Raya Hisar 1706: An Indianmustard variety with low erucic acid

Abstract

Raya Hisar 1706 (RH 1706), the first zero erucic acid (erucic acid <2%) Indian mustard [*Brassica juncea* (L.) Czern&Coss] variety in public sector developed by Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana. It was released for commercial cultivation in 2023. It is black seeded with 38.0 % oil content. In Indian mustard varieties erucic acid (C:22) is a major (40-50%) fatty acid. The mustard oil is considered as antinutritional due to the presence of erucic acid as main component, as it has been concern with heart health. T variety RH 1706 has been developed with the objectives to get higher seed and oil yield with low erucic acid content under irrigated conditions by crossing NOID X EC-597324 and subsequently hybridization followed by pedigree method of selection. The NOID (RC-187) is a low erucic acid germplasm being maintained at Hisar and EC-597324 is an exotic line and a good combiner parent having desired component traits like siliqua density, number of seeds/siliqua etc. Single plants of medium duration, profuse branching with low erucic acid in oil was selected using pedigree selection method in the segregating generations during generation advancement. After F6 generation, uniform advance lines having low erucic acid characteristics, more than 38% oil content, numerically at par or better for seed yield with the best checks were retained for further evaluation in replicated trials. The superior bulks were evaluated in a station trial, initial variety trial (IVT), advance variety trial-I (AVT-I),advance variety trial-II (AVT-II), and the RH 1706 was found better in seed yield than the checks *viz* PM-29, RH 0749 and Kranti.

Key-words: *Brassica juncea*,RH 1706, Oil content, Pedigree,Zero erucic acid

Introduction

India is the fourth largest producer of mustard seed in the world contributing to around 11 % of world's total production and 19.29 % of total area. Rapeseed-mustard oil ranks third globally, surpassing soybean and palm oil, and accounts for almost 12% of the world's vegetable oil production (Qian *et al*, 2022). India is one of the main producers of rapeseed mustard and ranks first in terms of area and second in terms of production, behind China (Khavse*et al*., 2014). Its area, production, and productivity are 7.99 million hectares, 11.96 million tons, and 1497 kg per hectare, respectively, and it is primarily grown in India during the

Rabi season (Anonymous, 2024). With an area of 0.714 million hectares and a production of 1.366 million tons, Haryana had rapeseed-mustard productivity of 1914 kg per hectare, which was higher than the national average (Anonymous, 2024).

Indian mustard is mainly used for extraction of mustard oil which has a hot nutty taste and pungent aroma. The production in India has been witnessing an increasing trend since the last decade due to increasing usage of mustard seed oil in food [6-8]. Moreover, strong domestic demand for mustard seed oil was also one of the reasons for rise in production. In India, mustard seed is mainly grown in North Western parts of India. Rajasthan and Uttar Pradesh are the major mustard producing states in the country. Indian mustard is primarily grown to produce mustard oil, popular cooking oil with a distinctive spicy, nutty flavor and a strong, pungent smell. Typically, mustard oil contains about 70% MUFA (Mono Unsaturated Fatty Acids), including 42% erucic acid and 12% oleic acid. It also has 22% PUFA (Poly Unsaturated Fatty Acids), composed of 10% omega-3 alpha-linolenic acid and 12% omega-6 linoleic acid, along with 8% Saturated Fatty Acids (SFAs) (Kumari *et al*, 2022). While mustard oil is rich in omega-3 (10%), its high erucic acid content has traditionally made it unsuitable for human consumption. To address such issue, mustard varities have been developed in India. Preferred varietal traits are the different levels of various attributes of the mustard varieties like yield, oil content, resistance to pests and diseases, taste, erucic acid content etc. which are preferred by the farmers in the selection of the varieties [9,10].

Raya Hisar 1706 (RH 1706), the first zero erucic acid (erucic acid <2%) Indian mustard [*Brassica juncea* (L.) Czern&Coss] variety was developed at Oilseeds Section, Department of Genetics and Plant Breeding, college of Agriculture, Chaudhary Charan Singh Haryana Agricultural University, Hisar It was earlier released and notified (Gazette Notification No. 1056 (E) dated 06.03.2023) under timely sown conditions for Zone-II (Jammu, Punjab, Haryana, Delhi & Northern Rajasthan) of the country. In Indian mustard varieties erucic acid (C:22) is a major (40-50%) fatty acid. The mustard oil is considered as anti-nutritional due to the presence of this fatty acid as main component, as it has been concernwith heart health. Further, defatted mustard seed meal is an excellent source of animal nutrition as it contains about 40% high-quality protein owing to its balanced amino acid composition. To bring the level of erucic acid to the internationally acceptable standard (erucic acid < 2% in seed oil),

research programme was initiated at Oilseeds Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar. Rigorousand constant efforts led to the development and release of the first public sector low erucic acid Indian mustard variety RH 1706 by CCS HAU, Hisar with the yield levelequivalent to the conventional Indian mustard varieties.The variety RH 1706 has been developed with the objectives to combine agronomically desirable traits such as higher seed yield and oil yield with low erucic acid content under irrigated conditions by crossing NOID X EC-597324 and subsequently hybridization followed by pedigree method of selection.The NOID (RC-187) is a low erucic acid germplasm being maintained at Hisar and EC-597324 is an exotic line and a good combiner parent having desired component traits like siliqua density, number of seeds/siliqua etc. Single plants of medium duration, profuse branching with low erucic acid in oil was selected using pedigree selection method in the segregating generations during generation advancement. After F6 generation, uniform advance lines having low erucic acid characteristics, more than 39% oil content, numerically at par or better for seed yield with the best checks were retained for further evaluation in replicated trials. The superior bulks were evaluated in a station trial and the genotype RH (0E) 1706 was found better in seed yield than the checks *viz*., PM-29, RH 0749and Kranti.

The RH 1706 was contributed to the Initial Varietal Trial (Quality Mustard) in the All India Coordinated Research Project on Rapeseed-Mustard (AICRP-RM) during 2014-15 for testing in zones II (Delhi, Haryana, Punjab, northern Rajasthan and Jammu) which was further evaluated during 2016-18 in AVT-I and AVT-II in Zone II. During 2022, RH 1706 was released and recommended for notification vides Gazette Notification No. 1056 (E) dated 06.03.2023.

Materials and methods

A brief account of the development of the Indian mustard variety RH 1706 was documented by Ram Avtar (2022). The process began with the crossing of two parent varieties, NOID and EC-597324. The NOID (RC-187) is a low erucic acid germplasm being maintained at Hisar and EC-597324 is an exotic line and a good combiner parent having desired component traits like siliqua density, number of seeds/siliqua etc. The first generation after the cross, known as the F1 generation, contained hybrid plants with mixed traits from both parents. Single plants were selected from the F1 generation based on desirable traits to produce the F2 generation. The F2 generation underwent another selection process to identify

the best-performing plants. This process of single-plant selection continued through successive generations, leading to the F5 generation, ensuring only the best plants were advanced. At the F6 stage, selected plants were bulked together using the "Plant to Row" method to stabilize desirable traits in the population. The breeding line was then subjected to station trials to evaluate its performance under different environmental conditions.Once a successful breeding line was identified, it was named RH 1706. Following this, the line underwent station trials, Initial Varietal Trials (IVT), and two stages of Advance Varietal Trials (AVT-I and AVT-II) to assess its performance, yield, and agronomic traits. This meticulous process ultimately led to the foundation of the RH 1706 variety, ensuring it exhibited the best traits for low erucic acid, yield, resilience, and adaptability.

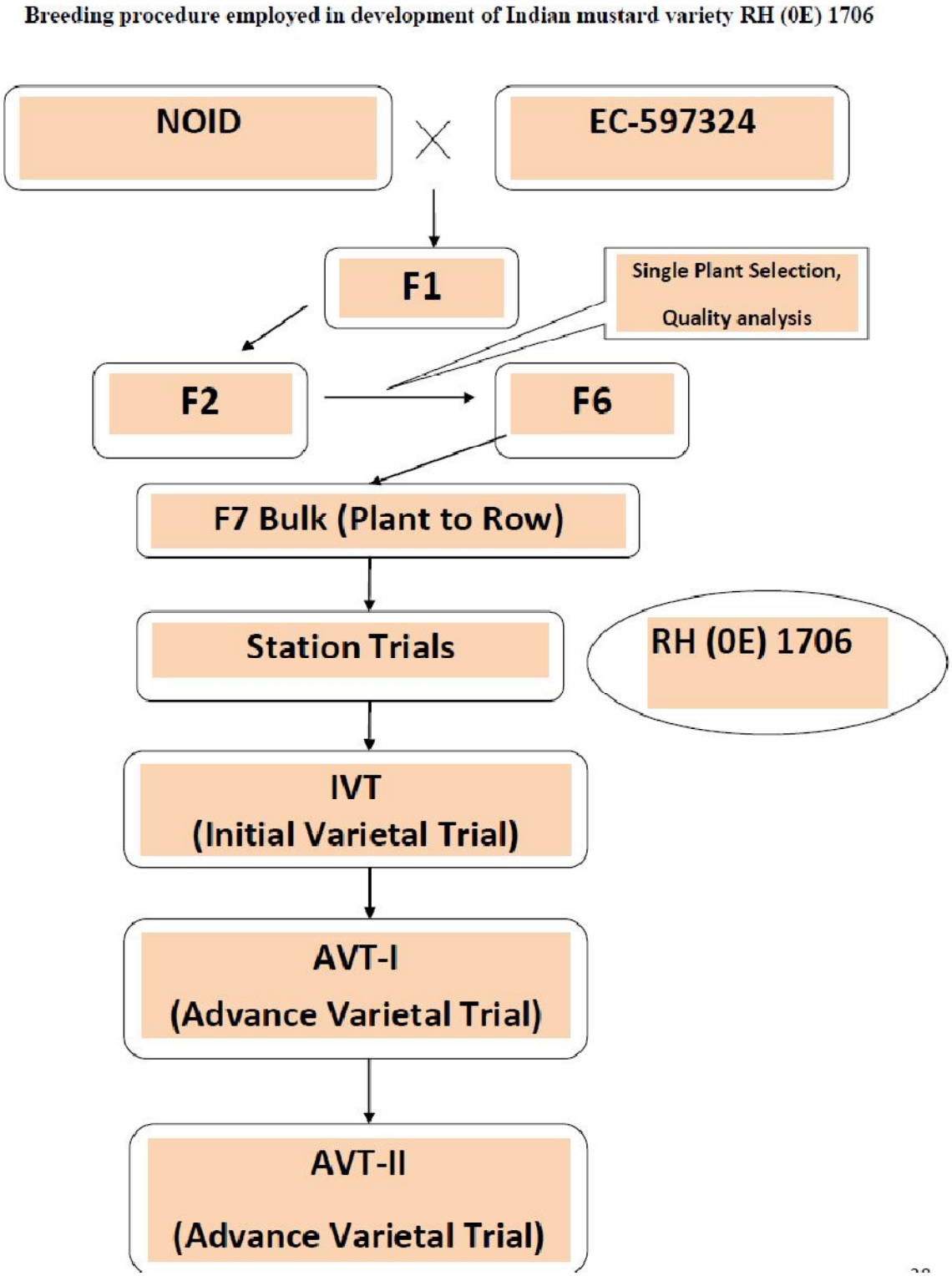

Fig. 1. Breeding procedure employed in development of Indian mustard variety

Results

Key agronomic and quality traits

The RH 1706 is a low erucic acid variety with a plant height ranging from 172 to 177 cm.with long main shoots, more number of primary (7-8) and secondary branches (20-24) and semi-appressed siliqua. It is mature in 135-145 days, with an average of 141 days. The yield potential of RH 1706 is up to 2422 kg/ ha. It can produce 70-80 siliqua per plant. The number of seeds per siliqua is 18-20. This variety has high biomass. The oil content is about 39.7 % in RH 1706. The key feature of the variety in terms of yield & its attributes and oil content is given in table 2-4.

Medium tall plant height

List 1 : Fatty acid profile of RH (0E) 1706 variety in comparison to quality check varieties

Fattty acids (%)	**RH (0E) 1706**	**PM 29**	**PDZM 31**
Palmitic acid	3.39	4.03	3.77
Stearic acid	1.66	1.89	1.74
Oleic acid	38.75	40.98	47.17
Linoleic acid	32.33	36.49	32.83
Linolenic acid	18.36	11.78	9.98
Erucic acid	**1.91**	**1.29**	**1.67**

The single zero variety RH (0E) 1706 has wider adaptability under irrigated conditions of Zone-II as it has shown consistent superiority in seed and oil yield (Table 1). It has given 21.0 % higher seed yield over the quality check, PM 29 and exhibited 7.6 and 11.1 % increase over conventional checks, RH 0749 (ZC) and Kranti (NC), respectively under different environments (Table 1). For oil yield also, it recorded 32.8 % increase over quality check, PM 29 while it showed more than/at par performance over conventional checks, RH 0749 (ZC) and Kranti (NC) across the zone (Table 1). The variety RH(0E)1706 possessed 4.7g 1000-seed weight compared with 5.4, 5.9 and 4.4 g of the checks, PM 29, RH 0749 and Kranti, respectively (Table 2). The maturity period of RH (0E) 1706 was observed as 140 days compared with 146, 144 and 143 days of the check varieties, PM 29 (QC), RH 0749 (ZC) and Kranti (NC), respectively (Table 2). Average seed yield (2002 kg/ha) of RH(0E)1706 in the AICRP agronomy trial (irrigated) over

different locations was 13.6 % higher as compared to quality check PM 29 (1763 kg/ha) and at par with the conventional checks (Table 4).

This variety had less severity to foliar diseases like Alternaria leaf blight and white rust; and Sclerotinia stem rot as compared to susceptible checks (Tables 5). The RH (0E) 1706 had low aphid infestation as compared to check varieties over the years (Table 6).

Looking to higher seed and oil yield as well as other desirable traits (<2% erucic acid), RH(0E)1706 is being release and notified for timely sown and irrigated conditions of Zone-II (Punjab, Haryana, Delhi, northern Rajasthan, western UP and plains of Jammu) during *Rabi* season (Gazette Notification No. 1056 (E) dated 06.03.2023).

Table 1: Summary of seed and oil yield (kg/ha) of coordinated trails

Parameters	RH 1706	Check Varieties		
		PM 29*	RH 0749**	Kranti**
Mean seed yield (kg/ha)	2690	2223 (21.0)	2501 (7.6)	2422 (11.1)
Mean oil yield (kg/ha)	1027	774 (32.8)	1010 (1.7)	956 (7.4)

- values in the parenthesis indicates the percent increase over checks
  *Quality check, ** Conventional checks (non-quality)

Table 2: Summary of days to maturity (days), Oil content (%) and 1000-seed weight (g) of coordinated trails

Parameters	RH 1706	Check Varieties		
		PM 29*	RH 0749**	Kranti**
Days to maturity	140	146	144	143
Oil content (%)	38.0	35.1	39.6	38.6
1000-seed weight (g)	4.7	5.4	5.9	4.4

Table 3: Seed yield (kg/ha), days to maturity and 1000-seed weight of RH (OE) 1706 against check varieties in station trial at Hisar under irrigated condition

Parameters	RH 1706	Check Varieties	
		PM 29*	RH 0749**
Seed yield (kg/ha)	3734	3017	3360
Days to maturity	139	147	146
1000-seed weight (g)	5.1	5.3	6.4

Oil content (%)	40.5	40.0	40.2
Oil yield (kg/ha)	1481	1192 (24.2)	1337 (10.8)

* Values in parenthesis indicates the superiority (%) over checks

Table 4: Summary of seed yield (kg/ha) data of RH (0E) 1706 under different fertility level in agronomy coordinated trails

Entries/Varieties	Fertility levels			Mean
	100 % RFL	125 % RFL	150 % RFL	
RH (0E) 1706	**1884**	**2031**	**2093**	**2002**
Les 60	1670	1930	2026	**1875**
PM 29	1561	1833	1896	**1763**
RH 749	1630	1846	2003	**1826**
Kranti	1786	2022	2153	**1987**
Filler	1783	2039	2051	**1958**
Mean	**1719**	**1950**	**2037**	**1902**

* RFL: Recommended fertility level

Table 5: Reaction of Alternaria leaf blight, White rust and Sclerotinia rot for RH (0E) 1706 in comparison to checks under artificial inoculation conditions

Alternaria leaf blight incidence (%)		White rust severity (%)		Sclerotinia rot incidence (%)	
Entries	**Mean**	**Entries**	**Mean**	**Entries**	**Mean**
RH (OE) 1706	29.6	**RH (OE) 1706**	29.9	**RH (OE) 1706**	32.9
Rohini (SC)	31.9	Rohini (SC)	38.8	Rohini (SC-WR)	35.0
PHR-2 (TC)	28.3	BIOYSR(RC-WR)	10.6	NRCYS-5-2 (SC-WR)	68.5
		DRMRMJA 35(RC-WR)	4.5	DLSC 1 (TC)	26.8

Table 6: Reaction of RH (0E) 1706 resistance for mustard aphid against checks

Year	Entries	Aphid Infestation Index (AII)
		Mean
2018-19	**RH (0E) 1706**	2.5
	Kranti (NC)	1.8
	PM-29	2.1
	PDZ-1	2.8
2020-21	RH (0E) 1706	1.8
	BSH-1	2.3
	PM-30	1.9
	PDZ-1	1.9
2021-22	RH (0E) 1706	1.7
	Kranti (NC)	1.6
	PM-30	1.5
	RH 725	1.9
	PDZM 31	1.9
	BSH 1	1.9

Conclusion

Raya Hisar 1706 (RH 1706), the first zero erucic acid (erucic acid <2%) Indian mustard [*Brassica juncea* (L.) Czern&Coss] variety in public sector developed by Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana. It was released for commercial cultivation in 2023.

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