Annual Report

2016-17

ICAR-Directorate of Rapeseed-Mustard Research
(Indian Council of Agricultural Research)
Sewar, Bharatpur 321 303 (Rajasthan) India

(An ISO 9001:2008 Certified Organization)

ANNUAL REPORT
2016-17

Indian Council of Agricultural Research (ICAR) established ICAR- Directorate of Rapeseed-Mustard Research as a national repository for rapeseed-mustard genetic resources and also for undertaking basic, strategic and applied research to enhance the productivity and quality of oil and seed-meal. The Directorate is assigned the leadership role, not only for the ICAR institutes but also for the Central and State Agricultural Universities, in developing ecologically sound and economically viable agro-production and protection technologies for rapeseed-mustard based on location specific interdisciplinary information through multi-location testing and co-ordination. With a view to further the cause of Yellow Revolution, the Directorate has the responsibility to establish linkages and promote co-operation with national and international agencies in relation the problems of regional and national importance and to extend technical expertise and consultancies in this area.

ICAR-Directorate of Rapeseed-Mustard Research
(Indian Council of Agricultural Research)
Sewar, Bharatpur 321 303 (Rajasthan) India

ICAR-DIRECTORATE OF RAPESEED-MUSTARD RESEARCH
SEWAR, BHARATPUR- 321 303 (RAJASTHAN), INDIA

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ICAR-Directorate of Rapeseed-Mustard Research
(Indian Council of Agricultural Research)
Sewar, Bharatpur-321 303 (Rajasthan), India

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Brassica Science for oil and nutritional security

MISSION

Harnessing science and resources for
sustainable increase in productivity of Rapeseed-Mustard

Preface

It is an honour and pride to present the 24th Annual Report of ICAR-Directorate of Rapeseed-Mustard Research comprising of research achievements and programmes carried out during the period of 2016-17. An Indian mustard variety NRCHB 101 was identified for rainfed conditions of zone V by variety identification committee of AICRP on Rapeseed-Mustard on 5th August, 2016 during XXIII AGM. A germplasm DRMR 541-44 (IC 0598624, INGR15066) has been registered by Plant Germplasm Registration Committee of ICAR-NBPGR, New Delhi for drought tolerance (high water use efficiency under rainfed conditions). Five entries of Indian mustard i.e. DRMRIJ 16-1, DRMRIJ 16-2, DRMRIJ 16-3, DRMR IJ 15-85 and DRMR 13-38 were inducted for evaluation under IVT (Timely Sown Irrigated), IVT Rainfed, IVT Late Sown, white rust resistance and AVT I Late Sown (zone V), respectively. Three hybrid entries DRMRHJ 913, DRMRHJ 2513 and DRMRHJ 3913 were inducted for evaluation under IHT. Six promising entries i.e. DRMRCI-58, DRMRCI-59 (early mustard), DRMRCI-55 (timely sown irrigated), DRMRCI-65, DRMRCI-70 (timely sown rainfed), were inducted for multi-location testing under AICRP-RM in different coordinated trials during 2016-17. Based on heat susceptibility index (≤ 0.5), yield stability ratio ($\geq 80\%$), siliqua per plant, higher RWC, MSI values, and molecular diversity analysis genotypes DRMR-13-20, DRMR-13-13, DRMR-13-28, DRMRHT-13-7, DRMR-541-44, DRMR-1165-40, BPR-543-2, RH-555 and Urvashi were identified as heat tolerant at seedling stage. Twenty M_3 mutant progenies of RH 749 (Gamma 100kr) and 6 WR free M_4 mutant progenies of RH 749 & Kranti were planted in field for further selections and advancement. Based on 25 polymorphic Simple Sequence Repeat (SSR) markers with 57 polymorphic alleles, the genetic diversity and relatedness of 10 genotypes, including 6 high yielding, 4 quality lines (2 low erucic and 2 double low) of Indian mustard (*Brassica juncea*) and their 24 crosses were carried out. Successful induction of artificial autotetraploidy has been achieved in three plants of *B. tournefortii* (2n=20), a wild relative of cultivated brassicas are highly promising as an valuable resource for resistance/tolerance against the major abiotic and biotic factors. The highest percentage of success was recorded in when the seedlings were treated with 0.2% aqueous colchicine for 12 hour within two days.

A total of 916 q TL seeds of Rapeseed-mustard varieties were produced during rabi 2015-16. Improved Rapeseed-mustard varieties i.e. DRMRIJ31, NRCHB101, NRCDR-02, NRCDR601, RH-406, RH-749, NRCYS-05-02 and YSH 401 were included in the seed production programme. Breeder seed of DRMRIJ31 (19.54 q), NRCDR02 (4.67q), NRCHB101 (14.79 q), DRMR601 (1.77q) and NRCYS 05-02(0.16q) was produced during 2015-16.

A newer GC-MS method has been standardized to study the major anticancer components (Aliphatic glucosinolate, aromatic glucosinolate & indoyl glucosinolates) present in the brassica species. A Simple Spectrophotometric Method for Estimating Total Glucosinolates in Mustard de-oiled cake is obtained. Six independent putative transgenic events of *B. juncea* var. NRCDR-2 were developed with *TvD1* gene via *Agrobacterium tumefaciens*-mediated gene transfer technique. Molecular characterization of the putative transgenic plants of *B. juncea* var. NRCDR-2 had been carried out by PCR using *TvD1* gene specific primers and two events were confirmed PCR positive for *TvD1* gene integration. A web based expert system of crop variety selection has been developed. The system was developed by applying knowledge engineering approaches with scientific knowledge base in backend.

A total of 324 frontline demonstrations of improved varieties i.e. DRMRIJ 31, RH 406 RH and 749 were conducted in different villages of Bharatpur district of Rajasthan which showed 6.9, 12.1 and 7.3 per cent yield advantage, respectively over other varieties sown by the farmers.

ICAR-DRMR successfully organized 6 training programmes for KVK personnel of different states, 2 for field level extension workers and 12 for farmers/ATM/BTM for effective and wider dissemination of scientific production and protection technology of mustard.

The "Mera Gaon Mera Gaurav" programme has been actively taken up by the Directorate during 2016-17 by adopting 25 villages by the five teams of Interdisciplinary members comprising of both scientific and technical staff. The farmers were provided required scientific information, knowledge and advisories on regular basis through conducting 283 FLDs on mustard, 5 FLDs on wheat, organizing 5 Srason field days, interface meetings, trainings, Mobile based advisories, literatures, linkages with line departments, etc.

A total of 29 research papers, 5 technical bulletin, 3 books, 4 book chapters and 18 technical folders were published during this period.

I extend my humble gratitude and thanks to Dr. T. Mohapatra Secretary, DARE and DG, ICAR, Dr. J.S. Sandhu, Deputy Director General (Crop Science) and Dr. S. K. Chaturvedi, Acting Assistant Director General (Oilseed and Pulses) of the council for their meticulous guidance, support and encouragement. My sincere thanks goes to all the scientific, technical, administrative and supporting staff for their admirable contributions to this report and also for bringing laurels to the Directorate. My sincere appreciation and thanks are due to the editors, Drs Ashok Kumar Sharma, Bhagirath Ram, Anubhuti Sharma and Ibandalin Mawlong for their dedicated efforts in compiling the programmes and achievements of the Directorate in the present form.

26.6.17

ICAR-DRMR, Bharatpur
June 30, 2017

(Pramod Kumar Rai)
Director

Abbreviations

AAU	Assam Agricultural University/ Anand Agricultural University
ADG	Assistant Director General
AICRP	All India Coordinated Research Project
AICRP-RM	All India Coordinated Research Project on Rapeseed-Mustard
ANMR	Additional Net Monitory Return
ARS	Agriculture Research Station
ATMA	Agricultural Technology Management Agency
AVT	Advance Varietal Trial
BARC	Bhabha Atomic Research Center
BAU	Birsa Agricultural University
CAZRI	Central Arid Zone Research Institute
CMS	Cytoplasmic Male Sterility
CIAH	Central Institute of Arid Horticulture
CSAUAT	Chandra Shekhar Azad University of Agriculture and Technology
CV	Coefficient of Variance
DAC	Department of Agriculture and Cooperation
DARE	Department of Agriculture Research and Education
DAS	Days After Sowing
DDG	Deputy Director General
DM	Dry matter/Downy Mildew
DMAPR	Directorate of Medicinal and Aromatic Plant Research
DRMR	Directorate of Rapeseed-Mustard Research
DSI	Drought Stability Index
DST	Department of Science and Technology
DSR	Directorate of Seed Research
DUS	Distinctiveness, Uniformity and Stability
DUSC	Delhi University South Campus
EDI	Entrepreneurship Development Institute of India
FIGs	Farmer Interest Groups
FIRB	Furrow Irrigated Raised Bed System
FLD	Front Line Demonstration
FYM	Farm Yard Manure
GCV	Genotype Coefficient of Variance
IAA	Indole Acetic Acid
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistics Research Institute
IBCR	Incremental Benefit Cost Ratio
ICAR	Indian Council of Agricultural Research
IIAB	Indian Institute of Agricultural Biotechnology
IIOR	Indian Institute of Oilseed Research
IHT	Initial Hybrid Trial
IJSC	Institute Join Staff Council
IPR	Intellectual Property Right
IRC	Institute Research Council/International Rapeseed Congress
ISTM	Institute of Secretariat Training & Management
IVT	Initial Varietal Trial
KVK	KrishiVigyan Kendra
LT	Latest Release
LAMP	Linux, Apache, MySQL and PHP Technology
MBC	Microbial Biomass Carbon
MEY	Mustard Equivalent Yield

MoU	Memorandum of Understanding
MPUAT	MaharanaPratap University of Agriculture and Technology
MPKV	Mahatma PhuleKrishiVidyapeeth
MS	Murashage Skoof
MSI	Membrane Stability Index
MSI	Mustard Straw Incorporate
MSL	Mean Sea Level
MTC	Model Training Course
MUFA	Mono Unsaturated Fatty Acid
NAARM	National Academy of Agricultural Research and Management
NAAS	National Academy of Agricultural Sciences
NBPGR	National Bureau of Plant Genetic Resource
NC	National Check
NCD	North Carolina Design
NDN	National Disease Nursery
NGO	Non-Government Organization
NIFM	National Institute of Financial Management
NPTC	Network Project on Transgenic in Crops
NRCPB	National Research Centre of Plant Biotechnology
PAU	Punjab Agricultural University
PCR	Poly cyclic Chain Reaction
PCV	Phenotypic Coefficient of Variance
PPV&FRA	Protection of Plant Varieties & Farmers Rights Authority
PMC	Pollen Mother Cells
PRWC	Percent Relative Water Content
PSB	Phosphorus Solubilizing Rhizobacteria
PUFA	Poly Unsaturated Fatty Acid
RAC	Research Advisory Committee
RCBD	Randomized Complete Block Design
RDF	Recommended Dose of Fertilizers
RCT	Resource Conservation Technology
RFD	Results-Framework Document
R&M	Rapeseed & Mustard
RRS	Regional Research Station
RVSKVV	RajmataVijayaraje Scindia Krishi Vishwa Vidhyalaya
RWC	Relative Water Content
SAC	Space Applications Centre
SAU	State Agricultural University
SDA	State Department of Agriculture
SDAU	Sardar Dantiwada Agricultural University
SGM	Sesbania Green Manure
SIAM	State Institute of Agriculture Management
SKRAU	Swami Keshwanand Rajasthan Agricultural University
SOC	Soil Organic Carbon
SPS	Single Plant Selection
SSG	Supporting Staff Grade
STMS	Sequence Tagged Microsatellites
TSP	Tribal Sub Plan
UAS	University of Agriculture Sciences
VPKAS	Vivekanand Parvatiya Krishi Anusandhan Sansthan
WHO	World Health Organization
WP	Wettable Powder/Whole Pacakge
WSC	Wide Spaced Crop
WUE	Water Use Efficiency
ZC	Zonal Check

Executive Summary

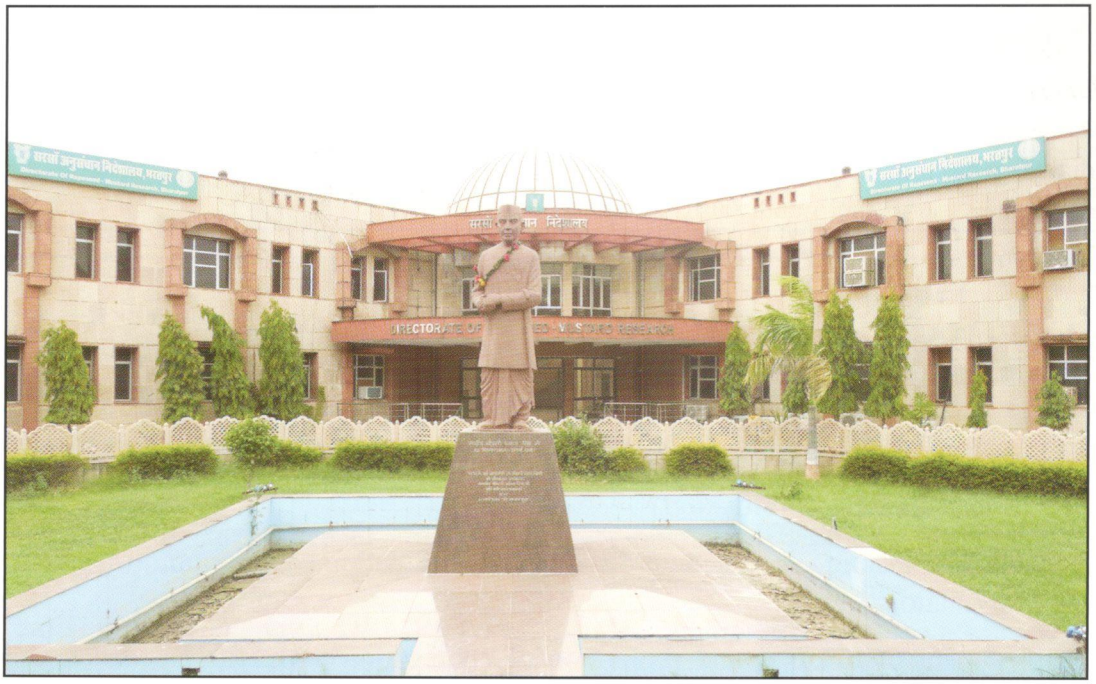
- Indian mustard variety NRCHB 101 was identified for rainfed conditions of zone V (Asom, Bihar, Orissa, West Bengal, Jharkhand, and NEH States) by Variety Identification Committee of AICRP on Rapeseed-Mustard on 5th August, 2016 during 23rd annual group meeting of AICRPRM at DUVASU, Mathura.
- Germplasm DRMR 541-44 (IC 0598624, INGR15066) has been registered by Plant Germplasm Registration Committee of ICAR-NBPGR, New Delhi for drought tolerance (high water use efficiency under rainfed conditions).
- It was recommended that the foliar spray of Mancozeb 0.2% followed by Propiconazole 25 EC @ 0.05% was most effective in controlling WR, SR, ABL, and ABP. Similarly foliar spray of mancozeb @ 0.2% was found most effective for the management of powdery mildew followed by Mancozeb 0.2% + followed spray of Hexaconazole 25 EC @ 0.05% during XXIII Annual Group Meeting of AICRP-RM at DUVASU, Mathura.
- Five entries of Indian mustard i.e. DRMRIJ 16-1, DRMRIJ 16-2, DRMRIJ 16-3, DRMR IJ 15-85 and DRMR 13-38 were inducted for evaluation under IVT (Timely Sown Irrigated), IVT Rainfed, IVT Late Sown, white rust resistance and AVT I Late Sown (zone V).Three hybrid entries DRMRHJ 913, DRMRHJ 2513 and DRMRHJ 3913 were inducted for evaluation under IHT.
- 58 entries of Inbreds and selections from segregating generations were screened at IARI Regional Station Wellington during offseason nursery (June to September 2016). Two lines DRMRIJ 16-112' DRMRIJ 16-124 exhibited resistance against white rust at Wellington.
- Six promising entries i.e. DRMRCI-58, DRMRCI-59 (early mustard), DRMRCI-55 (timely sown irrigated), DRMRCI-65, DRMRCI-70 (timely sown rainfed), were inducted for multi-location testing under AICRP RM in different coordinated trials during 2016-17.
- Based on heat susceptibility index($\leq$ 0.5), yield stability ratio($\geq$ 80%), siliqua per plant, higher RWC, MSI values, and molecular diversity analysis genotypes DRMR-13-20, DRMR-13-13, DRMR-13-28, DRMRHT-13-7, DRMR-541-44, DRMR-1165-40, BPR-543-2, RH-555 and Urvashi were identified as heat tolerant at seedling stage.
- Twenty M_3 mutant progenies of RH 749 (Gamma 100kr) and 6 WR free M_4 mutant progenies of RH 749 & Kranti were planted in field for further selections and advancement.
- Based on 25 polymorphic Simple Sequence Repeat (SSR) markers with 57 polymorphic alleles, the genetic diversity and relatedness of 10 genotypes, including 6 high yielding, 4 quality lines (2 low erucic and 2 double low) of Indian mustard (*Brassica juncea*) and their 24 crosses were carried out.
- Successful induction of artificial autotetraploidy has been achieved in three plants of *B. tournefortii* (2n=20), a wild relative of cultivated brassicas, are highly promising as an valuable resource for resistance/tolerance against the major abiotic and biotic factors. The highest percentage of success was recorded in when the seedlings were treated with 0.2% aqueous cochicine for 12 hour within two days.
- A total of 916 q TL seeds of rapeseed-mustard varieties were produced during *rabi* 2015-16. Improved Rapeseed-mustard varieties i.e. DRMRIJ31, NRCHB101, NRCDR-02, NRCDR601, RH-406, RH-749, NRCYS-05-02 and YSH 401 were included in the seed production programme.
- Breeder seed of DRMRIJ31 (19.54 q), NRCDR02 (4.67q), NRCHB101 (14.79 q), DRMR601 (1.77q) and NRCYS 05-02(0.16q) was produced during 2015-16.
- We isolated the oil storage body and its protein oleosin from selected genotypes. The oleosin content was found to range from 0.31% to 5 %. To understand further their relationship to oil content we isolated oil storage bodies.
- A newer GC-MS method has been standardized to study the major anticancer components (Aliphatic glucosinolate, aromatic glucosinolate & indoyl glucosinolates) present in the brassica species. A Simple Spectrophotometric Method for

Estimating Total Glucosinolates in Mustard de-oiled cake is obtained.

- *Six independent putative transgenic events of B. juncea* var. NRCDR-2 were developed with *TvD1* gene via *Agrobacterium tumefaciens*-mediated gene transfer technique. Molecular characterization of the putative transgenic plants of *B. juncea* var. NRCDR-2 had been carried out by PCR using *TvD1* gene specific primers and two events were confirmed PCR positive for *TvD1* gene integration.
- Among the organic sources, MSI + SGM produced significantly higher seed yield than rest of the organic sources. It was followed by VC and SGM. The interaction between FYM and OS was found significant. At SFM strategy, all organic sources of nutrient except MSI + SGM significantly reduced the seed yield atleast by 30.2% from CC (100% RDF). At MFM level, MSI + SGM produced significantly higher seed yield than rest organic sources. The increase in seed yield due to MSI + SGM at MFM level was more than 22.4% over CC.
- 65 *S. sclerotiorum* isolates of different geographical regions showed variations in pathogenicity in respect of stem lesion length. On the basis of longest and shortest stem lesion formed by different geographical isolates on seven Brassica species, following 7 groups were made :Group I – (*B. juncea* var.NRCDR-02), Group II –(*B. napus* var. NRGLS) , Group III- (*B.rapa* var. YS) , Group IV – (*B. rapa* var. BS) , Group V- (*B. rapa* var. toria), Group VI-(*B. carinata)* , Group VII-(*B. alba)*.
- A web based expert system of crop variety selection has been developed. The system was developed by applying knowledge engineering approaches with scientific knowledge base in backend. The system suggests the varieties of farmer's/ advisor's choice based on location for climatic conditions such as rainfed or irrigated or for both conditions.
- A total of 324 frontline demonstrations of improved varieties i.e. DRMRIJ 31, RH 406 RH and 749 were conducted in different villages of Bharatpur district of Rajasthan which showed 6.9, 12.1 and 7.3 per cent yield advantage, respectively over other varieties sown by the farmers.
- ICAR-DRMR successfully organized 6 training programmes for KVK personnel of different states, 2 for field level extension workers and 12 for farmers/ATM/BTM for effective and wider dissemination of scientific production and protection technology of mustard.
- The "Mera Gaon Mera Gaurav" programme has been actively taken up by the Directorate during 2016-17 by adopting 25 villages by the five teams of Interdisciplinary members comprising of both scientific and technical staff. The farmers were provided required scientific information, knowledge and advisories on regular basis through conducting 283 FLDs on mustard, 5 FLDs on wheat, organizing 5 Srason field days, interface meetings, trainings, Mobile based advisories, literatures, linkages with line departments, etc.

  A total of 29 research papers, 5 technical bulletin, 3 books, 4 book chapters and 18 technical folders were published during this period.
- Under Tribal Sub Plan, on farm demonstrations of rapeseed-mustard crop in 96.6 ha in project area of Assam, 120 ha area of Jharkhand, 60 ha area of Madhya Pradesh and about 552 ha area of North Eastern States (Manipur, Meghalya, Mizoram & Arunachal Pradesh) have been laid out during 2016-17. Besides, a 3 days training-cum- Exposure visit to ICAR-DRMR was also organized in collaboration with RVSKVV, Gwalior during 13-15 December 2016 for capacity building of the 31 tribal farmers of Jhabua district of MP for dissemination of scientific technology of rapeseed-mustard among them.

1 ICAR-DRMR: *An Overview*



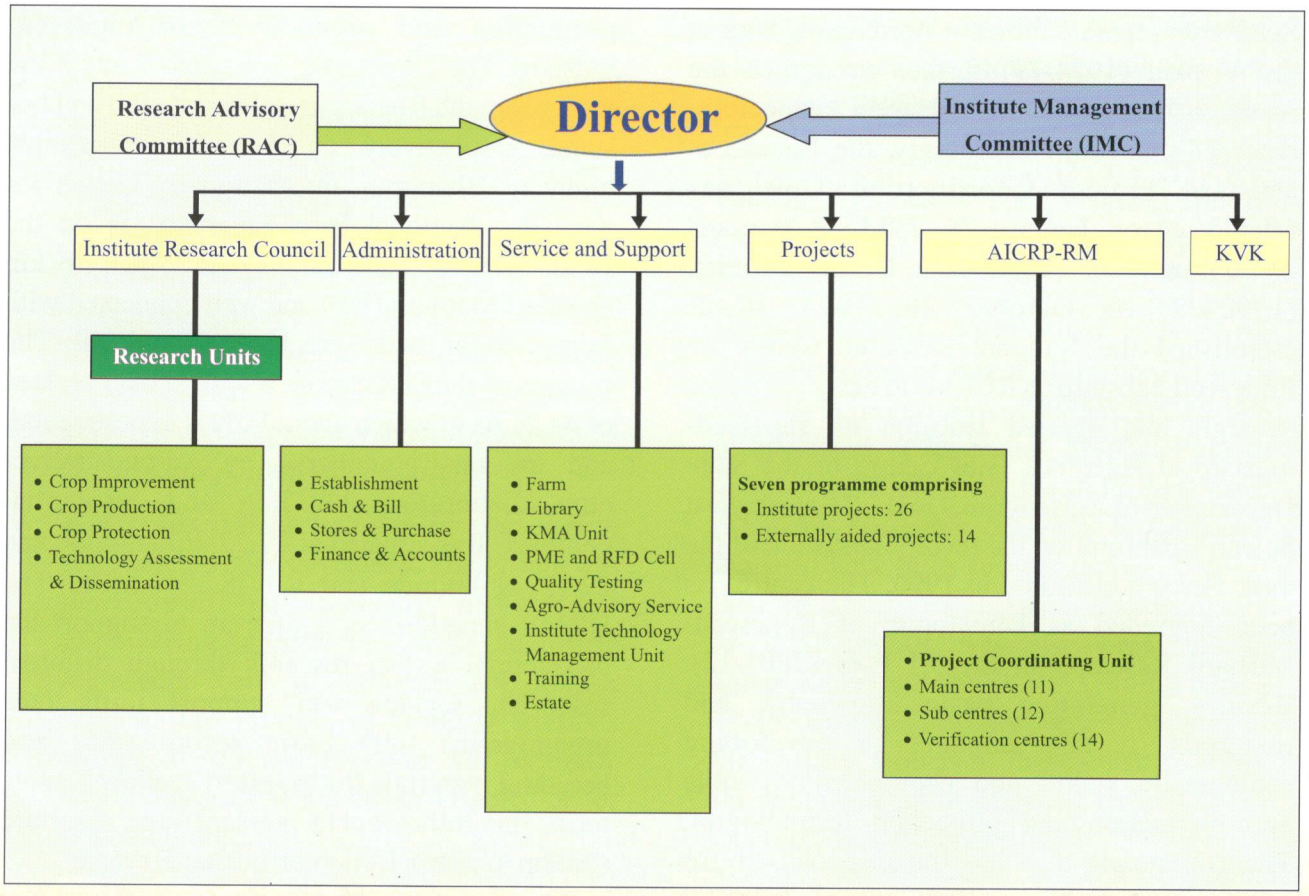
Indian Council of Agricultural Research established All India Coordinated Research Project on Oilseeds (AICRPO) in April 1967 for the improvement of oilseeds in the country. Setting up separate Project Coordinating Unit in the V plan (1974-79) further strengthen the research program on oilseeds, especially rapeseed-mustard. Accordingly, the Rapeseed-Mustard Project Coordinating Unit was established on January 28, 1981, at Haryana Agricultural University, Hisar. During VII Plan (1992-97) on October 20, 1993, ICAR established the National Research Centre on Rapeseed-Mustard (NRCRM) to carry out basic, strategic and applied research on rapeseed-mustard at Adaptive Trial Centre of the State Department of Agriculture, Govt. of Rajasthan at Sewar, Bharatpur on the recommendation of the Task Force constituted in 1990. The centre has been upgraded as Directorate of Rapeseed-Mustard Research in the XI Plan (2007-12). Besides, generating basic knowledge and materials, it also engages in developing ecologically sound and economically viable agro-production and protection technologies. The Directorate also has the responsibility to plan, coordinate and execute the research program through a wide network of 11 main and 12 sub-centres across the country in addition to need-based verification centres under the umbrella of AICRP-RM to augment the production and productivity of rapeseed-mustard. The Directorate is located 7 and 3 km away from the Bharatpur railway station and bus stand, respectively on Agra-Jaipur national highway. Bharatpur, internationally known for Keoladeo National Bird Sanctuary, is on the Delhi-Mumbai main railway track just 36 km ahead of Mathura (UP) and well connected with Jaipur, Delhi, and Agra by road and rail. The campus of the Directorate is spread over an area of 44.21 ha of which about 80% is experimental, and the rest is covered by Administrative-cum—Laboratory building and residential complex. It is situated at 77.27° E longitude and 27.12° N latitude and is 178.37m MSL. The DRMR functions as a fulcrum to support the production system research through different research, service and support units (see organogram) with basic technologies and breeding materials for rapeseed (yellow sarson, toria, taramira, gobhi sarson) and mustard (Indian mustard, Ethiopian mustard) crops.

Objectives

- Utilizing frontier research for better exploitation of genetic resources.
- Development and identification of appropriate production-protection technologies.
- Capacity building and knowledge management through technology assessment, refinement and dissemination.

Functions

- The National repository of rapeseed-mustard genetic resources and information.
- Basic, strategic and applied research improve the productivity and quality of oil and seed meal.
- Development of ecologically sound and economically viable production and protection technologies for different situations.
- Generation of location specific interdisciplinary information based on multi-location testing and coordination.
- Establishment of linkages and promotion of cooperation with national and international agencies to achieve above objectives.
- To extend technical expertise and consultancies.



2 Research Achievements

2.1 Genetic enhancement for stress tolerance in Indian mustard

DRMR CI-10: Breeding for high yield and oil content under normal and moisture stress conditions

Principal Investigator: V. V. Singh, Pr. Scientist (Genetics and Plant Breeding)

Co-Investigators: P. K. Rai, Pr. Scientist (Plant Pathology), R. S. Jat, Sr. Scientist (Agronomy), H.S. Meena, Sr. Scientist (Genetics and Plant Breeding)

Contribution and performance of entries in AICRP-RM trials

Five promising entries viz; DRMRCI-58, DRMRCI-59 (early mustard), DRMRCI-55 (timely sown irrigated) DRMRCI-65, DRMRCI-70 (timely sown rainfed), were inducted for multi-location testing under AICRP RM in different coordinated trials during 2016-17.

Entry DRMR 1165-40 has been promoted to AVT II in timely sown (Rain fed) zone II. Entry DRMR 1153-12 has been repeated in AVT I (late sown, Zone V). DRMR 1165-40 (continuously 02 years) and DRMR 15-9, has been identified as thermo-tolerant at seedling stage. Genotype DRMR 541-44 (03 years) has been identified as promising under low light stress. Genotypes DRMR 10-40 (four years) and DRMR 15-5 were identified as tolerant to moisture stress under AICRP-RM plant physiology trials.

Germplasm Registration

Germplasm DRMR 541-44 (IC 0598624, INGR15066) has been registered by Plant Germplasm Registration Committee of ICAR-NBPGR, New Delhi for drought tolerance (high water use efficiency under rainfed conditions).

Evaluation of promising entries in station/ advanced trials

During the period, 64 entries were evaluated in 04 station trials for selection of promising entries for varied situations. From station trial of 2015-16, strain DRMRCI 55 (2211 kg/ha) recorded maximum yield in comparison to checks (Best check NRCHB 101 yielded 2058 kg/ha). In another station trial, entry DRMRCI 65 (1958 kg/ha) out yielded the best check NRCHB 101 (1664 kg/ha). In station trial under rain fed conditions, entries DRMRCI-70 (1565 kg/ha), DRMRCI-65 (1536 Kg/ha), DRMRCI 68 (1462 kg/ha) recorded better yield than the check RH819 (1250 kg/ha). In early trial, entry DRMR 59 and DRMR 58 recorded more yield i.e. 2141 Kg/ha and 1624 kg/ha respectively in comparison to best check NPJ 112 (1404 kg/ha).

Observation nursery

One hundred twenty three advanced progenies were grown in observation nursery along with checks (NRCHB 101, DRMRIJ 31, RH 749 and NRCDR 2). On the basis of per se performance, progenies DRMR 1724-49 (2286 Kg/ha, OC 42.6%), DRMR 1716-5 (2106 Kg/ha, OC 43.3%), DRMR 1716-3 (2045 Kg /ha, OC 42.8%), DRMR 1721-29 (1936 Kg/ha, OC 42.3%), DRMR 1721-26 (1866 Kg/ha, OC 42.2%), DRMR 1724-45 (1860 Kg/ha, OC 42.8%), DRMR 1721-18 (1851 Kg/ha, OC 41.8%) were selected.

GCV and PCV were higher for biological yield per plant (24.32 and 24.54% respectively) followed by seed yield per plant (20.22 and 21.63% respectively) and fruiting zone length (13.04 and 13.13 % respectively). Genetic advance expressed as % of mean was higher for biological yield (43.34%), plant height (31.9%), fruiting zone length (24.46%) and seed yield per plant (15.9%).

Evaluation of high oil lines

19 half sib lines, derived from 3rd cycle of selection were again evaluated for oil content check varieties Rohini and NRCDR 2. Two derivatives i.e. 253-17-3 (43.75%) and 253-16-1 (43.7%) which recorded high oil content (>43%) in comparison to Rohini (41.1%) in

2015 gave oil content of 42.36% and 43.94% respectively. Other derivatives which recorded high oil content were 12-1 (43.16%), 17-1 (43.23%) and 16-2 (42.97%).

Rainfed

Observation Nursery

Same set of observation nursery (123) was grown under rainfed conditions. On the basis of plot yield and drought susceptibility index (DSI), progenies DRMR 1680-100 (1437 Kg/ha, DSI 0.25), DRMR 1686-99 (1381 Kg/ha, DSI 0.50), YSH 33 (1300 Kg/ha, DSI 0.13), DRMR 1678-98 (1281 Kg/ha), YSH 33 (1196 Kg/ha, DSI 0.59) and YSH 113 (1125 Kg/ha, DSI 0.96) were selected.

Generation of breeding material

Nine fresh crosses were attempted and 23 F_1 s were advanced to F_2 generation.

Selection from segregating generations

The segregating and non-segregating generations [$F_3$187 SPS (04 crosses), F_4 85 SPS (04 crosses), F_5 144 (3 crosses), observation nursery 120 (20 crosses)] were grown in blocks with standard checks under irrigated conditions. Under rain fed conditions, [F_2 06, F4 (*Brassica carinata* type) 81 SPS (3 crosses) F4 (*Brassica juncea* type) 163 (9 crosses), F_5 117 SPS (05 crosses), observation nursery (120 bulk from 20 crosses), were grown along with checks for selection and evaluation. About 1000 individual plants as well as promising lines have been selected.

340 SPS were selected from 6 F_2 populations for generation advancement. 100 single plants (Brassica carinata type) and 150 (Brassica juncea type) were selected from F_4 generation. 32 bulk selectins were made from promising lines of F_5 generations.

Selection of promising cultures of Brassica carinata for early maturity, high oil content (%) and test weight were madefrom F_4 generations. The progenies 3-1 (42.2%), 6-2 (42.5%), 9-2 (42.6%), 12-1 (43.98%), 12-3 (42.9%), 32-4 (42.2%), 36-1 (42.5%), 39-1 (42.0%), 49-1 (43%), 62-2 (42%), 63-1 (42.2%), 64-2 (42.3%) were selected for high oil content. Progenies, 70-3 (125 DM, 42.7% OC), 72-4 (124 DM, 42.2% OC), 74-4 (123 DM, 42.5% OC), 81-1 (123 DM, 42.3% OC) were selected for early maturity and high oil content. Three progenies viz; 20-2 (TW 4.7g), 25-1 (TW 5.2g) and 25-2 (TW 5.4g) were found promising for high test weight while progenies 40-4 (124 DM, 42.6% OC, 4.3g TW), 70-1 (125 DM, 42.9% OC, 4.8g TW) and 77-3 (124 DM, 40.6% OC, 4.7g TW) possesses early maturity, high test weight and high oil content.

DRMR CI 12: Widening of gene pool in Brassicas through inter-specific and inter-generic hybridization.

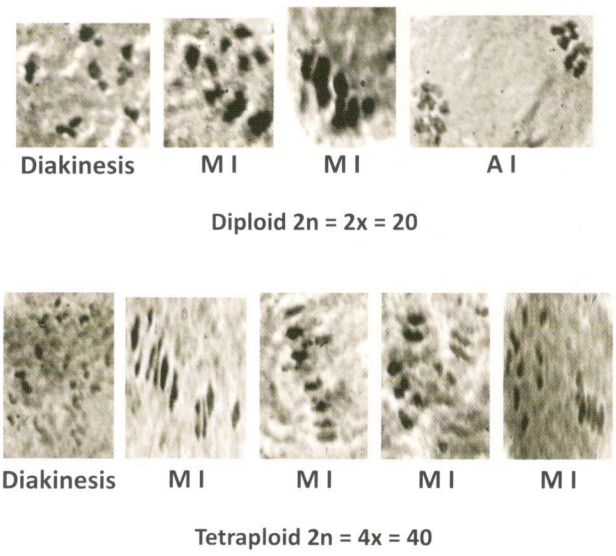
Principal Investigators: Arun Kumar, Sr. Scientist (Genetics-Cytogenetics)

Co-Investigators: H.S. Meena, Sr. Scientist (Genetics and Plant Breeding) and Anubhuti Sharma, Sr. Scientist (Biochemistry)

Cytogenetical investigations in colchicine-induced tetraploids of Brassica. tournefortii and utilization in hybridization with *B. juncea*

Successful induction of artificial autotetraploidy has been achieved in three plants of *B. tournefortii* (2n=20), a wild relative of cultivated brassicas, are highly promising as an valuable resource for resistance/tolerance against the major abiotic and biotic factors (Figs. 2.1).

The highest percentage of success was recorded in when the seedlings were treated with 0.2% aqueous cochicine for 12 hour within two days. The synthesized plants showed remarkable enhancement in several morphological and floral characters making them more robust.



Figs. 2.1 : Cytological examinations (male meiosis) in diploid and colchicine – induced tetraploids of *B. tournefortii*

Development of dwarfing source in *B. carinata* with desirable traits

Indian mustard variety NRCDR-2 was crossed with NRCKR 304 registered germplasm line of *B. carinata*. Desirable characteristics, such as dwarf height less than 100 cm, fruiting zone length, long pod size, high test weight, early maturing etc., were observed when compared with parental lines. Out of these lines one stable line designated as DRMR-C-16-6 has been selected for dwarf height and with other desirable traits of economic importance (Figs. 2.2).

Figs. 2.2 : New plant type with dwarf height

Development of brown seeded *B. rapa* lines through inter-specific cross between *B. tournefortii* and *B. rapa* (var. NRCYS 05-02)

The two F_1 plants obtained from the above cross were back crossed with *B. rapa* (NRCYS-05-02) and few seeds have been obtained in BC_1 and segregated into 1:1 ratio. Two types of seeds in colour (dark brown and yellow) have been obtained from the segregating lines. Out of these segregating lines two lines have been advanced F_5 generation designated as DRMR-IS-17-01 and DRMR-IS-17-02 has been selected for brown seeded with tetra -locular pods and another with brown seeded with bi-locular pods types, respectively (Fig. 2.3).

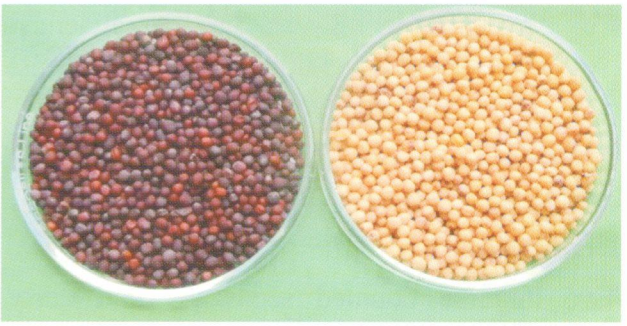


Fig. 2.3 : Brown seeded type NRCYS 05-02

Generation advancement and selection from segregating generations of inter-specific crosses

During *rabi* 2015-16 about 80 desirable *B. juncea* type selections were made from F_5 progenies of inter-specific cross *B. juncea* (NRCDR-2) x *B. carinata* (NRCKR-304) for various component traits.

Raising and generation advancement of F_2 segregating progenies of confirmed inter-specific hybrids obtained between *B. juncea* x *B. fruticulosa* (Tetraploid)

From the F_2 segregating progenies of confirmed inter-specific hybrids obtained between *B. juncea* x *B. fruticulosa* (Tetraploids), screening and scoring for mustard aphid infestation, selection of single plant progenies have been done in progenies of F_3 generations. About 80 single plants were selected from the F_3 progenies. Screening for the mustard aphid infestation in the field conditions was performed against check BSH 1. Based upon the

screening 20 plants selected on the basis of aphid injury symptoms on 0 to 05 scale following the procedure of Bakhetia and Sandhu (1973).Also, F_2 segregating progenies created valuable genetic variability.

DRMR-CI-14: Breeding for earliness and high temperature tolerance in Indian mustard

Principal Investigator: Bhagirath Ram, Sr. Scientist (Genetics and Plant Breeding)

Co- Investigator: R. S. Jat, Sr. Scientist (Agronomy); M. S. Sujith Kumar, Scientist (Plant Biochemistry)

Relative performance of heat tolerant and susceptible genotypes (donors) under heat stress regimes:

Two hundred counted seeds of each thirty genotypes including tolerant and susceptible were sown in the field under heat stress (seeding date on September 28, 2015) and normal conditions (seeding date on October 24, 2015) in rcbd with three replications. The days to 50% flowering and days to maturity under heat stress condition ranged from 42 to 57 and 136 to 160, respectively. Among the genotypes, 1000-seed weight (g) was maximum in (DRMR-1191-2(5.11; 5.13) followed by GM2 (4.89; 4.51) and RH-555(4.49; 5.41) under normal and heat stress conditions. Genotypes DRMR-1187-55(32g), DRMR-1672-2(32g), BPR-543-2(28.5g) and DRMR-HT-13-20(28g) recorded the maximum seed yield per plant under normal condition, while genotypes DRMR-HT-13-7 (20g), DRMR-1165-40 (19.8g), BPR-541-4(18g), BPR-549-9(17.5g) and DRMR-HT-13-13(17g) recorded the maximum seed yield per plant under stress condition. The population survival (%) at 10 DAS and 25 DAS under heat stress situation ranged from 39 to 69 (%) and 31 to 61 (%), respectively. Among the genotypes, membrane stability index was recorded maximum in DRMR-541-44 (72.22%), DRMR-HT-13-28 (67.86%), NPJ-124 (67.80%) and RH-555 (64.47%) under heat stress condition while it was minimum in DRMR-1672-2 (4.84%) under heat stress condition. Genotype DRMR-HT-729 (33.64 %), NRCHB 101 (35.42 %), Urvashi (36.46 %), NPJ 124 (38.71 %), DRMR-HT-13-28(38.86%) and RH 119 (44.52 %) were identified as heat tolerant and genotype Varuna (73.87 %) and DRMR-1187-55 (66.67 %), as heat sensitive for ELWL, irrespective of environmental condition. The relative water content (%) ranged from 70.59 to 89.19 under heat stress condition. The significant correlation between seed-yield and other morpho-physiological functional traits ranged from 0.322*- 0.901**. The hierarchical cluster analysis showed that the genotypes were mainly divided into three major clusters at a similarity coefficient of 0.73, which separated all heat sensitive and heat tolerant genotypes. Majority of heat sensitive genotypes were grouped into one major group. Estimates of genetic distance based on simple matching coefficient varied from 0.73 to 0.88. These thirty genotypes altogether shared 73% similarity on the basis of simple matching coefficient. Cluster I consists of eight genotypes which were heat tolerant. Based on heat susceptibility index ($\leq$ 0.5), yield stability ratio ($\geq$ 80%), siliqua per plant, higher RWC, MSI values, and molecular diversity analysis genotypes DRMRHT-13-20, DRMRHT-13-13, DRMRHT-13-28, DRMRHT-13-7, DRMR-541-44, DRMR-1165-40, BPR-543-2, RH-555 and Urvashi were identified as heat tolerant at seedling stage.

Evaluation of Indian mustard germplasm for high temperature stress tolerance

A total of 64 germplasm accessions alongwith two checks were evaluated under heat stress (early sown) and normal (timely sown) conditions during *rabi* 2015-16 in augmented block design for their *per se* performance with

respect to their high temperature stress tolerance at seedling stage. Hundred counted seeds of each 64 germplasm alongwith two checks were sown in the field under heat stress (28th Sept) and normal (24th Oct) conditions. Soil moisture along with soil temperature observations were recorded at different soil depths (surface, 5cm, 10cm and 20 cm.). The population survival percentage at 10 and 25 DAS decreased continuously with increasing heat stress in all the germplasm. However, the decrease was lesser in germplasm BBM 06-02, P32, HPLM 06-11, UP II-73, DRMRIJ 447 and PBR 378. Among the germplasm MSI was high in BPR-543-2, MRN-J-2001-3, HP 30, B 337, IC 267700, UP II-73, and PBR 378 under normal and stress conditions, while it was low in DRMR-1998 (1.04 %), DRMR-1077 (1.45 %), IC-511611 (1.56 %) and DU 4 (1.69 %) at high temperature stress relative to the normal. Under the heat-stress conditions, the RWC values of germplasm BPR 549-9 (92.11 %), RRN 752 (91.11%), BPR-543-2 (90.86%), MRN-J-2001-3 (89.74%), B 337 (86.67%), RM 14 (85.71%) and DRMR-2001 (85.71%) were higher compared to germplasm lines EC 511664 (66.67%) and HP 02-03-2 (71.62%). Based on population survival (%) at 10 and 25 DAS, MSI, ELWL, RWC values, heat susceptible index ($\leq$ 0.5) and yield stability ratio ($\geq$ 80%) germplasm, HPLM06-25, HP96, UP I-11, UPI-77, EC414320, UP-II-73, BPR-543-2, and MRN-J-2001-3 were identified as heat tolerant at seedling stage.

Generation advancement and evaluation of F_3 stage material for earliness/high temperature stress tolerance

Progeny row yield trials of threes selected crosses i.e. DRMRHT-13-13(GM2xBPR-549-9), DRMRHT-13-20(JN032xUrvashi) and DRMRHT-13-28(BPR-543-2xBPR-549-9) was conducted separately under early sown conditions. Two hundred counted seeds of each line were sown in two rows of 5 m length. BPR543-2 and NPJ-112 were used as check varieties for high temperature stress tolerance and earliness, respectively. Out of 62 F_3 populations tested, 41 early and high temperature tolerant types were advanced to F_4 for further evaluation and selection.

Hybridization Programme

Eight genetically diverse varieties of Indian mustard [*Brassica juncea* (L.) Czern & Coss] namely; NRCHB 101, DRMRIJ-31, NRCDR02, RH-749, RH-119, RH-406, Urvashi and BPR-549-9 were crossed in diallel fashion (excluding reciprocals) during *rabi* 2015-16. 28 F_1 crosses seeds were harvested.

Comparative tolerance response of parents and F_1 (early x early) crosses to high temperature stress

A total of 44 F_1 crosses including parents were evaluated in rcbd with two replications in two rows of five metre length for their *per se* performance with respect to their high temperature stress tolerance at seedling stage. Two hundred counted seeds of forty four cross combination including parents were sown in the field under heat stress (28th September) condition during *rabi* 2015-16. The PS (%) at 10 DAS and 25 DAS under heat stress situation ranged from 51 to 71 (%) and 39 to 58 (%), respectively. MSI(%) was high in cross JN032xTGP-13 (62.29%), NRCHB101xTGP-5 (61.11%) and BPR549-9x Core-50 (56.12%) under heat stress conditions, while it was low in TGP-6 (17.12%) and TGP-13 (24.81%) under heat stress conditions. The RWC values of Urvashix BPR-549-9 (92.50%), NRCHB101 x Urvashi (89.66%), TGP-20 (89.47%), RH-119 x RH406(88.71%), BPR 543-2 (88.00%), BPR549-9 x Core-50 (86.21%), JN-032xTGP-13 (86.05%) and Urvashi x TGP-20 (84.85%) were higher compared to TGP-6 (77.19%). Similarly, cross Urvashi x TGP-20 (16.5g), TGP-6 (16.3g), Core-50 (15.5g), DRMRIJ31 x

Urvashi (15g), BPR-549-9 x Core-50 (14.4g), RH-119xRH-406 (14g), and NRCHB101x RH119 (13.5g) recorded the higher seed yield per plant(g), while TGP-5 (8g), NRCHB-101 (8.2g), DRMRIJ31 x NRCDR02 (9g) and NPJ-112 (9.6g) recorded the lower seed yield per plant (g) under heat stress conditions.

Combining ability and gene action for seed yield and heat stress tolerance traits

For each set of experiments, high temperature stress was created by sowing in the last week of September under conserve moisture conditions. Results indicated that analysis of variance showed a significant difference in studied traits. Phenotypic values of population survival (10 DAS and 25 DAS), cell membrane stability index (MSI), excised leaf water loss (ELWL), relative water content (RWC), water retention capacity of leaves (WRCL) and seed yield per plant, differed significantly among the eight parental lines and 28 F_1 crosses ($P \leq 0.01$). Both GCA and SCA were highly significant for population survival (10 and 25 DAS), cell membrane stability index, excised leaf water loss, relative water content, water retention capacity of leaves and seed yield per plant ($P \leq 0.01$). Crosses NRCHB101 x BPR-549-9, NRCHB101 x BPR-543-2, JN032 x Urvashi, NRCDR601 x Urvashi and BPR541-2 x Urvashi had high values for population survival (10 DAS), cell membrane stability index (MSI), relative water content (RWC), water retention capacity of leaves and seed yield per plant; however, the crosses Urvashi x BPR-549-9 and JN032 x BPR-543-2 has a negative value for excised leaf water loss under heat stress condition.

DRMR CI-15: Resynthesis of Indian mustard (*Brassica juncea* L. Czern. & Coss.) through Inter-specific Hybridization.

Principal Investigator: H. S. Meena, Sr. Scientist (Genetics and Plant Breeding)

Co-Investigator: Arun Kumar, Sr. Scientist (Cyto-genetics)

Entries contributed in AICRP-RM

During 2015-16, two entries (DRMR 4001 & DRMR 4104) were contributed for testing under IVT rainfed and late sown conditions. DRMR 4104 (1483kg) over yielded best check PM 26 (1451), LR- RVM 2 (1209 kg), NC- Kranti (1155kg) in Zone II (late sown). Both entries showed high temperature tolerance at seedling stage and DRMR 4001 was also rated as highly tolerant to moisture stress showed yield reduction $\leq$ 10% with DSI $\leq$ 0.5 at different centres. Both entries are repeated for further testing under physiological trials during 2016-17. Entries DRMR 2019 & DRMR 2035 revealed WR resistance under NDN & UDN trials. Entry DRMR 2035 has been contributed in National Disease Nursery (NDN) for Sclerotinia rot under AICRP-RM for multilocation screening during 2016-17. Entries DRMR 2019 & DRMR 2035 again contributed in UDN trial during 2016-17 for major diseases of RM. Four entries viz., DRMR 4011 (timely sown irrigated mustard), DRMR 4685 (timely sown rainfed mustard), DRMR 4005 (Early sown mustard) and DRMR 2035 (late sown mustard) have been inducted in coordinated trials for multilocation testing during 2016-17 under AICRP-RM.

Screening at off-season nursery, Wellington (TN)

During *kharif* 2016, a total of 121 progenies including 50 re-synthesized *B. juncea* (S3), segregating progenies (F_3, F_4, F_5) from various crosses (DRMR 2035 x NRCHB 101; DRMR 2019 x NRCDR 2; RH 749 x NRCHB 101; NRCDR 2 x NRCHB 101; YRN-6 x TM 118; TPM-1 x RRN 727 (dwarf); NPJ 112 x RRN 727; *etc.*), BC_1 (DRMR 2035 x NRCHB 101/NRCHB 101), breeding lines (DRMR 2035, 2019, 5206, 4415, 4695) and mutant progenies were planted

Fig. 2.4 : Screening for WR resistance at Wellington

at off-season nursery, Wellington for WR resistance, generation advancement & back crossing. About 73 WR free (Score: 0.0) single plants from synthetics & segregating progenies were selected. Three re-synthesized *B. juncea* progenies (100-1-3, 100-6-3, 100-6-7), 3 advance breeding lines (DRMR 5206, DRMR 2019, DRMR 2035) and 6 M_3 mutant lines of RH 749 & Kranti were found highly resistant (Score: 0.0) in which all the plants were WR free. All white rust free plants were selfed and seeds were collected on maturity. The single plant progenies from them were again grown at DRMR during *rabi* 2016-17 and desirable single plants were selected & will be further screened at wellington.

S_3 progenies of re-synthesized *B. juncea*

During *rabi* 2015-16, 32 synthetic progenies belonging to 12 inter-specific crosses *viz*., Jhumka x BN-2, Ragini x BN-2, Pusa Kalyani x SKJ-2, KOS 1 x BN-2, PT-30 x SKJ-2, NDYS-2 x SKJ-2, Pusa Kalyani x SKJ-2, TH-68 x BN-2, JMT 02-06 x BN-2, Pusa gold x BN-2, YSH 401 x BN-2 and PYS 2005-06 x BN-2 varied from true *juncea* type to intermediate types were planted in the pots. Ten of them (Syn_2/100-1, Syn_2/100-$_2$, Syn_2/100-5, Syn_2/100-6, Syn_2/100-7, Syn_2/100-8, Syn_2/108-1, Syn_2/108-2, Syn_2/160-1, Syn_2/169-1) having sufficient seeds were also planted in the field to observe their real expression and agronomic worth under field conditions. The data on individual synthetic plants on various traits were recorded & a good range of genetic variability was observed for different agro-morphological & yield contributing traits viz; PB 8.0-18.0, MSL 40.0-123.0 cm, SMS 45.0-127.0, SL 3.0- 6.0 cm, S/S 4.0- 22.0, 1000-SW 1.66- 5.65g, OC 35.58-42.49 % & DM 113.0-137.0 days etc. About 170 plants including 160 re-synthesized *B. juncea* type and 10 intermediate or *rapa* type desirable plants were selected from pots & field. During *rabi* (2016-17), 153 re-synthesized S_3 single plant progenies of were planted in field with 2 rows of 5m length each for evaluation, further selections and stabilization. Similarly, 52 S_3 progenies were planted in the pots. Nearly 300 desirable single plants were selected and data were recorded on various traits (Table 2.1). A good spectrum of variability was observed in S_3 progenies which consisted of early maturity, dwarf plant type, robust plants with more number of primary, secondary & tertiary branches, high siliqua density, yellow seed, base branching, unique branching pattern, long main shoot with more siliquae, hardy stem, very long (>3m) plants with late maturity, stay green trait, bold seeds and high oil content etc. Some of the progenies still segregated into fertile, partially fertile & sterile plants.

Table 2.1 : Genetic variability for various traits in S_3 re-synthesized *B. juncea* progenies.

Trait / Entry	PH (cm)	PB	SB	MSL (cm)	SMS	SL (cm)	S/S	OC (%)	1000-SW (g)	DF	DM
S_3 progenies*	126.0-305.0	4.0-22.0	14.0-67.0	39.0-110.0	40.0-134.0	3.0-7.4.0	8.0-22.0	36.01-44.30	2.52-8.38	27.0-68.0	103-157
NRCHB 101**	175.3	5.3	18.2	78.6	49.3	5.3	15.7	41.84	5.48	37	134
DRMRIJ-31**	180.2	6	16.1	79.6	64	5.7	16.6	42.37	6.49	41	138

*Range based on 295 re-synthesized single plants; ** Check varieties

S_4 progenies from WR free plants

During Kharif 2016, 50 re-synthesized *B. juncea* S_3 progenies were planted at off-season nursery, Wellington and 14 WR free plants were selected. During rabi 2016-17, S_4 single plant progenies from these plants were planted in the field at DRMR for further selections and advancement. A total of 48 single plants were selected on the basis of desirable traits and will be further screened at wellington for WR resistance.

Raising S_1 generation

During *rabi* 2015-16, thirteen inter-specific F_1 crosses between *B. rapa* x *B. nigra* were planted in pots & about 55 individual F_1 plants were treated with 0.2% colchicine at two leaf stage by

Fig. 2.5 : Re-synthesized S_1 plants

cotton swab method for chromosome doubling. Two colchicine treated plants from the inter-specific cross, Jhumka x SKJ-2 revealed *B. juncea* type morphological features which were confirmed through cytological studies and meiotic configurations. Single plant progenies from these plants were grown in pots during *rabi* 2016-17 for selection of re-synthesized plants (Fig. 2.5). There were 15 plants from B. juncea type plants and all showed typical *juncea* type traits.

F_3 progenies from crosses of amphidiploids

During 2015-16 F_2 generation from inter-specific cross between *B. carinata* & *B. napus* (NRCKR 304 x NRCGS-1) was planted in the field and single plants were selected. Six single plant progenies were planted in the field during 2016-17 to select *B. juncea* type and other desirable plants. The progenies were segregated into carinata, intermediate and *juncea* type plants with sufficient genetic variability for desirable traits viz; extra dwarf (<60 cm) & highly branched *carinata* type, highly branched & medium height *juncea* type, long siliqua, bold seeds etc. About 13 desirable single plants were selected & harvested.

Raising F_1 generation of inter-specific crosses

During 2016-17, eleven inter-specific crosses including NRCKR 304 x NRCGS-1, NRCGS-1 x NRCKR 304, GSL-2 x NRCKR 304, GSC-6 x NRCKR 304, NRCHB 101 x *S. alba*, *S. alba* x NRCHB 101, NRCHB 101 x NRCKR 304, NRCHB 101 x NRCGS-1, GSL-2 x IJ-31, GSC-6 x IJ-31 and NRCHB 101 x *Brown sarson* (P. Kalyani) were planted. Of them NRCHB 101 x NRCKR 304, NRCHB 101 x NRCGS-1 and NRCHB 101 x *S. alba* were planted in the field and rest were planted in pots. From pots only one cross NRCHB 101 x *Brown sarson* was germinated and from it 4 intermediate partially fertile plants were recovered. From field the derived *B. juncea* plants were recovered from all three crosses with desirable traits. Five *juncea* type plants form NRCHB 101 x *S. alba* were artificially inoculated with Sclerotinia and all revealed resistance for Sclerotinia rot. A total of 17 plants were selected from three crosses in the field.

Inter-varietal F_1 crosses (*B. juncea*)

Forty eight (48) crosses between 12 yellow seeded lines & 4 testers (RH 1231, RH 1239, Basanti & Navgold) of *B. juncea* were generated in line x tester fashion during 2015-16 and these were planted in field during rabi 2016-17 to evaluate for combining ability and heterosis for various component traits including white rust. BC_2 generation of the cross (DRMR 2035 x NRCHB 101) has been planted in the field for

selection of white rust resistant plants and generation advancement.

Generation advancement and selection from segregating generations

During rabi 2016-17, seven F_2 populations of RH 749 x Rohini, TM 118 x RH 406, NRCHB 101 x NPJ 112, DRMRIJ-31 x NPJ 112, TM 117 x Dwarf (RRN 727), [DRMR 2035 x NRCHB 101/ DRMR 2019 x NRCDR 2] & Tetralocular x RRN 727 crosses were planted in 60 rows of 5m each to select plants for component traits & yield attributes. Three F_2 populations of crosses TM-1 x Dwarf, [(TM-1 x Dwarf) x TM-1] & [(TM-1 x Dwarf) x Dwarf] were planted for short height, yellow seed and high oil content. Similarly 226 F_3, 63 F_4, 26 F_5 & 12 F_6 progenies (SPS) of various crosses were grown for generation advancement and selection of desirable plants. A good spectrum of variability was observed for different component traits. A total of 287 SPS from F_2, 244 from F_3, 117 F_4, 20 F_5 were selected & 12 F_6 progenies were bulked.

Selections from mutant progenies

Twenty M_3 mutant progenies of RH 749 (Gamma 100kr) and 6 WR free M_4 mutant progenies of RH 749 & Kranti were planted in field for further selections and advancement. Two white flower mutants (one yellow seeded & appressed, DRMR-WFYSM 15 and one brown seeded & open, DRMR-WFBSM 15-1) of *B. juncea* (M_7 & M_6) and one white flower mutant of Toria were planted in the field during 2016-17 for further advancement, maintenance and evaluation. Six SPS from M_3 & 11 from M_4 were selected including one purple mutant from M_3 progenies (Fig. 2.6). The data were recorded on different traits for white flower mutants. Plant height (cm), number of primary branches, main shoot length (cm), number of siliquae on main shoot, siliqua length (cm), seeds/ siliqua, 1000-SW (g), oil content (%), seed yield/plant (g) in DRMR-WFYSM 15 and DRMR-WFBSM 15-1 were (169.0, 162.6), (6.0, 6.0), (80.3, 76.3), (42.3, 44.3), (4.97, 4.2), (15.67, 14.0), (4.51, 4.45), (41.98, 42.81), (23.6, 20.2), respectively. Similarly, in white flowered toria the1000-SW was 3.72g and oil content 42.61%.

Genotype with tetralocular siliquae and long main shoot

The homogeneous F_5 progeny (10-2-19-23-10) with tetra-locular siliquae, long main shoot, high SMS, more number of branches & bold seed size has been bulked during 2015-16 (Fig. 2.7). It was evaluated and advanced at Wellington (TN) with check Geeta during off-season, *Kharif* 2016. The F_7 progeny designated as DRMRTJ-2016 was planted at ICAR-DRMR, Bharatpur for evaluation and advancement along with check Geeta. Average plant height (cm), number of primary branches, main shoot length (cm), number of siliquae on main shoot (SMS), siliqua

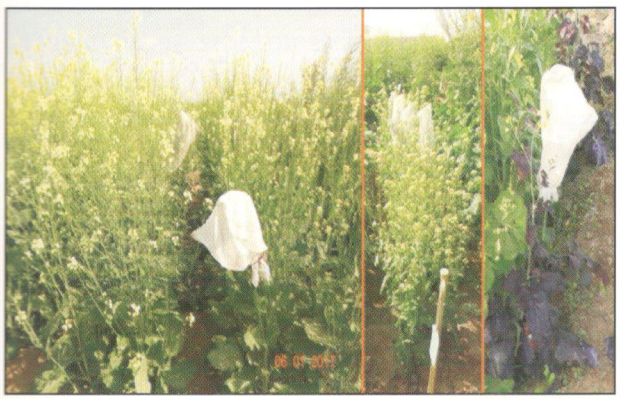


Fig. 2.6 : White flower & purple mutants

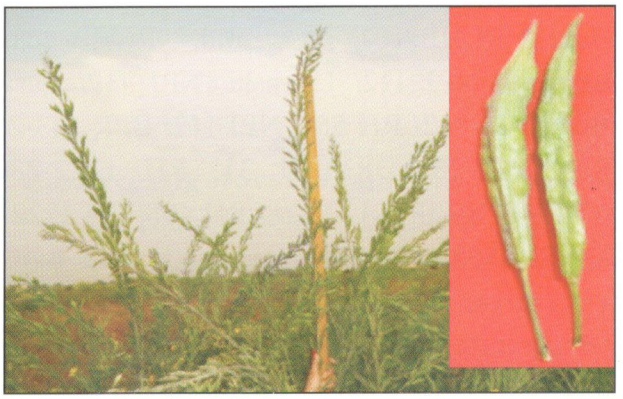


Fig. 2.7 : Tetralocular prozeny of *B. Juncea*

length (cm), seeds / siliqua, 1000-SW (g), oil content (%), seed yield/plant (g) in DRMRTJ-2016 and check Geeta are (256.6, 202.4), (13.2, 11.4), (117.0, 84.6), (129.6, 70.2), (4.12, 3.96), (27.2, 19.4), (5.48, 5.21), (38.87, 39.3), (36.4, 23.7), respectively. The tetralocular *B. juncea* genotype will be highly useful in breeding programmes for crop improvement.

Evaluation of advanced breeding lines

Twenty six advance breeding line with 4 checks (RH 749, DRMRIJ 31, NRCHB 101 and Kranti) were planted in RCBD with 3 replications for evaluation under timely sown irrigated conditions. The trial was sown on 09-10-2016 in 5 rows of 5m with row to row distance of 30 cm & the data were recorded on various traits. Statistical analysis will be carried out after 100-SW & oil estimation. Seed multiplication of eleven advanced lines viz., DRMR 2269, DRMR 2178, DRMR 2398, DRMR 2341, DRMR 2243, DRMR 2326, DRMR 2486, DRMR 2613, DRMR 2448, DRMR 2424 and DRMR 5206 was carried out during 2016-17.

Generation of breeding material

Fresh inter varietal/inter-specific crosses were attempted between NRCHB 101, DRMRIJ 31, RH 406, RH 1301, RH 555, RH 1117, RH 1060 and NPJ 112 in 8 x 8 diallel fashion excluding reciprocals. Similarly, 14 crosses between DRMRIJ 31/ NRCHB 101, DRMRIJ 31/ RH 749, DRMRIJ 31/ Urwashi, DRMRIJ 31/ Pusa Bold, NRCHB 101/ Pusa Bold, NRCHB 101/ Urwashi, NPJ 112/ Urwashi, NPJ 112/ Pusa Bold, NPJ 112/ RH 555, NPJ 112/ BPR 543-2, RH 1222-28/ DRMRIJ 31, RH 1222-28/ NRCHB 101, RH 1222-28/ RH 406, RH 1222-28/ RH 555 were generated for various traits viz; high seed yield, bold seed, high temperature tolerance, long siliqua, disease resistance and adaptation under various sowing conditions.

2.2. Designer Brassica for Oil Quality

DRMR CI 13: Genetic enhancement for quality traits in Indian mustard (*Brassica juncea*)

Principal Investigator: Priyamedha, Scientist (Genetics and Plant Breeding)
Co-Investigator: Bhagirath Ram, Sr. Scientist (Genetics and Plant Breeding)
M. S. Sujith Kumar, Scientist (Plant Biochemistry)

Genotyping of advanced fixed lines for low glucosinolate trait

A set of five primers i.e. (GER-1MRPR + IP3GER-1F(Q1);Myb28(Q2); At5g41(Q3); At5GAJ67(Q4) and GER-5FPF+GER-5MRPR(Q5) (Bisht *et al.*, 2009) were used for genotyping of advanced fixed lines for double low traits. Primers Q1 and Q5 gave amplicons of 950/650 bp and 350/310 bp for high and low glucosinolate, respectively.

Biochemical analysis for glucosinolate content of two advanced fixed lines (DRMR 1-5 & DRMR 2-11) showed 22.08 and 30.64 µmol/g of defatted seed meal with oil content 41.41 and 43.83% with erucic acid 1.24 and 1.71%.

Biochemical analysis of seed samples of 25 plants in F_5 generation of 4 crosses developed by involving high yielding and quality donor parents, showed glucosinolate content ranging from 35 to 50µmole/ g of defatted seed meal with oil content ranging from 40-43 per cent.

Cluster Analysis

Based on 25 polymorphic Simple Sequence Repeat (SSR) markers with 57 polymorphic alleles, the genetic diversity and relatedness of 10 genotypes, including 6 high yielding, 4 quality lines (2 low erucic and 2 double low) of Indian mustard (*Brassica juncea*) and their 24 crosses were carried out. The estimated similarity coefficients, using the Jaccard similarity index amongst the genotypes ranged between 0.35-0.97, calculated by using UPGMA

and SHAN clustering algorithm in NTSYS-pc, version 2.02e (Applied Biostatistics) software.

Generation of breeding materials

A total of 26 F_1s involving 3 high yielding (DRMRIJ-31, NRCHB 101, RH-749) and 4 quality donor parents (PDZ-1, RLC-3, Pusa Mustard-24, Pusa Mustard-30) and 8 fixed quality lines have been generated.

Generation Advancement and selection

A total of 52 SPS have been selected from F_5 generation of 4 crosses involving high yielding (NRCDR 2, NRCHB 101) and quality donor parents (LES 1-27, LES -44, LES-46, RLC-2).

DRMR B 7: Proteomic studies in oilseed *Brassica*

Project Investigator: Ibandalin Mawlong, Scientist (Plant Biochemistry)

Co-Investigators : M. S. Sujith Kumar, Scientist (Plant Biochemistry); O. P. Premi, Pr. Scientist (Agronomy) and Arun Kumar, Sr. Scientist, (Genetics & Plant Breeding)

Understanding the relationship between oil and other seed storage compounds

In order to understand further the oil accumulation, we isolated the oil storage body and its protein oleosin from selected genotypes. The oleosin content was found to range from 0.31% to 5 %. The method of oil body extraction is standardized which is also visible in our microscopic study by using nile red stain. However, it size measurement is still under progress.

Nutritional quality of oil and meal under the influence of nitrogen fertilizer

Nitrogen fertilization changes nutritionally beneficial compounds present in meal and oil. We observed the changes in total phenol and ascorbic acid in turn affects the total antioxidant capacity. There was reduction in crude fiber and soluble sugars under nitrogen fertilization which are desirable changes in terms of digestibility and palatability of meal. The total soluble protein was found to increase up on nitrogen application. The changes in protein banding patterns were suggestive of the idea that nitrogen application could alter the profile of 11S and 2S proteins. Their difference in the banding pattern after nitrogen treatment implies its effect on quality, as it is very much prominent in case of α and β chains of the cruciferin. Fatty acid profiling showed decrease in SFA and ω6/ω3 ratio. Oil stability index (OSI) also increased to almost the ideal level. In this study quality traits showed a variation among genotypes within the same species even under zero fertilization and even more with 80kg/ha N

A Simple Spectrophotometric Method for Estimating Total Glucosinolates in Mustard de-oiled cake

A regression model was obtained using Ordinary Least Square technique which predicted a formula. Total glucosinolates (μmol/g) = 1.40 + 118.86 × A_{425}, where A_{425} is the absorbance at 425 nm. The total glucosinolate content obtained by the prediction formula when compared with HPLC data showed a correlation coefficient of 0.942. This high correlation between the two data sets validated the developed methodology. This method also simplifies the estimation of total glucosinolates by excluding the use of HPLC or other sophisticated instruments.

DRMR B 8: Screening of oilseed *Brassica* germplasm for value addition

Principal Investigator : M. S. Sujith Kumar, Scientist (Plant Biochemistry)

Co-Investigators: Ibandalin Mawlong, Scientist (Plant Biochemistry); K. H. Singh, Pr. Scientist (Genetics and Plant Breeding) and Prashant Yadav, Scientist, (Biotechnology)

Beta-carotene

β-carotene content ranged from 0.03 ppm in yellow sarson variety YSH-401 to 2.82 ppm in

NRCDR-2 which is a *B. juncea* variety. *B. carinata* varieties can be considered as the best source among oilseed Brassica species.

Ascorbic Acid

Ascorbic acid was observed in *B. napus* (100 mg/g) group with maximum level in the variety GSL-1. The lowest average was shown by *B. juncea* (51.67 mg/g) group with lowest levels in varieties RH-781 and RH-0749 (20 mg/).

Glucosinolates

Glucosinolate content was found to be highest in the Brassica rapa var. Toria group (172.80 µmol/g) the lowest level was recorded by Brassica carinata variety Pusa Aditya (69.74 µmol/g).

Phytate

Highest average phytate content was recorded by the Brassica carinata group (3.31 %). Lowest average phytate content was recorded by Brassica juncea group (1.2 %) with lowest level in variety RH 781 (0.2 %).

Complete Lipidomic Profiling of different species of Oilseed Brassica using High Resolution Mass Spectrometry

There are no comprehensive reports on complete lipidomic profile of these oilseed crops. In this study, the lipidomic profiling of 7 different cultivated species of oilseed Brassica including *B. juncea*, *B. rapa* var. Yellow sarson, *B. rapa* var. Toria, *B. rapa* var. Brown sarson, *B. napus*, *B. carinata* and Eruca sativa were performed by a shotgun approach using electrospray tandem mass spectrometry (ESI-MS) shown in fig 2.8. The mass spectrum under positive polarity revealed 1098 lipids under different lipid classes. Erucic acid in free fatty acid form was found to be most abundant in Yellow and Brown sarson. *B. napus* contains almost all forms of cardiolipins. Yellow and Brown sarson have cardiolipins with linoleic and erucic acid as acyl groups. OAHFA is reported for the first time in plant system and was detected only in Yellow and Brown sarson (Fig. 2.9).

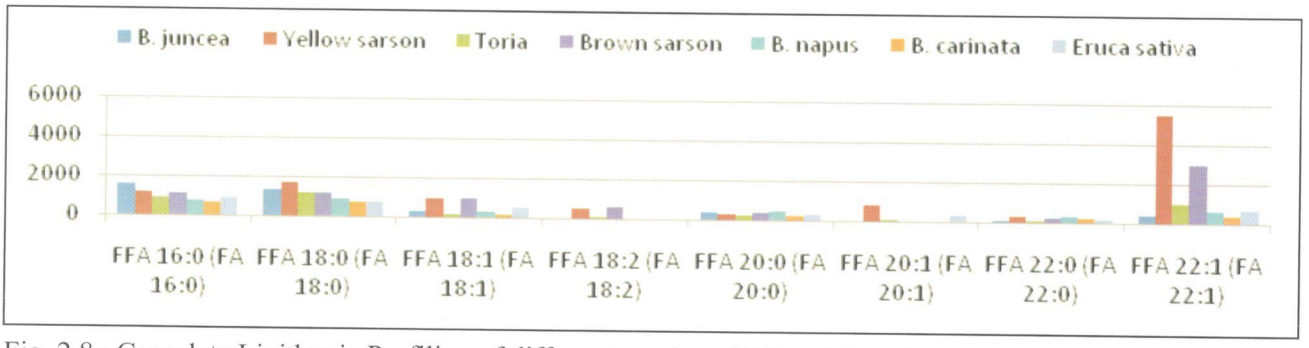


Fig. 2.8 : Complete Lipidomic Profiling of different species of Oilseed Brassica

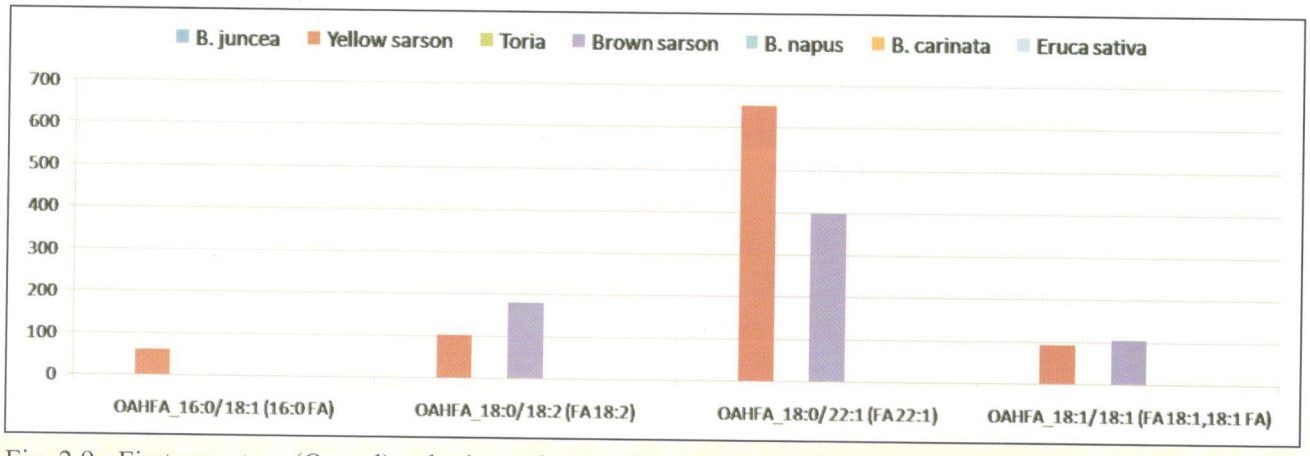


Fig. 2.9 : First report on (O-acyl) ω-hydroxy fatty acids (OAHFA) in Rapeseed-Mustard

DRMR B 9: Quantitative and qualitative estimation of glucosinolates and fatty acids in oilseed *Brassica*

Principal Investigator: Anubhuti Sharma, Sr. Scientist (Biochemistry)

Co-Investigator: Arun Kumar, Sr. Scientist, (Genetics & Plant Breeding)

Glucosinolates (GSLs) and their degradation products are associated with anti-nutritive and toxic effects, limiting the usefulness of seeds and seed meals for human and animal feed. Two varieties were taken for this analysis i.e. DRMR IJ 31 & PDZ-1. The main glucosinolates identified in seeds were 2-butyl isothiocyanate, phenylethyl isothiocyanate along with α-D-galactopyranoside, linolenic acid, tetradecanoic acid and oleic acid. The study confirmed that the glucosinolates with allyl and phenylethyl groups as side chain in Indian mustard are predominant.

These bioactive compounds offers powerful, broad-spectrum support for protecting against the ubiquitous cancer provoking agent encountered every day in our environment. Quantitative & qualitative determination of glucosinolates was done by spectrophotometric method, which were further investigated by HPLC. After glucosinolate digestion different secondary metabolites were identified e.g. allyl isothiocyanates etc. as figures below.

Using GC-MS different components e.g. allyl isothiocyantes, indoyl isothiocyanates etc. are identified (Fig. 2.10 a+b). Preliminary study on quantitative analysis of phenolic acids was determined by HPLC. Apart from aliphatic glucosinolates, Cinnamic, ferulic, vanillic, p-coumaric, p-hydroxy benzoic, and caffeic acids were also detected. Further studies to isolate bioactive compounds e.g. aliphatic glucosinolates is going on.

Quantitative & qualitative estimation of Fatty acid was also studied. Apart from 100 core set studied earlier, new 147 core set were studied. In these 147 core sets, range for glucosinolates was 5.50-131.93 (µmole/g) whereas oil content was 36.84- 42.07 %. In core set phenols (1.00- 2.18 %), erucic acid (12.48- 46.12 %) & fibre (7.32-13.96 %) was also estimated. Few experiments with low erucic acid & low glucosinolates were carried out in duplicates. GC analysis of core set showed presence of important fatty acids (e.g. palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, eicosanoic acid, & erucic acid). C-IV-20, C-II 19, C-III-17 were identified as low eucic acid (< 2%) lines from core set. Work is under progress. Color coding of the genotypes was also done.

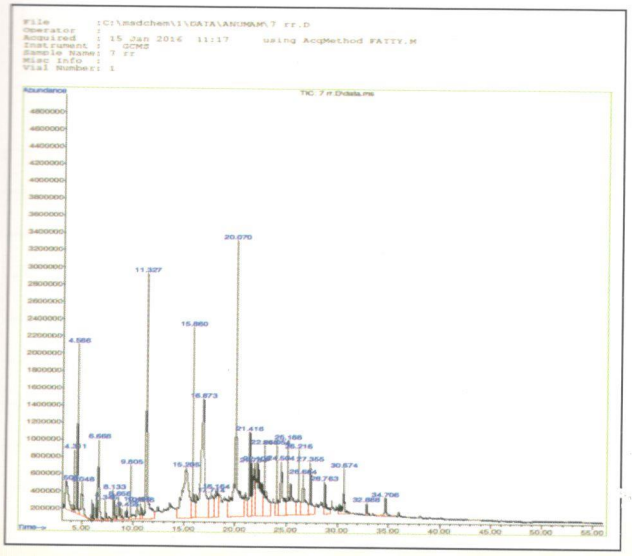


Fig. 2.10 a : GC analysis 1

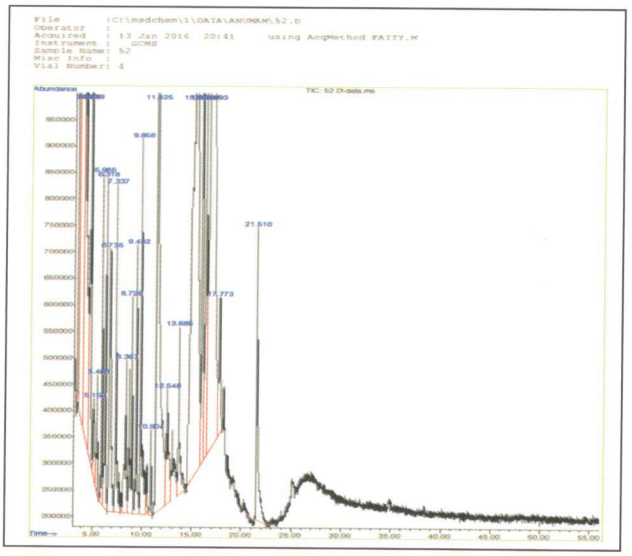


Fig. 2.10 b : GC analysis 2

Defense index of seeds was also studied in both extracts i.e. in methanolic extracts & hexane extracts. Cell wall synthesizing compounds were identified as carboxylic acids & esters, fatty acids & proteins.

2.3. Breeding for yield and quality

DRMR CI 5: Development of hybrids in Indian mustard (*Brassica juncea*)

Principal Investigator: K.H. Singh, Pr. Scientist (Genetics and Plant Breeding)

Co-Investigators: Ajay Kumar Thakur, Scientist, Sr. Scale (Biotechnology), Bhagirath Ram, Sr. Scientist (Genetics and Plant Breeding), H. S. Meena, Sr. Scientist (Genetics and Plant Breeding), P. K. Rai, Pr. Scientist (Plant Pathology)

Significant Achievements

One variety "NRCHB 101", of Indian mustard was identified for rainfed conditions of zone V (Asom, Bihar, Orissa, West Bengal, Jharkhand, and NEH States) by Variety Identification Committee of AICRP on Rapeseed-Mustard on 5th August, 2016 during 23rd annual group meeting of AICRPRM at DUVASU, Mathura

Induction/promotion of promising entry/ hybrid into AICRP–RM Trials

Five entries of Indian mustard; DRMRIJ 16-1, DRMRIJ 16-2, DRMRIJ 16-3, DRMR IJ 15-85 and DRMR 13-38 were inducted for evaluation under IVT (Timely Sown Irrigated), IVT Rainfed, IVT Late Sown, white rust resistance and AVT I Late Sown (zone V). Three hybrid entries DRMRHJ 913, DRMRHJ 2513 and DRMRHJ 3913 were inducted for evaluation under IHT. Further, 23 entries were inducted for evaluation of disease reaction under National Disease Nursery trial of AICRPRM.

Performance of entries evaluated during 2015-16

During 2015-16, 580 entries including 465 inbred/germplasm lines and 115 F_1 crosses were evaluated in different trials. In station trial 1, five experimental hybrids were tested, out of which HJ 0913 (2578 kg/ha) showed 12.9 percent heterosis for seed yield over best check DMH1 (2281 kg/ha).Out of 50 F_1 crosses evaluated in augmented block design, following eight F_1 crosses had significant heterosis for seed yield over NRCHB 506 (Table 2.2).

Experiments conducted during 2016-17

Conducted field experiments for evaluation of 51 experimental hybrids, 330 F_1s, 311 inbreds, 45 germplasm lines, 87 progeny rows of *Brassica juncea*. Selection from 13 segregating populations ($06F_2$, $03F_3$ and $04F_4$) of *Brassica juncea*. Generation of 121 F_1 and 44 backcrosses of *B. juncea*. Conducted one Initial Hybrid Trial with 16 entries (Table 2.3 to 2.5).

Table 2.2 : Promising Heterotic Crosses of Indian mustard

S.No.	Name of Entry	Seed Yield (kg/ha)	heterosis (%)
1	MJA 25/MJR 3	2126	27
2	MJA 38/MJR 13	2030	21.3
3	MJA 14/MJR 3	2022	20.8
4	MJA 38/MJR 8	2219	32.6
5	EC 597326/EC 597313	2111	26.1
6	EC 597326/EC 597313	2104	25.7
7	MJA 9/MJR 13	2163	29.2
8	MJA 2/MJR 17	2307	37.8
	NRCHB 506 (Check)	1674	
	Kranti (Check)	1489	

Table 2.3 : In station trial 4, early maturing genotypes were evaluated, following two entries were found promising

Name	Seed Yield (kg/ha)	Superiority (%)	Reaction to WR
F4 -4-1(Varuna/ NUDHYJ 3)	2176	16.9	MR (4.0)
F4- 6-10(NRCHJ-2602)	1973	6.1	R (0.0)
GIRIRAJ (CHECK)	1861		
CD 5%	399		
CV %	13.6		

Table 2.4 : Following two entries were found promising for resistance against white rust disease

Name	Seed Yield (kg/ha)	Superiority (%)	Maturity duration (days)
ST 4-2 (EC597309/NUDHYJ3)	2389	28.4	120
ST 4-6 (PQR 2005-1/MJB 38	2067	11.1	120
NRCHB-101 (CHECK)	1860		130
PM 28 (CHECK)	1687		125
CD 5%	426		
CV %	12.8		

Table 2.5 : 255 inbred lines were evaluated in augmented block design. Range for important traits is presented below

Agronomic traits	Minimum	Maximum
Plant Height (cm)	97	207
MSL (cm)	22	150
Days to 50% flowering	27	93
Days to flowering Senescence	68	113
Days to maturity	119	134
Oil content (%)	34	42.9
1000 seed weight (g)	1.7	6.8
Siliquae length (cm)	2.5	7.3

Screening for resistance against white rust

58 entries of Inbreds and selections from segregating generations were screened at IARI Regional Station Wellington during offseason nursery (June to September 2016). Two lines DRMRIJ 16-112, DRMRIJ 16-124 exhibited resistance against white rust at Wellington. Twenty one lines of *B. juncea* expressed mixed reaction, while 31 lines were found susceptible. All five *B. carinata* lines were resistant to white rust. Resistant plants were selfed and selfed seed was harvested. Resistant plants were also selected from segregating generation of two crosses; EC597342/EC597313 and DRMRIJ31/ Kranti. F_2 generation of 12 *B. carinata* crosses was raised for generation advancement as a result F_3 seed of 12 crosses was harvested.

2.4. Oilseed *Brassica* Genetic Resource Management

DRMF CI 06: Oilseed *Brassica* genetic resource management

Principal Investigator: Arun Kumar, Sr. Scientist (Genetics-Cytogenetics)

Co- Investigator: K.H. Singh, Pr. Scientist (Genetics and Plant Breeding); Pankaj Sharma, Pr. Scientist (Plant Pathology)

Maintenance of core set and trait specific reference sets in Indian mustard

A core set of 147 Indian mustard accessions and trait specific reference sets of 157 accessions were sown for maintenance during the cropping season 2016-17. Further, 754 rapeseed-mustard accessions, 110 varieties, 30 registered lines and 14 other accessions including wild relatives were rejuvenated/maintained/multiplied by adopting proper pollination control measures.

Screening of Indian mustard accessions against white rust resistance (at Wellington)

A total of 1000 Indian mustard accessions which included white rust resistance and NGB material were grown at IARI, RS, Wellington, Tamilnadu during the Kharif 2016 and scored for white rust incidence. A total of 41 accessions were found resistant based on Percentage Disease Index (PDI) values. These 41 accessions were grown during the cropping season 2016-17 at DRMR for further screening of white rust incidence.

2.5. Biotechnological interventions to improve rapeseed-mustard productivity

DRMR-BT-01: Enhancing the level of resistance/tolerance against *Alternaria blight* in Indian mustard (*Brassica juncea* L. Czern. & Coss.) using biotechnological approaches

Principal Investigator: Ajay Kumar Thakur, Scientist, Sr. Scale (Biotechnology)

In vitro plant regeneration and genetic transformation of *Brassica juncea* L. Czern. & Coss. with an antifungal defensin gene

Six independent putative transgenic events of *B. juncea* var. NRCDR-2 were developed with *TvD1* gene via *Agrobacterium tumefaciens*-mediated gene transfer technique. Molecular characterization of the putative transgenic plants of *B. juncea* var. NRCDR-2 had been carried out by PCR using *TvD1* gene specific primers and two events were confirmed PCR positive for *TvD1* gene integration. These events were multiplied and maintained under *in vitro* conditions. The well elongated shoots were transferred to rooting media (MS basal medium containing 0.3 mg/l IAA) and complete plantlets were obtained.

Introgression of Alternaria blight tolerance from wild crucifers into Indian mustard through embryo rescue approach

175 crosses, each of *B. juncea* varieties Giriraj & RH 749 x *Sinapis alba* were attempted. 10-12 day-old ovaries were cultured on MS medium supplemented with 2.5 mg/l BAP & 500 mg/l casein hydrolysate and the developing embryos were rescued on culture medium after 30-45 days. Shoot regeneration could take place within 10-12 days after culturing and these shoots are being multiplied and maintained on MS medium containing 2.5 mg/l BAP. Genomic-DNA had been extracted and purified from 25 F_1 plants along with both of the parents for confirmation of hybridity using SSR markers.

2.6 Enhancing resource use efficiency and abiotic stress management for resilient rapeseed mustard production

DRMR CP 6: Enhancing soil resilience under mustard based systems through integrated crop management practices

Project Investigator: O. P. Premi, Pr. Scientist (Agronomy)

Economic feasibility and sustainability of Indian mustard (*Brassica juncea*) productivity through organics under semi - arid region of Rajasthan.

The long term replicated experiment keeping conventional practices (CP), *Sesbania* Green Manuring (SGM) and 2.5 t/ha mustard straw recycle + SGM (MSGM) in main plot and eight combinations of NPK fertilizers in subplot were started in 2004-05. In general SGM significantly increased mustard seed yield by 22.1% over control. MSI + SGM further augmented the seed yield by 10.6% over SGM alone and by 35.00% over control. And application of balance fertilizer (F_8) increased the seed yield atleast by 22.3% over suboptimal doses F_1, F_2, F_3 and F_4.

While growing of SGM significantly enhance the nutrient uptake capacity thereby increasing the seed yield at F_8 by >11.1% over F_1 to F_6. Adoption of MSI + SGM system further augmented the seed yield at F_8 atleast by 19.1% over suboptimal doses (F_1 to F_4) indicating better nutrient recycling and availability for sustainable higher yields.

In general, SGM significantly improved the SOC, available NPK status, but decreased bulk density over CP. MSGM further augmented the soil health attributes. The increase in fertilizer levels from $N_{40}P_{8.7}K_0$ to $N_{80}P_{17.4}K_{33.3}$ also improved the soil attributes gradually.

Evaluation of nutrient management strategies for sustainable mustard production

Among the organic sources, MSI + SGM produced significantly higher seed yield than rest of the organic sources. It was followed by VC and SGM. The interaction between FYM and OS was found significant. At SFM strategy, all organic sources of nutrient except MSI + SGM significantly reduced the seed yield atleast by 30.2% from CC (100% RDF). At MFM level, MSI + SGM produced significantly higher seed yield than rest organic sources. The increase in seed yield due to MSI + SGM at MFM level was more than 22.4% over CC (Table 2.6).

Table 2.6 : Effect of fertilizer management strategy and organic sources on mustard productivity (kg/ha)

Fertilizer management strategy (FMS)	Organic Sources (OS)						Mean
	SGM	MSI	MSI + SGM	MS mulch	FYM	VC	
CFM: Conventional (100% RDF)	2106	2106	2060	2060	2130	2245	**2118**
MFM: Moderate (50% RDF)	1167	1319	1991	1273	1597	1667	**1586**
SFM: Subsistence (no fertilizer)	1250	1127	1412	1018	1227	1019	**1192**
Mean	2006	1897	2359	1744	1997	2147	-
AC: Absolute control- 763				CD 5%:	FMS=166, OS= 172, FMS x OS= 298		
CC: Conventional control (100%RDF)- 1627							

DRMR CP-16: Sustainable Intensification of Brassica Production System (SIBPS)

Principal Investigator: R. S. Jat, Sr. Scientist (Agronomy)

Co-Investigators: Mukesh Meena, Scientist (Soil Science), Har Vir Singh, Scientist (Agronomy), Pankaj Sharma, Pr. Scientist (Plant Pathology)

Developing resource use efficient and resilient rapeseed-mustard based cropping systems for enhancing rapeseed-mustard production and farm income under the current and future climates

The experiment was initiated during kharif, 2016 for evaluation of rapeseed-mustard based cropping systems under current and future climates. Three tillage practices; furrow irrigated raised beds (FIRB), zero tillage (ZT) and conventional tillage (CT) and six mustard based cropping systems; soybean-mustard, cluster bean-mustard, green gram-mustard, maize-mustard, sesame-mustard and pearl millet-mustard were tested under split plot design and replicated thrice. The *kharif* crops were raised and harvested as per treatments leaving the residues on the surface.

Indian mustard var. RH 479 was sown in *rabi*, 2016 as per treatments and being evaluated for resource use and yield performance under different practices. In the first year of experimentation, mustard seed yield influenced significantly with cropping systems and non-significantly with tillage practices. The highest mustard seed yield (3215 kg/ha) was recorded from cluster bean-mustard cropping system sown with conventional tillage practices followed by soybean-mustard (3132 kg/ha) and green gram-mustard (2980 kg/ha) cropping

system under the same management. The maize-mustard and sesame-mustard cropping system performed better under zero tillage and recorded highest mustard seed yield of 2886 and 2747 kg/ha, respectively. The pearl millet-mustard cropping system showed maximum mustard seed yield (2626 kg/ha) under FIRB system.

Mechanization of Brassica Production System

In India, mustard is largely grown as rainfed crop during dry season after the harvest of Kharif crops. Under these situation farmers generally practice early sowing of mustard either by broadcasting of seeds or sowing with traditional wheat seed drill whichsubjected to less germination, breakage of seeds, uneven and higher plant population, early exhaustion of soil moisture, more diseases and pests, weak plant growth, less branches, less siliquae and ultimatelylesser seed yield. Also lack of provisions to simultaneous drilling of seeds and fertilizers which is much more crucial under conserved soil moisture in rainfed conditions. Efficient seeding of rapeseed-mustard at 15-20 cm plant to plant and 45 cm row to row spacing at uniform depth under moist zone with simultaneous fertilizer drilling was in dire need to increase the production and productivity, and efficient utilization of limited resources under rainfed conditions. A mustard seeder prototype was designed and developedby ICAR-DRMR, Bharatpur in consultation with CIMMYT, India to address these issues.Field demonstrations were conducted at farmer's field in Bharatpur region during 2016-17 by ICAR-DRMR to evaluate its performance using two popular mustard varieties (RH 749 and DRMRIJ 31). The results of mustard seeder on crop growth and yield performance were compared with sowing by traditional wheat seed drill. The crops sown with wheat seed drill recorded just double plant population (30-35) per square meter in comparison to 15-17 plants per square meter with mustard seeder at harvest. Both the varieties exhibited better crop growth parameters when sown with mustard seeder. Sowing with mustard seeder recorded more plant height (210 cm), primary and secondary branches per plant (15 and 30), and girth of stem at basal node (7.4 cm) over sowing by wheat seed drill.

Plants sown with mustard seeder recorded more diversion of photosynthates towards sink part (siliqua) than in sources (plant leaves and stem).With optimum plant population and better plant growth parameters, crop sown with mustard seeder recorded higher seed yield of both the varieties compared to sowing by wheat seed drill. The increase in seed yield was recorded to the tune of 18 and 20% for RH 749 and DRMRIJ 31 over sowing by wheat seed drill.

DRMR CP-18: Growth and yield response to plant density and stage of transplanting in Indian mustard

Principal Investigator: Har Vir Singh, Scientist (Agronomy)

Co- Investigators: R.S. Jat, Sr. Scientist (Agronomy) and M. K. Meena, Scientist (Soil Science)

Competitive ability of a rapeseed mustard plant depends greatly upon the density of plants per unit area and soil fertility status. The optimum plant population density/unit area varies with the environment, the genotype, the seeding time, and the season. Uniform distribution of crop plants over an area results in efficient use of nutrients, moisture, and suppression of weeds leading to high yield. A field experiment was conducted during 2016-17 comprising three planting geometries 45x30 cm, 60x30 cm, 90x30 cm with 3 planting dates to evaluate various planting geometries with planting dates.

DRMRCP-17: Role of micro and secondary nutrients and their fortification on Rapeseed-Mustard productivity and quality

Project Investigator: M. K. Meena, Scientist (Soil Science)

Co-Investigators: R S Jat, Sr. Scientist (Agronomy), Ibandalin Mawlong Scientist (Plant Biochemistry)

The application of micronutrient enriched FYM may improve availability and their uptake to mustard results in higher productivity and quality of crop in calcareous soils. Field experiment conducted during 2016-17 comprising 15 treatment combination replicated thrice, was laid out in split plot design with three treatment of FYM level (Control, @5 t ha-^{1} and @10 t ha-^{1}) and five treatment of sources of nutrient (control, 2.5 kg Zn + 1 kg B+ 5 Kg Fe + 10 kg S ha-1, 5 kg Zn + 2 kg B+ 10 kg Fe +20 S kg ha-^{1}, 2.5 kg Zn + 1 kg B+ 5 Kg Fe +10 kg S Enriched FYM @ 500 kg ha-^{1} and 5 kg Zn + 2 kg B+ 10 kg Fe+20 kg S Enriched FYM @ 500 kg ha-^{1}). Application of micro and secondary nutrient by their enrichment with FYM significantly increased seed yield of mustard over control. Result revealed that significantly highest seed yield (2872 kgha-^{1}) was observed under the treatment in which micro and secondary nutrient applied at the rate of 5.0 kg Zn +2 kg B+10 Kg Fe +20g S Enriched FYM @ 500 kg ha-^{1}(Zn_2 B_2 Fe_2 S_2 En) and FYM was added @10 t ha-^{1}. Analysis of soil biochemical properties and enzymatic activities are being done. Analysis of soil physico-chemical properties and nutrient availability are also being done in soil samples taken from experimental plots at the harvest of crop.

Soil Health Card (SHC) Scheme

Micronutrient (i.e. Zn, Fe, Cu and Mn) status was analyzed using AAS in the Soil Science Laboratory of 255 soil samples. Zinc and Iron deficiency was found in soil samples collected from Palka village. Likewise, 36.89% and 05.82% deficiency of Zn and Fe was found in Sinthala village. But, in Undra village, only, Zinc deficiency (42.85%) was observed. However, Copper and Manganese were found sufficient in samples of all the three villages.

2.7. Management of biotic stresses in Indian mustard

DRMR PP 1: Management of Sclerotinia rot in rapeseed-mustard

Project Investigator: Pankaj Sharma, Pr. Scientist (Plant Pathology)

Co-Investigators: P. D. Meena, Pr. Scientist (Plant Pathology); Anubhuti Sharma, Sr. Scientist (Biochemistry)

Collection and maintenance of geographical isolates of *S. sclerotiorum*

65 isolates of *S. sclerotiorum* were collected from different geographical regions of oilseed Brassica growing areas in the country. All isolates were cultured and after purification these were maintained for further study.

Epidemiology

Epidemiological studies was done using 8 dates of sowing starting on Oct 1, 2016 at weekly intervals with three replications in plot size of 4.5x5 m using cultivar RH 749 of Indian mustard. The maximum incidence was observed in 29 Oct (9.7%) followed by 22 Oct while it was minimum in 19Nov(2.0%)sown crop. The highest seed yield was recorded in 22 Oct (36.8 q/ha) followed by 29 Oct (33.9 q/ha) while it was lowest in 19 Nov (11.8 q/ha) sown crop. Per cent petal infection (PPI) and initiation of SR incidence resulted in first standard week but later it was not increased due to unfavourable weather conditions for Sclerotinia rot development.

Germplasm Screening for Sclerotinia rot

303 germplasm lines of *Brassica* from core set, already been identified as tolerant were screened under sick plot at DRMR during 2016-17 season, sown on 25 Oct 2016 in single row of 3 m length with 30 cm x 10 cm spacing with susceptible check in randomized block design with two replications. Among all the tested germplasm RH 1222-28, EC 597317, DRMR 261, DRMR 1034, DRMR 1493 and WR 2035 showed tolerant reaction (lesion size <3.0 cm and disease

incidence<10%).Eight tolerant and 3 susceptible (Rohini, NRCYS 5-2 and EC 597314) were used for diversity analysis and the dendrogram constructed gave two distinct groups. The cluster analysis evidently discriminated and differentiated the 11 genotypes into tolerant and susceptible. The similarity coefficients varied between 0.38 to 1.0 thus revealing the presence of maximum diversity between these genotypes.

Screening of promising genotypes with detached leaf technique (*in vitro*)

During 2015-16 more than 1500 Brassica germplasm lines were screened against *S. sclerotiorum*, out of which 40 tolerant lines were selected. Based on lesion size 60 h after inoculation, cultivars IC 492678 and IC 121676 were most susceptible while, IC 570316, IC 492794, DRMR 2585, EC766097, EC 766539, IC 73225, RH-1222-28 and DRMR-261 were the most tolerant genotypes (Fig 1).

Screening of promising genotypes and F_1 crosses with detached stem technique (*in vitro*)

Diverse level of resistance against *S. sclerotiorum* was found among 52 genotypes and F1crosses in detached stems. Among these 19 were observed tolerant (Fig. 2.11).

Management of Sclerotinia rot

An experiment on management of Sclerotinia rot was laid out in randomized block design with 8 treatments (including control) in three replications on Sclerotinia infested plot at experimental farm, DRMR. The crop was sown on 25 Oct 2016 with T1: Seed treatment (ST) carbendazim 50WP 2g/Kg seed T2: T1+ No irrigation during 25th Dec to 15 Jan; T3: T1+T2+Foliar spray (FS) (Carbendazim 50 WP @2g/l at 60-65 DAS); T4: T1+T2+FS at 45-50 and 65-70 DAS; T5: T1+T2+FS (Propicanozole 25 EC@0.05% 60-65 DAS); T6: T1+T2+FS (*Trichoderma* 6g/l 60-65 DAS; T7: Control (no treatment;30x10cm) and T8: Control (no treatment; 45x15cm). Among different treatments, T4 given highest yield (29.2 q/ha) and minimum per cent disease incidence (1.8%) followed by T3 and T5 (26.2 q/ha) as compared to control T7 (24.0 q/ha and 13.6%).

Yield losses due to Sclerotinia rot

An experiment was conducted with four high yielding varieties NRCDR 2, RH 406, DRMRIJ 31 and RH 749 to estimate yield losses due to Sclerotinia rot. The control was NRCDR-2. Maximum yield loss (16.9) was in NRCDR 2 followed by DRMR IJ 31 (12.1%) and it was minimum in RH 406 (9.3%).

Variation in oxalic acid production

Oxalic acid production was qualitatively investigated; using PDA+ bromophenol blue (Bb) plates inoculated with *S. sclerotiorum* isolates (ESR 1- 65) as evident by the change of color in the medium from purple to yellow was taken as an indication for oxalic acid production by the fungus (Fig. 2.12).

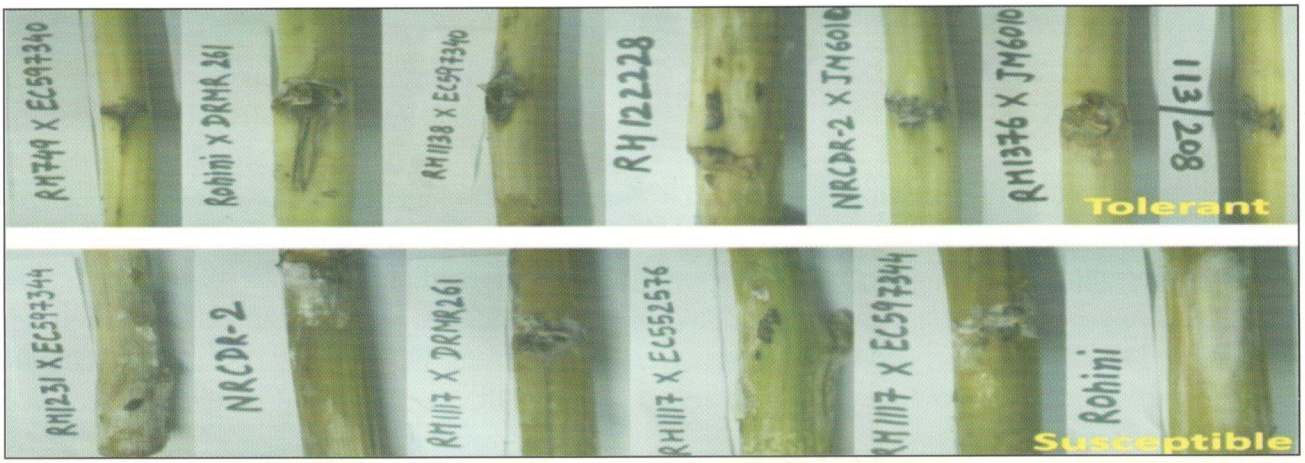


Fig. 2.11 : Tolerant and susceptible reaction with detached stem technique (in vitro)

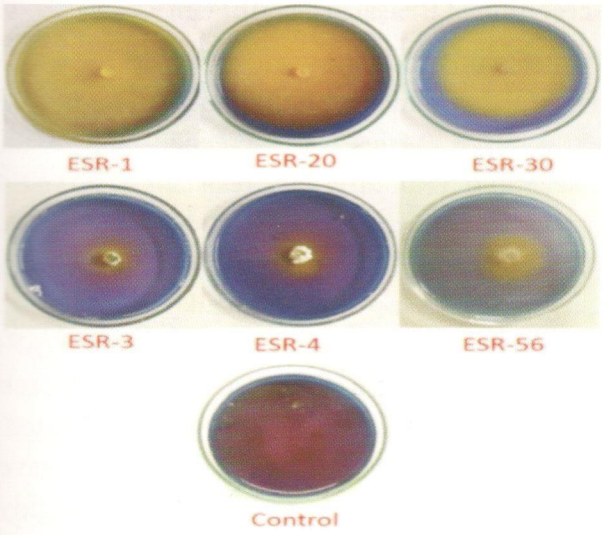


Fig. 2.12 : Isolates showing yellow colour according to oxalic acid secreation

Based on the radial growth after incubation the isolates were classified into 3 groups: (i) Highly Virulent (SR- 01, SR-06, SR-10 to SR-17, SR- 19 , SR-20, SR-22, SR-28 to SR-30, SR-32 to SR-34, SR-39 to SR-42, SR-48, SR-49, SR-57 to SR-59 and SR-61 to SR-65) (ii) Moderately virulent (SR-02, SR-07 to SR-9, SR-15, SR-18, SR-21, SR-23 to SR-27, SR-31, SR-35, SR-36, SR-38, SR-43 to SR-47, SR-50, SR-51and SR-53 to SR-55) and (iii) Weakly virulent (SR-03, SR-04, SR-05, SR-37, SR-52, SR-56 and SR-60). It was found that highly virulent and weak isolates could equally utilize several components of host cell wall as nutrients but differed in their ability to utilize them for oxalate production and pathogenicity.

Pathogenicity of geographical isolates of S. sclerotiorum

65S. *sclerotiorum* isolates of different geographical regions showed variations in pathogenicity in respect of stem lesion length. On the basis of longest and shortest stem lesion formed by different geographical isolates on seven Brassica species, following 7 groups were made :Group I – (*B. juncea* var. NRCDR-02), Group II –(*B. napus* var. NRGLS) , Group III- (*B. rapa* var. YS) , Group IV – (*B. rapa* var. BS) , Group V- (*B. rapa* var. toria), Group VI-(*B. carinata*) , Group VII-(*B. alba*).

Based on the stem lesion formation, among the 7 groups isolate ESR- 36 was found to be the most common isolate producing longest stem lesion whereas isolate ESR- 60 was found to be the most common isolate producing shortest stem lesion.

DRMR PP 3: Management of *Alternaria blight* in rapeseed-mustard crops

Principal Investigator: P. D. Meena, Pr. Scientist (Plant Pathology)

Co-Investigators: Pankaj Sharma, Pr. Scientist (Plant Pathology)

Relationship between AB disease parameters in *Brassica juncea*

PHR-2 as tolerant and Kranti as susceptible were studied for the relationship between *Alternaria blight* (AB) parameters. Different treatments included seed inoculation, seed+cotyledon inoculation, cotyledon inoculation, leaf inoculation at 45 d.a.s. and un-inoculated as check under field inoculations. Observations were undertaken for disease initiation, lesion number, lesion size and per cent AB severity. Among the five treatments, inoculation of both seed and cotyledon method was found highly effective where mean AB severity on cotyledon was 84.6% in comparison to 49.3% in the inoculation of seed and 62.5% in the inoculation of cotyledon methods under laboratory conditions. Results indicated that other methods were not much effective may be due to lack of favourable weather conditions during the inoculation.

Alternaria blight disease map

On the basis of their conidiophores and conidial morphology, the pathogen was identified as *A. brassicae* infecting rapeseed-mustard. The disease was generally prevailing severely in states of Himachal Pradesh, Uttara Khand, Bihar, Uttar Pradesh, Rajasthan, Haryana, and Madhya Pradesh but appear in almost all the parts of the rapeseed-mustard growing areas. Usually, disease becomes visible at 40-45 days after

sowing Fifteen years (2001 to 2015) of Alternaria blight (AB) severity data was analyzed to observe the disease severity trends at different zones in the country. Data indicated that the AB severity decreased by 10% over the six locations during 2001 to 2015 on *Brassica juncea* cultivar Rohini.

DRMR PP-5 Epidemiology and management of White rust

Project Leader: P. K. Rai, Pr. Scientist (Plant Pathology)

Co-Investigators: V. V. Singh, Pr. Scientist (Plant Breeding), Pankaj Sharma, Pr. Scientist (Plant Pathology)

Epidemiology of White rust

Experiment was laid out with 10 dates of sowings i.e. 1st, 08th, 15th, 22nd, 29th October, 05th, 12th and 19th November 2016 for epidemiological observations. Periodical data on disease incidence was taken. Highly susceptible variety 'Rohini' was used in the experiment. Data on different epidemiological parameters viz., Relative Humidity, Sunshine hrs, temperature were recorded to correlate it with white rust outbreak (Fig. 2.13). Maximum (44.4%) disease severity was recorded on 5th November sown crop fallowed by 15th November sown crop. Minimum (20.6%) disease severity was recorded on 8th October sown crop followed by 15th October sown crop (22.8%)

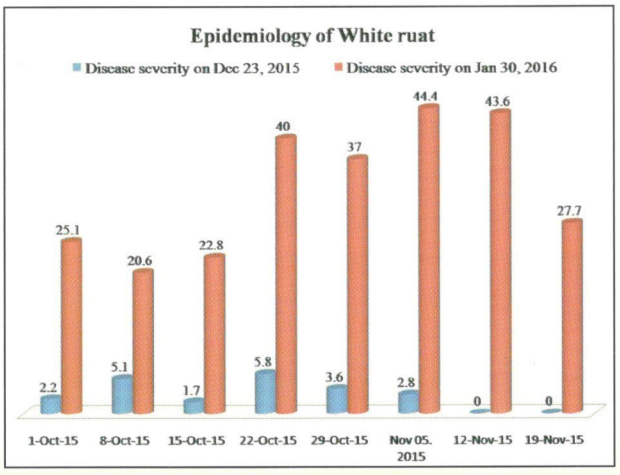


Fig. 2.13 : Epidemiology of White rust

Screening of Brassica germplasm

Two sets of genotypes were screened for white rust reaction under artificial inoculation. In one set, total 28 entries were screened under with susceptible (Rohini) and resistant (BioYSR) checks. Sowing was done on November, 04, 2015 in 2 rows of 3 m length with 30 x 10 cm spacing. Plants were spray inoculated with spore suspension of *A. candida* twice 45 and 60 DAS. Disease reaction was recorded 90 DAS on each genotypes and disease severity was calculated. Out of 28 entries screened, 08 entries gave immune response whereas, 5 entries were highly resistant. In another set, 18 genotypes were screened with Rohini (as susceptible check) as per procedure described above. Out of 18 genotypes RLC-3, EC-597325, PDZ-1, BEC-144, Heera and Donskaja were immune to white rust.

Management of white rust

For effective management of white rust with minimum use of chemical fungicides, seven treatments involving PGPR and new generation fungicides alone and in different combinations viz., seed treatment with metalaxyl 35@ 6g/kg seed+ foliar spray of metalaxyl 8%+ mancozeb 64% @ 0.2%; seed treatment with mancozeb @ 3 g/ kg seed+ foliar spray of metalaxyl-M @ 0.2%; seed treatment with metalaxyl 35@ 6g/kg seed + foliar spray of Folicur @ 0.1%; seed treatment with metalaxyl 35@ 6g/kg seed+ foliar spray of metalaxyl-M @ 0.2%; seed treatment with metalaxyl 35@ 6g/kg seed + foliar spray of *Bacillus subtilis* (109 cfu); seed treatment with metalaxyl 35@ 6g/kg seed + foliar spray of *P. fluorescence* (10^9 cfu) and control were tested under filed conditions. Data on WR incidence were recorded (Fig. 2.14). The maximum reduction in disease severity was observed in T1 (Seed treatment with metalaxyl 35@ 6g/kg seed+ foliar spray of metalaxyl 8%+ mancozeb 64% @ 0.2%) followed by T_4 (Seed treatment with metalaxyl 35@ 6g/kg seed+ foliar spray of metalaxyl-M @ 0.2%).

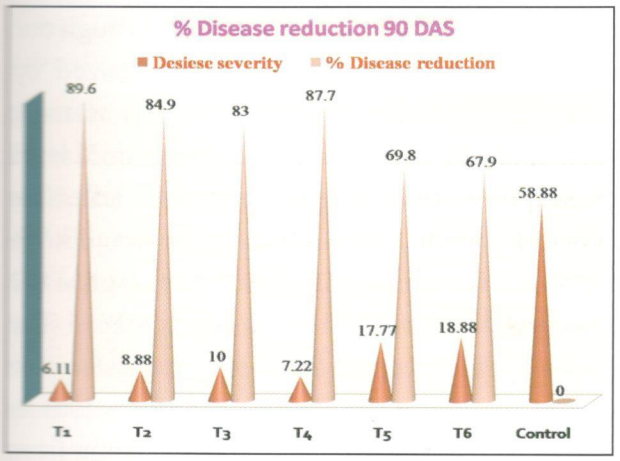


Fig. 2.14 : Per cent disease reduction

Effect of soil/ seed infestation and flower bud inoculation

Experiment was laid out to see the effect of soil/ seed infestation and flower bud inoculation on systemic infection of WR on mustard with different treatments viz., Oospore infested seeds, oospore infested plots, Bud inoculation (50 DAS) with seed treatment and Bud inoculation without seed treatment (50 DAS) Observations on disease index, number of infected leaves/plant, total number of pustules on all infected leaves on 20 randomly selected plants were recorded. Maximum (108.9) pustules/plant was recorded in bud inoculated without seed treated plants followed by 70.46 pustules/plant in bud inoculated + seed treated plants. Minimum (49.2) pustules/ plant was recorded in oospore infested seeds followed by oospore infested soil (Fig 2.15). The maximum (70.3%) white rust severity was recorded in bud inoculated and without seed treated plants. The minimum (63.7%) white rust severity was recorded in bud inoculated + seed treated plants (Fig. 2.16).

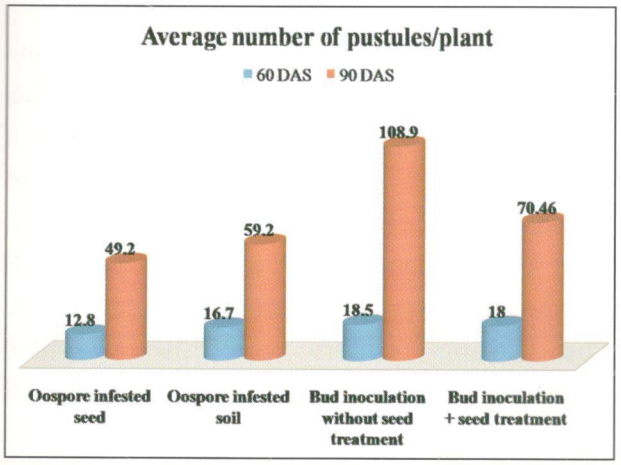


Fig. 2.15 : Effect of soil/ seed infestation and flower bud inoculation on WR

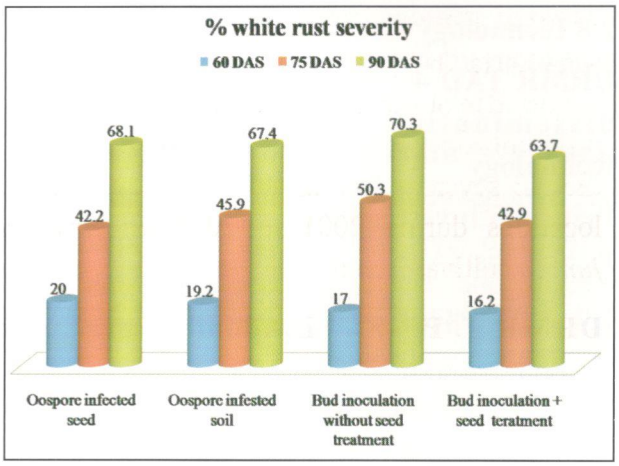


Fig. 2.16 : White rust severity

Multiple disease resistance

F_2 population derived form diallel crosses between 11 resistant and susceptible genotypes to white rust and Alternaria blight were raised for disease reaction in order to develop multiple disease resistance. Out of 55 cross combinations, 21 were found resistant to white rust. All the 21 lines were resitant to Alternaria blight. However, the Alternaria blight disease pressure was very low (15.5%).

Identification of host differentials for white rust

A set of 11 *B. juncea* varieties (10 resistant and 1 susceptible to white rust) raised in order to identify white rust host differentials. Based on reaction of 10 rapeseed-mustard genotypes to HSR and BPR isolates of *Albugo candida*, Basanti and RH-30 may be categorized as primary differential. Basanti of *B. juncea*, PBC-9221 (*B. carinata*) and GSL-1 (*B. napus*) showed resistance to both the isolates.

2.8 Technology assessment and dissemination

DRMR TAD 4 : Participatory extension for dissemination of rapeseed-mustard technology

Principal Investigator: Ashok Kumar Sharma, Pr. Scientist (Agriculture Extension)

Co- Investigator: Vinod Kumar, Sr. Scientist, (Computer Application)

Study the information sources of the farmers about seed availability at ICAR-DRMR.

Farmers are getting information about different aspects of agriculture production. A number of public and private information sources are available which are providing agriculture knowledge through various medium to the farmers. ICAR-DRMR has also been organizing different extension programmes for the benefit of the farmers. A popular endeavor of providing quality seed along with technological know-how to the farmers under the name of "Seed fortnight" has been organizing for last 18 years. A large number of farmers from different mustard growing areas especially Rajasthan, Uttar Pradesh and Madhya Pradesh visited during "Seed fortnight- 2015" for purchase of seeds and getting technology knowledge from Scientists. A study was conducted to find out the information sources of the farmers about seed availability at ICAR-DRMR based on 360 randomly selected farmers from Rajasthan (210), Uttar Pradesh (120) and Madhya Pradesh (30) who visited ICAR-DRMR during Seed fortnight 2015. The data were collected on multiple responses of the respondents. The study showed that majority (52.8%) of the respondents got information from fellow farmers about the seed availability at DRMR followed by relatives (45%). The popularity of ICAR-DRMR by organizing different extension programmes has clearly visible as 38.6% respondents from different states visited during this Pakhwada and purchased seeds of different improved varieties of mustard after getting information through one or more extension programmes organized by DRMR regularly. The impact of training programmes organized by DRMR for field level extension workers also resulted in effective communication to the farmers as 33.9% respondents reported that they got the information from field extension workers. The study further revealed that newspaper were also one of the important sources of information as 24.4% respondents sought the information from this source. KVKs are engaged in dissemination of information about different aspects of agriculture and working as information sources at district level for farmers. KVKs are also communicating about the seed availability at DRMR to those farmers who come in their contact as revealed that 18% respondents received the information from KVKs. Only 9.2% respondents reported that they listen the radio for agriculture information. However, less number of respondents does not undermine the importance of radio because it is the important source for those farmers who are not able to access the other sources due to many reasons. It was also revealed that increasing number of farmers are getting information through phone/SMSs as 7.8% respondents reported for this source. About 22% respondents also reported that they got information from other sources also.

During seed fortnight, the seeds were sold to the farmers on first-come-first-serve basis. All stakeholders appreciated the efforts of directorate for providing quality seeds at affordable prices to the farmers along with technical guidance and expertise rapeseed-mustard production and protection technologies. The visiting farmers were also provided counseling for situation specific varietal selection along with advice on scientific cultivation of rapeseed-mustard.

Constraints faced by Extension Workers in transfer of technology and their training need

A study was conducted based on data collected from 160 extension personnel from Rajasthan (90), and Uttar Pradesh (70) who participated in training programmes organized by ICAR-DRMR during 2015-16 for identification of major constraints faced by them in transfer of technology to the farmers and their training needs.

Constraints faced by extension workers: The study showed that more than 70% respondents reported that "more jurisdiction area of working" and "involvement in other activities/ programmes of other departments more than extension activities of agriculture" were the most important constraints faced by them in transfer of technology. The 'non-cooperation and "lack of interest of farmers to participate in extension activities/ programmes organized by the department", "lack of training/skill in using extension approaches/ methodologies" and "lack of practical exposure to technology demonstration unit" were another important constraints which were reported by more than 65% respondents (Table 2.7).

Training need of extension workers: Regarding training needs, the study reported that 90% respondents had highest level of training need in the aspects of "pest and disease management" followed by varieties, seed rate and sowing by 87.5%. The training need in "management and use of fertilizers", "weed management", "abiotic stress management" and "field management" were reported by 83.8%, 78.1%, 75% and 68.8%.

Impact of training in terms of increase in knowledge of participants

A number of training programmes have been organizing by ICAR-DRMR for last three years for enhancing the knowledge and skills of the farmers for increasing rapeseed-mustard production in their field. To study the impact of farmers trainings in terms of enhancing the knowledge level of the participants after

Table 2.7 : Constraints faced by extension workers in transfer of technology to the farmers

S.N.	Constraints	Raj. (90) %	UP (70) %
1	More jurisdiction area of working	75.55	71.42
2	Involvement in other activities/ programmes of other departments more than extension activities of agriculture	71.11	71.42
3	Non-cooperation and lack of interest of farmers to participate in extension activities/ programmes organized by the department	68.88	74.28
4	Lack of training/skill in using extension approaches/ methodologies	67.77	72.85
5	Lack of practical exposure to technology demonstration unit	66.66	72.85
6	Lack of knowledge and skill about latest technological advances.	64.44	75.71
7	Delay in receiving minikit demonstrations/ inputs to be given to farmers	63.33	65.71
8	Inferior quality of inputs supplied by cooperative societies under minikit demonstrations	63.33	68.57
9	Non-availability of recommended inputs (seed, fertilizers, culture, fungicides, insecticides, etc.) in the market	62.22	65.71
10	Delay in receiving of guidelines/ information about implementation of activities and budget release	60	62.85
11	Dependency on package of practices developed by the department.	60	57.14
12	Lack of opinion leadership in the village	58.88	60
13	Non-feasibility of recommendations	57.8	64.28

training, the data on pre and post knowledge of the participants were collected from 150 farmers belonged to Rajasthan (40), MP (40) and UP (70) who participated in training programme organized by ICAR-DRMR during 2015-16. The study reported that the maximum increase (54.7%) in knowledgeof respondents was in the aspects of varietal and seed production followed by pest management with 41.2% increase in knowledge after the training of respondents. Regarding field preparation & soil treatment, crop management practices, fertilizer & irrigation management, there was about 25 to 28 per cent improvement in knowledge. However, post knowledge MPS was more than 68 per cent in all aspects which showed the high impact of training programme in terms of increase in knowledge level of the participants.

Study the level of adoption of improved mustard production technology by the farmers and constraints faced by them in rapeseed-mustard production.

A study was carried out to find out the level of improved mustard production technology by the farmers and constraints faced by them in rapeseed-mustard production. The data were collected from 150 farmer respondents belonged to Rajasthan (40), Uttar Pradesh (70) and Madhya Pradesh (40) who participated in training programmes at ICAR-DRMR organized during 2015-16.

On the basis of adoption index, the adoption of different practices were categorized into low (< 40 MPS), medium (40-60 MPS), high (61-80 MPS) and very high (> 80 MPS) level.

The study reveals that level of adoption of recommended technology of varietal, soil treatment, seed treatment, pest and disease management by the respondents of all three states were low. It was also worth noting that majority of respondents were sowing the crop in time as adoption of "time of sowing" aspect was reported at very high level by all the groups of respondents (Raj., UP and MP). The adoption level regarding Seed rate & spacing and irrigation management was also at high level. In case of field preparation, fertilizer management and weed management, the adoption level was at medium level by all the respondents.

Constraints faced by the farmers: The data were also collected for studying major constraints faced by the 150 farmer respondents in rapeseed-mustard production. Farmers of Rajasthan, Madhya Pradesh and Uttar Pradesh reported 10 major constraints faced by them with almost similar magnitude. The study showed that "lack of knowledge about technological advances in rapeseed-mustard" was the top most constraints (92%) faced by the farmer respondents followed by "non-availability of pure/improved seeds in the market (85.3%)". High cost of crop cultivation and high temperature at the time of sowing were reported at third and fourth ranked constraints. The 76% respondents reported that "lack of visit by extension personnel to the villages" was also important constraints in dissemination of recommended technology. The other important constraints reported by the farmers were more attack of insects-pest and diseases, lack of irrigation facilities, shortage of labour, low selling price of mustard and poor water and soil quality.

NRCRM CA-1: Development of application software for rapeseed-mustard information management

Principal Investigator: Vinod Kumar, Sr. Scientist (Computer Application)

Co-Investigator: Ashok Kumar Kumar, Pr. Scientist (Agriculture Extension)

Variety Selection tool

The area of rapeseed-mustard being grown in India has been classified in to five major agro-

ecological zones. The basic climatic conditions targeted for developing the resource efficient varieties are rainfed and irrigated. About 30% of total rapeseed-mustard cultivation area in country is under rainfed condition. In erratic behavior of climatic conditions, it is imperative to the farmers be informative with the available technologies suitable for their situations. In India, rapeseed-mustard researchers have developed the improved varieties performing well in rainfed, irrigated and in both rainfed & irrigated conditions. The availability of the information about improved varieties is scattered and by means of several forms. The challenge was to organize the information electronically so that the farmers of the country could be benefited from this information for increase in rapeseed-mustard production. For this purpose, a web based expert system of crop variety selection has been developed. The system was developed by applying knowledge

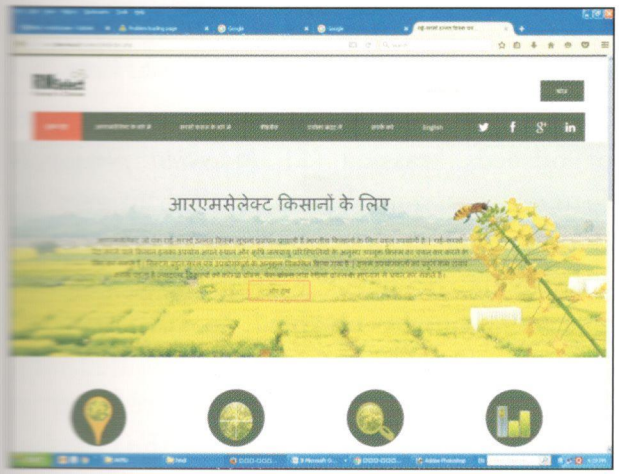


Fig. 2.17 : Varity Selection Tool

engineering approaches with scientific knowledge base in backend. The system suggests the varieties of farmer's/ advisors's choice based on location for climatic conditions such as rainfed or irrigated or for both conditions. The system carries detailed information about 160 notified varieties that have been stored in its knowledge base. The important feature implemented in this expert system is that it is bilingual i.e. in English and Hindi languages (which can be easily understood by the Indian farmers and all concerns).

AICRP-RM Progress Reporting system

The All India Coordinated Research Project on Rapeseed-mustard has taken. The use of information technology may improve the quality of research and efficiency in data reporting. The Directorate of Rapeseed-Mustard Research is in process to develop an online Progress Reporting System. For proper reporting, the system is able to submit the trails information at three stages e.g. Crop Sowing Status, Crop Growth Status and Final Report. Two modules for submission of report of Crop Sowing Status and Crop Growth Status have been developed; the module for submission of final report is in process.

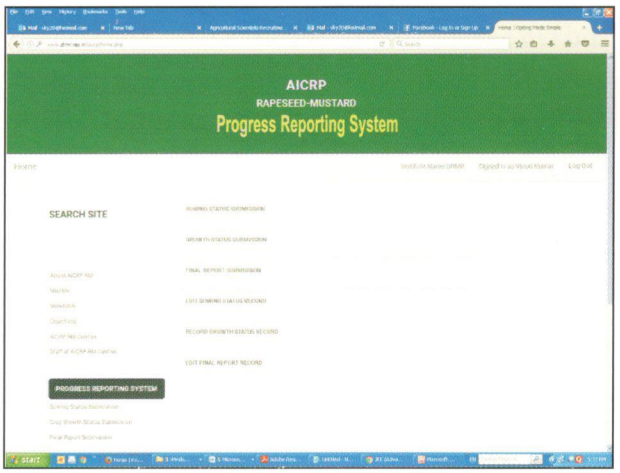


Fig. 2.18 : AICRP-RM Progress Reporting system

Updation and maintenance of web site

The website of DRMR developed and regularly updated as per guidelines of ICAR. As the name of institute changed accordingly the new domain was registered and new website hosted. The new URL of website of DRMR is www.drmr.res.in

Externally Funded Projects

DRMR EA-14: Incentivizing research in agriculture - Indian mustard

(Sub Project-IV): Molecular genetic analysis of resistance/tolerance to different stresses

Principal Investigator: V. V. Singh, Pr. Scientist (Genetics and Plant Breeding)

Co-Investigators: Ibandalin Mawlong, Scientist (Plant Biochemistry), Pankaj Sharma, Pr. Scientist (Plant Pathology), Bhagirath Ram, Sr. Scientist (Genetics and Plant Breeding)

Validation of heat tolerant lines under laboratory conditions using BOD

Total 94 heat tolerant and susceptible genotypes were validated for heat tolerance under lab condition using BOD at different temperature gradient (270,320,350,380,400,420and 450). Total 20 seedlings of each genotypes were screened. The number of seedlings survived was taken as criteria for relative tolerance. The genotypes DRMR 1165-40, UP II 73, BPR 543-2, BPR 549-9, NPJ 124, JN 032, DRMR 1191-2 and DRMR 1616-47 were selected. The seeds of these genotypes were sent to IARI for Phytotron Screening along with 08 other genotypes

Development of RIL population for heat tolerance

Selfed plants from F1 generation of the crosses NRCDR 2 X BPR 541-4, NRCHB 101 X BPR 541-4, NRCHB 101 X BPR 543-2 and NRCHB 101 X BPR 543-2 for developing RIL population for high temperature tolerance were harvested and threshed.

Genetics of heat tolerance

For determine genetics of heat tolerance, a 10x10 diallel involving toleranrt and susceptible parents was developed (Genotypes: BPR 543-2, Urvashi, BPR 549-9, DRMR 1165-40, UP II-73, EC 511664, NRCDR 02, NRCHB 101, Rohini, DRMRIJ 31). Crosses have been harvested and threshed.

Physico-biochemical Identification and characterization of selected heat tolerant lines at different developmental stages

Based on the physiological parameters RWC, Total chlorophyll, carotenoid content and chlorophyll stability index, the selected breeding and germplasm lines were characterized (Table 2.8 & 2.9) at different developmental stages for heat tolerance. The selection was done based on the comparison of physiological parameters over that of normal sown condition.

Screening of new set of germplasm lines for high temperature tolerance

Three hundred lines of germplasm were sown in the month of last September (Temp) to assess the tolerance of germplasm lines on the basis of survival of seedlings during initial period. The seedlings were counted after 30 days of sowing. Out of 300 lines, only one line (EC 0333597) recorded 40-50% survival, 32 lines recorded 30-40% survival and 57 lines exhibited 20-30% survival. Rest of the lines had very poor survival or no survival.

Component: STEM ROT

Molecular profiling stem rot tolerant and susceptible genotypes using SSR marker

The study was conducted on fifty six genotypes of oilseeds brassica (51 *Brassica juncea*, 4 *Brassica carinata*, 1 Sinapis alba) to gain the information on extent of genetic diversity using 110 Simple Sequence Repeat (SSR) markers. The dendrogram obtained by the UPGMA analysis of 82 polymorphic loci amplified using 30 polymorphic SSR markers resulted in definitive groupings among the studied genotypes, which is being partitioned into two major groups. The estimated similarity coefficients, using the Jaccard index amongst the genotypes ranged between 0.54 to 1.00. The polymorphic information content (PIC) values observed varied from 0.225 to 0.667 with an average of 0.528. The highest PIC value of 0.667 wasobserved for BRMS-054 marker that makes it the most informative marker. All the four B. carinata genotypes were grouped in one cluster.

Table 2.8 : Comparison of selected genotypes with percentage of their increase or decrease (-) of physiological parameters over that of normal sown condition.

Selected genotypes	Characteristic	Bud	Flowering	Pod
		CSI (%)	**CSI (%)**	**CSI (%)**
RH-555	Highly tolerant	13.04	11.95	15.68
DRMR-11912	Tolerant	13.24	11.18	11.58
DRMR-1616-47	Moderately tolerant	87.81(-)	1.32	5.67(-)
BPR-549-9(Check)	Moderately tolerant	14.53	8.73	6.98
BPR-541-4 (Check)	Medium tolerant	3.32	2.24	7.73
BPR-543-2 (check)	Medium tolerant	28.46	4.38	4.77
URVASHI (check)	Medium tolerant	12.69	7.05	0.42
		Total Chlorophyll (%)	**Total Chlorophyll (%)**	**Total Chlorophyll (%)**
RH-555	Highly tolerant	10.19	12.06	9.66
DRMR-11912	Tolerant	12.17	7.17	3.41(-)
DRMR-1616-47	Moderately tolerant	37.76	3.27	13.78
BPR-549-9(Check)	Moderately tolerant	7.57	3.45	4.69
BPR-541-4 (Check)	Medium tolerant	4.84	42.36(-)	2.74
BPR-543-2 (check)	Medium tolerant	2.93 (-)	15.05	10.88
URVASHI (check)	Medium tolerant	21.69(-)	12.85	3.75
		Carotenoid (%)	**Carotenoid (%)**	**Carotenoid (%)**
RH-555	Highly tolerant	13.29	20.72	0.75
DRMR-11912	Tolerant	1.94	4.04	15.58
DRMR-1616-47	Moderately tolerant	2.58	1.66	25.73
BPR-549-9(Check)	Moderately tolerant	7.11	8.54 (-)	14.75 (-)
BPR-541-4 (Check)	Medium tolerant	14.75	15.43(-)	23.14(-)
BPR-543-2 (check)	Medium tolerant	7.14	5.74(-)	8.29 (-)
URVASHI (check)	Medium tolerant	22.48(-)	0.01	9.38
		RWC (%)	**RWC (%)**	**RWC (%)**
RH-555	Highly tolerant	6.38	17.56	5.2
DRMR-11912	Tolerant	at par	1.53	1.85
DRMR-1616-47	Moderately tolerant	5.07	3.63	2.51
BPR-549-9(Check)	Moderately tolerant	1.80	1.61	0.41
BPR-541-4 (Check)	Medium tolerant	3.86(-)	4.85(-)	0.80
BPR-543-2 (check)	Medium tolerant	1.02	6.62(-)	1.54
URVASHI (check)	Medium tolerant	0.86	6.10(-)	1.22

Table 2.9 : Comparison of selected germplasm lines with percentage of their increase or decrease (-) of physiological parameters over that of normal sown condition.

Selected genotypes	Characteristics	Bud	Flower	Pod
		RWC %	**RWC %**	**RWC %**
BPR-541-4 (checks)	Reported heat tolerant	0.56	1.41	5.64
BPR-543-2(checks)	Reported heat tolerant	0.43	1.74	5.93
Urvashi(checks)	Reported heat tolerant	0.41	1.40	5.84
DRMR 2059		0.97	1.38	5.94
DRMR 2584		0.88	1.84	5.64
DRMR 2291		0.44	1.24	5.55
DRMR 2489		0.39	1.92	5.80
DRMR 2300		0.49	1.36	5.64
DRMR 2055		0.79	1.29	5.72
DRMR 1469		0.42	1.83	5.92
DRMR 2062		0.95	1.36	5.60
		CSI (%)	**CSI (%)**	**CSI (%)**
BPR-541-4 (checks)		4.40	2.50	1.88
BPR-543-2(checks)		4.89	2.26	2.25
Urvashi(checks)		1.59	2.63	1.78
DRMR 2059		4.34	1.57	2.53
DRMR 2584		2.25	1.87	2.70
DRMR 2291		5.05	2.23	2.78
DRMR 2489		2.75	2.99	1.98
DRMR 2300		2.75	1.84	3.08
DRMR 2055		2.73	2.07	3.32
DRMR 1469		1.17	3.88	3.64
DRMR 2062		3.41	1.97	2.68

DRMR EA-15 : CRP on Molecular breeding for improvement of tolerance to biotic (white rust/stem rot) and quality traits (low erucic acid and glucosinolates) in Mustard

Principal investigator: V. V. Singh, Pr. Scientist (Genetics and Plant Breeding)

Co- Investigators: P. K. Rai, Pr. Scientist (Plant Pathology), Priyamedha, Scientist (Genetics and Plant Breeding), Pankaj Sharma, Pr. Scientist (Plant Pathology), Ibandalin Mawlong, Scientist (Plant Biochemistry)

Foreground selection of F_1 using molecular markers for white rust.

Foreground selection of F_1s for white rust resistance was done using molecular markers i.e.At5g41560(AcB1-A4.1) and At2g36360 (AcB1-A5.1). Crosses namely NRCHB101 x BioYSR, NRCHB101 x BEC-144, DRMR-150-35 x BioYSR, DRMR-150-35 x BEC-144 were found to be white rust resistant (Fig. 2.19 a & b). Crosses namely NRCHB101 x BioYSR, DRMR-150-35xBioYSR, DRMR-150-35 x BEC-144 were found to be resistant to white rust when validated phenotypically at off-season nursery Wellington.

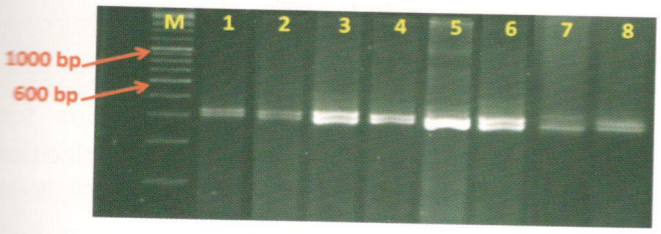


Fig. 2.19(a): Agarose gel showing Validation of markers linked to white rust At5g41560 (AcB1-A4.1) loci, with an expected product size 430bp.M-100bp ladder 1NRCHB101xDonskaja2-NRCHB-101XBioYSR 3-NRCHB-101XBEC-144 4-DRMR150-35xDonskaja5-DRMR-150-35XBioYSR 6-DRMR-150-35XBEC 7-HEERA 8-VARUNA

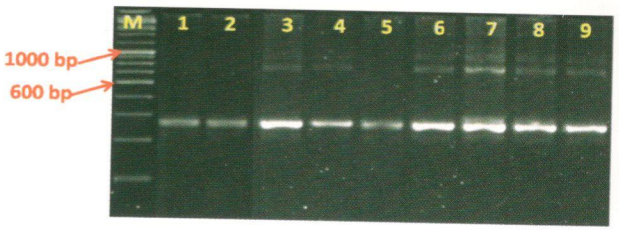


Fig. 2.19(b): Agarose gel showing validation of markers linked to white rust At2g36360 (AcB1-A5.1) loci, with amplified product size of 730bpM-100bp ladder 1- NRCHB-101 2-DRMR-150-35 3-Donskaja4-NRCHB101xDonskaja 5-NRCHB-101XBEC-144 6-NRCHB-101XBioYSR 7-DRMR-150-35xDonskaja 8-DRMR-150-35XBioYSR 9-DRMR-150-35XBEC-144

Foreground selection of F1 using quality markers.

Glucosinolate: A set of five primers i.e. (GER-1MRPR + IP3GER-1F(Q1);Myb28(Q2); At5g41(Q3); At5GAJ67(Q4) and GER-5FPF+GER-5MRPR(Q5)(Bishtet al., 2009) were used for foreground selection among F1s.Primers Q1 and Q5 gave differentiating results among F1s (Fig.2. 20).

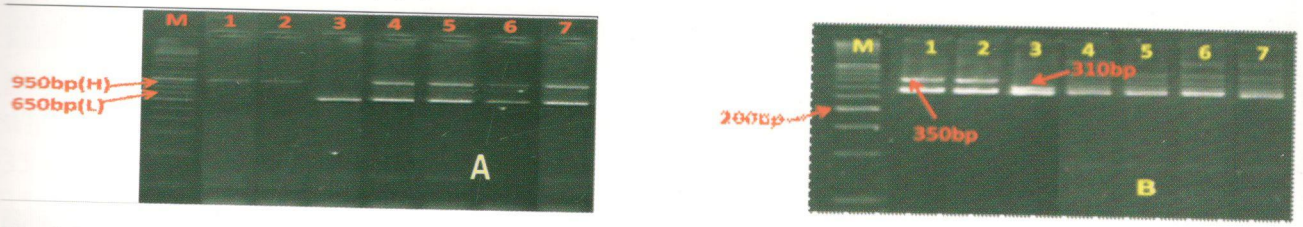


Fig. 2.20: Agarose gel showingValidation of markers linked to quality (Glucosinolate);(A)GER-1MRPR+ IP3GER-1F (Q1),(B) GER-5FPF + GER-5MRPR (Q5) M-100bp 1-NRCHB101 2-DRMR150-35 3-HEERA 4-NRCHB101XPDZ-1 5-NRCHB101XHEERA 6- DRMR150-35XPDZ-1 7-DRMR150-35XHEERA

Erucic acid: Foreground selection for low erucic acid among F1s with two CAPS markers, FAE II (E1) and FAE III (E2)(Gupta et al., 2004) was used. Crosses namely NRCHB-101xPDZ-1, NRCHB-101xHEERA, NRCHB-101xRLC-3, DRMR150-35xPDZ-1,DRMR150-35xHEERA,DRMR150-35xRLC-3 were validated for low erucic acid (Fig.2.21 a & b).

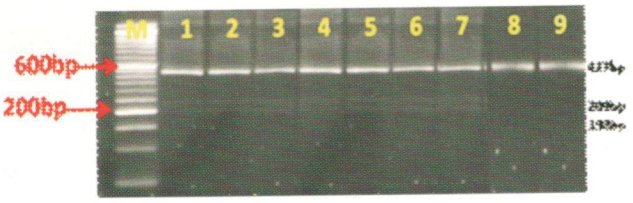


Fig. 2.21 (a): Agarose gel showing validation of markers linked to quality trait(Erucic acid);FAE III (E2)M-50bp Ladder 1-NRCHB101XPDZ-1 2-NRCHB101XHEERA 3-NRCHB101XRLC-3 4-DRMR150-35XPDZ-1 5-DRMR150-35XHEERA 6-DRMR150-35XRLC-3 7-Heera(low) 8-NRCHB101(high) 9-DRMR-150-35(high).

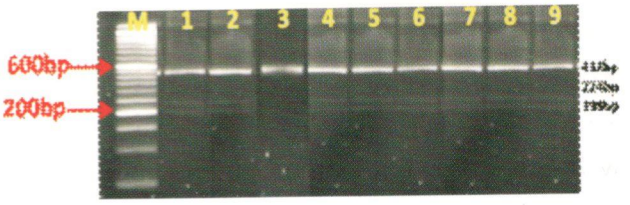


Fig. 2.21(b): Agarose gel showing validation of markers linked to quality trait (Erucic acid);FAE II (E1).M- 50bp Ladder, 1-NRCHB101 2-DRMR-150-35 3-Heera,4-NRCHB101XPDZ-1 5-NRCHB101XHEERA 6- NRCHB-101xRLC-37-DRMR150-35XPDZ-1 8-DRMR150-35XHEERA 9-DRMR150-35xRLC-3

BC1 attempted at off season nursery at Wellington

BC1s attempted at offseason nursery Wellington were asNRCHB-101X(NRCHB-101XBioYSR),NRCHB-101X(NRCHB-101XPDZ-1),NRCHB-101X(NRCHB-101XHeera), NRCHB-101x(NRCHB-101 x BEC-144) DRMR-150-35X(DRMR-150-35XBioYSR),DRMR-150-35X(DRMR-150-35XBEC-144), DRMR-150-35X(DRMR-150-35XPDZ-1),DRMR-150-35X(DRMR-150-35XHeera).

Phenotyping of BC1 for White Rust

BC1 plants were screened for white rust resistance. Inoculum was sprayed and field was irrigated frequently to create artificial epiphytotic conditions, however, the disease pressure was very low. The plants were screened and those possessing resistance to white rust as well as phenotypically looking similar to the recurrent parent(s) with regard to morphological traits were selected.

Foreground selection of BC1 generation using markers linked to white rust.

Foreground selection of BC1 generation for white rust resistance was done using molecular markers i.e.At5g41560(AcB1-A4.1) and At2g36360(AcB1-A5.1) which gave amplified products of 430 and 750 bp, respectively.

White rust resistant plants were found among crosses namely, [DRMR150-35x(DRMR150-35xBioYSR)],[DRMR150-35x(DRMR150-35xBEC-144)],[NRCHB101x(NRCHB101x BioYSR)](Fig. 2.22 & 2.23).

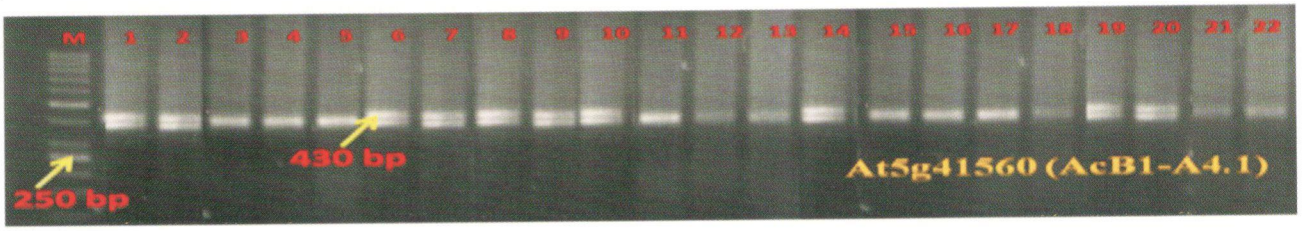


Fig. 2.22 : Agarose gel showing Validation of markers linked to white rust, At5g41560 (AcB1-A4.1) loci,with an expected product size 430bp. M-50bp ladder 1-4[DRMR150-35x(DRMR150-35xBioYSR)],5-12[DRMR150-35x(DRMR150-35xBEC-144)],13-20[NRCHB101x(NRCHB101xBioYSR)], 21-22[NRCHB101x(NRCHB101x BEC-144)].

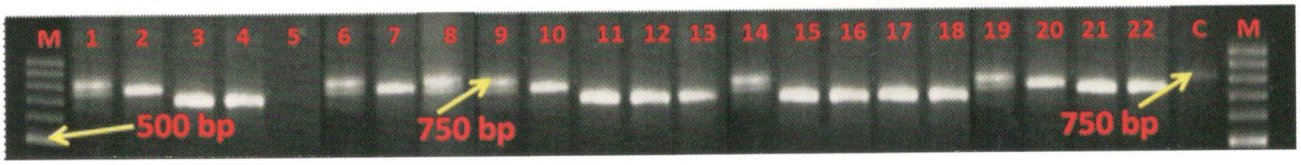


Fig. 2.23 : Agarose gel showing Validation of markers linked to white rust, At2g36360 (AcB1-A5.1) loci,with an expected product size 750bp. M-100bp ladder. 1-4 [DRMR150-35x(DRMR150-35xBioYSR)],5-12[DRMR150-35x(DRMR150-35xBEC-144)],13-20 [NRCHB101x(NRCHB101xBioYSR)],21-22[NRCHB101x(NRCHB 101x BEC-144)], C-DONSKAJA(Control)

Foreground selection of BC_1 generation using markers linked toGlucosinolate loci.

Foreground selection of BC_1s for glucosinolate was done using molecular markers i.e. (GER-1MRPR + IP3GER-1F(Q1); Myb28 (Q2); At5g41 (Q3); At5GAJ67(Q4) and GER-5FPF+GER 5MRPR (Q5). Plants having low glucosinolate loci were found among the crossesnamely DRMR150-35 x (DRMR150-35xPDZ-1), DRMR150-35x(DRMR-150-35xHEERA), NRCHB101 x (NRCHB101 x PDZ-1), NRCHB101 x(NRCHB101 x HEERA).

Foreground selection of BC_1 generation using CAPS markers for Erucic Acid loci.

CAPS markers, FAE II(E1) and FAE III(E2) (Gupta et al., 2004) were used for foreground selection of BC_1 generation.Plants having low Erucic Acid loci were found among the crosses namely, [DRMR150-35 x (DRMR150-35 x PDZ-1)], [DRMR150-35(DRMR150-35xHEERA)], [NRCHB101x(NRCHB101 x PDZ-1)], [NRCHB-101 (NRCHB-101 x HEERA)], [NRCDR-02 (NRCDR-02 x PDZ-1)], [NRCDR-02 (NRCDR-02 x HEERA)] (Fig. 2.24 & 2.25)

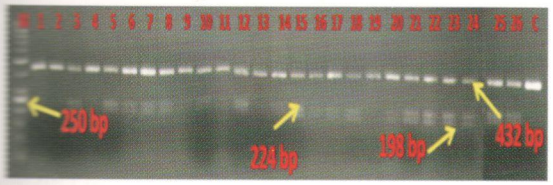


Fig. 2.24 : Agarose gel showing validation of markers linked to quality trait (Erucic acid);FAE II (E1) among BC1 generation.M- 50bp Ladder, C-HEERA (Control),1-5 [DRMR150-35 (DRMR150-35xPDZ-1)],6-9 [DRMR150-35 (DRMR150-35xRLC-3)], 10-11[DRMR150-35 (DRMR150-35xHEERA)],12-16[NRCHB-101(NRCHB-101xPDZ-1)], 17[NRCHB-101(NRCHB-101xRLC-3)],18-20 [NRCHB-101(NRCHB-101xHEERA)],19-25[NRCDR-02(NRCDR-02xPDZ-1)], 26[NRCDR-02(NRCDR-02xHEERA)]

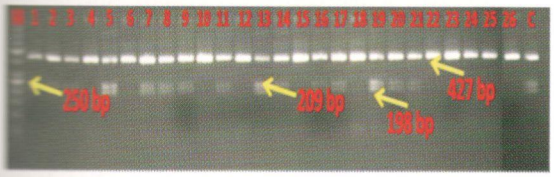


Fig. 2.25 : Agarose gel showing validation of markers linked to quality trait(Erucic acid);FAE III (E2) among BC1 generation.M-50bp Ladder, C-HEERA(Control), 1-5 [DRMR150-35 (DRMR150-35xPDZ-1)],6-9 [DRMR150-35 (DRMR150-35xRLC-3)], 10-11[DRMR150-35 (DRMR150-35xHEERA)],12-16[NRCHB-101(NRCHB-101xPDZ-1)], 17[NRCHB-101(NRCHB-101xRLC-3)],18-20 [NRCHB-101(NRCHB-101xHEERA)],19-25[NRCDR-02(NRCDR-02xPDZ-1)], 26[NRCDR-02(NRCDR-02xHEERA)]

Background selection of BC1 using SSR Molecular Markers

In order to identify polymorphic markers for background selection, 139 SSR markers which were already screened for polymorphism between parent and donor genotypes were used. A subset of 45 out of 139 polymorphic markerused for background selection of those BC1crosses, which showed positive results during foreground selection for quality as well as white rust i.e.DRMR150-35x(DRMR150-35xBioYSR),DRMR150-35x(DRMR150-35xBEC-144),DRMR150-35x(DR MR150-35xPDZ-1),DRMR150-35x(DRMR150-35xHeera),NRCHB-101x(NRCHB-101 xBioYSR),NRCHB-101x(NRCHB-101xBEC-144),NRCHB-101x(NRCHB-101xPDZ-1),NRCH B-101x(NRCHB-101xHeera).

DRMR EA-16 : Development of white rust resistant mustard with high oil quality (Up to May 2016)

Principal Investigator: V. V. Singh, Pr. Scientist (Genetics and Plant Breeding)

Co-Investigator: P. K. Rai, Pr. Scientist (Plant Pathology), Arun Kumar, Sr. Scientist (Cyto-Genetics), Ibandalin Mowlong, Scientist (Plant Biochemistry)

Under this project also, Forground selection of F_1, BC_1 and BC_2 using white rust and quality markers was done. (NRCDR 02 X Donskaja, NRCDR 02 X BioYSR, ,NRCDR 02 X BEC-144, DRMR IJ-31 X Donskaja, DRMR IJ-31 X BioYSR, DRMR IJ-31 X BEC-144), BC_1 and BC_2 were also conformed. For quality, NRCDR 02 X PDZ-1, NRCDR 02 X RLC-3, NRCDR 02 X Heera, DRMR IJ-31 X PDZ-1, DRMR IJ-31 X RLC-3, DRMR IJ-31 X Heera), BC_1 and BC_2 were also conformed. Offseason nursery at Wellington was raised and crosses were grown for generating BC_1 and BC_2.

DRMR EA-4 : ICAR Seed Project on Seed production in agricultural crops

Principal Investigator: Bhagirath Ram, Sr. Scientist (Genetics and Plant Breeding)

Co-Investigators: Ashok Kumar Sharma, Pr. Scientist (Agriculture Extension) and Pankaj Sharma, Pr. Scientist (Plant Pathology)

Seed Production

The quality seed is very crucial and essential for increasing agricultural production and productivity. Seed has played an important role in deciding the performance of the crop and it is the cheapest and most efficient input compared with other costly input like fertilizers, pesticides, weedicide etc. With the advancement in agriculture, the role of quality seed is increasing. A total 916 q TL seeds of rapeseed-mustard varieties were produced during *rabi* 2015-16. Improved Rapeseed-mustard varieties i.e. DRMRIJ31, NRCHB101, NRCDR-02, NRCDR601, RH-406, RH-749, NRCYS-05-02 and YSH 401 were included in the seed production programme. Quality seed production programme was conducted at different locations i.e. at ICAR-DRMR, Farmer's field, KVK Kumher, Madhurikund (DUVASU) Farm, CIRG, Makhdoom in participatory mode.

Breeder seed of DRMRIJ31 (19.54 q), NRCDR02 (4.67q), NRCHB101 (14.79 q), DRMR601 (1.77q) and NRCYS 05-02(0.16q) was produced during 2015-16.

Farmer's training programmes organized

A two days farmer's training programme on "Mustard seed production and its management" was organized at ICAR-DRMR, Bharatpur from 21st to 22nd November 2016 for 35 farmers from 25 villages of Bharatpur district adopted by ICAR-DRMR under *"Mera Gaon Mera Gaurav"* (My *village*, My pride) scheme during rabi 2016-17.

Besides, a three days tribal farmer's training programme on "Rapeseed-Mustard seed production and its management" was also organized at ICAR-DRMR, Bharatpur from 24th to 26th January 2017 under TSP fund of ICAR seed project for 26 farmers from different villages for Devgad Tehsil of Pratapgarh district of Rajasthan.

DRMR EA-13: XII Plan Scheme National Agriculture Innovation Fund/intellectual property management and technology transfer/commercialization of agriculture technology.

Principal Investigator: Vinod Kumar, Sr. Scientist (Comp Application)

During 2016, ITMU has been involved in protection, management and commercialization of Intellectual property generated by the ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur and the Institutes under AICRP-RM Project. Two Applications have been filed for protection of Rapeseed-Mustard Varieties namely RH 749 and RH 0406 of AICRP Centre, CCSHAU, Hisar under PPV&FRA. For Copyright of Software developed by the Directorate, two applications have been filled to obtain the copyright of AgripubInfo (Publication Information system) and RMSelect (Online tool for Rapeseed-Mustard Variety Selection) Software with Copyright office Government of India. Vigorous efforts of ITMU made to commercialize the technologies developed by DRMR. As a result three MoU were signed for licensing two rapeseed-mustard varieties namely NRCHB 101 and Giriraj (DRMRIJ-31).For licensing variety NRCHB 101 two MoU signed with Hytech Seed Pvt. Ltd, Hyderabad and Nandi Seeds Pvt. Ltd., Ahmedabad; and for licensing the variety Giriraj (DRMRIJ-31) MoU signed with Kalash Seeds Pvt. Ltd, Jalna, Maharashtra. A sum of Rs 4.5 Lakh resource was generated through licensing these varieties.

DRMR EA-2: Characterization of rapeseed-mustard varieties for DUS testing

Principal Investigator: Priyamedha, Scientist (Genetics and Plant Breeding)

Under this project the major activities were

carried out involve testing of 19 varieties (01 New, 02 VCK and 16 Farmers) for DUS testing with 12 reference varieties. In addition, 131 rapeseed-mustard varieties (89 varieties of Indian mustard (*Brassica juncea*), 2 varieties of brown sarson (*B. campestris* var brown sarson), 7 varieties of gobhi sarson (*B. napus*), 5 varieties of Karan rai (*B. carinata*) 12 varieties of yellow sarson (B. campestris var yellow sarson) and 15 varieties of Toria (*B. campestris* var toria) including, 1 varieties of Taramira (*Eruca sativa*) were maintained through appropriate mating systems.

DRMR NMOOP 1: Frontline demonstrations and other related activities of Oilseeds

Principal Investigator: Ashok Kumar Sharma, Pr. Scientist (Agriculture Extension).

Co-Investigator: Pankaj Sharma, Pr. Principal Scientist (Plant Pathology) Vinod Kumar, Sr. Scientist (Computer Application)

FLDs Organized

Under the project, 27 cooperating centres of AICRPRM/ ICAR institutes/ Ag. Universities conducted 1945 frontline demonstrations (FLDs) under irrigated as well as rainfed conditions on rapeseed (toria, yellow sarson, taramira, brownsarson and gobhisarson) and mustard (Indian mustard and karanrai) in 81 districts across 14 states during 2016-176. Rajasthan had maximum (624) followed by Uttar Pradesh (296), Manipur (250), Assam (200) and Jammu & Kashmir (138) FLDs. Of the 27 FLDs conducting centres, 7 were in Rajasthan followed by 6 in Uttar Pradesh, 2 each in Haryana and Jammu & Kashmir and one each in rest of the 10 states. Maximum districts (16) were covered in Uttar Pradesh followed by 13 in Assam, 9 in Rajasthan and 6 each in Haryana, Madhya Pradesh and Jammu & Kashmir, 5 in Punjab, 4 in Uttarakhand, 3 each in Bihar and Maharashtra, 2 each in Gujarat and Himachal Pradesh and one each in Manipur and west Bengal.

Training programmes

ICAR-DRMR took the new initiative for upgrading the knowledge and skills of KVK's personnel who are engaged in the dissemination of rapeseed-mustard technology in their respective districts. In collaboration with ATARI, Kanpur; Jabalpur, Jodhpur and Ludhiana, ICAR-DRMR organized six training programmes of 2 days duration each on "Scientific production technology of rapeseed-mustard" for personnel of KVKs from Uttar Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Chhattisgarh, Punjab, Haryana and Delhi during Sept. and Oct. 2016 before the sowing of the crops. Six training programme were organized for KVK's personnel from Uttar Pradesh (5-6 Sept. 2016 for 17 personnel), Rajasthan (8-9 Sept. 2016 for 23 personnel), Gujarat and Rajasthan (19-20 Sept. 2016 for 17 personnel), Madhya Pradesh and Chhattisgarh (22-23 Sept. 2016 for 14 personnel), Uttar Pradesh and Chhattisgarh (3-4 Oct. 2016 for 14 personnel) and Punjab, Haryana & Delhi (6-7 Oct. 2016 for 22 personnel). Thus, a total of 71 KVK's personnel from 8 states participated in these training programmes. Besides, four training programmes (two programmes simultaneously) for 75 field level extension functionaries of State Department of Agriculture from Alwar district of Rajasthan (6-7 Feb. 2017 for 40 personnel and 14-15 Feb. 2017 for 35 personnel) were organized to make them aware of the new technologies advances in rapeseed-mustard cultivation so that they communicate the same to the farmers in the field (Details in Annexure).

The linkage between DRMR and KVKs/ extension personnel will accelerate the process of assessment, refinement, and dissemination of rapeseed-mustard technology. These training programs will serve an instrument for selection of appropriate technology and conduct the FLDs successfully and effectively that will go a long way in increasing the production of this important oilseed crop.

DRMR EA-12 : Pre-breeding for Genetic Enhancement of Ethiopian (*Brassica carinata*) and Indian mustard (*B. juncea*) Gene Pool

Principal Investigator: K.H.Singh, Pr. Scientist (Genetics and Plant Breeding)

Co-Investigators: Ajay Kumar Thakur, Sr. Scale, Scientist (Biotechnology), O. P. Premi, Pr. Scientist (Agronomy), M. S. Sujith Kumar, Scientist (Plant Biochemistry)

Two *B. juncea* lines derived from interspecific hybridization between *B. juncea* and *B. carinata* were found promising (Table 2.10).

Sixty *B. carinata* F_1 crosses were evaluated in augmented block design out of that one cross showed significant superiority for days to flower initiation, days to maturity, and plant height but it was at par for seed yield with best check Kiran.

Table 2.10 : Two B. juncea lines derived from interspecific hybridization between B. juncea and B. carinata

S.N.	Entry	Days to flower initiation	Days to maturity	Plant Height (cm)	Seed Yield (kg/ha)	Seeds / siliquae	1000 Seed wt. (g)	Oil content (%)
1	MCB 1-1-6-5	48	130	199	2194	17	5	41.5
2	MCB 1-2-3-7-1	47	129	203	2141	16	4.2	41.2
3	NRCHB-101 (CHECK)	51	132	192	1990	15	4.9	41.4

Evaluation of rapeseed-mustard entries during 2016-17

Two hundred ninety two entries comprising 216 of *B. carinata*, 45 of *B. juncea*, 26 of *B. napus* and five of *B. rapa* were evaluated in five different experiments for seed yield and other related agronomic traits.

Experiment wise performance of different entries is presented below:

Evaluation of promising genotypes: Eleven advanced strains of *B. carinata* were evaluated in replicated trial at three centres; Bharatpur, Ludhiana and Pantnagar for seed yield and agronomic traits and for disease reaction particularly at Pantnagar. Three strains of derived *B. carinata*; MCB 1-2-3-13-5, MCB 1-2-3-5-1 and MCB 1-2-3-1 produced more seed yield than the best check Giriraj, though the differences were not statistically significant. There was significant improvement in these strains for early flowering, early maturity, short plant height and seed weight. MCB 1-2-3-13-5 had 11.6, -10.1, -39.7 and 74.0% advantage, respectively over *B. carinata* check Pusa Swarnim (Table 2.11).

Table 2.11 : Characterization of promising derived *B. carinata* lines and their superiority over best check Pusa Swarnim for respective trait

Entries	SY	DFI	DM	PH	SW	Superiority over best check			
						seed yield	days to maturity	plant height	Seed weight
MCB 1-2-3-13-5	3165	54	143	144	5.4	11.6	-10.1	-39.7	74.2
MCB 1-2-3-5-1	3086	54	145	146	5.4	8.8	-8.8	-38.9	74.2
MCB 1-2-3-7	2815	51	140	136	5.4	-0.7	-11.9	-43.1	74.2
MCB 1-2-3-2-5	2360	53	139	135	4	-16.7	-12.6	-43.5	29
PusaSwarnim (Check)	2835	86	159	239	3.5				

Evaluation of *B. carinata* F_1 Crosses: Fifty six F_1 crosses generated during 2015-16 under Line X Tester fashion were evaluated in augmented design with 03 check varieties; Pusa Swarnim, Kiran (*B. carinata*) and NRCHB 101 (B. juncea) to assess extent of heterosis. Five crosses exhibited higher seed yield than the best check Kiran. Cross MCB 1-2-7-3 X Pusa Swarnim expressed highest (32 percent) heterosis for seed yield, while heterosis for days to flower, days to maturity and plant height was -29, -11 and -24 %, respectively.

Progeny Row Testing: Forty three progenies of individual plants selected during 2015-16 were evaluated in augmented block design in two row plot of 3 m length.

Evaluation of germplasm/ inbred lines

172 genotypes comprising 105, 45, 17 and 05 of *B. carinata*, *B. juncea*, *B. napus* and *B. rapa*, respectively were evaluated in augmented block design. Results indicated significant improvement for days to flower initiation, days to maturity, plant height and seed yield of inbred lines of both species; *B. carinata* and *B. juncea*. It endorsed development of *B. carinata* lines with 44 days to flower initiation, 129 days to maturity duration, 98 cm plant height in comparison to check cultivar Pusa Swarnim with 80 days to flower initiation, 161 days maturity duration and 228 cm plant height. Similarly, in derived *B. juncea* also we developed lines having 32 days to flower initiation, 113 days maturity duration and 138 cm plant height in comparison to check variety NRCHB 101 having 48 days to flower initiation, 128 days maturity duration and 169 cm plant height. Lines with higher seed yield than check varieties were also developed in both species (Table 2.12).

Table 2.12 : Range for different characteristics in inbred lines of Pre-breeding experiments

S. N.		Range					
		Days to flower initiation		Days to maturity		Plant height (cm)	
		Min	Max	Min	Max	Min	Max
1	*B. carinata*	44	117	129	164	98	283
2	*B. juncea*	32	70	113	144	138	237
3	*B. napus*	47	101	133	161	122	248
4	*B. rapa*	54	71	132	138	112	135
5	NRCHB 101 (Check)	48		128		169	
6	Pusa Swarnim (Check)	80		161		228	

Material shared with collaborating centres

Eleven advanced derived *B. carinata* lines, 16 promising lines of *B. napus*/*B. carinata* and 10 F_2 crosses were supplied to PAU Ludhiana and GBPUAT Pantangar for evaluation and further selection under target environments.

14 Interspecific crosses attempted and 69 intervarietal F_1 crosses were generated in Line X tester fashion with 23 lines and 3 testers

F_2 generation of following 12 crosses of *B. carinata* was raised and selection for desirable types was practiced (Fig. 2.26 a, b & 2.27).

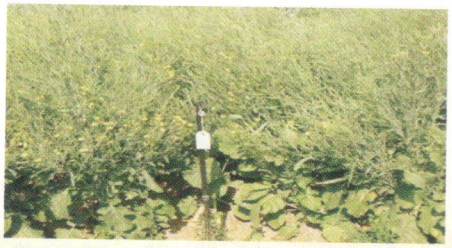
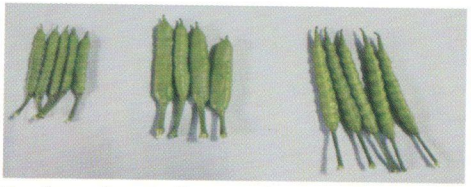


Fig. 2.26 a : Improved *B. carinata* strain



Pusa Swarnim | Improved *B. carinata* | NRCHB 101

Fig. 2.26 b : Siliquae characteristics

Pusa Swarnim | Improved *B. carinata* | NRCHB 101

Fig. 2.27 : Improvement for plant height over Pusa Swarnim (*B. carinata* P1) & NRCHB 101 (*B. juncea* P2)

SB/YS/LS-86/2014-Development of a core set of SSR markers for characterization of *Brassica juncea* varieties and germplasm

Principal Investigator: Ajay Kumar Thakur, Scientist (Sen. Scale)-Biotechnology

A total of 700 SSRs, evenly distributed among the 10 chromosomes of *B. rapa* (A-genome, 50 SSRs/ chromosome) and 8 chromosomes of *B. nigra* (B-genome, 25 SSRs/ chromosome) had been evaluated for their cross-amplification in a representative set of *B. juncea* germplasm and varieties. In addition to that, 20 SSRs derived from *B. oleracea* and *B. napus*, each had also been evaluated for their cross-transferability to the reference set. A total of 523 (70.67%) of the SSRs evaluated out of a set of 740 markers, showed successful amplification across all the genotypes under investigation, of which 236 primer pairs (45.13%) produced polymorphic amplicons. The highest frequency of cross-species amplification and transferability had been obtained for *B. rapa*-derived SSR markers, where a total of 368 SSRs (73.6%) out of 500 markers tested showed cross-amplification in *B. juncea* genotypes. A total of 134 (36.42%) markers resulted into polymorphic amplicons and monomorphic amplification products were produced by 234 (63.58%) SSRs. Among *B. nigra*-derived SSR markers, 144 (72%) of the 200 markers showed successful cross-amplification in *B. juncea* genotypes, where 96 (66.66%) markers produced polymorphic amplicons (Fig. 2.28). Among *B. oleracea* and *B. napus*-derived SSR markers (20 each), only 30% and 25% of the markers could respond positively for cross-species amplification, respectively. The number of alleles detected at each locus ranged from 1 to 6 with DNA fragment size from 50-500 bp.

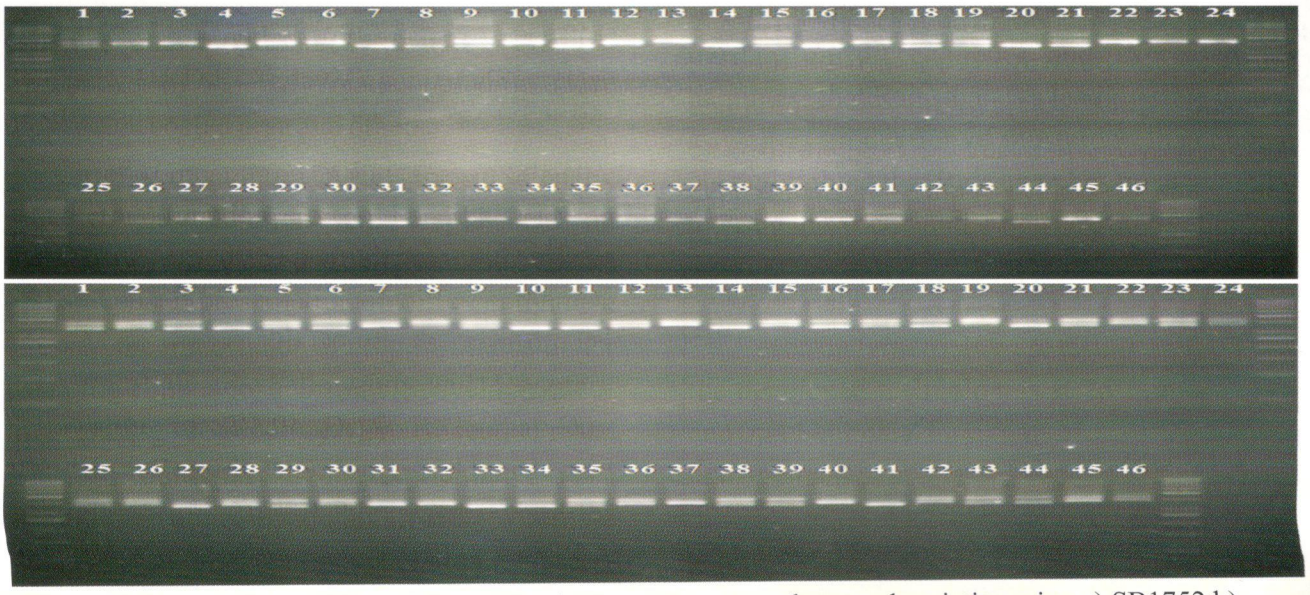


Fig. 2.28 : Amplification profile of representative *B. juncea* germplasm and varieties using a) SB1752 b) SA0306 markers

DRMR EA-10 : Study on *Sclerotinia sclerotiorum* with emphasis on management of Sclerotinia stem rot in *Brassica*

Principal Investigator: Pankaj Sharma, Pr. Scientist (Plant Pathology)

Co- Investigators: V. V. Singh, Pr. Scientist, (Genetics and Plant Breeding); Laxman Prasad, Sr. Scientist, ICAR-IARI; N. C. Gupta, Scientist, ICAR-NRCPB

Screening of available tolerant Brassica germplasm and wild cruciferous.

Screening of new diverse lines/core set of oilseed *Brassicas* for stem rot tolerance: 4092 *Brassica juncea* germplasm from core set screened at DRMR during 2016-17 cropping season. After artificial stem inoculation the lesion size and per cent infection were recorded. Among all the tested germplasm forty seven germplasm showed tolerance (lesion size <3.0 cm and disease incidence<10%), which will be further evaluated under sick plot during next season.

Exotic collection of wild *Brassica* and wild crucifer were screened *in vitro* for leaf and stem assays. Pots maintained in glass house at National Phytotron facility, IARI. A total 48 Brassica lines were analysed, three putative tolerant lines of *B. juncea* from DRMR, Bharatpur were also re-evaluated. Among wild crucifers accession no 114,116 and 122 showed promising result from stem and leaf assay. A tolerant *Brassica juncea* RH1222-28 line was promising as well by showing considerable amount of tolerance or resistance in both stem and leaf assays. 300 Brassica lines including different genera and species were analysed in field conditions at IARI. Among *B. juncea* lines obtained from DRMR were also re-evaluated and observed RH 1222-28 line performs better.

Identification of clonality based on MCGs, MAT loci, morpho-pathological, chemo-profiling and aggressiveness variations

Morphological variability among different geographical isolates: The growth rates in the 65 isolates differed and there were also differences in all morphological characters of S. *sclerotiorum*. Based on the radial growth 72 hrs after incubation the isolates were classified into 3 groups: However 96 h after incubation the majority of isolates became fast growing and filled the Petri plate with mycelial growth. Most isolates were had whitish mycelial growth with smooth texture, where as isolates ESR-02, ESR-06, ESR-08, ESR-12, ESR-14, ESR-17, ESR-21, ESR-31, ESR-42 and ESR-48 had off-white colour.

Based on number of sclerotia produced by the isolates of *S. sclerotiorum*, they were divided in 3-groups: (i). High producer (ii). Intermediate and (iii). Low producer. Majority of isolates produced the sclerotia in 6-9 days. The sclerotia of isolates SR-26, SR-27, ESR-44, ESR-49, ESR-55 and ESR-65 were bigger in size (2.4-2.5 mm dia), while those of ESR-1, ESR-2, ESR-4, ESR-9, ESR-13, ERSR-18 were smallest (1.8-1.9 mm dia). The isolates varied in their sclerotial length (2.9-6.6 mm), however, the sclerotia of isolate ESR-65 had maximum length (6.6 mm).

Genetic diversity among 65 isolates of *S. sclerotiorum* by genome wide SSR markers

Genetic diversity analysis is being performed among the various isolates of S. sclerotiorum (ESR 1-ESR 65) using Simple sequence repeat markers (25 SSR primers sets from different repeat motifs) and will be analysed for genetic diversity. Modified CTAB method for isolating the gDNAfrom 7-days old mycelial mat was adopted.These amplified products were separated on 3.5% Agarose gel electrophoresis and analyzed using ethidium bromide fluorescence in a gel documentation system. The bands were scored as either 0 or 1 based on presence and absence and formed as a dissimilarity matrix file in DarWIN software. Finally the data matrix which is clustered was used to make the phylogenetic tree to analyze the genetic diversity among all the isolates of India.

Identification of clonality based on MAT loci

Isolates were genetically analyzed with MAT-locus marker having either inversion plus or inversion minus character (Fig. 2.29). Data recorded showed that there are only few isolates which shows compatibility with other isolates and fused to form a new progeny.

Fig. 2.29 : Identification of clonality based on MAT loci

Mycelial Compatibility Group (MCG)

There were 2080 pairings of 65 isolates, of these 166 combinations showed compatible reaction (7.9% of all combinations), where mycelia of the two isolates intermingled at the interaction zone (Fig. 2.30). The isolates, ESR-2, ESR-3 and ESR- 5 were most compatible with other isolates. The compatibility and incompatibility between different 65 geographical isolates of *Sclerotinia sclerotiorum* were considered as 0 and 1 and data recorded were used for cluster analysis.

Mycelial Compatibility Group

Integrated management of Sclerotinia rot

A management strategy including seed treatment with carbendazim (2g/kg seed), no crop irrigation during 25 Dec to 15 Jan and foliar spray of carbendazim (0.2%) during first week of January was formulated and well tested through experiments, on farm testing and demonstrations.

Development of RILs

Based upon already identified resistance sources, recombinant inbreed lines (RILs) were initiated during 2015-16. EC 597328, EC 597340 (*B. juncea*, China) and DRMR 261 (*B. carinata*, India) were crossed with high yielding B. juncea varieties, multiple disease resistance lines and improved germplasms RH 749, NRCDR 2, RH 555, RH 1372, RH 1231, RH 345 and RH 1117. F1 population sown under sick plot condition with stem inoculation technique and 5 crosses showed good tolerance (lesion size <3.0 cm and disease incidence<10%). New crosses were also attempted with RH 1222-28 germplasm.

Transcriptome profiling

To know the basic molecular mechanism behind its potential tolerance and also to identify the potential target gene (s) RNASeq analysis by transcriptome profiling was done. Three time point were chosen for the RNASeq analysis, 24 hpi (hour post inoculation), 48 hpi and 96 hpi. To mitigate the genetic and environmental effect two biological replicates were taken along with the mock control. For each time point samples were collected from five different individual and thus total 60 individual samples were collected from R (RH 1222-28) lines and similarly 60 plants from S (NRCHB- 101) line.All the 120 samples both from R and S line were subjected for RNA isolation for RNASeq purpose.The 16 samples, (8 from each R and S line) are being used for RNASeq library preparation and after that it will run the prepared RNASeq Library on Illumina HiSeq 4000 platform for transcript sequencing. Once sequence will come rigorous bioinformatics will be required to analyse all the data received from R and S lines in replicate and then the potential target genes and pathways will be analysed for further studies and application.

DRMR EA 9 : Induced mutagenesis for isolation of *Alternaria blight* resistant mutant in *Brassica juncea*

Principal Investigator: P.D. Meena, Pr. Scientist (Plant Pathology)

Co-Investigator: H. S. Meena, Sr. Scientist (Genetics and Plant Breeding)

Screening for white rust resistant at Wellington, Tamil Nadu

A set of 140 mutants were grown at IARI, RS Wellington, Tamil Nadu and scored for white rust disease severity. Six mutants of M_2 generation viz., RH-0749-G 90Kr, four mutants of Kranti E 0.5%, Kranti G 100 kr were identified as resistant to white rust. Total 24 mutants M_3 were harvested as white rust resistant. These 24 white rust resistant mutants were further confirmed for resistant at Bharatpur and harvested as M_4 generation. These 24 mutants (DRMR-M-167 to 170) are subjected to further detailed evaluation and use

ICAR-DRMR, Bharatpur

During 2016-17, total 640 mutants of M_3 & M_4 generation including check Kranti, RH-0749, Rohini were sown at Bharatpur for different traits including Alternaria tolerance (119) white rust resistant (200), high oil content (30), early maturing (Fig. 5) & dwarf (120), white flowered (8), bold seed (12) and Appressed & high yielding (148) etc. Among 119 mutants, selected for Alternaria blight at Bharatpur (45) and Pantnagar (74) were further screened during the year. Laboratory screening at cotyledonary stage and true leaf stage for *Alternaria blight* tolerance under controlled conditions was done. Out of 140 mutants of M_2 generation, 24 mutants were advanced to M_3 generation (DRMR-M-16-167 to DRMR-M-16-170) were found resistant against white rust disease under severe disease pressure at Wallington (TN) in off season nursery. Total 5 mutants were found promising to long siliquae >6cm viz., RH-749- G 110kr + E 1.0% [DRMR-M-72] (6.70 cm), Kranti-E 0.75% [DRMR-M-231] (6.48cm), RH-749- E 1.0% [DRMR-M-462] (6.35 cm), NRCHB-101-G100kr [DRMR-

M-497] (6.33 cm) and RH-119-G100kr [DRMR-M-367] (6.23 cm). Two mutants were observed long silique (>6mm) was observed in BRNS-M-391 and BRNS-M-660, while mutant DRMR-M-149 was showed long main shoot

High oil content

On the basis of per cent oil content 30 lines were selected having more than 42% oil content and promising mutants were DRMR-M-16-3 (43.14%), DRMR-M-16-12 (42.73%), DRMR-M-16-20 (42.72 %), DRMR-M-16-28 (42.96%), DRMR-M-16-29 (43.01%) and DRMR-M-16-30 (42.73%). Out of 32 mutants, 3 mutants of M_4 generation were selected as promising for yellow seed color with high oil content viz., DRMR-M-16-27 (44.9%), DRMR-M-16-31(43.7%), DRMR-M-16-32 (43.3%) showed additional characters of earliness, seeds per siliqua (>18), dwarf, white rust resistant during 2016-17 (Fig. 6). These 3 mutants were also reported for high oil content in M_3 generation i.e. 42.5%, 43.4% and 43.5% respectively.

White flowered mutant

Among 8 white flowered mutants selected during 2015-16 were further confirmed during 2016-17 for flower colour viz., DRMR-M-83 to DRMR-M-88 (Fig. 7). These were also having glossy leaf could be utilized for aphid tolerance after detailed evaluation.

Detached leaf screening

Among 119 mutants, a total of 93 mutants were screened under laboratory condition using detached leaf technique based on lesion size (Fig. 8) was ranged between 0.5 mm to 4.77 mm. Based on lesion size mutants including DRMR-M-54 (0.5mm), DRMR-M-42 (1.1mm), DRMR-M-55 (1.1mm), DRMR-M-53 (1.16mm) and DRMR-M-56 (1.17mm) were found promising.

CCSHAU, Hisar

Out of 401 mutants, 8 mutants were observed Alternaria tolerance based on Alternaria blight severity on leaves and pods.

GBPUAT, Pantnagar

Only 8 mutants i.e. 4M2P-5, 7M2P-14, 12M2P-10, 12M2P-11, 12M2P-12, 12M2P-13, 12M2P-14 and 12M2P-15 showed moderately resistant to Alternaria blight (AB) on leaf whereas rest entries showed susceptible to highly susceptible reaction.

SAREC, Kangra

Out of 220 mutants of RH 749, none of the plant of any mutant line showed resistance to *Alternaria* blight.. These mutants were also screened against white rust disease under natural conditions and 41 plants were selected for resistance to white rust for further evaluation during next season under artificial conditions. Similarly, out of 225 mutants of Kranti, none of the plant of any mutant line showed resistance to *Alternaria* blight.

DRMR - EA 8 : Gramin Krishi Mosam Seva

Principal Investigator: O.P. Premi, Pr. Scientist, Agronomy

Co-Investigators: Ashok Kumar Sharma, Pr. Scientist (Agriculture Extension).

During 2016-17, AMFU Bharatpur received 103 forecasts for the next 5 days on every Tuesday and Friday from Meteorological centre, IMD, Jaipur. Based on the forecasts, the advisories 101 (GKMS Bulletins) were prepared for the 5 districts separately in Hindi and English. The SMS on weather forecasts and important agro-advisories were being sent on regular basis to 10352 farmers of Alwar, 8642 of Bharatpur, 2134 of Dholpur, 4637 of Karauli and 5474 of Sawai Madhopur districts. To further promulgate the benefits of agromet advisories to the farmers, a one-day Farmers Awareness Programme was organized on Mar 04, 2017 at Borai, Kumher, Bharatpur.

3 Transfer of Technology

19th Beej Pakhwada organized

ICAR-DRMR's popular endeavour, 19th Beej Pakhwada, was organized during Sept. 15 – Oct 10, 2016 at DRMR to salethe quality seeds of improved varieties namely RH-749, DRMRIJ 31, NRCDR-02, NRCHB-101, RH-406, NRCHB-506, DRMR 150-35 of Indian mustard and YSH 401 of Yellow sarson to the rapeseed-mustard farmers. The seeds were sold to the farmers on first-come-first-serve basis. A record number of farmers from different states visited during this Pakhwada and purchased seeds of different improved varieties of rapeseed-mustard that shows the impact of different extension programs of this Directorate, which provided information about the seed availability at ICAR-DRMR to the farmers and extension personnel.

The visiting farmers were also provided counselling for situation specific varietal selection along with advice on scientific cultivation of rapeseed-mustard.

A large quantity of seeds of different varieties were also procured by a number of KrishiVigyanKendras and Agricultural Universities this year for conducting frontline demonstrations in their respective districts/states across the country so that production potential of improved varieties can be shown to large number of farmers that will lead to their wide spread adoption in different agro climatic situations of the country.

About 916 quintal TL seeds of improved varieties of Indian mustard were sold to thousands of the farmers of different states.

Front line demonstrations (FLDs) on mustard conducted.

The 324 frontline demonstrations (FLDs) under whole package with three improved varieties Giriraj (DRMRIJ 31), RH 406 and RH 749 were laid out in different villages of Bharatpur district of Rajasthan during the crop season 2016-17 to show the impact and production potential of these varieties on farmers' field. The average yield of demonstrated varieties viz., Giriraj, RH 406 and RH 749 was 2519, 2265 and 2348kg/ha with yield improvement of 12.2, 7.3, 6.9%, respectively over prevailing varieties. The average cost of cultivation under all FLDs was Rs. 30850 against Rs. 29200 in farmers'plot. On an average, the improved varieties fetched additional net monetary return (ANMR) of Rs 5665/ha in response to additional cost of Rs. 1650/ha. Among all FLDs, 283 were laid out in 25 villages adopted under MGMG and rest of 41 were laid out in other villages for wider dissemination of improved varieties.

Training programmes organized

Training programmes for ATM/ BTM/ farmers: ICAR-DRMR organized 12 training programmes of 2 to 5 days duration for farmers. Two training programmes of 5 days each were organized for field level extension workers (ATM/ BTM) and progressive farmers of different districts of Uttar Pradesh during 13-17 Sept. 2016 (20 participants) and 26-30 Sept. 2016 (21 participants) which were sponsored by State Institute of Agriculture Management,

Rehamankheda, Lucknow (UP).Two programmes of 5 days each on "Scientific production technology of mustard and agriculture management" sponsored by PD, ATMA, Gwalior (7-11 Nov. 2016 for 16 farmers) and PD, ATMA, Bhind (8-12 Feb. 2017 for 23 farmers) districts of Madhya Pradesh and Three programmes on "Bee keeping and Agriculture management" sponsored by PD, ATMA, Tonk (5-9 Dec. 2016 for 33 farmers and 1-5 March 2017 for 25 farmers) and PD, ATMA, Jhabua (1-5 March 2017 for 17 farmers) were organized.Two training programmes of 3 days under Tribal sub-Plan (13-15 Dec. 2016 for 30 farmers of Jhabua district of MP) and (24-26 Jan 2017 for 26 farmers of Pratapgarh district of Rajasthan) were organized on different aspects of scientific production of mustard. Three programmes of 2 days each for farmers of Bharatpur district of Rajasthan (21-22 Nov 2016 for 35 farmers) under ICAR Seed Project on Seed Production in Agricultural Crops and for farmers of Ajmer and Alwar district of Rajasthan (24-25 Sept. 2016 for 42 farmers and 3-4 Feb. 2017 for 37 farmers)sponsored by Rajasthan Rural Institute of Development Management (BAIF), Ajmer, Rajasthan were organized. A total of 285 farmers were provided extensive training about scientific production technology of mustard, seed production, bee keeping and agriculture management through these programmes.

MeraGaonMera Gaurav Programme:

The "MeraGaonMera Gaurav" programme has been actively taken up by ICAR-DRMR during 2016-17 to provide farmers with required information, knowledge and advisories on regular basis by adopting villages. 25 villages were adopted by the five teams of Interdisciplinary members comprising of both scientific and technical staff. The team members visited their respective adopted villages during all stages of farming operations to give necessary instructions.

FLDs : Under the programme, ICAR-DRMR provided seeds of improved varieties viz. RH 749, DRMRIJ 31 and RH 406 along with fertilizers to 283 progressive farmers from adopted 25 villages of Bharatpur district of Rajasthan under MGMG for conducting FLDs on mustard to show the production potential of these improved varieties at farmers' field along with other technological interventions like sulphur application, Zinc application, seed treatment with Carbandazim to the farmers and

extension workers. The advantage of improved seed drill for mustard was also demonstrated in 2 villages. The 5 FLDs on improved varieties of wheat HD 2967 were also conducted in adopted villages. The selected farmers were given pre-sowing training to motivate them for adoption of scientific production technology of mustard.

Sarson Field days organized: Five Sarson Field days were also organized in different villages adopted under MGMG to show the performance and production potential of improved varieties of Indian mustard to the farmers and extension personnel at the farmers' field practically. About 1000 farmers and extension personnel participated in these Sarson field days. All appreciated the performance of newly demonstrated varieties in the field and motivated to adopt them in next season.

Regular visits to the adopted villages were done for interaction meeting with farmers, monitoring of FLDs, providing first hand solution of the problems faced by the farmers, etc. The farmers of adopted villages were also provided the opportunity to participate in ICAR-DRMR programmes, like kisan mela, exhibitions, visitors' advisory services, etc. The awareness about the use of bio gas, organic farming, sanitization and cleaning, Pradhanmantri Fasal Beema Yojana (PMFBY), farm mechanization, etc. was created by the team of scientists in the adopted villages.A total of about 9723 farmers were benefitted through different programmes organized by ICAR-DRMR like providing seeds of improved varieties, conducting FLDs, organizing field days, interface meetings, trainings, Mobile based advisories, providing literatures, linkages with line departments, etc.

Kisan gosthies organised

A management strategy including seed treatment with carbendazim (2g/kg seed), no crop irrigation during 25 Dec to 15 Jan and foliar spray of carbendazim (0.2%) during first week of January was formulated and well tested through experiments, on farm testing and demonstrations. This effective management strategy is now popularizing among farmers and during 2016-17, demonstrations were conducted. Under, ICAR-Extra mural research project on Sclerotinia rot management, Dr. Pankaj Sharma organised two kisangosthies in village Motuka, Bansur and Jugla Patti, Uchain. Following the irrigation management and spray of carbendazim farmers harvested good crop without stem rot incidence.

"Sarson School on AIR" programme covered three States

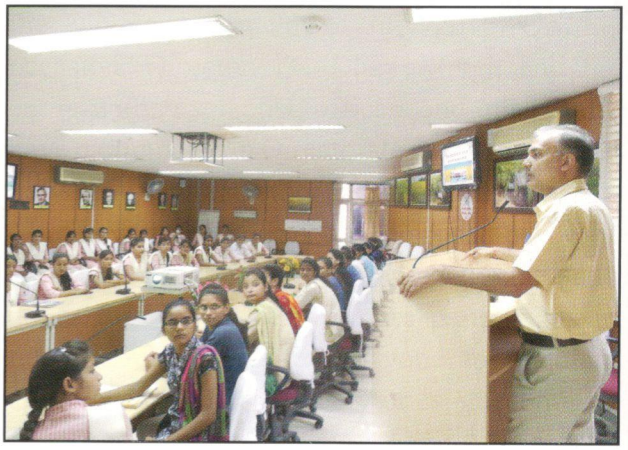
DRMR's popular technology dissemination programme through All India Radio under the name of Sarson School on AIR (Radio KrishiShiksha Programme), covered three major mustard producing states viz. Rajasthan, Madhya Pradesh and Uttar Pradesh during 2016-17. DRMR's scientists communicated the scientific technology to the farmers and extension personnel of these states through weekly radio programmes, which was being broadcasted through 18 All India Radio stations of Jaipur, Alwar, Kota, Swai Madhopur & Suratgarh of Rajasthan; Gwalior, Rewa, Chatarpur, Bhopal, Indore and Shivpuriof Madhya Pradesh; Lucknow, Mathura, Gorakhpur, Bareilly, Faizabad, Jhansiand Agra of Uttar Pradesh during Sept., 2016 to Feb., 2017.

Taking the benefit of wide coverage and reach provided by All India Radio (AIR) net work, the "Sarson School on AIR" programme of DRMR has gained the wide popularity because of easy accessibility by large number of farming community scattered in far-flung areas.

DRMR broadcasted technology delivery modules through 24 radio talks from each of the selected AIR stations during the crop season 2016-17 to provide timely advice about various advanced production practices of rapeseed-mustard that enhanced the knowledge and create confidence for adoption of improved technology among the farmers.

Visitors Advisory Services of DRMR

Under Visitors Advisory Services, successfully organized/ coordinated 68 interaction meetings and counselling sessions on rapeseed-mustard cultivation for visiting groups from Rajasthan, Uttar Pradesh and Madhya Pradesh consisting of 2539 stakeholders including 1476 farmers, 278 farm women, 612 students and 173 extension personnel/ teachers.



The visiting groups were educated/ trained through lectures, visits to Technology Park, experimental fields, museum and also provided literature. Besides, other visiting farmers were also provided timely technical advice to their problems in mustard cultivation.

Exhibitions organized:

ICAR-DRMR organized 7 exhibitions displaying scientific technologies of rapeseed-mustard, research and development activities of ICAR-DRMR. More than 3000 farmers, farm women, extension personnel and students were educated through these exhibitions organized at KVK, Kumhar on April 11, 2016; Holabas village of Alwar district of Raj. on April 17, 2016; at DUVASU, Mathura district of UP on April 30, 2016; CAZARI, Jodhpur on Sept 21, 2016; Farah, Mathura during Sept. 26-29, 2016; KVK, Kumher on Feb. 2, 2017 and IARI, New Delhi on March 15-17, 2017. Visitors were also provided literatures on scientific cultivation of rapeseed-mustard.

SarsonVigyan Mela organized

ICAR-DRMR organized the 2nd SarsonVigyanMela on February 10, 2017. The mela was inaugurated by honourable Vice Chancellor, UP Pt. Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalya Evam Go Anusandhan Sansthan (DUVASU), Mathura Professor K.M.L. Phatak. Addressing the farmers, he urged to make the post harvest value addition of agriculture produce before selling in the market so that farmers can get higher price and farming can become profitable occupation. He emphasised the need for better coordination among all departments/ agencies viz. research institutes, Ag. universities, KVKs, departments of agricultures, seed agencies, NGOs, etc. to make the farming community aware of scientific production technology for doubling the farming income. For sustainable agriculture and income enhancement, development and adoption of animal husbandry is important for all the farmers. The role of women is very important in agriculture, therefore, they should be trained for adoption of scientific practices of different aspects of agriculture especially animal husbandry. He appreciated the efforts of the directorate for dissemination of rapeseed-mustard technology among the farmers across the country and stressed for value addition of mustard oil.

On the occasion, chairman of the function, Sh. Yadavendra Singh, Joint Director, NMOOP, Department of Agriculture, Govt. of Rajasthan said Govt. of Rajasthan is doing itsall out efforts to increase the production and productivity of oilseed crops in the state and declaration of mustard state. He urged the farmers to adopt the high yielding mustard varieties developed by ICAR-DRMR.

Dr. P. K. Rai, Director, ICAR-DRMR welcome all the dignitaries and addressed the farmers. He said that rapeseed-mustard is important oilseed crops contributed significantly in agriculture economy of the country. He also highlighted the programmes and activities of the directorate being organized for the benefit of the farmers.

Addressing the farmers, Sh. Yogesh Sharma, Joint Director (oilseeds), Bharatpur division, Department of Agriculture, Govt. of Rajasthan said that land holdings were decreasing day by day, therefore, integrated farming model should be adopted by the farmers to increase the income from farming. He urged the farmers to visit the research institutes and take the advantage of different govt. programmes to develop their farming system. Dr. Udaibhan Singh and Sh. Deshraj Singh, DD, Agriculture, Bharatpur also addressed the farmers and urged to keep regular contacts with scientists and extension personnel

for seeking knowledge and skill about the advances in the field of agriculture.

Five technical folders/bulletins were also released by the dignitaries during mela. The mustard crop competition, kisan gosthies, visit of experimental field, exhibitions, etc. were also organized on the day. About 20 exhibitions stalls were also organized by different departments/ research institutes, input dealers, etc. involved in transferring information on improved farming techniques.

The winners of crop competition, kisan Prashnotharies, progressive farmers, NGOs, that contributed significantly towards development and dissemination of improved farming techniques of rapeseed- mustard were also honoured in mela. About 1500 farmers, farm women, extension workers, students, etc. actively participated in the mela.

Review meeting of FLDs farmers organized

A review meeting of FLDs farmers was organized on April 28, 2016 at ICAR-DRMR to discuss the performance of the mustard technologies demonstrated in Frontline demonstrations during 2015-16. One hundred twenty fiveFLDs on varietal namely RH 749, DRMRIG 31 and RH 406 of Indian mustard were conducted in different villages of Bharatpur district of Rajasthanto show the impact and production potential of these varieties on farmers' field in order to the effectivetransfer of mustard production technologies. Under the successful FLDs, the farmers reported thatthe improved variety DRMRIJ 31 (22 FLDs), RH 749 (35 FLDs) and RH 406 (15 FLDs) had a yield advantage of 20.17, 14.7, and 11.49 per cent over other varieties. The average yield of these improved varieties was 2018, 1859 and 1872 kg/ha despite the adverse weather condition during maturity.

Addressing the participating farmers, Director, ICAR-DRMR said that the performance of newly released varieties had shown the yield superiority over the prevailing varieties in the region. Farmers should have the confidence among the scientific technology developed by public sectors.

The Nodal officer of FLDs, Dr. Ashok Sharma said that FLDs are working on the principle of "Seeing is believing", therefore it is the best tool for the farmers to see the potential of the technology at their own field. He urged the farmers to take part in different extension programsof this Directorate for enhancing their knowledge and skill. Farmers appreciated the efforts of the directorate and performance of the newly released varieties. About 65 contact farmers participated in the meeting

Review meeting on Frontline demonstrations in Oilseeds with ICAR Institutions under NMOOP organized

A Review meeting on Front Line Demonstrations (FLD) in Oilseeds laid out by ICAR Institutions and coordination centers under NMOOP was organized by ICAR-DRMR, Bharatpur sponsored by DAC&FW, MOA&FW, under the chairmanship of Dr. Anupam Barik, Additional Commissioner (Oilseeds), NMOOP, DAC&FW, New Delhi on March 17, 2017. At the outset of the meeting, Dr. P. K. Rai, Director, ICAR-DRMR welcomed the chairman and all participants. He highlighted the importance of Oilseeds in economy of Indian agriculture and challenges for increasing the production and productivity of oilseeds in the country. He also mentioned scenario of rapeseed-mustard production in the country by giving the overview of the constraints and technological advances in the crop and yield gap analysis.

In his introductory remark, Chairman Dr. Anupam Barik, Additional Commissioner (oilseeds), NMOOP said that FLDs are important tool to demonstrate newly released crop production and protection technologies and its

management practices in the farmers' field under different agro-climatic regions and farming situations. The FLDs should be conducted properly and effectively based on different agro-climatic situations. He emphasised the importance of minor oilseeds and said that efforts should be made to increase the production and productivity of minor crops which have significant contribution in export. He maintained that country is importing more than 50 per cent of our edible oil requirement and there is a need to enhance availability of vegetable oils by adoption of improved technology of oilseed developed by the research institutes. He also raised a concern about higher per capita consumption of edible oils. He emphasised the need to make the public awareness about the recommended consumption of edible oils.

Dr.Barik also urged the scientists to also concentrate on nutritive value of all vegetable oils and make the consensus on the quality parameters so that everyone may know, which is the best vegetable oil. He also emphasised about the reporting of FLDs data by comparing the yield of improved technology with district, state, national and world average.

The presentations on progress and impact of NMOOP Programme on rapeseed-mustard was made by Dr. P. K. Rai, groundnut by Dr. G. Naryanan, , Soyabean by Dr. S.D. Billore, Sesame and Niger by Dr. P. K. Singh, Sunflower, Safflower, castor by Dr. G.D. Satish. Besides, other scientists from AICRP centres also presented the progress report of their respective crops. A detailed deliberation was held on different aspects to make the FLDs programme on oilseeds more effective to enhance the production and productivity of oilseeds in the country. A number of recommendations were made in the meeting to make the programme more effective. The meeting was coordinated by Dr. Ashok Kumar Sharma, Pr. Scientist (Ag. Extn), ICAR-DRMR.

National Productivity Week organized

ICAR-DRMR organized National Productivity Week during 12-18 February, 2017 and conducted the meetings and awareness

campaigns of various stakeholders to enhance the agriculture productivity. During the week, a campaign was launched by Dr. P.K. Rai, Director (Acting), ICAR-DRMR in the Ludhawai and Habibpur village on 18.02.2017 that also addressed by Dr. Pankaj Sharma and Dr. R.S. Jat. The farmers were informed about the ICAR-DRMR technologies for mustard cultivation like improved varieties, disease and insect pest management and mustard seeder besides the other technological options available to enhance the agriculture productivity and livelihood.

4 Training and Capacity Building

Training attended

Topic	Venue/Date	Participant
Farmer Producers' companies - Issues and challenges organized by MANAGE, Hyderabad in collaboration with SIAM, Durgapura, Jaipur	SIAM, Durgapura, Jaipur 18-21 April, 2016	A.K. Sharma Rupender Kaur Sandeep Rastogi
Genomics and Phenomics for enhancement of crop use efficiency	ICAR-NRCPB, Delhi 1-21 September, 2016	Ibandalin Mawlong
Conservation Agriculture: Gateway for productive & sustainable cropping systems	BISA, Ludhiana 7-21 November, 2016	R.S. Jat
Integrated Scientific Project Management for Women Scientists/ Technologists	New Delhi 21-25 November, 2016	Anubhuti Sharma
Advanced training programme on lipidomics using high resolution mass spectrometry	SCIEX, Gurgaon 17-21 January, 2017	M.S. Sujith Kumar
Competency enhancement programme for effective implementation of training functions by HRD Nodal officers of ICAR	NAARM, Hyderabad 13-15 February, 2017	Pankaj Sharma

Participation in Seminars, conferences, symposia, workshops and meetings

Sl. No.	Event	Venue	Period	Participant
1.	3rd International IUPAC Conference	New Delhi	6-9 April, 2016	R.S. Jat
2.	3rd Training cum workshop on Bio safety for IBOs	NASC, New Delhi	13 April, 2016	K.H. Singh
3.	Annual Zonal Workshop of Zone VI	Anand	1-3 May, 2016	Dhiraj Singh
4.	QRT (ICAR-DRMR/AICRP-R&M)	Srinagar	4-8 May, 2016	Dhiraj Singh
5.	5th TSP workshop on Augmenting rapeseed-mustard production of tribal farmers for sustainable livelihood security under tribal sub plan	Imphal	16-17 May, 2016	Dhiraj Singh, A.K. Sharma, Pankaj Sharma
6.	National workshop on FLDs and Seed Production	NASC Complex, New Delhi	17 May, 2016	Dhiraj Singh
7.	XXXIVth of Plant Germplasm Registration Committee	NBPGR, New Delhi	24 May, 2016	Dhiraj Singh
8.	Review meeting of Incentivization in Agriculture and CRP on Molecular breeding projects	IARI, New Delhi	28 May, 2016.	V.V. Singh
9.	Review meeting of CRP on Hybrid Technology	IARI New Delhi	29 May, 2016	K.H. Singh
10.	North zone zonal workshop of ITMU	IARI, New Delhi	9 June, 2016	K.H. Singh
11.	Panel Discussion on "driving food safety through science based principles"	Le Meridien, New Delhi	24 June, 2016	M.S. Sujith Kumar, Ibandalin Mawlong
12.	Workshop on "FLDs on Oilseeds -Way Forward"	Hyderabad	27 June, 2016	Dhiraj Singh, A.K.Sharma
13.	ICAR-DAC meeting on enhancing the preparedness of Agricultural Contingencies for Rajasthan: Kharif 2016	Jaipur	4 July, 2016	V.V. Singh

14.	Bureau of Indian Standard (BIS), Technical Textiles for Agro Tech Sectional Committee (TX 35) meeting	SASMIRA, Mumbai	21 July, 2016	Pankaj Sharma
15.	23rd Annual Group Meeting of AICRP-RM	DUVASU, Mathura	05-07 August, 2016	Director and Staff
16.	Zonal workshop of KVKs of zone VII for cluster demonstrations on pulses and oilseeds	RVSKVV, Gwalior	10-11 August, 2016	Pankaj Sharma
17.	11th Annual Review Meeting of ICAR Seed Project	GBPUAT, Pantnagar	17-18 August, 2016.	Bhagirath Ram
18.	Eleventh Oils and Oilseeds Sectional Committee, FAD 13	Bureau of Indian standards, (BIS) New Delhi	Sept 02, 2016	Anubhuti Sharma
19.	XXIV meeting of ICAR Regional Committee	Jodhpur	12 -15 September, 2016	Dhiraj Singh
20.	National symposium on Challenges to Plant Pathologists under changing Disease Scenario	Goa University, Goa	5-7 October, 2016	Pankaj Sharma
21.	Accelerated Breeding using Doubled Haploid (DH) technology	ICAR, New Delhi	17-18 October, 2016	Dhiraj Singh, V.V. Singh
22.	Inter-Session Meeting of 'Consultative Committee of the Ministry of Agriculture & Farmers Welfare"	ICAR, New Delhi	25 October, 2016	Dhiraj Singh
23.	1st International Agro biodiversity Congress	New Delhi	6-9 November, 2016	Dhiraj Singh, P.K. Rai, V.V. Singh, K.H. Singh, M.S. Sujith K.
24.	Global Rajasthan Agriculture Meet- 2016 (GRAM)	Jaipur	9-11 November, 2016	Dhiraj Singh, Pankaj Sharma Arun Kumar H.S. Meena,
25.	Review meeting of ICAR Extramural project on Pre-breeding for Genetic Enhancement of Ethiopian and Indian mustard Gene Pool	Krishi Bhawan, New Delhi	18 November, 2016	K.H. Singh
26.	Review meeting of Extramural research projects	ICAR, Krishi Bhawan New Delhi	18 November, 2016	Pankaj Sharma
27.	Brain storming workshop on Converging Liquid Fertilizer/Fertigation with Conservation Agriculture	Ludhiana	19 November, 2016.	Dhiraj Singh V.V. Singh
28.	4th International Agronomy Congress on Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge	ICAR-IARI, New Delhi	22–26 November, 2016	R.S. Jat, Harvir Singh
29.	Regional Agricultural Fair (RAF-2016)	Muzaffarnagar (UP)	28-30 November, 2016	Dhiraj Singh, H.S. Meena
30.	International conference on Nutraceuticals and functional foods- The challenges and opportunities	Anand Agricultural University, Anand	6-8 December, 2016	Anubhuti Sharma, M.S. Sujith Kumar, Ibandalin Mawlong

Dr. Ashok Kumar Sharma, Principal Scientist (Agriculture Extension), received Best Scientist Award by ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur for better linkages

and coordination with farmers and extension personnel during the year 2015-16 on the occasion of 23rd foundation day of ICAR-DRMR on Oct. 20, 2016. He also received FSRMR Award by Society of Rapeseed-Mustard Research, Bharatpur for significant contribution in advancement of rapeseed-mustard research and development in "3rd National Brassica Conference" organized by Society of Rapeseed-Mustard Research in collaboration with IARI, New Delhi during 16-18 Feb. 2017 at IARI, New Delhi.

Dr. Bhagirath Ram, Senior Scientist (Genetics and plant breeding), received Best Poster Awardin "International Seminar on Oilseed Brassica (ISOB)", held at Jaipur during Feb 23-27, 2017.

Dr. R.S. Jat, Senior Scientist (Agronomy), received Best Scientist Award from ICAR-DRMR, Bharatpur for new initiatives in mustard mechanization and seed production and overall growth of ICAR-DRMR during the year 2015-16 on the occasion of 23rd foundation day of ICAR-DRMR on Oct. 20, 2016 and He also received Outstanding Scientist Award foroilseed brassica mechanizationin "International Seminar on Oilseed Brassica (ISOB)", held at Jaipur during Feb 23-27, 2017.

Dr. Anubhuti Sharma, Senior Scientist (Biochemistry), received Young Scientist Award for innovative work in the field of Biochemistry and Best Poster Presentation Award on secondary metabolites in oilseed crops at National Conference on "Advances in Global Research in Agriculture and Technology" organized by Society of Human Resource and Innovation at Agraduring February, 11-12, 2017.

Dr. Ibandalin Mawlong, Scientist (Bio-chemistry), received SESR Young Scientist Award in the international conference on "Green technology on health and environment: implementation and policies" Bengaluru during Dec 15-16, 2016.

Dr. M.S. Sujith Kumar, Scientist (Bio-chemistry), received Best Scientist Award for contributions to PME cell on 23rd Foundation day, ICAR-DRMR, Bharatpur on October 20, 2016.

Dr. Mukesh Meena, Scientist (Soil Science), received 3rd best oral presentation prize in "3rd National Brassica Conference" held at ICAR-IARI, New Delhi during February 16-18, 2017.

Dr. Harvir Singh, Scientist (Agronomy) received Best Oral Presentation Award in "3rd National Brassica Conference" held at ICAR-IARI, New Delhi during February 16-18, 2017.

Appreciation award for contribution towards the International seminar on oilseed brassica (ISOB) organized by ICAR- DRMR & SIAM held at Jaipur from 23rd- 26th February 2017 were given to Dr. V.V. Singh, Principal Scientist (Genetics and Plant Breeding), Dr. K.H Singh, Principal Scientist (Genetics and Plant Breeding), Dr. Ashok Kumar Sharma, Principal scientist (Ag. Extension), Dr. Anubhuti Sharma Senior Scientist (Bio-chemistry), Dr. M.S. Sujith Kumar, Scientist (Bio-chemistry).

6 Linkages and Coordination

3rd National Brassica Conference (NBC 2017)

The 3rd National Brassica Conference on "Enhancing Oilseed Brassica Production Through Climate-Smart Technologies" was organized by the Society for Rapeseed-Mustard Research, Bharatpur in collaboration with ICAR-Indian Agricultural Research Institute, New Delhi during February 16-18, 2017 at the Dr. B. P. Paul auditorium of IARI, New Delhi. Oilseed Brassica researchers from different parts of the country gathered to discuss their research contributions in the area of Brassica Production Through Climate-Smart Technologies.

The conference was inaugurated by Dr Mangla Rai, Former Secretary, DARE & DG, ICAR as the Chief Guest highlighted on the climate change has far reaching consequences for national food and nutritional security. Like other winter crops, rapeseed-mustard crops are going to be impacted strongly due to rising average temperature and early onset of temperature. He expressed the need to bridge the large gap in demand and supply, since we are importing edible oil worth about Rs. 80,000 crores per annum recently. He expressed that food security is incomplete without nutritional security.

Dr. V. L. Chopra, Former Secretary, DARE & DG ICAR, the Chairman of function, called for enhanced interdisciplinary research and science-based actions to improve climate resilience of rapeseed-mustard crops.

In his presidential address, Dr. Arvind Kumar put forth the scenario of oilseed in India and shown the concern for huge import of edible oil, he emphasized for the overall development of the crop including hybrid development, yield improvement, developments in biotic and abiotic stress tolerance and extension activities. He expressed that the challenge ahead is to double the production in next decade in changing climate scenario with limited scope for area expansion.

The conference were graced by renowned rapeseed-mustard researchers from India including Dr. Deepak Pental, former Vice Chancellor, DU, New Delhi; Dr. S.S. Banga, ICAR-National Professor, PAU, Ludhiana; Dr. C. Chattopadhyay, Vice chancellor UBKV, Coonch Behar; Directors from different ICAR institutes and from abroad Dr. David Edwards, Prof. Jacueline Batley, University of Western Australia, Crawley, Australia; Dr. Muhammad Habibur Rahman, University of Alberta, Edmonton, Canada; Dr. Yong Pyo Lim, Chungnam National University, Daejeon, Korea; and Dr. Martin Barbetti, University of Western Australia.

Chairperson of the Valedictory function, Secretary, DARE and DG (ICAR), Dr. T. Mohapatra, in his address, asked the house to cut-down the oil imports by increase the production of mustard in the country. He pointed out that to improve the mustard production the rice fallow land should be used for cultivation of mustard and replace the *Brassica rapa* genotypes by *Brassica juncea* genotypes specially from North-East region of India. He emphasized on the re-organization of breeding programs to address the heat stress in present scenario, using the wild species specially *Brassica tournefortii*,

Brassica carinata and need basic research to tackle the other stresses. He also suggested to constitute a panel of *Brassica* crop specialists to discuss the breeding priorities and to refine the recommendations along with well defined action plan, which can subsequently be provided to GOI for consideration and further support so that we can target India self-sufficient in edible oil without any burden on imports which otherwise country is facing today and in the yesteryears.

In his concluding remarks, Chief Guest, Padm Bhushan Prof. R.B. Singh, Chancellor, Central Agricultural University, Imphal, expressed his satisfaction that country is safe in the hands of experienced, young scientists and students working and contributing in crop Brassica. He urged the house that breeding program should be chalked-out to improve the crop improvement program by developing more genetic resources. He called the scientific forum for combining the "Science with human face" to develop Brassica varieties with resilience with whole hearted accountability and responsibility to double the farmers' income. He called for reinventing the priorities required under climate change perspective so that a national plan may chalked –out by which nation can achieve self-sufficient edible oil status in a targeted decade period. Session ended with a formal vote of thanks by Dr. D.K. Yadav, Organizing Secretary of NBC-2017.

Chief Guest and Chairperson of the Valedictory function along with dignitaries on the Dais awarded the participants with prizes: oral and poster presentation on different themes; best M.Sc., best Ph.D. thesis award, Dr. P.R.Verma Award, Fellowship and Honorary Fellowships of SRMR, Dr. P. R. Kumar Outstanding Brassica Scientist Award and prestigious Life Time Achievement Award for their overall contributions towards rapeseed-mustard research and development.

In different sessions, besides the lead presentations by the eminent speakers from India and abroad, there were more than 250 posters received from the delegates across the country including various international organizations were presented.

International Seminar on Oilseed Brassica (ISOB)

ICAR-Directorate of Rapeseed and Mustard Research (ICAR-DRMR) in collaboration with State Institute of Agriculture Management (SIAM), Government of Rajasthan organized the International Seminar on Oilseed Brassica (ISOB 2017) during 23-27 February 2017 at SIAM, Jaipur to bring together the researchers, extension people, farmers and other Brassica stakeholders. The ISOB was inaugurated in the auspicious presence of the Chief Guest, Dr. PrabhuLal Saini, Hon'able Minister of Agriculture, Government of Rajasthan; Chairman, Dr. J.S. Sandhu, DDG (CS), ICAR, New Delhi, and Guest of Honour, Dr. Neel Kamal Darbari, Principal Secretary, Agriculture. Government of Rajasthan; Dr. Shital Sharma, Director, SIAM; Dr. P. K. Rai, Director, ICAR-DRMR.

Dr. Prabhu Lal Saini, in his inaugural address spoke about the contribution of rapeseed-mustard in oil economy and expressed his happiness that Rajasthan is a leading state in area as well as production of mustard in the country. He highlighted that Rajasthan has great potential to bring more area under mustard cultivation due

to its large agro biodiversity and ecosystem variability and to christen as 'Mustard State' in the country. He stated that this is a unique and first of its kind seminar in the country where a conglomeration of scientists, development agencies and farmers gathered together on a common platform to solve the constraints faced by famers and plan future roadmap. He emphasized that scientist engaged in rapeseed-mustard research should focus not only productivity but also product quality parameters in the emerging challenges of climate change, shrinking natural resources and declining soil health. Dr. J.S. Sandhu highlighted the current status and future developments in rapeseed-mustard production and nutritional security in India and emphasized more focused approach to enhance the production with reducing cost of production. Dr. Neel Kamal Darbari expressed her views on rapeseed-mustard productivity, quality and trade status and mentioned to take steps in policy reforms to enhance the production and export. Dr. P.K. Rai, Director, ICAR-DRMR, Bharatpur expressed his views on present research trends in rapeseed-mustard in the country and presented the vote of thanks to participants and dignitaries in the inaugural function.

The ISOB delivered on 5 main themes; genetic enhancement, crop management, plant protection, quality, nutrition and processing, trade policies and technology dissemination including one day exposure/field visit at ICAR-DRMR, Bharatpur. The ISOB was attended by about 450 delegates including research scholars and farmers. The eminent speakers during the seminar were Dr. Katarzyna Mikolajczyk, GCIRC, Poland, Dr. Dhiraj Singh, Dr. G.S. Saharan, Dr. M. Premjit Singh and Dr. M.L. Jat. Other dignitaries present during the seminar and chaired/Co-chaired different technical sessions were Dr. Sian Das, Dr. S. Jambholkar, Dr. Chittaranjan Kole, Dr. Abha Agnihotri, Dr. P.S. Rathore, Dr. V.K. Singh, Dr. A. Pouzet, GCIRC, France andDr. Rodney Mailler, GCIRC, Australia. The Seminar was ended with the valedictory function in the presence of Chief Guest Shri Ambrish Kumar, Director of Agriculture, Government of Rajasthan and Chairman Dr. S.K. Chaturvedi, ADG, Oilseeds (Acting), ICAR, New Delhi.

The significant outcomes of the seminar were also presented by Dr. P.K. Rai in the concluding session. He also narrated the future road map of Brassica in the country through development of varieties tolerant to biotic and abiotic stresses, commercialization of hybrids in different agro-climatic zones, integration of genomics, transcriptone, MAS in breeding programmes to break the yield barriers, mechanization and quality improvement.

ICAR-DRMR-IARI collaborative National Extension programme

Under the programme, ten demonstrations on 2 improved varieties viz. HD 2967 and HD 3086 of wheat developed by IARI, New Delhi were conducted in different villages of Bharatpur and Alwar district of Rajasthan to assess the performance of newly released varieties at farmers' field. All the demonstrated wheat varieties had higher yield of 20-25 per cent than the prevailing varieties. All the farmers appreciated the performance of demonstrated varieties and were motivated to wider dissemination of these varieties in their areas.

7 All India Coordinated Research Project on Rapeseed-Mustard

Twenty-third Annual Group Meeting of AICRP on Rapeseed-Mustard was successfully organized by ICAR- Directorate of Rapeseed-Mustard Research, Bharatpur during August 5-7, 2016 at U.P Pandit Deen Dayal Upadhyaya Pasu Chikitsa Vigyan Viswavidyalaya evam Go-Anusandhan Sansthan (DUVASU), Mathura. Dr. K.M.L. Pathak, Vice-Chancellor, DUVASU, Mathura presided over the inaugural session. Dr. J.S. Sandhu, DDG(CS), ICAR, New Delhi was the Chief Guest of the function. Dr. B.B. Singh, ADG (OP), ICAR, New Delhi and Dr. Saravjeet Yadav, Director Extension, DUVASU, Mathura also graced the occasion. Dr. Dhiraj Singh, Director, ICAR-DRMR, Bharatpur, formally welcomed the dignitaries and participants. He presented Project Coordinator's report and emphasized that increase in population and per-capita consumption of edible oils has burdened the national exchequer. India is now importing more than 50% of total edible oils consumed in the country. Biotic stresses, especially *Sclerotinia* rot and *Orobanche*, and aboitic stresses along with growing conditions continuously challenging the production systems. He presented a detailed state-wise productivity status of mustard crop and suggested measures to improve it beyond present level. Dr. B.B. Singh, ADG (OP), ICAR, New Delhi suggested that there is need to change the breeding programme and approaches as per the emerging challenges. The yield potential of the varieties need to be relooked and mustard hybrid programme should be strengthen in the country for achieving larger genetic gains. He emphasized on the need of bringing the non-conventional areas, especially the rice fallows and peninsular region of the country, under mustard cultivation.

Dr. J.S. Sandhu, DDG(CS), ICAR, New Delhi emphasized the importance of oilseed and pulse crops to the national food security and economy and asked the Scientists to critically examine and correct the gaps which are impeding oilseed productivity. Technological interventions such as hybrids, varietal replacement and management options, crop management practices, quality seed production, diseases and *Orobanche* management are very critical for improving mustard production and productivity in the country. Varieties resistant to heat and frost are very important in stabilizing the yields. He advised having a focused programme on development and refinement of hybrid technology. The Chairman of the Session Dr. K.M.L. Pathak, Vice-Chancellor, DUVASU, Mathura, in his address expressed his desire to cooperate with Crop Science Division of ICAR, New Delhi on common issues. He agreed to provide required facilities for mustard seed production in this university. On this occasion, four publications were released by the dignitaries. Best performing centre awards were presented to CCSHAU Hisar (Main Centre) and SKNCA, Jobner (Sub-centre) for 2015-16.

Twelve sessions including presentation of reports, wherein, all PIs presented the progress report of 2015-16 of their respective disciplines, technical programme formulation, technology dissemination and impact analyses, presentations in key areas, breeder seed production and plenary were held during the meeting. Technical programmes for the year 2016 -17 were formulated for various disciplines. In the session on presentation in key areas and panel discussion, three presentations were made and issues on the enhancement of heterosis, Sclerotinia management, Orobanche management, varietal replacement and GM crops were discussed. The session was chaired by Dr. J.S. Sandhu, DDG (CS), ICAR and panelist were Dr. B.B. Singh, ADG (OP), ICAR; Dr. Sain Das, Ex- Director, DMR; Dr. M.L. Jat, Agronomist, CIMMYT; Dr. G.S. Saharan, Ex-Prof. & Head, CCSHAU, Hisar; Dr. Abha Agnihotri, Amity University. Dr. K.H. Singh,

Principal Scientist, ICAR-DRMR outlined the progress in enhancement of heterosis and hybrid development in rapeseed-mustard. Dr. J.S. Sandhu stated that the basic requirement for hybrid development is purity of parental lines. The Chaiman Dr. Sandhu suggested that pre-breeding material should also be utilized for hybrid development. He also suggested that all four centres involved in hybrid development should chalk out program jointly. Dr. B. B. Singh opined that heterosis exists in the mustard hybrids and there is a need to identify best heterotic combinations. Dr. Sai Das advocated about the maintenance of the purity of parental lines. Other panelists also expressed their viewpoints on various issues. Later on, Dr. G S Saharan delivered his talk on 'Terminology used in plant pathology'. Dr. Saharan elaborately defined and differentiated the terms like latent period – incubation period, infestation – infection, life cycle-disease cycle, disease intensity-disease incidence, sign-symptoms etc. Dr. Saharan also clarified horizontal and vertical resistance with many plant disease examples. Dr. Abha Agnihotri delivered her lecture on nutritional benefits of oilseed crops: rapeseed-mustard. She emphasized on the importance of edible oil for human nutrition, which is a major source of essential fatty acids and minerals. She described different fatty acids, their production and another important constituents of oil i.e try glycerol etc. She also discussed on phenolics phytate, Vitamin A, tocopherols, phytosterols, canola quality. Dr. H. Bassappa, Principal Scientist, IIOR delivered his talk on scope and strategies to enhance rapeseed-mustard production in southern India. He discussed the front line demonstrations conducted in Telangana, Andhra Pradesh, and Karnataka and mentioned that the varietal demonstrations of different varieties particularly that of NRCHB 101 conducted at IIOR, Hyderabad were very impressive. Timely sown crop can produce good yield as compared to the late sown. He suggested that a large number of demonstrations should be conducted in potential districts for enhancing access to quality and high yielding seed, support with all production technologies. He stressed upon the development of short duration, terminal heat tolerance and good agronomic practices for rapeseed mustard production in southern India.

The Variety Identification Committee of AICRP on Rapeseed -Mustard was held on 05.8.2016 under the Chairmanship of Dr. J.S. Sandhu, DDG (CS). A total of 6 proposals of Indian mustard (*Brassica juncea*) viz., CS 11000-1-2-2-3, CS 15000-1-2-2-3, Albeli 1, RH 749, NRCHB 101 and PRO 5111 were submitted to the Committee. The committee identified three strains (CS 11000-1-2-2-3, RH 749 and NRCHB 101) of Indian mustard for release under different agro-ecological conditions. More than 170 scientists/ personnel associated with rapeseed-mustard research and development in the country participated in this meeting. With the plenary session chaired by Dr. B.B. Singh, ADG (OP), ICAR, the meeting was successfully concluded on 7th August 2016.

The following actions were suggested for implementation:

- Trial for timely sown irrigated conditions shall be conducted at 45 cm row to row and 15 cm plant to plant spacing in Zone II
- IVT shall be conducted in six rows of 5-meter length. Similarly, advanced trials shall have 10 rows of 5-meter length instead of nine.
- The appropriate time of conduct of timely sown trails in Zone V shall be from 15 October to 15 November.
- It was also decided that RAU, Dholi centre shall now be considered in Zone III in place of Zone V.
- The length of a row in NEH region shall be 4 meters but a number of rows shall be increased from 6 to 7 in IVT and from 10 to 12 in AVT.
- The data upon sterility/ fertility in hybrid trial shall be recorded by selfing at least 20 plants in boarder rows in each replication.

- In toria, few seeds of Tora type material shall be shared by Director, DRMR with all centers involved in toria improvement programme for its use in heterosis breeding.
- It was decided that each centre shall submit a monthly report of the conduct of trials with appropriate data and photograph.
- Data of plant stand shall be reported within 40 days after sowing.
- Screening for the high temperature at seedling stage under field conditions the material should be provided by August end or at the first week of September.
- The promising genotypes that show consistent results during the last 2 years will be tested for the third year.
- A new experiment on the foliar application of growth regulating substances has been formulated.
- For quality experiments in biochemistry, two checks will be taken, quality and national checks.
- Those centers which do not have sufficient facilities regarding GC can perform their analysis at DRMR, Bharatpur. Only whole package demonstrations with latest release varieties should be conducted to show the greater impact of developed technologies.
- At least 70 percent of recently released varieties of the zone must be included in FLDs by each centre other than its own centers. The required seed may be obtained by respective university/institute.
- In zone V, 50 per cent FLDs are to be conducted with yellow sarson
- Concerted efforts should be made to replace the older varieties of rapeseed- mustard with the recently released ones.

The following recommendations were made on the basis of multi-location experimentation at various centers:

- Foliar spray of Mancozeb 0.2% followed by Propiconazole 25 EC @ 0.05% was found most effective in controlling WR, SR, ABL, and ABP.
- Foliar spray of mancozeb @ 0.2% was found most effective for the management of powdery mildew followed by Mancozeb 0.2% + followed spray of Hexaconazole 25 EC @ 0.05%.

Identified three strains of Indian mustard for release under different agro-ecological conditions

Name of Variety	Organization	Average Seed Yield (kg/ha)	Maturity duration (days)	Mean Oil Content (%)	Salient features	Recommended for the states
Indian mustard (*Brassica juncea*)						
CS 1100-1-2-2-3	CSSRI Karnal	1734-2168	128-142	38.5-39.5	Salinity tolerant	Salinity affected areas of mustard growing regions of country
RH 749	CCS HAU, Hisar	1906-2463	123-142	39.1-40.3	Suitable for timely sown irrigated conditions	Timely sown irrigated conditions of zone III (UP, Uttarakhand, Madhya Pradesh and eastern Rajasthan)
NRCHB 101	ICAR-DRMR, Bharatpur	1178-1262	111-114	39.4-40.6	Suitable for rainfed conditions after harvest of paddy	rainfed conditions of zone V (Asom, Bihar, Orissa, West Bengal, Jharkhand, and the NEH States

8 Publications

Research papers

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9 Research Programmes and Projects

Institute Research Projects

Name of Programme	Project Code	Leader/PI
Programme 1. Genetic enhancement for stress tolerance in Indian mustard		**V. V. Singh**
Breeding for high yield and oil content under normal and moisture stress condition	DRMR CI-10	V. V. Singh
Widening of gene pool in *Brassicas* through interspecific and intergeneric hybridization	DRMR CI-12	Arun Kumar
Breeding for earliness and high temperature tolerance in Indian mustard	DRMR CI-14	Bhagirath Ram
Re-synthesis of Indian mustard (*Brassicajuncea* L. Czern. &Coss.) through inter-specific hybridization	DRMR CI-15	H. S. Meena
Programme 2. Designer Brassica for oil quality		**V. V. Singh**
Genetic Enhancement for quality traits in Indian mustard (*Brassicajuncea* L.)	DRMR CI-13	Priyamedha
Proteomics studies in oilseed Brassica*Brassicajuncea* L.)	DRMR B-7	IbandalinMawlong
Screening of oilseed Brassica germplasm for value addition.	DRMR B-8	M. S. Sujith Kumar
Quantitative and qualitative estimation of glucosinolates and fatty acids in Oilseed Brassica	DRMR B-9	Anubhuti Sharma
Programme 3. Breeding for yield and quality enhancement in rapeseed-mustard		**K. H. Singh**
Development of hybrids in Indian mustard (Brassica juncea)	DRMR CI–5	K. H. Singh
Programme 4. Oilseed *Brassica* genetic resource management		**Arun Kumar**
Oilseed *Brassica* Genetic Resource Management	DRMF CI 06	Arun Kumar
Programme 5. Biotechnological interventions to improve rapeseed-mustard productivity		**Ajay Thakur**
Enhancing the level of resistance/tolerance against *Alternaria blight* in Indian mustard (*Brassica juncea L. Lzerh&cos*) using biotechnological approaches.	DRMR BT-1	Ajay Thakur

Programme 6. Enhancing resource use efficiency and abiotic stress management for resilient rapeseed-mustard production system		**O. P. Premi**
Enhancing Soil resilience under mustard based systems through integrated crop management	DRMR CP-6	O. P. Premi
Sustainable Intensification of Brassica Production System (SIBPS)	DRMR CP-16	R.S. Jat
Role of micro and secondary nutrients and their fortification on rapeseed-mustard productivity and quality	DRMR CP-17	Mukesh Meena
Growth and yield response to plant density and stage of transplanting in Indian mustard	DRMR CP-18	HarVir Singh
Programme 7. Management of biotic stresses in Indian mustard		**P. K. Rai**
Management of Sclerotinia rot in Rapeseed-Mustard	DRMR PP-1	Pankaj Sharma
Management of *Alternaria* Blight in Rapeseed-Mustard	DRMR PP-3	P. D. Meena
Epidemiology and management of white rust	DRMR PP-5	P. K. Rai
Programme 8. Technology assessment and dissemination		**Ashok Kumar Sharma**
Development of application software for rapeseed-mustard information management	DRMR CA-1	Vinod Kumar
Participatory extension for dissemination of rapeseed-mustard technology	DRMR TAD–4	Ashok Kumar Sharma

Externally Funded Projects

Name of Project	Project Code	PI/Leader
Characterization of rapeseed-mustard varieties for distinctness, uniformity and stability (DUS) testing	DRMR EA-2	Priyamedha
ICAR seed project on seed production in agricultural crops	DRMR EA-4	Bhagirath Ram
Development of a core set of SSR markers for characterization of *Brassica juncea* varieties and germplasm	SB/YS/LS-86/2014	A. K. Thakur
Induced Mutagenesis for Isolation of Alternaria blight resistant mutant in *Brassica juncea*	DRMR EA-9	P. D. Meena
Gramin Krishi Mausam Sewa	DRMR EA-8	O. P. Premi
Development of white rust resistant mustard genotypes with high oil quality	DRMR EA-16	V. V. Singh
Study on *Sclerotinia sclerotiorum* with emphasis on management of Sclerotinia rot in Brassica	DRMR EA-10	Pankaj Sharma
Frontline demonstrations and other related activities of Oilseeds	DRMR NMOOP-1	A. K. Sharma
CRP on Hybrid technology (Indian mustard component)	DRMR EA-11	K. H. Singh
Pre-breeding for Genetic Enhancement of Ethiopian (*Brassica carinata*) and Indian Mustard (*B. Juncea*) Gene Pool	DRMR EA-12	K.H. Singh
XII Plan Scheme National Agriculture Innovation Fund/ Intellectual Property Management and Technology Transfer/ Commercialization of Agriculture Technology.	DRMR EA-13	Vinod Kumar
Incentivizing research in agriculture-Indian mustard	DRMR EA-14	V.V. Singh
CRP on Molecular breeding for improvement of tolerance to biotic (white rust/stem rust) and quality traits (low erucic acid and glucosinolate) in mustard	DRMR EA-15	V.V. Singh

10 IRC, QRT and RAC Meetings

Institute Research Council (IRC)

ICAR-DRMR organized its 26th Institute Research Council (IRC) meeting during August 30-31, 2016 under the Chairmanship of the Director of ICAR-DRMR. The individual scientist presented progress of project work done during year 2015-16 and proposed technical program for the year 2016-17. Dr. Sain Das, former Director of Directorate of Maize Research, was the special invitee.

The chairman called on all the scientists for building inter-disciplinary linkages and to make joint efforts for rapeseed-mustard research development in the country. He emphasized that research quality should be improved and every scientist must evaluate their activities in the context of resources and their personal capability.

Dr. Sain Das expressed satisfaction on overall progress made by the scientists of the Directorate and said that efforts should be made to provide the quality seeds of improved varieties to the farmers.

The IRC expressed satisfaction with the progress made under various projects during 2015-16 and approved the technical program for 2016-17.

QUINQUENNIAL REVIEW TEAM (QRT) submitted report to ICAR

QRT report of ICAR-DRMR/AICRP-RM (2010-2015) was submitted to ICAR on August 23, 2016 by Dr. B. L. Jalali, Chairman, QRT. Dr B. L. Jalali and Dr. Dhiraj Singh, Director, DRMR briefed to DDG (CS) and Hon'ble Secretary DARE & DG, ICAR about major QRT recommendations. The QRT was constituted vide office order F.No. CS.11/10/2009-IA.III dated 5th August, 2015. During the process of visits to various centres, the QRT interacted with Vice Chancellors, Dean/Directors, HODs, Scientists from ICAR-DRMR & AICRP-RM centres, State Department officers, KVK staff, NGOs and farmers. The team visited six major coordinated centres besides DRMR, Bharatpur.

Meeting of the Research Advisory Committee

The 19th Meeting of the Research Advisory Committee was held onDecember 24, 2016 under the chairmanship of Dr. J S Sandhu, DDG (CS), ICAR, New Delhi. The other members were Dr. M. L. Jat, CIMMYT-CCAFS South Asia Coordinator, CIMMYT, New Delhi; Dr. R.S. Malik, Ex-Principal Scientist, Division of Genetics, IARI, New Delhi; Dr. Dhiraj Singh, Director, DRMR, Bharatpur and Dr. V.V. Singh, Principal Scientist, DRMR, Bharatpur. In his introductory remarks, Dr. J.S. Sandhu, Chairman appreciated the efforts of the Directorate in taking new initiatives. While visiting the field experiments, Chairman mentioned that the experimental fields are well maintained, agronomical experiments are quite new and good variability has been generated for important traits. He said that pre-breeding material is the backbone of the new variability of future needs and changing climatic conditions. Therefore, breeders should look for new traits in germplasm. Dr. M. L. Jat said that research on rain-fed part should be strengthened. Dr. R.S. Malik, Member, RAC asked scientists to work more on hybrids and enhancing yield levels of quality varieties.

Dr. Dhiraj Singh, Director ICAR-DRMR presented New Initiatives at ICAR-DRMR and research highlights for the year 2015-16. RAC appreciated the efforts and achievements since the last RAC meeting. Dr. V V Singh, Member-Secretary presented Action Taken Report on the recommendations of the 18th RAC held on Feb 19, 2016. Research highlights of all the research units of DRMR in their respective areas and technical programs of the current season was presented by unit In-charges. After an extensive discussion and interaction, suitable recommendations were made.

11 Tribal Sub-Plan

ICAR-DRMR, Bharatpur implemented Tribal Sub-Plan during 2016-17 in collaboration with 4 SAUs viz. AAU, Jorhat (Assam); CAU, Imphal (Manipur); BAU, Ranchi (Jharkhand) and RVSKVV, Gwalior (Madhya Pradesh) to augment rapeseed-mustard production through capacity building, exposure visits, organizing field days/ kisan diwas, on and off-campus trainings, farmer participatory varietal selection / front line demonstrations, providing farm implements, developing rain water harvesting structures, etc. in selected tribal dominated district of jurisdiction area of respective universities for the sustainable livelihood security of tribal farmers. On farm demonstrations of rapeseed-mustard crop in 96.6 ha. area in project area of Assam, 120 ha. area of Jharkhand, 60 ha. area of Madhya Pradesh and about 552 ha area of North Eastern States (Manipur, Meghalya, Mizoram & Arunachal Pradesh) have been laid out during 2016-17. Besides, one 3 days training-cum- exposure visit to ICAR-DRMR was also organized in collaboration with RVSKVV, Gwalior during 13-15 December 2016 for capacity building of the 31 tribal farmers of Jhabua district of MP for dissemination of scientific technology of rapeseed-mustard among them.

5th TSP Workshop held at CAU, Imphal, Manipur

A two-day 5th TSP workshop was organized by ICAR- Directorate of Rapeseed- Mustard Research, Bharatpur in collaboration with Directorate of Extension Education, Central Agricultural University, Imphal, Manipur at the DEE, CAU, Imphal during May 16- 17, 2016. The 2 days workshop was inaugurated by Prof. M. Premjit Singh, Hon'ble Vice-Chancellor, Central Agricultural University, Imphal, Manipur and chaired by Dr. Dhiraj Singh, Director, ICAR-DRMR, Bharatpur.

Hon'ble Vice-Chancellor, Prof. M. Premjit Singh spoke about the vision of Hon'ble Prime Minister, Shri Narendra Modi to make north-eastern organic states. He also stated the importance of the practice of zero tillage rapeseed mustard cultivation started only with 100 ha. area and now it was practiced in the area of more than 1000 ha. He said that farmers in Manipur were becoming more aware of the process of zero tillage mustard cultivation and it was the responsibility of all concerned to educate the farmers about the scientific cultivation of rapeseed-mustard to harness the full potential of the crop and enhancing the income of the farmers especially tribal farmers of north-eastern states. He also stressed on promoting integrated farming system by raising honey bee production with rapeseed-mustard cultivation simultaneously for the greater benefit of the farmers.

Dr. Dhiraj Singh, on the occasion, said that income enhancement and capacity building of the farmers should be our prime goal. A number of suitable technology and varieties for increasing production of rapeseed-mustard have been developed by the scientists. Now they should reach to the farmers. We must develop the confidence of the farmers for adoption of scientific practices. He stated that tribal sub plan had provided an opportunity for capacity building of tribal farmers. The rapeseed-mustard crop is more remunerative than other crops in rice-fallow cropping pattern under resource constraint condition, therefore, there is the tremendous scope of adoption of rapeseed-mustard cultivation in north-eastern states, he opined. Dr. Singh also emphasized that budget should be used judiciously and strictly only for the activities that directly benefit to the tribal farmers.

On the occasion, the guest of honour Dr. GN Hazarika, Director of Research, AAU, Assam gave a presentation on "Role of AAU in the development of tribal farmers". He also emphasized the importance of rapeseed-mustard crop in Assam state and said that concerted efforts were being made to popularize the rapeseed-mustard crop and covering more area under the crop to fulfill the demand of edible oil.

Dr. Ashok Kumar Sharma, Sr. Scientist, ICAR-DRMR & Nodal Officer, TSP gave a presentation on "Benefits of tribal farmers through the adoption of agriculture technology with special reference to the rapeseed-mustard under tribal sub-plan". He also presented an overview of the work done during last 5 years by collaborating universities under TSP. Thereafter, the progress reports of TSP made during 2015-16 were presented by Nodal Officers/ Team leaders of the respective collaborative universities.

The annual plan for TSP 2016-17 was presented by respective universities and after through discussion, MoUs with participating universities were finalized for implementation of TSP programme during 2016-17. On the second day, all the participants visited research farm of Central Agricultural University at Andro, Imphal East. Participants interacted there with beneficiary tribal farmers under TSP. They also visited oil expeller established at KVK, Andro and different demonstration units, besides research trials.

The 2 days workshop was attended by Dr. Niva Bara, Deputy Director of Extension, BAU, Ranchi; Dr. Renuka Devi, Dr. Nandani, Dr. Robindro, from CAU, Imphal; Dr. IS Tomar, Incharge, KVK, Jhabua, RVSKVV, Gwalior; Dr. Dhiren Chowdhury, Senior Scientist, RARS, AAU, Assam; Dr. Ashok Sharma and Dr. Pankaj Sharma, Sr. Scientist, ICAR-DRMR along with other team members working in TSP programme of respective universities, besides CAU scientists and staff.

TSP activities conducted during 2016-17 by CAU, Imphal (Manipur)

ICAR- Directorate of Rapeseed-Mustard Research, (DRMR), Bharatpur and Directorate of Extension Education, Central Agricultural University, Imphal, Manipur collaboratively implemented a Project entitled" Augmenting Rapeseed-Mustard Production of Tribal Farmers of NE States for Sustainable Livelihood Security" in rice fellow during rabi 2016-17. During the period, the historical data collection and KAP (Knowledge, Attitude & Practice) survey of the farmers in the project site were undertaken and depending on the moisture condition in the field as well as suitability of the field, three methods of traditional zero tillage cultivation of rapeseed – mustard, i.e., i) As relay crop, ii) Sowing seeds after burning straw, and iii) Sowing seeds and straw mulching are generally practiced by the farmers of the project site. Based on the available indigenous technical knowledge, an appropriate location specific Improved zero tillage cultivation of rapeseed - mustard was developed by the project team.

Taking into consideration of the water scarcity during rabi season, zero tillage cultivation in residual soil moisture of rice fallow was demonstrated in 552 ha covering 6 (six) districts of Manipur 1 (one) district of Arunachal Pradesh, 1(one) district of Mizoram and 1 (one) district of Meghalaya by using 3 (three) toria varieties, M-27, TS-38 and TS-36 and 1 (one) variety of yellow sarson, YSH-401 and 2 (two) varieties of Indian Mustard, NRCHB-101 & PM-28.

A total of 1380 farmers across 9 districts of North eastern Hill Region were involved in the project for on farm demonstration and participatory varietal selection:

Since there was no rain throughout the crop period during rabi, 2016-17, the average yield in all the rapeseed-mustard varieties was on an average. Under participatory varietal selection

trials, toria variety, TS-38 was grown in 33 ha across 7 (seven) villages in 3 districts of North-eastern Hill Region and the average yield was 6.1 q/ha with wide variation of yield from lowest 2.4 to highest 9.1 q/ha. Similarly, toria variety, M-27 grown in 317 ha across fifteen villages in six Districts of North-eastern Hill Region gave average yield of 6.3 q/ha (2.4 to 12.0 q/ha) and TS-36 grown in 8 ha in two villages covering two districts of Manipur gave average yield of 6.3 q/ha (2.7 to 9.1 q/ha). Yellow sarson, YSH-401 grown in 32 ha in two villages of Imphal West, Manipur and South West Garo of Meghalaya gave average yield of 6.5 q/ha (3.3 to 10.4 q/ha). The Indian mustard, NRCHB-101 grown in 41.5 ha across 4 villages in three districts of Manipur gave the highest average yield of 7.1 q/ha (3.3 to 11.3 q/ha) and another mustard variety, PM-28 grown in 119.5 ha across 5 villages of three district of Manipur gave the average yield of 6.8 q/ha (2.5 to 10.4 q/ha).

Under the water stress situation where there was no rainfall during the crop period, TS-36 among toria varieties, YSH-401 of yellow sarson and NRCHB-101 among mustard varieties gave maximum average yield of 6.4, 6.5 and 7.0 q/ha, respectively under zero tillage cultivation. This indicates that rapeseed-mustard is a climate resilient crop which can be grown without water in the residual soil moisture condition. Since the cost of cultivation is very low in zero tillage cultivation, the improved version of this zero tillage cultivation with Bee pollination and no chemical method of plant protection may be recommended to the resource poor farmers of the North Eastern Region in the context of climate change.

Farmers were motivated towards improved zero tillage cultivation of rapeseed-mustard in rice fallow with non-chemical method of plant protection and bee pollination. The farmers of Manipur who cultivated rice crop only during Kharif with net profit of Rs. 12,000/ha realized this low cost technology with higher net profit of Rs. 19,996 /ha and Rs.20,896/-. Further the farmers who grow Indian mustard, NRCHB-101 could get more net profit of Rs. 21,946/- ha. Realizing the feedback from the progressive farmers, the University has decided that rapeseed-mustard production technology will be demonstrated in an area of 1000 ha during rabi, 2017 in North-eastern hill states. For increasing the productivity of rapeseed-mustard the farmers felt the need of water harvesting structures in farmers' field with micro-irrigation facilities for which the University has initiated action and trying for convergence with developmental departments. There is a high demand of consumers in the state on organic honey and pesticide free mustard oil produced by the farmers of the project site. The farmers of the North-eastern Hill Region realized the importance of beekeeping as subsidiary occupation and for increasing the crop productivity

TSP activities conducted during 2016-17 by AAU, Jorhat (Assam)

ICAR-Directorate of Rapeseed-Mustard Research, (DRMR), Bharatpur and Directorate of Research, Assam Agricultural University, Jorhat, Assam collaboratively implemented TSP Project entitled "Augmenting Rapeseed-Mustard Production of Tribal Farmers of Assam for Sustainable Livelihood Security" in two tribal dominated districts of Assam viz., Dhemaji and Karbi Anglong during 2016-17 through Regional Agricultural Research Station, Diphu to develop capacity building, on farm demonstration, dissemination of technology to the tribal farmers and thereby increasing the rapeseed production and productivity of the region.

Under the programme, the AAU conducted the 196 demonstrations on toria and Indian mustard in different villages of Dhemaji and

Karbi Anglong districts in an area of 96.6 ha covering 196 tribal farmers during 2016-17. The demonstrations were conducted under rainfed condition. The sowing was completed by 15th Nov, 2016. The toria varieties - TS-36 and TS-38 and a newly released short duration Mustard variety - NRCHB 101 along with local variety were used in the programme for demonstration

The demonstrated varieties out yielded the local popular varieties. The average productivity of demonstrated toria varieties - TS-36 and TS-38 and mustard variety - NRCHB 101 and local were 10.2 q/ha, 9.8 q/ha, 16 q/ha and 6.3 q/ha, respectively. The yield performance of the tested variety was much better than those used by the farmers in the neighbouring fields. In Dhemaji, it was observed that storing of pulses seed was very difficult because of heavy infestation of stored grain pests. Missing (tribal) farmers manage this problem up to 90-100% by storing pulse seed bags surrounded by the Rapeseed bags. In Karbi Anglong, it was observed that higher seed rate was generally used by farmers to compensate loses due to birds/pests attack. Thickly grown mustard seedling are sold as vegetables during thinning. Karbi farmers keep the seeds in gunny bags and store them in bamboo racks inside their house for future use and seeds remain free from the attack of insect pest and disease.

During the period, the participating farmers were also imparted training on modern techniques of raising toria and mustard under rice-fallow situation. Two on- farm trainings and one on-campus training were conducted that benefitted about 178 farmers. Besides, 2 field days and 7 scientist-farmers interactions were also organized that benefitted about 105 tribal farmers.

TSP activities conducted during 2016-17 by BAU, Ranchi (Jharkhand)

ICAR-Directorate of Rapeseed-Mustard Research, (DRMR), Bharatpur and Directorate of Extension Education, Birsa Agricultural University, Ranchi, Jharkhand collaboratively implemented TSP Project entitled "Capacity building and extension activities in the field of rapeseed-mustard in tribal region of Jharkhand under Tribal Sub-Plan for Scheduled Tribes" in three tribal dominated districts namely, Ranchi, Lohardaga and East Singhbhum during 2016-17. The basic objective of the project was to demonstrate improved proven technology of recently released, high yielding, bold seeded and disease resistant varieties. NRCDR-02 and NRCHB-101 were the varieties which were demonstrated in 120 ha area at 353 farmers field through BAU, headquarter & KVKs during the year under report (2016-17) to bring in enhanced application of modern technologies to generate yield data and collection of farmers' feedback.

Total area covered under demonstration were 60 ha, 40 ha and 20 ha in Ranchi, Lohardaga and East Singhbhum districts, respectively. All demonstrations were conducted either in rice-fallow or maize-fallow cropping systems in upland situation.

Two different varieties of mustard NRCDR-02 and NRCHB-101 along with prevailing farmers' variety Pusa Mahak were tested at farmers' field in three agro-climatic reason of Jharkhand. The result shows that mustard variety NRCHB-101 (13.82 q/ha) and NRCDR-02 (12.05 q/ha) found superior over Pusa Mahak (9.32 q/ha). Increase in yield over farmers' variety was 48.28%, and 29.29% in variety NRCHB-101 and NRCDR-02, respectively.

Altogether 11 field days/kisan gosthies were organized in Chipra, Panchdiha, Bhagalpur, Kudlong, Upper Tola, Dumdum Toli, Tamtam Toli villages of Ranchi district; Mundo and Bhakso villages of Lohardaga district and Lokeshra and Gorgora villages of East Singhbhum. Altogether 426 farmers participated in these field days/kisan gosthies during cropping season. Two On-campus training

programme were organized at KVK East Singhbhum in which 55 farmers participated. Two On-farm training programmes were organized at village Chipra of Ranchi district and village Baratpur of Lohardaga district in which 125 tribal farmers participated.

TSP activities conducted during 2016-17 by RVSKVV, Gwalior (Madhya Pradesh)

ICAR- Directorate of Rapeseed-Mustard Research, (DRMR), Bharatpur and Director of Extension Services, RVSKVV, Gwalior (MP) collaboratively implemented TSP project entitled "Augmenting Mustard Production of Tribal Farmers of Madhya Pradesh for Sustainable Livelihood Security in Jhabua district of Madhya Pradesh during 2016-17. During the period, 150 Demonstration were conducted in 60 hectare covering six blocks of Jhabua district viz., Thadala (Sutrethi, pachkheria, Panchpiplia) Rama (Chapari, Rotala, Gomala, Kokawad), Jhabua (Dhewar, Dewjhiri) Ranapur (Bhurimati), Meghnagar (Sajeli) Petalabad (Mohankot, Kadwali, kardawat,Gahadi) under TSP mustard project. During the showing time mustard seed (DRMRIJ-31, NRCDR-2, RH-406, RH-749) with fertiliser and insecticide/ pesticide like Sulphur, NPK (19:19:19), Trizophos and Imidachloprid as critical inputs were provided to the beneficiaries. Sowing of all the demonstrations were completed in between first fortnight of November and harvesting up to 23 March 2016.

Average yield in the demonstration plots was 14.28 q/ha in comparison to farmers field where average yield was 11.12 q/ha which showed 28.55 percent yield improvement. Maximum yield in the demonstration plot was 15.51 q/ha while minimum was 10.53 q/ha. Variety wise analysis shows that DRMRIJ-31, NRCDR-2, RH-406, RH-749 varieties gave 29.29, 28.40, 28.25, 28.55 per cent yield improvement over farmers' practice, respectively. Average B: C ratio generated in FLDs was 2.30 as against 2.10 in farmers' practices. It can be concluded that all the varieties performed equally and are suitable for Jhabua region of Madhya Pradesh.

During the period, one on campus and three off campus trainings were organised that benefitted 155 tribal farmers. One Farmers Field Day and two scientist-farmers interaction meeting were also organized that benefitted 117 farmers.

Besides, one 3 days training-cum- Exposure visit to ICAR-DRMR was also organized under the project during 13-15 Dec. 2016 for capacity building of the 30 tribal farmers and one extension staff of KVK, Jhabua for dissemination of scientific technology of rapeseed-mustard among them.

12 KrishiVigyan Kendra (ICAR-DRMR), Gunta, Bansur

Awareness programme on Pradhan Mantri Fasal BimaYojna:

KVK, Gunta-Bansur organized an awareness programme on "Pradhan Mantri Fasal Bima Yojna" at Holawas village on 17th April 2016. The program was inaugurated by Col. Rajyavardhan Singh Rathore, Minister of State for Information & Broadcasting, Govt. of India. In his inaugural address, the Minister said the main aim of the scheme is to provide a more efficient insurance support to the farmers of the country. He said that the scheme will build confidence in the farmers and thus will bring progress in the country. He further stated the Government's commitment for improvement of soil health conditions at farmers' fields which has been reflected through the distribution of one crore soil health cards by March 2016 and this is to be enhanced to 9 crores by 2017. Highlighting the special features of PMFBY, he added that farmers will have to pay a very low premium for insuring their crops which will be 2% for Kharif crops, 1.5% for Rabi crops and 5% for commercial and horticultural crops. The remaining amount of the premium will be borne by the Government. He also informed the other schemes and programmes including Pradhan Mantri Krishi Sinchai Yojana, per drop more crop, neem coated urea and others.

Dr. J.S. Sandhu, DDG (Crop Science), presided the function and emphasized on features of PMFBY and highlighted the benefits of the scheme in terms of low premium. He stressed the importance of crop insurance under changing climate for sustainable development of the farming community. Dr. Sheetal Prasad Sharma, Additional Director, Agriculture, Govt. of Rajasthan appealed to the farmers to promote organic farming for better soil health and enhanced farm income. Dr. Dhiraj Singh,

Director, ICAR-DRMR, Bharatpur highlighted the significant achievements of the KVK, Bansur and its commitment for upliftment of farmers, farm women through various extension activities like Soil Health Card Distribution, Mera Gaon Mera Gaurav Scheme, skill entrepreneurship development program etc.

In this event, more than 1800 farmers, farm women, local youths & extension functionaries were participated. During the inaugural session, a kisangosthi was also held for the farmers, where the objectives, terms & conditions of PMFBY were discussed along with the production technologies. In this event, three technical bulletins were also released and twenty progressive farmers were felicitated by the chief guest for their contribution in adoption and dissemination of improved agriculture technology in their areas. More than 25 exhibition stalls were put by different departments and input dealers to show their programs and products to the visiting farmers.

On farm trials (OFT):

Seven on farm trials were testing and refining the developed technologies at 25 farmers' field and on 11 animals. Five trials each on Orobanche management in mustard, Irrigation Management in Mustard, Management of Fruit & flowers in Chilli, Management of blossom end rot in tomato, IPM in Cotton crop were conducted at

five farmer's fields each, respectively. Three trials on effect of mineral mixture and mineral block on the age of puberty of cross breed heifers were conducted on three animals at farmers' fields. Eight trials on Improvement of fertility through oestrussynchronization in buffaloes were conducted on eight animals at farmers' field.

Front Line Demonstrations (FLDs):

A total of 300 FLDs were conducted in 106.2 ha area and benefitted a total of 53 village of Bansur, Behror and Mundawar tehsil of Alwar district. During kharif season 48 FLDs were conducted in 21 hectare area and benefitted 12 villagesof Bansur tehsil on cluster bean and bajra fodder crops for varietal evaluation and integrated disease management. In Rabi season total 252 FLDs were conducted in Mustard, Chickpea, Wheat, Oat and Tomato in total 85.2 ha area and benefited 41 village of Bansur, Behror and Mundawar tehsil of Alwar district. The front line demonstrations were conducted for popularizing the new varieties and techniques of disease management in different tehsil of Alwar district through varietal evaluation, fodder production and disease management in kharif and Rabi crops. The 10 Field days and Kisan gosthies were also conducted to popularize the new varieties and technologies for disease management.

Trainings :

Third most important activity of Krishi Vigyan Kendra are conducting vocational trainings to the practicing farmers including, farm women, youth and extension functionaries in improved technologies in the field of agriculture, horticulture, animal husbandry, and

other allied enterprises. A total of 70 On campus and Off campus trainings were conducted and a total of 2071 farmers were benefitted though these trainings. Out of total 70 trainings, 32 (On campus) and 38 (Off campus) trainings were conducted and benefitted 926 and 1145 farmers, respectively.

Field days:

A total of 10 field days were conducted in kharif and Rabi season and benefitted 298 farmers in different village of Bansur, tehsil

through improved technologies on farmers' fields. The field days were conducted to popularize the new technologies for benefits other farmers of village.

Other extension activities:

Four kisan gosthies for 2010 farmers, 4 exhibitions for 3793 farmers, 6 Awareness programmeon Pradhan Mantari Fasal Bima Yojna, Parthnium Awareness week, Swach Bharat Abhiyan, Yoga Diwas and Jay Kisan Jay Vigyan Diwas for 2232 farmers were organized during the period. A total of 23 quintal of mustard seed were sold to the farmers in Bansur, Behror, Mundawar, Kisangath Bas, Kotkasim, Tijara and Neemrana tehsil of Alwar district. A total of 97 lectures were delivered through KVK staff in Agriculture, Horticulture and Animal husbandry in sponsored training of Agriculture, Horticulture and Animal husbandry department of Alwar district and DRMR, Bharatpur. A total of 23 TV and Radio talks were delivered on improved technologies of agriculture, horticulture and animal husbandry. A total of 32 news though Newspaper were covered for benefits of farmers of Alwar district. 20 popular articles were published in different newsletters, 11 technical folders were published in different aspects of crop production, plant protection, animal husbandry, horticulture crops and agriculture extension activities for benefitted of the farmers. A total of 56 message were delivered through M kisan portal and benefitted total 400962 farmers. A total of 347 telephonic advisory services were given to the farmers of Bansur, Behror and Mundawar, Neemrana, Kisangarh Bas, Kotkasim and Tijara tehsil of Alwar District. A total of 1127 farmers visited KVK office. The farmers' problem were solved by KVK staff in aspects of agriculture, horticulture and animal husbandry. A total of 80 visits were conducted by SMS at farmer's field and solved the field problem of farmers. Total 41 Film shows were shown to the farmers and benefited 1069 farmers in agriculture technologies. In Kharif season, Dhaincha were grown in approx. 8.0 ha area on KVK farm for improvement of physico-chemical properties of soil and in Rabi season, mustard was grown in 6 hectare area and produced approx. 33-35 quintal mustard.

13 Final Distinguished Visitors

Name	Designation & Address	Date
Sh. Mohanbhai	Minister of State for Agriculture & Farmer's Welfare, Govt. of India	6-Jun-16
Dr. B.L. Jalali	Ex-Director of Research, CCSHAU, Hisar	June 27-29, 2016
Dr. G.S.Saharan	Ex-Professor, CCSHAU, Hisar	June 27-29, 2016
Dr. D.R.C. Bakhetia	Ex. Head, Division of Entomology, PAU, Ludhiana	June 27-29, 2016
Dr. M.L.Lodha	Ex.-Professor & Head, Division of Biochemistry, IARI, New Delhi	June 27-29, 2016
Dr. M.L. Jat	Senior Cropping Systems Agronomist, CIMMYT, New Delhi	June 27-29, 2016
Dr. Sain Das	Ex-Project Director, ICAR-DMR, Ludhiana	30-Aug-16
Dr. Gurbachan Singh	Chairman, ASRB	20-Oct-16
Dr. J.S.Sandhu	DDG(Crop Science), ICAR, KrishiBhawan, New Delhi	20-Oct-16
Dr. GopalLal	Director, NRCSS	20-Oct-16
Sh. Deshraj Singh	Deputy Director, State Agriculture Department, Bharatpur	20-Oct-16
Sh. Yogesh Kumar Sharma	Joint Director, State Agriculture Department, Bharatpur	20-Oct-16
Dr. Amar Singh	PC KVK & Dean COA, Bharatpur	20-Oct-16
Dr. Udaibhan Singh	Prof. & PI ARSS, Kumhere, Bharatpur	20-Oct-16
Dr. R.S. Malik	Ex-Principal Scientist, IARI, New Delhi	24-Dec-16
Sh. S.K. Sinha	FA & AS, DARE-ICAR	14-Jan-17
Smt. Namita J. Priyadarshee	Chief conservator of Forest (CCF), Ghana Bird Sanctuary, Bharatpur	20-Jan-17
Dr. K.M.L. Pathak	Hon'ble Vice Chancellor, DUVASU, Mathura	10-Feb-17
Dr. Anupam Barik	Addl. Commissionar (Oil Seed), DAC & FW, New Delhi	17-Mar-17

14 Personnel

Director's Office

1. Dr. P. K. Rai, Director (Acting) since Jan. 1, 2017
2. Smt. Veena Sharma, Personal Assistant
3. Sh. Lala Ram, Supporting staff (SSS)

Scientific Staff

Crop Improvement

1. Dr. V.V. Singh, Principal Scientist (Genetics & Plant Breeding)
2. Dr. K.H. Singh, Principal Scientist (Genetics & Plant Breeding)
3. Dr. Bhagirath Ram, Senior Scientist (Genetics & Plant Breeding)
4. Dr. Aurn Kumar, Senior Scientist (Genetics & Plant Breeding)
5. Dr. H. S. Meena, Senior Scientist (Genetics & Plant Breeding)
6. Dr. Priyamedha, Scientist (Genetics & Plant Breeding)

AICRP-RM Unit

1. Dr. K. H. Singh, Principal Scientist (Genetics & Plant Breeding)

Natural Resource Management

1. Dr. O. P. Premi, Principal Scientist (Agronomy)
2. Dr. R. S. Jat, Senior Scientist (Agronomy)
3. Sh. Har Vir Singh, Scientist (Agronomy)
4. Dr. Mukesh Kumar Meena, Scientist (Soil Science)

Plant Protection

1. Dr. P. K. Rai, Principal Scientist (Plant Pathology)
2. Dr. P. D. Meena, Principal Scientist (Plant Pathology)
3. Dr. Pankaj Sharma, Principal Scientist (Plant Pathology)

Plant Biotechnology

1. Dr. Ajay Kumar Thakur, Scientist, SS (Plant Biotechnology)
2. Ms. Reema Rani, Scientist (Plant Biotechnology) on study leave
3. Sh. Prashant Yadav, Scientist (Plant Biotechnology) on study leave

Plant Biochemistry

1. Dr. Anubhuti Sharma, Senior Scientist (Plant Biochemistry)
2. Dr. Ibandalin Mawlong, Scientist (Plant Biochemistry)
3. Dr. M. S. Sujith Kumar, Scientist (Plant Biochemistry)

Technology Assessment & Dissemination

1. Dr. Ashok Kumar Sharma, Principal Scientist (Agricultural Extension)

Agriculture Knowledge Management Unit

1. Dr. Vinod Kumar, Senior Scientist (Computer Application in Agriculture)

Technical Staff

1. Sh. U. S. Rana, Chief Technical Officer (CTO)
2. Dr. R.C. Sachan, Chief Technical Officer (CTO)
3. Sh. M.L. Meena, Assistant Chief Technical Officer (ACTO)
4. Sh. H. P. Meena, Assistant Chief Technical Officer (ACTO)
5. Sh. Ram Narayan, Assistant Chief Technical Officer (ACTO)
6. Sh. Karnal Singh, Assistant Chief Technical Officer (ACTO)
7. Dr. Kailash Narayan, Senior Technical Officer (STO)
8. Sh. Sanjay Sharma, Senior Technical Officer (STO)
9. Sh. Govind Prasad, Technical Officer (Driver)
10. Sh. Ram Singh, Senior Technical Assistant (STA)
11. Sh. R. C. Meena, Senior Technical Assistant (STA)
12. Sh. Rakesh Goyal, Senior Technical Assistant (STA)
13. Sh. Bachuchu Singh, Senior Technical Assistant (STA)
14. Sh. Radha Charan Rajpoot, Technical Assistant (Driver)

Administrative Staff

1. Sh. Shitanshu Kumar, Administrative Officer
2. Sh. U. C. Sharma, Asstt. Admin Officer
3. Sh. Mukesh Kumar, Assistant
4. Smt. Poonam Keshri, Assistant
5. Sh. G. L. Meena, Sr. Clerk
6. Sh. Pankaj Pathak, Sr. Clerk

Audit and Accounts Unit

1. Sh. P. K. Tiwari, Finance & Accounts Officer
2. Sh. Ajay Tandon, Junior Accounts Officer
3. Sh. Ram Sahay Meena, Assistant

Supporting

1. Sh. Lala Ram, Skilled Supporting Staff
2. Sh. Tara Singh, Skilled Supporting Staff
3. Sh. Kamal Singh, Skilled Supporting Staff
4. Sh. Sheetal Kumar Sharma, Skilled Supporting Staff

KrishiVigyan Kendra, Gunta- Bansur

1. Dr. Bhagwat Singh Rathore, Sr. Scientist & Head
2. Dr. Rupendra Kaur, T-6
3. Sh. Sandeep Rastogi, T-6
4. Sh. Bajrang Lal Ola, T-6
5. Sh. Sunil Kumar, T-6
6. Sh. Prem Chand Garhwal, T-6
7. Dr. Arvind Kumar Verma, T-6

S. No.	Committee	Members
1.	Priority Setting, Monitoring and Evaluation (PME Cell)	Dr. P.D. Meena, Pr. Scientist (In charge); Dr. Vinod Kumar, Sr. Scientist; Dr. Bhagirath Ram, Sr. Scientist; Dr. Anubhuti Sharma, Sr. Scientist; Dr. H.S. Meena, Sr. Scientist; Dr. Priyamedha, Scientist.
2.	Results-Framework Document (RFD)	Dr. Vinod Kumar, Sr. Scientist (Incharge)
3.	Institute Technology Management Unit (ITMU)	Director (Ex-office Chairman); Dr. K.H. Singh, Pr. Pr. Scientist (Member Secretary); Dr. (Mrs.) ArchanaSuman, Pr. Scientist, IARI; Dr. R.S. Jat, Sr. Scientist; Dr. Arun Kumar, Sr. Scientist; Dr. H.S. Meena, Sr. Scientist.
4.	Institute purchase Committee (IPC)	Dr. Pankaj Sharma, Principal Scientist (Chairman), Dr. R.S. Jat, Sr. Scientist (Member), Dr. H.S. Meena, Sr. Scientist (Member), Sh. Ramesh Chand Meena, Sr. A.O (Member), Sh. Pawan Kumar Tiwari, F.AO (Member), Sh. Umesh Chand Sharma , AAO (Member)
5.	Institute Joint staff Committee (IJSC)	Dr. K.H. Singh, Principal Scientist & Secretary office side., Dr. KapilaShekhawat, Scientist & Member office side, Dr. Pankaj Sharma, Senior Scientist & Member Office side, Dr. Vinod Kumar, Senior Scientist & Member Office side, Finance & Accounts Officer & Member Office side, Administrative Officer & Member Office side, Sh. Mukesh Kumar, Assistant & Secretary staff side, Sh. Govind Prasad, T-3 (Driver) & Member staff side, Sh. RamchandraMeena, T-4 & Member staff side, Sh. Pankaj Pathak, Lower Division Clerk & Member staff side, Sh. Lalaram, SSS & Member staff side, Sh. Sheetal Sharma, SSS & Member staff side
6.	Institute Research Committee (IRC)	Director (Chairman), Dr. Ashok Kumar Sharma, Pr. Scientist (Member Secretary)
7.	Research Advisory Committee (RAC)	Dr. J.S. Sandhu, DDG Crop Science, ICAR (Chairman), Director, ICAR-DRMR, Dr. V.V.Singh, Principal Scientist (Member Secretary), Dr. R.S. Malik, Ex-Principal Scientist, IARI, Dr. M.L. Jat, Programme Coordinator, CIMMYT, Dr. Harvir Singh, Ex-Principal Scientist, DOR, Dr. Asha Shivpuri, Professor and Head (Retd.), RAU, Dr. J.P. Shrivastava, Professor, BHU, Dr. S.P.S. Karwasra, Ex-Director of Research, CCSHAU, ADG (OP), ICAR.
8.	Institute Germplasm Identification Committee (IGIC)	Director (Ex-office Chairman); Dr. K.H. Singh, Pr. Scientist (Member Secretary); Dr. O.P. Premi, Pr. Scientist; Dr. Pankaj Sharma, Pr. Scientist; Dr. H.S. Meena, Sr. Scientist.
9.	Women Complaint Committee (WCC)	Ms. Reema Rani, Scientist (Chairperson); Dr. Rupender Kaur, SMS; Ms. Veena Sharma, PA, Administrative Officer.

15 Panorama

Hon'ble Union Minister of State for Agriculture and Farmers Welfare visit to ICAR-DRMR

Shri Mohanbhai Kalyanjibhai Kundariya, Hon'ble Union Minister of State for Agriculture and Farmers Welfare visited ICAR-DRMR on

May 6, 2016. He had an interaction meeting with staff members. Director, ICAR-DRMR, Dr. Dhiraj Singh apprised Hon'ble Minister about the research and extension activities and achievements of ICAR-DRMR. Sh. Mohanbhai Kalyanjibhai Kundariya, in his address, emphasized to take the advantage of research development to the farmers at field level. He said that prime objective of the govt. was to make the welfare of the farmers through the implementation of the different centrally sponsored programs like Pradhan Mantri Fasal BimaYojana, Pradhan Mantri Krishi Sinchai Yojana, Soil Heath Card, e-NAM (National Agriculture Market), Mera Gaon, Mera Gaurav, etc. He further expressed his concern about the rising cost of cultivation and urged the scientists to motivate and guide the farmers properly to adopt appropriate scientific technology to improve farm income. He appreciated the efforts of DRMR scientists for the benefit of the farmers. Dr. V. V. Singh, Principal Scientist expressed vote of thanks to the Hon'ble Minister for sparing his valuable time for visit of ICAR-DRMR.

International Yoga Day

ICAR-DRMR celebrated 'International Yoga Day' on 21st June 2016. Dr. P. K. Rai, Acting Director, welcomed all the staff and emphasized on the importance of daily practicing yoga. He emphasized the urgent need

to adopt good food habits and yoga in our day to day life for healthy mind and body. Various exercises were demonstrated and conducted by Yoga expert. He also explained the various asanas and highlighted the importance of yoga in human life for holistic development.

Independence Day

DRMR celebrated the 70th Independence Day on August 15, 2016 with great enthusiasm. Dr. Dhiraj Singh, Director hoisted the national flag on this historic day and delivered the Independence Day message. He asked to introspect ourselves that how we could contribute in the further progress of our country. He also emphasized that agriculture faces multiple challenges, the largest being from the changing climate and called upon the young & scientific minds to explore agriculture for addressing the issues and serving the farmers of our country. He further greeted all the staff members and their family and spoke about the significant contributions made by Mahatma Gandhi, Sardar Patel, Pandit Nehru and countless great persons, who fought ceaselessly for the freedom of our nation.

Parthenium Awareness Week

The ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur celebrated the Parthenium Awareness Week during 16-22 August, 2016. As part of celebration of this program, awareness

has been created among the staff and locals to clean the cropped and non-cropped parthenium infested area. Information regarding ill-effect of Parthenium hysterophoru which is, locally called Gajar Ghas or Congress Grass, an alien weed spread alarmingly and invaded cropped as well as non-cropped area and causes enormous losses in agricultural productivity, human and animal health and biodiversity, were given to the participants. Integrated approach of control viz. through biological control using Mexican beetle, botanical agents like Cassia extract, hand removal before flowering and making compost were also delivered to the participants.

Swachh Bharat Abhiyan

A voluntary cleanliness programme under "Swachh Bharat Abhiyan" of Hon'ble Prime Minister, Swachta campaign was conducted in

the Directorate on 9th of July 2016. On this occasion, Director, Dr. Dhiraj Singh and the entire willing scientist, officers and other staffs have participated in Directorate premises. All the polythene bags and other garbage scattered in the campus were picked up and disposed properly. The programme was kept truly voluntary and hopes that it will attract more participants in future. Director asked everyone to maintain cleanliness of offices, laboratories, guest house, residential complex, farms and adjoining area of Directorate on weekly basis.

Vigilance Awareness Week

ICAR-Directorate of Rapeseed-Mustard Research observed Vigilance Awareness Week by administering of the Pledge in Hindi and English respectively to all the staff members of the Directorate on the first day i.e. on 31st Oct. 2016 at 11.00 A.M. Interaction session with the Scientists and Staff was held where views of CVC on vigilance awareness were shared and various vigilance related issues were discussed on the topic "Public participation in promoting integrity and eradicating corruption" which was the main focus of week. During discussion the Director, emphasized that the purpose of Vigilance Awareness Week is to generate awareness in the public at large about the bad effects of corruption. A set of posters on Vigilance Awareness were displayed at the prime locations of office such as on Notice Board, Library etc. The closing ceremony of the Vigilance Awareness Week was held on 05/11/2016 at 3.00 P.M. in seminar hall, which was attended by all the scientific staff as well as officers and administrative staff of the Directorate with a note to imbibe the culture of preventive vigilance and progress towards openness and transparency.

Hindi Pakhwara

DRMR organized Hindi Chetna Pakhwara (fortnight) during Sept. 14-28, 2016. On inaugural day, Dr. Rambabu Shukla was of the

view that Hindi language should be popularized all over the country. Sh. Rambabu Vidrohi, Renowned Hindi Poet, recited several Hindi poems during this event. Dr. Raghunath Dangur delivered talks on Role of Hindi in nation building and asked the people for using Hindi in official work. Dr. Dhiraj Singh appreciated the efforts of Directorate for Hindi language and motivated everyone to work in Hindi. Awards were distributed to several employees of DRMR for their maximal contribution for the Hindi language. Dr. Vinod Kumar, Senior Scientist, coordinated the event.

Foundation Day

ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur celebrated its 23rd Foundation Day on 20 October, 2016. Dr. Gurbachan Singh, Chairman, Agricultural Scientist Recruitment Board (ASRB) was the Chief Guest of function. Dr. J. S .Sandhu, Deputy Director General (Crop Science) graced the function as guest of honor. Speaking on the occasion, Dr. Gurbachan Singh emphasized that, in recent years agriculture witnessed tremendous

changes in climate due to which the farmers have confronted a lot of setbacks in terms of production. Farmers were either forced to revamp the farming operations or shift entirely to another crop in order to minimize loss. This has been reflected in the case of mustard cultivation as well. Farmers are shifting to other crops such as wheat. Another major issue is the depletion of natural resources such as water. Farmers should adhere to the agronomic practices to ensure "more crop per drop". He also stated that, the newly inducted programme "mera gaon mera gaurav" has been proven to be a success so far. I urge all scientists involved in this programme to capitalize on its effectiveness to enable the farmers to generate regular income.

Dr. J. S .Sandhu, appreciated the efforts made by the DRMR for development of economically important crop of rapeseed-mustard. He has sown great satisfaction on seed programme taken by DRMR to provide quality seed to the farmer. Dr Sandhu also appreciated the contribution of farmers and entrepreneurs in development of crop.

Dr. Dhiraj Singh, Director while addressing the gathering appreciated the efforts of all the staff involved in bringing the directorate to the current shape and hoped that the progress of DRMR would increase by leaps and bounds. Dignitaries and scientists from AICRP-RM centres and other official from different organizations participated in the programme. Former Scientists and Staff of the Directorate were also present on the occasion. On this occasion a holy work to donate the blood which saves the lives of many persons was also organised. 35 units blood was donated by DRMR staff in blood bank of RBM Govt. Hospital, Bharatpur. The Chairman, ASRB honoured the progressive farmers and also distributed the best worker award of the institute to selected persons under scientific, administrative, technical as well as supporting category. Nearly 100 people attended this function.

Republic Day

DRMR celebrated 68th Republic day on 26th Jan, 2017 with great fervor and joy. Dr. P. K. Rai, (Acting Director) hoisted the national flag on this occasion. In his address, the Director saluted the sacrifices of freedom fighters, solders and great leaders of the country and laid emphasis on the future scientific challenges while highlighting the achievements of the instituteduring past year. He extended good wishes to the staff for their happiness, prosperity and success. He also gave away prizes to the winners of Annual Sports Meet. All staff members including the scientists, administrative

staff, technical staff, supporting staff, research fellow sand contractual staff participated actively in this national festival.

Hindi Karyashala

DRMR organized one day Hindi Karyashala on 28th March 2017. Inaugurating the programme, Dr. P. K. Rai (Acting Director) DRMR said that language is the strong medium of expression and Hindi is not confined to any region. He described that in the era of globalization and advertisement, Hindi became important and suggested use of Hindi in official, legislative, executive and judiciary work. Dr. Ashok Kumar Gupta, Hindi Lecturer, M.S.G. College, Bharatpur, emphasized the need of publishing research work in Hindi so that results could reach to the end users, farmers effectively and speedily. He delivered talk on alphabets of Hindi language i.e. swara and vyanjan with the help of which a sentence can be formulated. He also describes the daily mistake a common man make while writing a sentence in Hindi. Dr. Vinod Kumar, Senior Scientist coordinated the event.

ICAR-DRMR on Print media

About 80 news items / stories/advice, etc. were published during the period in different dailies and weekly Hindi newspapers viz., Rajasthan Patrika, Dainik Bhaskar, Srusti Agro, Amar ujala, Dainik Navjoyati, Rastradoot, Punjab Kesari, Haldhar Times, Krishi Goldline etc. to educate and make farmers, farm women, extension personnel, etc about scientific rapeseed-mustard technology and programmes and activities of Directorate.

Delegation from Bhutan to visit ICAR-DRMR

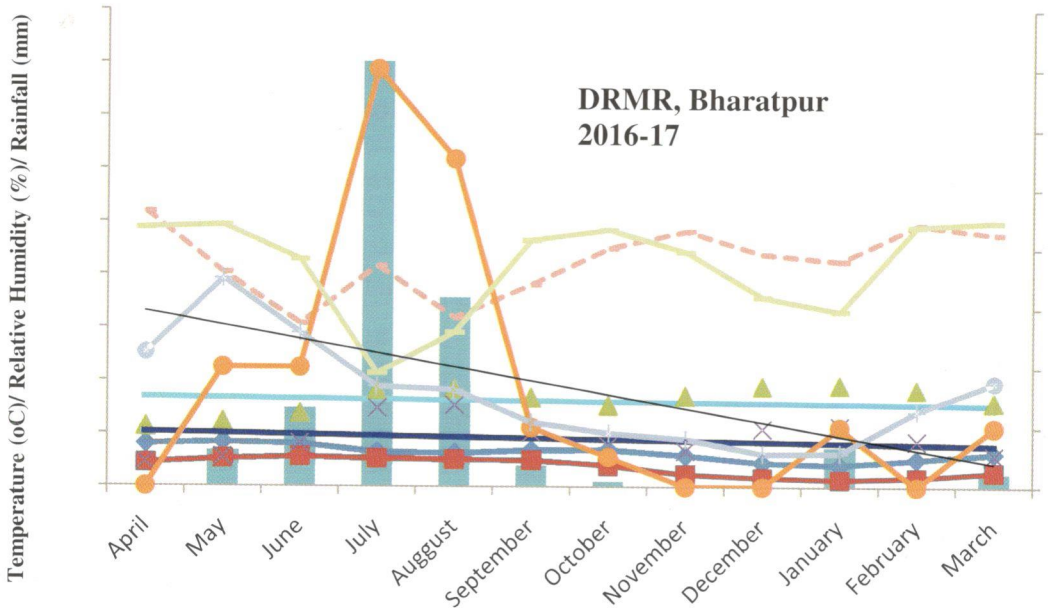
A delegation of ten members from Bhutan visited ICAR-DRMR on 23rd Dec 2016. These members, mainly belong to Agriculture officer, senior Horticulture officer, senior extension officers, senior research assistants, visited experimental farm, experimental labs to study Brassica and its related science. They discussed with scientists of ICAR-DRMR regarding advancement in Brassica and its mechanization in field.

Student Delegation from USA-Colorado to visit ICAR-DRMR

A ten member student's delegation from Colorado, USA visited ICAR-DRMR on 21st March 2017. They visited experimental farm, experimental labs and interacted with scientists of ICAR-DRMR regarding advanced technologies to enhance crop production and its protection from various diseases.

16 Meteorological Data

Overall it was a good monsoon year with total 765.2 mm rainfall in 41 rainy days. Although initially monsoon got delayed by 2 weeks but later monsoon became active in last week of May and remained active throughout the June, July and August. The monsoon withdrew in last week of September leaving sufficient conserved moisture for subsequent mustard crop and 42.7 mm rainfall was received from October-February. Throughout the cropping season the mean monthly temperature remained favourable for rapeseed-mustard production. However, minimum daily temperature reached <7.0oC during last week of Dec. 2016 to 2ed week of Jan. 2017. However, the daily maximum temperature reached around 4.8o C during last week of December 2016. The average sunshine during crop season was 3.8-10.3 hours.



April 2016- March 2017

Budget (Rs in Lakhs)

Head	Plan	Non-plan		
	Sanctioned	Utilized	Sanctioned	Utilized
DRMR	250.00	250.00	615.00	584.44
AICRP-RM	890.00	890.90	-	-

Resource generation		Income generated from internal resource generation schemes	
Head of Account	**Amount (Rs.)**	Training	629319
Sale of Farm Produce	2492144	Guest House	355749
Sale of Tender Form	88400	Transport charges	61395
License Fee	266968	DRMR	726058
Analytical testing fee	800600	**Total**	**1772521**
Total	**3648112**	**Total Income Generated**	**5420633**

Annexure

List of trainings programmes organized for KVKs/ extension personnel/ farmers by ICAR-DRMR during 2016-17

Training programmes for KVKs personnel and Field level extension personnel Under NMOOP

S.N.	Date	Duration	Subject/Title	Participants	No.	Sponsored by
1.	5-6 Sept 2016	2 days	Scientific production technology of R-M	KVK personnel from UP	17	Under FLDs NMOOP
2.	8-9 Sept 2016	2 days	Scientific production technology of R-M	KVK personnel from Rajasthan	23	Under FLDs NMOOP
3.	19-20 Sept 2016	2 days	Scientific production technology of R-M	KVK personnel from Gujarat and Rajasthan	17	Under FLDs NMOOP
4.	22-23 Sept 2016	2 days	Scientific production technology of R-M	KVK's personnel of MP and Chhattisgarh	14	Under FLDs NMOOP
5.	3-4 Oct 2016	2 days	Scientific production technology of R-M	KVK's personnel of UP and Chhattisgarh	14	Under FLDs NMOOP
6.	6-7 Oct 2017	2 days	Scientific production technology of R-M	KVK's personnel of Punjab and Haryana	22	Under FLDs NMOOP
7.	6-7 Feb 2017	2 Days	Scientific production technology of R-M	Extension workers from Alwar district of Rajastahn	40	Under FLDs NMOOP (2 trainings clubbed)
8.	14-15 Feb 2017	2 Days	Scientific production technology of R-M	Extension workers from Alwar district of Rajastahn	35	Under FLDs NMOOP (2 trainings clubbed)
	Total				**182**	

Training programmes for ATM/ BTM/ farmers:

S.N.	Date	Duration	Subject/Title	Participants	No.	Sponsored by
1.	13-17 Sept. 2016	5 days	Scientific production technology of mustard and Ag. Management	ATM/BTM/TA	20	SIMA, Rehamankheda, Lucknow
2.	24-25 September 2016	2 days	Scientific production technology of mustard and Ag. management	Farmers from Ajmer and Alwar district of Rajasthan	42	Rajasthan Rural Institute of Development Management (BAIF), Ajmer (Raj.)
3.	26-30 Sept. 2016	5 days	Scientific production technology of mustard and Ag. management	ATM/BTM/TA	21	SIMA, Rehamankheda, Lucknow
4.	7-11 Nov. 2016	5 days	Scientific production technology of mustard and Ag. management	Farmers of Gwalior district of MP	16	PD, ATMA, Gwalior (MP)
5.	21-22 Nov. 2016	2 days	Mustard seed production and its management	Farmers of Bharatpur	35	ICAR Seed Project on Seed Production in Agricultural Crops
6.	5-9 December 2016	5 days	Bee keeping and Agriculture management	Farmers of Tonk district of Rajasthan	33	PD, ATMA, Tonk(Raj)
7.	13-15 December 2016	3 days	Scientific Production Technology of Mustard	Tribal Farmers of Jhabua district of MP	30	DRMR-RVSKVV under TSP for 2016-17
8.	24-26 Jan 2017	3 days	Rapeseed-Mustard seed production and its management	Tribal farmers from Pratapgarh district of Raj.	26	ICAR Seed Project on Seed Production in Agricultural Crops tribal component.
9.	3-4 Feb. 2017	2 days	Package of practices of mustard with institutional focus and recommendations	Farmers from Ajmer and Alwar district of Rajasthan	37	Rajasthan Rural Institute of Development Management (BAIF), Ajmer (Raj.)
10.	8-12 Feb 2017	5 days	Scientific production technology of mustard and Ag. management	Farmers of Bhind district of MP	23	PD, ATMA, Bhind (MP)
11.	1-5 March 2017	5 days	"Bee keeping and Agriculture management"	Farmers of Jhabua district of MP	17	PD, ATMA, Jhabua (MP)
12.	1-5 March 2017	5 days	"Bee keeping and Agriculture management"	Farmers of Tonk district of Rajasthan	25	PD, ATMA, Tonk (Raj)
	Total				325	

Notes

हर कदम, हर डगर
किसानों का हमसफर

भारतीय कृषि अनुसंधान परिषद

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