Coordinated Research Project on Rapeseed-Mustard (AICRP-R&M) trial (Anonymous, 2023) [1]. These trials were conducted annually across diverse agro-ecological zones. This designated entry, RH 1975, was contributed to the AICRP-R&M trial during Rabi 2020–21 for rigorous multi-environment evaluation. In these trials, comprehensive data were generated to evaluate the overall potential of a variety, particularly focusing on:

- **Agronomic performance:** Seed yield and crucial yield-related traits.
- **Pathology & entomology:** Host-pathogen interactions and insect-pest resistance.

To accurately evaluate pest and disease resistance, standardised scoring scales are used for comparison with well-known susceptible checks (Bakhetia *et al.*, 1989; Conn *et al.*, 1990) [3, 5].

3. Results and Discussion

3.1 Yield performance, stability, and adaptability

Multi-location data collected through the AICRP-R&M trials between 2020–21 and 2022–23 prove that RH 1975 exhibited wide adaptability and high yield potential with stability under irrigated, timely-sown conditions in Zone-II. In 2020–21 Initial Varietal Trial (IVT) across eight locations in Zone-II, RH 1975 exhibited an average seed yield of 2,834 kg/ha. This outperformed all three checks, including Giriraj (Latest Release), RH 749 (Zonal Check), and Kranti (National Check) by 21.3%, 14.0%, and 25.6%, respectively (Table 1). It ranked among the top five entries at seven out of eight locations. Based on seed yield performance, this entry was promoted to Advanced Varietal Trial (AVT-I).

During 2021-22 (AVT-I) in seven locations, RH 1975 maintained its advantage with a mean seed yield of 2,686 kg/ha, exceeding the standard checks, Giriraj (Latest Release), RH 749 (Zonal Check) and Kranti (National Check) by 6.6%, 11.6% and 12.9%, respectively, while ranking in the top five at four locations (Table 1). Based on AVT-I performance, the genotype was promoted to the advanced stage of testing (AVT-II).

In the final 2022–23 testing trial (AVT-II), the genotype held its performance across eight locations with a mean yield of 2,637 kg/ha, beating the zonal check RH 749 (2,356 kg/ha) and ranking in the top five at six locations. Based on pooled data from three years and 23 environments, RH 1975 achieved a mean seed yield of 2,720 kg/ha, exhibiting a 13.6%, 11.8%, and 19.7% yield advantage over Giriraj (Latest Release), RH 749 (Zonal Check), and Kranti (National Check), respectively. The frequency of an entry ranking in the first non-significant statistical group (1st NS group) reflects stable seed yield performance (Eberhart & Russell, 1966) [6]. RH 1975 showed high reliability, placing in the 1 st NS group in 19 out of 23 environments across Zone-II. This performance outclassed checks Giriraj (8/23), RH 749 (8/23), and Kranti (6/23).

Table 1: Summary of seed yield (kg/ha) data of AICRP (R&M) co-ordinated trials.

Parameter	Year of testing	No. of trials	RH 1975	Giriraj (LR)	RH 749 (ZC)	Kranti (NC)
Mean seed yield (kg/ha)	2020–21	8	2834	2336	2485	2256
	2021–22	7	2686	2520	2407	2379
	2022–23	8	2637	2335	2356	2186
	Weighted Mean	**23**	**2720**	**2392**	**2416**	**2269**
Percent increase (+) or decrease (−)	2020–21	8	—	(+) 21.3	(+) 14.0	(+) 25.6
	2021–22	7	—	(+) 6.6	(+) 11.6	(+) 12.9

over checks	2022–23	8	—	(+) 12.9	(+) 11.9	(+) 20.6
	Mean		—	**(+) 13.6**	**(+) 11.8**	**(+) 19.7**
Frequency in top 5 group	2020–21	8	7/8	2/8	2/8	1/8
	2021–22	7	4/7	2/7	2/7	1/7
	2022–23	8	6/8	2/8	3/8	1/8
	Pooled (3 Years)	**23**	**17/23**	**6/23**	**7/23**	**3/23**
Frequency in First NS group	2020–21	8	7/8	2/8	3/8	1/8
	2021–22	7	4/7	4/7	4/7	3/7
	2022–23	8	6/8	2/8	1/8	2/8
	Total	**23**	**19/23**	**8/23**	**8/23**	**6/23**

3.2 Quality parameters and morpho-agronomic traits

For large-scale adoption, a variety must possess a genotype that satisfies the requirements of both farmers and processors. RH 1975 fulfiled these requirements, matching or exceeding current popular cultivars. RH 1975 exhibited a mean pooled oil content of 39.3% as against 38.0% of Giriraj, 38.5% of RH 749, and 37.1% of Kranti. Combining the oil content with higher seed yield resulted in total oil yield gains of 13.4%, 13.9%, and 23.7% over Giriraj, RH 749, and Kranti across recorded environments (Table 3).

From agronomic viewpoint, RH 1975 took an average 143–144 days to attain physiological maturity, which is roughly 1 to 3 days earlier or at par with standard checks. This enables crops to escape terminal heat stress, a sudden rise in temperature during the crop maturity stage. The plant architecture feature a tall plant height (194 cm) and bold seeds, exhibiting an average 1000-seed weight of 5.5 g. Both farmers and crushing mills prefer bold seeds due to higher oil extraction efficiency, which fetches better prices in oilseed markets. Comprehensive evaluation data across essential morphological and architectural parameters further confirm its robust phenotypic blueprint (Table 2).

Table 2: Ancillary traits data of RH 1975

Sr. No.	Ancillary Plant Trait	Value / Expression Range
1	Leaf length	> 20 cm
2	Leaf width	> 8 cm
3	Days to flowering	42–46 days
4	Days to maturity	140–145 days
5	Plant height	190–199 cm
6	Number of primary branches per plant	6–8
7	Number of secondary branches per plant	12–16
8	Main shoot length	85–95 cm
9	Number of siliquae on main shoot	62–70
10	Siliqua length	5.5–6.2 cm
11	Beak length	0.9–1.1 cm
12	Number of seeds per siliqua	18–20

Table 3: Quality characteristics (Oil Yield, Oil Content, and Seed Weight) of RH 1975

Parameter	Trial Stage	Locations	RH 1975	Giriraj (LR)	RH 749 (ZC)	Kranti (NC)
Oil Yield (kg/ha)	AVT-I (2021–22)	5	1,042	—	923	865
	AVT-II (2022–23)	8	1,047	920	911	825
Oil Content (%)	AVT-I (2021–22)	5	38.8%	36.6%	38.3%	36.4%
	AVT-II (2022–23)	7	39.7%	39.4%	38.7%	37.7%
1000-Seed Wt. (g)	IVT (2020–21)	8	5.3	5.5	5.7	4.5
	AVT-I (2021–22)	5	5.7	5.7	6.0	4.7
	AVT-II (2022–23)	7	5.6	5.7	5.9	4.6

3.3 Biotic stress performance (Pathogens and insect pests)

Biotic stress directly threatens seed yields, making genetic resistance/tolerance essential to reduce chemical use and protect the environment. Screenings under both natural stress pressure and artificial inoculations confirmed that RH 1975 is less prone to major foliar diseases and insect pests than standard checks.

3.3.1 Alternaria blight

Alternaria blight, caused by the necrotrophic fungus *Alternaria brassicae*, reduces seed yields by 32% to 57% in typical years (Meena *et al.*, 2010) [7]. Under artificial inoculation, RH 1975 exhibited a mean Percent Disease Index (PDI) of 34.7%, keeping it within the 15.0% and 45.0% range (Table 4). By contrast, the susceptible check NRCYS-5-2, found highly vulnerable, exhibited a maximum PDI of 67.5% with a mean value of 38.5%. This lower variance and reduced mean PDI demonstrate that RH 1975 possesses enhanced quantitative tolerance, which retards *A. brassicae* tissue colonization.

Table 4: Reaction to Alternaria Blight severity (%) under artificial inoculation

Genotype / Entry	Mean PDI (%)	Range Observed (%)	Remark
RH 1975	**34.7%**	**15.0% – 45.0%**	—
NRCYS-5-2 (Susceptible Check)	38.5%	7.5% – 67.5%	High Susceptibility

3.3.2 White rust

White rust, caused by the biotrophic oomycete *Albugo candida*, severely damages crops by its capacity to inflict damage to all aerial parts and, in the later stage, severe malformation of the inflorescence known as staghead formations (Saharan *et al.*, 2016) [8]. Replicated artificial inoculations across multiple seasons showed that RH 1975 recorded white rust severity to a mean PDI of 31.2% (ranging from 16.0% to 42.0%). RH 1975 demonstrated less susceptibly compared to the susceptible check, Rohini, which recorded an average disease severity of 36.4% (Table 5).

Table 5: Reaction to White Rust severity (%) under artificial inoculation

Genotype / Entry	Mean PDI (%)	Range Observed (%)	Remark
RH 1975	**31.2%**	**16.0% – 42.0%**	—
Rohini (Susceptible Check)	36.4%	Highly Susceptible	Baseline Susceptibility

3.3.3 Sclerotinia stem rot

Sclerotinia stem rot, caused by *Sclerotinia sclerotiorum*, leads to severe stem breakdown, damage to plant tissue, and early lodging (Yadav *et al.*, 2021) [12]. Since absolute immunity rarely exists in *B. juncea* germplasm, breeding efforts focus on partial, polygenic resistance. Under combined natural and sick-plot screenings, RH 1975 reported a mean incidence of 35.3%, showing an approximate 47% reduction in disease severity compared to the heavily infected susceptible check NRCYS-5-2 (66.9%, Table 6).

Table 6: Sclerotinia Stem Rot incidence (%) under natural and sick plot conditions

Genotype / Entry	Mean Incidence (%)	Screening Conditions	Remark
RH 1975	**35.3%**	Natural & Sick Plot	Less Structural Collapse
NRCYS-5-2 (Susceptible Check)	66.9%	Natural & Sick Plot	Severe Structural Collapse

3.3.4 Mustard aphid

The mustard aphid (*Lipaphis erysimi*) remains a major threat, reducing seed yield, oil yield, and oil quality by sucking sap and promoting the growth of black sooty mould (Singh *et al.*, 2018) [9]. Evaluation for the Aphid Infestation Index (AII) from 2020–21 to 2022–23 shows that RH 1975 maintained a lower mean AII of 1.9 compared to the national check, Kranti (2.2). This confirms it can withstand heavy insect pressure across different testing environments (Table 7).

Table 7: Performance against Mustard Aphid based on Aphid Infestation Index (AII)

Genotype / Entry	Mean AII Score (0–5)	Evaluation Period	Remark
RH 1975	**1.9**	2020–21 to 2022–23	Reduced Sap-Sucking Damage
Kranti (National Check)	2.2	2020–21 to 2022–23	Higher Infestation

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