Oil crops: Brassica Subnetwork

Proceedings of the Third Workshop, Quality Training, and Chinese Project Reports, held in Shanghai, People's Republic of China, 21–24 April 1990

Abbas Omran

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PRESENT STATUS AND FUTURE STRATEGIES OF OILSEED BRASSICA RESEARCH IN INDIA

P.R. Kumar and P.S. Bhatnagar

In India oilseed Brassica is the second important oilseed crop after groundnut. In recent years (1986-87 to 1988-89) production and productivity of Brassica oil seed have increased substantially to 4.4 million tones and 909 kg/ha from the levels of 2.61 million tones and 708 kg/ha, respectively, Table 1 & Fig. 1. By 2000 AD, additional production of 4 million tonnes is to be achieved to provide 30 g fats per person per day (1). The task is stupendous and challenging, yet achievable. The strength of recently developed technology-tests on farmers' fields has led to the optimism of achieving the desired productivity increase under both rainfed and irrigated conditions. However, stability in production and productivity is still elusive. The paper highlights the current status of research activities and future research strategies in achieving envisaged targets.

Table 1. Area, Production, Productivity of Rapeseed/ Mustard in India during 1966-67 to 1988-89.

Year	Area (Million ha)	Productivity (kg/ha)	Production (Million Tonnes)
1966-67	3.01	408	1.23
1967-68	3.24	483	1.57
1968-69	2.87	469	1.35
1969-70	3.17	493	1.56
1970-71	3.32	594	1.98
1971-72	3.61	396	1.43
1972-73	3.32	545	1.81
1973-74	3.46	493	1.70
1974-75	3.68	612	2.25
1975-76	3.34	580	1.94
1976-77	3.13	496	1.55
1977-78	3.58	460	1.65
1978-79	3.54	525	1.86
1979-80	3.47	411	1.43
1980-81	4.11	560	2.30
1981-82	4.40	541	2.38
1982-83	3.83	577	2.21
1983-84	3.87	673	2.61
1984-85	3.99	771	3.07
1985-86	3.98	674	2.68
1986-87	3.72	700	2.61
1987-88	4.62	788	3.46
1988-89	4.87	907	4.41

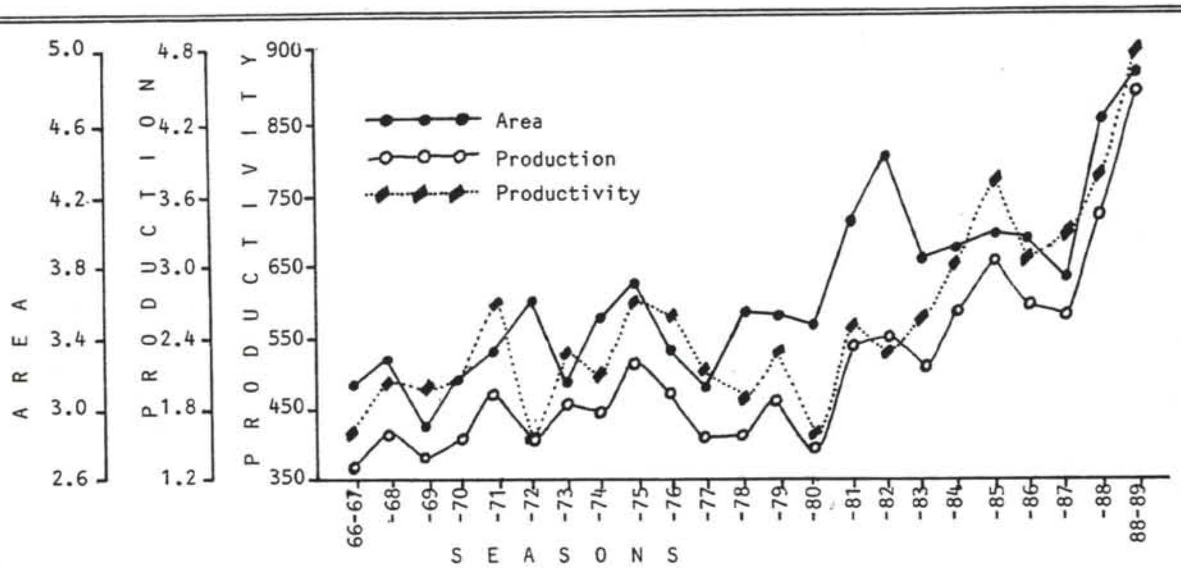

Fig. 1. Area, Production and Productivity of Rapeseed-Mustard in India during 19ι -67 to 1988-89.

PRESENT STATUS

Management of genetic resource

India is considered the primary centre of diversity; distributed over eight phytogeographical zones in the country. During 1981 to 1989, 2164 land races have been collected from different parts of the country. During this period, 1634 accessions were introduced from 18 countries (Canada, USA, Sweden, France, Holland, Australia, Pakistan, West Germany, Bangladesh, Nepal, Hungary, USSR, U.K., Poland, Bulgaria, New Zealand, Zambia and Spain). the lines have been evaluated for qualitative and quantitative characters on the basis of descriptors prepared. The promising ones have been identified for different biotic and abiotic stresses and other economic attributes.

Utilization of genetic resource:

The spectrum of genetic diversity available has helped in bringing improvement of oilseed Brassica The promising accessions have been subjected to selection pressure and/or utilized in recombination/mutation breeding for developing high yielding and stable varieties. The promising high yielding varieties identified/released through different breeding approaches are given below:

(i) Through selection

- *Brassica juncea* L. Czern & Coss: T-11, T-16, BR-13, BR-40, Patan-67, Varuna, Kranti, Krishna, Durgamani, Laha-101, Shekhar, Rohini, RL-18, Seeta, RH-30 and NDR-8501.

- *Brassica campestris* L. var. Toria: M-2, M-3, M-18, M-27, TS-29, B-54, BR-23, BR-29, BR-36, RAUTS-17, T-36, DK-1, T-9 and ITSA.

- *Brassica campestris* L. var. Brown Sarson: BSA, BSG, BSH-1, BS-2, BS-70, B-65 and KOS-1.

- *Brassica campestris* L. var. Yellow Sarson: YS-66-197-3, PYS-6, K-88, Patan-66, T-10, T-42 and YST-151.

(ii) <u>Through recombination</u>

- *Brassica juncea* L. Czern & Coss: Sanjucta Asesh, Prakash, Pusa bold, RW 85-59, RW-351, Vaibhav, Vardan, RH-819, RH-8113, RH-785, RH-781, RL-1359, DIRA-367 and DIRA-247.

- *Brassica campestris* L. var. Toria: PT-303, TH-63 and Panchali.

- *Brassica campestris* L. var. Yellow Sarson: YSB-19-7-C.

(iii) <u>Through mutation breeding</u>

- *Brassica juncea* L.: RLM-198, RLM-514, RLM-619, TM-2, TM-4, TM-18, TM-19, TM-21 and RH-7859.

<u>Insect-resistance</u>:

Among different insects, Mustard Aphid (*Lipaphis erysimi* Kalt.); Painted Bug (*Bagrada cruciferarum* Krik.); Mustard sawfly (*Athalia laucens proxima* Klug.); Leaf minor (*Phytomyze* horticola Gouraceu) and Flea bettle (*Phyllotreta cruciferae* Goeze.) are of economic importance. The chemical control is quite effective but most of the chemicals are lypophilic in nature. It is, therefore, considered essential to develop varieties with inbuilt resistance and to adopt biological control measures.

Hybridization using T-6342 as a source of aphid resistance was undertaken and genotypes RH-7846 and RH-7847 with fair degree of tolerance have been developed. The genetic material generated through hybridization is under different stages of testing under multilocation trials.

There are more than twelve natural enemies of mustard aphid. Two insects, lady bird beetle (*Coccinella septumpunctata*) and syrphid fly (*Syrphid* sp.) are important predators. Unfortunately, their population remains low at the peak time of aphid infestation, as the predators require higher temperature for survival and multiplication, whereas low temperature in December-January is conducive for multiplication of aphids. The efforts are underway to develop a predator race which can multiply rapidly at the peak period of aphid infestation.

<u>Disease resistance</u>

Alternaria blight, white rust, downy mildew and phyllody are some of the major diseases of oilseed Brassica in India. Hybridization program has resulted in developing the variety RH-8113 with field resistance to Alternaria blight and white rust diseases. In addition, strains RH-8114, KRV-Tall, PR-8701, and PR-8705 have been identified showing field tolerant reaction. The gene(s) responsible for resistance to white rust have been successfully transferred from *Brassica carinata* to *B. juncea* (3). The material developed through interspecific crosses between *juncea* and *carinata* is under advanced stages of testing.

Frost tolerance

Frost is not a common phenomenon but it leads to considerable losses in seed yield in unpredictable frosty years. Four *juncea*-(RH-781, Rh-8574, RH-8886 and RW-175) and one *Eruca sativa*-(TMH-52) frost tolerant (<10% damage) genotypes have been identified.

Drought tolerance

More than 53% of the area under oilseed Brassica is rainfed. A number of varieties/strains of Indian mustard (RLM-514, RH-7361, RH-30, RH-819, Vardan, RH-781) have been identified drought tolerant under rainfed conditions.

Quality improvement

Intervarietal and interspecific crosses have been made to eliminate/reduce concentrations of erucic acid and glucosinolates and to balance fatty acid composition in the oil. The lines with low erucic acid (<5%) and low glucosinolates (<30 μmoles/g) have been developed by crossing exotic *juncea* cultivars (Zem-1 and Zem-2) possessing low erucic acid with Indian cultivars (RLM-619, RL-1359 and RH-30) possessing high erucic acid. Likewise, exotic *campestris* cultivar Tobin possessing low erucic acid and glucosinolate was crossed with Toria cultivars TL-15, TLC-1, and T-9. The exotic sources used for zero erucic acid content possess Fig. 1 some undesirable agronomic characters, viz., late maturity, poor yield and susceptibility to downy mildew. The generated breeding material is in different segeregating generations. Interspecific hybridization between *juncea* (cv. RLM-198) x *napus* (cv. Oro) gave a large number of progenies with chromosome number 2n=36; some of them possessing lower erucic acid concentration and good agronomic characters in the F_1s.

Development of hybrids

The cytoplasmic male sterility (cms) in Indian mustard generated interest in the development of hybrids. Initial efforts through intraspecific hybridization between indigenous and exotic lines of *juncea* and cms sources did not result in pollen fertility. Parental ancestor monogenomic species (*campestris* AA and *nigra* BB) constituting digenomic *juncea* species (AABB) reverted to partial fertility restoration. Complete fertility restoration was, however, brought when genes from both AA (RF_1 RF_1 RF_2 RF_2) and (RF_3 RF_3 RF_4 RF_4) genomes were brought together in a single genotype. The restorer genes were considerably influenced by modifier genes and the adverse climatic conditions resulting into male sterility in hybrids. Efforts are underway to diversify cms system for developing superior hybrids as well as for purification of restorer gene(s). The hybrids are under trials at different locations in the country.

Salt tolerance

The problem of salinity and alkalinity is gradually increasing with the increase in ground water irrigation facilities. A large number of strains/germplasm is screened at the Central Soil Salinity Research Institute, Karnal. Strains DIRA-337, DIRA-343, RH-851, NDR-8604 and 8501 have been found to be high yielding and promising in salt affected soils.

Shattering resistance

The dehiscence of siliquae at the time of harvesting causes considerable loss in seed yield. Efforts made in the past resulted in identification of Indian mustard genotypes like RH-30, Pusa bold, RH-8130, RLC-1021 and RH-8131 as resistant/moderately resistant to shattering. Some resistant lines have also been developed through introgression.

Varieties for late sown conditions

In order to bring a sizeable area under intensive cropping system, efforts have been made to identify suitable varieties for late sown and limited irrigation conditions in different agro-climatic situations. A number of promising varieties of Indian mustard, viz., RH-7859, Vardan and RLM-619 have been found performing well under such conditons.

Varieties for non-traditional areas

Results are quite encouraging in improving productivity of rapseed/mustard in non-traditional areas. The varieties like Seeta, RLM-619, Pusa bold, Pusa Barari, RLM-514 and Kranti are performing exceedingly well in southern and western states.

Varieties for high altitudes

Summer cultivation of rapeseed-mustard at high altitudes on hills and valleys has become a reality. In Himachal Pradesh, a promising and better adaptable toria variety, TL-15 has been developed recently in 1988.

PRODUCTION TECHNOLOGY

Soil test calibrations for targetted yields:

Soil test calibration for recommending fertilizer doses for targetted yields of oilseed Brassica has been developed. The results have been verified subsequently on farmers' fields. Results of trials conducted on research farms and farmers' fields to verify soil test calibrations are presented in Table 2. Data on the average values indicate that the yields are within ± 15% deviation from the targetted yields.

Production under high intensity crop rotation:

Production potential of high intensity crop rotations involving Indian mustard as a winter crop and relative economics have been worked out under the All India Coordinated Research Project, Table 3. It is evident that crop rotations involving rice-mustard-green gram, rice-mustard-black gram, guar-mustard-bajra resulted in higher productivity and net returns. This is particularly significant in areas where assured irrigation and intensive fertilizer application are the major constraints in improving productivity of oilseed Brassica.

Potential of improved technology

The relevance and effectiveness of improved technology package have direct bearing on its application and adoption on extensive scale. Large-scale field demonstrations on farmers' fields have been conducted to demonstrate the potentials of the improved technology.

The results of field demonstrations established, beyond doubt, the potentials of improved agro-production technology in realizing increased yields of oilseed Brassica, Table 4.

FUTURE RESEARCH STRATEGIES

1. Development of varieties for higher seed and oil yields with in-built resistance/tolerance to:
   a. Mustard aphid,
   b. Alternaria blight and white rust,
   c. frost,
   d. drought, and
   e. salinity/alkalinity.

2. Emphasis on increasing oil content *per se*.

3. Increase emphasis on hybrid Brassica for increased productivity.

4. Application of biotechnological approaches for breaking yield barriers for increased and stabilized production.
5. Improvement of oil and seed meal qualities.

6. Development of varieties for late \ sown conditions.

7. Introduction and improvement of rapeseed-mustard in non-traditional areas.

8. Acceleration of researches on integrated nutrient management.

9. Intensification and diversification of rapeseed-mustard based cropping system.

10. Intensification of researches to develop integrated pest management practices.

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Table 2. Soil-test based fertilizer recommendation for mustard: Results of verification trials (2).

Location, Soil (type)	No. of trials	Average soil test values (kg/ha) N	P	K	*	Average Fertilizer (kg/ha) N	P_2O_5	K_2O	Mean yield target	Mean yield obt. (kg/ha)	Response Ratio (kg/ha) (kg/ha)	% Deviation
Dhali, Alluvial (YS. 66-197-3)	1	200	20.0	100	a	68	7	23	1500	1680	-	12.0
Jabalpur, Black (Varuna)	7	287	10.7	381	a	122	72	51	2000	1912	6.1	-4.4
					b	60	30	20		1157	6.8	
					c	0	0	0		413		
New Delhi, Alluvial (Varuna)	1	223	23.7	235	a	88	94	96	2500	2167	4.2	-13.3
					c	0	0	0		1010		
New Delhi, Alluvial (Pusa Bold)	1	228	33.0	342	a	78	106	55	2500	2110	4.1	-15.6
					c	0	0	0		1140		
New Delhi, Alluvial (Pusa Kalyani)	2	202	28.7	335	a	100	41	4	2250	1927	5.0	-14.4
					c	0	0	0		1208		
Ludhiana, Grey-Brown (RLM-619)	6	90	14.7	143	a	38	60	18	1500	1362	-	9.2

* a = Soil test based fertilizer recommendation for specific yield target.
b = General recommended dose.
c = Control.

Table 3. Production potential of high intensity crop rotations and their relative economics from selected locations involving mustard as a rabi crop.*

Centre, STATE	Crop rotation Kharif	Rabi	Summer	Total fertilizer (kg/ha) N	P	K	Average yield (kg/ha) during Kharif	Rabi	Summer	Tot. yield (kg/ha) including pulses & oilseeds	Gross return (Rs/ha)	Net return (Gross minus fert. cost)
Pantnagar, UP	Rice	Wheat	Greengram	260	175	37	3826	4204	711	8741	11875	9669
"	Rice	Mustard	Greengram	227	162	37	3676	899	954	5529	10971	8985
Mashodha, UP	Rice	Wheat	Greengram	250	152	120	4435	4796	865	10096	13805	11604
"	Rice	Mustard	Blackgram	210	140	100	4420	1578	569	6567	13273	11358
Varanasi, UP	Rice	Wheat	Greengram	310	160	140	4748	3494	1000	9242	13147	10592
"	Rice	Mustard	Greengram	310	160	120	4757	1427	813	6997	13862	11347
S.K. Nagar, GUJARAT	Bajra	Wheat	Greengram	225	142	40	1930	2009	565	4504	6439	4425
"	Guar	Mustard	Bajra	140	120	0	714	1476	1654	3844	9866	8576
Navsari, GUJARAT	Rice	Wheat	Greengram	365	195	120	5680	2242	1438	9360	14012	11508
"	Rice	Mustard	Guar	185	150	60	3783	559	837	5179	9097	7320
Banswara, RAJASTAN	Rice	Wheat	Greengram	215	115	0	3935	3196	159	7290	8949	7156
"	Rice	Mustard	Greengram	175	150	0	4000	490	134	4624	7024	5414

* Three years pooled data, AICORPO, ICAR.

Table 4. On-farm testing of rapeseed-mustard improved technology in different states.

State	Crop	No. of demonstrations	Average Yield (kg/ha)	State Average seed yield (kg/ha)
Punjab	Mustard	27	1492	922
"	Toria	25	1516	
"	Gobhi Sarson	10	1901	
Haryana	Mustard	826	1882	783
Rajasthan	Mustard	6	2562	812
Gujarat	Mustard	5	2561	1293
"	Yellow Sarson	1	2430	
Uttar Pradesh	Mustard	244	1393	612
"	Toria	6	1299	
Bihar	Mustard	2	1950	684
West Bengal	Mustard	2	1751	600
"	Yellow Sarson	5	1768	
Assam	Toria	171	1022	481
All India		1330	1809.76	

* Includes entire rapeseed-mustard crop commodity.

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