Canola cultivation in India: scenario and future strategy

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ABSTRACT

'Canola' which is a registered trade mark of Canadian Oil Association denotes the seeds having less than 2 per cent erucic acid in it's oil and less than 30 micro -moles of glucosinolate per gram of it's deoiled meal. Canola is only a quality standard and not a classification based on biological attributes. Varieties with canola quality are also termed as 'double low' or '00' rapeseed-mustard (LEAR) has also been released recently. Indian varieties under cultivation have high erucic acid (about 50%) and high glucosinolates (≥ 100 moles/g defatted seed meal). Efforts have been made to develop zero erucic rapeseed- mustard at, PAU Ludhiana, TERI, New Delhi, IARI, New Delhi, DRMR, Bharatpur and GBPUAT, Pantnagar. So far three *Brassica juncea* and six *Brassica napus* lines with double low characteristics have been registered with National Bureau for Plant Genetic Resources (NBPGR).

Key words: Rapeseed mustard – canola - erucic acid - glucosinolates

INTRODUCTION

India is the third largest rapeseed-mustard producer in the world after China and Canada with 12 per cent of world's total production. India holds a premier position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production respectively. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop. Due to the gap between domestic availability and actual consumption of edible oils, India has to resort to import of edible oils with a projected demand for edible oils at more than 20 mt in 2014-15. About 6.8 m ha is occupied under rapeseed- mustard 2006-07 and nearly 30.7% area is rainfed. The Indian cultivars, due to high content of erucic acid and glucosinolates, have limited preference in international market.

Winter rape (*Brassica napus*) with Canola quality, i.e. low-glucosinolate, low-erucic acid varieties, represents one of the world's major sources of vegetable oil. Since early 1970s, the 'canola' quality oil has gained acceptance worldwide as a healthy edible oil cooking medium. It is the major edible oil in many countries like Australia, Japan and Canada. Though the nutritional advantages of rapeseed-mustard oil available in India outdo many other edible oils (lowest amount of harmful saturated fatty acids, and contains two essential fatty acids – linoleic and linolenic), the presence of erucic acid and glucosinolates are considered to be undesirable. Erucic acid is feared to cause health problems and high glucosinolates in the oil cake are not desired for animal feed. Hence efforts to develop canola quality and also low erucic acid containing mustard varieties acquire importance in the crop improvement programme of Rapeseed- Mustard in India.

RAPESEED MUSTARD SCENARIO IN INDIA

Among the seven annual edible oilseeds cultivated in India, rapeseed-mustard contributes nearly 30 percent in the total production of oilseeds. Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat cover more than 80% of acerage under mustard. Toria is a short duration winter crop cultivated largely in eastern India. Taramira (*Eruca sativa*) is grown in the drier parts of North Western India. Gobhi sarson and karan rai are the new emerging oilseed crops having limited area under cultivation. Gobhi Sarson (Brassica *napus*) is a long duration crop confined to Punjab, Himachal Pradesh and some parts of Haryana. The overall national average yield of 1095 kg/ha. was recorded during 2007 with more than 1.3 tonnes per hactare yield levels in Gujarat and Haryana.

CANOLA

'Canola' quality varieties are commonly developed from either or two species of *Brassica napus* and *Brassica campestris.* Efforts to develop Canola quality *Brassica juncea* varieties have been fairly successful in India. With the development of canola cultivars in major producing countries including Canada, the use of rapeseed oil has increased manifold. The characteristics of canola include:

- Higher yield with < 2% erucic acid
- Relatively shorter duration of the crop
- Perceived as a healthy cooking medium having less than 2 per cent erucic acid
- Demand as livestock feed as oil meal contains less than 30 micromoles glucosinolates per gram of defatted meal,
- Used as salad oil for it's light colour and texture
- Used in baking industry (reduces the saturated fatty acid intake, modifies the texture of baked product by making it more moist and softer)

Crop improvement programmes for developing canola varieties in India

Quality enhancement has always been one of the key focus areas of crop improvement programmes in rapeseed-mustard in India. Accordingly, Indian rapeseed-mustard breeding programme was also reoriented to accommodate quality parameters and lay emphasis to develop "Canola" varieties. Initial efforts concentrated on the development of genetic stocks for low erucic acid and low glucosinolate in the indigenous cultivars using exotic donor sources (Agnihotri et al*,* 2004). Crop improvement programmes have been taken up in a coordinated network mode under the umbrella of All India Coordinated Research Project on Rapeseed Mustard (AICRP-RM). Hyola 401 (2000) and TERI-Unnat (2001) were identified for release by AICRP-RM. Another highlight is the notification of double low *B. napus var.* TERI-Uttam-Jawahar, with >43% oil content, early maturity and shattering tolerance. The meal from this variety, in the studies conducted at IVRI, has shown better digestibility as animal feed and is being explored as a new protein source for food and feed, a better quality meal for cattle and poultry at par with soybean meal (Ravichandran et al*.,* 2008) A critical part of crop improvement for development of rapeseed-mustard of canola-quality variety involves strategic selection of plants having desired quality parameters as well as good yielding attributes. The initial efforts carried out in India to develop such varieties were by introduction of exotic canola quality cultivars. These efforts met with limited success due to the inability of introductions to thrive under Indian agro-climatic conditions.

It is widely acknowledged that crop improvement for canola qualities is rendered more difficult by the fact that erucic acid and glucosinolate content of the oilseed are governed by multiple recessive genes. Under such circumstances, a combination of conventional methods of plant breeding coupled with biotechnological approaches need to be employed to develop new strains. Genetic enhancement of *B. napus* has been undertaken by introgressing agronomic and quality traits through integeneric/ interspecific hybridization. Several canola quality rapeseed strains having supplementary desirable characters like early maturity and shattering tolerance have been developed and registered under the AICRP- RM programme. So far three *Brassica juncea* and six *Brassica napus* lines with double low characteristics have been registered with National Bureau for Plant Genetic Resources (NBPGR).

Sources for canola quality characteristics

The zero erucic mustard developed by Kirk and Oram (1981) has been utilized by Indian scientists for transferring zero erucic traits to Indian mustard varieties. Under the AICRP Programme, research efforts are directed towards identification of suitable donors for desirable characters to be used in the breeding programme. Many such donors have been identified in the past for canola type qualities and efforts are continued in this direction.Australian and Chinese double low lines have been used extensively in breeding programme which may prove very useful in future. These include the Australian lines namely JR-042, JN-010, JN-033, JN-031, JN- 049, JN-009, JN -004, JN- 028, JM-16 and JM- 006 and the Chinese lines namely CBJ-001, CBJ-002, CBJ-003 CBJ-004, and XINYOU-5. Some of the identified sources of such desirable traits in Rapeseed Mustard are given in table 1.

It is expected that these promising donors shall further fast track the development of canola varieties both in *Brassica napus* and *Brassica juncea.*

Table 1. Sources for canola quality characteristics

Characteristics	Promising donors
Low erucic acid and high oleic acid (single low)	• ***B.juncea :*** LES 39
High oleic and linoleic acid (double low)	• ***B. juncea*** : TERI Uphaar (TERI GZ-05)
Glucosinolate content less than 30 micro mole/g defatted meal	• ***B. juncea*** : NUDH-YJ-1, NUDH-YJ-2 • ***B. napus*** : HNS 99(0E)3, NUDB-09, NUDB-26-11
Low erucic acid (up to 2%)	• ***B. juncea*** : LES 17 -1, LES 21, LES 38, LET-14, LET-17, YSRL 9- 18 -23, TERI-Swarna [TERI (OE) M 21] • ***B. napus*** : NUDB-26-11, Phaguni [TERI (0E) R 03], Shyamali [TERI (0E) R 09]
Low erucic acid (< 2%) and low glucosinolate (< 30 µ moles / g fat free meal)	• ***B. juncea*** : Heera, NUDHYJ- 5, • ***B. napus*** : OCN-3 (GSC -6), NUDB-26-11, NUDH-07, BCN 14, CAN 138, GSC 5 (GSC 3A), TERI-Garima [TERI(00)R985], TERI-Gaurav [TERI(00) R 986],TERI-Uttam [TERI(00) R 9903]

Varieties

Canola type varieties suited for different agro- climatic regions have been developed in Brassica napus and released for cultivation after extensive testing. Work for imparting canola quality in B. juncea genotypes is underway. So far only single low varieties with low erucic acid content (< 2%) have been developed in *Brassica juncea*. An effort for developing true canola type varieties (Double low) in *B. juncea* is being taken up under various crop improvement and quality improvement programmes. The list of varieties developed with single and double low characteristics in *Brassica napus* and *Brassica juncea* are given in table 2.

Insect and disease status in canola

No entries were found tolerant to Alternaria blight. However, white rust tolerance was reported in entries viz. BIO-Q-108-2000, HNS 9605, HNS 0004, GSL-1, OCN-3, CAN- 130, CAN 39, CAN 78, and TERI (00) R-9903. Bio chemical analysis of constituent revealed that higher amount of total phenols, surface wax and glucosinolates were responsible for the aphid resistance. The peak aphid population at Bharatpur centre was recorded during 8th std. week which was 1196.3 per 10 cm top twig in Hyola 401 that disappeared after 13th std. week. Low (30 aphid/plant) aphid population was recorded in TERI (00) R 9903. (AICRP-RM, 2003-09).

Promotion of Canola cultivation

Release of canola quality cultivars GSC 5 and GSC 6 has precipitated significant interest among farmers due to higher price the canola produce fetches from millers as compared to conventional rapeseed mustard genotypes. Increased popularity of these canola varieties is apparent from the fact that these varieties now account for the bulk of seed production programme for *B.napus* in Punjab. Several organizations are promoting contract farming for canola rapeseed in Punjab and adjoining states like Rajasthan and Haryana. For example, an NGO, Kalgidhar Trust, had arranged to crop about 20000 acres of area under GSC 5/GSC 6 during 2007-08/2008-09. The organization had promised to procure the produce at a premium.

Case study - canola cultivation in Punjab

The potential of canola quality varieties in India is clearly depicted in the experience of Punjab Agro Food Grains Corporation, which took up the cultivation of Hybrid *Brassica napus* (Hyola) in Punjab. Canola types are gaining wide acceptance among the farmers in Punjab, due to more

returns, white rust and frost tolerance and higher oil content with better oil quality. The area under cultivation increased from 9798 acres in 2002-03 to 55500 acres in 2006-07. The venture conclusively proved the existence of niche market for canola quality oil and viability of bringing more area under canola cultivation.

Table 2. Varieties with single and double low characteristics

S. No.	Variety	Year of release	Maturity (Days)	Oil content (%)	Average Yield (kg/ha)	Special characteristics
Gobhi Sarson(*Brassica napus*)						
1	Hyola-401 (Hybrid)	1996/2000	148-182	42	1200-1640	Double low - low erucic acid, 0.8 % and low glucosinolate
2	TERI (OE) R-03 (TERI Unnat)*	2001	128-138	40-44	800-1450	Low erucic acid (< 2%) and high oleic acid (59.5%)
3	GSC-5	2003	141-168	37-43	1719-2390	Low erucic (< 2%) and low glucosinolate
4	TERI –Uttam-Jawahar [TERI (00) R 9903]	2004	130-135	43-45	1619-2685	Low erucic acid (< 2%) and low glucosinolate
5	GSC-6 (OCN-3)	2007	151	39.2	1795	Short duration Low erucic acid and low glucosinolate.
6	NUDB 26-11*	2007	156	38.7	984-1339	Low in erucic acid and glucosinolate content (canola type) suited for normal sown irrigated conditions
Indian Mustard (*Brassica juncea*)						
1	Pusa Karishma (LES 39)	2004	137-161	37-38	1731-2506	Low erucic acid (< 2%)
2	Pusa Mustard -22 (LET 17)	2006	142	35.5	2070	Suitable for irrigated conditions, low erucic acid.
3	Pusa Mustard-21 (LES 1-27)	2006	137-152	34.0 - 40.0	2111	Low erucic acid (<2%)
4	ELM-079	2007	152	38	1600-2000	Suitable for irrigated areas, prone to lodging and shattering, tolerant to Alternaria blight, resistant to white rust, low erucic acid <2%.
5	Pusa Mustard -24 (LET 18)*	2007	140	36.6	2025	For timely sown irrigated conditions, low in erucic acid.

* Not notified.

CONSTRAINTS AND FUTURE STRATEGIES

The production constraints facing canola type rapeseed mustard varieties are diverse in nature. The problems of common nature include non availability of superior seed material to farmers at the correct time, lack of price support policies, the predominance of rain-fed cultivation in oilseed crops (72 % under rain-fed conditions) and the inadequate research and extension linkages. Apart from these canola crops cultivation faces certain specific constraints which are listed below.

- Cultivation of *Brassica napus*, the major canola genotype in India is mainly confined to the states Punjab, Himachal Pradesh and Haryana . Further scope for area expansion beyond these states is limited due to climatic conditions.
- The use of recommended dosage of fertilizers, especially Sulphur is not practised in most of the growing areas of canola varieties leading to decline in productivity and production.
- The prevalence of biotic stress (mustard aphid, white rust, Alternaria blight and Sclerotinia rot) and abiotic stress (frost and high temperature) causes severe yield loss in the major producing areas of the crop.
- Delayed sowing of the crop after harvesting of Kharif crops like cotton and rice leads to low yield realisation.
- Non availability of *Brassica juncea* varieties with double low (Canola) characteristics
- Low stability of introgressed canola quality characters like low erucic acid content and low glucosinolate content exhibited by the varieties under development is a serious concern.

STRATEGIES TO PROMOTE CANOLA CULTIVATION IN INDIA

At present the cultivation of canola crop accounts for less than 1 percent of the total area under rapeseed- mustard in India. Raising the share of canola crops in total rapeseed mustard cultivation is important for increasing the quality of edible oil available to the consumers in the country. The traditional preference for qualities like pungency notwithstanding, there exist a niche market for the canola oil among a section of the Indian consumers. The strategies to be adopted to benefit canola cultivation in India can be broadly classified into Production strategies, dealing with the technical and agro ecological aspects of canola cultivation, marketing strategies aimed at getting better market share for the canola oil and policy support strategies for creating conducive environment for proper implementation of production and marketing strategies.

Production strategies

- Develop canola varieties with *Brassica juncea* genotype for wide adaptability in rapeseed mustard growing regions of the country.
- Use of improved exotic donors for canola variety development programme through partnership research and better linkages
- Use of improved varieties and improving the agronomic potential of existing *Brassica napus* varieties through conventional and advanced crop breeding techniques
- Acerage enhancement though Cultivation of Gobhi Sarson through transplanting in areas, which are vacated late (upto mid- December) by the previous Kharif crops such as cotton and paddy, which gives more economic returns than late sown wheat.
- Emphasize on pure crops of Gobhi Sarson (*Brassica napus*) than intercropping through the improved production technology
- Timely sowing and Balanced use of fertilizers especially sulphur
- Timely management of serious menace like aphid, Alternaria blight and Sclerotinia rot.

Marketing Strategies

- Creation and stabilization of demand for the canola oil through awareness
- Price rationalization of Canola oil with respect to that of other premium edible oils
- Introduction of canola oil in non traditional
- Development of value added products from by products to enhance the profitability
- Exploring the possibilities for export oriented production and processing

Policy Support Strategies

- Promoting contract farming for enhancing production and technology
- A Price support schemes to protect against market risk
- Research policy giving priority to tackle production problems of canola
- Ensuring availability of all critical inputs
- Efficient public extension service network

The objective of raising domestic availability of quality edible oil can be realised only by increasing the productivity of the oilseed crops. Rapeseed-Mustard, which contributes nearly 80 percent of the total *rabi* oilseed production, is a key component in edible oil sector. Enhancing the production and productivity of the crop assumes significance, not only from the farmers view point but also for the edible oil industry and other vertically and horizontally linked enterprises. In ensuring availability of high quality edible oil, canola has a crucial role to play. India can become a key contributor to world canola production through focussed approach and appropriate strategic interventions.

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