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Canola Cultivation in India: Status and Production Systems

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Distribution:

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.

Characteristics of 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

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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).

Characteristics of Hyola:

It is"canola" quality hybrid rapeseed mustard recently introduced in India. The Hyola (variety PAC-401) is only hybrid 'canola' quality gobhisarson notified by Govt. of India after extensive trials by Indian Council of Agricultural Research (I.C.A.R.). It has the yield potential with high oil percentage. In current crop diversification programme, Hyola is gaining wide acceptance among the farmers in Punjab. The acreage of Hyola has already crossed 50,000 acres. Besides farmers, it has also been accepted by the traders and consumers. As a result, Punjab Agro Industries Corporation Ltd (PAIC) is promoting the Hyola cultivation through contract farming system and has identified the Hyola (variety PAC 401) as a suitable alternative in place of wheat during rabi season. By realizing it's benefits, the Govt. of Punjab has given more emphasis on it's cultivation and set a target to extend the cultivation to more than 1 lakh acre by 2004-05 and which will be 5,00,000 acres by 2007-08. However, Hyola has the following beneficial characteristics:

- Higher yield (around 12 quintals/acre).
- Identified as a well suitable crop for diversification.
- Returns more than wheat.
- An ideal intercrop with autumn sown sugarcane.
- Tolerant to white rust disease and frost, hence more acceptable to farmers than other varieties.

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- Fetch more price in the mandi due to higher oil percentage F Higher oil content(41-44 percent)in the seeds.
- Contract farming facility as provided by Punjab Agro-Industries Corporation (PAIC) is available.
- Export quality oil meal (contains less than 30 micromoles glucosinolates per gram of defatted meal).
- Export quality oil (contains less than 2 per cent erucic acid).
- More acceptable to the consumers as it contains less than 2 per cent erucic acid, which is healthier.

Characteristics of TERI-UTTAM:

The scientists of 'The Energy and Resources Institute' (TERI),New Delhi have developed a new variety of gobhisarson and named as "Teri-Uttam". Oil obtained from Teri-Uttam is nutritious with better fatty acid profile and is comparable to the Internationally recognised "Canola " oil. This variety has shown immense potential because it contains high oil content, early maturity period within 135 days and more than 20 per cent yield as compared to the Brassica napas National check variety GS-1. It has also potential of earning foreign exchange as it's oil meal contains low glucosinolate. However, the following characteristics of Teri-Uttam have made it a potential cultivar to expand its growth in India:

- Owing to low in erucic acid content, the oil quality is comparable to internationally recognis ed 'Canola oil'.
- It has a potential to earn foreign exchange as the oil meal contains low glucosinolate which has a high international demand.
- Yields 25 per cent more than other gobhisarson varieties.
- Short duration variety than conventional varieties of gobhisarson.

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

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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.

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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.

Table-1:Sources for canola characteristics in Brassica juncea and Brassica napus.

Characteristics	Promising donors
Low erucic acid and high oleic acid (‘0’)	LES-39
High oleic and linoleic acid (‘00’)	TERI Uphaar (TERI GZ-05)
Glucosinolate content less than 30 µ mole/g. in defatted meal.	NUDH-YJ-1, NUDH-YJ-2
Low erucic acid (<2%)	LES 17-1, LES-21, LES-38, LET-14, LET-17, YSRL 9-18-23, TERI-Swarna [TERI (0E) M21]
Low erucic acid (<2%) and low glucosinolate (<30 µ mole/g fat free meal)	Heera, NUDH YJ-5
Characteristics	**Promising donors**
Low glucosinolates contents ((<30 µ mole/g fat free meal)	HNS 99 (0E)3, NUDHB-09, NUDH-26-11.
Low erucic acid (<2%)	NUDH-26-11, Phalguni [TERI (0E) R 03], Shyamali [TERI (0E) R 09]
Low erucic acid (<2%) and low glucosinolate (<30 µ mole/g fat free meal)	OCN-3 (GSC-6), NUDH-26-11, NUDH-07, BCN 14, CAN 138, GSC 5 (GSC 3A), TERI-Garima [TERI (00) R 985], TERI-Gaurav [TERI (00) R 986], TERI-Uttam [TERI (00) R 9903].

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

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

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GSC 5/GSC 6 during 2007-08/2008-09. The organization had promised to procure the produce at a premium.

Table-2: Varieties with single and double low characteristics.

Variety	Year of release	Maturity (Days)	Oil content (%)	Average yield (Kg/ha)	Special characteristics
B. napus					
Hyola-401 (Hybrid)	1966/ 2000	148-182	42	1200-1640	Double low-low erucic acid, 0.8% and low glucosinolate
TERI (0E) R-03 (TERI-Unnat)	2001	128-138	40-44	800-1450	Low erucic acid (<2%) and high oleic acid (59.5%)
GSC-5	2003	141-168	37-43	1719-2390	Low erucic acid (<2%) and low glucosinolate
TERI-Uttam Jawahar [TERI (00) R 9903]	2004	130-135	43-45	1619-2685	Low erucic acid and low glucosinolate
GSC-6 (OCN-3)	2007	151	39.2	1795	Short duration, low erucic acid and glucosinolate
NUDB 26-11	2007	156	38.7	984-1339	Low erucic acid and glucosinolate, suited for normal sown irrigated conditions
B. juncea					
Pusa Karishma (LES 39)	2004	137-161	37-38	1731-2506	Low erucic acid
Pusa mustard-22 (LET 17)	2006	142	35.5	2070	Suitable for irrigated conditions, low erucic acid
Pusa mustard-21 (LES 1-27)	2006	137	34.0-40.0	2111	Low erucic acid
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
Pusa mustard-24 (LET 18)	2007	140	36.6	2028	For timely sown irrigated conditions, low erucic acid

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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.