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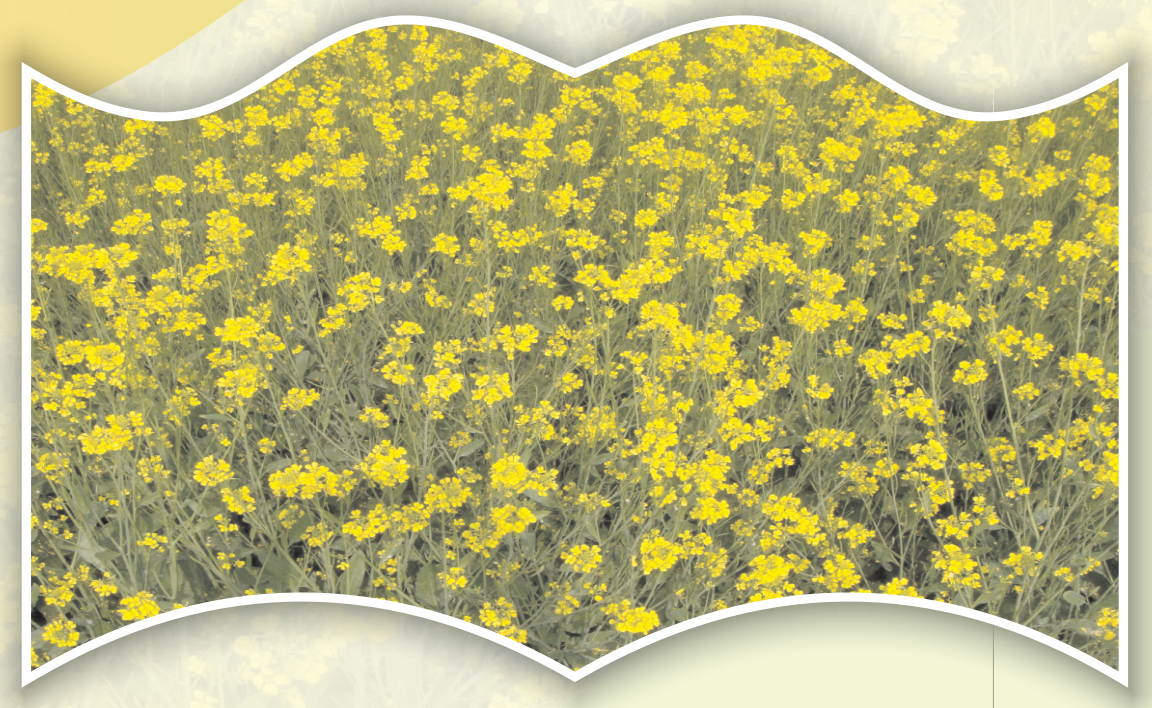
ANNUAL REPORT

2010-2011



सरसों अनुसंधान निदेशालय

Directorate of Rapeseed - Mustard Research

(भारतीय कृषि अनुसंधान परिषद्)

(Indian Council of Agricultural Research)

सेवर, भरतपुर 321 303 (राजस्थान), भारत

Sewar, Bharatpur 321 303 (Rajasthan), India

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The Indian Council of Agricultural Research (ICAR) established Directorate of Rapeseed-Mustard Research as a national repository for rapeseed-mustard genetic resources as 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 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 to the problems of regional and National importance and to extend technical expertise and consultancies in this area.

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(Indian Council of Agricultural Research)
Sewar, Bharatpur 321 303 (Rajasthan), India

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Goal

To develop and provide knowledge based resource management technology to different stakeholders to enhance rapeseed-mustard productivity, improve oil quality and livelihood of the people.

Vision

Farmers are empowered and adapted to eco-friendly, cost effective precision rapeseed-mustard farming to have an access to quality edible oil.

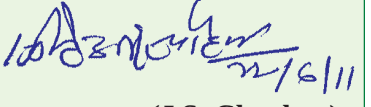
Preface

With immense pleasure I present Annual Report of Directorate of Rapeseed-Mustard Research for the year 2010-11 to our esteemed scientific fraternity and other stakeholders including policy makers who evince keen interest in this important group of oilseed crops in the country. During the year under report an all time high crop yield was recorded with marginal increase in the acreage.

The highlights of the research programme and other activities at the Directorate were registration with NBPGR, New Delhi of 4 germplasm accessions having earliness and short stature in *Brassica napus*, earliness and bold seeds in *Brassica carinata*, high water use efficiency, salinity tolerance at seedling stage and thermo tolerance at seedling/ terminal stage in *Brassica juncea*, development of early maturing strains, DRMR 2011-1, DRMR 2011-2 and DRMR 2011-9 having higher seed yield, oil content and test weight with comparable maturity with earliest maturing check variety NPJ 112, DRMR243 and DRMR 270 of *B. carinata* showed tolerance to downy mildew and white rust disease. Twenty five independent putative transgenic events were developed in *Brassica juncea* var. NRCDR 2 using cotyledonary petiole explants harboring *TvD1* gene via *Agrobacterium tumefaciens*-mediated gene transfer. Further, modified protocol for isolation of genomic DNA from oilseed *Brassica* without using liquid nitrogen was standardized. Evaluation of cross transferability and polymorphic potential of 162 STMS *Brassica* markers in 21 *Brassica* species revealed that average cross-transferability of these markers was 45.5%. Among the resource conservation technologies evaluated to reduce cost of crop production, drip system of irrigation produced highest seed yield and water use efficiency. Studies on mycelial compatibility and protein profile of 25 geographical isolates of *Sclerotinia sclerotiorum* suggested possibility of different pathotypes. Of the 16 wild crucifers, *B. fructiculosa, B. spinescens, Capsella bursa pastoris*, *Crambe* sp. and *Lepidium* sp., were found tolerant to mustard aphid with average aphid infestation index of 1. The Directorate sponsored 6 weekly radio programmes with 124 episodes on the technological advances in rapeseed-mustard which benefitted thousands of farmers of Rajasthan and Uttar Pradesh. The scientists of the Directorate published 15 research papers, 6 popular articles, 3 technical bulletins, 2 books and 4 book chapters. Further, 4 scientists of the directorate were awarded/ recognized by different societies/ organizations for their significant professional contributions.

With sense of pride I place on record my heartfelt thanks and profound gratitude to Dr. S. Ayyappan, Secretary DARE, Government of India and Director General, ICAR; Prof. Swapan Kumar Datta, Deputy Director General (Crop Science); Dr. V.D. Patil, former Assistant Director General (Oilseeds & Pulses) and Dr. B.B. Singh, Assistant Director General (Oilseeds & Pulses) of the Council for their immense help, guidance and support extended to this Directorate.

I am pleased to congratulate all the research and service staff of the DRMR whose immense contributions formed the bases of this report and also for bringing repute to this Directorate. I express my sincere appreciation and thanks to the editors Drs. P.K. Rai, V.V. Singh, A.K. Sharma and Kapila Shekhawat for their untiring efforts in bringing out the achievements of the Directorate in the present form. Last but not least I acknowledge with thanks much needed direct and indirect help of all the staff of the Directorate for timely publication of this report.



DRMR, Bharatpur
June 22, 2011

(J.S. Chauhan)
Director

Abbreviations

AVT	Advance Varietal Trial
BS	Breeder Seed
CIAH	Central Institute of Arid Horticulture
CRIJAF	Central Research Institute on Jute and Allied Fibers
CT	Conventional Tillage
DAC	Department of Agriculture and Cooperation
DMAPR	Directorate of Medicinal and Aromatic Plant Research
DMR	Directorate of Maize research
DRMR	Directorate of Rapeseed-Mustard Research
DST	Department of Science and Technology
DUS	Distinctiveness Uniformity and Stability
ERNET	Education and Research Network
FASAL	Forecasting Agricultural output using Space, Agrometeorological and Land based observations
FLD	Front Line Demonstration
FP	Full Package
FS	Foundation Seed
FTNIR	Fourier Transformation Near Infra Red
GBPUA&T	Govind Ballabh Pant University of Agriculture & Technology
HDP	High Density Protein
IAAS	Integrated Agro Advisory Services
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistics Research Institute
ICAR	Indian Council of Agricultural Research
IEEE	Institute of Electrical and Electronics Engineers
IGFRI	Indian Grassland Fodder Research Institute
IIHR	Indian Institute of Horticultural Research
IIPA	Indian Institute of Public Administration
INSA	Indian National Science Academy
IP	Internet Protocol
IPS	Indian Phytopathological Society
IR	Infra Red
IRS	Indian Remote Sensing
ISOPOM	Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize
ITK	Indigenous Technical Knowledge

IVT	Initial Varietal Trial
KVK	Krishi Vigyan Kendra
MACRS	Modified Accelerated Cost Recovery System
MESY	Mustard Equivalent Seed Yield
MoU	Memorandum of Understanding
MPUAT	Maharana Pratap University of Agriculture and Technology
NAARM	National Academy of Agricultural Research and Management
NALMOT	National Monitoring Team on Oilseed and Pulses
NARS	National Agricultural Research System
NASC	National Academy of Science Complex
NBAIIM	National Bureau of Agriculturally Important Microorganisms
NBPGR	National Bureau of Plant Genetic Resources
NSKE	Neem Seed Kernel Extract
NIRD	National Institute of Rural Development
NSP	National Seed Project
PAU	Punjab Agriculture University
PDA	Potato Dextrose Agar
PPV&FR	Protection of Plant Variety & Farmers Rights
PGPR	Plant Growth Promoting Rhizobacteria
PME	Prioritization, Monitoring and Evaluation
PPP	Public Private Partnership
PSB	Phosphorus Solubilizing Rhizobacteria
QRT	Quinquennial Review Team
RAC	Research Advisory Committee
RCBD	Randomized Complete Block Design
RCT	Resource Conservation Technology
RF	Rainfed
SAS	Statistical Analysis Software
SKUAS & T	Sher-E-Kashmir University of Agriculture Sciences and Technology
SMS	Subject Matter Specialist
SRM	Soil Resource Mapping
TL	Truthful Level
TMOP	Technology Mission on Oilseeds and Pulses
VC	Vice-Chancellor
WP	Wettable Powder
WUE	Water Use Efficiency

कार्य सारांश

- राई–सरसों के चार जननद्रव्यों, क्रमशः एनआरसीजीएस 1 (अगेती तथा बौनी), एनआरसी केआर 304 (अल्प समय में परिपक्वता, मुख्य तना लम्बा तथा मोटा दाना), बीपीआर 541–4 (अंकुर अवस्था में लवण सहनशीलता, अधिक जल उपयोग क्षमता तथा अंतिम अवस्था में अधिक तापमान के प्रति सहनशीलता) एवं बीपीआर 543–2 (प्रारम्भिक अवस्था में तापमान के प्रति सहनशील एवं अधिक जल उपयोग क्षमता) का एनबीपीजीआर नई दिल्ली में पंजीकरण कराया गया।
- भारत के विभिन्न भौगोलिक क्षेत्रों के 450 जननद्रव्यों को सस्य–आकारकीय गुणों के आधार पर वर्गीकृत किया गया। 115 जननद्रव्यों को शोध कार्यक्रमों हेतु विभिन्न सरकारी, गैर सरकारी तथा राज्य कृषि विश्वविद्यालयों में वितरित किया गया।
- डीआरएमआर 2011–1 (1580 किग्रा/हैक्टर), डीआरएमआर 2011–2 (1597 किग्रा/हैक्टर) तथा डीआरएमआर 2011–9 (1613 किग्रा/हैक्टर) प्रभेदों में अल्पकाल में पकने वाली चैक किस्म एनपीजे 112 (1466 किग्रा/हैक्टर) की तुलना में उपज, तेल की मात्रा तथा 1000–दानों का भार अधिक पाया गया।
- आर ए पी डी जाँच के आधार पर लाहा के 50 जननद्रव्यों में से ईसी 552581, एचबीक्यु एम 16, एमजेबी 5 तथा ईसी 597309 में सबसे अधिक विभिन्नता पायी गई।
- लाहा के एक प्रभेद डीआरएमआर 541–44 में नवोद्भिद अवस्था में अधिक तापमान के प्रति सहनशीलता पाई गई। करन राई की डीआरएमआर 243 तथा डीआरएमआर 270 प्रजातियाँ मृदुरोमिल आसिता एवं सफेद रतुआ रोग के प्रति सहनशील पाई गई।
- सरसों के फसल अवशेष (2.5 टन/हैक्टर) तथा ढैंचा की हरी खाद के उपयोग से उपज में 64.1 प्रतिशत वृद्धि, बल्क घनत्व में 13.3 प्रतिशत की कमी तथा मृदा के अन्य भौतिक व रासायनिक गुणों में सुधार पाया गया।
- सरसों में बूँद–बूँद सिंचाई पद्धति द्वारा अधितकम उपज (1680 किग्रा/हैक्टर) पाई गई जो कि सूक्ष्म फव्वारा विधि के समतुल्य (1660 किग्रा/हैक्टर) थी। बूँद–बूँद सिंचाई में बाढ़ सिंचाई (10.5 किग्रा/हैक्टर–सेमी.) की अपेक्षा अधिक जल उपयोग क्षमता (28 किग्रा./हैक्टर–सेमी.) पाई गई।
- विभिन्न संसाधन संरक्षण तकनीकों में, चौड़ी बैड एवं नाली प्रणाली विधि में ग्वार–सरसों फसल चक्र की सरसों समतुल्य उपज (3344 किग्रा./हैक्टर) अधिकतम पाई गई जिसका लाभः लागत अनुपात 2.15 पाया गया।
- चौड़ी बैड एवं नाली सिंचित प्रणाली में परम्परागत विधि की अपेक्षा एक तिहाई जल संरक्षण पाया गया।
- *स्क्लेरोटिनिया स्क्लेरोशिएरम* के 25 भौगोलिक आइसोलेट्स को आकारकीय गुण, कवकजाल अनुकूलता तथा प्रोटीन प्रोफाइल के आधार पर वर्गीक त किया गया ।
- कार्बेन्डाजिम कवकनाशी के बीज उपचार (0.2 प्रतिशत) एवं छिड़काव (0.1 प्रतिशत) से तना गलन बीमारी का 93 प्रतिशत नियन्त्रण पाया गया।
- एच पी सरसों स्प्रे तेल के 1.25 प्रतिशत, 1.50 प्रतिशत तथा 1.75 प्रतिशत एवं डाइमेथोऐट 30 ईसी के 1 ली./हैक्टर के छिड़काव से सीरेफिड मक्खी के लार्वा में क्रमशः 6.67, 16.67, 20 तथा 100 प्रतिशत एवं *क्राइसोपर्ला सेप्टमपंकटेटा* में 3.33, 6.67, 16.67 तथा 100 प्रतिशत मृत्यु दर पाई गई।
- औसत चेंपा संक्रमण सूचकांक के आधार पर कुल 16 जंगली में से *ब्रेसिका फ्रुक्टीकुलोसा, ब्रेसिका स्पाइनेसेन्स, केपसिला बरसा–पासटोरिस, क्रेम्ब जाति* तथा *लेपिडियम जाति* सरसों के चेंपा के विरूद्ध सहनशील पायी गईं।
- कम $\ddot{A}^{13}$ कार्बन वाले 25 जननद्रव्यों मे मोर्फो–फिजियोलोजिकल गुणों के आधार पर बारानी क्षेत्रों के लिए बीपीआर 349–9, बीपीआर 541–4, उर्वशी, बीपीआर 549–9 तथा बीपीआर 543–2 उत्तम पायी गईं।

- लाहा के 70 जननद्रव्यों को बुआई के समय अधिक तापमान हेतु मूल्यांकित किया गया तथा 5 जननद्रव्य (आरजीएन 13, वीएसएल 5, एनडीवाइआर 8, स्वर्ण ज्योति तथा वसुन्धरा) में नवोद्भिद मृत्यु दर न्यूनतम पाई गई।
- लाहा की प्रजातियों में गैर विनाशक तरीके से फिनॉल की मात्रा के आंकलन हेतु एफटीएनआइआर का मानकीकरण किया गया।
- राई–सरसों की 8 प्रजातियों में कुल फिनॉल के विश्लेषण में लाहा की कॉन्ती प्रजाति में अधिकतम फिनॉल (20.32 मिग्रा. /ग्राम गैलिक अम्ल समतुल्य) पाया गया।
- राई–सरसों के जीनोमिक डीएनए के पृथक्कीकरण हेतु बिना तरल नाइट्रोजन के उपयोग के एक संशोधित प्रोटोकॉल विकसित किया गया।
- लाहा की प्रजाति एनआरसीडीआर 2 में जीन स्थानांन्तरण की कॉटीलिडनरी पेटीओल एक्सप्लांट तकनीक द्वारा एग्रोबैक्टिरियम ट्यूमिफेसिएन्स की मध्यस्थता द्वारा *टीवीडी–1* जीन स्थानांतरण के 25 स्वतंत्र *प्यूटेटिव ट्रॉन्सजेनिक* घटित किए गए।
- लाहा हेतु विकसित 162 मार्करों की क्रॉस–ट्रांसफरेबिलिटी एवं पॉलिमोर्फिक (बहुआकृतिक) क्षमता का आंकलन लाहा एवं उससे संबंधित 21 अन्य जाति/प्रजातियो में किया गया।
- किसानों के उपयोग हेतु राई–सरसों में शोध तथा विकास कार्यक्रमों एवं उन्नत तकनीको के बारे में कुल 124 रेडियो वार्ताओं का प्रसारण उत्तर प्रदेश के नजीबाबाद, आगरा, मथुरा एवं रामपुर तथा राजस्थान के जयपुर व कोटा आकाशवाणी केन्द्रों से किया गया।
- रबी फसलों (राई–सरसों, गेहूँ, मसूर तथा चना) की उन्नत बीज उत्पादन तकनीक पर 7 दिवसीय किसान प्रशिक्षण कार्यक्रम आयोजित किया गया। साथ ही 17 वें सरसों विज्ञान मेले एवं प्रदर्शनी का सफल आयोजन भी किया गया।
- निदेशालय के वैज्ञानिकों द्वारा कुल 15 शोध पत्र, 6 तकनीकी लेख, 3 तकनीकी प्रसार पत्रक, 2 पुस्तकें एवं 4 पुस्तक अध्याय प्रकाशित किये गये।
- वर्ष के दौरान निदेशालय के 4 वैज्ञानिकों को विभिन्न समितियों/संगठनों द्वारा सम्मानित किया गया।
- वर्ष 2010–11 के दौरान कुल ₹ 25,76,000 जुटाये गए।

Executive Summary

- Four germplasm accessions of rapeseed-mustard, *viz*., NRCGS 1 (early and dwarf), NRCKR 304 (early maturing, long main shoot and bold seeded), BPR 541-4 (salinity tolerant at seedling stage, high WUE, thermo tolerant at terminal stage) and BPR 543-2 (thermo tolerant at seedling stage, high WUE) were registered with NBPGR, New Delhi.
- 450 accessions belonging to different geographical regions of the country were characterized for agro-morphological traits. One hundred fifteen accessions were distributed to various government and non-government research organizations including SAUs for use in research programme.
- Three strains, DRMR 2011-1 (1580 kg/ha), DRMR 2011-2 (1597 kg/ha) and DRMR 2011-9 (1613 kg/ha) gave significantly higher seed yield, oil content and test weight with comparable maturity with earliest maturing check variety NPJ 112 (1466 kg/ha).
- On the basis of RAPD analysis of 50 genotypes of Indian mustard, EC 552581, HBQM 16, MJB 5 and EC 597309 were found to be most divergent.
- Strain DRMR 541-44 of *B. juncea* was identified as high temperature tolerant at seedling stage. Strains DRMR243 and DRMR 270 of *B. carinata* showed tolerance to downy mildew and white rust diseases.
- Incorporation of mustard straw @ 2.5t/ha + green manure (*Sesbania*) increased mustard seed yield by 64.1%, lowered bulk density by 13.3% and improved infiltration rate, organic carbon content, available N and P over the control.
- Drip system of irrigation produced highest seed yield (1680 kg/ha) being *at par* with micro-sprinkler (1660 kg/ha). Maximum water use efficiency (28 kg/ha-cm) was recorded with drip irrigation but lowest in check basin (10.5 kg/ha-cm).
- The highest mustard equivalent seed yield was obtained under cluster bean- mustard (3344 kg/ha) followed by pearl millet-mustard (2149 kg/ha) cropping system with B:C ratio 2.15 under furrow irrigated raised bed.
- FIRB (1051.94 m^3) saved 1/3rd water as compared to CT (1535.17 m^3) and also gave high WUE (18.58 kg/ha-mm).
- Twenty five geographical isolates of *Sclerotinia sclerotiorum* were grouped on the basis morphological characters, mycelial compatibility and protein profile.
- Seed treatment (0.2%) and foliar spray (0.1%) of carbendazim gave significant (p= 0.05) reduction (93.0%) in Sclerotinia rot disease.
- HP Mustard spray oil @ 1.25%, 1.50% & 1.75% and dimethoate 30 EC @ 1 litre/ha resulted in 6.67, 16.67, 20.00 and 100% mortality of larvae of syrphid fly and 3.33, 6.67, 16.67 and 100% mortality of the grub of *C. septempunctata*.
- Out of 16 wild crucifers, *B. fructiculosa, B. spinescens, Capsella bursa pastoris*, *Crambe* sp. and *Lepidium* sp., were found tolerant to mustard aphid with average aphid infestation index ≤1.

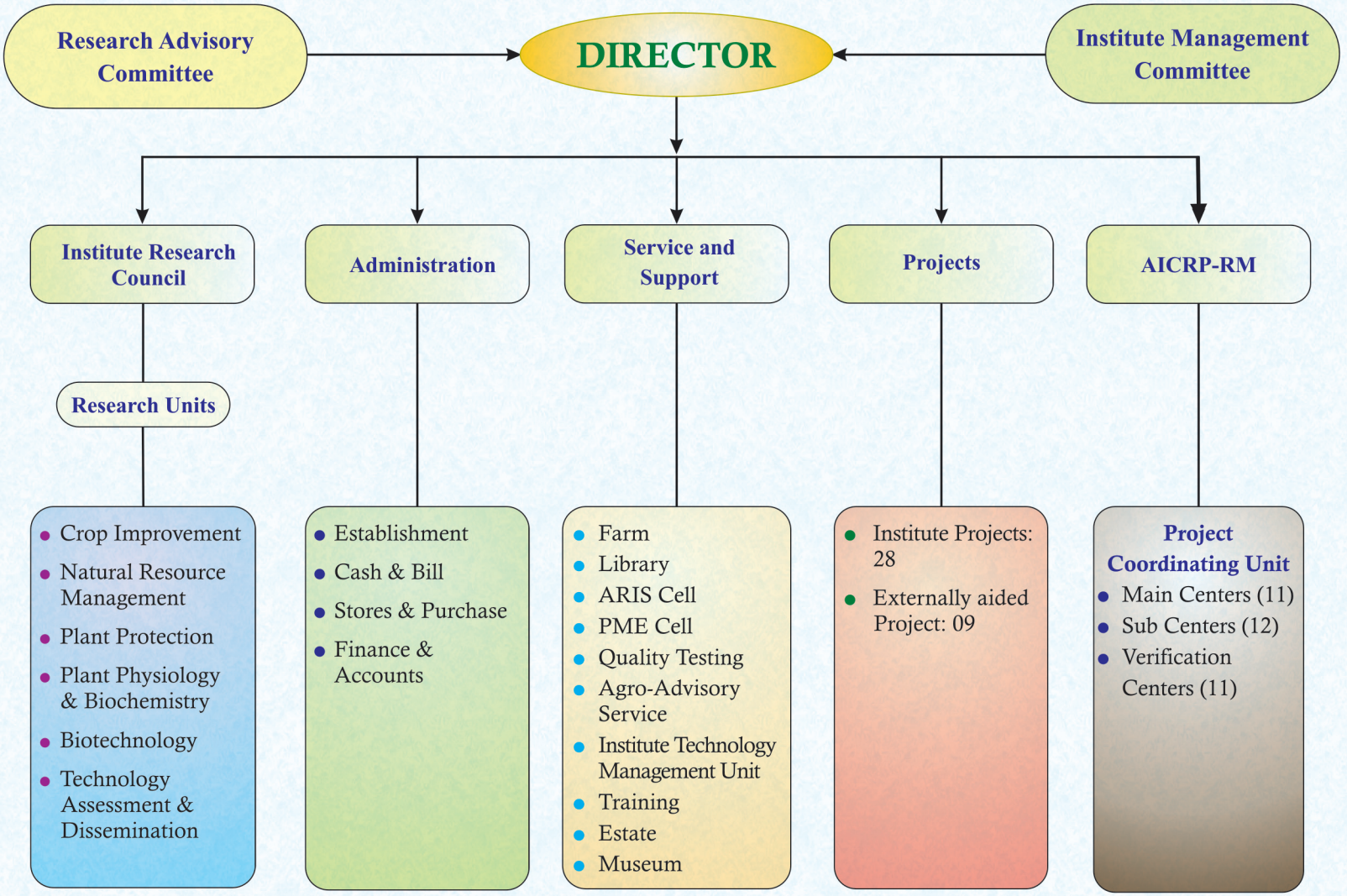
- On the basis of morpho-physiological characterization of 25 low Ä^{13}C mustard genotypes, BPR 349-9, BPR 541-4, BPR 543-2, BPR 549-9 and Urvashi were found promising for rainfed condition.
- Five genotypes of Indian mustard out of 70 i.e. RGN 13, VSL 5, NDYR 8, Swaran Jyoti and Vasundhra showed high temperature tolerance at seedling emergence with lowest seedling mortality.
- FTNIR calibration was developed for non-destructive estimation of total phenolic content of rapeseed mustard seed/seed meal.
- Of the 8 genotypes of rapeseed-mustard evaluated, the highest total phenolic content (20.32 mg/g gallic acid equivalent) as well as antioxidant activity (32.32 trolox equivalent mM/g) was observed in cv Kanti of Indian mustard.
- A modified protocol for isolation of genomic DNA from oilseed *Brassica* was standardized without using liquid nitrogen.
- Twenty five independent putative transgenic events have been developed in *Brassica juncea* var. NRCDR 2 using cotyledonary petiole explants harboring *TvD1* gene via *Agrobacterium tumefaciens*-mediated technique.
- Cross transferability and polymorphic potential of 162 STMS markers developed in different *Brassica* species were evaluated using 21 species of *Brassica* and allied genera. The average cross-transferability of these markers was 45.5%.
- One hundred and twenty four radio talks related to rapeseed-mustard research and development programmes and improved practices were broadcasted from 6 radio stations, Najibabad, Mathura, Agra and Rampur of Uttar Pradesh and Jaipur and Kota of Rajasthan.
- A 7-day farmers' training programme on seed production technology of *rabi* field crops (rapeseed-mustard, wheat, lentil and gram) and 17th Sarson Vigyan mela-cum-exhibition were organized.
- A total 15 research papers, 6 popular articles, 3 technical bulletins, 2 books and 4 book chapters were published.
- Four scientists of the directorate were awarded/ recognized by different societies/ organizations. ₹ 25, 76,000 was generated during 2010-11.

1 DRMR: An Overvew

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 strengthened the research programme on oilseeds, especially rapeseed-mustard. Accordingly, the rapeseed-mustard Project Coordinating unit was established on January 28, 1981 at Haryana Agricultural University, Hisar. During VIII Plan (1992-97) on October 20, 1993 ICAR established the 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 DRMR in the XI Plan (2007-12) vide letter no. F. No. 9 (7)/ 2007-1A III dtaed February 24, 2009. 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 programme through wide network of 11 main- and 12 sub-centers across the country in addition to need based verification centers 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 Roadways bus stand, respectively on Agra-Jaipur national highway. Bharatpur, internationally known for Keoladeo National Bird Sanctuary, is on the Delhi-Bombay main railway track just 35 km ahead of Mathura 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 77.27^0E longitude and 27.12^0N latitude and is 178.37m AMSL. 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 and Ethiopian mustard) crops. The mandate is as follows:

- National repository for rapeseed-mustard genetic resources and information.
- Basic, strategic and applied research to improve the productivity and quality of oil and seed meal.
- Development of ecologically sound and economically viable agro-production and protection technologies for different situations.
- Generation of location specific interdisciplinary information based on multilocation 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.

ORGANOGRAM


Research Advisory Committee
DIRECTOR
Institute Management Committee
Institute Research Council
Administration
Service and Support
Projects
AICRP-RM
Research Units
Crop Improvement
Natural Resource Management
Plant Protection
Plant Physiology & Biochemistry
Biotechnology
Technology Assessment & Dissemination
Establishment
Cash & Bill
Stores & Purchase
Finance & Accounts
Farm
Library
ARIS Cell
PME Cell
Quality Testing
Agro-Advisory Service
Institute Technology Management Unit
Training
Estate
Museum
Institute Projects: 28
Externally aided Project: 09
Project Coordinating Unit
Main Centers (11)
Sub Centers (12)
Verification Centers (11)

2 Research Achievements

2.1 Crop Improvement

DRMR CI 5: Development of hybrids in Indian mustard

Project Leader: K H Singh, Sr. Scientist (Plant Breeding)

Associate: J Nanjundan, Scientist (Plant Breeding)

Two strains, *viz.*, DRMRIJ 20 and DRMR 447 inducted to AICRPRM trials during 2009-10 were promoted to AVT I (2010-11) on the basis of superiority over the best checks. DRMRIJ 20 under irrigated (2604 kg/ha) and rainfed (2229 kg/ha) conditions performed better than the check RL 1359 (2428 kg/ha) and RB 50 (2029 kg/ha), respectively, in zone II. DRMR 447 (990 kg/ha) out yielded the best check Kranti (880 kg/ha) under late sown irrigated condition in zone V. Four new strains *viz.*, DRMR 258, DRMRIJ 31, DRMRHJ 3802 (hybrid) and DRMRHJ 44009 (hybrid) were inducted to various trials during 2010-11. One strain MCB 1 of *B. carinata* is being tested under national disease nursery for reaction to white rust disease.

Analyses of genetic diversity based on RAPD markers

Genetic diversity among 50 genotypes of Indian mustard including indigenous and exotic lines was assessed using 15 RAPD primers. Dendogram was constructed (DARWIN version 5.0 software) using statistical analysis involving generation of dissimilarity matrix based on average taxonomic distance and unweighted pair group method. Twelve of the 15 primers were found polymorphic which generated 85 fragments. The number of polymorphic bands/ primer ranged from 2 (OPB 10) to 10 (OPB 8) with an average value of 5.6. The fragment length varied from 150–1000 bp. Fifty genotypes were grouped into 4 major clusters. Cluster 1, 2 and 3 included 15, 13 and 18 genotypes, respectively. Cluster 4 had 4 genotypes. The 6 exotic lines, 3 and 2 were grouped into cluster 4 and 3, respectively. Maximum similarity (96.4%) was found between MJB 8 and MJB 11 followed by MJR 9-S and MJR 9-F. Most divergent lines were EC 552581, HBQM 16, MJB 5 and EC 597309.

Estimation of variability among inbreds

With the objectives of estimating the extent of variability, identification of promising lines and understanding the associations among different yield contributing traits, 250 inbred lines along with 3 check varieties (Maya, Rohini and Kranti) were planted in augmented block design keeping 15 blocks. Days to flower initiation, leaves at flower initiation, plant height at flower initiation, days to flower senescence, days to maturity, main shoot length, siliquae on main shoot, siliquae density, seeds/siliqua,1000-seed weight, plant height at maturity, biological yield, seed yield and harvest index were recorded. Analysis of variance revealed significant variation among genotypes for all the traits except days to maturity. The maximum phenotypic coefficient of variation (32.8%) was recorded for seed yield followed by biological yield (30%). The appreciable (>10%) variability observed for all the traits except days to maturity provides ample scope for further improvement through selection. Genotype HB

9910 was earliest to flower (34 day), DRMRIJ 118 had long main shoot (118 cm), 4-1-21 had high siliquae on main shoot (71). Genotype MJR 2 had high siliquae bearing density (1.2), HB 303-7 had short plant height (140 cm) while MJR 15 had maximum seed yield (610 g/row) and biological yield (3207 g/row). Harvest index was recorded up to 36.9% in the genotype 6-3-4. Seeds/siliqua were highest (21.5) in EC 552582 and 1000 seed weight was maximum (7.7 g) in 78-1-5-2. Seed yield had positive and significant correlation with days to flower senescence (r=0.13*), siliquae on main shoot (r=0.26**), plant height (r=0.15**), biological yield (r=0.87**) and harvest index (r=0.17**).

Evaluation of hybrids/promising strains

Sixteen experimental hybrids and 26 pure lines were evaluated in 4 station trials using replicated complete block design with 3 replications. Further, 50 F_{1s} were evaluated along with checks in augmented block design in single row plot of 2 m length. Three hundred eighteen inbred lines were also evaluated in augmented block design with 3 check varieties (Rohini, Kranti and Maya) in single row plot of 3 m length. Days to flower initiation, days to maturity, plant height, main shoot length were recorded.

Conversion of A and R lines

Fifteen *mori* CMS lines of Indian mustard were planted along with respective maintainer lines and 15 backcrosses (BC_1–BC_9) were attempted. One line of *B. carinata*, MCA 1 was maintained through backcrossing with its maintainer MCB 1. Similarly, 8 restorer lines were also planted for attempting back crosses (1 BC_8, 1 BC_6, 3 BC_5 and 3 F_1) with recurrent parent.

Selection from segregating generations

Single plant selection was made from 6 F_2: 78-1-1-2 x EC 597313, MJA 39 x MJR 14, KLM 227 x EC 597313, 39-3-2-3 x EC 597313, MJA 40 x MJR 9, MJA 39 x MJR 13; 6 F_3: MJA 25 x HB 101-1, MJA 34 x SSR 1-8, (EC 597309 x NUDHYJ 3) x RL 1359, EC 597313 x MJR 9, SSR 2 x WF 2 and DR 7 x HB 101); 6 F_4: HB 9918 x HB 9914, MJA 11 x SSR 1-9, ZEM 2 x BPR 6-166, MJA 26 x MJR 2 and 2 (hybrids) generations.

Generation of F_1 crosses

Ninety crosses in line x tester (15 x 6) design involving 78-1-1-6, QM 16, DU 38, BPR 6-166, YM 8, RS 2, PR 8988, HB 9909, DHR 991, NDR 8209, SSR 32-1-3, EC 399302, EC 399288, HB 101, YM 6 and NUDHYJ 3 x RL 1359, EC 597309, EC 597313, MJR 9, EC 399307, 39-3-1-1 were attempted and seeds were harvested. Ten crosses which have been identified as heterotic in earlier studies were also attempted involving genotypes MJA 8, MJA 25, MJA 34, HB 9918, 78-1-1-2, KLM 227, 39-3-2-3, 4-7-12-6, 56-1-16 and SSR 2-10, HB 101-2, TC 2-10, BPR 6-166, HB 9914, EC 597313. In addition, 26 test crosses and 10 inter-specific crosses between *B. juncea*, *B. carinata*, *B. napus* and *B. rapa* were also attempted.

Multiplication of parental lines

Seeds of 8 A lines were produced by growing them with their respective maintainers in plots covered by nets. Seeds of 7 promising strains and 8 experimental hybrids were also produced in isolation.

DRMR CI 6: Management of rapeseed - mustard genetic resources

Project Leader: J Nanjundan, Scientist (Plant Breeding)

Associates: K H Singh, Sr. Scientist (Plant Breeding); N S Bhogal, Sr. Scientist (Soil Science);

Maharaj Singh, Sr. Scientist (Plant Physiology); and Vinod Kumar, Scientist (Computer application)

Characterization of Indian mustard accessions

With an objective to develop core collection in Indian mustard, 450 germplasm accessions available at the DRMR (Table 2.1) belonging to different geographical regions of the country were grown for characterization in augmented block design along with 3 checks (Kranti, Maya and RGN 73). Flowering pattern, leaf (7) and flower morphological traits (3) were recorded.

Table 2.1: Indian mustard accessions under characterization

Geographical origin	Accessions (number)
North East	50
Himachal Pradesh	117
Punjab	75
Jaipur region	13
Uttar Pradesh	81
Hyderabad region	69
Gujarat	45
Total	**450**

Development of trait specific gene pool in Indian mustard

The oil content ranged from 40.0-42.7% with low coefficient of variability (3%) in 185 Indian mustard accessions.

Maintenance of germplasm

One thousand one hundred ten accessions of rapeseed-mustard comprising Indian mustard (761), toria (177), yellow sarson (121), gobhi sarson (30), taramira (11) and karan rai (10) were maintained by adopting proper pollination control.

Acquisition

One hundred two accessions of rapeseed-mustard (IVT and AVT strains) were obtained from various cooperating centers under AICRPRM network.

Distribution

One hundred fifteen accessions were distributed to various government and non-government research organizations including SAUs for use in research programme. Fourteen accessions promoted for testing under AVT II during 2010-11 were submitted to NBPGR for seeking IC numbers and long term conservation in the National Gene Bank.

Registration of genetic stocks

Four germplasm accessions with unique traits were registered with NBPGR, New Delhi. NRCGS 1 (INGR 10048), an early and dwarf *B. napus* line derived from inter-specific hybridization [BEC 107 (*B. juncea*) and NRCGS 11 (*B. napus*)], NRCKR 304 (INGR 10049) an early maturing, long main shoot and bold seeded line derived from interspecific cross of Varuna (*B. juncea*) x BPKR 13 (*B. carinata*), BPR 541-4 (INGR 10050) salinity tolerant at seedling stage, high WUE, thermo tolerant at terminal stage derived from the cross MDOC 8 x PCR 7 and BPR 543-2 (INGR 10051) thermo tolerant at juvenile stage, high WUE derived from the cross TM 2 x PCR 9202.

DRMR CI 9: Genetic enhancement of Indian mustard by characterizing and introgressing the novel traits from the related species for biotic stresses

Project Leader: S S Meena, Sr. Scientist (Plant Breeding)

Associates: P D Meena, Sr. Scientist (Plant Pathology); V V Singh, Sr. Scientist (Plant Breeding)

Two strains, DRMREJ 902 and DRMR 904 gave 10% higher seed/oil yield, hence promoted to AVT 1 (early sown) in zone V and late sown in zone III, respectively. Five strains (DRMREJ 2010-

1, DRMREJ 2010-2, DRMR 2010-4, DRMR 2010-5, DRMR 2010-6) have been included in IVT for multilocation testing under coordinated varietal trials during 2010-11 crop season.

Development of early maturing Indian mustard genotypes

Nineteen early maturing genotypes and 5 checks, NPJ 112, SEJ 2, NPJ 124, EJ 20, PR 2006-1 were planted in randomized complete block design with 3 replications in 5 rows of 5 m length. Three strains, DRMR 2011-1, DRMR 2011-2 and DRMR 2011-9 gave significantly higher seed yield, oil content and 1000-seed weight with comparable maturity with earliest maturing check variety NPJ 112 (Table 2.2).

Table 2.2 : Performance of promising advanced strains

Strains	Pedigree	Days to 50% flowering	Days to maturity	1000 seed wt. (g)	Oil content (%)	Seed yield (kg/ha)
DRMR 2011-1	HC 2 x BEC 107	41	118	5.2	41.4	1580
DRMR 2011-2	HC 2 x BEC 107	44	119	4.8	42.0	1597
DRMR 2011-5	SEJ 2 x K 28	50	123	4.2	42.5	1466
DRMR 2011-9	NRCM 351 x NBPGR 619	45	120	4.1	41.6	1613
DRMR 2011-11	PCR 7 x BPKR 13	46	121	4.7	41.5	1250
DRMR 2011-12	Rohini x GSL 1	32	113	4.8	41.2	1187
DRMR 2011-18	MDOC 43 x NBPGR 36	30	112	5.4	42.6	923
Checks						
NPJ 112 (Pusa mustard 25)		37	116	4.5	41.2	1466
SEJ 2 (Pusa agrani)		51	127	4.8	41.5	1720
EJ 20		50	122	4.0	42.3	1596
PR 2006-1		48	129	4.9	42.3	1573
NPJ 124		44	122	4.3	41.9	1547
CD (p=0.05)		**5.0**	**9.0**	**0.6**	**1.2**	**108**

Yield trials

Thirty four strains and 6 check varieties/hybrids *viz.*, NRCDR 2, DMH 1, PAC 32, Kranti, Maya, Rohini were planted in RCBD with 3 replications. The trial was sown on October 11, 2010 and plot size was 5 rows of 5 m length for each strain.

White Rust

Yield evaluation of white rust resistant strains

One hundred forty five strains derived from 32 crosses of Indian mustard with high level of white rust disease resistance were planted in augmented block design keeping 4 blocks.

The check varieties Rohini, Maya and Kranti were replicated thrice in each block. The trial was sown on October 25, 2010 and plot size of each strain was 2 rows of 4 m length. A set of these lines was also planted at GBPUAT, Pantnagar for screening against local pathotype of *Albugo candida*.

Creation of variability

Twenty fresh crosses among high yielding varieties and white rust resistant strains were attempted for introgressing disease resistance in high yielding back ground.

Alternaria blight

Twenty six putative lines selected during the previous year on the basis of low Alternaria blight disease score were planted for further screening

NRCDR 2 x 10-2243 (GSL 1 x BIO 902), NRCDR 2 x 10-2341 (RH 819 x BPKR 13) x (NBPGR 272 x RK 9903), NRCDR 2 x 10-2269 (GSL 1 x BIO 902) x PYSR 2), NRCDR 2 x 10-2178 (RH 819 x BPKR 13) x RH 819 x MDOC 3), NRCDR 2 x 10-2326 (RH 819 x BPKR 13) x (PYSR 2 x PBR 181), NRCHB 101 x 10-2269 (GSL1 x BIO 902) x PYSR 2), NRCHB 101 x 10-2178 (RH 819 x BPKR 13) x RH 819 x MDOC 3), NRCHB 101 x 10-2341 (RH 819 x BPKR 13) x (NBPGR 272 x RK 9903), NRCHB 101 x 2178 (RH 819 x BPKR 13) x RH 819 x MDOC 3), Ashirwad x 10-2243 (GS 1 x BIO 902), Ashirwad x 10-2178 (RH819 x BPKR 13) x RH819 x MDOC 3), Ashirwad x 10-2506 (GSL 1 x BIO 902) x (RH 819 x MPC 3), Urvashi x 10-2269 (GSL 1 x BIO 902) x PYSR 2), Urvashi x 10-2448 (GSL 1 x BIO 902) x (Rohni x Hyola 401), Urvashi x 10-2178 (RH 819 x BPKR 13) x RH 819 x MDOC 3), Urvashi x 10-2506 (GSL 1 x Bio 902) x (RH 819 x MPC 3), Rohini x 10-2178 (RH 819 x BPKR 13) x RH 819 x MDOC 3), Rohini x 10-2506 (GSL 1 x BIO 902) x (RH 819 x MPC 3), Rohini x 10-2243 (GSL 1 x BIO 902)

and yield evaluation. Sowing was done in augmented block design in 3 blocks using plot size of 3 rows of 5 m length. The strains were artificially inoculated for enhancing disease pressure. The disease was scored on the basis of lesion size and type on leaves and pods. Progenies derived from the crosses (EC 399299 x EC 399301) x (PHR 2 x EC399313), (EC 399299 x EC 399301) x (PAB 9511 x PAB 9534), (EC 399299 x EC 399301) x (EC 399301 x PAB 9534), (PAB 9511 x PAB 9534) x (EC 399313 x PHR 2), EC 399301 x JMM 915, EC 399299 x JMM 915, PAB 9534 x EC 399313, PAB 9534 x EC 399313, PAB 9534 x EC 399299 were selected on the basis of disease score of 10-20% for Alternaria blight intensity as compared to check. The same set was also planted at Pantnagar.

DRMR CI 10: Population improvement for higher productivity and oil content in Indian mustard under normal and moisture stress conditions

Project Leader: V V Singh, Senior Scientist (Plant Breeding)

Associates: S S Meena, Sr. Scientist (Plant Breeding), Maharaj Singh, Sr. Scientist (Plant Physiology)

Four promising strains were inducted for multi location testing under AICRPRM during 2010-11. One strain, DRMR 541-44 of *B. juncea*, identified as tolerant to high temperature at seedling stage. Strains DRMR243 and DRMR 270 of *B. carinata* showed tolerance to downy mildew and white rust diseases.

Yield evaluation

Two station trials consisting of 7 strains and 6 checks (RGN 73, Rohini, Kranti, NRCHB 101, Maya, NRCDR 2) and 8 strains with 4 checks (RGN 73, Kranti, Maya, NRCDR 2) were conducted under irrigated conditions in randomized complete block design with 3 replications in 6 rows of 5 meter length. Data on days to 50% flowering was recorded. A station trial with 20 strains and 3 checks (Bio 902, PCR 7, and RB 50) was conducted in randomized complete block design with 3 replications in 6 rows of 5 m length at DRMR, Bharatpur and SKNCOA, Jobner under limited moisture conditions.

Evaluation of half-sib progenies

One hundred eighty half-sib progenies derived from the base population developed after 2 cycles of random mating were evaluated in augmented block design along with base population and checks (RGN 73, Kranti, NRCDR 2 and Maya). Similarly, 250 half-sib progenies developed for high oil content were evaluated in augmented block design along with check Rohini.

Generation of breeding material

Thirty F_1s along with parents and 12 F_2 populations were grown for evaluation and generation advancement. 100 crosses were

attempted as per NCD I with a view to develop full-sib progenies for next cycle of full-sib progeny selection.

Selection from segregating generations

Segregating and non-segregating generations [F_3: 509 SPS (24 crosses), F_5: 67 lines (20 crosses), F_6: 43 (27 crosses), observation nursery 60 (27 crosses)] were sown in augmented blocks design with checks under irrigated conditions. Under rainfed conditions, [F_3 :100 (3 crosses), F_4 :90 (5 crosses), F_5 :60 lines (DRMR and Jobner) and 120 lines (DRMR only), observation nursery 40 lines (DRMR and Jobner) and 45 lines (DRMR only) were evaluated and selections were effected.

Population synthesized from selected half-sibs after first cycle of selection was grown in isolation under rainfed conditions for selection of moisture stress tolerant plants for 2nd cycle of half-sib progeny selection. Another population derived from selected half-sibs for high oil content was also grown in isolation.

Genetic studies

An experiment involving 6 generations (F_1, F_2, BC_1, BC_2 , P_1 and P_2) was grown in randomized complete block design with two replications to study genetics of water use efficiency. The data on days to 50% flowering, SPAD value and transpiration have been recorded. Correlations were worked out for yield and its component characters in a set of full-sib families. Seed yield/ plant showed positive and significant correlation with plant height (r=0.256**), seeds/ siliqua (r=0.258**), 1000-seed weight (r=0.335**), oil content (r=0.311**) and protein content (r=0.286**). Among physiological characters, seed yield/plant showed positive and significant association with SPAD reading at both flowering (r=0.319**) and grain filling (r=0.335**) stage and transpiration at flowering stage (r=0.216*). Drought tolerant lines (on the basis of drought susceptibility index) of *B. juncea* derived from interspecific crosses were subjected to DNA fingerprinting for variability. The progenies could be distinguished from each other by means of a combination of fragments which is repeatedly present in one progeny and absent in other.

DRMR CI 11: Molecular mapping of fertility restoring gene for *moricandia* cytoplasmic male sterility in Indian mustard

Project Leader: K H Singh

Associate: Binay Kumar

70 crosses involving diverse genotypes were attempted to develop the mapping population for fertility restoring gene for *moricandia* cytoplasmic male sterility in Indian mustard.

DRMR CI 12: Widening of gene pool in *Brassicas* through interspecific and intergeneric hybridization

Project Leader: Arun Kumar, Sr. Scientist (Genetics & Cytogenetics)

Twenty four interspecific/intergeneric crosses involving *B. juncea, B. rapa, B. napus, B. carinata B. nigra, S. alba, B. fruiticulosa*, *E. canariense* were attempted.

Standardization of protocol for embryo rescue

Ovary culture protocol for interspecific cross *B. juncea* x *B. fruiticulosa* was standardized using MS medium.

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

Project Leader: K H Singh, Sr. Scientist (Plant Breeding**)**

BIO 902, LET 21, NRCDR 601, NRCHB 506, MJA 5, MJB 5, MJR 1 (parental lines), RB 50, Rohini, RGN 145 and Varuna of *B. juncea*; Agrani and Panchali of toria and NRCYS 05-02 and YSH 401 of yellow sarson were evaluated as per DUS guidelines. In another experiment recently released varieties/ advance strains EJ 17, EJ 20, HYT 33, LET 1-27, LET 17, LET 18, LET 36, NPJ 93, NPJ 112, NPJ 113, NPJ 124 and Tarak of *B. juncea* and IGC 01 and Pusa Aditya of *B. carinata* and 3 example varieties (Bio 902, Rohini and Varuna)

were tested for DUS characteristics. 20 traits which included 3 traits: leaf, seed coat and flower colour were recorded visually; 2 traits: days to flowering and maturity were recorded on the basis of group of plants; 11 traits: number of leaf lobes, leaf length, leaf width, length of petals, width of petals, main shoot length, plant height, siliqua length, siliqua beak length, siliquae number on main shoot and siliquae density on main shoot were recorded on 20 plants or parts of 20 plants/ replication; 5 traits, leaf hairiness, leaf lobes, dentation of margin, siliqua angle and siliqua surface texture were also recorded visually. 110 varieties were sown in 3 row plots of 5 m length for maintenance of self/sib seed.

DRMR EA 4: ICAR seed project on seed production in agricultural crops

Project Leader: V V Singh, Senior Scientist (Plant Breeding)

Associates: S S Rathore, I/C Farm; A K Sharma, Sr. Scientist (Agril. Extension)

TL seed production of mustard varieties, Rohini, Urvashi, NRCHB 101, Laxmi, BIO 902 and Maya was taken up. Participatory seed production programme of mustard varieties NRCDR 2 and Rohini was given to Madhuri Kund Farm, Veterinary University, Mathura and Farmers field, respectively. TL seed of Dhaincha varieties PD 1 (13.8 q) and DH-1 (7.2 q) were also produced.

2.2 Physiology and Biochemistry

DRMR PHY 2: Screening of mustard genotypes for high temperature tolerance at seedling stage

Project Leader: Maharaj Singh, Sr. Scientist (Plant Physiology)

Associate: J S Chauhan, Director

Twenty strains of *B. juncea* were screened for high temperature tolerance at seedling stage. The experiment was conducted in plastic trays. One set of trays was kept in BOD incubator and seeds were allowed to germinate and grow at 25±1^{0}C. The other set of trays was exposed to 4 hrs high temperature treatment (45±1^{0}C) and thereafter allowed to grow at 25±1^{0}C. The experiment was replicated thrice in RCBD. The carbohydrate content and amylase activity was measured in embryo of seeds soaked for 12 hrs. Activities of peroxidase and superoxide dismutase were measured in the 4- days-old seedling. The mortality due to high temperature was measured as percent killed seedlings at 5th, 6th and 7th days after seed soaking.

Seedling mortality varied from 12.8 (BPR 543-2) to 44.2% (BPR 542-14). Urvashi, NPJ 92, BPR 349-9, NRCDR 02, NRCDR 601, JR 042, JN 033, RB 50, BPR 541-4, JN 032 and RH 8814 showed < 20% seedling mortality. The amylase activity decreased significantly under high temperature and was maximum in BPR 543-2 followed by NRCDR 601. All the Australian strains except JN 033, showed lower activity as compared to tolerant Indian lines. The carbohydrate content was least in BPR 543-2 followed by RB 50 and JN 032. The high temperature increased the activity of antioxidative enzymes like peroxidase which was maximum in BPR 543-2 followed by Urvashi. BPR 543-2 showed higher tolerance as compared to other strains. The other promising genotypes were JN 033, Urvashi and NPJ 92.

DRMR PHY 3: Morpho-physiological and biochemical basis of drought tolerance in Indian mustard

Project Leader: Maharaj Singh, Sr. Scientist (Plant Physiology)

Associate: J S Chauhan, Director

To study the effect of drought on morpho-physiological characters, an experiment with 25 mustard genotypes was conducted in RCBD under irrigated and rainfed conditions. There were 5 rows of 5m length for each genotype. The spacings between rows and within row was kept 30 and 10 cm, respectively. The fertilizer dose of 40 N: 40 P_2O_5 and 20 K_2O kg/ha was applied before sowing and remaining 40 kg N/ha was given after the first irrigation while in case of rainfed experiment, the full recommended dose of fertilizer (80: 40: 40 kg/ha) was given at the time of sowing. The need

based plant protections measures were followed. Plants from 50 cm row length/replication were taken to record observations on yield and yield attributing characters. The leaf gas exchange parameters were measured on a fully expanded main stem leaf using CIRAS-2 PP system at bolting and full flowering stage. Water use efficiency at cellular level was computed as the ratio of assimilation to transpiration and expressed as $\mu mol^s/mmole$. Photosynthesis ($\mu mol^s/m^2/sec$) under irrigated condition varied from 10.2 to 19.4 (BPR 349-9) at flowering stage and 16.5 (BPR 537) to 24.6 (BPR 549-9) at bolting stage, while under rainfed condition from 9.8 to 15.7 (BPR 549-9) at flowering and 13.2 (BPR 125-1) to 20.5 (NRCDR 2) at bolting stage (Table 2.3). Genotypes BPR 349-9, BPR 549-9, BPR 541-4, Urvashi and BPR 543-2 showed higher photosynthesis than others under irrigated and rainfed conditions. Water use efficiency varied from 3.31(BPR 537) to 8.24 (BPR 349-9) at bolting stage and 2.72 (BPR 537) to 7.44 (BPR-349-9) at flowering stage under irrigated condition. Under rainfed conditions it increased significantly and showed variation between 5.23-10.9 (bolting stage) and 5.32-8.31 (flowering stage). Primary branches/plant under irrigated condition varied from 4.0 (BPR 538-12) to 9.3 (BPR 139-8) while under rainfed conditions from 3.7 (BPR 541-3) to 8.3(BPR 139-8). Maximum pods on primary branches were in Varuna (218.0) under irrigated conditions, while BPR 139-8 under rainfed conditions recorded the higher (186.7) pods on primary branches. Similarly, maximum secondary branches under irrigated conditions were observed

Table 2.3: Range, mean and coefficient of variance (CV) for different characters under irrigated and rainfed condition

Character	Range		Mean/± SEm	CV(%)
	Minimum	Maximum		
WUE (IR) at BS	3.31 (BPR 537)	8.24 (BPR 349-9)	5.4 ± 0.22	20.8
WUE (IR) at FS	2.72 (BPR 537)	7.44 (BPR 349-9)	5.0± 0.22	22.0
WUE (RF) at BS	5.23 (BPR 549-2)	10.9 (BPR 543-2)	7.0± 0.25	17.7
WUE (RF) at FS	5.32 (BPR 540-6)	8.31 (BPR 549-9)	6.5 ± 0.18	13.9
Photosynthesis(IR) at BS	16.5 (BPR 537)	24.6 (BPR 549-9)	21.5± 0.62	14.4
Photosynthesis (IR) at FS	10.2 (BPR 125-1)	19.4 (BPR 349-9)	13.0± 0.56	16.5
Photosynthesis(RF) at BS	13.2 (BPR 125-1)	20.5 (NRCDR 2)	18.2 ± 0.48	13.2
Photosynthesis (RF) at FS	9.8 (BPR 125-1)	15.7(BPR 549-9)	13.1± 0.36	13.4
Gs* (IR) at BS	245.4 (BPR 125-1)	469.7 (BPR 549-9)	335.7± 12.5	18.6
Gs (IR) at FS	210.1 (BPR 125-1)	412.2(BPR 549-9)	295.2± 10.6	18.0
Gs (RF) at BS	176.8 (BPR 172-7)	331.2(BPR 542-14)	247.2 ± 8.5	17.2
Gs (RF) at FS	155.4 (BPR 125-1)	268.4(BPR 542-14)	209.5± 6.43	15.3
Plant dry wt.(IR) at BS	7.6 (BPR 541-3)	16.4 (Varuna)	12.6± 0.49	19.5
Plant dry wt. (IR) at FS	15.3 (BPR 549-2)	30.4 (BPR 139-8)	21.5± 0.87	20.3
Plant dry wt.(RF) at BS	4.6 (BPR 541-3)	12.4 (Varuna)	8.2 ± 0.43	25.9
Plant dry wt. (RF) at FS	11.3 (RLM 619)	21.8 (BPR 538-12)	15.4 ± 0.61	19.7
Seed yield (IR)	8.2 (BPR 537)	17.3 (BPR 349-9)	13.0 ± 0.38	14.8
Seed yield (RF)	6.9 (BPR 549-2)	13.7 (BPR 543-2)	9.6 ± 0.33	16.8
Oil content (IR)	40.5 (BPR 540-6)	42.9 (BPR 541-3)	41.8 ± 0.13	1.6
Oil content, % (RF)	40.2 (NRCDR 601)	43.6(RLM 619)	41.9 ± 0.16	1.9
1000-seed wt. (IR)	4.0 (BPR 540-6)	5.9(BPR 349-9, BPR 549-2)	5.0 ± 0.11	10.5
1000-seed wt. (RF)	3.7 (BPR 538-12)	5.3 (BPR 543-2)	4.4 ± 0.08	11.2

*Gs- stomatal conductance

in BPR 549-9 (19.0) as compared to BPR 538-12 (3.3). Under irrigated conditions the maximum seed yield was recorded in BPR 349- 9 followed by BPR 541-4 while under rainfed conditions maximum seed yield was observed in BPR 543-2 followed by Urvashi. Thus on the basis of high water use efficiency, total plant dry matter and seed yield , BPR 349-9, BPR 541-4, Urvashi, BPR 549-9 and BPR 543-2 strains were identified as potential genotypes for utilization in the breeding programme.

DRMR B 6: Analytical procedure for FT-NIR for mass screening and value edition

Project leader: Manju Bala, Sr. Scientist (Biochemistry)

Associates: Satyanshu Kumar, Sr. Scientist (Organic Chemistry), Sandeep Kumar, Scientist (Biochemistry)

To estimate total phenolic content in seed/ seed meal of rapeseed mustard, calibration was developed using FT- NIR. Total phenolic content was estimated using photometric Folin-Ciocalteau assay, using gallic acid as standard (0.1-0.5 mg). Spectra of intact seed samples were recorded in 13400-4000 cm^{-1} region. Each spectrum was the average 32 scans. The calibration developed is being further modified to cover wider range of values.

Phytochemical constituents of seed meal

Total phenol, flavonoid and radical scavenging activity in methanolic extracts of seed meal from eight Indian rapeseed-mustard varieties were determined (Table 2.4). The methanolic extract was found to have different levels of antioxidant properties in the DPPH (1, 1-diphenyl, 2-picrylhydrazine) and ABTS (2, 2-azobis-3-ethylbenzthiazoline-6-sulphonic acid) systems. Both activities increased with increasing concentration of the sample extracts. Highest total phenol content was observed in *Brassica juncea* variety Kanti (20.32 mg/g gallic acid equivalent (GAE). Significant correlation between DPPH radical scavenging activity and total phenol content (r=0.726**) was observed.

2.3 Natural Resource Management

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

Project Leader: O P Premi, Sr. Scientist (Agronomy)

Associates: B K Kandpal Principal Scientist (Agronomy), S S Rathore, Sr. Scientist (Agronomy)

Table 2.4: DPPH activity, ABTS activity, reducing power assay, total phenol and flavonoid content of different rapeseed-mustard varieties

Species	Genotypes	DPPH (Trolox equivalent mM/g)	ABTS (Trolox equivalent mg/g)	Reducing power (GAE mg/g)	Total phenols (mg/g)	Total flavonoids (µg/g)
B. juncea	Kanti	32.32±0.53	13.95±0.40	20.55±0.88	20.32±0.46	518.60±42.09
	Rohini	30.46±0.71	14.66±0.26	20.40±0.24	17.14±0.74	357.08±10.21
	Sej 2	26.65±0.51	11.85±0.28	20.18±0.08	18.14±0.45	255.09±05.88
B.rapa var.	B 9	26.22±0.17	11.50±0.48	17.10±0.31	13.75±0.35	425.34±12.14
yellow sarson	YST 151	24.43±2.28	12.60±0.32	24.12±0.72	14.98±0.04	306.72±18.48
	RS 1	28.38±0.20	11.10±0.06	18.66±0.66	14.85±0.24	263.25±15.04
B.rapa var. toria	BR 23	27.34±0.18	10.57±0.27	21.13±0.32	15.30±0.32	146.24±06.80
	PT30	26.15±0.93	09.53±0.20	23.01±0.10	15.22±0.47	311.55±16.71
CD(p=0.05)		2.88	0.94	1.52	1.30	58.08

A long-term experiment under fallow – Indian mustard system, was started during 2005-06 to evaluate the effect of organic manures and fertility levels on mustard productivity and physico-chemical properties of the soil. The initial fertility status of the experimental field was clay loam (25% sand, 41% silt and 34% clay) inceptisol (Typic Ustochrepts) with a pH of 8.1, electrical conductivity 0.60 dS/m, organic carbon 2.6 g/kg, available N 95.4 kg/ha available P 5.4 kg/ha and exchangeable K 267 kg/ha. The soil bulk density was 1.50 Mg/m^3 and infiltration rate was 5.9 mm/hr. The experiment was conducted in split-plot design with 3 replications. Three organic manure treatments, *viz.*, control (fallow-mustard), mustard straw @ 2.5t/ha + *Sesbania* (green manure) - mustard, *Sesbania* (green manure) + *Azotobactor* (100g/kg mustard seed) were split in to sub-plots of 8 fertility levels ($N_{80,40}$, $P_{17.4,8.7}$ and $K_{0, 33.3}$ kg/ha). *Sesbania* was sown in first week of July with recommended doses of fertilizers and were incorporated in to the soil after 45 days of sowing. The mustard straw was incorporated in to the soil at the time of sowing of *Sesbania.* The mustard crop was sown in the first fortnight of October during all the cropping seasons. Other recommended package of practices, including insect, pests and weed control were followed as and when required. Soil samples were collected after harvest of the fifth year's mustard crop. The soil samples were analysed for physico-chemical properties, using standard laboratory methods. Incorporation of mustard straw @ 2.5t/ha + green manure (*Sesbania*) increased mustard seed yield by 64.1% over the control (Fig 2.1). Bulk density of soil decreased due to the adoption of green manure crop with or without mustard straw residue over no manures. Growing of *Sesbania* as green manure lowered the bulk density by 6.7% over control. Further, the bulk density was lowered by 13.3% with the addition of mustard straw + *Sesbania* green manure. Mustard straw + green manure improved the soil infiltration substantially. The lowest rate of infiltration was observed with fallow-mustard whereas, rate of infiltration with organic manures was higher. Similarly balanced nutrition had better infiltration rate as compared to low fertility levels. *Sesbania* green manuring alone or along with mustard straw increased organic carbon content significantly over the control. Due to these organics, the improvement in the organic carbon content was noticed to the tune of 0.095 and 0.125 over no manure and initial level.

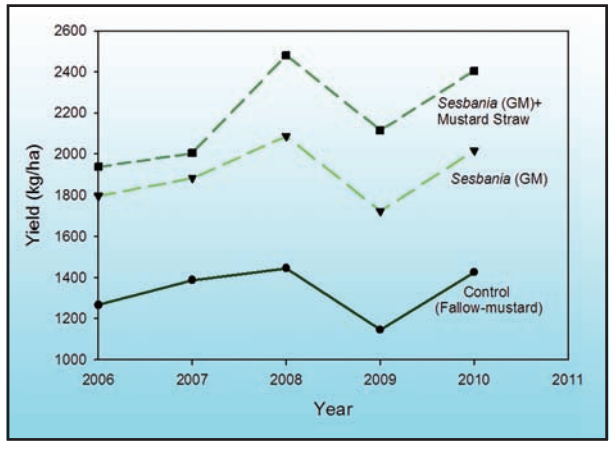


Fig 2.1: Effect of organic treatments on seed yield of Indian mustard

Significantly higher content of carbon was recorded with 40 kg N + 8.7 kg P but *at par* with that of same fertility + 33.3 kg K. Incorporation of mustard straw + *Sesbania* had more available soil nitrogen and phosphorus followed by *Sesbania* green manuring but significantly superior to control. The increase in available N, P and K was 24.9, 72.2 and 26.4%, respectively, over their initial level. The increasing fertility levels caused corresponding improvement in available nitrogen, phosphorus and potassium after 5th year of experimentation.

DRMR CP 10: Standardization of micro-irrigation and fertigation for mustard crop under semiarid conditions

Project Leader: S S Rathore, Sr. Scientist (Agronomy)

Associates: B K Kandpal, Principal Scientist (Agronomy), O P Premi, Senior Scientist (Agronomy) and Kapila Shekhawat, Scientist (Agronomy)

An experiment consisting of 5 irrigation methods in main-plot, *viz.,* micro-sprinkler irrigation system (MS), micro sprinkler followed by check basin (MS+CB), drip irrigation system (DS), drip irrigation followed by check basin (DS+CB) and check basin (CB) irrigation system and 4 nitrogen doses *viz.,* Control (0 N), 40 kg/ha N, 80 kg/ha N and 120 kg/ha of N doses in sub-plot was conducted during rabi 2010-2011 in split-plot design with 3 replications. The soil pH varied from 8.1-9.0. The soil was poor in available nitrogen, medium in available phosphorus and potash. Significantly higher seed (1660 and 1680 kg/ha), oil (710 and 730 kg/ha) and protein (340 and 320 kg/ha) yields were recorded in micro sprinkler and drip irrigation systems followed by micro irrigation along with the check basin irrigation systems. Among fertigation treatments, 80 kg N /ha was found *at par* with the 120 kg N /ha in enhancing seed (1680 and 1780 kg/ha), oil (760 kg/ha of each) and protein (340 and 300 kg/ha) yields. Maximum water use efficiency was recorded with drip irrigation, which was *at par* with that of micro-sprinkler irrigation system. Compared to check-basin irrigation system, the water use efficiency was higher in other irrigation treatments. The response of different levels of fertigation on WUE by mustard seed yield with respect to mini-sprinkler, drip and check basin irrigation systems has been depicted in Fig. 2.2.

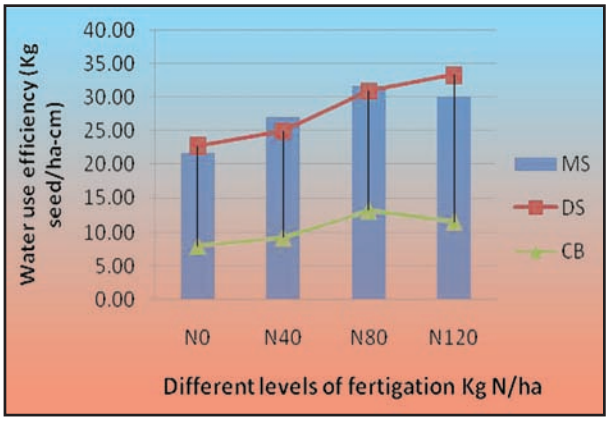


Fig 2.2: Water use efficiency in response to the irrigation systems and levels of fertigation

DRMR CP 11: Evaluation and standardization of resource conservation technologies (RCTs) for mustard based cropping systems in semi-arid conditions of Rajasthan

Project leader: Kapila Shekhawat, Scientist (Agronomy)

Associates: B K Kandpal, Principal Scientist (Agronomy), S S Rathore, Senior Scientist (Agronomy) and N S Bhogal, Senior Scientist (Soil Science).

To assess the impact of various RCTs on growth, yield attributes and yield, soil properties, soil moisture dynamics and economics of mustard based cropping systems, 5 cropping systems, *viz.*, fallow-mustard, green manure-mustard, brown manure-mustard, cluster bean (*Cyamopsis tetragonoloba*)-mustard and pearl millet (*Pennisetum glaucum*)-mustard were analysed under conventional tillage (CT), reduced tillage (RT), zero tillage (ZT) and furrow irrigated raised beds (FIRB) in split-plot design.

The maximum system productivity and mustard equivalent yield of 2427 and 2393 kg/ha, respectively, was obtained under FIRB as compared to various tillage methods. Hence, the B:C ratio was also highest (2.5) in FIRB followed by RT. The B:C ratio under CT and ZT was similar. The pH varied from 8.1-8.4 under various tillage methods. The highest system productivity was found in pearl millet-mustard cropping system (2925 kg/ha) which was *at par* with that of the cluster bean-mustard cropping systems (2796 kg/ha). The highest mustard equivalent yield (3344 kg/ha) was obtained under cluster bean- mustard cropping system because of the higher market price of cluster bean. The highest B:C ratio (2.15) was obtained with cluster bean-mustard system followed by pearl millet-mustard (1.87) which was superior over the remaining three systems. The water applied was maximum (1535.17 m^3/ha) in the CT treatment. The water applied in FIRB was 1051.94 m^3, resulting in appreciable water saving. Water use efficiency (WUE) was also higher under FIRB,

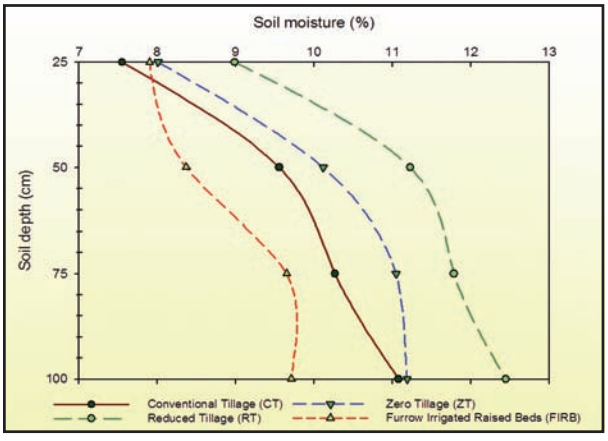


Fig 2.3: Residual soil moisture profile after harvest under various tillage methods

followed by RT (11.23 kg/ha-mm). The maximum residual moisture was recorded in RT (Fig 2.3).

DRMR SS 1: Nutrient efficiency under saline, alkali and normal condition of soil and water in mustard crop

Project Leader: N.S. Bhogal, Senior Scientist (Soil Science)

The effect of zinc and boron interaction in zinc and boron deficient soil (0.48 ppm zinc and 0.41 ppm boron) was studied using NRCDR 2 as a test variety. A split-plot design was used with 4 levels of zinc (0, 12.5, 25.0, 37.5 kg $ZnSO_4$/ha) as main and 4 levels of boron (0, 5, 10 15 kg borax/ha) as sub-plots in the plots of 3.0 x 4.0 m with 4 replications. Recommended dose of fertilizer (N: P_2O_5: K_2O:: 80 : 40 : 20 kg/ha) was added as the basal dose except N of which half of the dose was added at the time of sowing and remaining after the first irrigation. The application of boron increased boron uptake to the tune of 55.3 % at 15 kg borax /ha as compared to control.

2.4 Plant Protection

DRMR ENT 2: Biological control of major pests of *Brassica* with special reference to mustard aphid

Project Leader: Y P Singh, Principal Scientist (Agricultural Entomology)

Associate: S P Singh, Sr. Scientist (Agricultural Entomology)

Evaluation of normal and cold tolerant *Coccinella septempunctata*

Laboratory reared and field collected cold tolerant *Coccinella septempunctata* (collected under severe cold condition having the minimum temperature nearly 5°C) was evaluated for their feeding potential under controlled condition in environmental chamber/BOD. Ten adults of each of laboratory reared and field collected cold tolerant *C. septempunctata* were kept separately in Petri-dishes. Each Petri-dish having the *C. septempunctata* were provided 50 mustard aphid as food which was counted after 24 hrs and replaced again. Observations were made for 3 days at 15-20°C temperature and 70% humidity.

Evaluation of artificial diets for the mass rearing of *Coccinella septempunctata*

10 artificial diets and control were evaluated in laboratory for the mass rearing of *C. septempunctata* having the ingredients i.e. proteinex, nutripet, homefood plus agar powder, honey, yeast powder, methyl parafen, ascorbic acid, vitamin B. complex, formaldehyde (10%) and distilled water in different combinations.

DRMR ENT 3: Plant-pest interaction of major pests of *Brassicas*

Project Leader: Y P Singh, Principal Scientist (Agril. Entomology)

Associates: S P Singh, Sr. Scientist (Agril. Entomology), Manju Bala, Sr. Scientist (Biochemistry), J S Chauhan, Director

Population dynamics of insect pests in rapeseed-mustard

Four species of rapeseed-mustard *i.e.* PCR 7 (Indian mustard), GSC 6 (gobhi sarson), BSH 1 (brown sarson) and T 27 (taramira) in 3 replications were sown on 2 dates, i.e. October 15, 2010 (timely sown) and December 4, 2010 (late sown). The population of insect pests was observed on weekly basis. Pollinators other than

the honey bee were also recorded and specimens collected were sent for identification.

Monitoring of mustard aphid on yellow sticky traps

The population of alate mustard aphid (*Lipaphis erysimi* Kalt.) was monitored with the help of yellow sticky traps in the field. The population of alate aphid was very low this year.

Toxicity of HP Mustard Spray Oil to honey bee and natural enemies

Under laboratory conditions, 8 treatments, i.e. HP Mustard Spray Oil @ 0.50%, 0.75%, 1.00%, 1.25%, 1.50% & 1.75%, dimethoate 30 EC @ 1 litre/ha and control were evaluated for the toxicity against the larvae of syrphid fly and adult and grub of *Coccinella septempunctata.* HP Mustard Spray Oil @ 0.50%, 0.75% and 1.00% did not cause any mortality of larvae of syrphid fly and grub of *C. septempunctata*. HP Mustard Spray Oil @ 1.25%, 1.50% & 1.75% and dimethoate 30 EC @ 1 litre/ha resulted in 6.67, 16.67, 20.00 and 100% mortality of larvae of syrphid fly and 3.33, 6.67, 16.67 and 100% mortality of the grub of *C. septempunctata.* Mortality of *C. septempunctata* was 6.67%, 10.00% and 100.00% in HP Mustard Spray Oil @ 1.50%, 1.75% and dimethoate 30 EC @ 1 litre/ha, respectively.

DRMR ENT 6: Bioassay studies of mustard aphid on wild crucifers

Project Leader: S P Singh, Senior Scientist (Entomology)

Associate: Y P Singh, Principal Scientist (Entomology)

Seventeen wild crucifers i.e. *Brassica tournifortii, B. fructiculosa, B. spinescens, B. rugosa, Camelina sativa, Diplotaxis muralis, D. assurgens, D. sattiana, D. gomezcampoi, D. tenuisiliqua*, *Entharocarpus lyratus, Capsella bursa pastoris*, *Lepidium* sp., *Crambe* sp., *Sinapis alba* and Kateli sarson were grown in covered pots for screening against mustard aphid, *Lipaphis erysimi* (Kalt.) while 6 different genotype of wild crucifers namely *B. tournifortii, B. rugosa, C.rambe sp*., *Lepidium sp., S. alba, Arabidopsis thaliana* Kateli sarson were also grown in the field. Cultivated *Brassicas* i.e. *B. rapa* (BSH 1), *B. juncea* (Rohini), *B. napus* (GSC 6), *B. carinata* (DLSC 2) and *Eruca sativa* (T 27) were also grown in pots as well as in the field for comparison. Twenty aphids were released in each pot and covered with net. Out of these, *B. fructiculosa, B. spinescens, C. bursa pastoris*, *Crambe* sp. and *Lepidium* sp., were found resistant to mustard aphid with average aphid infestation index (AA II) ≤1 in pot experiment where known number of mustard aphid was released while other genotypes were found susceptible to highly susceptible (AAII 3-5). *B. rapa* (BSH 1), *B. napus* (GSC 6), *B. carinata* (DLSC 2) and *Eruca sativa* (T 27) grown in pots were susceptible (AAII 3-4) and *B. juncea* (Rohini) was highly susceptible (AAII 5). Under field condition mustard aphid pressure was negligible.

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

Project Leader: Pankaj Sharma, Senior Scientist (Plant Pathology)

Associates: P D Meena, Sr. Scientist (Plant Pathology), Sandeep Kumar, Scientist (Biochemistry)

Morphological variability in *Sclerotinia sclerotiorum* isolates

Twenty five different geographical isolates of *Sclerotinia sclerotiorum*, collected from different parts of Rajasthan, Uttar Pradesh, Uttarakhand, West Bengal, Madhya Pradesh, Bihar, Punjab, Jammu & Kashmir and Himachal Pradesh states, were studied for morphological and cultural variability. On the basis of morphological data, isolates were grouped into two major clusters I and II which showed only 7% similarity with each other. In cluster I, the mycelial growth on PDA was recorded between 30.4 to 40.0 mm but sclerotia length was 4 mm in all the isolates. Similarly, all the isolates had e"4.0 pH of the cultural filtrate. Group A comprised SR05, SR09,

SR20 and SR21 and showed variability for all the characters observed. Group B included the isolates which had 35 and 38.4 mm growth on PDA after 96 hrs of inoculation, 0.40 and 0.43 g dry mycelial weight and sclerotia length was 6 and 5 mm, respectively. Further, isolates in both the groups formed sclerotia in 9 days each and weight/ sclerotium was also similar. Group C consisted of isolates which showed 90 mm growth on PDA after 96 hrs of inoculation and sclerotial length was about 3 mm. Group D contained isolates having 90 mm growth on PDA after 96 hrs of inoculation and sclerotial length was about 4 mm. In this group SR 01 showed maximum similarity with SR 06 (36%). Similarly, SR 03, SR 12 and SR 19 also showed maximum (36%) similarity to each other.

Mycelial compatibility group (MCG)

Mycelial compatibility is the ability of two strains of filamentous fungi to anastomose and form one continuous colony. As an easy test for self-recognition, mycelial compatibility has been extremely useful in intraspecific isolates comparisons. Compatible pairings formed one confluent colony while incompatible pairings produced a visible reaction in the interaction zone.

The compatibility and incompatibility among 25 geographical isolates were considered as 0 and 1 and data recorded were used for cluster analysis. The first cluster comprised 7 isolates namely SR 19, SR 23, SR 21, SR 22, SR 25, SR 20 and SR 24. SR 20 and SR 24 got separated from other isolates at a similarity coefficient of 60%.

Based upon the cross reaction 40% variability was obtained. SR 19, SR 23, SR 21, SR 22 and SR 25 showed 65% similarity among the isolates in cluster II. In this cluster the cross reactivity range of isolates was within first 20 isolates, *i.e.* from SR 01 to SR 20. Major cluster II was occupied by 19 isolates which showed 74% similarity among them. In this group, the isolates showed cross reactivity with SR 13 and from SR 18 to SR 25. In this group SR 06 and SR 07 showed maximum similarity because these did not react with any of the other isolates.

Effect of culture filtrate on seed germination and seedling vigour

Culture filtrate of all the different geographical isolates of *S. sclerotiorum* (25) caused significant reduction (%) in seed germination of *Brassica juncea* which was minimum in SR 15 (53.3%) followed by SR 3 and SR 18 while it was maximum in case of SR 19 (83.3%). Highest pre-emergence mortality was recorded in SR 15, however post-emergence mortality of seedlings were maximum in SR 08 followed by SR 19 (Fig 2.4). The culture filtrate of SR 08 and SR 14 inhibited significantly radicle and plumule length over control. Minimum inhibition of radicle length was observed in SR 21 and SR 01 while for plumule length it was in SR 02 and SR 01.

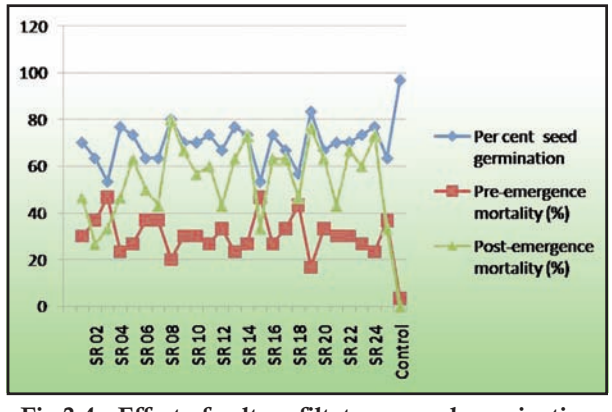


Fig 2.4 : Effect of culture filtatre on seed germination and seedling mortality

Protein profile based characterization of *Sclerotinia sclerotiorum* isolates

Sclerotia of 19 different geographical isolates were used to study protein banding pattern and genetic diversity among the isolates with SDS-PAGE. A total of 25 bands was observed having

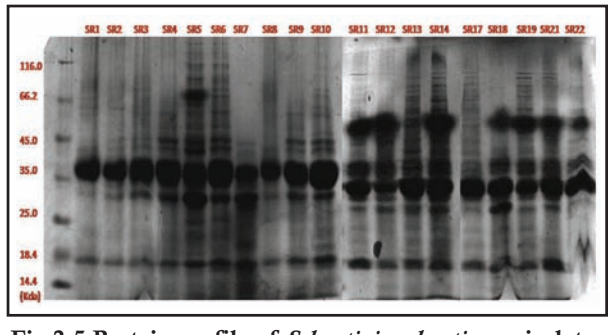


Fig 2.5 Protein profile of *Sclerotinia sclerotiorum* isolates

Rm value ranging from 0.14 to 0.72 and all the bands were obtained only in SR 14 isolates (Fig 2.5). The similarity indices for different isolates ranged from 0.32 to 1.0 indicating high variability among the isolates. SR 06 and SR 19 were 100% similar and the minimum similarity (32%) was between SR 02 and SR 14, SR 06 and SR 07, SR 07 and SR 19, SR 07 and SR 22. The average similarity index value was 0.66. They were grouped into two major clusters at a similarity coefficient of 0.50. Major cluster I was further divided into clusters A and B at a similarity coefficient of 0.672. Cluster A was further divided into two sub-clusters (i) and (ii) at a similarity coefficient of 0.687. Cluster II was further divided into clusters C and D at a similarity coefficient of 0.742.

Effect of various treatments on biochemical profile of *Brassica juncea* plants

Seed treatment (0.2%) and foliar spray (0.1%) of carbendazim gave significant (p= 0.05) disease reduction (93.0%) among the treatments over control. All the treatments, in general, resulted into higher accumulation of phenol, glucosinolates and total sugars compared to control. Seed treatment with carbendazim and spray (0.1%) at flowering stage was found to be highly effective in reducting Sclerotinia disease.

In general, total phenols, glucosinolates and sugars increased in all the plant parts up to 60 DAS and thereafter it decreased at 90 DAS. Leaves had higher phenols, glucosinolates and sugars followed by shoot and root.

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

Project Leader: P D Meena, Sr. Scientist (Plant Pathology)

Associates: Pankaj Sharma, Sr. Scientist (Plant Pathology), Sandeep Kumar, Scientist (Biochemistry)

Thirty isolates of *Alternaria brassicae* collected from Jammu & Kashmir, Uttrakhand, Himachal Pradesh, Uttar Pradesh, Rajasthan, Haryana, Bihar, West Bengal, Assam, Meghalaya and Nagaland were studied for variability within species by mycelial biomass and sporulation using 5 different liquid culture media, *viz.*, Asthana and Howker's, Brown's, Czapek's, Elliot and Richard's media. The fungal growth of each isolate was obtained by wet and oven dried mycelial biomass.

Different test synthetic media showed profound variation in wet mycelia biomass of *A. brassicae* isolates infecting rapeseed-mustard. Maximum wet mycelial biomass of *A. brassicae* isolates (BAB 48, BAB 42, BAB, 40 and BAB 44) was recorded in Elliot's, followed by Brown's and Czapeck's media. However, least mycelial wet biomass was observed for all isolates in Asthana & Howker's medium.

Least mycelial dry weight was observed for all the isolates in Brown's and Asthana & Hawker's media. Maximum sporulation was observed in isolate BAB 28 followed by isolate BAB 18 in Eilliot's and Asthana & Howker's media. Brown's medium showed no sporulation in all the isolates. Differential sporulation of *A. brassicae* isolates indicated that the fungus require organic sources of nutrition for better growth and sporulation.

DRMR NP 5: Diagnosis and management of leaf spot diseases of field and horticultural crops

Project leader: P D Meena, Sr. Scientist (Plant Pathology)

Associate: Pankaj Sharma, Sr. Scientist (Plant Pathology)

Variability among *Alternaria brassicae* isolates

Cultural and morphological variability

A. brassicae isolates showed variable cultural characteristics varied from regular to irregular, cottony white, dark green to light brown mycelial growth and based on characteristics, all *A. brassicae* isolates were grouped into 4 colony types. Group 1 consisted of colonies showing lettuce green to olive green and prominent (2-5 mm) white margin. Colony texture was fluffy to woolly. Group 2

isolates produced pale olive grey to olive grey colonies, often with a very thin (1-2 mm) white margin with woolly to cottony colony texture. Group 3 isolates produced dark olive grey to iron grey colonies with wavy or torn margin and fluffy to woolly colony texture. Group 4 isolates produced white to pale gray or apricot orange colonies with a cottony texture. Tufts of sterile white hyphae were present at the center of the colony.

Based on the conidial chain structure, the unidentified isolates were grouped into 4 groups. Mean conidia size was 182.8 x 41.0 µm with a beak size of 95.0 µm (41.4–180.0 µm). Mean transverse and longitudinal septa number were 4.4 and 0.7, respectively (Fig 2.6). Conidia length in different groups varied a lot. Group I: > 250 µm (isolates BAB 06, BAB 18 and BAB 50), Group II: 200-250 µm (BAB 23, BAB 41 and BAB 49), Group III: 150-200 µm (BAB 02, BAB 04, BAB 20, BAB 29, BAB 30, BAB 40, BAB 42, BAB 47 and BAB 48) and Group IV: 100-150 µm (BAB 08, BAB 19, BAB 28, BAB 39, BAB 43, BAB 44 and BAB 45)

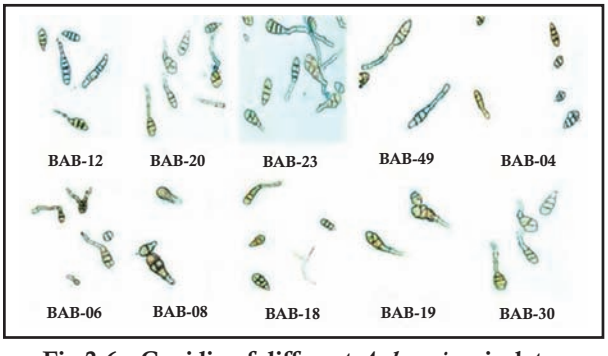


Fig 2.6 : Conidia of different *A. brassicae* isolates

Pathogenic variability

Thirty isolates were also evaluated for their pathogenic response by detached leaf technique on different species of *Brassica* and related genera under controlled laboratory conditions. Isolates of *A. brassicae* showed variable response on various *Brassica* species. Tolerance was observed in *Eruca sativa, B. juncea* (PAB 9511) and *S. alba* against all isolates, which matched with natural Alternaria blight severity reported on these hosts earlier.

Fungicide sensitivity

Four test fungicides showed variable mycelial growth of 22 *A. brassicae* isolates grown in potato dextrose agar medium used as food poisoning technique. Maximum per cent mycelial growth inhibition over control was observed in Ridomil-MZ fungicide with a wide variation from 5.1% (BAB 41) to 92.1% (BAB 48). However, fungicide Kavistin gave least mycelial growth inhibition over control ranging from 3.6% (BAB 42) to 86.1% (BAB 08). Isolates, BAB 08, BAB 18 and BAB 20 were found sensitive to fungicides showing similar response against all the four fungicides. Some isolates (BAB 40, BAB 42, BAB 44, BAB 45) seemed to be highly virulent which showed resistance against these fungicides. Results indicated that all test fungicides showed inhibition in the mycelia growth over control but differed in extent of inhibition.

Developed repository of *Alternaria brassicae*

Twenty two pure single spore *A. brassicae* isolates with passport data have also been deposited to develop the national repository at NBAIM, Mau (UP) and accession numbers were allotted (NAIMCC-F-02599- NAIMCC-F-02620).

DRMR PP 5: Epidemiology and management of white rust

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

Associates: Pankaj Sharma, Senior Scientist (Plant Pathology), V V Singh, Senior Scientist (Plant Breeding)

An experiment was laid out under RCBD in plot size 5 x 4.8 m, spacing 30 x 10 cm on 3 dates of sowing at 2 weeks interval starting from October 27, 2010 with 4 replications using cv. Rohini to study the epidemiology of white rust disease. Weather data were recorded to correlate it with disease severity.

Another experiment was laid out in RCBD using 10 treatment combination including control. The sowing was done on October 27, 2010 in plot size of 5 x 3 m with spacing of 30 x 10 cm. The seed treatment with Apron SD was done @ 6g/kg seed at the time of sowing whereas, other chemicals, *viz.*, Dithane M 45 (0.2%), Ridomil (0.2%) and

Multineem (0.1%) were applied individually and in combination after 60 and 75 days of sowing with seed treatment. Two PGPR strains, *viz.*, *Pseudomonas fluorescence* and *Bacillus subtilis* were used as foliar spray after 60 and 75 days of sowing.

Twenty promising genotypes of rapeseed-mustard including cv Rohini (susceptible check), were raised in 3 rows of 3 m length with 30 x 10 cm spacing for screening under artificially inoculated conditions. The sowing was done on October 27, 2010. Artificial inculcation was done after 60 and 75 days of sowing using zoosporangial suspension (10^3sporangia/ml) of *A. candida*. Observations on disease severity were recorded before the inoculation on December 25, 2010 followed by 1st and 2nd inoculation on January 27 and February 16, 2011, respectively.

DRMR NP 2b: ICAR-NPTC: *Brassica* functional genomics for Alternaria blight and drought/heat tolerance

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

Associates: P D Meena, Sr. Scientist (Plant Pathology), Binay Kumar Singh, Scientist (Biotechnology), V V Singh, Sr. Scientist (Plant Breeding), Pankaj Sharma, Sr. Scientist (Plant Pathology)

Development of recombinant Inbred Lines (RIL)

Out of Rohini x PHR 2, Rohini x PBR 97, Rohini x EC 399301 (QTLs mapping for *Altrenaria* tolerance), Rohini x RH819 and Rohini x NRCDR 2 (QTLs mapping for drought/ heat tolerance) crosses, F_3 seeds of cross combinations Rohini x PHR 2, Rohini x PBR 97 and Rohini x RH 819 were raised for generation advancement in single row of 3 m length with 45x15cm spacing. Segregation pattern for morphological traits was observed at vegetative as well as reproductive stage. Populations were segregated for violet colour mid-rib and veins, plant vigour, plant height, flowering initiation and days to maturity. Disease incidence (*Alternaria* blight) in terms of number of lesions and size were recorded on 3rd leaf at both vegetative and reproductive stages. Genomic DNA from F_3 population of cross Rohini x PHR2 was isolated and quantified.

Interspecific hybrids derived from cross combination *B.* juncea x B. *carinata* and *B.* juncea x B. *napus* were intermediate to parental species in respect various traits, i.e. main shoot length, days to flower, days to maturity. High pollen fertility (95%) was observed in all the parents as compared to F_1s (55% in *B. juncea* x *B. carinata* and 72% in *B. juncea* x *B. napus*). Cytogenetic analysis of progenies between *B. juncea* (2n=36[AABB] = {*B. campestris*=20 +*B. nigra*=16}) and *B. carinata* (2n=34[BBCC] = {*B. nigra*=16+*B. oleracea* =18}) revealed (2n=35 [ABBC] {*B. campestris*=10 +*B. nigra*=16 +*B. oleracea*=9}) in the F_1 progenies. On the other hand F_1 progenies of *B. juncea* x *B. napus* showed chromosome configuration (2n=37[AABC]. Out of 162 pollen mother cells of the hybrids analyzed at diakinesis not a single PMC was observed to be deviated with their expected chromosome configuration. All the observed PMCs showed 2n=35 and 2n=37 in *B. juncea* x *B. carinata* and *B. juncea* x *B. napus* crosses respectively. Minimum two quadrivalent and maximum of thirteen bivalents were observed. The mode of chromosome association observed was 10 II + 2 IV + 1 III + 4 I, 13 II + 2I V + 0 III + 3 I. Parental polymorphism and hybrid confirmation was performed using RAPD and SSR markers. Out of 55 primers of arbitrary sequences screened for their ability to produce polymorphic amplicons, 43 gave reproducible, scorable and distinct polymorphic patterns. A total of 706 RAPD products were scored using these primers. The size of bands ranged from 550 to 2100 base pairs similar to the previously reported range in *Brassica* germplasm. However, out of 706 scored bands, about 83 % were polymorphic (Fig 2.7). A total 35 SSR primers were screened for parental polymorphism (Fig 2.8). Out of these, 12 set of primers were used for F_1 characterization. Heterozygocity resulted by the SSR markers confirmed the F_1 progenies. Fragments were sized (100 to150bp) by measuring the distance migrated in relation to a 100 bp molecular marker. The SSR bands were scored as present (1) or absent (0), each of which was treated as an independent character regardless of its intensity.

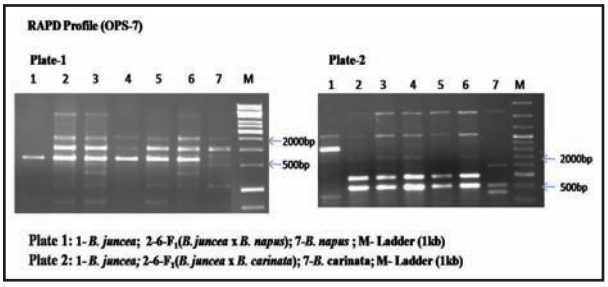


Fig 2.7 : RAPD profile of interspecific F_1s

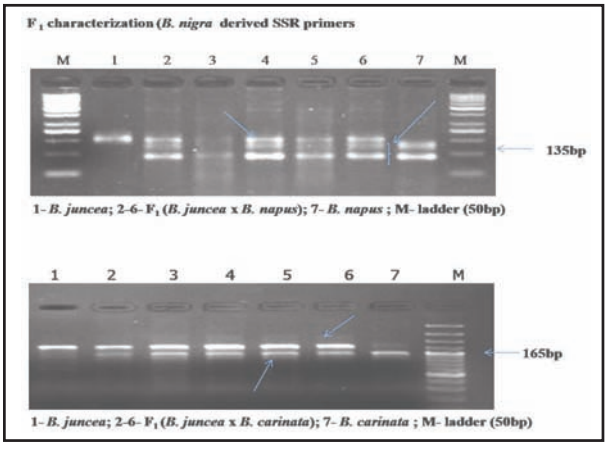


Fig 2.8 : SSR profile of interspecific hybrids

In addition, modified protocol for isolation of genomic DNA from oilseed *Brassica* was also standardized without using liquid nitrogen. Isolated DNA was in sufficient amount and suitable for long term storage. The protocol was equally good for isolation of genomic DNA from pulses and pearl millet. The modified protocol enables rapid, low-cost and safe DNA extraction as compared to one using liquid nitrogen. An ovule clearing protocol was also standardized in rapeseed- mustard using a series of alcohol: methylsalicilate solution to examine early stages of ovule, embryo sac structure and pollination. Protocol could be better utilized in crop improvement program through pure line selection as well as wide hybridization.

2.5 Biotechnology

DRMR BT 1: *In vitro* plant regeneration and genetic transformation of *Brassica juncea* L. Czern. & Coss. with an antifungal defensin gene

Project Leader: Ajay Kumar Thakur, Scientist (Biotechnology)

A high frequency plant regeneration protocol has been standardized for *Brassica juncea* var. NRCDR 2 using cotyledonary petiole explants. To study the promoting effect of $AgNO_3$ on shoot bud formation and explants regeneration, the optimum shoot regeneration medium was supplemented with various concentrations of $AgNO_3$ in the range of 5-25 mg/l through filter sterilization. The frequency of shoot formation increased significantly when explants were cultured on shoot regeneration medium containing 5 and 10 mg/l $AgNO_3$. By the addition of $AgNO_3$ (10 mg/l) to MS medium, explant regeneration frequency was not affected but the shoot buds formed/explant increased from 4.56 (control) to 6.73. The regenerated plantlets were acclimatized successfully under the green house conditions. Eighty per cent survival of plants was observed during hardening.

Twenty five independent putative transgenic events have been developed in *Brassica juncea* var. NRCDR 2 using cotyledonary petiole explants harboring *TvD1* gene via *Agrobacterium tumefaciens*-mediated technique of gene transfer. Molecular characterization of the putative transgenic plants is in progress (Fig 2.9).

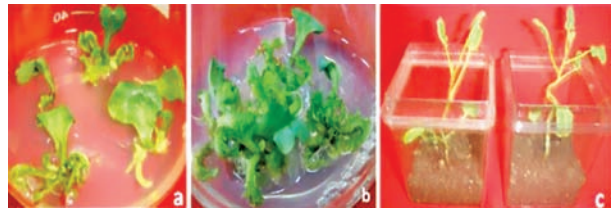


Fig 2.9 : *In vitro* plant regeneration in *Brassica juncea* var. NRCDR2 from cotyledonary petiole explants

a. Shoot bud induction from cotyledonary petiole explants after 10 days in culture on shoot regeneration medium; **b.** Shoot regeneration after 10 days in culture on shoot regeneration medium supplemented with 10 mg/l $AgNO_3$; **c.** Acclimatized plantlets growing in peat moss.

DRMR BT 3: Assessment of cross-transferability and polymorphic potential of genomic STMS markers of *Brassica* species

Project Leader: Binay Kumar Singh, Scientist (Biotechnology)

Cross transferability and polymorphic potential of 162 Sequence Tagged Micro Satellite Markers developed in different *Brassica* species were evaluated using 21 species of *Brassica* and allied genera. Data analysis of cross-transferability of 66 STMS markers to five different species of *Brassica* and related genera revealed that markers derived from *Brassica napus*, *Brassica nigra* and *Brassica rapa* showed significant cross-transferability. Of the total 66 markers used 56 (84.8%) produced clear DNA bands. However, only 32 (48.5%) STMS markers showed cross-transferability to atleast one of five different species used in the study. PCR amplification pattern of Na 14-F11 and Na 14-G02 (*B. napus* derived), Ni 4-A03 and Ni 4-A10 (*B. nigra* derived) and Ra2-E 04 and Ra2-E11 (*B. rapa* derived) has been shown in Fig. 2.10. Of the total 32 cross-transferable STMS markers 23 (71.9%) amplified in *Sinapis alba* followed by 19 (59.4%) in *Brassica tournifortii*, (17) 53.1% in *Eruca sativa* and 10 (31.25 %) in *Lepidium sativum.* In case of *B. nigra*, 17 (85%) out of 20 cross-transferable STMS markers (excluding cross-transferable markers of its own origin) amplified to produce clear DNA bands.

Nine of the 11 STMS markers derived from *B. napus* gave amplification in at least one of the species accounting for a total cross-transferability of 81.8% (Fig 2.11a). The cross-transferability of these markers was maximum (88.9%) in *S. alba* and *B. nigra.* 36 *B. nigra* derived markers were evaluated for cross-transferability of which 14 markers amplified only in the species of their origin (*B. nigra*). Remaining 12 STMS markers amplified in atleast one of the species other than *B. nigra* accounting for a total cross transferability of 33.3%. The cross-transferability of these markers was maximum (66.7%) in *Sinapis alba* and *Eruca sativa* followed by *Brassica tournefortii* (58.3%) (Fig 2.11b).

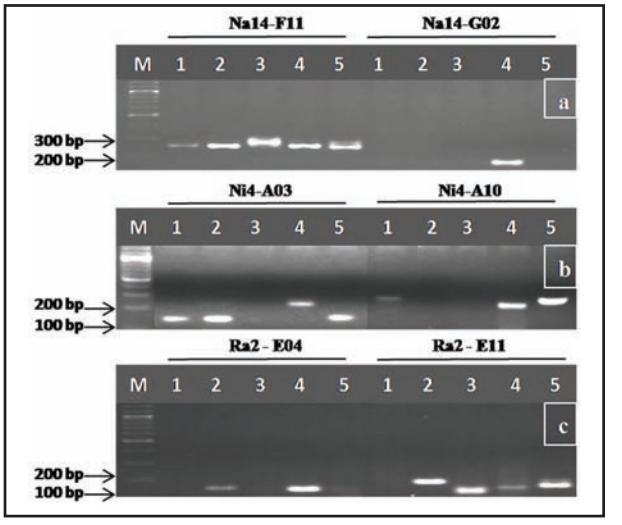
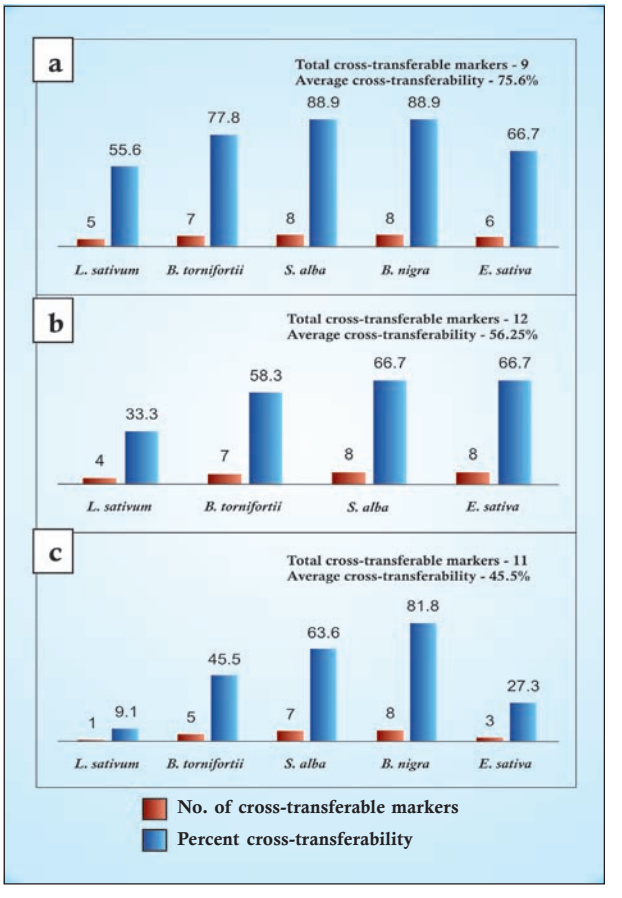


Fig 2.10 : PCR amplification pattern obtained with STMS markers (a) *Brassica napus* derived markers NA14-F11 and Na14-G02 **(b)** *Brassica nigra* derived Ni4-A03 and Ni4-A10 **(c)** *Brassica rapa* derived markers Ra2-E04 and Ra2-E11. Lane M - 100- bp DNA ladder, Lane 1- *Lepidium sativum,* Lane 2- *Brassica tornifortii,* Lane 3- *Sinapis alba,* Lane 4- *Brassica nigra,* Lane 5- *Eruca sativa*



2.11 : Extent of cross-transferability of STMS markers derived from *Brassica napus* (a) *Brassica nigra* **(b)** and *Brassica rapa* **(c)**.

11 of the 19 STMS markers derived from *Brassica rapa* amplified in at least one of the species used in the study accounting for a total cross-transferability of 57.9% (Fig 2.11c). Cross-transferability of these markers was maximum (81.8%) in *Brassica nigra* followed by *Sinapis alba* (63.6%). The average cross-transferability of these markers was 45.5%.

DRMR NP 2a: ICAR–NPTC: Development of aphid resistant transgenic Brassica

Project Leader: Ajay Kumar Thakur, Scientist (Biotechnology)

Associates: P K Rai, Principal Scientist (Plant Pathology) and Y P Singh, Principal Scientist (Entomology)

Twenty five independent putative transgenic events of *Brassica juncea* var. Rohini and Pusa Bold were developed with chickpea (*Cicer arietinum*) lectin gene via *Agrobacterium tumefaciens*-mediated technique of gene transfer. Molecular characterization of the putative transgenic plants is in progress.

2.6 Technology Assessment and Dissemination

DRMR ECT 1: Study the pattern of rapeseed-mustard production problems, indigenous technical knowledge (ITK) and impact assessment of technology transfer programme

Project Leader: S K Jha, Sr. Scientist (Agril. Extension)

Associate: A K Sharma, Sr. Scientist (Agril. Extension)

The acreage of rapeseed-mustard in 3 major states of India namely Rajasthan, Haryana and Gujarat has reduced in the recent past. The reduction in area of rapeseed-mustard in 2009-10 over the base year 2004-05 has been 36, 27 and 39 %, respectively. Presence of competitive crops with higher return, small return from rapeseed-mustard due to stagnant support/output price and high cost of cultivation, urbanization in certain area, etc. were presumed to be associated with the reduction in rapeseed-mustard acreage in these states. In order to learn the specific reason(s) for reduction in area of rapeseed-mustard in theses states, it was envisaged to survey one important district in each of the three states. Hence, Tonk district of Rajasthan, Banaskantha district of Gujarat and Bhiwani district of Haryana were selected for the study and it was planned to find out the responses of 60 farmers from each of the district on a structured schedule, besides conducting focus group discussions with the farmers on this important issue and collecting secondary data to substantiate the findings. The process of data collection on the structured schedule is underway.

In the *rabi* 2010-11 season, 2 focus group discussions held in Wasra village (Deesa taluka) and Dhelana village (Palanpur taluka) of Banaskantha district of Gujarat by a multi-disciplinary team from DRMR-AICRPRM cooperating centres have given the preliminary indication that the acreage of mustard in these villages have been drastically reduced due to low profitability. The reflections of the participating farmers have been summarized below.

- Groundnut-Potato/Wheat-Pearl millet (summer), Fallow-Mustard-Pearl millet (summer) and Sorghum (*chari*)-Castor-Pearl millet (summer) were the prevailing cropping systems in the area.
- Potato (November 1st fortnight- February 1st fortnight) and castor (August 1st fortnight - March 2nd fortnight) with higher profitability due to better marketing support were the two crops competing with mustard (October 1st fortnight-February 2nd fortnight).
- The productivity of mustard has been low due to high terminal temperature (forced maturity) coupled with biotic stresses (powdery mildew, white rust, aphid and *Orobanche).* Its average productivity was 1200 kg/ha. Against this, the average productivity

of castor was 1500 kg/ha and that of potato was 25000 kg/ha.

- During the last three years, per quintal market price of mustard in local *mandi* had come down to Rs. 2,000 from Rs. 3,000 while that of castor had gone up by 3 times from Rs 2,000 to 6,000 and that of potato had been encouraging with the increased intervention of processing industries which was about Rs. 500.

- The gross return/ha from mustard, castor and potato happened to be Rs. 24,000, Rs. 90,000 and Rs. 1,25,000, respectively at the prevailing market price. The cost of cultivation was estimated to be about 50% of the gross return in case of mustard and potato and 30% in case of castor but higher magnitude of net return/ha from potato (Rs. 62,500) and castor (Rs.63,000) has tilted majority of the farmers (almost 90%) away from mustard completely in these villages.

DRMR ECT 2: Study the adoption pattern and farmers' perception of technological advances

Project Leader: A K Sharma, Sr. Scientist (Agril. Extension)

Associates: S K Jha, Sr. Scientist (Agril. Extension), Vinod Kumar, Scientist (SS), (Computer application in Agriculture) and R C Sachan, Technical Officer

The level of adoption of improved mustard production technology by the farmers and the constraints faced by them in adopting these technologies were studied based on the data collected from 150 farmers who visited DRMR, Bharatpur to seek technical guidance and visit of experimental fields. These farmers belonged to Bharatpur (35) and Dausa (25) districts of Rajasthan, Aligarh (30) and Badaun (10) districts of Uttar Pradesh and Palwal (50) district of Haryana.

For studying adoption level, a standardized adoption scale developed by the investigators was used to collect the data on 12 major cultivation practices, *viz.*, i) variety ii) field preparation iii) soil treatment iv) seed treatment v) sowing time vi) seed rate and spacing vii) fertilizer management viii) irrigation management ix) weed management x) pest management xi) disease management and xii) harvesting and threshing. Each major practice was further divided into sub-practices and score was assigned to each practice according to its importance. After assigning the scores, adoption index were computed as mean per cent scores (MPS). On the basis of adoption index, the adoption was categorized as low (< 40), medium (40-60), high (61-80) and very high (> 80) level.

The study revealed that majority of respondents were sowing the crop in time as adoption of "time of sowing" aspect was reported highest by all the groups of respondents. The MPS of this aspect was 82.3. This was followed by the practices like "irrigation management", improved varieties, "seed rate and spacing" and "weed management" where level of adoption was high (MPS 61-80). The MPS of these practices were 77.2, 68.5, 66.3 and 61.6, respectively. The level of adoption of "harvesting and threshing", "field preparation" and "fertilizer management" was medium with MPS 55.5, 53.9 and 52.0, respectively. The majority of respondents had low adoption (MPS < 40) of "seed treatment", "pest management" "disease management" and "soil treatment" with MPS 23.2, 16.3, 9.7 and 5.4, respectively.

Regarding the constraints faced by the farmers, study reported that 5 economic, 8 infrastructural, 4 agro-climatic and 5 technological constraints were affecting the adoption of mustard technology among different groups of farmers in different magnitude. The overall and important constraints experienced by all groups of the farmers as first ranked were, low selling price, non-availability of seed, high temperature at the time of sowing and lack of technological know-how. The second ranked constraints were high cost of crop cultivation, inadequate supply of electricity at the time of sowing and irrigation, occurrence of hailstorms and lack of visits of extension personnel. Further, high cost of chemical fertilizer,

inadequate supply of chemical fertilizers at the time of sowing, poor fertility of soil and lack of training were ranked third.

Therefore, it is essential to ensure timely supply and easy availability of quality seed, chemical fertilizers, pesticides and improved agricultural implements to enable the farmers to adopt all the package of practices to obtain better yields.

DRMR ECT 3: Participatory validation and transfer of DRMR's technology package for Indian mustard in Bharatpur district of Rajasthan

Project Leader: S K Jha, Sr. Scientist (Agril. Extension)

Associate: A K Sharma, Sr. Scientist (Agril. Extension)

Twenty demonstrations on DRMR's package for Indian mustard, in one acre area each, were conducted in Paharsar, Andhiyari, Aau and Gadoli villages of Bharatpur district. The DRMR's package included improved variety (cv. NRCDR 2), soil treatment with 4% Endosulfan dust (10 kg basal), urea (35 kg basal and 35 kg top dressing), SSP (100 kg basal), MOP (25 kg basal), Zinc Sulphate (10 kg basal), Borax (4 kg basal) and need based plant protection measures under irrigated and rainfed conditions. A control plot with the farmers' practice was also arranged for comparison. The demonstrations have been successful at all the locations.

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

Project Leader: Vinod Kumar, Scientist, SS (Computer Application)

Associate: A K Sharma, Sr. Scientist (Agril. Extension)

Under germplasm retrieval system, user friendly forms for retrieving notified varieties characterized on the basis of DUS descriptors (passport, leaf, flower, plant, siliqua, maturity, seed, etc) were developed. System interface is very user friendly and user can make the query simply by selecting options in general such as crop name (Indian mustard, karan rai, brown sarson, yellow sarson, taramira, toria, gobhi sarson, etc.) genotype (notified varieties, advance lines, germplasm accessions, etc.) Fig. 2.12.

Updation and maintenance of website

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

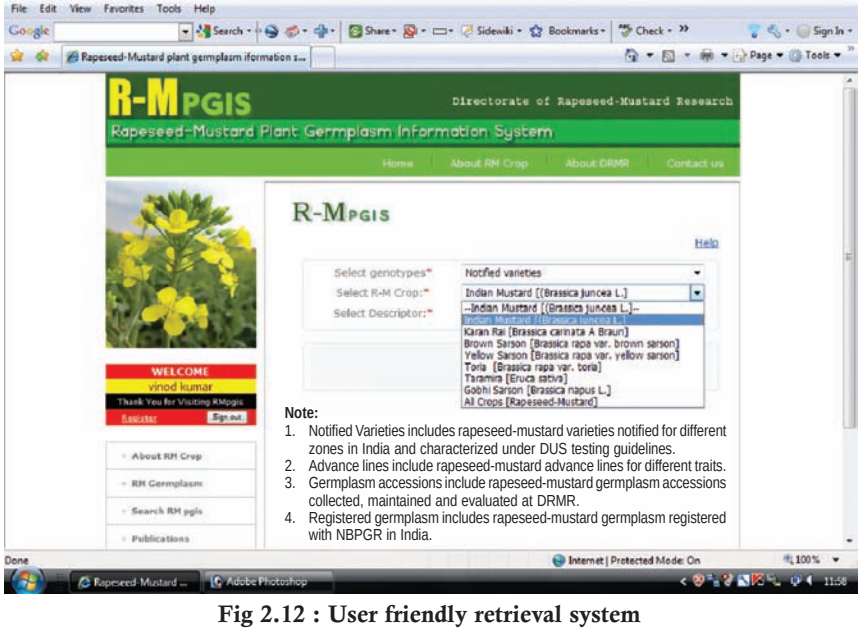


Fig 2.12 : User friendly retrieval system

3 Transfer of Technology

13th *Beej Pakhwada* organized

The DRMR's popular endeavour for the sale of mustard seed, counselling for situation specific varietal selection and educating the farmers about the improved package of practices, *Beej Pakhwada,* was organized during September 16-30, 2010 at DRMR Farm. The Directorate earned the appreciation of thousands of mustard seed buyers of Rajasthan, Haryana, Madhya Pradesh and Uttar Pradesh for providing quality seeds of NRCDR 2, NRCHB 101, Maya, Uravashi, Laxmi, Rohini and Bio 902 of Indian mustard at reasonable price and technical guidance.

Radio educational series from DRMR

One hundred and twenty four radio talks related to rapeseed-mustard research and development programmes and improved practices were broadcasted from 6 radio stations, Nazibabad, Mathura, Agra, Rampur of Uttar Pradesh, Jaipur and Kota of Rajasthan during September 2010-February 2011. This serial broadcast catered the farmers' specific and timely technical queries related to rapeseed-mustard cultivation as per the crop growth stages. The programme had benefited thousands of farmers from Rajasthan, Western Uttar Pradesh and Uttarakhand.

Shooting of a new video film on DRMR and production technology of rapeseed-mustard commenced

Shooting for production of a bilingual video film on DRMR and production technology of rapeseed-mustard was started in January, 2011 and near completion.

Frontline demonstrations

Under the aegis of All India Coordinated Research Project on Rapeseed-Mustard, DRMR successfully conducted 18 FLDs in Gadoli, Lulhara and Nagla Chahar villages of Bharatpur district of Rajasthan and Nagla Vishnu village of Agra district of Uttar Pradesh. The FLDs were conducted to demonstrate the productivity potential of two improved varieties of Indian mustard developed by DRMR, Bharatpur, *viz*., NRCDR 2 and NRCHB 101 against Rohini and other varieties of private seed companies. The demonstrations on NRCDR 2 and NRCHB 101 drew the attention of the farmers of the adopted villages because of their good agro-morphological and yield attributes. On the basis of 16 locations, the NRCDR 2 had an average yield of 2470 kg/ha against the average yield of 2358 kg/ha from Rohini and other varieties of private seed companies with a yield improvement of 4.75%, while on the basis of 2 locations the improved variety NRCHB 101 had an average yield of 2520 kg/ha against the average yield of 2350 kg/ha from varieties of private seed companies with a yield

improvement of 7.23%. The average additional net monetary return (ANMR) from the NRCDR 2 was Rs 2884 /ha, while it was Rs 4475/ha.

Exhibition at IVRI Kisan Mela

DRMR installed an exhibition on rapeseed-mustard production technology in a Kisan Mela organized by IVRI, Izatnagar during November 1-2, 2010. Maya, Urvashi and Rohini varieties of Indian mustard were made available for sale during the Kisan Mela. Hon'ble DDG (Animal Science), ICAR and about 200 farmers from Bareilly district visited the stall and appreciated the DRMR exhibition.

Technology Park

A technology park on rapeseed-mustard was established at DRMR's research farm demonstrating 14 *Brassica* species, 34 latest released varieties/hybrids of rapeseed-mustard and improved technological components like thinning, thiourea spray, aphid insect pest and disease management for the benefit of visitors. The park has attractied the visiting farmers, extension personnel, technocrats, scientists and others to assess the variability in the Brassica family and the varieties developed for specific purposes all at one place.

Farmers' training

A 7 day farmers' training programme on seed production technology of *rabi* field crops (rapeseed-mustard, wheat, lentil and gram) was organized at the DRMR campus from December 15-21, 2010 under ICAR Seed Project. Inaugurating the training, Director, Dr. J.S. Chauhan advised the farmers to use certified and quality seeds every year along with other recommended technology for getting higher production of mustard. He urged the participants to work as representatives of the Directorate and transfer the knowledge gained during the training to other fellows for the benefit of the masses. 19 progressive farmers from Bharatpur, Sawai Madhopur and Jaipur district participated in the training and learnt the principles of seed production, hybrid seed production technique, integrated nutrient, pest and disease management, indigenous technical knowledge, situation specific improved varieties and abiotic stress management. Dr. J. S. Sandhu, ADG (Seeds), ICAR, New Delhi also addressed the trainees in valedictory function and talked about New Seed Act enabling the farmers to have right of compensation in case of crops failure due to poor quality seeds. He also urged the participants to produce the quality seeds for their requirements and also gave away the certificates to the trainees.

Sarson vigyan mela-cum-exhibition

17th Sarson Vigyan Mela was organized at DRMR on February 1, 2011 wherein abot 800 farmers from Rajasthan, Madhya Pradesh and Uttar Pradesh states and officials from different

ICAR and Government of Rajasthan organizations, press and media personnel participated. There were 25 stalls exhibiting different aspects of agriculture. Chief guest Dr C. D. Mayee, Chairman, ASRB, New Delhi inaugurated the mela and Prof. Swapan K. Datta, DDG (Crop Science), ICAR, New Delhi presided over the function.

This Mela provided an opportunity to the various stakeholders in the field of agriculture especially rapeseed-mustard growers, research and development personnel to demonstrate the technological know how for the benefit of farming community. In the inaugural address, Dr Mayee emphasized that research focus should be on climate change and farmers must adopt recently released varieties of rapeseed-mustard along with matching production technologies as per their growing conditions. Dr Mayee advised the farmers for organized farming by forming farmers club that will help in regulating the market prices, citing example of Maharastra farmers. He also cautioned over exploitation of natural resources and imbalance use of fertilizers may prove great deterrent in long run in achieving higher productivity.

In his presidential address, Prof. Datta emphasized that rapeseed-mustard crops play an important role in oilseed economy of the country. But farmers are not getting remunerative prices of their crop, they are sometimes forced to sale out produce at lower prices due to lack of proper storage facilities as well as economic condition. He suggested for value addition in mustard oil and makes the consumers aware about the quality of mustard oil, enabling the farmers in fetching higher price of their produce.

On this occasion, Director, DRMR, Dr. Chauhan welcomed all the guests and participants. In his address, he reiterated the mission of establishing the DRMR in Bharatpur i.e. to increase the productivity of rapeseed-mustard, improve the quality of oil and livelihoods of farmers.

Dr. Amar singh, Incharge KVK, Kumher and Sh B.K. Singh Joint Director, Agriculture Department, Govt. of Rajasthan also addressed the participants. Two technical bulletins "Improved varieties of Indian mustard for different

climatic condition for seed production" and "Production technology of quality seed of rapeseed-mustard" in Hindi were also released by

the Chief guest and President. Thirty five progressive farmers from different villages of Bharatpur district of Rajasthan and Agra district of Uttar Pradesh were felicitated for their excellent contribution for the cause of rapeseed-mustard production.

Before inaugurating the mela, Dr C. D. Mayee also inaugurated the construction of vertical extension (II floor) of Type IV quarters at the Campus. Dr. Mayee and Prof. Datta also visited the experimental fields/ laboratories, discussed with scientists and provided invaluable suggestions.

Bharatpur farmers visited Pusa *Krishi vigyan mela*, New Delhi

Twenty nine farmers and 16 farmwomen from 5 villages of Bharatpur district actively participated in the Pusa Krishi Vigyan Mela at IARI, New Delhi during March 3-5, 2011. They were happy to get an opportunity to learn about useful technologies demonstrated/exhibited in the Mela. DRMR facilitated their visit and Sh. Ramesh Yadav, a progressive farmer from DRMR-IARI adopted village Paharsar (Bharatpur) was also felicitated on the occasion for his innovative approaches to farming.

4 Education and Training

Training imparted

DRMR reconstituted its training cell and made it a multi-member unit since April 2010. Dr. S. K. Jha, Senior Scientist (Ag Extension), Dr. Maharaj Singh, Senior Scientist (Pl. Physiology), Dr. Kapila Shekhawat, Scientist (Agronomy) and Dr. Binay Kumar Singh, Scientist (Plant Biotechnology) have been made its members. The newly constituted training cell has selected four batches of 22 students for M. Sc. dissertation work and 40 students for project/training work since then and generated resources worth ₹ 2.93 lakhs.

Training attended

Participants	Training programme	Duration	Institute
	International		
S. S. Meena	Marker assisted selection in crop plants	June 26 - September 24, 2010	Crop Genetics, Genomics and Breeding Division, Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, Walsh, UK.
K. H. Singh	Plant variety protection and DUS Testing	June 28 - July 9, 2010	National Institute of Agricultural Botany Cambridge, UK
	National		
V.V. Singh O.P. Premi	MDP workshop on PME support to consortia based research in agriculture	July1-6, 2010	NAARM, Hyderabad
D. C. Mishra	Data analysis using SAS	July 19-August 23, 2010	MPUAT, Udaipur
Pankaj Sharma	MDP workshop on PME of Agricultural research and development projects	September 6-10, 2010	NAARM/NIRD, Hyderabad
J.S. Chauhan	Executive development programme in agriculture research management	September 17-21, 2010	NAARM, Hyderabad
Kanta Prasad	Enabling administrative personnel of the department of science & technology	September 20-October 8, 2010	IIPA, New Delhi
D. C. Mishra	Genomics and trainer's training on data analysis using SAS	October 4-15, 2010	IASRI, New Delhi

Participants	Training programme	Duration	Institute
S. S. Rathore	Research station management	October 11-16, 2010	ICRISAT, Patancheru, Andhra Pradesh
K. H. Singh	Application of molecular markers in crop improvement	November 8-19, 2010	ICRISAT, Patancheru, Andhra Pradesh
Ajay Kr. Thakur	Gene isolation and characterization	November 8-28, 2010	NRCPB, New Delhi
Manju Bala	Biotechnological approaches for the enhanced production of nutraceauticals in fruits and vegetables of arid zone	February 14-27, 2011	CIAH, Bikaner
S. S. Rathore J. L. Sharma	Employer's perspective on labour related laws	February 17-19, 2011	NAARM, Hyderabad

Seminar conducted at DRMR

Speaker	Topic	Date
K.H. Singh	Plant variety protection & DUS testing for Indian experts	September 9, 2010
Manju Bala	Omics and their studies	November 6, 2010
Sanjay Sharma	Project information management system-ICAR	January 13, 2011
Y.P. Singh	Latest national and International publications in entomology	January 22, 2011
Priyamedha	Linkage map in *Brassica carinata*	February 24, 2011
S.S. Meena	Development and utilization of molecular markers in trait selection and crop improvement	March 10, 2011

5 Awards/Recognition

Dr. Pankaj Sharma, Senior Scientist (Plant Pathology) was conferred Fellowship by Plant Protection Association of India, Rajendranagar, Hyderabad on April 28, 2010 and by Society for Plant Protection Sciences, IARI, New Delhi on Feb 12, 2011. Dr. Sharma also received K. S. Bilgrami Best Paper Presentation Award 2010 for the paper "Evaluation of soil amendments, botanical and fungicide against *Sclerotinia sclerotiorum* causing stem rot of Indian mustard" from Indian Society of Mycology and Plant Pathology during 32nd Annual Conference and Symposium held at Junagadh Agricultural University, Junagadh. Nov 24-26, 2010. The paper was co-authored by Drs. P.D. Meena, P.K. Rai, S. Kumar and S.A. Siddiqui.

Dr. Kapila Shekhawat, Scientist (Agronomy) was conferred Dr. S. S. Bains Memorial Award (Biennium 2007-2008) for the best Ph. D. thesis entitled " Effect of nitrogen sources, sulphur and boron levels on spring sunflower-mungbean cropping system" by the Indian Society of Agronomy , New delhi on May 6, 2010.

Sh. Vinod Kumar, Scientist Senior Scale (Computer Application in Agriculture) was awarded Doctor of Philosophy (Ph. D) in Computer Science by the Institute of Computer and Information Science, Dr. B. R. Ambedkar University, Agra on October 4, 2010.

Dr. J.S. Chauhan, Director, DRMR was conferred Fellowship by Indian Society of Oilseeds, DOR, Hyderabad January, 2011.

Dr. J.S. Chauhan, Director, DRMR was appointed Chairman, Oilseeds Sectional Committee, Food and Agricultural Division 13, Bureau of Indian Standards, New Delhi in November 2010 and member by DBT, New Delhi to the Site Visit Committee under BIPP and also to the panel of reviewers, December 2010.

Promotion

Dr. Y.P. Singh, Senior Scientist (Entomology), DRMR was promoted to the post of Principal Scientist (Entomology) w.e.f. November 23, 2007.

Sh. Lala Ram, Sh. Tara Singh, Sh. Radha Charan and Sh. Kamal Singh, supporting skilled grade staff, DRMR, Bharatpur were granted financial upgradation under Modified Assured Career Progression Scheme w.e.f. September 1, 2008.

Smt. Veena Sharma, Junior Stenographer promoted to the post of Personal Assistant, Director, DRMR w.e.f. September 13, 2010.

Sh. Ram Sahay Meena, Senior Clerk promoted to the post of Assistant, DRMR, Bharatpur w.e.f. November 1, 2010.

Sh. Kanta Prasad, Assistant, DRMR, Bharatpur was granted financial upgradation under Modified Assured Career Progression Scheme w.e.f. November 27, 2010.

Sh Mukesh Kumar, Senior clerk promoted to the post of Assistant, DRMR, Bharatpur w.e.f. January 31, 2011.

Selection

Dr. Satyanshu Kumar, Senior Scientist (Organic Chemistry), DRMR, Bharatpur was selected to the post of Principal Scientist at DMAPR, Anand, Gujarat by ASRB, New Delhi.

Dr. Sandeep Kumar, Scientist (Biochemistry), DRMR, Bharatpur was selected to the post of Senior Scientist at NBPGR , New Delhi by ASRB, New Delhi.

Sh. P. K. Pandey, Junior Accounts Officer, DRMR, Bharatpur joined IGFRI, Jhansi on selection as Assistant Finance & Accounts Officer w.e.f. October 15, 2010.

The DRMR family congratulates and wishes them a very rewarding future

6 Linkages and Collaboration

Mustard production forecast using remote sensing data at national level {Under forecasting agricultural output using space agricultural meteorology and land based observations (FASAL) programme}

A multiple estimation of acreage and production at National/State level using multi-date AWiFS data and weather data has been done. Ground Truth (GT) observations form predominately rapeseed-mustard growing districts of Uttar Pradesh, Rajasthan, Haryana and Madhya Pradesh were recorded during November-December 2010 and January, 2011. IRS P6 multi-date AWiFS data acquired between October 2010 and January 2011 were used for acreage estimation. Dynamic crop growth simulation model "WOFOST" was used for acerage and production forecasts.

Based on the data analysis and modeling about 7.33 mt mustard production from 6.33 mha area was forecasted. At national level, an overall increase of 6.3% and 18.1% in mustard acreage and production, respectively, was expected. At state level, Rajasthan showed significant increase in acreage and production of 23% and 33%, respectively, while Uttar Pradesh showed decrease in acreage and production of 28% and 22%, respectively.

Integrated Agro-met Advisory Services (IAAS)

The Directortae releases medium range weather forecast for eastern flood plain zone of Rajasthan (Alwar, Bharatpur, Karauli, Swai Madhopur and Dholpur) in collaboration with National Centre for Medium Range Forecasting, Noida twice in a week. The advisory includes forecast for next five days and contingency crop/farm planning. The information is communicated through Telephone, FAX, email and SMS to farmers, extension workers, scientists, administrators, policy makers and media personnel regularly. Five raingauges were installed in different villages surrounding DRMR, Bharatpur for recording daily rainfall and understanding spatial variability in rainfall intensity and distribution in the district.

Performance of Indian mustard as influenced by soil-sites, phosphate fertilizers and phosphate solubilizing fungi in semi-arid conditions (Sponsored by Novozymes Biological Limited)

A study on bio-efficacy of phosphorous solubilising fungus (*Pencillium bilaii*) on Indian mustard was undertaken in moderately well drained, sodic, fine loamy, calcareous, Typic Ustochrepts soils of Bharatpur. The experiment was designed in factorial RCBD keeping phosphate fertilizers (0, 50% and 100% of recommended level) and seed treatment (@ 6 ml/kg seed) with two strains of *Pencillium bilaii* (No, JumpStart-1, JS2 and JS1 +JS2) as two factors, respectively.

Mean mustard seed yield (1567 kg/ha) was significantly influenced by seed treatment with *Pencillium bilaii* and phosphate fertilization. Successive increase in phosphorus application from control to 50% and 100% of recommended level (40 kg P_2O_5/ha) significantly increased seed yield. The increase in yield due to phosphorous application was attributed to higher phosphorus

and nitrogen uptake and thus, increased primary and secondary branches), siliquae/ plant and 1000-seed weight. In general, seed treatment with *Pencillium bilaii* significantly improved mustard yield. The increase due to *Pencillium bilaii* strains was attributed to increased availability of phosphorus from fixed soil calcium and organic phosphate. The available P content and organic P fraction in soil increased with the inoculation of *Pencillium bilaii* while total and inorganic P fractions declined.

National level monitoring team for Rajasthan

A National level monitoring team (NALMOT) comprising Sh. M.N. Raju, Assistant Director, Directorate of Oilseeds Development, Hyderabad, Dr. Pankaj Sharma, Senior Scientist, DRMR, Bharatpur, Dr. Mahipal Singh, Senior Technical Officer, Directorate of Millets Development, Jaipur, Sh. Pukhraj Mansion, Joint Director Agriculture (ISOPOM), Pant Krishi Bhawan Jaipur and Dr. J.P. Tetarwal, Assistant Professor, AICRP on Linseed, Agricultural Research Station (MPUAT), Kota monitored oilseeds, pulses and maize production programmes under ISOPOM in Rajasthan state during February 9-10, 2011. Team visited Baxawala, Sanganer and Bada Padampura, Chaksu villages in Jaipur district. Minikits of mustard hybrid (DMH 1) in Jaipur and Vasundhara variety in Tonk district under rainfed conditions were given to the farmers. An interaction meeting was also held with local farmers at Khiljipur village in Sawaimadhopur district. Suggestions were given to introduce new mustard varieties like RB 24, RB 50, Aravali, RGN 48 under rainfed and NRCDR 2, RGN 73, RGN 13, NRCDR 601 and NRCHB 101 for irrigated conditions.

DRMR-IARI collaborative National Extension Programme for technology assessment and transfer in Bharatpur district

Under this joint initiative, 5, 17,7 and 10 varietal demonstrations on pearl millet (cv P-443), green gram (cv Pusa Vishal), sorghum chari (cv. PC-9), bottle gourd (cv Pusa Naveen) and brinjal (cv Pusa Uttam), respectively were successfully conducted in 3 villages of Bharatpur district during *kharif* 2010 and in rabi 2010-11, 18 varietal demonstrations on wheat (cv. HD 2733, HD 2985, HD 2687 and HD 2932), 2 on carrot (cv. Pusa Rudhira) and 5 on onion (cv. Pusa Red) were conducted in 4 villages of Bharatpur district. The farmers appreciated all the demonstrated varieties due to their distinctive superiority over the respective local cultivars. Under this joint initiative, farmers have been given regular counselling for establishing biogas plant.

MoU signed for promotion of mustard hybrids under PPP mode

DRMR entered public-private-partnership with the signing of a Memorandum of Understanding with J. K. Agril. Genetics Ltd. for joint collaboration on development, identification, production and marketing of suitable Indian mustard hybrids with high yield and/or disease resistance and/or quality on December 13, 2010. Dr. K H Singh, In-Charge, Institute Technology Management Unit facilitated the signing of MoU and will coordinate the programme.

MoU signed for strengthening statistical computing

DRMR signed a Memorandum of Understanding with Indian Agricultural Statistics Research Institute, New Delhi for accessing SAS software under the NAIP Project being implemented by IASRI, New Delhi entitled "Strengthening Statistical Computing for NARS".

DUSC/ Dhara and DRMR collaboration

A meeting for conducting field trials on GM Mustard Hybrid DMH 11 was held at DRMR Bharatpur on October 1, 2010. Scientists from Delhi University, DRMR and other partners participated in the meeting to work out modalities to conduct trials in Rajasthan. The DRMR has been entrusted with the responsibility of coordinating the conduct of DBT approved trial of DMH 11 along with appropriate checks at KVK, Kumher, ARS, Navgaon, ARS, Sriganganagar under SKRAU, Bikaner.

7 All India Coordinated Research Project on Rapeseed-Mustard

17th Annual Group Meeting of Rapeseed-Mustard Research Workers was organized by DRMR, Bharatpur during September 1-3, 2010 at RVSKVV, Gwalior (MP). Dr. J.S. Sandhu, ADG (Seeds), ICAR, New Delhi inaugurated the meeting and chairman was Ho'ble Prof. V.S. Tomar, Vice-Chancellor, RVSKVV, Gwalior. Inaugurating the meeting, Dr. J. S. Sandhu highlighted the importance of rapeseed-mustard and also expressed concern over the huge import of edible oil in the country. Further, he highlighted the issue of variable productivity among the states.

Prof. V. S. Tomar, in his address, reiterated the importance of rapeseed-mustard as one of the oldest crops in India and its pungent aroma should not be forgotten. He suggested that farmer's concern should be adequately and appropriately addressed by all the cooperating centres across the country. He highlighted the productivity constraints especially, high temperature at the early stage of crop growth, lack of soil moisture, decreasing water table and pests like mustard aphid. He called upon the scientists to develop technologies while keeping these perspectives in mind. Two publications from DRMR namely, "Rapeseed-Mustard: Dietary and Nutritional Aspect" and "Annual Report (2009-10)" were released by the guests on the occasion. Director, DRMR presented the highlights of the programme for the year 2009-10.

Crop Improvement

A total of 4,094 accessions comprising toria, Indian mustard, yellow sarson, gobhi sarson, brown sarson, karan rai, taramira, *Brassica tournefortii*, *Sinapis alba*, *B. caudatus*, *B.nigra*, *B. oleracea*, *Raphanus sativa*, *R. caudatus, Crambe spp*, *Lepidium spp* and *Camellina spp* were maintained through the appropriate mating system. 82 new accessions of Indian mustard, toria and taramira were collected and 2,486 accessions of Indian mustard, toria, yellow sarson, gobhi sarson, karan rai and taramira were evaluated. Five new germplasm accessions, viz., NRC GS 1 (INGR 10048) early and dwarf; NRCKR 304 (INGR 10049) early maturing, long mainshoot and bold seeded; BPR 541-4 (INGR10050) salinity tolerant at seedling stage, high WUE, thermo tolerant at terminal stage; BPR 543-2 (INGR 10051) thermo tolerant at seedling stage, high WUE and PRB 2006-5 (INGR 10108) bold seeded were registered with NBPGR, New Delhi, thus bringing total number of germplasm registered to 42.

With a view to improve seed yield, earliness, seed size, disease/pest resistance, high temperature tolerance, quality and high oil content. Fresh crosses (573) were attempted in toria, yellow sarson and Indian mustard at Morena, Kanpur, Pantnagar, Dholi, Jagdalpur, Bhubaneswar and Hisar. In toria, development of composites and reconstituting population after selection was the main objective. In yellow sarson, selection from segregating generations was attempted at Pantnagar and Dholi. In Indian mustard, 3,084 single plants and 1,299 bulks were selected from segregating and advanced generations.

69 strains of toria were tested at Hisar, Kanpur, Dholi and Jagdalpur. The yield superiority was up to 39.9 % over the check (RAUTS 17) at Dholi. Total of 50 yellow sarson strains were tested at Kanpur and Dholi and yield superiority up to 29 % over the check Swarna was recorded at Dholi.

In Indian mustard, 541 strains were evaluated at 8 centres in 12 trials and12 strains of taramira were evaluated in a trial at Jobner. Yield superiority up to 18.8 % over the Aravali (check) in Indian mustard at Navgaon and up to 12.9 % over the RTM 314 (check) in taramira was recorded.

In Indian mustard, mapping populations for various morphological and economic traits were developed at IARI, New Delhi. CMS and restorer conversion programme for hybrid development has also been undertaken at IARI New Delhi, Hisar, Morena and S.K. Nagar.Against the indent of 76.28 q breeder seed of 35 centrally and 28 state released varieties of rapeseed – mustard, 137.71 q breeder seed was produced at 18 different centres.

One hundred seventy nine promising strains of toria, yellow sarson , Indian mustard , karan rai , gobhi sarson and taramira were evaluated in 25 yield trials at 239 locations across 5 agro-climatic zones of the country. A total 39 strains comprising 3 of toria and 36 of Indian mustard has been promoted for advance stage testing.

Crop Production

Eight rapeseed-mustard genotypes were evaluated under 4 fertility levels at 9 locations. Genotype RH 0304 followed by EJ 17 of Indian mustard was superior to check JD6 at Kanpur. In Zone II, NPJ 113 produced >10% higher yield than the best check at Hisar and Navgaon. Application of 25% more than recommended fertilizer significantly enhanced seed yield at Morena, Ludhiana and Sriganganagar. However, reduction in fertilizer level to 75% significantly reduced the seed yield across the locations.

Mustard seed yield was significantly higher under black gram-Indian mustard sequence at Dholi. Application of 20 kg S/ha increased yield by 16.8% at Dholi (mustard) and 7.2% at Khudwani (Brown sarson). At SK Nagar, mustard seed yield in guar-mustard and bajra-mustard sequences were *at par* but significantly higher than rest of the cropping sequences. Recommended fertility level through inorganic sources, gave highest yield at Morena and SK Nagar while integrated approach (Vermicompost+fertilizers) produced maximum seed yield at Bharatpur.

In paira-cropping system, line sowing of toria after land preparation at Dholi; mustard line sowing under zero tillage at Imphal and brown sarson line sowing after land preparation at Khudwani gave maximum seed yield. Response to nitrogen was obtained up to 80 kg N/ha at all locations.Diversification from maize-wheat to maize-mustard-green gram system resulted in significant increase in mustard equivalent seed yield (MESY) at Kangra. Significantly higher MESY was achieved in mustard + maize inter-cropping at Bhubneshwar (1:1) and Dholi (1:2). At Varanasi and Nagpur, mustard + wheat intercropping (1:9) was superior to rest of the combinations. At Kanke, sole wheat and sole mustard were superior to wheat + mustard and mustard +maize intercropping combinations, respectively.

Seed treatment with *Azotobactor* and PSB besides application of 100% or 75% N + P_2O_5 fertilizers produced significantly higher rapeseed-mustard (toria- Bhubneswar, Kanke, Shillongani; Taramira: Jobner; Indian mustard: Hisar, Kanpur, Kota, Morena, SK Nagar, Varanasi; Brown sarson: Khudwani) yield than 100% N+ P_2O_5 treatment at all the 11 locations. The increase in yield varied from 2.5% at Varanasi to 20.7% at Kanke.

At Berhampore weed-free environment produced significantly higher mustard seed yield (1416 kg/ha) followed by pre-plant incorporation of fluchloralin @ 1.5 and 1.0 kg a.i./ha, respectively. At S.K. Nagar, the high seed yield and *Orobanche* control efficiency was recorded under directed spray of glyphosate @0.25 %.

At Bawal, growing of S*esbania* as green manure recorded significantly higher mustard seed yield (1814 kg/ha) and lowest Orobanche heads/ m^2 but at par with cluster bean (fodder)-mustard and incorporation of sesame at flowering in sesame- mustard sequence. Data pooled over 3 years revealed superiority of *Sesbania* (GM)-mustard followed by GM-mustard/barley sequence.

Sowing of mustard hybrids at wider spacing of 45 cm x 15 cm was significantly superior to other spacings. Among the genotypes, DMH 1 out yielded the other hybrids at all the locations except Nagina. On an average DMH1 produced about 11.6%, 10.4% and 19.8% higher seed yield over NRCHB 506, PAC 437 and Kranti, respectively. Among fertility levels, successive increase in fertilizer levels from RF to 125 and 150%RF significantly increased seed yield at Morena and Sriganganagar. At Bawal, Nagina and IARI the significant increase in seed yield was only up to 125%RF. At all the locations, reduction in fertilizer dose to 75%RF significantly reduced the seed yield.

At Dholi, recommended package of practices gave maximum seed yield of Indian mustard in rice-based system. Reduction in either factor of production (50% fertilizer, weed control or plant protection) significantly reduced mustard yield by 21.5-31.8%. The contribution of 50% fertilizer + weed control was 39.6%, which was the highest among other production factors. Indian mustard sown on October 10 gave maximum seed yield (1186 kg/ha) but *at par* with that of September 25 and November 9 sowings. Among cultivars, Urvashi recorded significantly higher seed yield (1218 kg/ha) over JD6 and Sej2.Application of P fertilizer significantly increased mustard seed yield at Sriganganagar, Hisar, Bharatpur and SK Nagar. Seed treatment with *Penicillium bilaii* strains (@6 ml/kg seed) was found significantly effective at Bharatpur and SK Nagar.

Crop Protection

The disease pressure, in general, was moderate at different locations. Timely sown crop encountered mild to moderate severity of alternaria blight and white rust on leaves with no staghead formation. Moderate to severe incidence of AB was recorded at Ludhiana, Hisar, Faizabad, and Behrampur. Sclerotinia rot severity was mild to moderate at most of the places except Sriganganagar, Navgaon and Morena. Comparatively high incidence of powery mildew was recorded at Faizabadand Kangra. Moderate to high severity of downy mildew was observed at Hisar, Faizabad and Jagdalpur. Incidence of downy mildew on cotyledons and true leaves was recorded at Pantnagar only. Club root was observed in severe form from Behrampur. Bacterial rot, mosaic and seedling wilt were also noticed at Hisar, Pantnagar and Faizabad. At farmers' field, the disease pressure was moderate. In general, the timely sown crop encountered less alternaria blight, white rust, powdery mildew severity. Light and frequent winter rains at Ludhiana, Hisar, Morena and Pantnagar favoured high incidence of alternaria blight. Sclerotinia rot severity was comparatively higher at Srigangannagar and Navgaon under irrigated conditions. Foggy weather and winter rains also favoured carpogenic infection of sclerotinia rot at Navgaon. Bacterial rot appeared with moderate severity at Hisar and Faizabad. In general, weather conditions were not very favorable for the development of insect-pests.

Diseases

All entries showed susceptible reaction to alternaria blight and sclerotinia rot. PBR 357, EJ 20 of *B. juncea* and RTM 1212 of *E. sativa* were moderately resistant to white rust. RTM 1212 also showed resistance to downy mildew and powdery mildew under artificial condition. None of the test entries was tolerant to alternaria blight and sclerotinia rot. PBC 9221 and DLSC 1 of Karan rai and GSL 1 of *B. napus* were resistant to white rust at most of the centres. DRMR 243, DRMR 270 (*B. juncea*), JMTA 9 (Toria), T 27 (taramira), PBC 9221 and DLSC 1(Karan rai) showed resistance to downy mildew at Faizabad and Pantnagar. PBC 9221 also showed resistance to powdery mildew. Starins EC 339000 and EC 338997 had alternaria blight reaction *at par* with tolerant check (PHR 2). EC 399299, EC 338997, EC339000 and EC 399296 of *B. juncea* were found resistant to white rust. NPJ 143 and EC 338997 showed resistance to powdery mildew whereas, EC 339000 and EC 338997 were resistant to downy mildew. EC 414291, EC 399299, PBR 293 and NPJ 121 were moderately resistant to white rust. No stag head formation was observed in EC 414293, EC 414291 and NRCIJ 6-112. None of the entries was found resistant to Alternaria blight,

Sclerotinia rot, downy mildew and powdery mildew. PBC 9221 was found moderately tolerant to Sclerotinia rot. None of the entries was tolerant to Alternaria blight. BCS 3, BCS 4, PBC 9221, and NPC 16 of *B. carinata* were resistant to white rust whereas, BCS 3, BCS 4, NPC 16 and Kiran had moderate resistance to powdery mildew. Entries HNS 9605 and HNS 0004 of *B. napus* showed resistant reaction to white rust and downy mildew. None of the entries was found resistant/ tolerant to alternaria blight, powdery mildew and sclerotinia rot.

Pathogenic diversity analysis among 29 isolates of *A. brassicae* collected from Uttarakhand, Rajasthan, Punjab, Maharastra, West Bengal, Assam, Meghalaya and Nagaland revealed variability in terms of mycelial growth, conidial size and septation, sectoring behavior and symptoms produced on host. Variability of two *A. candida* isolates (from *B. rapa* and *B. juncea*) was observed on 20 genotypes of *B. juncea*. *A. candida* isolate from *B. juncea* was more virulent as compared to *B. rapa* isolate. Significant morphological and molecular variability among 17 geographical isolates of *S. sclerotiorum* was recorded.

At Bharatpur, first appearance of Alternaria leaf blight occurred on December 17 in October 8 sown crop (71 DAS) on cv Varuna. During 3rd week of February when maximum temperature was 24^{0}C, minimum 10^{0}C, morning RH 97% and bright sunshine hrs. 5.5, the incidence of AB was higher. Initiation of WR on leaf occurred at 61 DAS on cv Varuna as well as NRCDR 2. The maximum staghead formation was observed in Nov.19 sowing in cv Varuna while in NRCDR2 it was maximum in November 26 sowing.

Most of the treatments provided significantly less severity of AB (on leaves and pods) and WR over control. Maximum control of SR was obtained with the treatments involving carbendazim, *T. harzianum*, Neem seed kernel extract and Neem oil alone and in combination with other treatments. Sulphur in combination with borax, and mancozeb spray was most effective in controlling alternaria leaf and pod blight. Soil application of ZnO + Sulphur minimized the severity of white rust and powdery mildew.

Insect Pests

The strains, TK 07-2, PT 303, JMTA 1, Panchali (toria) , RH 0304, EJ 20, NPJ 124, TERIHOJ 48, ELM 134, HYT 33, SKM 0526, RH 0555-A, RGN 229, RL 1359, JMWR 08-03, RGN 241, NRCRM 802, NPJ 113, 45 S 45, NRCHJ 1103, NRCHB 506, PCJ 04-405, Pusa Mustard 21, EC 414291, RYSK 0602, EC 399296, EC 399299, Ashirwad, BBM 07-01, JMM 927, Varuna (Indian mustard), T 27, RTM 1212 and RTM 2002 (taramira), DLSC 1, NRCKR 299, PBC 9221, NPC 16 (karan rai) had low AAII.

Mustard aphid population was least in the strains DLSC 2 (karan rai) and T 27 (taramira) whereas BSH 1 (brown sarson) and YST 151 (yellow sarson) had the maximum aphid population, in general. Higher amount of total phenols, glucosinolates and lectins were negatively correlated with mustard aphid population. The significant appearance of mustard aphid was reported from most of the centres during 3rd-10th std. week and higher activity was observed during 5th-9th std. week. The painted bug was active during 46th-52nd std. week and again 7th-13th std. week at Hisar while at Bharatpur it was active from 47th-52nd std. week and again 6th-14th std. week. Low to moderate population of sawfly was reported from Kanpur, Faizabd and Berhampur. The moderate intensity of cabbage caterpillar was observed from 6th-11th std. week at Ludhiana and 5th-13th std. week at Hisar. Alate mustard aphid appeared as early as in 43rd std. week at Ludhiana and Morena however the higher population was recorded during 3rd-13th std. week that started declining after 10th std. week at most of the centres and disappeared completely after 17th std. week.

Low mustard aphid population and high seed yield was observed with treatment oxy-demeton methyl 25 EC @ 1ml/l or dimethoate 30 EC @ 1ml/l of water followed by NSKE @ 5% and neem oil @ 2% at S.K. Nagar, Navgaon, Ludhiana, Dholi and Kanpur while at Morena and Hisar

insecticidal treatment was followed by neem oil @ 2% and NSKE @ 5%. *Coccinella septempunctata* @ 5,000 beetles/ha was found most effective and provided the highest yield followed by *Coccinella septempunctata* @ 3,000 beetles/ha Bharatpur, Morena, Hisar and Ludhiana. NSKE @ 5%, neem oil @ 2%, *Verticillium lecanii* @10^8CS/ml + NSKE @ 5%, *Verticillium lecanii* @10^8CS/ml + neem oil @ 2% and *Verticillium lecanii* @10^8CS/ml + Azadirachtin 1500ppm @ 4ml/litre were found effective in reduction of aphid population and provided higher yield.

Plant Physiology & Biochemistry

Of the 44 Indian mustard genotypes screened for salinity tolerance (12dS/m) during seedling stage at Hisar, Kanpur and S.K.Nagar centres, BPR 549-9 was identified as salinity tolerant on the basis of < 20% reduction in shoot length and seedling dry weight. This genotype along with BPR 349-9 also showed higher imbibition under saline conditions. Of the 44 Indian mustard genotypes screened for high temperature tolerance at seedling and terminal stage at Hiasr, Kanpur, Bharatpur, Ludhiana and S.K. Nagar. Genotypes, BPR 543-2, CS54 and DRMR 541-44 showed consistently < 20% seedling mortality and characterized as high temperature tolerant at all the centers. The genotypes, NRCDR601, PRKS28 and BPR541-4 had <20% reduction in seed yield under temperature stress during terminal stage and thus had tolerance. Further, PBR331, NRCRDR701, RH555A and RB50 had high photosynthetic efficiency under temperature stress during terminal stage. Soaking seeds in epibrassinosteroid (10^{-10}M) considerably delayed seedling mortality under high temperature.

Oil content in rapeseed-mustard germplasm and advanced breeding material ranged from 30.7 - 43.4% (*B. juncea*), 38.0 - 47.0 % (*B. rapa* var. toria), 37.1 - 45.6 % (*B. rapa* var. yellow sarson), 36.2 - 43.8 % (*B. napus*), 36.0 - 41.0 % (*B. carinata*) and 36.6 - 37.8 % (*E. sativa*). Among *B. juncea*, *B. rapa* var. toria and *B. napus,* highest oil content 43.4% (45 S 42), 47.0 % (RMT 08-7) and 43.8 % (CNH 876) was recorded at Ludhiana. *B. rapa* var. yellow sarson had highest oil content of 45.6% (NDYS 141-3) at Hisar. *B. carinata* and E.sativa had highest oil content of 41.0 % (NPC18) and 37.8 % (RTM 1212) at Pantnagar and Morena center, respectively. Strains LET 40, LET 41, RH 0801, ELM 123 and ELM 134 had < 2% erucic acid. Relatively high surface wax, phenol and glucosinolates were recorded in DLSC 2 (karan rai) and T 27 (taramira) genotypes accompanied with low yield losses due to aphid infestation. Reducing sugar decreased whereas protein content increased with increase of *Alternaria blight* disease infection in 7 Indian mustard strains. The inherent level of antioxidative enzymes-superoxide dismutase, peroxidase, ascorbate peroxidase and glutathione reductase were higher in five days old seedlings of thermo tolerant genotype, BPR542-6. Abscisic acid spray (50 ìM/l) increased survival at LT_{50} by 5% and 17% in resistant and susceptible *B.napus* genotypes, respectively.

Technology Assessment

Twenty four cooperating centres and an NGO conducted 560 FLDs in 53 districts across 16 states of the country. Rajasthan had maximum FLDs (210) followed by Uttar Pradesh (53) and Haryana (40). Of the total FLDs, 132 were conducted on rapeseed and 408 on mustard. There were 255 FLDs on the whole package (WP), 167 on varietal component and 118 on other component technology (CT) under irrigated as well as rainfed conditions.

Under rainfed conditions, the maximum average yield kg/ha from the whole package for Indian mustard, toria, gobhi sarson and brown sarson was 941, 927, 1260 and 1125, the maximum yield gap was 65.3%, 50.2%, 43.2% and 63.1%, respectively. The maximum additional net monetary return (ANMR)/ha was Rs 5,283, Rs 5,093, Rs 6,770 and 9,070/ha, respectively. Under irrigated conditions, the maximum average yield kg/ha from the WP for Indian mustard, toria, yellow sarson and gobhi sarson was 2296, 1793, 1839 and 1806, and the maximum yield gap was 59.4%, 56.7%, 34.3% and 21.1% respectively. The maximum ANMR was Rs 8,279 (Indian mustard), Rs 7,972 (Toria), 7,570 (Yellow sarson) and 6,345/ha (Gobhi sarson).

Twenty six improved varieties of Indian mustard, 2 each of toria and yellow sarson, 1each of karan rai, brown sarson and gobhi sarson were used for varietal FLDs. Among all the states, improved variety demonstrated in Gujarat recorded maximum yield of 2248 kg/ha with an improvement of 16.0% over local and maximum ANMR of Rs 6,840/ha nder irrigated conditions. It was followed by Haryana where demonstrations on improved varieties recorded average yield of 2222 kg/ha with yield improvement of 7.9%. The maximum FLDs (54) on varietal component under irrigated conditions were conducted in Rajasthan by 5 centres with IP recorded average yield of 2131 kg/ha with an improvement of 10.5% and ANMR of Rs 4,236/ha. The IP with PT 303 and Uttara of toria, PYS 1 of yellow sarson and Kalyan of gobhi sarson had an average yield of 1482, 1578 and 1151 kg/ha, respectively under irrigated conditions. The RGN 48 variety of Indian mustard, Jayanti of karan rai, KBS 3 of brown sarson and Ragini of yellow sarson had an average yield of 1439, 1153, 775 and 995 kg/ha, respectively under rainfed conditions. A total of 96 FLDs with 15 component technologies for Indian mustard were carried out. Among all the components, powdery mildew management had maximum average yield of 2520 kg/ha in Gujarat. However, maximum yield improvement of 37.4% was recorded with Sclerotinia rot management at Kanpur and Morena.

Sowing method and seed rate in toria, thinning in yellow sarson, fertility management in gobhi sarson, recommended fertilizer with improved variety of taramira and proper plant protection with improved variety of taramira gave 0.5%, 8.3%, 73.7%, 35.8% and 21.5% yield improvement over FP, respectively.

Twelve sessions were organized during this group meeting. In the various disciplins- specific sessions, results of the previous year were critically analyzed and technical programme for the year 2010-11 was formulated. Six presentations were also made in key areas of research by invited speakers from ICAR/ SAUs/ Private seed companies.

The major recommendations were:

- On the basis of experimentations at Kanpur it was concluded that hybrid mustard DMH1 is superior and should be cultivated at planting geometry of 45 cm x 15 cm.
- The seed treatment of mustard with *Azotobacter* + PSB alongwith recommended fertilizer (120 kg N: 60 kg P_2O_5/ha) was found beneficial at Kanpur and should be popularized.
- On the basis of 3 years experimentation at Nagpur, second week of October is optimum planting time for mustard.
- From the 6 years trials at Dholi it was found that black gram-mustard with 40 kg S/ha to mustard is most remunerative system.
- Balanced fertilizer (N_{100} P_{40} K_{40} per ha) application is recommended for effective management of AB, WR and SR.
- Seed treatment with *Trichoderma harzianum* @ 10 g/kg seed followed by foliar spray of *Pseudomonas fluorescence* (oil-based) @ 10ml/L at flower initiation stage was effective in reducing WR, SR, DM and AB diseases.
- *Coccinella septempunctata* @ 5000 beetles/ha or spray of *Verticillium lecanii* @ 10^8 CS per ml at ETL level effectively reduced mustard aphid population.
- Foliar spray with NSKE @ 5% or Neem oil @ 2% for the management of mustard aphid is an alternative to chemical control.
- Two strains EJ 17 and NPJ 113 were identified for release in zone III (early sowing irrigated) and zone II (late sown irrigated) conditions, respectively.

8 Publications

Research papers

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9 Research Programmes and Projects

S. No.	Institute Projects	Principal Investigator
1.	DRMR CI 5**:** Development of hybrids in Indian mustard	K.H. Singh
2.	DRMR CI 6**:** Management of rapeseed-mustard genetic resource	J. Nanjundan
3.	DRMR CI 9: Genetic enhancement of Indian mustard by characterizing and introgressing the novel traits from the related species for biotic stresses	S.S. Meena
4.	DRMR CI 10**:** Population improvement for higher productivity and oil content in Indian mustard under normal and water stress conditions.	V.V. Singh
5.	DRMR CI 11**:** Molecular mapping of fertility restoring gene for *moricandia* cytoplasmic male sterility in Indian mustard	K.H. Singh
6.	DRMR CI 12: Widening of gene pool in *Brassicas* through interspecific and intergeneric hybridization	Arun Kumar
7.	DRMR CP 6**:** Improved soil resilience under mustard based systems through integrated crop management practices	O.P. Premi
8.	DRMR CP 7**:** *Orobanche* management in rapeseed-mustard	O.P. Premi
9.	DRMR CP 10: Standardization of micro-irrigation and fertigation for mustard crop under semiarid conditions	S.S. Rathore
10.	DRMR CP 11**:**Evaluation and Standardization of RCT's for mustard based cropping systems under semi-arid conditions of Rajasthan	Kapila Shekhawat
11.	DRMR SS 1: Nutrient efficiency under saline, alkali and normal conditions of soil and water in mustard crop	N.S. Bhogal
12.	DRMR B 6 **:** Analytical procedure for FT-NIR for mass screening and value addition	Manju Bala
13.	DRMR BT 1: *In vitro* plant regeneration and genetic transformation of *Brassica juncea* L. Czern. & Coss. with an antifungal defensin gene	A.K. Thakur
14.	DRMR BT 3**:** Assessment of cross-transferability and polymorphic potential of genomic STMS markers of Brassica species	B.K. Singh
15.	DRMR PP 1**:** Management of *Sclerotinia* rot in rapeseed-mustard	Pankaj Sharma
16.	DRMR PP 3**:** Management of *Alternaria* blight in rapeseed-mustard	P.D. Meena
17.	DRMR PP 5: Epidemiology and management of white rust	P.K. Rai
18.	DRMR PHY 2: Screening of mustard genotypes for high temperature tolerance at seedling stage	Maharaj Singh
19.	DRMR PHY 3: Morpho-physiological and biochemical basis of drought tolerance in Indian mustard	Maharaj Singh
20.	DRMR ENT 2**:** Biological control of major pests of *Brassicas* with special reference to mustard aphid	Y.P. Singh

21.	DRMR ENT 3 : Plant-pest interaction of major pests of *Brassicas*	Y.P. Singh
22.	DRMR ENT 6: Bioassay studies of mustard aphids on wild crucifers	S.P. Singh
23.	DRMR CA 1**:** Development of application software for rapeseed-mustard information management	Vinod Kumar
24.	DRMR AS 4: Rapeseed-mustard germplasm core collection through standard statistical methods and development of its retrieval system	D.C. Mishra
25.	DRMR ECT 1: Study the pattern of rapeseed-mustard production problems, indigenous technical knowledge (ITK) and impact assessment of technology transfer programme	S.K. Jha
26.	DRMR ECT 2**:** Study the adoption pattern and farmers' perception of technological advances	A.K. Sharma
27.	DRMR ECT 3 **:** Participatory validation and transfer of DRMR's technology package for Indian mustard in Bharatpur district of Rajasthan	S.K. Jha

Externally Funded Projects

1.	DRMR EA 2 : Characterization of rapeseed–mustard varieties for distinctness, uniformity and stability (DUS) testing	K.H. Singh
2.	DRMR EA 4: ICAR seed project on seed production in agricultural crops	V.V. Singh
3.	DRMR EA 5: Oilseed *Brassica* improvement in China, India and Australia	J. S. Chauhan
4.	DRMR EA 6: Mustard production forecast using remote sensing data at national level (FASAL)	B.K. Kandpal
5.	DRMR EA 7: Intellectual property management and transfer/ commercialization of agricultural technology scheme	K.H. Singh
6.	DRMR EA 8: Integrated agro-met advisory services	B.K. Kandpal
7.	DRMR NP 2a: ICAR-NPTC: Development of aphid resistant transgenic *Brassica*	A.K. Thakur
8.	DRMR NP 2b: ICAR-NPTC: *Brassica* functional genomics for Alternaria blight and drought/ heat tolerance	P.K. Rai
9.	DRMR NP 5: Diagnosis and management of leaf spot diseases of field and horticultural crops	P.D. Meena

Contractual Research

1.	Bio efficacy of HP mustard spray oil against mustard aphid safety to predators/parasites and honey bees	Y.P. Singh
2.	Studies on the bio-efficacy of "Jumpstart" (*Penicillium bilaii*) on the phosphorous use efficiency in Indian mustard	B.K. Kandpal
3.	Efficacy of liquid fertilizers on mustard productivity	O.P. Premi
4.	Performance of Coral 432 (Mustard Hybrid) under different cropping system	S.S. Rathore

10 IRC, RAC, IMC and QRT Meetings

Institute Research Committee

DRMR organized its 16th Institute Research Committee (IRC) meeting on June 28-29, 2010 under the Chairmanship of the Director of DRMR. In this IRC, the results of the experiments carried out during 2009-10 crop season were discussed and reviewed. The Director reaffirmed all support to the scientists for achieving excellence in their area of specialisation.

In the17th IRC meeting held from August 26 to 27, 2010, individual scientist presented progress of project work done during year 2009-10 and proposed technical programme for the year 2010-11. The Chairman appreciated the scientists for their achievements and asked to give the requirement of instruments, chemicals and other facilities well in advance for effective implementation of the projects. For precise results and ensuring accountability, the chairman also reiterated for downsizing the number of projects.

The Chairman asked for following ICAR guidelines strictly for becoming PI and Co-PI with clear cut distribution of work in the project. He further suggested for maintaining high team spirit by duly acknowledging all the contributors in the research work and proper credit should be given in RPF too. Dr. S. S. Banga, National Professor, ICAR, PAU, Ludhiana and Dr S N Sharma, Professor, Plant Physiology ,Agricultural Research Station, Durgapura, Jaipur were the external subject experts who provided valuable inputs for improvement of research programme.

Institute Management Committee

13th meeting of the Institute management Committee of DRMR was held on November 22, 2010 under the Chairmanship of Dr. J. S. Chauhan, Director. It was attended by the official members Dr. V. D. Patil, ADG (O&P), ICAR, Dr. K. V. Prabhu, Head, Division of Genetics, IARI, New Delhi, Dr. D. Kumar, Project Coordinator (Arid Legumes), CAZRI, Jodhpur, Dr. S. S. Rathore (Incharge AF&AO, DRMR) and Sh. J. L. Sharma (Member Secretary) and a non-official member Smt Sushma Singh from Lucknow. The committee discussed 12 different agenda items and made suitable recommendations for approval of the Council. The agenda items included construction of Basic Science Complex, HRD, Extension activities, under plan and non-plan, procurement of equipments, etc.

Research Advisory Committee

DRMR held its 14th Research Advisory Committee (RAC) meeting during March 13-14, 2011. Dr. D.P. Singh (Ex-VC, JNKVV, Jabalpur) Chairman, Dr. S.E. Pawar (Ex-Scientist, BARC, Mumbai), Dr. M.P. Sahu (Director of Research, RAU, Bikaner), Dr. S.N. Upadhyay, (Prof. &

Head, Entomology, RVSKVV, Gwalior), Dr. K.P. Singh (Professor and Ex. Head, Mycology & Plant Pathology, BHU, Varanasi) and Dr. B.B. Singh, ADG (OP), ICAR, New Delhi, members attended the meeting.

Dr. J.S. Chauhan, Director, DRMR, Bharatpur welcomed Hon'ble Chairman and members of the Research Advisory Committee. He explained about the mandates, infrastructure, research and development programmes of DRMR, Bharatpur to the newly constituted RAC. In his introductory remarks Dr. D.P. Singh, Chairman advised to develop effective collaboration and linkages to face emerging abiotic and biotic challenges to rapeseed-mustard crop in changing climate scenario. He emphasized detailed studies on partitioning of photosynthates to develop suitable HYV especially for rainfed mustard growing regions of Rajasthan. Dr. M.P. Sahu suggested extensive exploration of worldwide knowledge base before developing any research programme. He raised concern about global warming, declining productivity and injudicious use of chemicals in agriculture. He highlighted importance of effective technology transfer mechanism for sustainable mustard production and called the scientists to develop synergy through ITK incorporation in research system. Dr. K.P. Singh asked for detailed study of soil-microorganisms vis-à-vis soil health, translocation of nutrients/ water soil borne diseases etc. He advised to take standard procedure/protocols for selection of white rust tolerant lines. Dr. S.E. Pawar emphasized importance of understanding farmers' need before developing any research programme and suggested farmers' participation in different stages of technology development. Dr. B.B. Singh asked for need based changes in rapeseed-mustard breeding programme to meet future challenges. He further suggested identification/breeding efforts for short duration varieties with efficient partitioning of photosynthates. Dr. B.K. Kandpal, Member-Secretary presented Action Taken Report on the recommendations of the 13th RAC held during February 13-14, 2010. The RAC advised more focused efforts in some of the areas. After

the deliberations, the action taken report was accepted and minutes of the previous RAC meeting were approved. Dr. J.S. Chauhan presented research highlights of AICRP-RM for the year 2009-10. In-charges of all the research units of DRMR presented the research highlights and technical programmes for the 2010-11 crop season.

On March 14, 2011 the RAC visited research experiments, seed production plots at the DRMR farm. The committee also visited laboratories and museum for in-depth interaction with the scientists. This was followed by detailed discussion on issues and strategies for 12th FYP. Dr. J.S. Chauhan presented a base paper on the subject to acquaint RAC on gaps and challenges. Many fruitful issues emerged out of the discussion for inclusion in 12th FYP document. A wrap-up meeting followed the discussion. The RAC

appreciated the efforts of the Directorate in doing target oriented productive research and developing strong linkages with all the stakeholders.

Quinquennial Review Team (QRT) for AICRP-RM and DRMR reviewed the rapeseed-mustard programme

Project leaders of 22 AICRP on RM centres from 15 states of the country met at DRMR, Bharatpur during April 22-24, 2010 to present highlights of their respective rapeseed-mustard research programmes and achievements for the period 2004-2010. Dr. J. S. Chauhan, Director (Acting), DRMR, Bharatpur presented research programmes and achievements of DRMR.

Three days meeting was chaired by Dr. B. Mishra, chairman of QRT and Vice Chancellor, Sher-E-Kashmir University of Agriculture Sciences and Technology, Jammu. The other QRT members Dr. S.S. Banga, National Professor (ICAR), PAU Ludhiana; Dr. S.J. Kolte, Ex-Professor (Plant Pathology), GBPUAT, Pantnagar; Dr. O.P. Dubey, Ex-ADG (PP), ICAR, New Delhi were also present in the meeting. The presentations of work done during the period were critically reviewed and the members gave constructive suggestions for improvement of the rapeseed-mustard research programme in the country. The QRT advised the centres to focus their activities as per the mandate and resources available.

11 Participation in Conferences, Meetings, Seminars, Symposia and Workshops

Events	Venue	Period	Participants
National			
National Seminar on Global Plan of Action for Germplasm Information Management System	NBPGR, New Delhi	April 17, 2010	K.H. Singh J. Nanjundan
Annual Breeder Seed Review Meeting	NBPGR, New Delhi	April 24, 2010	K.H. Singh P.D. Meena
Brain Storming meeting on Public-Private Partnership	DMR (IARI) New Delhi	April 28, 2010	J.S. Chauhan B.K. Kandpal P.K. Rai K.H. Singh S. K. Jha V.V. Singh S.S. Meena P.D. Meena
Annual Group Meeting of NSP (Crops)	CRIJAF, Barrackpore	May 4-5, 2010	J.S. Chauhan K.H. Singh
Review Meeting of ICAR-NPTC	NRCPB, New Delhi	May 19-20, 2010	P.K. Rai A.K. Thakur
National Consultation on Section 41: Rights of Communities under PPV& FR Act	NASC, New Delhi	May 25, 2010	K.H. Singh
18th Hindi Sammelan and Workshop	Gangtok, Sikkam	May 25-27, 2010	Pankaj Sharma
National Consultation on Agro-biodiversity Management	NASC, New Delhi	May 26, 2010	K.H. Singh
Meeting of the Task Force for special characteristics under PPV & FR Act organized by PPVFRA	NASC, New Delhi	June 16, 2010	K.H. Singh
Scientific Advisory Committee meeting	KVK, Hindaun City, Karoli	July 6, 2010	B.K. Kandpal A.K. Sharma
Technical Advisory Committee Meeting	KVK, Dholpur	July 21, 2010	Y.P. Singh P.K. Rai
Interactive Session on Biotechnology Research in ICAR	NASC, New Delhi	July 26 -27, 2010	A.K. Thakur

Surveillance for Pest and Diseases in Oilseed Crop as Advance Warning to Initiate Coping Strategies for Pest and Diseases in Mustard Crop in the State of Rajasthan	NCIPM, New Delhi	August 6, 2010	J.S. Chauhan Y.P. Singh P.K. Rai
Partner's Meet on Agricultural Bioinformatics	NBPGR, New Delhi	August 7, 2010	A.K. Thakur
Brain Storming Discussion on Strategies for Increasing Oilseeds/ Vegetable oils Production	DOR, Hyderabad	August 7-8, 2010	J.S. Chauhan Vinod Kumar
Workshop to review the conduct of DUS test	NAARM, Hyderabad	August 11-12, 2010	K.H. Singh
17th Annual Group Meeting of Rapeseed-Mustard Research Workers	RVSKVV, Gwalior, Madhya Pradesh	September 1-3, 2010	J.S. Chauhan Y.P. Singh B.K. Kandpal P.K. Rai K.H. Singh P.D. Meena S.K. Jha V.V. Singh O.P. Premi S.S. Meena S.S. Rathore A.K. Sharma Arun Kumar Vinod Kumar
Global Environment and Ozone Conservation	R.D. Girls (P.G.) College, Bharatpur	September 16, 2010.	Y.P. Singh
Indian Science Congress Association Young Scientist Award Presentations	SRM University, Chennai, Tamil Nadu	October 2-3, 2010	A.K. Thakur
Integrated Scheme for Oilseeds, Pulses, Oil palm and Maize meeting	Krishi Bhawan New Delhi	October 5, 2010	J.S. Chauhan S.K. Jha
Working Group on Agriculture to discuss and finalize the Agricultural Policy of the State of Rajasthan	Yojna Bhawan, Jaipur	November 2, 2010	P.K. Rai Maharaj Singh
Interactive meet on Information and Communication Technology in ICAR	NASC, New Delhi	November 3-4, 2010	Vinod Kumar
Seminar on Characterization and Conservation of Biodiversity for Sustainable Agriculture	MPUA & T, Udaipur	November 12, 2010	J.S. Chauhan V.V. Singh J. Nanjundan
Workshop on Oilseeds and Edible oils Scenario in India	IARI, New Delhi	November 12, 2010	S.K.Jha
32nd Annual Conference and Symposium on Innovations in Plant Pathology Research and Human Resource Development	JAU, Junagadh	November 24-26, 2010	Pankaj Sharma
National Symposium on Resource Management Approaches Towards Livelihood Security	UAS, Bengaluru, Karnataka	December 2-4, 2010	O.P. Premi S.S. Rathore Kapila Shekhawat

Workshop on Interdisciplinary Sciences, Technologies, Innovation & Development	Poddar International College, Jaipur	December 3, 2010	Manju Bala
US-India Workshop on Network enabled Research Collaboration	New Delhi	December 5-7, 2010	Vinod Kumar
QRT Meeting of Directorate of Seed Research, Mau	DSR, Mau (UP)	December 21, 2010	V.V. Singh
National Symposium on Molecular Approaches for Management of Fungal Diseases of Crop Plants	IIHR, Bangaluru	December 27-30, 2010	P.D. Meena Pankaj Sharma
Satellite meeting of Out reach Programme on Management of Leaf spot Disease in Field and Horticultural crops	IIHR, Bangalore	December 29, 2010	P.D. Meena Pankaj Sharma
Regional Workshop on Proposed Mission on Oilseeds and Oil palm for XII five year plan	Haryana Bhawan, Chandigarh	January 6, 2011	S.K. Jha S.S. Rathore
Scientific Advisory Committee meeting	KVK Bichpuri, Agra	February 3, 2011	A.K. Sharma Pankaj Sharma J. Nanjundan
National Symposium on Recent Advances in Plant Tissue Culture and Biotechnological Researches in India & XXXII Annual meet of Plant Tissue Culture Association (India)	M.N. Institute of Applied Sciences, Bikaner	February 4-6, 2011	Manju Bala
International Conference on Preparing Agriculture for Climate Change	PAU, Ludhiana	February 4-7, 2011	J.S. Chauhan S.K. Jha J. Nanjundan
Brain Storming Meeting to enhance Productivity of Rapeseed-mustard in Zone V	RAU, Pusa, Bihar	February 12, 2011	J.S. Chauhan Y.P. Singh B.K. Kandpal V.V. Singh K.H. Singh S.S. Meena P.D. Meena
Annual Breeder Seed Review Meeting	NBPGR, New Delhi	February 14, 2011	K.H. Singh
Review Meeting for conduct of DUS Test	NASC, New Delhi	February 25, 2011	K.H. Singh J.S. Chauhan
Seminar on Saghan Udhyan Ropan Takniki	Rastriya Krishi Vikash Yojana, Bharatpur	March 16-17, 2011	Y.P. Singh
Interanational			
3rd IEEE International Conference on Computer Science and Information Technology	International Convention Centre, University of Electronic Science and Technology of China, Chengdu, China	July 9 -12, 2010	Vinod Kumar

12 Workshop, Seminar, Winter School and Farmer's Days Organized

Visitors' Advisory Services

Under the visitors' advisory services, 29 groups of 1053 stakeholders including 838 farmers, 100 farmwomen, 50 extension personnel and 65 students from 10 districts of Rajasthan, 6 districts of Uttar Pradesh and 1 district of Madhya Pradesh attended interaction-cum-counselling sessions with the scientists and also visited experimental fields and museum.

Brain Storming Meeting on the Public-Private Partnership for Rapeseed-Mustard Research and Development in India

DRMR, Bharatpur organized a Brain Storming Meeting on the Public-Private Partnership (PPP) for Rapeseed-Mustard Research and Development in India at DMR, Pusa Campus, New Delhi on April 28, 2010. The meeting was chaired by Hon'ble Prof. S. K. Datta, DDG (Crop Science), ICAR, New Delhi and attended by 45 delegates from ICAR institutes, SAUs and private organizations/ university.

Prof. S.K. Datta, DDG (Crop Science) called for integration of both private and public organization to rapidly harness the benefits of available technology. And there is a need to harmonize and synergize the efforts through dialogues resulting in to fruitful public-private partnership, opined Prof. Datta. Dr. V. D. Patil, ADG (O &P), ICAR in his remarks highlighted the importance of PPP especially in development of varieties and hybrids. Dr. J.S. Chauhan, Director (Acting), DRMR, Bharatpur presented global and Indian scenario of rapeseed-mustard crops and objectives of this meeting. In all 18 presentations were made by the invitees in 2 sessions. After detailed deliberations, the issues like monitoring /verification of commercialized products and trade statements, pre-breeding for improving tolerance to biotic /abiotic stresses, exchange and sharing of germplasms, development of case specific MoUs and tracking of the supplied material for genuine ownership and hassle free utilization, product development, conduct of AICRPRM trials at locations of private organizations , inclusion of varieties developed by private organizations as checks and joint monitoring, participatory plant breeding and utilization of public infrastructure for research programmes of private organizations, establishing a consortium of all stakeholders for commercialization of hybrids/varieties and pre breeding were identified. In his concluding remarks Prof. S. K. Datta, DDG (CS) encouraged the idea of establishing consortium of interested stakeholders for strengthening PPP.

Institutional Bio-Safety Committee Meeting

Institutional Bio-Safety Committee meeting of the DRMR was held at Bharatpur under the Chairmanship of Dr. J. S. Chauhan, Director on September 23, 2010. The other distinguished participants who attended the meeting were, Dr. K. V. Prabhu, Head, Division of Genetics, IARI, New Delhi, Dr. K. V. Bhat, Principal Scientist, NBPGR, New Delhi, Dr. V. V. Singh, Senior Scientist (Plant Breeding) and Dr. A. K. Thakur, Scientist (Plant Biotechnology) & the Member-Secretary of the Committee. Various bio-safety aspects of the transgenic work being carried out at DRMR were discussed.

Hon'ble Union Minister of Agriculture, Govt. of India, Sh. Sharad Pawar visited mustard field

Hon'ble Union Minister of Agriculture, Govt. of India, Sh. Sharad Pawar and Secretary DARE & DG, ICAR, Dr. S Ayyappan visited mustard fields of farmer Sh Rajendra Singh in Singna Burj village of Kirawali tehsil of Agra district of Uttar Pradesh on January 24, 2011. Deputy Director General (AH) Dr. K.M.L. Pathak was also present on the occasion. Dr S. Ayeppan apprised the Hon'ble Minister about the programmes and

activities of the Directorate especially the first hybrid of Indian mustard, NRCHB 506, developed by this directorate. Director, DRMR Dr. J.S. Chauhan informed the Hon'ble Minister about the other DRMR developed varieties namely NRCDR 2, NRCHB 101, NRCDR 601 of Indian mustard and NRCYS 05-02 of yellow sarson.

Hon'ble Minister discussed with the DRMR scientists and farmers about improved varieties of mustard, cost of cultivation, productivity and return from the crop. He also discussed the effect of temperature on mustard, potato and wheat crop.

Awareness programme on Protection of Plant Varieties and Farmers Rights Act

DRMR organized one day training–cum-awareness programme on Protection of Plant Varieties & Farmers Rights Act (PPV &FRA) on Feb. 17, 2011 for the benefit of farmers, research, development personnel and other stake holders.

On the occasion, Director, DRMR, Dr. J.S. Chauhan said that India is rich in traditional and indigenous knowledge as well as bio-diversity. There is enormous indigenous technical knowledge available with the farming and tribal communities. He said that the PPV & FR Act will provide an effective system for protection of plant varieties and rights of both farmers as well as plant breeders. It also helps to recognize contributions of the farmers/community in conserving, improving and making available plant genetic resources for development of new plant varieties.

Dr. P.K. Singh, Registrar, PPV &FR Authority, New Delhi discussed the enactment and establishment of the Authority. He informed that India developed *sui generis* system for protection of plant varieties in consonance with UPOV system of Novelty, Distinctiveness, Uniformity and Stability. Farmers' Rights section was a unique feature of the Act, which gave the much needed importance to the farmers.

Sh. B. K. Singh, Joint Director (Oilseeds), Department of Agriculture, Govt. of Raj. also addressed the participants. More than 100 farmers, research and development personnel attended the programme.

Brain Storming Meeting on Enhancement of Productivity of Rapeseed-Mustard in Zone V

DRMR organized a Brain Storming Meeting on Enhancement of Productivity of Rapeseed-Mustard in Zone V at Rajendra Agricultural

University, Pusa (Bihar) on February 12, 2011. The meeting was chaired by Dr. V.P. Singh, Director Research, RAU, Pusa. Dr. V.P. Singh opined that rapeseed mustard is important in our economy but this crop has not got due attention hence, productivity is not up to the mark. He focused on major reasons for low productivity in zone V. Dr. J. S. Chauhan, Director, DRMR, Bharatpur gave an overview of national oilseed scenario. He opined that the targeted 64 million tonns of oilseeds production up to 2020 can be achieved by vertical as well as horizontal increase in production. Horizontal expansion can be achieved by introducing rapeseed-mustard cultivation in new areas. Other areas where attention is needed are mixed cropping, NUE, WUE, linking crop management with climate change and management of incidence of insect pests and diseases.

Kisan Diwas

DRMR organized 7 *Kisan Diwas* on the demonstrations laid out in the adopted villages in which 350 farmers and farmwomen were educated about the improved package of practices of several crops such as green gram, pearl millet, sorghum chari, mustard, wheat, carrot, onion, brinjal, etc Besides, a *Kisan diwas-cum*-interaction meeting was organized on March 5, 2011 at Nagla Vishnu, Khergarh tehsil, Agra district (Uttar Pradesh) where 10 frontline demonstrations (FLDs) on mustard with varieties NRCHB 101 and NRCDR-2 have been laid out by DRMR during 2010-11 in collaboration with RBS College, Bichpuri, Agra. Dr T. R. Chauhan, Principal, RBS college, Bichpuri and Dr Jitendra Chauhan, Head, Department of Extension Education & Joint Director, KVK, RBS college, Bichpuri were also present on the occasion.

Addressing the farmers, Dr. J. S. Chauhan, Director, DRMR opined that integrating farming by establishing collaboration among different agencies is the need of the hour for over all development. Farmers should adopt green manuring and organic manures for improving the soil fertility and increase the production. He urged the farmers to grow certified seeds of high yielding varieties of mustard and use sulphur for increasing oil and seed yield. He suggested that farmers should take the participatory seed production programme

and develop the seed village. Dr T. R. Chauhan assured the farmers for providing training and other required information for improved technologies through KVK of the college. Dr J.S. Chauhan, Dr Y.P. Singh and Dr S.K. Jha also addressed the farmers. Thereafter all the participants visited the FLDs and highly impressed with the performance of demonstrated varieties. Dr. A. K. Sharma coordinated the programme.

13 Distinguished Visitors

Name	Designation & Address	Date
Dr. B. Mishra	VC, SKUAS&T, Jammu	
Dr. S.S. Banga	National Professor (ICAR), PAU Ludhiana	
Dr. S.J. Kolte	Ex-Professor (Plant Pathology), GBPUAT, Pantnagar	April 22-24, 2010
Dr. O.P. Dubey	Ex-ADG (PP), ICAR, New Delhi	
Sh. Madhukar Gupta, IAS	Divisional Commissioner, Bharatpur	July 1, 2010
Dr. J.B. Mishra	Director, Directorate of Groundnut Research, Junagarh.	July 17, 2010
Dr. H.S. Gupta	Director, Indian Agricultural Research Institute, New Delhi.	August 23, 2010
Dr. K.V. Prabhu	Head, Division of Genetics, Indian Agricultural Research Institute, New Delhi.	September 23,2010
Dr. K.V. Bhatt	Principal Scientist, NBPGR, New Delhi	September 23, 2010
Dr. A.K. Pradhan	Professor, Department of Genetics, Delhi University, South Campus, New Delhi.	October 1, 2010
Prof. S.K. Datta	Deputy Director General (Crop Science), ICAR, New Delhi.	
Dr. P.R. Kumar	Ex-Director, Directorate of Rapeseed-Mustard Research, Bharatpur	
Dr. Devendra Swaroop	Director, Central Institute on Goat research, Makdoom, Mathura	October 20, 2010
Dr. B.K. Singh	Joint Director (Oilseeds), Bharatpur Division, Department of Agriculture, Govt. of Rajasthan	
Dr. Amar Singh	Incharge, KVK, Kumher, Bharatpur	
Dr. Chakresh Kumar	Breeder (Oilseeds), Agriculture Research Station, Navgaon, Alwar	
Dr. S.B.L. Srivastava	Principal Scientist (Oilseeds), CSA University of Agriculture & Technology, Kanpur	
Sh. Sarwar Khan IPS	Superintendent of Police (Anti Corruption Bureau), Bharatpur	October 29, 2010
Col. Y.B. Singh	Ordinance Depot, Kanzauli Line, Bharatpur	October 30, 2010
Dr. V.D. Patil	Assistant Director General (Oilseeds & Pulses), ICAR, New Delhi	
Dr. K.V. Prabhu	Head, Division of Plant Breeding and Genetics, IARI, New Delhi	November 22-23, 2010
Dr. D. Kumar	PC (Arid Legume), CAZRI, Jodhpur	
Smt. Sushma Singh	Member, RAC, DRMR, Bharatpur	
Prof. H.Y. Mohan Ram	INSA Honorary Secretary, Former Professor of Botany, Delhi University, Delhi.	November 23, 2010

Name	Designation & Address	Date
Sh. Anoop KR, IFS	Director, Keoladeo National Park, Bharartpur.	November 25, 2010
Dr. Rob Norton	Director, IPNI, Australia-New Zealand	December 6, 2010
Sh. P.S. Dravid	JK Agri Genetics, Ltd., Hyderabad.	December 13, 2010
Dr. S.K. Gupta	Vice President (R&D), JK Agri Genetics, Ltd., Hyderabad.	December 13, 2010
Dr. J.S. Sandhu	Assistant Director General (Seeds), ICAR, New Delhi	December 20, 2010
Prof. S.K. Datta	Deputy Director General (Crop Science), ICAR, New Delhi.	December 28-29, 2010
Dr. C.D. Mayee	Chairman, ASRB, New Delhi	February 1, 2011
Prof. S.K. Datta	Deputy Director General (Crop Science), ICAR, New Delhi.	February 1, 2011
Dr. A.P. Singh	Deputy Commissioner (TM O&P), DAC, Ministry of Agriculture, Govt. of India	February 1, 2011
Dr. D.P. Singh	Chairman, RAC and Ex-Vice Chancellor, JNKVV, Jabalpur	February 16, 2011
Dr. Deepak Pental	Ex-Vice Chancellor, University of Delhi, Delhi	March 8, 2011
Dr. D.P. Singh	Chairman RAC	
Dr. S.E. Pawar	Member, RAC	
Dr. M.P. Sahu	Member, RAC	March 13-14, 2011
Dr. K.P. Singh	Member, RAC	
Dr. S.N. Upadhyay	Member, RAC	
Dr. B.B. Singh	ADG (O & P), ICAR, New Delhi	
Sh. Ratan Singh	Hon'ble Member of Parliament, Bharatpur	March 14, 2011

Prof. S.K. Datta, DDG(CS), ICAR, New Delhi visit to exprimental far

Dr. H.S. Gupta, Director, IARI, New Delhi visit to DRMR labartory

14 Personnel

Director's Office

J.S. Chauhan	Director
Mrs. Veena Sharma	Personal Assistant
Lala Ram	Supporting staff (SSG III)

Scientific Staff

Crop Improvement

K.H. Singh	Sr. Scientist (Plant Breeding)
V.V. Singh	Sr. Scientist (Plant Breeding)
S.S. Meena	Sr. Scientist (Plant Breeding)
Arun Kumar	Sr. Scientist (Genetics & Cytogenetics)
Bhagirath Ram**	Sr. Scientist (Plant Breeding)
J. Nanjundan	Scientist (Plant Breeding)
Priya Medha**	Scientist (Plant Breeding)

Natural Resource Management

B.K. Kandpal	Pr. Scientist (Agronomy)
N.S. Bhogal	Sr. Scientist (Soil Science)
O.P. Premi	Sr. Scientist (Agronomy)
S.S. Rathore	Sr. Scientist (Agronomy)
Kapila Shekhawat	Scientist (Agronomy)
P. Kumararaja[a]	Scientist (Soil Science)

Plant Protection

Y.P. Singh	Pr. Scientist (Agril. Entomology)
P.K. Rai	Pr. Scientist (Plant Pathology)
S.P. Singh	Sr. Scientist (Agril. Entomology)
P.D. Meena	Sr. Scientist (Plant Pathology)
Pankaj Sharma	Sr. Scientist (Plant Pathology)

Plant Physiology & Biochemistry

Satyanshu Kumar*[1]	Sr. Scientist (Organic Chemistry)
Maharaj Singh	Sr. Scientist (Plant Physiology)
Manju Bala	Sr. Scientist (Biochemistry)
Sandeep Kumar*[2]	Scientist (Biochemistry)

Biotechnology

Ajay Kumar Thakur	Scientist (Plant Biotechnology)
Binay Kumar Singh	Scientist (Plant Biotechnology)

Technology Assessment & Dissemination

S.K. Jha	Sr. Scientist (Agricultural Extension)
A.K. Sharma	Sr. Scientist (Agricultural Extension)
Vinod Kumar	Scientist SS (Computer Application in Agriculture)
D.C. Misra**[b]	Scientist (Agricultural Statistics)
Lijo Thomas[a]	Scientist (Agricultural Economics)

Technical Staff

U.S. Rana	Technical Officer (T 7/8)
R.C. Sachan	Technical Officer (T 7/8)
R.N. Singh	Tech. Officer (T 6)
M.L. Meena	Tech. Officer (T 6)
H.P. Meena	Tech. Officer (T 6)
Ram Narayan	Tech. Officer (T 6)
Karnal Singh	Tech. Officer (T 5)
Sanjay Sharma	Tech. Officer (T 5)

R.C. Meena	Tech. Asstt. (T 3)
Govind Prasad	Driver (T 3)
Ram Singh	Tech. Asstt. (T 3)
Rakesh Goyal	Tech. Asstt. (T 3)
Bachhu Singh	Tech. Asstt. (T 2)

Administrative Unit

J.L. Sharma	Assistant Adm. Officer
Kanta Prasad	Assistant
U.C. Sharma	Assistant
Mukesh Kumar[C]	Assistant
Pankaj Pathak	Jr. Clerk
G.L. Meena	Jr. Clerk

Audit and Accounts Unit

Sh. Karan Singh Tanwar**	Finance and Accounts Officer
M.M. Lal[b]	Assistan Finance and Accounts Officer
Pawan Kumar Pandey[b]	Junior Accounts Officer
Ram Sahay Meena[C]	Assistant

Supporting

Tara Singh	Supporting Staff (SSG II)
Radha Charan	Supporting Staff (SSG II)
Kamal Singh	Supporting Staff (SSG II)
Sheetal Sharma	Supporting Staff (SSG I)

*[1]Selected principal scientist, DMAPR, Anand, Gujarat; *[2] Selected Sr. Scientist, NBPGR, New Delhi;
**Joined during the year; [a]On study leave; [b]Transferred out during the year; [C]Promoted during the year

15 Panorama

निदेशक पद के लिए डा. जितेन्द्र सिंह चौहान का चयन

भारतीय कृषि अनुसंधान परिषद, नई दिल्ली द्वारा प्रधान वैज्ञानिक डॉ. जितेन्द्र सिंह चौहान का सरसों अनुसंधान निदेशालय, भरतपुर के निदेशक पद पर चयन किया गया। डा. जितेन्द्र सिंह चौहान ने 15 जून को निदेशालय के निदेशक का पद ग्रहण किया जो कि इस पद पर पाँच वर्ष तक रहेंगे।

अलीगढ़ (उत्तर प्रदेश) में जन्मे डॉ. जितेन्द्र सिंह ने 1976 में गोविन्द बल्लभ पंत कृषि एवं प्रोद्यौगिकी विश्वविद्यालय पकंतनगर से आनुवांशिकी में स्नातकोत्तर की उपाधि प्राप्त की तथा सितम्बर 1985 में भारतीय कृषि अनुसंधान परिषद में वरिष्ठ वैज्ञानिक के पद पर नियुक्ति प्राप्त करके हजारी बाग (बिहार) में स्थित परिषद के संस्थान में धान अनुसंधान पर कार्य किया था इसके बाद वे मई 1996 से इस संस्थान में राई–सरसों अनुसंधान से जुड़े हुए हैं।

डॉ. चौहान ने राष्ट्रीय एवं अन्तर्राष्ट्रीय स्तर की अनुसंधान पत्रिकाओं में 150 से अधिक अनुसंधान पत्र प्रकाशित किये हैं। कई राष्ट्रीय एवं अन्तराष्ट्रीय सम्मेलनों में 75 से अधिक शोध पत्र प्रस्तुत किये हैं।

डॉ. चौहान ने डेनमार्क, फिलिपींस, ब्रिटेन, ऑस्ट्रेलिया, चीन आदि देशों का दौरा करके इन देशों में चल रहे राई–सरसों अनुसंधान कार्यों का अध्ययन किया और देश के लिए तिलहन अनुसंधान एवं विकास कार्यक्रम विकसित करने में इनका विशेष योगदान रहा।

डॉ. चौहान ने 1999–2007 तक इण्डो–यूके अन्तर्राष्ट्रीय परियोजना में सलाहकार के पद पर भी कार्य किया है।

स्वतन्त्रता दिवस समारोह

सरसों अनुसंधान निदेशालय में 15 अगस्त को स्वतंत्रता दिवस हर्षोल्लास से मनाया गया। सुबह नौ बजे निदेशालय के निदेशक डॉ. जितेन्द्र सिंह चौहान ने निदेशालय प्रांगण में ध्वजारोहण किया। इस अवसर पर स्वंतत्रता सेनानियों एवं शहीदों को नमन करते हुये अपने उद्‌बोधन में उन्होंने कहा कि कृषि वैज्ञानिकों द्वारा किये गए अनुसंधानों को अपनाकर हमारे किसान भाईयों की कड़ी मेहनत से जिस तरह देश खाद्यान्नों में आत्मनिर्भर हुआ है उसी तरह से राई–सरसों की उन्नत किस्मों एवं तकनीकों को किसानों तक पहुँचाकर इसका उत्पादन बढ़ाना आज की जरूरत बन गया है। डॉ. चौहान ने वैज्ञानिकों और कर्मचारियों का आव्हान किया कि कड़ी मेहनत एवं परस्पर सहयोग से कार्य करके तिलहन अनुसंधान को एक नई ऊँचाई प्रदान करें ताकि देश खाद्य तेलों में आत्मनिर्भर हो सके। उन्होंने जय जवान, जय किसान और जय विज्ञान के नारे को उद्धृत करते हुये याद दिलाया कि यदि हम पर्याप्त मात्रा में तिलहनों का उत्पादन करते हैं तो हमें दूसरे देशों पर तेल आयात के लिए निर्भर नहीं होना पड़ेगा।

हिन्दी चेतना मास का आयोजन

सरसों अनुसंधान निदेशालय सेवर में 14 सितम्बर से 13 अक्टूबर तक हिन्दी चेतना मास का आयोजन हुआ। हिन्दी चेतना मास का शुभारम्भ करते हुए निदेशक

डॉ. जितेन्द्र सिंह चौहान ने कहा कि 14 सितम्बर 1949 को हिन्दी भारतीय संघ की राजभाषा बनी और इसे प्रतिवर्ष 14 सितंम्बर को हिन्दी दिवस के रूप में मनाते आ रहे है। निदेशक ने सभी कर्मचारियों को हिन्दी में अधिक से अधिक कार्य करने के लिये प्रोत्साहित किया साथ ही उन्होंने चेतना मास में आयोजित विभिन्न प्रतियोगिताओं में सभी वैज्ञानिक एवं कर्मचारियों को भाग लेने का आह्वान किया।

हिन्दी चेतना मास के दौरान एक दिवसीय हिन्दी कार्यशाला का भी आयोजन किया गया। निदेशालय के निदेशक डॉ. जितेन्द्र सिंह चौहान ने कार्यशाला का उदघाटन करते हुये कहा कि हिन्दी हमारी राष्ट्रभाषा है एवं इसका हमें अधिकाधिक प्रयोग करना चाहिये। हिन्दी विश्व में हमारे देश की पहचान है और यह एक सम्पर्क भाषा के रूप में कार्य कर रही है। हमें अन्य भाषाओं को सम्मान देना चाहिये एवं वैज्ञानिक कार्य प्रणाली में भी हिन्दी का प्रयोग बढाने की जरूरत है। निदेशालय में समय–समय पर आयोजित हिन्दी कार्यशालाओं का उद्देश्य वैज्ञानिकों एवं कर्मचारियों में हिन्दी के प्रयोग में सुधार करने एवं नई जानकारी देना है। कार्यशाला में महारानी श्री जया महाविद्यालय के हिन्दी विभाग की अध्यक्षा डॉ श्रीमती मिथलेश गुप्ता ने समानार्थक शब्द और प्रयोग भेद विषय पर बताया कि हिन्दी के समानार्थक शब्दों का प्रयोग करते समय उचित शब्द का चयन आवश्यक है अन्यथा सही अर्थ समझ पाना मुश्किल है। इसी महाविद्यालय के प्रध्यापक डॉ अशोक गुप्ता ने 'शब्द एवं वाक्य शुद्धिकरण' विषय पर अपना व्याख्यान देते हुये विभिन्न वाक्यों में होने वाली त्रुटि एवं इनके शुद्धिकरण के बारे में विस्तार से चर्चा की।

हिन्दी चेतना मास का समापन श्री हरीश चन्द्र जोशी, निदेशक, राजभाषा भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के मुख्य आतिथ्य में सपन्न हुआ।

इस अवसर पर श्री हरीश चन्द्र जोशी द्वारा 'भारतीय कृषि अनुसंधान परिषद के संस्थानों में राजभाषा कार्यान्वयन एवं वैज्ञानिक लेखन को प्रोत्साहन' विषय पर व्याख्यान दिया गया। उन्होंने कहा कि हिन्दी में सभी को योगदान देना चाहिये। भाषा एक स्थान विशेष की पहचान होती है। किसानों तक हिन्दी में शोध परिणामों को पहुचाने के लिये हिन्दी व क्षेत्रीय भाषाओं में पत्र–पत्रिकाओं का प्रकाशन करना चाहिए। श्री हरीश चन्द्र जोशी ने हिन्दी चेतना मास के समापन पर निदेशालय में आयोजित विभिन्न हिन्दी प्रतियोगिताओं में सफल प्रतियोगियों को पुरस्कार प्रदान करके सम्मानित किया। कार्यक्रम का संचालन राजभाषा प्रभारी डा. पकंज शर्मा ने किया।

Foundation day celebration

DRMR celebrated its 17th foundation day on October 20, 2010. Chief guest Prof. S. K. Datta, DDG (Crop Science), ICAR, New Delhi, in his inaugural address, highlighted importance of rapeseed-mustard, being world's third most important source of edible oil after soybean and oil palm in Indian agriculture.

He also outlined the perspective for future rapeseed-mustard research stressing bio-technological approaches and development of transgenics especially for aphid tolerance, low phytate content and Alternaria blight as the need of the hour for enhancing yield and sustainable production. He also emphasized that value addition is important area and should be addressed immediately to enhance crop value in the competitive market.

The breeding efforts with respect to oil and meal quality are required to reduce erucic acid in oil and glucosinolates in seed meal as well as enhancing oleic acid. Enhancing heterosis level is the main challenge to make the hybrid technology competitive and remunerative, opined Prof. Datta. Dr. J.S. Chauhan, Director, DRMR outlined the genesis of oilseed research and development programme in the country culminating in to the establishment of the National Research Centre on Rapeseed-Mustard (NRCRM) on October 20, 1993 and its upgradation as Directorate in 2009 by ICAR. He also informed the participants about the mandate, progress and achievements of the Directorate and its commitment to all the stakeholders in rapeseed-mustard research and development programme. Dr. P.R. Kumar, Ex-Director, NRCRM, Bharatpur, Dr. Devendra Swaroop Director, CIRG, Makhdoom, Mathura, Sh. B.K. Singh, Joint Director (Oilseed), Department of Agriculture, Govt. of Rajasthan, Dr. S. K. Gupta, Vice-President, J.K. Agri-Genetic Limited, Hyderabad, Sh. Harveer Singh, Progressive Farmers also expressed their views.The chief guest also released 2 publications

namely "Morphological descriptor of rapeseed–mustard varieties" and "Sidhartha: Sarson Sandesh" on the occasion. Dr. S. K. Jha, Sr. Scientist (Ag. Extension) facilitated the programme.

Vigilance awareness week

Vigilance Awareness Week was observed at the Directorate during October 25 to November 1, 2010. The focus of vigilance week was "Generation of Awareness and Publicity against Corruption". The observance of week commenced with a pledge administered to the officials and staff members on October 25, 2010 by the Director, DRMR. The officials and staff members reiterated that they would continuously strive hard to bring about transparency in all spheres of their activities. A seminar was also organized on October 29, 2010 wherein chief

guest Sh. K. Sarvar, IPS, Anti Corruption Bureau, Bharatpur, Govt. of Rajasthan delivered a lecture on "Effect of corruption and conduct of government officials". Dr. Y.P.Singh, Principal Scientist (Entomology) facilitated the programme.

New IMC constituted

Under the provisions of Rule 66(a) of the Rules of ICAR Society, the Union Minister of Agriculture & the President of ICAR Society has nominated the following members to the Managememnt Committee of DRMR, Bharatpur for a period of 3 years with effect from November 20, 2010.

Dr. J S Chauhan Joint Director of Agriculture, Directorate/ Deptt. of Agriculture, Govt. of Rajasthan, Bharatpur (Raj.)	Chairman
Joint Director of Agriculture (Oilseeds), Deptt. of Agriculture, Govt. of Madhya Pradesh, Bhopal	Member
Dr. Govind Singh Director, Planning, SKRAU, Bikaner (Raj.)	Member

Smt. Sushma Singh M M 4/45 Vinaykhand, Gomati Nagar, Lucknow (already nominated w.e.f. 21.6.2010 – 20.6.2013)	Member (Non-Official)
Dr. D. Kumar Ex-PC (Arid Legume), CAZRI, Jodhpur	Member
Dr. K.V. Prabhu Head Plant Breeding & Genetics IARI, New Delhi	Member
Dr. R.K. Jain Head Plant Pathology IARI, New Delhi	Member
Dr. C. Chattopadhyay Head Plant Protection IIPR, Kanpur (already nominated w.e.f. 3.2.2009 – 2.2.2012)	Member
Dr. B.B. Singh ADG (O&P), ICAR, Krishi Bhawan, New Delhi	Member
Sh. S.K. Pathak Senior Finance & Account Officer, ICAR, New Delhi	Member
Sh. J.L. Sharma Assistant Adm. Officer, DRMR, Bharatpur	Member Secretary

Bio-diversity day organized

DRMR organized Bio-diversity day on Nov 23, 2010 to commorate the International Bio-diversity Year and to make people aware about the importance of biodiversity in meeting the future challenges of increasing demand for food, feed, fibres, timbers, etc for healthy and sustainable development on earth. Dr. H.Y. Mohan Ram, Ex-Prof., Department of Botany, Delhi University, Delhi was the chief guest and Dr. V. D. Patil, ADG (O&P), ICAR, was the Guest of Honour. Continuous depletion of bio-diversity due to climate change, invasive alien species, urbanization and over-exploitation of niches leading to habitat loss threatening the very survival of valuable wealth of animals, plants and micro organisms with far reaching consequences to the human life through the ecosystems imbalance, Dr. Mohan Ram informed. He was of the opinion that sustainable conservation of biodiversity is the need of the hour. Dr Mohan Ram urged that policy makers, researchers, farmers and all stakeholders should develop a road map for efficient and effective management of rich heritage of our biodiversity.

Dr. V.D. Patil, in his address, emphasized the need to internalize ecological sensitivity into all our activities and development programmes. He said that mustard crop has potential for high productivity but it is vulnerable to biotic and abiotic stresses and there is vast bio-diversity in these crops and should be utilized for strengthening research programme. Bio-diversity constitutes the reservoirs of new and valuable genes and is building blocks for present and future varietal improvement programme. The access to available rich crop diversity in gene banks is the only hope of plant breeders to develop resilient and climate-adapted new crop varieties, Dr. Patil said. Dr. J.S. Chauhan, Director, DRMR in his address mentioned that Directorate has rich collection (over 6000 accessions) of rapeseed-

mustard crops which are being used for research purpose. He urged the participants to create awareness for preserving the bio-diversity. Dr. Ashok Sharma, Sr. Scientist (Ag. Extension) conducted the programme.

Communal harmony campaign week

DRMR observed the Communal Harmony Campaign and the Fund Raising Week during November 19-25, 2010 and the Flag Day on November 25, 2010.

Sh. Anoop K.R. Director, Keoladeo National Park, Bharatpur was the chief guest on Flag Day. He, in his address, stressed the need to promote the communal harmony and national integration keeping aside creed, caste, ethnicity and region. Dr. J.S. Chauhan, Director, DRMR suggested that everyone should contribute to the noble cause and cautioned the participants about the ills of communal violence for national unity and prosperity. National Foundation for Communal Harmony an autonomous organization with the Ministry of Home Affairs, Govt. of India coordinated this campaign. The foundation is working for rehabilitation of children rendered orphan or destitute in communal, caste, ethnic, terrorist or any other kind of violence. The week long programme was coordinated by Dr. Ashok Sharma, Sr. Scientist (Ag. Extension)

Annual Sports

Dr J.S. Chauhan, Director inaugurated Annual Sports Meet during January 21-24, 2011 at the Directorate. The staff and their family members participated in various games. A twelve member sports team of the Directorate also participated in the ICAR Zonal Sports Tournament 2010-11 (Western Zone) held at IGFRI, Jhansi (UP) during February 15-19, 2011.

Republic day celebration

DRMR celebrated the 62nd Republic day on January 26, 2011 with great fervour and gaiety. Dr. J.S. Chauhan, Director hoisted the national flag. On this auspicious and historic day, he extended good wishes to all for their happiness, prosperity and success. He also gave away the prizes to the winners of Annual Sports Meet.

ICAR constituted new RAC

The RAC of DRMR with the following members was constituted by the ICAR for a period of 4 years with effect from February 8, 2011.

Dr. D.P. Singh Ex-Vice Chancellor JNKVV, Jabalpur	Chairman
Dr. S.E. Pawar Ex-Scientist, BARC Mumbai	Member
Dr. M.P. Sahu Director Research, SKRAU Bikaner	Member
Dr. S.N. Upadhyay Head, Entomology, RVSKVV Gwalior	Member
Dr. K.P. Singh Professor Mycology and Plant Pathology BHU, Varanasi	Member
Dr. T. Mohapatra Principal Scientist NRCPB, New Delhi	Member
Smt. Sushma Singh Lucknow	Member
Dr. B.B. Singh ADG (OP), ICAR New Delhi	Member
Dr. J.S. Chauhan Director DRMR	Member
Dr. B.K. Kandpal	Member Secretary

Samaj Sadan

New executive committee of Samaj sadan was elected by the General body for the year 2011-13. The members of the new executive committee are as under:

President	:	Dr. J.S. Chauhan
Vice-president	:	Dr. Y.P. Singh
General Secretary	:	Dr. S.S. Meena
Joint Secretary	:	Dr. Manjubala
Cultural & Literary Secretary	:	Mrs. Priya Medha
Sports Secretary	:	Sh. Bachhu Singh
Treasurer	:	Sh. Kanta Prasad

Deepawali and New Year celebration

Samaj Sadan organized Deepawali Sneh Milan on October 30, 2010 and Navvarsh Sneh Milan on January 1, 2011. All the *Sarson* family participated in these programme. On the occasion children performed graceful cultural programmes. The President, Samaj Sadan addressed the members and distributed prizes to the participants of cultural programmes.

हिन्दी कार्यशाला का आयोजन

सरसों अनुसंधान निदेशालय में 30 मार्च 2011 को एक दिवसीय हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला में मुख्य वक्ता के रूप में डॉ. दाऊदयाल गुप्ता, श्री रामबाबू शुक्ल, श्री मोहनलाल मधुकर एवं डॉ. अशोक कुमार गुप्ता उपस्थित थे। इस मौके पर अपने उद्घाटन संबोधन में निदेशक डॉ. जितेन्द्र सिंह चौहान ने राजभाषा हिन्दी के कार्यालय कार्यों में अधिकाधिक प्रयोग पर बल दिया एवं समय–समय पर आयोजित की जा रही हिन्दी कार्यशालाओं के आयोजनों की सराहना की एवं कहा कि इन कार्यशालाओं से वैज्ञानिकों एवं कर्मचारियों में हिन्दी के प्रति रूचि एवं ज्ञान में वृद्धि होती है।

कार्यशाला में डॉ. दाऊदयाल गुप्ता ने राष्ट्रभाषा हिन्दी की दशा एवं दिशा पर बोलते हुए कहा कि भाषा अभिव्यक्ति का एक माध्यम होती है परन्तु हिन्दी भाषा अभिव्यक्ति के माध्यम के साथ ही हमारी संस्कृति की वाहिका भी है। हिन्दी का प्रयोग चीनी भाषा के बाद विश्व में दूसरे स्थान पर है एवं आज विश्व के 141 विश्वविद्यालयों में हिन्दी पढ़ाई जा रही है। इसी विषय पर बोलते हुए श्री मोहन लाल मधुकर ने कहा कि लोगों में जो भय है कि अंग्रेजी, हिन्दी को निगल जायेगी ऐसा बिल्कुल नही है। हिन्दी एक सरल भाषा है और इसी वजह से आज हिन्दी को अहिन्दी भाषी क्षेत्रों में बहुत अधिक बढ़ावा मिल रहा है। उन्होंने देवनागरी लिपि की विशेषताओं के बारे में भी बताया एवं कहा कि हिन्दी में 85 करोड़ शब्दों का निर्माण हो सकता है जो किसी अन्य भाषा में संभव नही हैं। श्री मधुकर ने आजादी के समय हिन्दी भाषा के प्रति राष्ट्रपिता महात्मा गांधी एंव डॉ. राममनोहर लोहिया के योगदान के बारे में बताया।

हिन्दी भाषा एवं शब्द निर्माण पर आयोजित व्याख्यान में बोलते हुए श्री रामबाबू शुक्ल ने कहा कि संस्कृत भाषा के पद्चिन्हों पर चलकर ही हिन्दी भाषा सुदृढ़ हुई है। हिन्दी में शब्दों का निर्माण संस्कृत की भांति ही होना बताया। उन्होंने उदाहरण देते हुये विभिन्न शब्दों के निर्माण के बारे में समझाया। इसी विषय पर बोलते हुये एम.एस.जे. कालेज के हिन्दी प्रवक्ता डॉ. अशोक कुमार गुप्ता ने समान शब्दों को लेकर शब्दनिर्माण के बारे में जानकारी दी। डॉ. गुप्ता ने कविता के माध्यम से हिन्दी भाषा के महत्व के बारे में प्रकाश डाला। कार्यशाला में एक परिचर्चा का भी आयोजन किया गया, जिसमें निदेशालय के वैज्ञानिकों एवं कर्मचारियों ने उत्साहपूर्वक भाग लिया। डॉ. पंकज शर्मा, वरिष्ठ वैज्ञानिक एवं प्रभारी राजभाषा ने कार्यक्रम का संचालन किया।

Library services

Particulars	No	Detailed descriptions
Journals subscribed	49	Agricultural review, Annals of Agricultural Research, Annals of Agri. Bio-Research, Annals of Biology, Brassica, Chip, Current Science, Dataquest, Indian Farming, Indian Journal of Biotechnology, Indian Journal of Traditional Knowledge, Indian Journal of Agronomy, Indian

Particulars	No	Detailed descriptions
		Journal of Genetics and Plant Breeding, Indian Journal of Plant Genetic Resources, Indian Research Journal of Extension Education, Indian Journal of Plant Physiology, Indian Science Abstracts, Journal Asian Agri. History, Indian Journal of Ephidology, Journal of Biological Control, Journal of Bio-Science, Journal of Communication Studies, Journal of Genetics, Journal of Intellectual Property Rights, Journal of Interacademia, Journal of Mycology and Plant Pathology, Journalof Oilseeds Research, Science and Culture, Science Reporter, The Indian Journal of Agricultural Science, Indian Journal of Entomology, The Indian Journal of Cytology and Genetics, Agronomy Journal, Plant Breeding Abstracts, Review of Plant Pathology, Review of Agricl Entomology, भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका, खेती, फल–फूल एवं कृषि चयनिका
Journals received as gratis	15	California Agriculture, IPR Bulletin, Pestology, PGR Newsletter, Span, The Economist, Khad Patrika (Hindi), Krishi Vigyan (Hindi), Krishi Bharti (Hindi)
News letters received	129	From various Government, ICAR, SAU and other institutes/centres
Annual reports received	90	From various Government, ICAR, SAU and other institutes/centres
Other reference materials	96	From various Government, ICAR, SAU and other institutes/centres
Books purchased	160	Latest books, encyclopedia, dictionaries, Hindi books, etc.

Budget (₹ in lakhs)		
	Sanctioned	Utilized
Plan	250.00	250.00
Non-plan	423.91	398.50

Resource generation
₹25.76 lakhs

Meteorological Data

Weather, DRMR, Bharatpur

Month	Mean temp (°C)		Mean RH (%)		Rainfall (mm)	Rainy Days	Wind Speed (kmph)	Sun Shine hrs	Pan Eva-poration (mm/day)
	Max.	Min.	0720 hrs	1420 hrs					
April 2010	42.3	23.7	31.9	9.9	1.0	1	5.6	7.8	5.9
May 2010	43.9	28.5	48.9	36.4	2.0	2	4.6	6.0	6.0
June 2010	42.7	28.3	50.7	27.2	8.6	5	5.8	5.5	5.5
July 2010	35.9	26.7	83.9	61.6	231.2	14	6.5	4.3	3.8
August 2010	34.2	26.1	91.0	73.0	140.4	18	4.9	4.7	5.0
September 2010	32.4	24.2	94.2	71.2	306.1	15	4.9	4.6	2.9
October 2010	34.2	19.7	82.1	31.6	0.0	0	3.3	7.8	4.7
November 2010	27.1	15.1	91.6	48.6	32.7	6	2.1	4.6	2.1
December 2010	22.1	6.4	94.9	48.3	1.8	1	1.5	6.7	1.3
January 2011	19.1	3.5	96.7	54.4	0	0	2.5	6.2	1.4
February 2011	24.5	8.5	95.2	47.6	26.9	4	4.1	8.1	2.0
March2011	31.7	13.1	81.7	49.4	0	0	3.4	7.9	4.8
Mean/Total	**32.5**	**18.6**	**78.6**	**46.6**	**750.7**	**66.0**	**4.1**	**6.2**	**3.8**