Annual Report
2011–12

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

भाकृअनुप
ICAR

ANNUAL REPORT
2011-12

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.

Directorate of Rapeseed–Mustard Research
Sewar, Bharatpur 321 303 (Rajasthan), India

Printed : **June 2012**

Citation : **Annual Report 2011-2012**
Directorate of Rapeseed-Mustard Research
(Indian Council of Agricultural Research)
Sewar, Bharatpur-321 303 (Rajasthan), India pp 76

Guidance : **Dr J S Chauhan**

Editors : **Drs P K Rai, V V Singh, Maharaj Singh and Ajay Kumar Thakur**

Photography : **Mr Rakesh Goyal**

Published by : **Dr J S Chauhan**
Director, Directorate of Rapeseed-Mustard Research
Sewar, Bharatpur- 321 303 (Rajasthan), India
Phone: +91-5644-260379, 260495
Fax: +91-5644-260565
e-mail: director.drmr@gmail.com
Web: http://www.drmr.res.in

Printed at : **M/s Royal Offset Printers**
A-89/1, Naraina Industrial Area, Phase-I
New Delhi 110 028

Contents

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

It is with immense pleasure and satisfaction to present 19th Annual Report of Directorate of Rapeseed-Mustard Research embodying the salient achievements during 2011-12. Looking back, it is satisfying progress as two novel genetic stocks, MCA-1 a *moricandia* based CMS line of karan rai (*Brassica carinata)* and BPR 349-9 of Indian mustard (*Brassica juncea*), with high temperature tolerance during juvenile stage were registered with NBPGR, New Delhi. Independent putative transgenic events of *B. juncea* var. NRCDR-2, transformed with *TvD1* and *NtPI* genes *via Agrobacterium tumefaciens*-mediated gene transfer, were multiplied and maintained under *in vitro* conditions. Flagship research programmes were initiated. The DRMR initiated recognizing the best performing personnel in scientific, administrative, technical and skilled staff categories and also constituted team awards. It also laid emphasis on human resource development for delivering quality output, 9 scientists, 4 administrative and technical staff were deputed for training. DRMR also signed MoUs with 4 state Agricultural Universities for effective implementation of Tribal Sub-Plan programme especially targeting rice-fallows in northeast. In our popular endavour, *beej pakhwara* to provide latest know-how of rapeseed-mustard production and seeds at affordable prices about 300 quintal seed of different varieties of mustard were sold to the farmers from Rajasthan, Uttar Pradesh, Haryana and Madhya Pradesh. Other land marks in the annals of DRMR were foundation stone laying of Basic Science Complex by Prof S K Datta, Deputy Director General (Crop Science) and sanctioning of a KVK to DRMR by the ICAR, New Delhi. Many of our colleagues won prestigious awards from various professional societies. Indian Council of Agriculture Research, New Delhi on its 83rd foundation day conferred second Rajarishi Tandon Rajbhasha Award for the year 2010 to DRMR. Our exhibits also received second prize in Agriculture and Sheep Fair at Central Sheep and Wool Research Institute, Avikanagar. I sincerely thank and congratulate my colleagues at the Directorate of Rapeseed Mustared Research for making all out efforts for the development of this vital crop, rapeseed-mustard.

With sense of pride and gratitude I place on record my profound heartfelt thanks to Dr S Ayyappan, Secretary DARE, Government of India and Director General, ICAR; Prof Swapan Kumar Datta, Deputy Director General (Crop Science) and Dr B B Singh, Assistant Director General (Oilseeds & Pulses) of the Council for their timely help, guidance and encouragement without which it would not have been possible to achieve whatever a little we could.

I am happy to congratulate all the scientific and supporting staff of the DRMR who contributed to 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, Maharaj Singh and Ajay Thakur 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.

20/6/12

DRMR, Bharatpur
June 20, 2012

(J.S. Chauhan)
Director

Abbreviations

AICRP	:	All India Coordinated Research Project
AICRP-RM	:	All India Coordinated Research Project on Rapeseed-Mustard
ARS	:	Agriculture Research Station
AVT	:	Advance Varietal Trial
AWS	:	Automatic Weather Station
BARC	:	Bhabha Atomic Research Center
BAU	:	Birsa Agricultural University
BS	:	Breeder Seed
BSSH	:	Bright Sunshine Hours
CAU	:	Central Agricultural University
CAZRI	:	Central Arid Zone Research Institute
CCSHAU	:	Chaudhary Charan Singh Haryana Agricultural University
CGMCP	:	Centre for Genetic Manipulation of Crop Plants
CIAE	:	Central Institute of Agricultural Engineering
CIAH	:	Central Institute of Arid Horticulture
CIPHET	:	Central Institute of Post Harvest Technology
CRIJAF	:	Central Research Institute on Jute and Allied Fibers
CRRI	:	Central Rice Research Institute
CSAUA&T	:	Chandra Shekhar Azad University of Agriculture and Technology
CSWCT RI	:	Central Soil Water Conservation Research & Training Institute
CSWRI	:	Central Sheep and Wool Research Institute
CT	:	Conventional Tillage
DAC	:	Department of Agriculture and Cooperation
DBT	:	Department of Biotechnology
DG	:	Director General
DGR	:	Directorate of Groundnut Research
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
EFC	:	Expenditure Finance Committee
ERNET	:	Education and Research Network
FASAL	:	Forecasting Agricultural Output Using Space and Agrometeorological 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
GT	:	Ground Truth
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
ICRISAT	:	International Crops Research Institute for the Semi-Arid Tropics
IGFRI	:	Indian Grassland and Fodder Research Institute
IHT	:	Initial Hybrid Trial
IIHR	:	Indian Institute of Horticultural Research
IIPA	:	Indian Institute of Public Administration
IIPR	:	Indian Institute of Pulses Research
IIVR	:	Indian Institute of Vegetable Research
IMD	:	India Meteorological Department
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
ISTM	:	Institute of Secretariat Training & Management
ITK	:	Indigenous Technical Knowledge
IVT	:	Initial Varietal Trial
JNKVV	:	Jawaharlal Nehru Krishi Vishwa Vidhyalaya
KVK	:	Krishi Vigyan Kendra
MACRS	:	Modified Accelerated Cost Recovery System
MESY	:	Mustard Equivalent Seed Yield
MoU	:	Memorandum of Understanding
MPS	:	Mean Percent Score
MPUAT	:	Maharana Pratap University of Agriculture and Technology
NAARM	:	National Academy of Agricultural Research and Management
NAAS	:	National Academy of Agricultural Sciences
NABARD	:	National Bank for Agriculture and Rural Development
NALMOT	:	National Monitoring Team on Oilseed and Pulses
NAIP	:	National Agricultural Innovation Project
NARS	:	National Agricultural Research System
NASC	:	National Agricultural Science Complex
NBAIIM	:	National Bureau of Agriculturally Important Insects
NBAIM	:	National Bureau of Agriculturally Important Micro-organism
NBPGR	:	National Bureau of Plant Genetic Resources
NIAR	:	National Institute of Administrative Research

NIRD	:	National Institute of Rural Development
NRCPB	:	National Research Center on Plant Biotechnology
NRCSS	:	National Research Center on Seed Spices
NSKE	:	Neem Seed Kernel Extract
NSP	:	National Seed Project
PAU	:	Punjab Agriculture University
PDA	:	Potato Dextrose Agar
PDFSR	:	Project Directorate on Farming System Research
PG	:	Post Graduate
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
RBM	:	Raj Bahadur Memorial
RBS	:	Raja Balwant Singh
RCBD	:	Randomized Complete Block Design
RCT	:	Resource Conservation Technology
RF	:	Rainfed
ROS	:	Reactive Oxygen Species
RVSKVV	:	Rajmata Vijayaraje Scindia krishi Vishwa Vidhyalaya
SAC	:	Space Applications Centre
SAS	:	Statistical Analysis Software
SDAU	:	Sardarkrushinagar Dantiwada Agricultural University
SKRAU	:	Swami Keshwanand Rajasthan Agricultural University
SKUAS & T	:	Sher-E-Kashmir University of Agriculture Sciences and Technology
SMS	:	Subject Matter Specialist
SRM	:	Soil Resource Mapping
SVPUA & T	:	Sardar Vallabhbhai Patel University of Agriculture & Technology
TL	:	Truthful Label
TMOP	:	Technology Mission on Oilseeds and Pulses
TSP	:	Tribal Sub Plan
UAS	:	University of Agriculture Sciences
UK	:	United Kingdom
VAM	:	Vesicular Arbuscular Mycorrhiza
VC	:	Vice-Chancellor
WP	:	Wettable Powder
WUE	:	Water Use Efficiency
ZARS	:	Zonal Agriculture Research Station

Executive Summary

- Two novel germplasm accessions *viz*., MCA-1 (CMS line of *Brassica carinata)* and Indian mustard (*Brassica juncea*) germplasm BPR-349-9 (thermo-tolerant at juvenile stage) were registered with NBPGR, New Delhi.
- In a joint exploration with NBPGR, New Delhi, in Arunachal Pradesh, 85 leafy vegetable *Brassica* accessions were collected. 415 accessions belonging to different geographical regions of the country were evaluated for 16 agro-morphological traits and 57 promising accessions were identified. 100 accessions were shared with various government and non-government research organizations including SAUs for use in research programme.
- Strain DRMRIJ 31 was promoted from IVT (mustard timely sown irrigated) to AVT 1 for zone II under AICRP-RM prpogramme.
- 2 strains DRMRIJ 145 (2809 kg/ha) and DRMRIJ 118 (2761 kg/ha) out yielded the best check, RGN 73 (2361 kg/ha) by a margin of 18.6 and 16.9%, respectively, in a station trial.
- Interspecific hybrid derived from cross NRCYS 5-02 (*B. rapa* ssp. yellow *sarson*) x *B. fruticulosa* (wild species) through sexual hybridization was confirmed using morphological, cytological and SSR markers.
- The highest seed yield (2990 kg/ha) was recorded when *Sesbania* (GM) + mustard straw was supplemental with $N_{80}P_{17.4}K_{33.3}$.
- Conjunctive application of PSB+VAM significantly increased P uptake by 21.8% over control.
- Maximum irrigation water productivity was recorded under micro sprinkler (3.5 kg/m^3) and drip system (3.1 kg/m^3) with fertigation of 120 kg N/ha and at recommended P and K levels (3.2 kg/m^3).
- Of the 141 strains evaluated, EC 597329 (*B. juncea*), 10-163 (Rohini x GSL 1) and 10-883 (Varuna x BPKR 13) showed tolerant reaction (lesion size < 3 cm) to Sclerotinia rot disease.
- Of the 16 wild crucifers, *B. fructiculosa, Crambe* sp. and *Lepidium* sp., were found tolerant to mustard aphid with average aphid infestation index <1.
- Carbendazim (ST+FS), carbendazim ST)+ Folicur (FS), Quintal (ST+FS), Carbendazim (ST)+ Folicur (FS) provided maximum reduction (88.9%) in Sclerotinia rot disease and highest seed yield (2583-3310 kg/ ha) over check (2408 kg/ ha).
- Independent putative transgenic events of *B. juncea* var. NRCDR-2, transformed with *TvD1* and *NtPI* genes *via Agrobacterium tumefaciens*-mediated gene transfer, were multiplied and maintained under *in vitro* conditions.
- A total of 161 genomic STMS markers derived from *Brassica napus*, *B. nigra*, *B. rapa* and *B. oleracia* were used to search orthologous match in other genera/ species of family Brassicaceae. Among the 161 STMS markers, 70 (43.5%) showed cross-transferability to at least one of the eleven species considered for the study. However, only 32 (45.7%) of the cross-transferable markers showed polymorphism and distinguished the studied taxa.
- Eighty radio talks related to rapeseed-mustard research and development programmes and improved practices were broadcasted from 4 radio stations, Agra and Mathura of Uttar Pradesh and Jaipur and Kota of Rajasthan.
- ICAR sanctioned a KVK to DRMR, Bhartapur. The proposed KVK is to be established at Gunta village of Tehshil Bansur, Alwar district.
- The foundation of basic science complex at DRMR, Bharatpur was laid by Prof. S.K. Datta, DDG (CS), ICAR, New Delhi on March 18, 2012.
- A 7day model training course, sponsored by Ministry of Agriculture, Govt of India, on Advances in seed production, processing and certification of *rabi* field crops and a 6 day farmers' training programme on seed production technology of *rabi* field crops (rapeseed-mustard, wheat, lentil and gram) were organized.
- Under TSP, 5 training programmes/ exposure visits at DRMR were conducted and 125 tribal farmers from Asom, Manipur, Jharkhand and Southern Rajasthan were educated about rapeseed-mustard production technologies.
- A total 22 research papers, 7 popular articles, 5 technical bulletins, 1 book and 7 book chapters were published. Further, 20 research papers were presented in various seminar, symposia/ conferences.
- Nine scientists of the directorate were awarded/ recognized by different societies/ organizations.
- Resource worth **₹ 34.93 lakh** was generated.

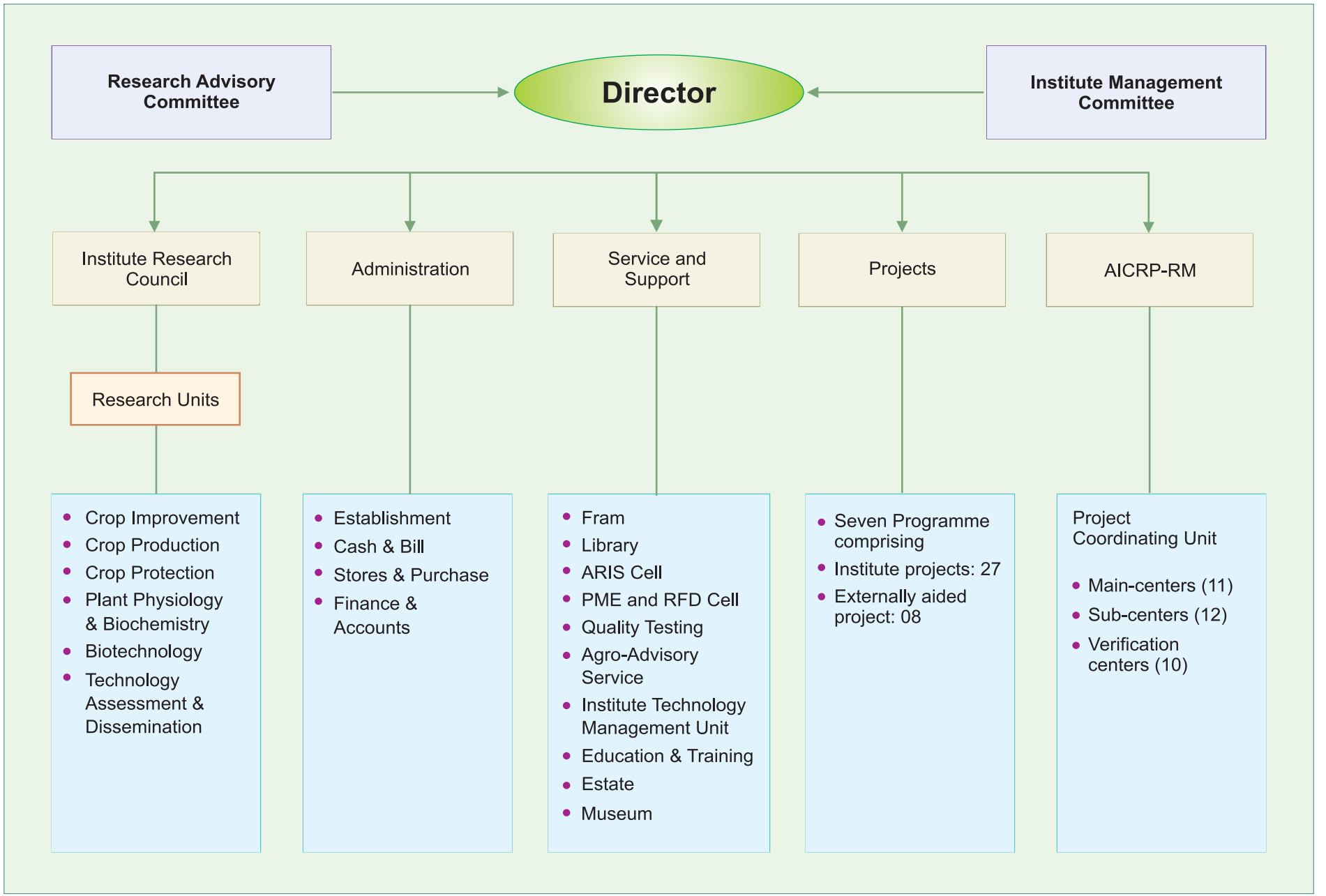
1

DRMR: *An Overview*

All India Coordinated Research Project on Oilseeds (AICRPO) was established at IARI, New Delhi in April 1967 for the improvement of oilseeds in the country. Setting up separate Project Coordinating Units for various crops during Vth Plan (1974-1979) and on January 28, 1981 for Rapeseed- Mustard at Haryana Agricultural University, Hisar, the research programme on oilseeds, especially rapeseed-mustard was further strengthened. The ICAR established the National Research Center on Rapeseed-Mustard on October 20, 1993 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 (77.27^{0}E longitude; 27.12^{0}N latitude and 178.37 m above mean sea level) on the recommendations of the Task Force constituted in 1990. The centre has been upgraded as DRMR in the XI Plan (2007-12) on 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 a wide network of 12 main- and 11 sub-centers across the country in addition to need based verification centers under the umbrella of AICRP 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 station, 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. 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.

Mandate

- 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 situation.
- Generation of location specific interdisciplinary information based on multiplication 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.


Research Advisory Committee
Director
Institute Management Committee
Institute Research Council
Administration
Service and Support
Projects
AICRP-RM
Research Units
Crop Improvement
Crop Production
Crop Protection
Plant Physiology & Biochemistry
Biotechnology
Technology Assessment & Dissemination
Establishment
Cash & Bill
Stores & Purchase
Finance & Accounts
Fram
Library
ARIS Cell
PME and RFD Cell
Quality Testing
Agro-Advisory Service
Institute Technology Management Unit
Education & Training
Estate
Museum
Seven Programme comprising
Institute projects: 27
Externally aided project: 08
Project Coordinating Unit
Main-centers (11)
Sub-centers (12)
Verification centers (10)

2

Research Achievements

2.1 Genetic enhancement for stress tolerance in Indian mustard

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

Project Leader : V V Singh, Principal Scientist (Plant Breeding & Genetics)

Associates : Maharaj Singh, Senior Scientist (Plant Physiology)

Induction and performance of strains in AICRP-RM trials

Three promising strains have been contributed for multi location testing under AICRP-RM programme for the year 2011-12. DRMR 537-40 and DRMR 538-41 of *B. juncea* were identified as tolerant to salinity at seedling stage while another strain DRMR 45 showed tolerance to high temperature at seedling stage at Hisar, Bharatpur and Ludhiana. DRMR 243, DRMR 261 and DRMR 270 of *B. carinata* were identified as resistant to downy mildew, powdery mildew and white rust disease.

Evaluation of promising entries in station/ advanced trials

In station trial, two strains DRMRIJ 145 (2809 kg/ha) and DRMRIJ 118 (2761 kg/ha) out yielded the best check, RGN 73 (2361 kg/ha) by a margin of 18.6 and 16.9%, respectively. In advanced trial strain BPR 150-35 (2653 kg/ha) performed better than the check, RGN 73 (2446 kg/ha). Similarly, in station trial under rainfed conditions, strain BPR 659-49 (2098 kg/ha) out yielded the best check, RB 50 (1851 kg/ha) at Bharatpur and BPR 605-40 (1630 kg/ha) and BPR 572-10 (1600 kg/ha) performed better than PCR 7 (1325 kg/ha) at Jobner.

Evaluation of half-sib progenies for yield components

Progenies, YHS 3, YHS 7, YHS 12, YHS 14, YHS 18, YHS 20, YHS 22, YHS 45, YHS 66, YHS 67, YHS 142, YHS 174, were selected for seed yield/ plant, progenies YHS 4, YHS 7, YHS 59, YHS 60, YHS 61, YHS 92, YHS 101, YHS 153 for 1000-seed weight (> 6 g) from 180 half sib progenies evaluated for yield components.

Generation of breeding material

9 F_1's were advanced to F_2 generation. More than 900 single plants were selected from 12 F_2 populations, out of them 300 single plant progenies were selected on the basis of oil content (>40%), 1000-seed weight (>5g) for generation advancement. 124 full-sib progenies were developed for second cycle of full-sib progeny selection.

Selection from segregating generations

Out of 509 single plant progenies, 50 single plants and 50 bulks were selected for generation advancement. Progenies BPR 1165-61, BPR 1139-39, BPR 654-241, BPR-654-681, BPR-1139-25 were selected from F_5 generation as they shown >20% higher yield than the best check Maya (512g/4.2 m^2). Among F_6 lines 5 progenies BPR 682-18, BPR 625-109B-105, BPR 1299-39, BPR 669-29, BPR 645-73 exhibited >20% superiority over the best check JD 6 (641g/4.2 m^2). From observation nursery, progenies BPR 141-14, BPR 648-60, BPR 775-57, BPR 582-59, BPR 150-97B, and BPR 150-33 recorded more than 10% higher yield than best check NRCDR 2 (725g/4.2 m^2).

Rainfed

From F_3 generation, progenies F_3-56, F_3-1, F_3-4, F_3-9, F_3-22, F_3-58, F_3-3, and F_3-16 showed superiority over best check, Geeta and selected for generation advancement. Progenies F_4-35-11, F_4-21-1, F_4-28-40, F_4-28-38 were selected from F_4 generation as they showed >10% yield superiority over the best check PBR-97 (Table 2.1)

Table 2.1 : Characterization of superior F_4 progenies for seed yield, 1000-seed weight and oil content

Progeny	Seed yield (g/4.2 m^2)	1000-seed weight (g)	Oil content (%)
F_4-35-11	525	4.4	41.4
F_4-21-1	500	3.9	41.2
F_4-28-40	545	4.2	41.5
F_4-28-38	450	3.9	38.7
PBR 97(BC)	380	4.7	40.5

Observation nursery and F_5 progenies were grown at two locations i.e. DRMR and Jobner. At each location promising entries on the basis of 20% yield superiority over the best check were selected and characterized (Table 2.2)

Table 2.2 : Seed yield and seed weight of superior progenies of Indian mustard under rainfed conditions at Bharatpur and Jobner

Observation Nursery					
Bharatpur			Jobner		
Progeny	Seed yield (g/4.2 m²)	1000-seed weight (g)	Progeny	Seed yield (g/4.2 m²)	1000-seed weight (g)
BPR 606-8	1100	5.6	BPR 648-60	745	5.8
BPR 659-34	1025	5.9	BPR 639-55	536	5.6
BPR 583-4	975	5.6	BPR 639-655	506	5.4
BPR 630-42	950	5.3	BPR 682-69	500	4.9
PBR 97 (BC)	575	4.5	Pusa bold (BC)	416	5.1
F_5 progeny					
BPR 1187-249	550	4.5	BPR 1153-182	583	4.8
BPR 1187-32	500	3.6	BPR 1153-181	576	4.4
BPR 1191-38	475	4.4	BPR 1153-111	574	5.1
BPR 1191-68	475	5.1	BPR 1195-14	573	4.6
RB 50 (BC)	366	4.3	Varuna (BC)	290	4.9

BC= best check

Population development programme

On the bases of stay green trait, siliquae/ plant, plant height, main shoot length and vigour more than 250 individual plants were selected from population grown in isolation under rainfed conditions to identify moisture stress tolerant plants for second cycle of half-sib progeny selection. Similarly, about 300 individual plants selected randomly from another population of high oil content were grown in isolation. From Alternaria blight population, 52 individual plants were selected on the basis of relative tolerance to Alternaria blight disease.

Genetic studies

To study the nature and magnitude of gene effects for water use efficiency, generation mean analysis, using two crosses Maya x BPR 543-2 and BPR 543-2 x BPR 2, was made. The analysis showed presence of duplicate gene action in both the crosses. The study revealed importance of both additive and non additive type of gene action for WUE.

An analysis was made to compare half-sib and full-sib progeny selection methods for 14 morpho-physiological characters. Genetic parameters were higher in full-sibs for more number of traits. The estimate of genetic advance expressed as % of mean showed that full-sib progenies had higher genetic advance (GA) for most of the traits except siliquae/ plant. In half-sib progenies, seed yield/ plant showed positive and significant correlation only with plant height (0.252*) and primary branches/ plant (0.218*) whereas, in full-sib progenies, seed yield/ plant showed positive and significant correlation with plant height (0.256*), seeds/ siliqua (0.258*), 1000-seed weight (0.335**), oil content (0.311**), and protein content (0.286*), SPAD values at flowering (0.319**), seed filling stage (0.335**) and transpiration at flowering (0.216*)stage. Full-sib progeny selection yielded more number of significantly superior progenies (18%) than half-sib progeny selection (7.7%).

Characterization of dwarf and early line of *Brassica carinata*

DRMR 596-100, a dwarf and early maturing line of *Brassica carinata* derived from interspecific cross of Varuna x BPKR 13 was characterized along with check Kiran for days to maturity, plant height and other morphological traits On the basis of pooled mean, DRMR 596-100 matured earlier (154 days) than the check Kiran (173 days) and showed short stature

DRMR 596-100

(162 cm) as compared to Kiran (238 cm). This line can be used as a genetic stock in karan rai improvement programme.

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

Project Leader : Arun Kumar, Senior Scientist (Plant Breeding & Genetics)

Interspecific hybrid derived from cross NRCYS 5-02 (*B. rapa* ssp. yellow *sarson*), x *B. fruticulosa* (wild species) through sexual hybridization was confirmed through morphological, cytological and molecular markers (SSR). Six plants were obtained out of 20 seeds sown in pots.

The hybrid plants were medium in height (52.7 cm), profusely branched and intermediate to their putative parent plants for most of the morphological and inflorescence attributes. The leaves were light green in colour with dense hair, lobes and medium dentation. Flower size (corolla length 0.5 cm and width 0.4 cm) and petal colour (light yellow) was intermediate to the parents (yellow). The hybrid plants had smaller silaquae (1.5 cm) with few seeds (8) in open pollination.

Meiotic characteristics of F_1 hybrids

Of the total 54 pollen mother cells (PMCs) analyzed 4 PMCs (7.4 %) exhibited all the 18 chromosomes as univalents, the remaining had bivalents and trivalents in addition to the compensating number of univalents. Although the occurrence of univalents was frequent, a maximum of 8 bivalents were observed in 2 PMCs (3.7%). 4, 3, 2 and 1 bivalents were observed in 5.6%, 3.7%, 40.7%, and 33.3%, respectively. Trivalents were also observed in few PMCs (2.5%). The univalents ranged between (2-18), bivalents (0-8) and trivalents (0-1) respectively (Fig 2.1).

The low pollen stainability in F_1 hybrids (7.6%) as compared to parents, NRCYS 5-02 (90%) and *B. fruticulosa* (83%) could be due to meiotic and/ or segregational irregularities. Hybridity of F_1 plants was confirmed through SSR markers. Out of 47 SSR primers validated for polymorphism, Ra-A01 showed the polymorphic bands (Fig.2.2).

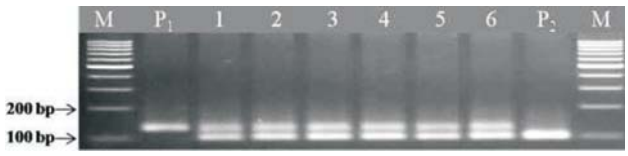


Fig 2.2: SSR primer analysis of parents and hybrids with the primer Ra2-A01, lane M - 100 bp DNA ladder, lane P1- *B. rapa* ssp. yellow *sarson* (NRCYS-2-05), lanes 1-6- F_1 hybrids, lane P2- *B. fruticulosa*

Morphologically F_1 plants of *B. juncea* (NRCDR 2, Kranti) x *B. napus* (GSC 6) were intermediate to parents and profusely branched. The leaves of the hybrid were dark green as compared to parents. Intermediate plants having medium size hairy leaves, light yellow petal with smaller siliqua and poor seed set were observed.

The chromosome associations observed in PMCs in some representative cells of the crosses NRCDR-2 x GSC-6 (Fig 2.3) and Kranti x GSC 6 (Fig 2.4), respectively. Meiotic analyses of F_1 hybrid (2n=37) at diakinesis/metaphase I in total 30 PMCs analyzed, exhibited trivalents (0-2) and quadrivalent (0-1). A maximum of 15 bivalents were observed in 2 PMCs. The chromosome associations recorded were as follows: 7II+23I, 1III+7II+20I, 6II+25I, and 15II+7I. Delayed terminalization of the chiasmata resulted in bridge formation in few of the PMCs. Cells devoid of laggards were also noted. The meiotic studies revealed major irregularities leading to low pollen stainability in NRCDR-2 x GSC 6 (26%) and Kranti x GSC 6 (24.6%) hybrids.

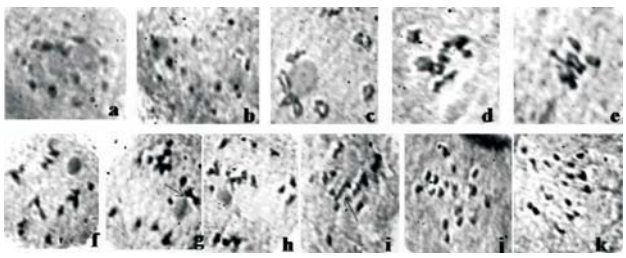


Fig 2.1: a-k Meiosis of *B. rapa, B. fruticulosa* and their F_1 hybrid. a-b *B. rapa,* diakinesis 10II. c-e *B. fruticulosa,* c-d diakinesis 8II. e metaphase I 8II. f-k F_1 hybrid, f diakinesis 3II+12I, g diakinesis 1III+15I, h diakinesis 4II+11I, i diakinesis 1III+1II+13I, j metaphase I 1II+16I, k metaphase I 18I. (trivalent marked by arrow)

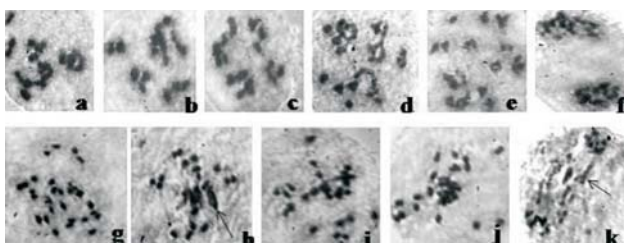


Fig 2.3: a-k Meiosis of *B. juncea* (NRCDR 2), *B. napus* (GSC 6) and their F_1 hybrid. a-c *B. juncea, d*iakinesis 18II, d-f *B. napus* d-e diakinesis 19II, f anaphase I 18:18. g-k F_1 hybrid g diakinesis 9II+19I, h diakinesis 1IV+3II+23I, i metaphase I 7II+23I, j metaphase I 3II+26I, k anaphase I (quadrivalent and laggards marked by arrow)

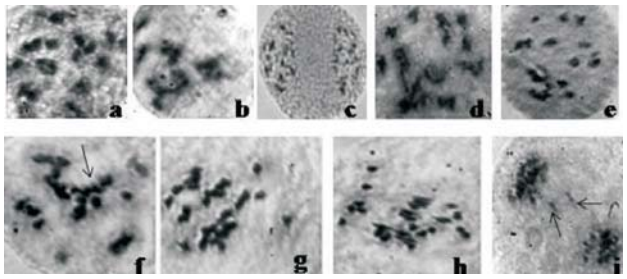


Fig 2.4: a-i Meiosis of *B. juncea* (Kranti), *B. napus* (GSC 6) and their F_1 hybrid. a-b *B. juncea*, diakinesis 18II, c anaphase I 18:18 d-e *B. napus* diakinesis 19II, f-i F_1 hybrid f diakinesis 1III+7II+20I, g metaphase I 6II+25I, h metaphase I 15II+25I, i anaphase I with laggards (trivalent and laggards marked by arrow)

DRMR CI 14: Genetic and molecular basis of heat tolerance in Indian mustard

Project Leader : Bhagirath Ram, Senior Scientist (Plant Breeding & Genetics)

Associates : M Singh, Senior Scientist (Plant Physiology); B K Singh, Scientist (Plant Biotechnology)

Screening of genotypes for high temperature tolerance in Indian mustard

24 high temperature tolerant and susceptible strains were evaluated in a randomized complete block design with 3 replications in 3 rows of 5 m length (Table 2.3). Sowing was done on September 29, 2011. Strains differed significantly for growth and physiological parameters, *viz*., plant survival % (10 and 12 DAS), membrane stability index (%), water retention capacity of leaves and relative water content (%). The population survival after 10 and 12 days of sowing ranged from 31.6 to 80% and 16.6 to 75%, respectively. The membrane stability index ranged from 20.6 to 68.3%. Similarly, water retention capacity of leaves and relative water content ranged from 5.8 to 17.5% and 9.5 to 78%, respectively. Strains RH 30, JN 32, NRCHB 101, RB 50 and BPR 543-2 recorded higher membrane stability index, whereas, JN 31 lowest (Table 2.3). Strains NPJ 93, RGN 13 and RH 30 expressed higher water retention capacity of leaves, whereas, JR 42 recorded the lowest. Similarly, NPJ 112, JN 32 and BPR 549-9 had higher relative water content while RGN 12 the lowest.

Table 2.3: Relative performance of Indian mustard varieties for high temperature tolerance

Genotypes	Plant survival (%) 12 DAS	Plant survival (%) 22 DAS	Membrane stability index (%)	Water retention capacity of leaves (%)	Relative water content (%)
NPJ 93	31.6	16.6	47	17.5	70.0
NPJ 113	61.6	60.0	29	9.2	64.2
NPJ 124	61.6	64.0	21	8.6	71.7
NPJ 112	71.6	72.3	53	5.9	78.0
Pusa Agrani	76.6	73.3	31	10.6	67.7
EJ 17	76.6	70.6	27	8.7	67.5
NRCDR 02	78.3	74.3	44	7.2	72.6
BPR 543-2	80.0	75.0	59	10.9	53.6
BPR 349-9	70.0	69.3	34	6.6	68.3
BPR 540-6	76.6	69.0	58	10.2	71.2
RGN 13	38.3	37.6	10	15.0	68.8
RGN 12	31.6	26.6	52	9.6	18.1
NRCDR 601	58.3	56.6	38	9.4	71.4
NRCHB 101	61.6	57.0	62	9.9	67.8
RH 30	51.6	49.0	74	13.6	68.1
Urvashi	56.0	54.3	43	7.3	69.1
BPR 549-9	36.6	30.6	54	11.1	72.9
BPR 541-2	45.0	35.3	43	8.1	52.5
JR 042	51.6	49.0	46	5.6	65.2
JN 032	53.3	57.6	72	11.8	75.8
JN 031	58.3	52.0	10	10.6	71.5
Varuna	60.0	53.3	42	8.1	67.3
GM 2	40.0	38.3	15	12.6	66.4

Genotypes	Plant survival (%) 12 DAS	Plant survival (%) 22 DAS	Membrane stability index (%)	Water retention capacity of leaves (%)	Relative water content (%)
RB 50	40.0	33.3	62	7.1	53.3
Mean	56.9	53.1	42.7	9.8	65.5
Range	31.6-80.0	16.6-75.0	10.0-74.0	5.6-17.5	18-78
CV (%)	19.6	7.7	16.4	12.8	3.4
CD(p=0.05)	18.9	6.9	12.2	2.1	3.8

2.2 Breeding for yield and quality enhancement in rapeseed-mustard

DRMR CI 5: Development of hybrids in Indian mustard

Project Leader : K H Singh, Senior Scientist (Plant Breeding & Genetics)

Associate : J Nanjundan, Scientist (Plant Breeding & Genetics)

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

One strain DRMRIJ 31 was promoted from IVT (mustard timely sown irrigated) to AVT 1 under zone II on the basis of 10% more oil yield over the best check NRCDR 2.Two new strains namely DRMRMJB 35 and DRMRIJ 118 were inducted in initial varietal trials for early mustard and timely sown mustard, respectively. Three hybrids, DRMRHJ 3813, DRMRHJ 3904 and DRMRHJ 1103 were also inducted to IHT. Likewise three strains DRMRIJ 11-275, DRMRIJ 11-286 and DRMRIJ 11-287 were inducted to uniform disease nursery. *Brassica carinata* strain MCB 1 was inducted to national disease nursery for white rust screening.

Estimation of variability among inbred lines

Variability was assessed among 255 inbred lines developed through continuous selfing and 3 check varieties *viz.*, Maya, Rohini and Kranti. The experiment was conducted in an augmented randomized block design keeping 15 blocks. 3 checks were replicated in each block. The plot size was single row of 3 m length with 30 x 10 cm spacing. Days to flower initiation (DFI), leaves at flower initiation (LFI), plant height (cm) at flower initiation (PHFI), days to flower senescence (DFS), main shoot length (MSL, cm), siliquae on main shoot (SMS), siliqua bearing density (SBD- the ratio between siliquae on main shoot and main shoot length), days to maturity (DM), plant height (PHM, cm) at maturity, biological yield (BY, g), seed yield (SY, g), harvest index (HI, %), seeds/ siliqua (S/S) and 1000-seed weight (SW, g) were recorded on 5 plants.

Range and co-efficient of variation were estimated for all the 14 characteristics (Fig 2.5). Maximum phenotipic coefficient of variation (32.8%) was observed for seed yield followed by biological yield (30%). Hence, these two characters had high scope for further improvement. Among the other characters, seed weight, harvest index, plant height at maturity, siliquae bearing density, main shoot length and siliquae on main shoot also provided fair scope for further improvement. However, there is need for collection of new germplasm for early maturity because of the low variability in the present material. Since genotypic coefficient of variation have been lower

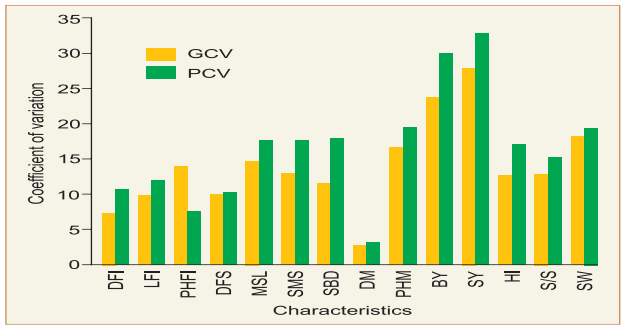


Fig 2.5: Genotypic (GCV) and phenotypic (PCV) coefficient of variation for 14 morphological characters in Indian mustard

than the corresponding phenotypic coefficient of variation but fairly high for all characters except days to maturity, days to flower initiation, leaves at flower initiation, plant height at flower initiation and days to flower senescence, selection is likely to be effective.

The mean values of each line for all characters were analyzed and adjusted by eliminating the block effects. Promising lines were identified on the basis of comparison between best check varieties and mean of each characters. Days to flower initiation, the lines which had lower values for days to flower initiation than the check (52.3 days, Maya) were selected. These included HB 9910 (34.1 days) to 39-

3-2-2 (40.8 days). In comparison to 7.2 leaves at flower initiation in Maya and Rohini, the best 10 lines had leaves varying between 8.9-9.5. Similarly the plant height of selected 10 promising lines ranged from 106.5-113.1cm in comparison to 98.6 cm of Maya. The line 4-5-1 was common among the promising lines selected for plant height and flower initiation, leaves at flower initiation accompanied with fewer days for flower initiation hence; this line is suitable for fast growth.

In comparison to 105 days of flower senescence of Rohini, promising lines had 118 days for flower senescence. Long main shoot length is expected to give higher seed yield hence the lines having long main shoot (103—118 cm) were selected. Similarly the lines which had more siliquae on main shoot than the check variety Rohini (51.5) were selected. There were only 5 lines which had higher siliquae than the check variety. Line MJR 2 (1.2) which had siliqua bearing density of more than 0.9 was selected. In the present material, the earliest maturing line was HB 303-07 (124 days), 10 days early than the check variety Kranti (133 days). In present material many lines could be found for short stature, the lowest was of DU 38 (140 cm) followed by BPR 6-166. Lines which had more bio-mass than the check variety were MJR 15 (3207 g/row), 78-1-1 (3198 g/row), 4-4-7 (3143 g/row). Highest seed yield was observed in MJR 15 (610 g/row of 3m length) followed by BEC-152 (556 g/row) and HB-208 (550 g/row). Among the other promising inbred lines three lines 4-7-12-7 (BIO 902 x ZEM 2), 78-1-5 (EC 399288 x PCR 13 x HB 9916), 32-3-4 (HB 9908 x HB 9916) had 23.7, 22.1 and 20.5 seeds/ siliqua with 1000-seed weight of 3.9, 3.8g and 5.8g, respectively while the check variety Maya had 14.6 seeds/ siliqua with 5.8 g 1000-seed weight. Three other promising lines 56-3-6, 5912-14 and HB 9923 had 8.5,7.7 and 7.7 g 1000-seed weight with 16.4, 16.5 and 16.8 seeds/ siliqua,

Inter relationship among 14 traits was also studied. Seed yield had positive and significant correlation with days to flower senescence (0.12*), siliquae on main shoot (0.38**), plant height (0.34**), biological yield (0.89**) and harvest index (0.17*). Seed and biological yield had close relationship (0.89**). It was concluded that the genotypes having high bio-mass, tall plant, more number of siliquae on main shoot, high harvest index and long reproductive phase should be selected for high seed yield.

Evaluation of hybrids/promising strains

66 experimental hybrids were evaluated along with 281 parental/inbred lines in six different trials of which four were conducted in randomized complete block design and remaining two in augmented block design. Two hybrids HJ 1103 (2553 kg/ha) and HJ 2703 (2469 kg/ha) out yielded the best check, NRCHB 506 (2249 kg/ha) by a margin of 13.5 and 9.8%, respectively. Out of the 50 hand bred F_1s evaluated in augmented block design in single row plot of 2 m length, 3 $F_{1'S}$, MJA 27 x IJ 221, MJA 38 x IJ 221 and NRCHB 1103 showed distinct superiority over best check Kranti by a margin of 35%, 34% and 24%, respectively.

DRMR B 6: Standardization of FT-NIR for mass screening of antinutritional factors and development of processes for protein based value addition in rapeseed-mustard

Project Leader : Manjubala, Senior Scientist (Biochemistry)

The total phenol in seed meal varied 7.8 (PT 30 of toria) to 23.9 mg GAE/g (CC 220 of Indian mustard). The crude fiber content of the tested genotypes ranged from 5 to 12 % in de-fated seed meal with mean crude fiber content of 8.7%.

For non-destructive estimation of total phenol using small quantity of intact seed samples, calibration was developed using FTNIR. Spectra of intact seed samples were recorded in 13400-4000 cm^{-1} region. Each spectrum was the average spectrum of 32 scans. During the process of development of calibration model and its validation, certain number of samples had to be excluded in order to obtain the most reliable model possible. Therefore, the number of samples used for developing calibration was lower than initial number of samples. Initially calibration was started with 115 samples, gradually outliers were removed and 68 samples for total phenol content were finally used with 264 selected data points, to develop the calibration model. The results of the statistics related to partial least square regression calibration model using full cross-validation obtained by FT-NIR for phenolic compounds showed that standard error of estimation was 0.07. High value of determination coefficient (R^2 =0.96), high residual predictive deviation value of 4.98 and low value of root mean square error of cross validation (RMSECV=0.08) for total phenol whereas, for crude fiber content R^2 (0.91), RMSECV (0.41) and RPD (3. 37) were achieved which indicated good correlation between FTNIR predicted and measured values (Fig 2.6 & 2.7). The best spectral region for screening of total phenol and fiber was between 6102-5446.3 cm^{-1}; 4601-4246.7cm^{-1} and 5450.1-4246 cm^{-1}, respectively.

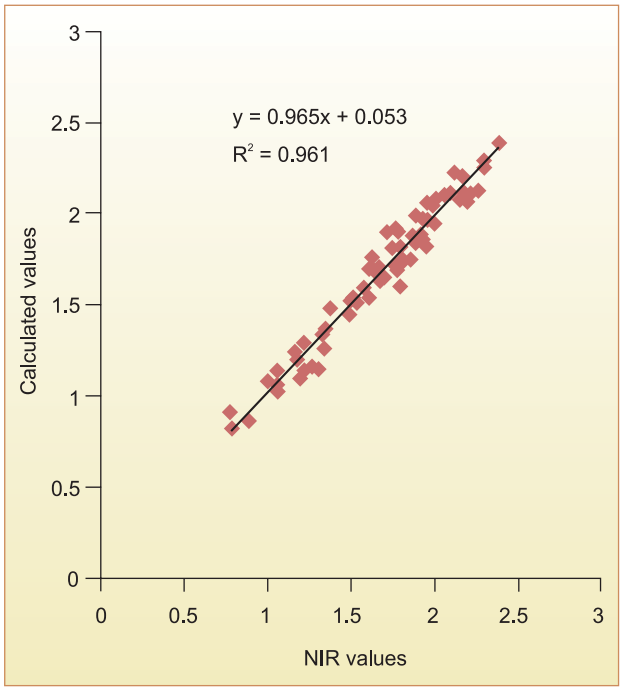


Fig 2.6 Regression line (cross-validation) of PLS models for total phenols obtained by FT-NIR spectroscopy

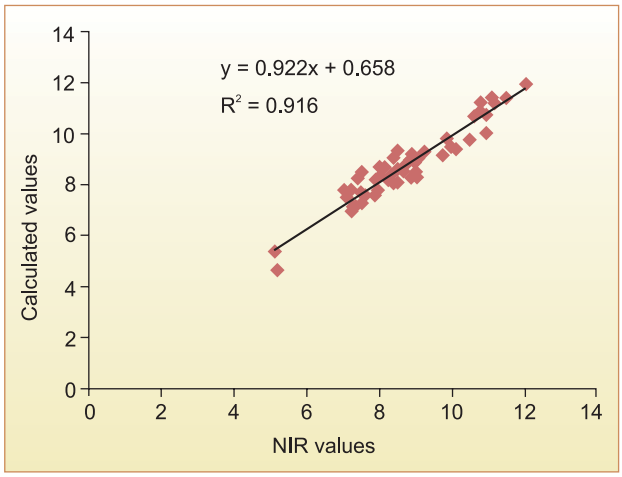


Fig 2.7 Regression line (cross-validation) of PLS models for crude fiber obtained by FT-NIR spectroscopy

DRMR CI 11: Mapping of fertility restoring gene for moricandia cytoplasmic male sterility in Indian mustard (*Brassica juncea* L)

Project Leader : K H Singh, Senior Scientist (Plant Breeding & Genetics)

Phenotyping was done for sterility/fertility in backcross (BC_1) population.

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

Project Leader : Priyamedha, Scientist (Plant Breeding & Genetics)

Associate : Manjubala, Senior Scientist (Biochemistry)

Evaluation of segregating generation selections for glucosinolate content

175 single plant selections were made in segregating generations (F_3: 6 crosses) and selfed seeds were analyzed for glucosinolate content. 12 plants had low glucosionolate content (< 30µM/g defatted seed meal) and 18 with glucosionolate content ranging between 30-40 µM/g defatted seed meal.

Selection in segregating generation

200 single plant selections were made from 7 F_2 populations on the basis of yield traits and yellow seed coat color. 50 single plant selections were made from 70 paired row progeny of low and near low glucosinolate plants of different generations (F_3: 3 crosses, F_4: 6 crosses & F_5: 3 crosses) on the basis of yield traits and yellow seed coat color.

Generation of new breeding materials

10 new F_1 crosses involving low erucic donors and high yielding varieties (NRCDR 2 & NRCHB 101) were made in line x tester design.

Maintenance breeding

30 Australian and Chinese quality donors have been maintained through selfing.

2.3 Rapeseed-mustard genetic resource management

DRMR CI 6: Management of rapeseed - mustard genetic resources

Project Leader : J Nanjundan, Scientist (Plant Breeding & Genetics)

Associates : K H Singh, Senior Scientist (Plant Breeding), P K Rai, Principal Scientist (Plant Pathology), M Singh, Senior Scientist (Plant Physiology)

Augmentation

In a joint exploration in Arunachal Pradesh, the DRMR, Bharatpur and NBPGR, New Delhi collected 85 leafy vegetable *Brassica* accessions. A total of 109 accessions of rapeseed-mustard were obtained from AICRP (R & M) network.

Maintenance of germplasm

685 accessions comprising Indian mustard (399), Karan rai (4), Toria (21), Yellow sarson (16), Taramira (21), Brown sarson (6), Gobhi sarson (54), advance breeding lines (96) and exotic (68) were maintained by adopting proper pollination control measures.

Characterization of Indian mustard accessions

To develop core collection, 415 accessions, belonging to different geographical regions of our country, were characterized using 16 agro-morphological traits (Table 2.4).

content (42-43%) against the check varieties Maya, Kranti and RGN 73.

Distribution of germplasm

A total of 100 accessions were distributed to various research organizations/students for use in research works/varietal developments.

Table 2.4: Mean, range and coefficient of variation of Indian mustard accessions for morphological traits

Traits	Mean ± SEm	Range	CV (%)	Values for best check
Initiation of flowering (days)	49.3 ± 2.7	40.0 - 65.0	10.4	49.8 (RGN 73)
50% flowering (days)	57.6 ± 2.9	46.0 - 76.0	9.0	59.1 (RGN 73)
Maturity (days)	155.1 ± 6.0	139.0 - 168.0	5.3	159.4 (RGN 73)
Plant height (cm)	204.4 ± 12.5	126.0 - 266.0	9.6	215.5 (RGN 73)
Primary branches / plant	6.5 ± 1.1	3.2 - 11.2	19.9	6.9 (Kranti)
Secondary branches / plant	12.7 ± 2.6	4.8 - 23.7	23.3	13.9 (Kranti)
Main shoot length (cm)	62.6 ± 7.6	38.0 - 90.7	12.6	66.4 (RGN 73)
Siliquae on main shoot	44.2 ± 5.9	28.3 - 68.0	14.1	47.4 (Kranti)
Siliqua length (cm)	4.0 ± 0.5	2.3 - 6.2	13.2	4.0 (RGN 73)
Seeds / siliqua	13.7 ± 0.1	3.7 - 25.7	17.5	13.8 (RGN 73)
1000 seed wt (g)	5.2 ± 2.0	2.1 - 8.8	22.9	6.2 (Maya)
Oil content (%)	40.2 ± 0.6	36.8 - 42.8	2.7	41.0 (Kranti & RGN 73)

White flowered Karan rai

Karan rai *(B. Carinata)* or Ethiopian mustard generally has bright yellow petal colour, characteristic of oilseed Brassica. Nevertheless, in the genotype DLSC 2, 8 plants of white flowers were observed at DRMR.

Genetic stock registered

One CMS line of *Brassica carinata* "MCA1" was developed for male sterility which will pave the way for hybrid development in *B. carinata*. One Indian mustard germplasm BPR 349-9 was registered for thermo-tolerance during juvenile stage.

Flower with rudimentary anthers of MCA 1

Development of trait specific gene pool in Indian mustard

From the 415 Indian mustard accessions evaluated, 57 accessions were selected for plant height, main shoot length, siliquae on main shoot, siliqua length, seeds/ siliqua, oil content and 1000-seed weight. 6 accessions were found promising for main shoot length (>80 cm), 5 each for siliquae on main shoot (>60) and siliqua length (> 5.5 cm), 25 for seeds/ siliqua (17-20), 2 for 1000-seed weight (> 8g) and 14 for oil

Flower of maintainer line MCB 1

2.4 Biotechnological interventions to improve rapeseed-mustard productivity

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

Project Leader : A K Thakur, Scientist (Biotechnology)

Random Amplified Polymorphic DNA (RAPD) markers were used to evaluate the genetic integrity of Indian mustard (*B. juncea*) var NRCDR 2 plants regenerated from cotyledonary petiole and cotyledon explants under *in vitro* conditions. The amplified products were monomorphic across all the selected regenerated plants and were similar to the mother plant confirming the genetic stability of the regenerants

The independent putative transgenic events of *B. juncea* var. NRCDR 2, transformed with *TvD1* and *NtPI* genes *via Agrobacterium tumefaciens*-mediated gene transfer, were multiplied and maintained under *in vitro* conditions. The well elongated shoots were transferred to rooting media (MS basal medium containing 0.3 mg/l IAA) and complete plantlets were obtained. Putative transgenic plantlets were hardened in culture room. Molecular characterization of the putative transgenic plants was carried out by PCR using *TvD1* gene specific primers. Bioassay of the PCR positive plants was done for *Alternaria* tolerance by detached leaf method.

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

Project Leader : B K Singh, Scientist (Biotechnology)

Cross-transferability and polymorphic potential of genomic STMS markers

A total of 161 genomic STMS markers derived from *Brassica napus*, *B. nigra*, *B. rapa* and *B. oleracea* were used to search orthologous match in other genera/species of family *Brassicaceae*. Among the 161 STMS markers, 70 (43.5%) showed cross-transferability to at least one of the eleven species considered for the study. 42 (60.0%) amplified in *B. tournefortii*, 34 (48.6%) in *Crambe abyssinica*, 47 (64.1%) in *B. fruticulosa*, 48 (68.6%) in *B. spinescens*, 37 (52.9%) in *Diplotaxis assurgens*, 38 (54.3%) in *D. siettiana*, 34 (48.6%) in *D. tenuisiliqua*, 40 (57.1%) in *Erucastrum canariense*, 18 (25.7%) in *Capsella bursa-pastoris*, 17 (24.3%) in *Camelina sativa* and 13 (18.6%) in *Lepidium sativum*. However, only 32 (45.7%) of the cross-transferable markers showed polymorphism and distinguished the studied taxa. Maximum (72.7%) cross-transferability was exhibited by *B. napus* having genomic composition (AACC), followed by 52.6% by *B. rapa* (AA) and 41.1% by *B. oleracea* (CC) derived STMS markers. *B. nigra* (BB) derived genomic STMS markers showed minimum (36.1%) cross-transferability (Fig 2.8).

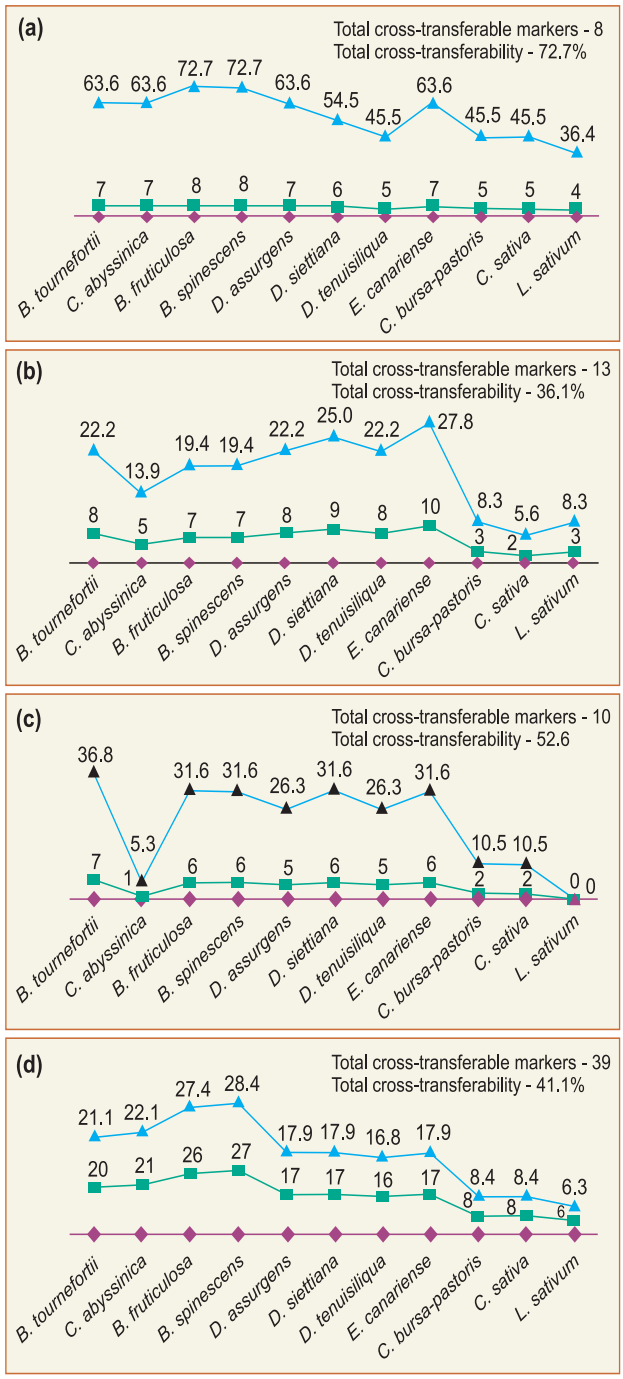


Fig 2.8: Extent of cross-transferability of STMS markers derived from (a) *B. napus*, (b) *B. nigra*, (c) *B. rapa*, (d) *B. oleracea*. Numbers depicted on the blue line and the green line on the y-axis indicate percent cross-transferability and the number of cross-transferable markers, respectively, to the corresponding taxa indicated on the x-axis

2.5 Enhancing resource use efficiency and abiotic stress management for resilient rapeseed-mustard production system

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

Project Leader : M Singh, Senior Scientist (Plant Physiology)

Twenty Indian mustard strains having low ^{13}C values (18.0-20.0‰) were studied for morpho-physiological and biochemical characters under irrigated and rainfed conditions in RCBD with 3 replications. The plot size was 5 rows of 5 m length for each strain with 30 x 10 cm spacing. 40 kg N and 40 kg P_2O_5/ha was applied before sowing and remaining 40kg N/ha was given after the first irrigation for the irrigated treatment only while in case of rainfed experiment, the full recommended dose of fertilizer (80: 40: 40 kg/ha) was given at the time of sowing. Plant from 50 cm row length/replication was taken to record observations on yield and yield attributes. The leaf gas exchange parameters were measured on a fully expanded main stem leaf using CIRAS-2 of PP System at full flowering stage. Water use efficiency at cellular level was computed as the ratio of assimilation to transpiration and expressed as µmol/mmole. Free proline in the matured leaves was estimated at full flowering stage following the method of Bates et al. (1973). Total carbohydrates were measured using the method given by Yemm and Willis (1954). The results showed significant decrease in primary and secondary branches, main shoot length, siliquae on different branches, plant dry weight and seed yield. The percent change in means of characters under rainfed conditions over the irrigated ones was calculated. The genotype BPR181-2 showed minimum (2.0%) decrease in primary branches closely followed by BPR 139-2 and BPR 325-4 (3%). In case of secondary branches, BPR 139-2 showed minimum (12%) decrease. The genotype BPR 537-4 recorded minimum reduction in siliquae on primary (2%) and secondary (8%) branches. No change in main shoot length was observed in BPR 181-15, BPR 349-4, BPR 181-2 and BPR 537-4. Similarly BPR 181-13, DRMR 537-40, BPR 331-3, BPR 181-15, BPR 541-4, BPR 543-2 and BPR 181-11 also did show any change in siliquae on main shoot. The drastic decrease in seed yield and plant dry weight was observed in all the genotypes. The interaction effects were also significant for plant dry weight and seed yield. The genotype BPR 543-2 recorded minimum (5%) decrease in seed yield closely followed by DRMR 541-44 (11%) and BPR 181-2 (13%). BPR 349-9 recorded maximum seed yield (14.3g/plant) followed by DRMR 541-44 (13.9g/plant) and BPR 549-9 (13.5g /plant) under rainfed condition. Water use efficiency increased significantly under rainfed conditions for different genotypes. Maximum WUE under rainfed conditions was observed in BPR 549-9, DHS 51, BPR 537-4 and BPR 541-4. The carbohydrate content decreased under rainfed condition whereas, free proline increased significantly. The minimum decrease in carbohydrate content was recorded in BPR 543-2 followed by DRMR 541-44 and BPR 541-4. Proline accumulation in *B. juncea* leaves increased progressively by increasing the moisture deficit period (Fig 2.9). The maximum positive change in free proline content was recorded in BPR 543-2 followed by DRMR 541-44. Such increase in proline content with increasing stress might be attributed to one of the defense mechanisms of plants to reduce cell osmotic potential.

Strain BPR 349-9 showed higher yield under rainfed condition because of higher siliquae on main shoot, primary branches, plant dry weight , carbohydrate

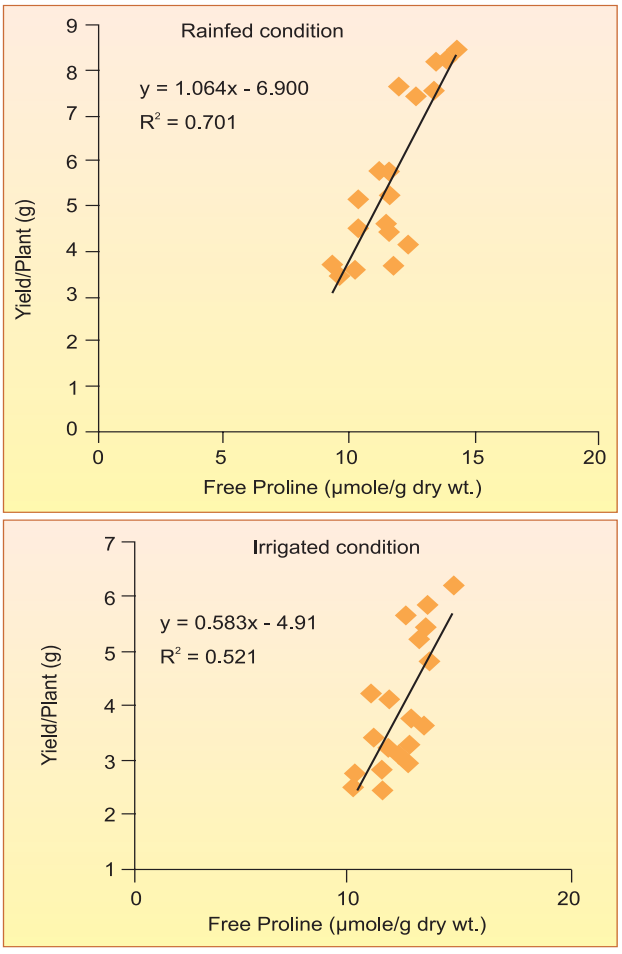


Fig 2.9 : Relationship of seed yield/ plant with free proline content under irrigated and rainfed condition

accumulation under rainfed situation. The high seed yield of DRMR 541-44 under rainfed condition could be due to high plant dry weight and carbohydrate accumulation. BPR 549-9 and DHS 51 also showed high water use efficiency under both irrigated and rainfed conditions.

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

Project Leader : O P Premi, Senior Scientist (Agronomy)

A long-term experiment under a fallow –mustard (*Brassica juncea*) system has been in progress since 2005-06 at DRMR to evaluate the effect of organic manures and fertility levels on mustard productivity. The pooled yield data of five years indicated that the *Sesbania* (GM) significantly increased mustard seed yield by 41.8% over control. Supplementary incorporation of mustard straw @ 2.5 t/ha increased the seed yield by 15.3% over *Sesbania* (GM) alone and 63.9% over control (Table 2.5). Application of inorganic fertilizers significantly influenced mustard seed yield during the experiment. In general, increase in N dose from 40 to 80 kg/ha increased seed yield by 43.2%. The increase in seed yield due to enhanced P and K application was 18.9% and 5.4%, respectively. The combined application of $N_{80}P_{17.4}K_{33.3}$ synergistically increased the seed yield by 82.1% over lowest dose combination.

Table 2.5: Effect of organic manures and chemical fertilizers on seed yield, oil content and oil yield (5 years pooled data)

Treatment	Pooled Seed yield (kg/ha)	Oil content (%)
Organic sources		
Control (Fallow – mustard)	1340[a]	42.4[c]
Sesbania (GM)	1900[b]	41.6[b]
Sesbania (GM) + mustard residue 2.5 t/ha	2190[c]	40.9[a]
Fertility level (kg/ha)		
$N_{40}\ P_{8.7}\ K_0$	1290[a]	42.0[bc]
$N_{40}\ P_{8.7}\ K_{33.3}$	1410[b]	42.1[bc]
$N_{40}\ P_{17.4}\ K_0$	1580[c]	42.3[c]
$N_{40}\ P_{17.4}\ K_{33.3}$	1670[d]	42.0[bc]
$N_{80}\ P_{8.7}\ K_0$	1920[e]	41.0[a]
$N_{80}\ P_{8.7}\ K_{33.3}$	1990[e]	41.3[ab]
$N_{80}\ P_{17.4}\ K_0$	2250[f]	41.1[ab]
$N_{80}\ P_{17.4}\ K_{33.3}$	2360[g]	41.3[ab]

*Means within a column followed by identical letters are not significantly different (p <0.05).

A consistent increase in mustard seed yield was observed with the increasing fertility levels under different organic sources treatments and highest seed yield (2990 kg/ha) was recorded when *Sesbania* (GM) + Mustard Straw was supplemental with $N_{80}P_{17.4}K_{33.3}$ (Fig 2.10). Among the fertility treatments analysed, application of $N_{80}P_{17.4}$ sustained the seed yield of mustard with or without potassium application.

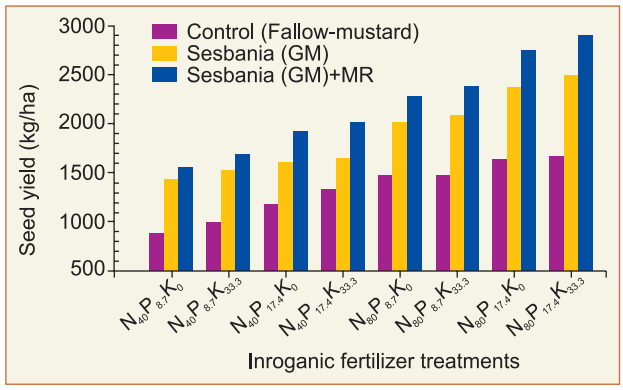


Fig 2.10: Seed yield of mustard as influenced by different chemical fertilizers combinations (pooled over five years)

The annual rate of increase in soil organic content (SOC) in 0-15 cm layer over the initial condition (carbon sequestration potential; CSP) was 0.373 mg/ha/year in *Sesbania* (GM) + MS treatment followed by 0.256 mg/ha/year in *Sesbania* (GM) and 0.124 mg/ha/year in control (Fig 2.11). Higher carbon sequestration potential rate (CSPR) values were also recorded with 80 kg N/ha and highest values were in $N_{80}P_{17.4}K_{33.3}$ treatment.

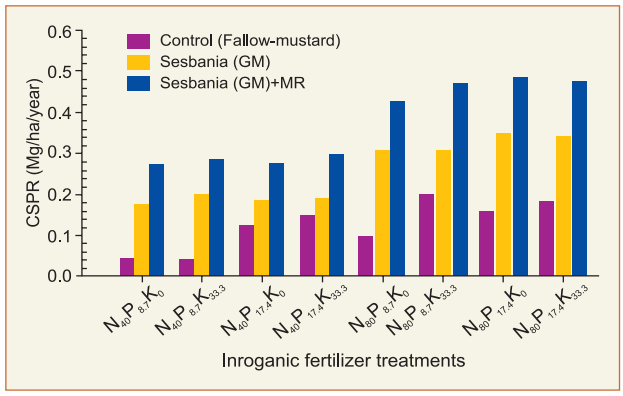


Fig 2.11: Carbon sequestration potential (mg/ha/year) of soil under various organic and inorganic treatments

Sustainability yield index

Over the study period, organic treatments as well as inorganic fertilizer treatments significantly influenced the sustainability yield index (SYI). *Sesbania* (GM) significantly increased SYI by 50.5% over control. Further, addition of mustard straw @ 2.5 t/ha increased the SYI by 16.7% over *Sesbania* (GM) and 75.0% over control.

Partial factor productivity (PFP)

The amount of total nutrients applied through *Sesbania* (GM) + MS incorporation was more than *Sesbania* (GM) alone, thus per unit increment in seed yield decreased and so also the PFP. The PFP decreased by 11.6% due to increased N levels (80 kg /ha) and by 29.3% due to K level (33.3 kg / ha).

DRMR CP 9: Enhancement of nutrient use efficiency in Indian mustard under limited moisture regime

Project Leader: O P Premi, Senior Scientist (Agronomy)

Associates : Kapila Shekhawat, Scientist SS (Agronomy), B K Kandpal, Principal Scientist (Agronomy)

To evaluate the efficacy of phosphorus solubilizing and mobilizing microorganisms on occluded *in situ* phosphates and methods of P fertilization to increase its uptake, 12 treatment combinations comprising 4 phosphate solubilizing/mobilizing micro-organisms (PSMM) and 3 phosphorous levels were laid out in factorial randomized block design with 4 replications. The PSMM combinations included control, PSB, VAM and PSB + VAM while P levels included control (P_0), 17.6 kg P/ha basal application (17.6 BA) and 15.4 kg P/ha basal application + 2.2 kg P/ha foliar spray at 35 DAS (15.4 BA + 2.2 FS).

Partitioning of phosphorus in seed and stover of mustard

Irrespective of the treatments, mobilization and accumulation of P in mustard seed was about 4.5 times higher than in stover (straw+husk). This partitioning was greatly influenced with the application of PSMM and P fertilization. The enhanced availability of P with PSB and PSB + VAM increased the proportion of accumulated P in stover by 23% .

Table 2.6 : Effect of phosphorus solubilizing and mobilizing micro-organism (PSMM) and phosphorus fertilization on seed yield, phosphorus removal and harvest index in mustard

Treatment	Seed yield (kg/ha)	P removal (kg/ha)	P harvest index (%)
PSMM			
Control	1531^{b}	9.6^{b}	82.0
PSB	1615^{a}	10.8^{a}	81.7
VAM	1505^{b}	10.0^{b}	83.4
PSB+VAM	1696^{a}	11.7^{a}	80.9
P Fertilization (kg/ha)			
0	1327^{c}	7.5^{c}	83.6
17.6BA	1513^{b}	10.0^{b}	81.7
15.4BA+2.2FS	1920^{a}	14.1^{a}	81.3

Removal of phosphorus

Conjunctive application of PSB+VAM significantly increased the P uptake by 21.8% over control and 17.7% over VAM. Similarly, P fertilization at 17.6BA significantly increased the total P uptake by 31.4% over control. Splitting the P dose to 15.2BA+2.2FS further improved the P uptake by 42.0% over 17.6BA and 86.7% over control (Table 2.6).

Indices of Phosphorus use

Various PSMM and P fertilization treatment significantly influenced phosphorus harvest index (HI_p), agronomic P efficiency (AE_p) and apparent P recovery efficiency (RE_p) over control. The variation in HI_p ranged from 80.9 to 83.4% due to PSMM treatments and from 81.3 to 83.6% due to P fertilization. In general, the HI_p value declined with increase in total P uptake. An average advantage of 14.5 kg seed/kg P fertilizer applied was observed at 17.6 BA. AE_p was further enhanced to 37.7 kg seed/kg P fertilizer when the dose was splited to 15.4BA+2.2 FS. Further, supplement of PSMM to P fertilizer treatments significantly influenced the AE_p. A significant antagonistic effect of VAM and significant synergistic effect of PSB and PSB+VAM on AE_p was recorded at both P application treatments.

The RE_p revealed average uptake of 21.9% of 17.6 BA and the uptake significantly increased to 45.7% when applied P was splited to 15.4BA+2.2FS. The effect of supplementary PSMM inoculation on RE_p was found similar to AE_p.

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

Project Leader : S S Rathore, Senior Scientist (Agronomy)

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

Experiment on micro irrigation and fertigation was repeated using Indian mustard variety Rohini. 61.4 mm rainfall was received during cropping season. Soil was poor in nitrogen (122.3 kg/ha), medium in phosphorus (20.4 kg/ha) and potash (259.2 kg/ha). With the increase in N levels, there was a gradual increase in plant height of mustard. Likewise, the highest increase in dry weight/ plant was observed in micro sprinkler with check basin and only micro sprinkler irrigation alone and lowest was recorded with check basin irrigation. With 80 and 120 kg N/ha, significantly higher dry weight/ plant was recorded

Table 2.7: Growth and yield parameters of Indian mustard under micro-irrigation and fertigation.

Treatments	Plant height (cm)	Dry weight/ plant (g)	Days to 50% flower-ing	SPAD value	Primary branches/ plant	Secon-dary branches/ plant	Main shoot length	Siliquae on main shoot	Siliquae/ plant	Seeds/ siliqua	1000-seed weight (g)	Harvest index
Main-plot												
MS	177a	69.0c	61.1a	43.8a	4.4a	8.5c	88.9d	73.6b	253.0bc	16.1d	5.5c	0.24bc
MS+CB	183ab	67.9c	57.8b	42.8a	4.4a	8.2c	76.7a	69.3b	266.0c	15.8cd	5.4b	0.26c
DS	196c	60.6b	58.0b	44.2ab	4.8b	6.3b	81.9bc	73.4b	228.2ab	15.4bc	5.1abc	0.22ab
DS+CB	185abc	54.4a	59.5ab	45.6b	5.1b	8.1c	84.2c	61.6a	201.8a	15.1b	5.0ab	0.25c
CB	193bc	53.7a	60.1a	43.5a	3.7a	5.9a	79.5ab	63.0a	195.2a	14.6a	4.8a	0.21a
Sub-plot												
Control	169a	43.2a	64.0a	36.6a	3.4a	4.4a	72.8a	51.8a	162.6a	13.7a	5.0a	0.22a
N40	190b	57.0b	62.3a	43.8b	4.1b	6.5b	81.9b	65.3b	217.6b	14.9b	5.1a	0.25b
N80	191b	70.8c	58.0b	46.0c	4.8c	9.4c	85.5c	78.9c	247.0c	16.2c	5.3a	0.24b
N120	197b	73.6d	56.0b	49.5d	5.5c	9.7c	88.9d	76.6c	288.0d	16.7d	5.3a	0.24b

MS: micro sprinkler; CB: check basin; DS: drip system
Note: Within column, values marked with different letter are significantly different (p=0.05)

over control. Highest SPAD value (49.5) was recorded under high level of N (120 kg N/ha) and among irrigation treatments it was drip alone and along with check basin. More primacy branches/ plant was recorded under drip system whereas, increase in primary and secondary branches was observed with increase in N levels' from control to 120 kg N/ ha (Table 2.7).

Among yield attributes, the maximum number of siliquae on primary and secondary branches and on main shoot was recorded in micro sprinkler alone and micro sprinkler with check basin irrigation systems and increase in siliquae was observed with increase in N doses. Maximum siliqua length was observed with drip irrigation. Micro irrigation especially micro sprinkler system alone and in combination with check basin resulted in highest increase in seed yield (Table 2.8). Micro irrigation treatments also resulted in increase in biological yield and harvest index. The highest increase in seed and biological yield was recorded at 120 kg N/ha over control (Table 2.8). Maximum irrigation water productivity was recorded under micro sprinkler (3.5 kg/m^3) and drip system (3.1 kg/m^3) with fertigation of 120 kg N/ha and at recommended P and K levels (3.2 kg/m^3).

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

Project Leader : Kapila Shekhawat, Scientist SS (Agronomy)

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

To assess the impact of various RCTs on growth, yield attributes and yield, soil properties and economics of mustard based cropping systems; an experiment was initiated at DRMR during *rabi* season,

Table 2.8: Effect of irrigation methods and fertigation on yield attributes, yield, protein and oil content of Indian mustard

Irrigation systems	Biological yield (kg/ha)	Seed yield (kg/ha)	Oil yield (kg/ha)	Sustainability index	Production efficiency (kg/ha/day)
MS	8812^{b}	2085^{bc}	861b	0.58	13.5^{b}
MS+CB	8542^{b}	2224^{b}	875b	0.63	14.4^{c}
DS	8451^{b}	1897^{ab}	803b	0.51	12.2^{ab}
DS+CB	7618^{a}	1914^{ab}	784b	0.52	12.4^{ab}
CB	8374^{b}	1758^{a}	537a	0.46	11.3^{a}
Fertigation					
Control	6296^{a}	1360^{a}	794ab	0.32	9.3^{a}
40 kg N/ha	7942^{b}	1913^{b}	743ab	0.52	12.3^{b}
80 kg N/ha	9118^{c}	2187^{c}	676a	0.61	14.0^{c}
120 kg N /ha	10081^{d}	2442^{d}	875b	0.71	15.5^{d}

Note: Within column, values marked with different letter are significantly different (p=0.05)

2009. Five cropping systems, *viz.* fallow-mustard, green manure-mustard, brown manure-mustard, cluster bean-mustard and pearl millet-mustard were grown under conventional tillage (CT), reduced tillage (RT), zero tillage (ZT) and furrow irrigated raised bed (FIRB) in split-plot design.

Various RCT_S significantly affected crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) and leaf area index (LAI). CGR increased till 60-90 DAS and declined thereafter. RGR represents the additional gain of dry matter on a base value, so it was found maximum during 30-60 DAS. In the initial growth stages, CGR, RGR and NAR were highest for CT due to fine seed bed and quick growth but later on these parameters remained highest for FIRB. LAI increased initially and reached a peak at 90 DAS. Between 60-90 DAS, the total coverage of the field due to maximum leaf expansion resulted in almost 100% interception of the incident light. (Fig 2.12).

The highest amount of water was applied in CT. The poor quality water of irrigation resulted in increase of EC at surface soil under CT. Under RT and ZT, the EC was low due to less water application through irrigation and higher residue retention. Under FIRB, lowest EC was recorded as the water was applied only in furrows and the beds were not in contact with the water. The organic carbon content varied significantly among various tillage methods. The highest amount of organic carbon was found under ZT; RT being *at par* with it and both were found significantly superior over CT and FIRB.

In another experiment, 4 improved varieties (Rohini, Varuna, Laxmi and NRCDR 2) and 3 hybrids (NRCHB 506, Coral 432 and DMH 1) of Indian mustard were evaluated under FIRB. The highest seed yield was obtained from Coral 432 (2613 kg/ha) which was at par with NRCHB 506 (2597 kg/ha) and DMH 1 (2496 kg/ha). The stover yield was recorded highest in DMH-1 (6720 kg/ha) which was at par with the remaining two hybrids but was significantly superior to varieties. The total N, P and K contents in the mustard seed was found non-significant. However, in mustard straw, significantly lower N content was recorded in hybrids (0.40-0.60 %) as compared to varieties (0.63-0.72%). The total P and K content among various varieties and hybrids ranged between 0.033-0.068% and 1.52-1.84%, respectively. The residual soil fertility indicated that the organic carbon content after growing various mustard hybrids and varieties did not differ significantly. The residual available

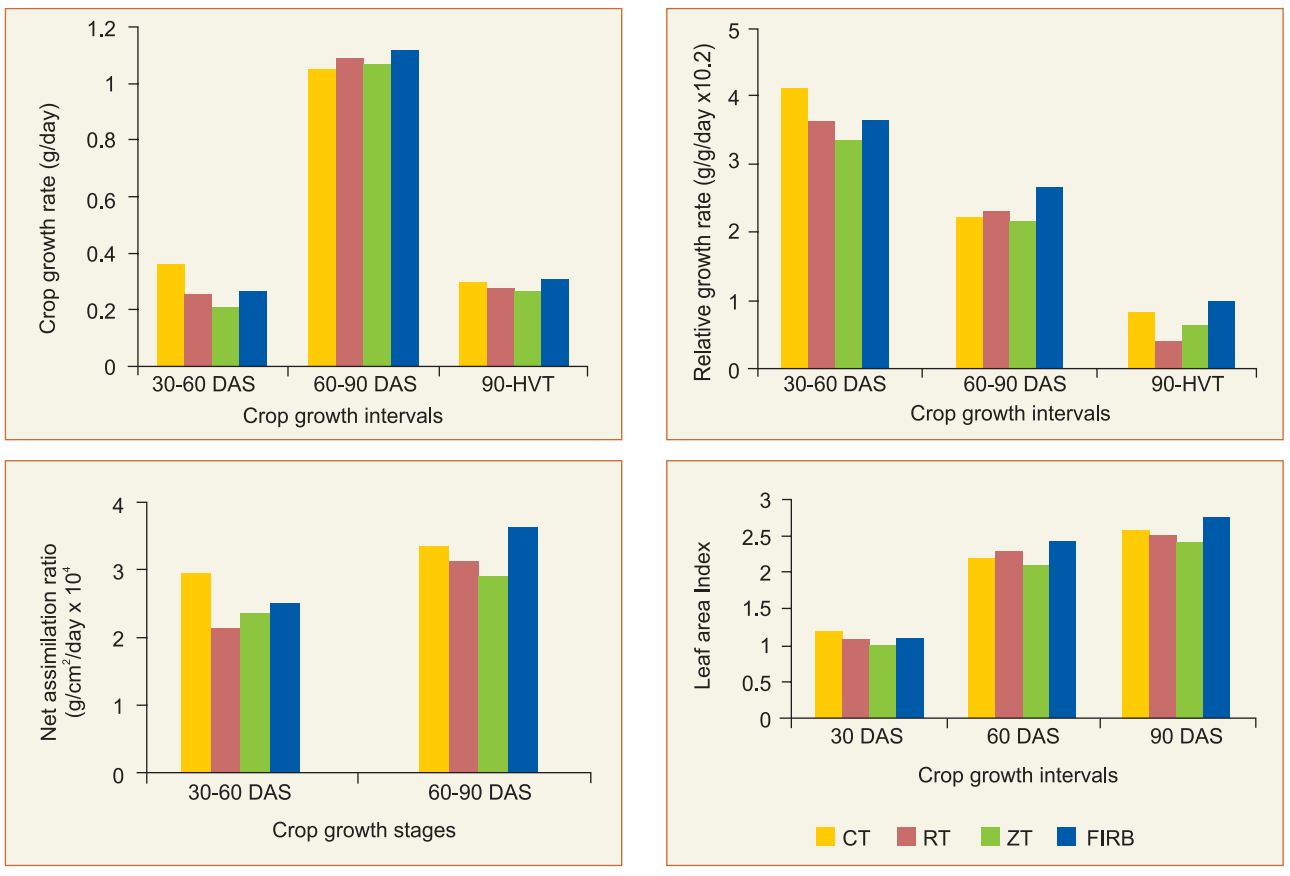


Fig 2.12: Physiological growth parameters of mustard at various crop growth stages as influenced by different tillage methods

N, P, K in the soil remained lower where hybrids were grown indicating higher uptake of nutrients by hybrids as compared to varieties.

DRMR CP 13: Characterization and classification of soil-site conditions for rapeseed-mustard production zones

Project Leader : B K Kandpal, Principal Scientist (Agronomy)

Characterization of winter season for rapeseed-mustard production

The climatic normals of 103 meteorological observatories, spread over the rapeseed-mustard growing zones of the country, were placed to various data mining process to develop homogenous climatic group based on 12 calibrated attributes (Table 2.9). The attributes were: (i) Average temperature at sowing time, (ii) Maximum day time temperature at sowing time, (iii) Average temperature during growing season, (iv) Average temperature at harvest, (v) Maximum day time temperature at maturity, (vi) Average lowest temperature of the coolest month during growing season, (vii) Rainfall in pre-sowing month, (viii) Total rainfall during growing season, (ix) Number of rainy days during growing season (x) Rainfall during maturity stage, (xi) Mean relative humidity of growing season, and (xii) Average bright sun shine hours during growing season.

Based on the analysis the climate of the rapeseed-mustard production zone could be categorized into 4 distinguished groups namely- (a) Frost prone cool (b) Sub-normal (c) Favorable normal and (d) Above normal. The climate at 43.7% stations was favorable (group III) for the cultivation of rapeseed-mustard crops. The optimum temperature at sowing (average 27.8°C and maximum 31.6°C), sufficient pre-sowing rainfall (242.7 mm) ensures proper germination and initial growth of the crop. The average temperature above 20°C during growing season, more than 6.5°C average minimum temperature in coolest month, better frequency and distribution of winter rains (229.7 mm in 19.9 days), less cloudiness and sufficient average sunshine hours (7.7 hrs/day) during growing season ensures optimum utilization of natural and input resources. The moderately high temperature during maturity supports proper harvest and drying of the produce. The climate at 12.6% stations was sub-normal (group II) due to significantly lower average temperatures at sowing, growing and harvesting period; occasional frost damage; frequency and distribution of rainfall during pre-sowing and post-sowing stages. The climate at 26.2% stations was significantly cooler (group I) than desirable for successful rapeseed–mustard production and the mean minimum temperature in the coolest month (3.0°C) indicates frequent frost damage in the region. The low rainfall and less sunshine hours during growing season indicate inefficient utilization of resources and sub-optimal photosynthesis of rapeseed-mustard crop. The climate at 17.5% stations was above optimal (group IV) due to significantly higher temperatures at sowing and harvesting periods causing abiotic stresses to crops at germination, juvenile and maturity stages of the crop.

Table 2.9: Climatic groups of rapeseed-mustard production zone

Attributes	Group I Frost prone cool	Group II Sub-normal	Group III Favorable normal	Group IV Above normal
Average temperature at sowing time (°C)	18.5^{a}	25.7^{b}	27.8^{c}	28.1 ^{c}
Maximum day time temperature at sowing time (°C)	22.6^{a}	31.6^{b}	31.6^{b}	33.5^{c}
Average temperature during growing season (°C)	11.5^{a}	18.2^{b}	21.2^{c}	22.4^{c}
Average temperature at harvest (°C)	16.1^{a}	23.4^{b}	27.5^{c}	27.7^{c}
Maximum day time temperature at maturity (°C)	21.9^{a}	31.1^{b}	33.7^{c}	36.2^{d}
Average lowest temperature of the coolest month during growing season (°C)	3.0^{a}	6.4^{b}	8.7^{c}	11.8^{d}
Rainfall in pre-sowing month (mm)	128.6^{a}	147.9^{a}	242.7^{b}	252.7^{b}
Total rainfall during growing season (mm)	86.1^{a}	148.5^{b}	229.7^{c}	346.4^{d}
Rainy days during growing season (count)	10.0^{a}	23.4^{a}	43.7^{b}	54.6^{b}
Rainfall during maturity stage (mm)	8.4^{a}	13.2^{b}	19.9^{c}	23.3^{c}
Mean relative humidity of growing season (%)	64.3^{a}	70.4^{b}	73.7^{b}	74.3^{b}
Average bright sun shine during growing season (hours)	6.9^{a}	7.0^{a}	7.7^{b}	8.0^{b}

*Different superscripts at each row indicate statistically significant value (p=0.05)

DRMR CP 15: Nutrient efficiency under saline, alkali and normal condition of soil and water in mustard crop

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

A replicated trial with 4 replications was conducted to assess the variability in nutrient uptake pattern of 3 varieties of Indian mustard (NRCDR 2, Rohini and NRCHB 101) and 2 each of Karan rai (PC 5 and JTC 1), brown *sarson* (KBS 3 and KOS 1), *toria* (TH 68 and Agrani), yellow *sarson* (B 9 and Jhumka), *gobhi sarson* (Neelam and GSL 2) and taramira (T 27 and TLMC 2). Total phosphorus uptake ranged from 8.7 kg/ha in TLMC 2 to 30.2 kg/ha in NRCHB 101and the genotypes were uniformly distributed in the range. In general, more than 82% of total P uptake was translocated to seeds. Indian mustard varieties were the most efficient and taramira varieties were least efficient in P uptake capacity.

Total S uptake ranged from 9.3 kg/ha in T 27 of *toria* to 47.6 kg/ha in Neelam of *gobhi sarson*. The S uptake pattern of the varieties was skewed towards lower range and leptokurtic with a mean uptake of 21.93 kg/ha. Almost 78% of the sulphur uptake remained in the straw, indicating potential recycling of S through mustard straw incorporation. In general, taramira and brown *sarson* varieties were poor and gobhi *sarson* varieties were better consumers of sulphur.

Zinc uptake in brassica varieties ranged from 0.19 kg/ha (KOS 1) to 0.60 kg /ha

(Neelam). The uptake pattern of the varieties was skewed towards higher range and mesokurtic with a mean uptake of 0.39 kg /ha. On an average, 70% of the total Zn uptake remained in the straw and the translocation of Zn to seed was much lower in *gobhi sarson*. In general, *taramira* and brown *sarson* were poor consumers and Indian mustard, Karan *rai* and Gobhi *sarson* varieties were higher accumulators of Zn (Table 2.10).

The total iron uptake ranged from 0.77 kg/ha in T 27 to 3.51 kg/ha in Neelam. The total Fe uptake pattern was moderately skewed with mean Fe uptake of 1.59 kg/ha as more than one quarter of varieties was distributed in a narrow range. Only a small proportion of the total Fe uptake (21%) was translocated to seeds and the lowest being in *gobhi sarson* varieties. Overall, taramira and brown *sarson* varieties accumulated less Fe while *gobhi sarson* varieties accumulated higher amount of Fe.

The total B uptake was normally distributed

Table 2.10: Nutrient uptake (kg/ha) pattern of rapeseed-mustard varieties

Crop/Variety	Seeds					Straw				
	P	S	Zn	Fe	B	P	S	Zn	Fe	B
Indian mustard										
NRCDR-2	19.60	8.40	0.20	0.50	0.05	4.70	16.20	0.27	1.25	0.24
Rohini	15.50	3.70	0.14	0.46	0.04	4.80	15.10	0.28	1.65	0.16
NRCHB-101	27.70	6.80	0.20	0.59	0.05	2.50	22.60	0.39	1.19	0.23
Karan rai										
PC-5	13.90	4.60	0.15	0.39	0.03	3.40	16.90	0.35	0.92	0.18
JTC-1	14.80	4.80	0.16	0.46	0.03	1.80	22.40	0.27	1.34	0.17
Brown sarson										
KBS-3	14.30	4.20	0.07	0.29	0.02	2.20	14.90	0.23	1.07	0.11
KOS-1	7.70	2.80	0.05	0.17	0.01	1.50	6.90	0.14	0.63	0.08
Toria										
TH-68	18.80	5.80	0.11	0.26	0.04	3.70	14.40	0.40	1.54	0.18
Agrani	11.00	4.30	0.07	0.17	0.02	1.90	12.20	0.18	0.90	0.10
Yellow sarson										
B-9	17.90	4.30	0.11	0.38	0.03	2.60	17.90	0.29	0.95	0.14
Jhumka	8.70	4.20	0.11	0.36	0.03	2.00	21.10	0.23	1.52	0.13
Gobhi sarson										
Neelam	17.00	7.50	0.12	0.34	0.03	7.50	40.10	0.48	3.17	0.42
GSL-2	8.80	4.20	0.79	0.19	0.02	3.50	32.90	0.31	1.55	0.26
Taramira										
T-27	9.90	3.50	0.09	0.20	0.01	2.20	5.80	0.14	0.56	0.10
TLMC-2	6.70	4.30	0.12	0.22	0.02	2.00	12.80	0.17	0.59	0.11

between 0.09 kg/ha in KOS 1 to 0.46 kg/ha in Neelam with the mean uptake of 0.20 kg/ha. More than 86% of the total accumulated B remained in the straw. In general, *gobhi sarson* and Indian mustard varieties were better consumer and taramira and brown *sarson* varieties were poor consumer of available B.

2.6 Management of biotic stresses in Indian mustard

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

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

Associate : S P Singh, Senior Scientist (Agril. Entomology)

Evaluation of normal and cold tolerant *Coccinella septempunctata* in laboratory

Laboratory reared and field collected cold tolerant *Coccinella septempunctata* (collected under severe cold condition having the minimum temperature nearly 5°C) was evaluated for feeding potential under controlled condition in environmental chamber. Ten adults, each of laboratory reared and field collected cold tolerant *C. septempunctata*, were kept separately in Petri dishes in environmental chamber. Each Petri dish having the *C. septempunctata* were provided 50 number of mustard aphid as food which was counted after 24 hours and replaced again. Such observations were made for 3 days at each temperature and on fixed humidity of 70%. It was found that cold tolerant field collected *C. septempunctata* consumed more aphids in comparison to laboratory reared ones (Table 2.11).

Table 2.11 : Feeding potential of laboratory reared and field collected *C. septempunctata*

Temperature (°C)	Feeding potential of *C. septempunctata* (Aphids consumed/day / beetle)	
	Laboratory reared	Field collected under cold condition
15	2.6 ± 0.2	4.2 ± 0.3
16	4.2 ± 0.3	7.5 ± 0.7
17	6.9 ± 0.6	9.7 ± 0.6
18	14.1 ± 0.8	18.8 ± 0.9
19	29.9 ± 0.7	32.3 ± 1.0
20	39.8 ± 0.3	41.2 ± 0.4

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

10 artificial diets have been evaluated in laboratory for the mass rearing of *C. septempunctata* having the ingredients *i.e.* proteinex, agar powder, honey, nutripet, homefood plus and distilled water in different combinations. 10 adults/ treatment were taken individually in the petri plates and observed for survival and other biological parameters. The maximum survival of 41.3 days was recorded on the home food (25 g) + agar powder (2.5 g) + honey (2.5 ml) + becosule capsule (B-complex, 150 mg) + formaldehyde 10% (0.2 ml) + distilled water (69.65 ml) diet followed by 39.7 days on protinex (12.5 g) + home food (12.5 g) + agar powder (2.5 g) + honey (2.5 ml) + becosule capsule (B-complex, 150 mg) + formaldehyde 10% (0.2 ml) + distilled water (69.65 ml) diet.

Biology of syrphid fly and its feeding potential

Biology of syrphid fly was studied in the laboratory at room temperature and humidity on mustard aphid. Observations on 5 petri dishes for each stage of maggot in 3 replications were taken. The mean incubation period was 2.8 ± 0.04 days, maggot period 8.7 ± 0.1 days and pupal period 6.4 ± 0.2 days. The feeding potential of maggot of syrphid fly was recorded as 23.64 aphids/maggot/day and total consumption of aphids by a maggot was 212.

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

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

Associates : S P Singh, Senior Scientist (Agril. Entomology), Manjubala, Senior Scientist (Bio-chemistry)

Basis of resistance against mustard aphid:

10 strains, *viz.*, RK 9501, Purple mutant, RH 9501, RH 7846, JMM 927 of *B. juncea*, GSC 6 of *B. napus*, DLSC 2 of *B. carinata*, T 27 of *E. sativa*, BSH 1 of *B rapa* ssp. brown sarson and YST 151 of *B rapa* ssp. yellow sarson were sown in 6 replications (3 each for protected and unprotected) in randomized block design. Total phenol, glucosinolate and lectin were analyzed (Table 2.12). DLSC 2 and T 27 had significantly higher glucosinolates whereas, significantly higher phenol content was recorded in Purple mutant followed by DLSC 2 and T 27 showing the resistance to the mustard aphid. The lectins activity of 4 HU/ml was observed in the inflorescence part of Purple mutant, JMM 927, GSC 6, DLSC 2 and T 27. In pods, significantly higher glucosinolates was observed in T 27 followed by Purple mutant and DLSC 2 whereas, phenol content was higher in Purple mutant, DLSC 2 and T 27.

Table 2.12: Glucosinolates, total phenol and lectins in inflorescence and pod of some Brassica genotypes

Brassica species	Strains	Inflorescence						Pods			
		Glucosinolates (µmol/g)		Total phenol (mg GAE/g)		Lectins (HU/ml)		Glucosinolates (µmol/g)		Total phenol (mg GAE/g)	
		UP	P	UP	P	UP	P	UP	P	UP	P
B. juncea	RK 9501	72.8	73.1	7.4	7.5	-	-	77.1	78.3	8.0	8.3
	Purple Mutant	108.9	109.4	15.1	15.2	4	4	114.3	117.6	15.4	15.7
	RH 9501	92.1	91.9	8.6	8.9	-	-	93.2	94.0	8.8	9.0
	RH 7846	76.4	76.9	7.1	7.3	-	-	79.8	80.2	7.3	7.6
	JMM 927	86.1	87.0	7.5	7.8	4	4	89.9	90.5	7.9	8.1
B. napus	GSC 6	17.8	18.0	9.2	9.5	4	4	20.2	20.7	10.5	10.9
B. carinata	DLSC 2	107.5	109.2	13.2	13.7	4	4	110.8	111.2	15.3	15.8
E. sativa	T 27	102.9	104.7	12.2	12.5	4	4	126.5	125.7	13.0	13.8
B. rapa	BSH 1	72.8	71.3	6.3	6.5	-	-	80.5	81.2	7.6	7.9
	YST 151	74.9	73.1	8.4	8.6	-	-	82.7	81.9	98.9	9.1
	CV (%)	2.2	2.1	3.5	8.4			5.3	4.4	14.1	13.8
	CD (p=0.5)	3.1	2.9	0.6	1.4			8.0	6.7	2.5	2.5

UP= unprotected, P=protected

Population dynamics of insect pests in rapeseed-mustard

4 species of rapeseed-mustard, *viz.*, *B. juncea* (PCR 7), *B. napus* (GSC 6), *B. rapa* ssp. brown sarson (BSH 1) and *E. sativa* (T 27) were sown in 3 replications under timely and late sown conditions. The insect pests population was observed on weekly basis. Painted bug appeared during the 47th std week in all strains and remained active up to 50th std week with a peek in 49th week. The pest population again appeared in the 6th std week and attained the peak during 12th std week in BSH 1 while 13th std week in T 27 and PCR 7. In GSC 6, the peak was observed in the 14th std week. The population of leaf miner was first observed during 5th std week in all the *Brassicas* and attained the peak during 9th std. week in PCR 7 & T 27 and in 10th std week in BSH 1 while GSC 6 had the peak in 14th std week.

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 mean population of alate aphid on five traps was found very low this year. The highest number of alate mustard aphid (36.3 alate/trap) was recorded during 8th std week.

DRMR ENT 6: Bio-assay studies of mustard aphid on wild crucifers

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

16 wild crucifers *i.e. Brassica tournefortii, B. fruticulosa, B. spinescens, B. rugosa, Camelina sativa, Diplotaxis muralis, D. assurgens, D. ieattiana, D. Gomez-campoi, D. tenuisiliqua, Enatharocarpus lyratus, Capsella bursa-pastoris, Lepidium., Crambe , Sinapis alba* and Kateli sarson along with 5 cultivated *Brassicas*, *viz.*, *B. rapa* (BSH 1), *B. juncea* (Rohini), *B. napus* (GSC 6), *B. carinata* (DLSC 2) and *Eruca sativa* (T 27) were sown in field and in pots for screening against mustard aphid, *Lipaphis erysimi* (Kalt.). Pots were covered with cages and 20 mustard aphids/ plant were released. *B. fruticulosa, Crambe* sp. and *Lepidium* . were resistant to mustard aphid with average aphid infestation index (AAII <1) while *B. spinescens* was highly tolerant (AAII~1.0). *Capsella bursa-pastoris* was found highly susceptible to bean aphid, *Aphis fabae* during its vegetative stage (100% mortality). Other strains were found susceptible to highly susceptible to mustard aphid (AAII~3-5).

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

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

Associate : P D Meena, Senior Scientist (Plant Pathology)

Epidemiology of Sclerotinia rot

Epidemiological studies on Sclerotinia rot was done using 3 sowing dates starting from October 8, 2010 at 3 week intervals with 4 replications in plot size of 4.8 x 5 m using cv Rohini. Data for soil moisture at weekly intervals, soil pH at three-week intervals and disease incidence were recorded apart from petal infection and weather data to correlate it with

disease development. Incidence of Sclerotinia rot was positively correlated with soil moisture and weather parameters including, relative humidity, bright sunshine hours (BSSH), rainfall etc. Combination of high RH, low BSSH, cool weather, high soil moisture and rainfall during the critical stage (60-70 DAS) favoured higher Sclerotinia rot incidence. Based on Sclerotinia rot incidence (%) and 11 independent variables, a multiple linear regression model has been described. The equation of the fitted model is Sclerotinia incidence (%) = - 7.36385 - 2.1794 BSSH + 2.60772 Eva(mm) + 0.659537 pH - 0.277927 PPI - 7.01493 RF(mm) + 0.127396 RH (7:20) + 0.176275 RH(14:20) + 0.265504 Soil moisture(%) - 0.456593 T (max) + 0.283453 T (min) - 0.16666 WS. There is a statistically significant relationship between the variables at the 95.0% confidence level. Under petal infection study, petals were found infected during 4-14 Jan 2011 with ascospore of *S. sclerotiorum* in 8th and 29th October sown crop, probably the critical stage (flowering). Rainfall have also been reported as an important factor during the early flowering stage which increased carpogenic infection of *S. sclerotiorum*. Maximum incidence of Sclerotinia rot was observed in 19th Nov and 28th Oct as compared to 8th Oct sown crop. Seed yield, oil content and test weight were highest and Sclerotinia rot incidence was lowest in 8th Oct sowing which could be considered as best sowing time for mustard. During second fortnight of January, apothecia were observed on soil surface in field.

Germplasm Screening for Sclerotinia rot

141 strains of *Brassica juncea, B. carinata* and B. *napus* were screened *in Sclerotinia* infested plot in single row of 3 m length with 30 x 10 cm spacing maintaining 2 test rows/ plot along with border rows of cv. Rohini (susceptible check) in randomized block design with 2 replications. Pathogen was mass multiplied on autoclaved *Sesbania* meal and sorghum grain and mixed with soil prior to sowing to create sick plot. The test strains were sprayed with mycelial suspension of the pathogen 45 DAS. Stem inoculatuion was also done with mycelial plug of pathogen by wrapping it to stem with parafilm. All the test lines were found susceptible except EC 597329 (*B. juncea*, exotic), 10-163 (Rohini x GSL 1) and 10-883 (Varuna X BPKR 13) showed tolerant reaction (lesion size < 3 cm).

Total 13 wild *Brassica* were also screened with artificial stem inoculation technique under green house condition. Reaction to the disease indicated that *Brassica fruticulosa, Diplotaxis assurgens, D. Settiana, D. gomezcampoi and Arabidopsis thaliana* showed tolerant reaction.

Management of Sclerotinia rot

An experiment on management of Sclerotinia rot was laid out in sick plot in RCBD with 12 treatments including control in 4 replications. The sowing was done with soil application of zinc (@ 25 kg/ha), boron (@ 1 kg/ha), mustard cake (@ 2 tonnes/ha), its combinations (zinc+boron, zinc+mustard cake, boron+mustard cake, zinc+boron+mustard cake) and combinations of seed treatment (ST) and foliar spray (FS) {carbendazim ST (2g/kg) seed+ FS (0.1%), carbendazim ST (2g/kg) + folicur FS (0.1%), quintal ST (2g/kg) +FS (0.1%)}. Among different combinations of seed treatments (ST) and foliar spray (FS) (carbendazim ST+FS, carbendazim ST+ folicur FS, quintal ST+FS), carbendazim ST+ folicur FS provided maximum disease reduction (88.9%) and highest seed yield (50.8%) followed by quintal ST+FS (86.9%) and carbendazim (82.6%) over check. All other treatments also minimize disease incidence and given significantly higher yield (2583-3310 kg/ ha) over check (2408 kg/ ha).

Fungicide sensitivity in Sclerotinia sclerotiorum isolates

Bavistin (crarbendazim), Quinital (iprodione+carbendazim), Tilt (propiconazole) and Folicur (tebuconazole) at 100 and 200 ppm concentration were used to treat the surface sterilized sclerotia of *S.sclerotiorum*. All the fungicides inhibited the germination of *S. sclerotiorum* at both the tested concentrations as compared to control. Folicur at 200 ppm was found most effective which inhibited sclerotial germination in all geographical isolates followed by tilt which provided the variable sensitivity among them. All the fungicides at 200 and 500 ppm concentration were used to observe the effect on mycelial growth of *S. sclerotiorum in vitro.* All tested fungicides inhibited the growth of all the isolates of *S. sclerotiorum* at both the concentrations as compared to control. Folicur followed by bavistin and tilt were most effective against *S. sclerotiorum* at both 200 and 500 ppm concentrations. All the 25 geographical isolates also exhibited variability in mycelial growth with fungicide.

Variability in culture filtrate pH

25 geographical isolates were used to determine the variation in pH of culture filtrate on potato dextrose broth medium (PDB). 5 mm bit of different isolate of *S. sclerotiorum* were inoculated in media after

adjusting pH 5.0. After incubation at 15 days, mycelial contents were filtered out through Whatman No 1 filter papers and culture filtrate from different isolates was used to measure pH. Different isolates showed significant variation in pH level of culture filtrate, which was minimum in SR-3 and SR-10 (2.3) while maximum in SR-06 (4.5). Oxalic acid production by *S. sclerotiorum* resulted in lower down the pH of culture filtrate of isolates.

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

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

Associate : Pankaj Sharma, Senior Scientist (Plant Pathology)

Epidemiology of Alternaria blight

Primary emergence of Alternaria blight on leaves (ABL) occurred on Jan 14 in Oct 22 sown crop (84 DAS) on cv Varuna whereas, on NRCDR 2 it appeared seven days later. The maximum severity of ABL on cv Varuna as well NRCDR 2 (2-3 wk) was in the 3rd week of February when maximum temperature was 24.4 ^{0}C, minimum 10.2 ^{0}C, morning RH 96.8% and BSSH 7.2. The maximum severity of Alternaria blight on siliquae (ABS) was observed 1 wk before harvest in 29th October sowing whereas, minimum in 26th November and 3rd December sowings, on both the cultivars. Disease severity on siliquae was favoured by maximum daily temperature of 26.4-29.8 ^{0}C, minimum 8.6-13.2 ^{0}C, morning RH 84-97 %, BSSH 7.5 – 9.2 and wind speed 2.1-4.0 km/hr.

Screening for tolerance to Alternaria blight

Among 45 test strains, ELM 134, DIVYA 22 and LET 41-01 of *B. juncea* and RTM 1212 of taramira, showed better tolerant to Alternaria blight than tolerant check PHR 2 on leaves during 90-100 DAS.

Among 52 breeding lines, PHR 2 was observed best having 7.7% disease severity and 2.78 mm lesion size at 100 DAS followed by 10-2751 (EC 399299 x EC 399301) showing disease severity of 8.5% and lesion size 3.52 mm, 10-2788 (PAB 9534 x EC 399301) with disease severity of 10.3 %, with lesion size 2.96 mm, EC-339000 with 11.1 % and 3.56 mm lesion size, 10-2786 (JMM 915 x EC 399299), 11.7% and 3.72 mm lesion size, 10-2719 (EC 399299 x EC 399301), 11.8% and 3.80 mm lesion size, EC 399296, 28.3% and 5.32 mm lesion size, respectively. Indian mustard breeding lines 10-2751, 10-2788, 10-2786 and 10-2719 were found promising with higher level of tolerance and could be utilized in the breeding programme.

Biochemical studies in response to Alternaria blight infection in Brassica genotypes

In all the strains tested, glucosinolates, sugar, carotenoids and chlorophyll content was found less in infected leaves as compared to healthy leaves. However, total phenol and protein content was found more in the infected leaves when compared with healthy leaves. In the infected leaves, the highest (4.9 mg GAE/g) and lowest (2.6 mg GAE/g) phenol content was observed in EC 399296 and Varuna, respectively. Disease severity (%) was maximum (44.2%) in Varuna and minimum (3.3%) in PHR 2.

Alternaria blight management

Role of Zn, Cu, K and S was studied in Alternaria blight management of Indian mustard. Zn and Cu were estimated by using Perkin-Elmer flame atomic absorption spectroscopy, S by using spectrophotometer and K was estimated by using flame photometer. Sulphur and zinc significantly reduced Alternaria blight of leaves in Indian mustard while copper also reduced the disease to some extent. Maximum Alternaria blight disease reduction (26%) was observed with soil application of potash @ 40 kg/ha + zinc sulphate @ 25 kg/ha + copper sulphate @ 40 kg/ha + sulphar @ 10 kg/ha + ridomil MZ-72 as foliar spray @ 0.25% followed by their foliar spray (21%). However, the lower three leaf removal at 40 DAS with foliar spray of ridomil MZ- 72 @ 0.25 reduced the disease by 19% followed by leaf removal (18.9%). Hence, the use of micronutrients could possibly induce tolerance and lower leaf removal might keep away the infection.

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, Principal Scientist (Plant Breeding & Genetics)

Under epidemiological experiment, the sowing was done at 3 dates i.e. October 27, November 10, and November 24. Cloudy and cool weather during mid January and early February favored the white rust infection (Fig 2.13). The first symptom of white rust appeared as small, white raised pustules on leaves. The disease development was initially slow but increased later on. The maximum disease incidence was recorded when minimum temperature of 15-16^{0}C, maximum temperature of 28-29^{0}C and average

relative humidity of >65% prevailed for quite some times. Maximum disease index (54.4%) was observed on late sown (24th November) crop whereas, the minimum disease index (33.3%) was observed on timely sown (27th October) crop. A sharp increase in disease index was observed during the 3rd and 4th week of February on both early and late sown crop (Fig 2.13). Light precipitation (26.9 mm rainfall) received in the month of February might have created a favorable condition for spread of the disease.

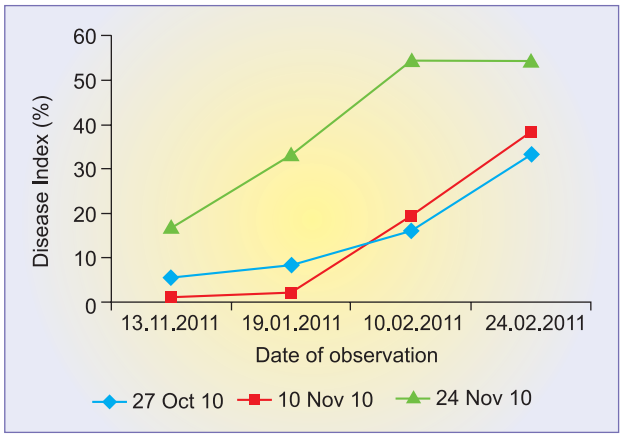


Fig 2.13: Effect of dates of sowing on white rust disease index

In white rust management experiment, no significant differences were observed among the treatments used. The disease pressure varied among the treatments from 21% to 25%. Seed treatment with apron SD 35 @ 6g/kg seed followed by foliar spray of ridomil MZ (0.2%) after 50-60 DAS was most effective in reducing the white rust incidence and higher seed yield. Foliar sprays of PGPR (*Bacillus subtilis* and *Pseudomonas fluorescens*) alone also showed effectiveness in controlling white rust disease incidence ranging 5% to 20%.

2.7 Technology Assessment and Dissemination

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

Project Leader : Ashok Kumar Sharma, Senior Scientist (Agricultural Extension)

Associates : S K Jha, Senior Scientist (Agricultural Extension), Vinod Kumar, Senior Scientist (Computer Application in Agriculture), R C Sachan, Technical Officer

During the period, a survey was carried out in Bharatpur district of Rajasthan and Agra district of Uttar Pradesh to study the cost of cultivation of mustard and its competing crops and returns thereof. The level of adoption of recommended mustard technology and constraints in production of mustard crop were also studied. 120 farmers were selected randomly taking 40 respondents from each of the selected villages i.e. Paharsar and Auw of Bharatpur and Nagla Vishnu of Agra .

The average cost / ha of mustard and wheat was Rs. 18675 and 30085, respectively in Bharatpur. The study reported that maximum cost (26.8%) was incurred in ploughing in case of mustard (Rs 5000/ ha) and on irrigations (36.5%) in case of wheat (Rs 11000/ ha.). The average seed yield/ ha of mustard and wheat was 2350 kg and 6000 kg respectively with net income / ha of Rs. 40075 and Rs. 58415, respectively.

In Agra, the average cost/ ha in mustard and potato was Rs. 19840 and 62830, respectively. Maximum cost (28.4%) was incurred on ploughing in mustard (Rs 5625/ ha) and maximum (25.1%) on digging and collection of potatoes (Rs 15750/ ha). On an average, farmers incurred Rs 19840 and Rs. 62830/ ha for the production of mustard and potato crop, respectively. The overall average net income from mustard and potato crop was Rs. 38785 and Rs. 87170/ ha, respectively.

In adoption study, conducted at Bharatpur and Agra, adoption of time of sowing recommendation was maximum with 82.5 mean percent scores (MPS) followed by irrigation practices (78.2 MPS). The level of adoption of seed rate and spacing (64.4 MPS) and harvesting and threshing (56.9 MPS) was medium. There was very low adoption in case of pest and disease management with 16.9 and 8.8 MPS, respectively

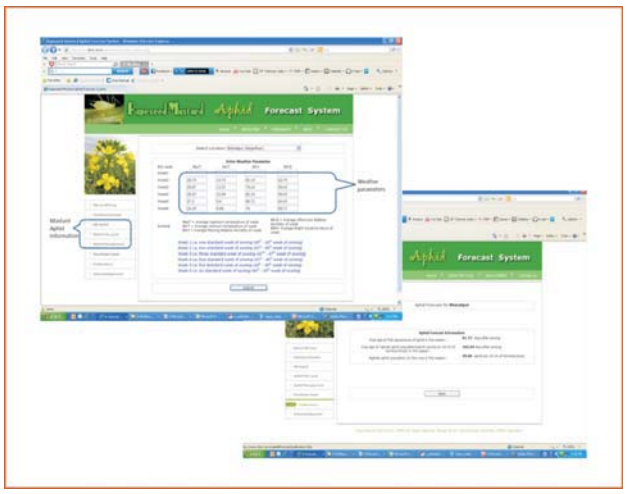
The study also revealed low selling price (93.2%), high cost of cultivation (88.8%) and non-availability of pure seeds (88.1%), inadequate supply of fertilizers (83.8%), high temperature at the time of sowing (88.8%), poor fertility of soil (73.2%), inadequate technological know-how (87.5%) and inadequate visit by extension personnel to the village (84.4%) as major constraints.

Project CA1: Development of application software for rapeseed-mustard information management

Project Leader : Vinod Kumar, Senior Scientist (Computer Application in Agriculture)

User-friendly web-based software for forecasting mustard aphid has been developed to help the plant researchers, extension personnel and farmers for timely application of control measures. The software used statistical prediction models developed based on weather parameters as independent variables

and crop age at time of first appearance of aphid, peaking of aphids and crop age at peak population



as dependent variables, which were fitted by multiple stepwise regression. The system provides forecasting of mustard aphid infestation well in advance.

Updation and maintenance of web site

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

Externally funded projects

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

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

Associate : J Nanjundan, Scientist (Plant Breeding)

17 varieties including 14 new varieties 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 were tested for DUS characteristics. 15 traits namely, leaf colour flower colour, time of flowering and maturity, number of leaf lobes, leaf length, leaf width, length of petals, width of petals, main shoot length, plant height, siliqua length, siliqua beak length, siliqua number on main shoot, siliqua density on main shoot were recorded on 20 plants. 5 traits namely leaf hairiness, leaf lobes, dentation of margin, siliqua angle and siliqua surface texture were recorded as visual observations.

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

Project Leader : V V Singh

Associates : S S Rathore, Senior Scientist (Agronomy), A K Sharma, Senior Scientist (Agricultural Extension)

138.08 q certified seed of wheat and 362.79 q truthful label seed of mustard varieties was produced. In addition to this 40.85 q truthful label seed of mustard was produced at farmer's field under participatory mode.

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

Project Leader : A K Thakur, Scientist (Biotechnology)

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

10 independent putative transgenic events in *B. juncea* var. Pusa bold and 6 independent putative transgenic events in var. Rohini had been developed with chickpea (*Cicer arietinum*) lectin gene *via Agrobacterium tumefaciens* mediated gene transfer technique. The putative transgenic shoots were multiplied and rooted on selective regeneration media containing 20 mg/l kenamycin and 250 mg/l cefotaxime. Molecular characterization of the putative transgenic plants was carried out by PCR using *npt-II* gene specific primers. Bioassay of the PCR positive plants was carried out for aphid tolerance by leaf disc assay.

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 : B K Singh, Scientist (Biotechnology), V V Singh, Principal Scientist (Plant Breeding), P D Meena, Senior Scientist (Plant Pathology)

Generation advancement of recombinant inbred lines (RILs)

F_4 seeds of crosses Rohini x PHR 2, Rohini x PBR 97, Rohini x EC 399301 (QTLs mapping for *Altrenaria* tolerance) and Rohini x RH 819 and Rohini x NRCDR 2 (QTLs mapping for drought/ heat tolerance) were harvested. Further, F_4 seeds of crosses 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 15 x 45 cm spacings. Population of F_2 and BC_1 generation of the crosses Rohini x Kiran and Rohini x GSL 1 were maintained through selfing. 20 isolates of *A. brassicae* were maintained through sub-culturing

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

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

Associates : Pankaj Sharma, Senior Scientist (Plant Pathology)

Survival of *Alternaria* species

Survival of *Alternaria* species on rapeseed-mustard plant debris and seed lying in the field during summer was evaluated. Results indicated that the survival (5) of *Alternaria* species on plant debris and seed was 22.2% and 66.6%, respectively during summer (temperature up to 47°C) in deep ploughed fields. Though, the pathogen was also observed on plant debris (11.2%) collected from an unploughed field. Hence, the survival of *Alternaria* spp. on plant debris and seed could be the primary source of infection even after summer deep ploughing.

Effect of *Alternaria brassicae* culture filtrate on seed germination, radicel plumule length of *Brassica* species

Effect of culture filtrate of 30 different geographical isolates of *A. brassicae* (BAB) was studied on seed germination of different *Brassica* species (*B. juncea, B. carinata, B. rapa* and *B. napus*). Highest germination reduction (%) was recorded in cultivar PT 303 [58% BAB 54 (*Alternaria brassicae* from *Brassica*)], PHR 2 (46% BAB 54), GSL 1 (38% BAB 54), Varuna (28% BAB 28) and Kiran (15% BAB 42) over control. However, the maximum germination (up to 100%) was observed in tested Brassica spp. against isolate BAB 4. Significant variability was observed for seedling vigour. Maximum plumule length (1.3 cm) was recorded in PHR 2 with isolate BAB 40, while it was maximum (5.0 cm) in GSL 1 with isolate BAB 18 and BAB 23. However, radical length was highest (10.8 cm) in GSL 1 with BAB 41 and lowest (1.4 cm) in PT 303 with BAB 43.

Thermal sensitivity

Thermal death point for various isolates of *A. brassicae* was identified by exposing them to high temperature (65°C) for 10' before inoculation on PDA plates at 25°C. Results indicated that all the isolates failed to germinate and 65°C seem to be the thermal death point. All isolates of *A. brassicae* grew well on exposure at 40°C for 10' and 65°C for 10' BAB 24, BAB 26 and BAB 51 which showed the difference in sensitivity among isolates. Maximum sporulation observed in BAB 03, BAB 04, BAB 42, BAB 47 and BAB 50 isolates at 60°C exposure. However, isolates BAB 02, BAB 6, BAB 18, BAB 23, BAB 41, BAB 43, BAB 44, BAB 52, BAB 54 and BAB 55 showed poor sporulation while others did not sporulate. Maximum sporulation was showed by BAB 04, BAB 18, BAB 19, BAB 44 isolates in control without temperature exposure.

3

Transfer of Technology

Consultation on stakeholders' perspectives for DRMR's vision 2030

Directorate of Rapeseed-Mustard Research organized Consultation on stakeholders' perspectives for DRMR's Vision 2030 on May 10, 2011. The meeting was attended by representatives from mustard oil processing industry, State Department of Agriculture, Adaptive Trial Centre, Rajasthan State Seed Corporation, Krishi Vigyan Kendra, State Agricultural University, non-governmental organization, progressive farmers and all the scientists of the Directorate under the Chairmanship of Dr J S Chauhan, Director, DRMR. All the stakeholders expressed happiness over a good harvest of mustard crop in the last season in which Bharatpur district has an average mustard productivity of over 2500 kg/ha and oil content up to 44%. Against the minimum support price (MSP) of Rs. 1850/q, the farmers received a market price of over Rs 2500/q in the open market.

A brief outcome of the meeting was as follows:

- Development of varieties with high seed and oil yield, medium height, basal branching and short duration should be given priority in the research programmes of DRMR.
- In the light of dwindling natural resources, emphasis should be on the development of resource conservation technology.
- Several *Kisan* clubs/SHGs in the area have become dysfunctional which need support in the form of technical guidance for their revival. These clubs may be motivated for seed production programme for ensuring the supply of quality seeds of mustard.
- A comprehensive weed management project should be taken up for the weeds left in the field after the mustard harvest like *pili kateri* and all out efforts should be made for developing effective technology for the management of *Orobanche* root parasite.
- There is a need for strong networking of stakeholders. It was agreed that the initiatives of each of the stakeholders such as mustard oil processing industries, agricultural department, DRMR, KVK and the NGO for developing model villages for faster dissemination of technology will be adequately supported by the other stakeholders on partnership basis.
- The policy framework regarding import duty should be in the interest of domestic edible oil producers.
- The issue of expansion of mustard area in the rice-fallow of eastern India was welcomed by the industrialists and it was assured that there would not be any problem for the marketing of produce in that area as a large number of processing units were in operation there.

14th *Beej pakhwada* organized

The DRMR's popular endeavour for the sale of mustard seeds and educating farmers for situation specific varietal selection and other associated technologies, *Beej Pakhwada,* was organized during September 12-26, 2011. Thousands of mustard growing farmers of Rajasthan, Haryana, Madhya Pradesh and Uttar Pradesh procured quality seeds of NRCDR-2, NRCHB-101, Maya, Uravashi, Laxmi, Rohini and Bio-902 varieties of Indian mustard at affordable prices.

Training programmes

Directorate of Extension, Ministry of Agriculture, Govt of India sponsored Model Training Course on Advances in seed production, processing and certification of *rabi* field crops (mustard, wheat, lentil, gram) was organised during December 1-8, 2011 at the DRMR. Sh Deshraj Singh, Joint Director, Department of Agriculture, Bharatpur, inaugrated the training programme on December 1, 2011.

Dr J S Sandhu, ADG (Seeds) ICAR, New Delhi in his veladictory address, emphasized the need to

provide good quality seeds for higher production. He was of the opinion that in the years to come greater emphasis should be given on developing mustard hybrid. Dr J S Chauhan, Director, DRMR, advised participants to disseminate the knowledge gained by them during this training to the fellow farmers specially regarding genetic purity of seeds of appropriate high yielding varieties. In all, 23 research/ extension personnel from the state agricultural departments of Assam, Orissa, Gujrat, Chhatisgarh, Haryana, Uttar Pradesh and Rajasthan participated in the training.

A 6-day farmers training programme under ICAR Seed project "Seed Production in Agricultural crops" was organized by DRMR, Bharatpur during January 23-28, 2012. Inaugurating the training, Sh B K Singh, Director (ATMA), Govt. of Rajasthan said that seed is an important input of crop production and use of good quality seed is pre-requisite for harnessing the full potential of a crop. The objective of this training was to make the farmers aware about seed production technology of important crops with special reference to mustard and wheat, and motivate them for participatory seed production programme. During the training programme, farmers were imparted training and skill on principle of seed production, hybrid seed production technology, integrated pest and disease management, selection of varieties for different agro-climatic situations, agronomic practices, seed certification procedure, seed processing, etc. by different experts. A total of 20 progressive farmers from Rajasthan, Haryana and Uttar Pradesh participated in the training. Addressing the participants in valedictory function, Dr J S Chauhan, Director, DRMR said that farmers should take the participatory seed production programme so that quality seed can be produced in large quantity and adoption of quality seeds will definitely contribute in the higher production of the crop.

Radio education series from DRMR

Eighty radio talks related to rapeseed-mustard research and development programmes and improved practices were broadcasted from 4 radio stations Mathura and Agra of Uttar Pradesh and Jaipur and Kota of Rajasthan during September 2011- February 2012. This serial broadcast catered to 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.

Visitors advisory services

Under visitors Advisory Services, 32 farmers-scientists interactions and counselling sessions on rapeseed-mustard cultivation for visiting groups from Rajasthan, Haryana, Uttar Pradesh, Madhya Pradesh and Jharkhand consisting of more than 1280 farmers and farmwomen and 55 extension personnel was organized. The visiting groups of farmers, farmwomen, and extension personnel were educated or trained through lectures, literatures, training, visiting technology park, experimental trials, museum, etc. Besides, about 150 visiting farmers were also provided timely technical advice to their problems in mustard cultivation.

Frontline demonstrations

Under the aegis of All India Coordinated Research Project on Rapeseed-Mustard, DRMR successfully conducted 50 FLDs in Unchagaon and Sevorana villages of Bharatpur district of Rajasthan. 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 the other varieties of private seed companies. On the basis of 33 locations, the NRCDR- 2 had an average yield of 2185 kg/ha against the average yield of 2005 kg/ha from varieties of private seed companies with a yield improvement of 9.0 %, while on the basis of 13 locations the improved variety NRCHB 101 had an average yield of 2165 kg/

ha against the average yield of 2074kg/ha from varieties of private seed companies with a yield improvement of 4.4 %. The average additional net monetary return (ANMR) from the NRCDR 2 was Rs 7300 /ha, while it was Rs. 4007/ha for NRCHB 101.

Capacity building of tribal farmers

Under tribal sub-plan, DRMR signed MoUs with MPUA&T, Udaipur (Rajasthan), BAU, Ranchi (Jharkhand), CAU, Imphal (Manipur) and AAU, Jorhat (Asom) to improve the livelihoods of tribal farmers in respective regions by enhancing mustard production through capacity building of the stakeholders, farmer participatory on farm/ frontline demonstrations, exposure visits and supply of small agricultural implements. Under the plan, 120 farmers were trained at DRMR and more than 2500 farmers were indirectly benefited.

DRMR towards villages

In its endeavour of "Towards Villages" DRMR adopted Unchagaon village of Sewar Panchayat, district Bharatpur to develop it into a model village especially for mustard cultivation by converging various government agencies to synergize efforts. In this context, NABARD sponsored farmers club, namely, *Pragatisheel Kisan Club* with around 100 men and women farmers was inaugurated on Oct. 11, 2011. Sh Vijayveer Singh, Manager, NABARD, Bharatpur informed about the various farmer centric schemes of NABARD and likely benefits to the club members. DRMR provided information about recently released varieties and associated technologies for enhancing mustard production. To assess the improved technology, 50 frontline demonstrations were laid out in this village, DRMR publications were given to the farmers. On November 30, 2011 a Farmer's Field School, sponsored by ATMA, Bharatpur was inaugurated jointly by Director, DRMR and Joint Director, Department of Agriculture, Bharatpur.

Stakeholders and innovative farmers' meet

One day national meet of stakeholders was organised at the Directorate on January 16, 2012 to develop strategies for enhancing rapeseed-mustard productivity during 12th FYP. Dr B Gangawar, Director, Directorate of Farming System Research, Modipuram and the Chief Guest of the function emphasized that, in spite of low average rapeseed-mustard productivity (12.0 q/ha) against the potential of 30 to 35 q/ha, mustard is more economic than wheat under marginal resource conditions. Rapeseed-mustard also has great potential under intercropping. Timely sowing and proper fertilization especially sulphur are critical for its higher productivity. Dr J S Chauhan, Director, DRMR informed that enhancing production, productivity and quality of rapeseed-mustard crop under changing climate and WTO regimes are major priorities of the Directorate. The productivity of the crop needs to be raised from existing 11.8 q/ha to 18 q/ha by the end of the 12th FYP. During the meeting, many issues viz., genetic improvements; development of hybrid technology; biotechnology for biotic stress management; improved agronomic practices; integrated weed, water and nutrient management; abiotic stress and natural resource management, resource conservation technologies; integrated biotic stress management; knowledge management strategies for effective technology dissemination; e-knowledge portals, opportunities of area expansion under rice-fallow in eastern part; value additions in seed meal; livelihood security development of model village and trade policies etc. were discussed at length. The scientists, administrators, policy makers and farmers

from Haryana, Rajasthan, Uttar Pradesh and Madhya Pradesh participated in the meet.

18th Sarson vigyan mela

The 18th sarson vigyan mela was organized at DRMR Bharatpur on February 3, 2012 wherein about 800 farmers from Rajasthan, Madhya Pradesh and Uttar Pradesh and officials from various ICAR and Government of Rajasthan organizations, press & media personnel participated. There were 25 stalls exhibiting different aspects of agriculture. Chief guest Dr R B Singh, President, NAAS, New Delhi inaugurated the mela and Dr D P Singh, Chairman, Research Advisory Committee of DRMR & member Farmers' Commission of Haryana presided over the function. Dr B B Singh, ADG (O&P), ICAR was the Guest of Honour.

The mela provided an opportunity to 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 R. B. Singh emphasized that agro-processing industries should be established in villages and farmers should form the club or companies and sell their product themselves that will help in regulating the market prices. He urged the farmers to adopt scientific technology to increase the productivity of the crop so that their income is increased.

On the occasion, Dr B B Singh said that there is a need to develop the short duration and high temperature tolerant varieties of rapeseed-mustard so that average productivity of the crop can be increased up to 20q/ ha in the next 10 years. He assured the farmers for multilateral support of ICAR for benefit to them.

In his presidential address, Dr D P Singh said that farmers should get remunerative prices of their crop, credit at lowest interest rate and every state should form Farmers commission so that better policies/ schemes can be made for the welfare of farming community. He also urged the farmers for adopting resource conservation technology including sprinkler and drip irrigation.

On this occasion, Director, DRMR, Dr J S Chauhan welcomed all the guests and participants. In his address he reiterated the mission of establishing the DRMR in Bharatpur, *viz.*, increase the productivity of rapeseed-mustard, improve the quality of oil and livelihoods of farmers'. Farmers' are empowered and adapted to eco-friendly, cost effective precision rapeseed-mustard farming to have an access to quality edible oil is our mission, Dr J S Chauhan emphasized. He also presented the highlights of the Directorate since the previous mela on February 1, 2011.

Dr Amar Singh, Incharge KVK, Kumher and Sh Desh Raj Singh Joint director Agriculture Department, Govt of Rajasthan also addressed the participants. Three innovative farmers namely, Sh Hukum Singh Lodha from Bharatpur (Raj.); Sh Jagdish Pareek from Sikar (Raj.) and Sh Anil Kamboj from Karnal (Haryana) and 37 other progressive farmers from different villages of Bharatpur district of Rajasthan and Agra & Mathura districts of Uttar Pradesh were felicitated for their excellent contribution for the cause of rapeseed-mustard production. Two technical bulletins "Resource conservation techniques for mustard based cropping pattern" and "Selection of improved varieties of mustard and their seed production through farmers participatory approach" in Hindi were also released by the Chief guest and President. Stalls from public as well as private sectors were appreciated.

R B Singh and Dr B B Singh also visited the experimental fields/ laboratories and had discussion with scientists and provided valuable suggestions.

Exhibitions

DRMR organized 5 on and off campus exhibitions viz., Eastern Rajasthan Agriculture Fair and Agriculture Industry Exhibition 2011 (November 3, 2011) at Bharatpur; CSWRI, Avikanagar (January 4, 2012); 18th Sarson Vigyan Mela, DRMR, Bharatpur (February 3,

2012); KVK, Kumher (February 9, 2012) and IARI, New Delhi (March 1-3, 2012) to showcase rapeseed-mustard technologies, research and development activities of DRMR. About 5000 farmers, farmwomen, extension personnel were educated by these exhibitions.

Technology Park

For the benefit of visitors in technology park at DRMR, Bharatpur, 13 species, 21 released varieties/ hybrids of rapeseed-mustard were demonstrated for the benefits of farmers, extension personnel, technocrats, scientists and others.

4

Education and Training

Training imparted

The training cell of DRMR selected 14 students for post graduate project/training and 8 students for M.Sc. dissertation/thesis work. Rs. 1.82 lakhs were generated during the year from the trainees.

Training attended

Participants	Training programme	Duration	Institute
Kanta Prasad	Record Management for Right to Information	April 18-21, 2011	ISTM, New Delhi
N S Bhogal	Rapid & Nondestructive Evaluation of Food quality & Safety factors using Spectroscopy & Bio-sensing	May 6-19, 2011	CIPHET, Ludhiana
B K Singh	Molecular Breeding in Vegetable Crops	May 6-19, 2011	IIVR, Varanasi
Mukesh Kumar Veena Sharma	Training Programme for Administrative Personnel	June 6-24, 2011	IIPA, New Delhi
J S Chauhan	Management & Leadership Development	September 12-16, 2011	LBS NIAR, Mussoorie
Y P Singh Maharaj Singh	Data Analysis Using SAS	September 12-17, 2011	MPUA&T, Udaipur
J Nanjundan	Genetic and Genomics Analysis Using SAS	September 19-24, 2011	IASRI, New Delhi
J L Sharma Sanjay Kumar	RTI Act-2005	October 7, 2011	ISTM, New Delhi
Y P Singh	Management Development Programme on Leadership Development	November 1-21, 2011	NAARM, Hyderabad
Manjubala	Agricultural Research Management for Newly Recruited Sr./Prin. Scientist	November 3-23, 2011	NAARM, Hyderabad
Vinod Kumar	Second Installation Training Programme of the SAS Software	November 25-26, 2011	Department of Agriculture Economics & Management, RCA, MPUAT, Udaipur
S S Rathore	Cropping System Models	December 5-9, 2011	ICRISAT, Hyderabad

Seminar Conducted at DRMR

Speaker	Topic	Date
Guests		
Dr S N Shukla, Ex-ADG (FFC), ICAR, New Delhi	My Experiences at ICAR, New Delhi	September 26, 2011
Dr Deepak Pental, Director CGMCP, Delhi University, South Campus	Overview of Rapeseed-Mustard Research in the World vis-a-vis India	October 20, 2011

Speaker	Topic	Date
Dr R K Singh, Director, Nand Education Foundation for Rural Development, Lucknow	Impact of Climate Change on Agriculture	November 11, 2011
Dr K P Singh, Prof Plant Pathology, BHU, Varanasi	Biological Control of Plant Parasitic Nematodes using Nematophagous Fungi	January 30, 2012
Dr J S Heslop Harrisen Dr (Mrs) Trude Hcswarzache University of Leicester, U.K.	Molecular Cytogenetics	February 10, 2012
Speaker from DRMR		
S S Rathore	Perspective on Labour Laws	August 11, 2011
Bhagirath Ram	Marker Assisted Selection and QTL Mapping in Crop Plants	September 8, 2011
N S Bhogal	Rapid and Non Destructive Evaluation of Food Quality and Safety Factors using Spectroscopy and Biosensing Methods	November 17, 2011
Arun Kumar	Chromosome Studies in some Important Arid Zone Tree Species of Rajasthan	November 24, 2011

Library Services

Particulars	No.	Detailed descriptions
Journals	49	*Agricultural review, Agronomy Journal Annals of Agricultural Research, Annals of Agri. Bio-Research, Annals of Biology, Brassica, Current Science, Indian Farming, Indian Journal of Biotechnology, Indian Journal of Agronomy, Indian Journal of Agricultural Science, Indian Journal of Entomology, Indian Journal of Cytology and Genetics, Indian Journal of Ephidology, Indian 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, 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, Journal of Oilseeds Research, Science and Culture, Plant Breeding Abstracts, Review of Plant Pathology*,
Newsletters	88	From various government, ICAR, SAU and other organizations
Annual reports	70	From various government, ICAR, SAU and other organizations
Other reference materials	66	From various government, ICAR, SAU and other organizations
Books	135	Latest books, encyclopedia, dictionaries, Hindi books, etc.

5

Awards/Recognition

DRMR

Rajshri Tandon Rajbhasha Puruskar

On the occasion of 83rd Foundation Day of ICAR, DRMR Bharatpur was awarded 2nd Rajshri Tandon Rajbhasha Prize for its contribution to the use of Rajbhasha Hindi in official work during 2010 in the category of other institutes of A & B area. Hon'ble ministers of state Dr Charan Das Mahant and Sh Harish Rawat presented the award and memento to Dr J S Chauhan, Director.

2nd best exhibition stall award

On the occasion of Kisan Mela at Central Sheep and Wool Research Institute, Avikanagar, the exhibition stall of DRMR, Bharatpur received 2nd best award on Jan. 4, 2012.

Personnel

Dr J S Chauhan, Director, DRMR was conferred with Fellowship award by National Academy of Agricultural sciences (NAAS), New Delhi for the year 2012 in recognition of outstanding contributions in the field of crop science research.

Dr Y P Singh, Principal Scientist (Agril. Entomology) was conferred with Fellowship by Society for Rapeseed-Mustard Research, Bharatpur, Rajasthan for his contributions in the field of *Brassica* research.

Dr K H Singh, Senior Scientist (Plant Breeding & Genetics) was conferred with Fellowship by Indian Society of Oilseed Research, DOR, Hyderabad, Andhra Pradesh for his valuable contribution in the field of mustard breeding.

Dr P D Meena, Senior Scientist (Plant Pathology) was conferred with Fellowship by Indian Society of Mycology and Plant Pathology, Udaipur, Rajasthan and Dr P R Kumar Outstanding *Brassica* Scientist-2011 by Society for Rapeseed-Mustard Research, Bharatpur for his outstanding contributions in the field of Brassica pathology.

Dr V V Singh, Principal Scientist (Plant Breeding & Genetics) was conferred with Distinguished Scientist -2011 award by Society for Recent Development in Agriculture, Meerut for his valuable contributions in agricultural research and education.

Dr Pankaj Sharma, Senior Scientist (Plant Pathology) was conferred with Prof H C Dube Outstanding Young Scientist award-2012 by Indian Society of Mycology and Plant Pathology, Udaipur, Rajasthan for his outstanding contributions in the field of Plant Pathology..

Dr S S Rathore, Senior Scientist (Agronomy) was conferred with Distinguished Scientist award by Scientist and Applied Research Center (SARC), Meerut, U P for his valuable contribution in the field of agricultural research.

Dr. Vinod Kumar, Senior Scientist (Computer Application in Agriculture) was awarded the Best IT Professional-2011 (IT Application in Agriculture) by Society of Extension Education, Agra and Dr P R Kumar Outstanding *Brassica* Scientist-2012 by Society for Rapeseed-Mustard Research, Bharatpur, Rajasthan for his outstanding contributions in application of computer science in agriculture.

Promotions/ Selections/ Nomination/Transfer/ Resignation

Personnel	New position	From
Promotions		
Dr Vinod Kumar, Scientist, Sr. Scale (Computer Application in Agriculture)	Senior Scientist	October 04, 2010
Dr (Mrs) Kapila Shekhawat, Scientist (Agronomy)	Scientist Sr. Scale	June 12, 2011

Personnel	New position	From
Sh R N Singh, Technical Officer (T-6)	Technical Officer (T-7/8)	July 1, 2010
Sh M L Meena, Technical Officer (T-6)	Technical Officer (T-7/8)	August 30, 2011
Sh Karnal Singh, Technical Officer (T-5)	Technical Officer (T-6)	January 30, 2011
Sh Govind Prasad, Technical Assistant (T-3)	Technical Assistant (T-4)	June 29, 2011
Sh Bachchu Singh, Technical Assistant (T-2)	Technical Assistant (T-3)	June 29, 2011
Sh G L Meena, Junior Clerk	Senior Clerk	December 1, 2011
Selection		
Dr V V Singh, Senior Scientist (Plant Breeding), DRMR, Bharatpur	Principal Scientist (Plant Breeding), DRMR Bharatpur	May 25, 2011
Dr S S Meena, Senior Scientist (Plant Breeding), DRMR, Bharatpur	Principal Scientist (Plant Breeding), IGFRI, Jhansi Regional Station, Avikanagar	May 30, 2011
Sh Kanta Prasad, Office Assistant Directorate, Kanpur	Assistant Finance & Accounts Officer, Zonal Project	June 4, 2011
*Dr N K Gupta, Asstt. Professor (Selection Scale), SKRAU, Bikaner, Rajasthan	Senior Scientist (Biotechnology), DRMR, Bharatpur	September 30, 2011
Transfer		
Dr S K Jha, Senior Scientist (Agril. Extension), DRMR, Bharatpur	Senior Scientist (OP), Crop Science Division, ICAR, New Delhi	March 29, 2012

* Resigned w.e.f. March 22, 2012

The DRMR family congratulates and wishes them a very rewarding future

6

Linkages and Collaboration

Forecast of rapeseed-mustard production 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 is being done under the FASAL project. The Directorate was mandated with the collection of ground truth (GT) observations form predominately rapeseed-mustard growing districts of Uttar Pradesh. The DRMR team surveyed Agra, Mathura, Etawah, Raibareli, Kanpur (Rural), Kanpur (Urban), Kannauj, Farrukhabad, Fatehpur, Hardoi, Jalaun, Lakhimpurkheri and Aligarh districts of Uttar Pradesh for rapeseed-mustard and its competing crops *viz*., wheat, gram, sugarcane, lentil, pea, potato and vegetables etc. The IRS P6 multi-date AWiFS data were used for acreage estimation. Dynamic crop growth simulation model "WOFOST" was used for yield and production forecasts taking weather data up to January 15, 2012. Based on the data analysis and modeling, the mustard production was forecasted to be down by 8% at 7.05 m tones due to the fall in the area under the crop and bad weather conditions.

Experimental Agro-met Advisory Service Project for flood prone zone of eastern Rajasthan

The Directorate releases medium range forecast for eastern flood prone zone of Rajasthan (Alwar, Bharatpur, Karauli, Sawaimadhopur and Dholpur districts) in collaboration with National Center for Medium Range Forecasting, Noida twice a week. The activity includes forecast for next five days and contingency crop/farm planning. The information is communicated through press, media, telephone, FAX, email and SMS to farmers, extension workers, scientists, administrators, policy makers and media personnel regularly. Five rain gauges were installed in different villages surrounding DRMR, Bharatpur for recoding daily rainfall and understanding 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

The bio-efficacy of phosphorous solubilizing fungus (*Pencillium bilaii*) on Indian mustard was tested at Sriganganagar, Hisar, SK Nagar and Bharatpur. At each location a replicated experiment in factorial RBD was conducted keeping phosphatic fertilizer levels 0, 50% and 100% of recommended dose and seed treatment option with Jump Start @6 ml/kg seed.

The mean mustard seed yield over different soil-site conditions was significantly influenced and ranged between 2022 to 2625 kg/ha at Bharatpur and Hisar, respectively. Application of 50% of recommended P fertilizer significantly increased the seed yield over control at Hisar and S K Nagar. Further, increase in fertility level remained *at par* with 50% and 100% of recommended dose of P at both the centers. The increase in yield due to phosphorous application was attributed to higher phosphorus and nitrogen uptake and thus, improved primary and secondary branches, siliquae / plant and 1000-seed weight. In general, seed treatment with *Pencillium bilaii* strains @6 ml/kg seed significantly improved mustard yield over control at all locations except Sriganganagar.

Energy and mass exchange in mustard based systems

The objective of the DRMR-Space Applications Centre (SAC) collaborative project was to understand and characterize vegetation atmosphere energy (E: radiative, convective) and mass (M: water, net CO_2 assimilation) exchange processes at canopy scale using measurements and simulations. The 30-minute interval data generated at AWS was compiled and processed to study heat flux at different height over the mustard crop. The study revealed significantly positive correlation between latent heat flux and the total biomass produced and could be expressed with linear model $Y= 0.23X-45.80$, $R^2= 0.82$, where Y is the biomass (g/plant) and X is the latent heat flux (W/m^2).

MoUs signed for implementation of tribal sub plan (TSP)

Under tribal sub-plan DRMR signed MoU_s with 4 Collaborative centers, MPUA & T Udaipur (Rajasthan), BAU Ranchi (Jharkhand), CAU Imphal (Manipur) and AAU, Jorhat (Asom) with an outlay of over Rs. 93.0 lakhs to improve the livelihoods of tribal farmers in respective regions by enhancing mustard production through capacity building of the stakeholders, farmer participatory on farm/ frontline demonstrations, exposure visits and supply of small agricultural implements.

Bio-efficacy of HP mustard spray oil

A study was conducted to test the bio-efficacy of HP Mustard Spray Oil against mustard aphid and safety to predators/parasites and honeybees at DRMR, Bharatpur and four coordinating centers i.e. PAU, Ludhiana, SDAU, S.K. Nagar, GBPUAT, Pantnagar and ARS, Sriganganagar. HP Mustard Spray Oil reduced mustard aphid population in the concentrations of 1.25 %, 1.50% and 1.75% at Bharatpur. No significant adverse effect of HP Mustard Spray Oil was observed on honeybees and natural enemies under the field conditions. No mortality was recorded in the treatments of HP Mustard Spray Oil @ 0.50%, 0.75%, 1.00% and control in any of the bioagents i.e. larvae of syrphid fly, adult and grub of *Coccinella septempunctata*. HP Mustard Spray Oil @ 1.25%, 1.50% and 1.75% and dimethoate 30 EC @ 1 litre/ha resulted 10, 18, 25 and 100% mortality, respectively to the grub of *Coccinella septempunctata*, 5, 12, 18 and 100% to the larvae of syrphid fly and 0, 7, 10 and 100% to adult mortality of *Coccinella septempunctata*. No phytotoxicity symptoms, *viz.*, epinasty, hyponasty, yellowing and stunting were observed up to 10 days after the spray.

DRMR-IARI collaborative National extension programme for technology assessment and transfer in Bharatpur district

In collaboration with IARI, New Delhi, 17 varietal demonstrations on wheat (cv. HD 2733, DL 153 (Kundan) and HD 2932) were successfully conducted at Unchagaon village of Bharatpur district.

On the basis of 2 locations, wheat varieties HD 2932 had an average yield of 6600 kg/ha against the average yield of 4000 kg/ha from other varieties with a yield improvement of 65% while, on the basis of 10 locations, variety HD 2733 had 5630 kg/ha against the average yield of 4000kg/ha with a yield improvement of 40%. The variety DL 153 (Kundan) had an average yield of 5580 kg/ha against the average yield of 4300 kg/ha from other varieties. The farmers expressed great satisfaction over the performance of the demonstrated varieties.

DRMR- Zonal project directorate zone IV collaboration for assessment of mustard hybrids/varieties

DRMR in collaboration with Zonal Project Directorate (Zone IV), Kanpur laid out 29 demonstrations on mustard hybrid NRCHB 506 and improved varieties NRCDR 2 and NRCHB 101 in different villages under Saharanpur, Sant Ravidasnagar, Muzaffarnagar, Kaushambhi, Pratapgarh Districts of UP and Haridwar of Uttaranchal. NRCDR 2 (14 locations) gave 37.1 % yield improvement with 2373 kg/ha of against average of 1715 kg/ha from varieties Varuna, Pusa Jaikisan, Pusa Bold. NRCHB-101 (12 locations) gave 40.7 % yield improvement with 1900 kg/ha against the average yield of 1350 kg/ha from Vardan. The mustard hybrid, NRCHB 506 (3 locations) showed 30.4 % yield improvement with 2250 kg/ha of against the average yield of 1725 kg/ha from variety Urvashi.

7

All India Coordinated Research Project on Rapeseed-Mustard

Directorate of Rapeseed-Mustard Research, Bharatpur organized 18th Annual Group Meeting of Rapeseed- Mustard Research Workers at Veterinary College, Khanapara Campus, Guwahati, Asom Agricultural University (AAU), Jorhat during August 5-7, 2011. Hon'ble Minister of Agriculture, Sh Nilamani Sen Deka and Hon'ble Minister of Irrigation and Soil Conservation, Dr. Ardhendu Kr Dey, Government of Asom inaugurated the meeting. Prof S K Datta, Deputy Director General (Crop Science), ICAR, New Delhi was the Chief Guest and Dr K M Bujarbaruah, Vice-Chancellor, AAU, Guwahati chaired the inaugural session. Dr R N Goswami, Dean, Faculty of Veterinary Science, AAU, Khanapara and Dr N N Sarmah, Director of Research (Agri.), AAU, Jorhat presented the achievements of AAU, Jorhat in general and rapeseed-mustard research in particular.

Inaugurating the annual group meeting, Hon'ble Minister of Agriculture, Govt. of Asom, Sh Nilamani Sen Deka, called for enhancing productivity of existing *toria* varieties under rice-fallows to cater the demand for edible oil in the state. He assured all help from Asom government to enhance rapeseed-mustard production. Hon'ble Minister of Irrigation and Soil Conservation, Govt of Asom, Dr Ardhendu Kumar Dey, in his address, stressed for convergence of various disciplines/agencies for increasing rapeseed-mustard production in the state. He expressed the need for development of roadmap for rapeseed-mustard research for the country and more specifically for Asom.

Prof S K Datta, DDG (CS), ICAR, New Delhi highlighted the successes in rapeseed-mustard production in the country and attributed this to crop improvement, good management, irrigation and govt. support. He emphasized the need of screening photo-synthetically efficient *Brassica* germplasm for low light intensity, one of the major causes for low productivity in states like Asom. He also suggested to develop road map for utilizing 11 m ha under rice-fallows in eastern and northeastern states which offers enormous potential for the growth of the crop in the region and could be harnessed by growing recently released early maturing (90-110 days) mustard varieties. Dr K M Bujarbaruah, Vice-Chancellor, AAU, Jorhat, said that acidic nature of soils of Asom is also one of the major reasons for low productivity of rapeseed-mustard. He stressed the need for development and extension of rapeseed-mustard production technology for north eastern states.

Two publications from the DRMR namely, "Directory of Rapeseed-Mustard Research Workers in India" and "Sarson News 15 (1): January-June 2011" were released by Hon'ble Ministers. Varietal Identification Committee, under the Chairmanship of Prof S K Datta, DDG (CS), ICAR, New Delhi, identified 7 varieties (PBR 357, Pant rai 19, Pusa mustard 28, RGN 229, RGN 236, RH 0406 and ELM 123) and one hybrid (Coral PAC 437) of Indin mustard for release under different production conditions of Zone-II (Delhi, Haryana, Pujanb, Jammu and Rajasthan).

Dr J S Chauhan, Director, DRMR, Bharatpur presented the highlights for the year 2010-11. He informed that 23 centers spread over 17 states carried out the varietal development programme in toria, yellow Sarson, gobhi Sarson, Indian mustard, karan rai and taramira and 5 varieties (Indian mustard 2, taramira 2 and yellow sarsons 1) have been released during the last year. A total of 429 FLDs on rapeseed (110) and mustard (319) were conducted in 60 districts across 16 sates of the country.

The discipline wise highlights of the programme were as follows:

Crop Improvement

A total of 4,721 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 following appropriate mating systems. 521 new accessions of Indian mustard, toria and taramira were collected. 2,249 accessions including Indian mustard, toria, yellow sarson, gobhi sarson, brown sarson, karan rai and taramira were evaluated. On the basis of germplasm evaluation promising donors were identified for earliness, tolerance to aphid and drought.

With a view to improve seed yield, earliness, seed size, disease/pest resistance, high temperature tolerance, quality and high oil content, 953 crosses were attempted in toria (32), yellow sarson (5) and Indian mustard (770) at Morena, Kanpur, Pantnagar, Dholi, Hisar, Navgoan, Nagpur, Sriganganagar and Varanasi. Selection of superior plants/bulk at different centres was practiced in toria, yellow sarson and Indian mustard. In toria, development of composites and reconstituting population after selection were the main objectives. 810 bulks were made. In yellow sarson, hybridization selection from segregating generations was attempted at Pantnagar and Dholi. In Indian mustard, 8,624 single plants and 687 bulks were selected from segregating and advanced generations.

Performance of selected advance breeding lines was evaluated under different station/ state / preliminary yield trials at various centres. 44 strains of toria were tested at Kanpur, Dholi and Pantnagar and yield superiority was up to 37.1 % over the check (PT-303) at Dholi. In yellow sarson, total of 49 strains were tested at Kanpur and Dholi and yield superiority up to 51.9 % over the check Swarna was recorded at Dholi. In Indian mustard, 559 strains were evaluated at 8 centers in 28 trials. Yield superiority up to 35.2 % over the check Kanti was recorded at Kanpur. 12 strains of taramira were evaluated in a trial at Jobner and yield superiority up to 15.5 % over the check, RTM 314 was recorded.

In Indian mustard mapping populations for white rust disease were developed at IARI, New Delhi. CMS and restorer conversion programme for hybrid development has been undertaken at IARI New Delhi, Hisar, Morena, S.K. Nagar and Pantnagar

Against the indent of 75.32 q breeder seed of 37 centrally and 31 state released varieties of rapeseed – mustard, 152.41 q breeder seed was produced at 19 different centers..

One hundred seventy five promising strains of toria, yellow sarson, Indian mustard, gobhi sarson and taramira were evaluated in 24 yield trials at 179 locations across 5 agro-climatic zones of the country. A total 16 strains comprising 1 of toria, 14 of Indian mustard and 1 of gobhi sarson has been promoted for advance stage testing.

Crop Production

At Khudwani, sulphur application @ 20 kg/ha increased seed yield of brown sarson by 7.8%. Cluster bean-mustard at SK Nagar and black gram-mustard cropping system at Dholi with 125% recommended fertility level recorded highest mustard seed yield. Organic system at Bharatpur (2792 kg/ha) and inorganic fertilization at Morena and Pantnagar produced significantly maximum mustard seed yield (1243-2317 kg/ha). Line sowing of brown sarson at Khudwani and toria at Dholi alongwith 80 kg N/ha gave maximum seed yield over other practices. Maize (PSM-1) - mustard (NDRE-4) - green gram (PM-4) was most remunerative alternative system at Pantnagar. Mustard + maize (1:1) intercropping significantly increased mustard equivalent seed yield (MESY) over sole mustard crop by 18.0% at Bhubaneswar and 42.0% at Dholi. Wheat + mustard (9:1) increased MESY over sole wheat by 43.0% at Varanasi, while sole wheat crop was superior at Kangra, Kanpur, Pantnagar, and Kanke centres. Wheat or mustard intercropping with pea showed negative impact on system productivity at Kanpur and Kanke. Seed treatment with *Azotobactor* + PSB along with 100% ($N + P_2O_5$) synergistically increased seed yield to the tune of 5.6-11.7% at Hisar, Kota, Morena, Pantnagar, Varanasi, Jobner and SK Nagar. Sheetal (gobhi sarson) at Kangra, Navgold at Bawal, Ashirwad at Varanasi, Kranti and GM-3 (Indian mustard) at Nagpur, Varuna at Bhubaneswar were found most competitive against annual weeds. However, Gulchin (brown sarson) at Khudwani, NRCDR-2 at Bawal, Chatha and Navgaon, Ashirwad at Varanasi, GM-3 at Nagpur produced maximum mustard seed yield.

Among the herbicides, oxadiargyl (ronstar) @0.75 kg a.i./ha (PE) at Varanasi, Morena, Kota, Sriganganagar, Bawal, Pantnagar and Chatha; oxyfluorfen (Goal) @ 0.15 kg a.i./ha (PE) at Kangra, Khudwani and Sriganganagar; quizalofop (turga super) @0.06 kg a.i./ha (25-30 DAS) at Kanpur, Khudwani, SK Nagar

and Pantnagar; clodinafop (topiK) @ 0.06 kg a.i./ha (25-30 DAS); isoproteuron @ 1.0 kg a.i./ha (PE) at Jobner and Dholi were found most effective against weeds in mustard crop. The yield losses due to weeds ranged from 18.1% to 41.7% across different locations.

DMH-1 at Bawal and Jobner, PAC 432 at IARI and Morena produced maximum seed yield. The wider spacing (45 cm x 15 cm) at Bawal, IARI, Ludhiana and Jobner and increased fertility to 125%RDF at Morena and Pantnagar significantly increased mustard seed yield.

September 30 to October 10 for Kranti; October 11-20 for NRCDR 2 and October 21-30 for PBR 357 and RL 1359 was observed optimum sowing time in zone II. While, October 11-20 across the centres in Zone III and at Jobner and October 21-30 at Nagpur and SK Nagar in Zone IV was found optimum.

PR 2006-1 consistently produced higher yield at all the locations except Sriganganangar of zone-II under early sowing conditions, where NPJ-124 and NPJ-112 significantly out yielded other varieties. Decreasing fertility levels to 75%RDF significantly reduced the average productivity by 8.6 to 19.5%. Under rainfed conditions all mustard genotypes significantly out yielded Geeta at all the locations except at Navgaon where only SKM-01 was superior to Geeta. RH 406 and SKM 301 at Hisar; SKM 526 and RH 406 at IARI, PKRS 28 at Ludhiana, SKM 301 at Navgaon and PBR 97 at Sriganganagar produced significantly higher yield than rest of the genotypes. Under late sown situations, RGN 236 at Bawal, Ludhiana, Hisar and Sriganganagar and ELM 123 at Navgoan were found superior. PT 303 at Bhubaneswar; JD 6 at Dholi and Kanke; and NDRE 7 at Shillongani of zone-V were highest yielder. The fertilizer levels up to 125%RDF at Kanke; up to 150% at Dholi and Shillongani increased the seed yield significantly.

Crop Protection

In general, the disease pressure was moderate at different locations. Moderate to severe incidence of Alternaria blight was recorded at Faizabad, Kanpur and Ludhiana. White rust severity was low to moderate at most of the locations. Low to moderate Sclerotinia rot severity was recorded at most of the places except Navgaon. In general, low to moderate incidence of powdery mildew was recorded at most of the centers except Hisar and Kanpur where it was severe on late sown crop. Moderate to high severity of downy mildew was observed at Faizabad and Kanpur. Moderate incidence of bacterial rot was recorded from Hisar and Faizabad.

Diseases

NPC 20, NPC 21 of *B. carinata* and EC 339000 and EC 338997 of *B. napus* showed tolerance to Alternaria blight. NPJ 127, NRCM 810, NRCDR 805, RAURDL 02-01 and EC 399313 of *B. juncea*; DRMR 270, DLSC 1, DRMR 243, MCB 1, BCS 3, BCS 4, NPC 16, NPC 20 and NPC 21 of *B. carinata*; NUDB 16-11, EC 339000 and EC 338997 of *B. napus*; TL 17, EC 414291 and EC 414293 *B. rapa* ssp *toria*; YSB 9 of *B. rapa* ssp *yellow sarson* showed resistance to white rust. BCS 3, BCS 4, NPC 16, NPC 20, NPC 21, DRMR 243, DRMR 261 and DLSC 1 of *B. carinata*; EC 414293 of *B. rapa* ssp *toria*; EC 338997, and NUDB 16-11 of *B. napus* showed resistance to downy mildew whereas, DRMR 243, DRMR 261 and DLSC 1 of *B. carinata* to powdery mildew. Genotypes NPC 20, NPC 21 of *B. carinata* showed tolerance to Sclerotinia rot.

Relative reaction of 13 rapeseed-mustard genotypes was tested against four isolates of *Albugo candida* collected from PNT, HSR, LDH and BHP. Variable reactions of genotypes were observed with different isolates both, at cotyledonary true leaf stage.

Profound variation in wet mycelia biomass *A. brassicae* isolates was observed on different test synthetic media. Aggressiveness of theses isolates was evaluated with regard to lesion development on 8 different *Brassica* species. Most of the isolates produced lesions of variable sizes on detached leaf after 4-5 days of inoculation at 25°C temperature. Variable reaction of isolates on different *Brassica* species suggests variability among the geographical isolates.

Significant morphological, cultural and pathogenic variability was recorded among 37 geographical isolates of *S. sclerotiorum*. On the basis of morphological data, isolates were grouped into two major clusters I and II which showed only 7% similarity to each other.

At Bharatpur, first appearance of Alternaria leaf blight occurred on January 14 in October 22 sown crop (84 DAS) on cv Varuna whereas, it appeared seven days later on cv NRCDR 2. The maximum severity of Alternaria leaf blight on cv Varuna as well NRCDR 2 was observed in the 3rd week of February when temperature was 24.4°C (max.), 10.2°C (min.), morning RH 96.8% and BSSH 7.2. One week before harvest, the maximum severity of ABP was observed on October 29 sown crop. Initiation of white rust on leaf occurred at 111 DAS on both the cultivars. The maximum staghead formation was observed in November 19 sown cv Varuna while in NRCDR 2 no staghead formation observed.

Soil application of ZnSO4 @ 15 kg /ha + borax @ 10 kg /ha + sulphur as per recommendation combined with foliar application of carbendazim + mancozeb was found most effective in controlling AB, WR, DM and PM diseases of mustard. Alternaria blight was reduced effectively with mancozeb spray and use of sulphur in combination with borax. Soil application of ZnSO4 + sulphur minimized the severity of WR and PM. Soil application of ZnSO4 soil @ 15 kg /ha + borax @ 10 kg /ha + sulphur as per recommendation also increased the seed yield,1000-seed weight and oil content.

Insects

The strains HYT 33, RH 0644, DRMR 447, RMM 09-02, RH 0406, DRMREJ 902, JMWR 08-02, PBR 378, NDRE 7, ELM 123, EC 399313, Purple mutant, PBR 330, PHR 2, EC 399299, EC 399296, RH 0216 and Divya 22, (all *B. juncea*), NPC 16, NRCKR 299, DLSC 1 and Kiran (*B. carinata*) EC 414291 (*B. rapa* ssp. *brown sarson*), RTM 1212, RTM 2002 (*Eruca sativa*) had low AAII. At Ludhiana and Hisar, highest yield loss of 18.4% and 22.2% was recorded respectively in BSH 1. Avoidable yield loss was recorded maximum in purple mutant (26.7%) followed by DLSC 2 (25.8%) at Kanpur while at Dholi in RK 9501 (16.0%). Higher amount of total phenols, ortho-dihydroxyphenols, flavonols and glucosinolates were found responsible for low aphid infestation in purple mutant, DLSC 2 and T 27.

Low population of mustard aphid was reported active from most of the centers during 1st to 12th with peak during 6th-8th standard week. Low to moderate population of painted bug was active from 46th to 1st and again 7th to 13th std. week at Hisar while at Bharatpur it was found active during 47th-50th and again 6th-14th std. week. Similarly, low to moderate population of sawfly was reported from Faizabad centre. Low to moderate population of cabbage caterpillar was recorded from 5th to 13th std. week at Hisar and 12th to 13th std. week at Ludhiana (25.4 larvae/plant on PC 5). Low population of leaf miner was reported from Bharatpur. Alate aphid appeared as early as in 43rd standard week at Ludhiana. This year population of alate aphid from most of the centre was reported low while moderate from Berhampore, SK Nagar and Pantnagar.

Oxy-demeton methyl 25 EC @ 250 g a.i./ha and imidacloprid 17.8 SL @ 20 g a.i./ha gave the highest seed yield at Berhampore (1347 kg/ha) and Morena (1606 kg/ha), respectively. Significantly higher aphid control and yield was obtained in the treatments where the use of NSKE @ 5%, neem oil @ 2% and dimethoate 30 EC @ 1 ml/litre was followed by *Verticillium lecanii* @108CS/ml, *Coccinella septempunctata* @ 5000 beetle/ha and *Chrysoperla carnea* @ 50,000 larvae/ha.

Plant Physiology & Biochemistry

Of the 43 rapeseed-mustard genotypes screened for salinity tolerance (12dS/m) during seedling stage at Hisar, Kanpur and SK Nagar centers, RH 0555A expressed salinity tolerance at all the locations based on < 20% reduction in shoot length and seedling dry weight. The genotypes, DRMR 902, JS 29 and RH 0555A showed higher imbibitions rate in saline medium. On the basis of < 20% seedling mortality, BPR 349-9 and BPR 540-6 were identified as promising strains for high temperature tolerance at seedling stage at 4 locations. Strains BPR 349-9 and RGN 236 were identified to possess tolerance and PBR 378, NRCDR 701, PRKS 28 and PBR 357 had high photosynthetic efficiency under high temperature stress during terminal stage.

The highest oil content was recorded in strain PR 2006-1 (44.4%) of *B. juncea* at LDH; JMT 08-12 (43.9%) of *B. rapa* var. *totria* at MOR and NDYS 09-01 (45.7%) of *B. rapa* ssp. *yellow sarson* at KPR. Seven strains (Pusa Karishma, LET 36, RH 801, ELM 3031, Pusa Mustard 21, LES 42 and LES 43) had erucic acid < 2% among the 15 strains evaluated in IVT and AVT-I. High total phenols and glucosinolates were recorded in DLSC 2 (*B. carinata*), Purple Mutant (*B. juncea*) and T 27 (*Eruca sativa*) at LDH. Among the aphid infested and healthy plants, DLSC 2 and Purple Mutant, respectively had maximum lectin activity. Of the six strains evaluated, total phenols and o- dihydroxy phenols increased and flavonols decreased with increase in Alternaria blight infestation. Further, genotypes EC 399313, EC 399296, EC 399299 had higher oxidative enzymes and phenyl ammonia lyase specific activity in the leaves of infested plants.

The salicylic acid (50µmoles/l) increased survival by 17% in *B. juncea* susceptible genotype. Increase in high temperature tolerance during seedling stage could be due to increased activity of oxidative enzymes. Tocopherols in leaves was highest in PBR 91(2107.3 mg/100g) followed by RLC 1 (1858.3 mg/100g) of *B. juncea*. Highest carotenoids were recorded at 35 DAS in RLM 619 of *B. juncea*. Highest phenols (10.6 mg/g and 13.1 mg/g) were observed in Purple Mutant at 45 and 75 DAS at BPR. The maximum flavonols and chlorophyll were observed in RH 7846 at 75 DAS. The sinapine content estimated in seed meal ranged from 0.8- 2.1 % in *B. rapa*, 1.0- 2.6% in

B. juncea and 0.9- 2.2% in *B. napus*. The fiber content in 45 rapeseed-mustard genotypes ranged from 2.65(Kiran of *B. carinata*) to 13.3% (Pusa bold of *B. juncea*).

Technology Assessment

Twenty three cooperating centres conducted 429 FLDs on rapeseed (110) and mustard (319) in 60 districts across 16 states of the country. Rajasthan had maximum FLDs (105) followed by Haryana (40). There were 121, 161 and 147 FLDs on the whole package (WP), varietal component and other component technology (CT), respectively under irrigated as well as rainfed conditions.

A total of 12 sessions were organized during this group meeting wherein all PIs presented the progress report of 2010-11 of their respective disciplines. In the session, creation of genetic variability through hybridization/ mutagenesis and selection, evaluation of advanced breeding lines, hybrid development, breeder seed production, germplasm collection and maintenance, crop management and protection including integrated disease & pest management under different situations, biochemical bases of diseases and insect pests, identification of tolerant donors for abiotic stresses, frontline demonstrations, etc. were discussed in respective sessions at length by the distinguished participants. The planning and technical programme for the year 2011-12 was also undertaken for various disciplines.

Varietal Identification Committee under the Chairmanship of Prof S K Datta, Deputy Director General (Crop Science), ICAR, New Delhi identified 7 candidate varieties and one hybrid for release.

The following recommendations were made after in depth discussion:

- Creating zones for conducting yellow sarson trials, which are being conducted across 10-12 locations spread over 11 states resulting in to large g x e interaction and making identification of promising materials difficult. The appropriate decision shall be implemented after approval of the Council.
- Evaluation of toria and early mustard strains in separate trials to avoid intercrop competition due to differences in plant type thus masking actual performance of both the crops. And also a new trial shall be constituted for evaluation of mustard strains exclusively under rainfed conditions.
- Line sowing of rapeseed-mustard after land preparation in rice field and 80 kg N/ha fertilizer is recommended under utera cropping system in Zone I (HP and Kashmir valley) and Zone V (Bihar, Chhattisgarh, Orissa, Jharkhand, West Bengal, Asom, Northeastern states).
- Maize- mustard (short duration) - green gram system was found more remunerative than the traditional maize-wheat system and recommended for Pantnagar and Kangra conditions.
- Mustard hybrid DMH 1 and PAC 432 were found superior to check across the Zone II (Delhi, Haryana, Punjab, Jammu and parts of Rajasthan) and Zone III (MP, UP, Uttarakhand and parts of Rajasthan). And wider spacing of 45 cm x 15 cm and 100%RDF were recommended.
- Application of 20 kg S/ha to *Brassica* under rice-brown sarson at Khudwani and black gram-mustard at Dholi and cluster bean-mustard system with 100%RDF at SK Nagar recommended for higher yield and net return.
- A meeting with the state department of agriculture should be held with regard to the indented varieties of rapeseed-mustard for breeder seed so that the old varieties could be replaced by the latest releases.
- Every centre should conduct more number of demonstrations on the whole package of the crop rather than on the technological components. At least 50% FLDs allotted to the centers should be conducted with the varieties recommended for their respective zone. In case of component technology demonstrations, minimum 4-5 FLDs must be conducted on one component by the center.

Every center should develop some success stories on the FLDs for increasing the pace of technology dissemination.

8

Publications

Research papers

- **Chattopadhyay C, B K Bhattacharya, Vinod Kumar, Amrender Kumar and P D Meena** (2011). Impact of climate change on opests and diseases of oilseeds Brassica - the Scenario Unfolding in India. *Journal of Oilseed Brassica* **2** (2): 1-8.
- **Chattopadhyay C, R Agrawal, A Kumar, R L Meena, K Faujdar, N V K Chakravarthy, Ashok Kumar, P Goyal, P D Meena and C Shekhar** (2011). Epidemiology and development of forecasting models for white rust of *Brassica juncea* in India. *Archives of Phytopathology and Plant Protection* **44** (8): 751-763.
- **Chauhan J S, K H Singh, S S Meena, M L Meena and M Singh** (2011). Environmental effects on oil, fatty acid profile, potein and glucosinolate content in Indian mustard (*Brassica juncea*). *Indian Journal of Agricultural Sciences* **81** (7): 648:653.
- **Chauhan J S, K H Singh, V V Singh and Satyanshu Kumar** (2011). Hundred years of rapeseed mustard breeding in India: accomplishments and future strategies. *Indian Journal of Agricultural Sciences* **81** (12): 1093-1109.
- **Choudhary, Seema, Vinay Singh and N S Bhogal** (2012). Status of total and available manganese in soils of Agra. *Indian Journal of Soil Science* **60** (1): 68-70.
- **Goyal P, M Chahar, A P Mathur, A Kumar and C Chattopadhyay** (2011). Morphological and cultural variation in different oilseed *Brassica* isolates of *Alternaria brassicae* from different geographical regions of India. *Indian Journal of Agricultural Sciences* **81** (11): 1052-1058.
- **Meena H P and K H Singh** (2011). Assessment of proper stage of harvesting in Indian mustard (*Brassica juncea* L.). *Journal Oilseeds Research* **28** (1):65-67.
- **Meena P D, C Chattopadhyay, A Kumar, R P Awasthi, R Singh, S Kaur, L Thomas, P Goyal, and P Chand** (2011). Comparative study on the effect of chemicals on Alternaria blight in Indian mustard- A multi-location study in India. *Journal of Environmental Biology* **32** (3): 375-379.
- **Meena P D, C Chattopadhyay, S S Meena and A Kumar** (2011). Area under disease progress curve and apparent infection rate of Alternaria blight disease of Indian mustard (*Brassica juncea*) at different plant age. *Archives of Phytopathology and Plant Protection* **44** (7): 684-693.
- **Meena P D, P Goyal and P Sharma** (2011). Pathogenic variability among *Alternaria brassicae* population infecting oilseed *Brassicas* in India. *Indian Journal of Plant Protection* **39** (3): 212-214.
- **Meena P D, R P Awasthi, S Godika, J C Gupta, Ashok Kumar, P S Sandhu, Pankaj Sharma, P K Rai, Y P Singh, A S Rathi, Rajendra Prasad, Dinesh Rai and S J Kolte** (2011). Eco-Friendly approaches managing major diseases of Indian mustard. *World Applied Sciences Journal* **12** (8): 1192-1195.
- **राठौर एस एस, कपिला शेखावत, ओ पी प्रेमी, बी के कण्डपाल** (2012). जलवायु परिवर्तन का राई सरसों उत्पादन पर प्रभाव: एक सिंहावलोकन। *भारतीय कृषि अनुसंधन पत्रिका* **26** (3–4): 133–136.
- **Sharma A K, Vinod Kumar, S K Jha and R C Sachan** (2011). Frontline demonstrations on Indian mustard: an impact assessment. *Indian Research Journal of Extension Education* **11** (3):25-31.
- **Sharma Pankaj, S A Siddiqui, P K Rai, P D Meena, J Kumar and J S Chauhan** (2012). Evaluation of *Brassica* germplasm for field resistance against clubroot (*Plasmodiophora brassicae* Wor.). *Archives of Phytopathology and Plant Protection* **45** (3): 356-359.
- **Siddiqui S A, P K Rai, P Kaushal, V V Singh and B K Singh** (2011). Efficient modified DNA extraction method for marker identification. *National Academy Science Letters* **34** (7&8): 239-245.
- **Singh B K, A K Thakur, S K Tiwari, S A Siddiqui, V V Singh and P K Rai** (2011). Transferability of *Brassica*-derived microsatellites to related genera and their implications for phylogenetic analysis. *National Academy Science Letters* **35** (1): 37-44.
- **Singh K H and J S Chauhan** (2011). Genetics of flower colour in Indian mustard (*Brassica juncea*

L. Czern & Coss). *Indian Journal of Genetics and Plant Breeding* **71** (4) : 377-378.

- **Singh K H, Rahul Bajpai, Ritu Shakya and Karnal Singh** (2011). Standardization of male: female row ratio in hybrid seed production of Indian mustard. *Crop Improvement* **38** (2): 137-141.
- **Singh S P, Y P Singh and A Kumar** (2011). Bio-effectiveness of neem products against mustard aphid, *Lipaphis erysimi* (Kalt.) in mustard crop. *Annals of Plant Protection Sciences* **19** (2): 278-281.
- **Singh V V, S A Siddiqui, Vandana Verma, P K Rai and Arvind Kumar** (2011). Phenotypic, cytological and molecular investigation on interogression of Brassica *juncea* into *Brassica carinata*. *Vegetos* **24** (1): 114-119.
- **Singh Y P, S P Singh and R Singh** (2011). Effect of seed treatment on the painted bug, B*agrada hilaris* Burm. in Indian mustard. *Indian Jounal of Entomology* **73** (2): 156-161.
- **Singh Y P, S P Singh, R Singh and R Nagar** (2011). Bioefficacy of insecticides against Painted bug, *Bagrada hilaris* at early stage of Indian mustard. *Indian Journal of Plant Protection* **39** (2): 153-154.

Technical bulletins

- **झा एस के एवं जे एस चौहान** (2011). सरसों अनुसंधान निदेशालयः एक दृष्टि में, सरसों अनुसंधान निदेशालय, भरतपुर. पृष्ठः 8.
- **शर्मा अशोक, एस के झा एवं जे एस चौहान** (2011). सरसों (लाहा) से अधिक उत्पादन के लिए उन्नतशील कृषि विधियाँ, सरसों अनुसंधान निदेशालय, भरतपुर. पृष्ठः 6.
- **सिंह के एच, ए के ठाकुर, जे नन्जून्दन एवं जे एस चौहान** (2012). पौध किस्म और कृषक अधिकार संरक्षण अधिनियम 2001 तथा सरसों में विशिष्टता, एकरूपता एवं स्थायित्व परीक्षण, सरसों अनुसंधन निदेशालय, भरतपुर. पृष्ठः 8.
- **सिंह वी वी एवं ए के शर्मा** (2012). किसान सहभागिता द्वारा राई–सरसों की उन्नत प्रजातियों का चयन एवं बीज उत्पादनः अवधरणा एवं अनुभव, सरसों अनुसंधान निदेशालय, भरतपुर. पृष्ठः 6.
- **शेखावत कपिला, संजय सिंह राठौड़, ओम प्रकाश प्रेमी, बंसत कुमार काण्डपाल एवं महाराज सिंह** (2012). सरसों आधरित फसल चक्रों हेतु संसाधन संरक्षण तकनीकें, सरसों अनुसंधान निदेशालय, भरतपुर. पृष्ठः 6.

Books

- **पंकज शर्मा, अशोक कुमार शर्मा एवं संजीव कुमार झा** (2011). सिद्धार्थः सरसों संदेश (द्वितीयांक). सरसों अनुसंधान निदेशालय, भरतपुर. पृष्ठः 77.
- Annual Report 2010-11. Directorate of Rapeseed-Mustard Research (ICAR), Bharatpur (Rajasthan). p. 67 + xi
- DRMR (2011). Vision 2030. Directorate of Rapeseed-Mustard Research (ICAR), Bharatpur (Rajasthan). p. 30

Book chapter

- **Bala M, S Kumar, S Sangwan, R Yadav, A Sharma and S P Singh** (2011). Mechanism of action of biocontrol agents: An Overview. p. 130-146. In: Plant Diseases and Their Biological control (Ed. Singh, A.) Pointer Publisher, Jaipur, India.
- **Chattopadhyay C, B K Bhattacharya, Vinod Kumar, Amrender Kumar and P D Meena** (2011). Epidemiology and Forecasting of Diseases for Value-added Agro-advisory. p. 132-140. In: Plant Pathology in India: Vision 2030. Indian Phytopathological Society, New Delhi.
- **Goyal P, P D Meena, R P Awasthi, A P Mathur, S J Kolte and C Chattopadhyay** (2011). Alternaria blight in rapeseed-mustard: a chronic problem. p. 187-210. In: Plant Health and Their Management (Ed. P C Trivedi). Agrobios (India), Jodhpur.
- **Husaini A M, D K Srivastava, M Z Abdin, A K Thakur and H Farooqi** (2011). Transgenic technology for engineering ROS and abiotic stress tolerant crops. p. 91-128. In: Antioxidants: Oxidative stress management in plants (Ed. P Ahmad and S Umar). Studium Press India Pvt. Ltd, New Delhi, India.
- **Kapila Shekhawat and S S Rathore** (2011). Plant disease management through diversified cropping systems. An eco-friendly approach. p. 33-39. In: Plant Diseases and their Control (Ed. Archana Singh). Aavishkar Publishers and Distributors, Jaipur.
- **Rathore S S and Kapila Shekhawat** (2011). Mitigating plant diseases through cultural practices and biological methods. p. 115-129. In: Plant Diseases and their Control (Ed. Archana Singh). Aavishkar Publishers and Distributors, Jaipur.
- **Singh Binay Kumar and Ajay Kumar Thakur** (2011). Disease management in Indian mustard: molecular advances. p. 147-154. In: Plant Diseases and Their Biological Control (Ed. Archana Singh). Aavishkar Publishers and Distributors, Jaipur.

Popular article

- **शर्मा अशोक कुमार** (2011). वैज्ञानिको के सुझाव अपनावें – सरसों (लाहा) की उपज बढ़ायें. *कृषि भारती* **1**(1): 16–17.

- **शर्मा अशोक कुमार एवं जे एस चौहान** (2012). सरसों फसल की कटाई, गहाई और भंडारण प्रबंधन. *कृषि भारती* **2** (5): 36–37.
- **शर्मा पंकज एवं पी के राय** (2011). जैविक नियंत्रण से फसलों में नाशीजीव प्रबंधन. *खेती* **63**(3): 16–19 एवं 25.
- **मीना पी डी एंव आशा रानी** (2011). सरसों–राई के मुख्य रोग एवं उनका समेकित प्रबंधन. *कृषि भारती* **3**: 4–6.
- **मीना पी डी, आशा रानी एवं पंकज शर्मा** (2011). सरसों–राई की फसल में होने वाले रोगों का जैविक प्रबंधन. *कृषि भारती* **3**: 30–33.
- **सिंह बी के एवं प्रिया मेधा** (2011). कृषि क्षेत्र में बी. टी. ट्रांसजेनिक की उपयोगिता: एक दृष्टि में. *प्रतियोगिता दर्पण.* **34**(5): 920–922.
- **सिंह बी के एवं पी के राय** (2012). जेनेटिक यूज़ रिस्ट्रिक्शन टेक्नॉलोजी (जी. यू. आर. टी.): किसानों के लिए वरदान या अभिशाप. *प्रतियोगिता दर्पण* **34** (8): 1509–1510.

Presentations in seminars/symposia/workshops

- **Bhogal N S, K H Singh, S Kumar, Sandeep Kumar and H P Meena** (2011). Biochemical markers for salinity tolerance in rapeseed-mustard. pp. 427. In: Proceedings, 13th International Rapeseed Congress. Prague, Czech Republic, June 5-9, 2011.
- **Chauhan J S, K H Singh, V V Singh, S S Banga, M Singh and S Kumar** (2011). An overview of hundred years of rapeseed-mustard breeding in India: Accomplishments and future strategies. pp. 40. In: Proceedings, 13th International Rapeseed Congress. Prague, Czech Republic, June 5-9, 2011.
- **Chauhan J S, K H Singh, V V Singh, S SMeena, D C Mishra and M L Meena** (2011). Additive main multiplicative interaction and bi-plot analysis to identify stable genotypes of Indian mustard for quality characters. pp. 330. In: Proceedings, 13th International Rapeseed Congress. Prague, Czech Republic, June 5-9, 2011.
- **Kumar Vinod, K H Singh, K K Chaturvedi and J Nanjundan** (2012). Developing a web-based database of rapeseed-mustard germplasm using LAMP technology. pp 6-7. In: Abstracts, 1st National *Brassica* Conference on Production Barriers and Technological Options in Oilseed *Brassica* CCSHAU, Hisar, March 2-4, 2012.
- **Medha Priya, S S Banga, Gurpreet Kaur and Manjeet Kaur Sangha** (2011). Development of a linkage map for Ethiopian mustard (*Brassica carinata*). pp. 45. In: Abstracts, National seminar on Contemporary Approaches to Crop Improvement, University of Agricultural Sciences, GKVK campus, Bangaluru, April 22-23, 2011.
- **Meena S S, K S Brar, J S Chauhan, P D Meena, P S Sandhu, R P Awasthi, A Rathi, A Kumar, J C Gupta and S J Kolte** (2011). GGE bi-plot analysis of *Brassica* genotypes for white rust disease severity under aided epiphytotic conditions in India. pp. 1201-1204 In: Proceedings, 13th International Rapeseed Congress. Prague, Czech Republic, June 5-9, 2011.
- **Meena S S, P D Meena, V V Singh and R P Awasthi** (2012). Development and characterization of white rust resistant genotypes of Indian mustard (*Brassica juncea*). pp.76. In: Abstracts, 1st National *Brassica* Conference on Production Barriers and Technological Options in Oilseed *Brassica* CCSHAU, Hisar, March 2-3, 2012.
- **Meena S S, V V Singh, P D Meena and J S Chauhan** (2011). Development of early maturing and dwarf genotypes in Indian mustard. pp. 107. In: Abstracts, National Seminar on Contemporary Approaches to Crop Improvement. University of Agricultural Sciences GKVK campus, Bangaluru, April 22-23, 2011.
- **Singh K H, Ritu Shakya, D K Chauhan and J S Chauhan** (2011). Assessment of genetic diversity in Indian mustard (*Brassica juncea* L. Czern & Coss) using RAPD Markers. pp. 303. In: Abstracts, National Seminar on "Contemporary Approaches to Crop Improvement" University of Agricultural Sciences GKVK campus, Bangaluru, April 22-23, 2011.
- **Singh K H, S C Gautam, J S Chauhan, D K Chauhan and Ritu Shakya** (2011). Characterization of inbred lines of Indian mustard (*Brassica juncea* (L.) Czern & Coss). pp.11. In: Abstracts, National Symposium on Technological Interventions for Sustainable agriculture, GBPUAT Hill Campus, Ranichauri, Uttaranchal, May 3-5, 2011.
- **Singh S P and Y P Singh** (2012). Comparative toxicity of insecticides against natural enemies of mustard aphid, *Lipaphis erysimi* (Kalt.). pp. 196-197. In: Abstracts, National seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate, CCS HAU Hisar, March 27-28, 2012.
- **Singh S P and Y P Singh** (2012). Development of artificial diets for mass rearing of ladybird beetle, *Coccinella septumpunctata* in laboratory. pp. 204-205. In: Abstract, National seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate, CCS HAU Hisar, March 27-28, 2012.

- **Singh V V, A Rajoria, J S Chauhan, M L Meena, P K Rai and Sunil Kumar** (2011). Morpho-seedling characters and their interrelationships in F_5 progenies of Indian mustard (*B. juncea*) grown under rainfed conditions. pp.138. In: Abstracts, International Conference on Issues for Climate Change, Land Use Diversification and Biological Tools for Livelihood Security, SVPUA&T, Meerut, October 8-9, 2011.
- **Singh V V and M Singh** (2012). Genetic management of major abiotic stresses in rapeseed-mustard. pp. 4. In: Abstracts, 1st National *Brassica* Conference on Production Barriers and Technological Options in Oilseed *Brassica*, CCSHAU, Hisar, March 2-3, 2012.
- **Singh V V, M Singh, J S Chauhan, S Kumar, S S Meena and P K Rai** (2011). Population Improvement approaches for moisture stress tolerance in Indian mustard. pp. 21. In: Proceedings, 13th International Rapeseed Congress. Prague, Czech Republic, June 5-9, 2011.
- **Singh V V, P Sharma, P K Rai and J S Chauhan** (2011). Increasing level of tolerance in Indian mustard against *Alternaria* blight through half sib progeny selection. pp. 226. In: Proceedings, 13th International Rapeseed Congress. Prague, Czech Republic, June 5-9, 2011.
- **Singh V V, S S Meena, J S Chauhan, Sunil Kumar and M L Meena** (2011). Half sib progeny selection for increasing oil content in Indian mustard. pp. 106-107. In: Abstracts, National Seminar on Contemporary Approaches to Crop Improvement. UAS, Banglore, April 22-23, 2011.
- **Singh Y P, S P Singh, R Singh and R Nagar** (2012). Population of alate mustard aphid (*Lipaphis erysimi*) on yellow sticky traps in relation to abiotic factors. pp145. In: Abstracts, 1st National *Brassica* Conference on Production Barriers and Technological Options in Oilseed *Brassica*, CCSHAU, Hisar, March 2-3, 2012.
- **Thakur A K, V Verma and B K Singh** (2011). Assessment of genetic fidelity of *in vitro* regenerated plants of *Brassica juncea* var. NRCDR-2 using RAPD markers. pp. 21. In: Proceedings, International Conference on Issues for Climate Change, Land Use Diversification and Biotechnological Tools for Livelihood Security, SVPUA & T, Meerut, UP, October 8-10, 2011.
- **Verma V, A K Thakur and B K Singh** (2011). Effect of genotype, plant growth regulators and $AgNO_3$ on regeneration of *Brassica juncea.* pp. 22. In: Proceedings, International Conference on Issues for Climate change, Land Use Diversification and Biotechnological Tools for Livelihood Security, SVPUA & T, Meerut, UP, October 8-10, 2011.

9

Research Programmes and Projects

Programme/ Project code	Name of Programme / Project	Programme Leader/PI
Programme: 1	**Genetic enhancement for stress tolerance in Indian mustard**	**VV Singh**
DRMR CI-10	Population improvement for higher productivity and oil content in Indian mustard under normal and water stress conditions.	VV Singh
DRMR CI-12	Widening of gene pool in Brassicas through interspecific and intergeneric hybridization	Arun Kumar
DRMR CI-14	Genetic and molecular basis of heat tolerance in Indian mustard	Bhagirath Ram
Programme: 2	**Breeding for yield and quality enhancement in rapeseed-mustard**	**KH Singh**
DRMR CI-5	Development of hybrids in Indian mustard	KH Singh
DRMR CI-11	Molecular mapping of fertility restoring gene for moricandia cytoplasmic male sterility in Indian mustard	KH Singh
DRMR CI-13	Breeding for quality traits in Indian mustard	Priyamedha
DRMR B-6	Analytical procedure for FT-NIR for mass screening and value addition	Manjubala
Programme: 3	**Rapeseed-mustard genetic resource management**	**J Nanjundan**
DRMR CI 6	Management of Rapeseed - Mustard Genetic Resources	J Nanjundan
Programme: 4	**Biotechnological interventions to improve rapeseed-mustard productivity**	**P K Rai**
DRMR BT-1	*In vitro* plant regeneration and genetic transformation of *Brassica juncea* L. Czern. & Coss. with an antifungal defensin gene	A K Thakur
DRMR BT-3	Assessment of cross-transferability and polymorphic potential of genomic STMS markers of Brassica species	B K Singh
Programme: 5	**Enhancing resource use efficiency and abiotic stress management for resilient rapeseed-mustard production system**	**B K Kandpal**
DRMR CP 9	Enhancement of nutrient use efficiency in Indian mustard under limited moisture regime	O P Premi
DRMR CP-10	Standardization of micro-irrigation and ferti-gation for mustard crop under semiarid conditions	S S Rathore
DRMR CP-11	Evaluation and standardization of RCT's for mustard based cropping systems under semi-arid conditions of Rajasthan	Kapila Shekhawat
DRMR CP-13	Characterization and classification of soil-site conditions to delineate rapeseed-mustard production zones	B K Kandpal
DRMR CP-15	Nutrient efficiency under saline, alkali and normal condition of soil and water in mustard crop	N S Bhogal
DRMR CP-6	Use of organics in rapeseed-mustard production	O P Premi
DRMR PHY-3	Morpho-physiological and biochemical basis of drought tolerance in Indian mustard	Maharaj Singh
Programme: 6	**Management of biotic stresses in Indian mustard**	**Y P Singh**
DRMR ENT-2	Biological control of major pests of Brassicas with special reference to mustard aphid	Y P Singh
DRMR ENT-3	Pest-plant interaction of major pests of Brassicas	Y P Singh
DRMR ENT-6	Bio-assay studies of mustard aphid on wild crucifers	S P Singh
DRMR PP-1	Management of Sclerotinia rot in rapeseed-mustard	Pankaj Sharma

Programme/ Project code	Name of Programme / Project	Programme Leader/PI
DRMR-PP 3	Management of Alternaria blight in rapeseed-mustard	P D Meena
DRMR PP-5	Epidemiology and management of white rust	P K Rai
Programme: 7	**Technology assessment and dissemination**	**S K Jha**
DRMR ECT-1	Study the pattern of rapeseed-mustard production problems, indigenous technical knowledge (ITK) & impact assessment of technology transfer programme	SK Jha
DRMR ECT-2	Study the adoption pattern and farmers' perception of technological advances	A K Sharma
DRMR ECT-3	Participatory validation and transfer of DRMR's technology package for Indian mustard in Bharatpur district of Rajasthan	S K Jha
DRMR CA-1	Development of application software for rapeseed-mustard information management	Vinod Kumar
Externally Funded Projects		
DRMR EA- 2	Characterization of rapeseed-mustard varieties for distinctness, uniformity and stability (DUS) testing	K H Singh
DRMR EA- 4	ICAR seed project on seed production in agricultural crops	V V Singh
DRMR EA- 6	Mustard production forecast using remote sensing data at national level (FASAL)	B K Kandpal
DRMR EA- 7	Intellectual property management and transfer/ commercialization of agricultural technology scheme	K H Singh
DRMR EA -8	Integrated agro-met advisory services	B K Kandpal
DRMR NP- 2a	ICAR-NPTC: Development of aphid resistant transgenic Brassica	A K Thakur
DRMR NP- 2b	ICAR-NPTC: Brassica functional genomics for Alternaria blight and drought/ heat tolerance	P K Rai
DRMR NP- 5	Diagnosis and management of leaf spot diseases of field and horticultural crops	P D Meena
Contract Research		
Bio efficacy of HP mustard spray oil against mustard aphid safety to predators/parasites and honey bees		Y P Singh
Studies on the bio-efficacy of "Jumpstart" (*Penicillium bilaii*) on the phosphorous use efficiency in Indian mustard		B K Kandpal
Efficacy of liquid fertilizers on mustard productivity		O P Premi
Performance of Coral 432 (Mustard Hybrid) under different cropping system		S S Rathore

10

IRC, RAC, IMC and QRT Meetings

Institute Research Council Meeting

Directorate of Rapeseed-Mustard Research organized its 18th and 19th Institute Research Council (IRC) meetings on June 13-14, 2011 and August 26-27, 2011, respectively under the Chairmanship of the Director, DRMR. Individual scientist presented progress of the project work. For ensuring focused and result oriented approach in research, it was decided that there will be 7 major programmes encompassing all the institute projects. Dr D P Singh, Chairman, Research Advisory Committee of the Directorate, was the special invitee.

Dr P R Kumar, Ex- Director, NRCRM and Dr D P Singh, Ex-Director Research, G. B. Pant University of Agriculture and Technology were the subject matter experts. In these meetings, progress of project work done during year 2010-11 and proposed technical programme for the year 2011-12 were presented. The chairman, IRC informed that for smooth conduct of research work, outsourcing of the analytical and research activities may be done for which there are constraints at the Directorate and also emphasized to make strict time line for achieving particular goals. Chairman, RAC suggested all the scientists to incorporate the recommendations of RAC in their proposed work. He expressed satisfaction on the overall progress of the Directorate since the previous RAC in March 2011. Both the experts gave valuable suggestions for the improvement of the programme.

The Director reaffirmed all support to the scientists for achieving excellence in their respective area of specialization. Further the Chairman emphasized for better coordination among the scientists for achieving the best output in terms of product, technologies development or publications from the research work.

Research Advisory Committee Meeting

15th meeting of Research Advisory Committee (RAC) of the Directorate was held during January 31- February 1, 2012. Dr D P Singh, Ex-VC, JNKVV, Jabalpur and member Haryana Farmers' Commission, Chairman, Dr S E Pawar, Ex-Scientist, BARC, Mumbai, Dr S N Upadhyay, Prof. & Head (Entomology), RVSKVV, Gwalior, Dr K P Singh, Prof, Mycology & Plant Pathology, BHU, Varanasi, Dr T Mohapatra, Director, CRRI, Cuttack, members attended the meeting. Dr J S Chauhan, Director, DRMR, Bharatpur welcomed Hon'ble Chairman and members of the RAC. In his introductory remarks, Dr D P Singh, Chairman expressed the hope of more productive current crop season of rapeseed-mustard in spite of slight reduction in area in the country. He emphasized the need to develop agro-technological package by combining suitable varieties/ hybrids along with appropriate resource conservation technology to reduce the cost of cultivation and

enhancing water use. Dr T Mohapatra, reminded the scientists on the vast scope for improvement in the productivity of mustard through conventional and biotechnological means. Dr S E Pawar, suggested the need for further improvement in several researchable issues and called for more fruitful cooperation among the stakeholders. Dr K P Singh and Dr S N Upadhyay expressed satisfaction on the progress made since the last RAC. Dr B K Kandpal, Member-Secretary presented Action Taken Report on the recommendations of the 14th RAC held during March 13-14, 2011. 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 2010-11.

The RAC visited research experiments and seed production plots at the DRMR farm, laboratories and museum for in-depth interaction with the scientists in the forenoon of February 1, 2012. In the afternoon, it had an interaction with the farmers of village Unchagaon, Bharatpur and visited front-line-demonstrations in progress with mustard varieties and hybrids. The RAC appreciated the efforts of the Directorate in the implementation of the suggestions made in previous RAC meeting, especially the target oriented productive research and developing strong linkages with all the stakeholders. However, there is need to further update the programmes on the basis of following suggestions given during the deliberations and field visits:

- A status report of rapeseed-mustard quality improvement programme should be prepared and a roadmap for next 5 years must be defined.
- The KVK at Bichpuri, Mathura and Avaagarh in U P and Morena in M P should also be involved in location specific technology validation programmes.
- The reasons for the rejection of several improved varieties by the farmers should be analysed.
- The germplasm development programme should be integrated with breeding programme and a diversity pool should be maintained.
- A core set for rapeseed-mustard germplasm including released varieties should be created. Molecular data should also be added to it. Director, NRCPB, New Delhi could be approached for molecular characterisation of the core set.
- Possibilities for collaboration with farmers/private agencies should be worked out to install apiaries during crop season at the DRMR to generate valuable data in systematic pattern.
- Possibilities of relay cropping of Indian mustard with guar crop in broad raised bed furrow system should be worked out.
- The museum of the Directorate should be well equipped with modern tools of extension and technology dissemination including touch screen display system with audio-visual capabilities.
- Effective measures to control the damage of mustard crop by *Orabanche* should be studied in collaboration with the Directorate of Weed Science Research at Jabalpur

Institute Management Committee

14th meeting of the Institute management Committee of DRMR was held on July 6, 2011 under the Chairmanship of Dr J S Chauhan, Director. It was attended by the official members Dr Govind Singh, Director (Planning), SKRAU, Bikaner, Dr D Kumar, Ex-Project Coordinator (Arid Legumes), CAZRI, Jodhpur, Dr R K Jain, Head, Division of Plant Pathology, IARI, New Delhi, Dr C Chattopadhyay, Head, Plant Protection, IIPR, Kanpur, Sh K S Tanwar, F&AO, DRMR and Sh J L Sharma (Member secretary). The committee discussed 8 different agenda items, research activities, HRD, Extension activities, constitution of Grievance cell, composition of IJSC etc and made suitable recommendations for approval of the Council.

IMC	
Dr J S Chauhan Director, DRMR	Chairman
Joint Director of Agriculture Directorate/ Dept of Agriculture Govt of Rajasthan, Bharatpur	Member
Joint Director of Agriculture (Oilseeds), Dept of Agriculture Govt of Madhya Pradesh, Bhopal	Member
Dr Govind Singh Director, Planning, SKRAU Bikaner	Member
Smt Sushma Singh M M 4/45 Vinaykhand (Non-Official) Gomati Nagar Lucknow	Member
Dr A N Sharma Principal Scientist, Directorate of Soybean Research, Indore	Member
Dr A L Singh Principal Scientist, Directorate of Groundnut Research, Junagadh	Member
Dr B D Sharma Principal Scientist, Soil Chemistry/ fertility, CIAH, Bikaner	Member
Dr Arjun Lal Head, Germplasm Exchange NBPGR, New Delhi	Member
Dr B B Singh ADG (O&P), ICAR, Krishi Bhawan New Delhi	Member
Sh K S Tanwar Finance & Account Officer DRMR, Bharatpur	Member
Sh J L Sharma Assistant Adm Officer DRMR, Bharatpur	Member Secretary

RAC	
Dr D P Singh Ex-Vice Chancellor JNKVV, Jabalpur & Member Haryana Farmers Commission Chandigarh	Chairman
Dr S E Pawar Ex-Sr. Scientist, BARC, Mumbai	Member
Dr M P Sahoo Dean, College of Agriculture 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 Director, CRRI, Cuttack, Odisha	Member
Smt Sushma Singh M M 4/45 Vinaykhand (Non-Official) Gomati Nagar Lucknow	Member
Dr B B Singh ADG (OP), ICAR, New Delhi	Member
Dr J S Chauhan Director, DRMR, Bharatpur	Member
Dr B K Kandpal Principal Scientist (Agronomy) DRMR, Bharatpur	Member Secretary

11

Participation in Conferences, Meetings, Seminars, Symposia and Workshops

Events	Venue	Period	Participants
	International		
13th International Rapeseed Congress	Prague, Czech Republic	June 5-9, 2011	J S Chauhan V V Singh
1st BIT's Annual World Congress of Microbes 2011	Beijing, China	July 30-August 1, 2011	Pankaj Sharma
	National		
Review Meeting of Externally Funded Projects	ICAR, New Delhi	April 19, 2011	J S Chauhan M Singh
National Seminar on Contemporary Approaches to Crop Improvement	UAS, Bangalore	April 22-23, 2011	J S Chauhan Bhagirathram Priyamedha
National Symposium on Technological Interventions for Sustainable Agriculture	GBPUAT Hill Campus Ranichauri, Uttaranchal	May 3-5, 2011	K H Singh
Brain Storming Meeting on Enhancement of Productivity of Rapeseed-Mustard in Zone II &III of India	GBPUA &T Pantnagar	May 15-16, 2011	J S Chauhan V V Singh K H Singh M Singh Manjubal B K Singh
20th Hindi Sammelan and Karyashala	Mysore, Karnataka	May 24-26, 2011	Pankaj Sharma
Germplasm Advisory Committee Meeting on Oilseeds	NBPGR, New Delhi	June 3, 2011	J Nanjundan
Interactive Meeting Towards More Effective Role of PDs/PCs	CIAE, Bhopal	June 16, 2011	J S Chauhan Y P Singh K H Singh
Directors' Conference and ICAR Foundation Day	NAAS, New Delhi	July 15-16, 2011	J S Chauhan
Workshop on National Network Project on Management and Use of PGR	NBPGR, New Delhi	July 28-30, 2011	J S Chauhan J Nanjundan
18th Group meeting of All India Coordinated Research Project on Rapeseed-Mustard	Khanpara Campus, AAU, Guwahati	August 5-7, 2011	J S Chauhan Y P Singh B K Kandpal P K Rai V V Singh S K Jha K H Singh O P Premi P D Meena Maharaj Singh A K Sharma Arun Kumar

Events	Venue	Period	Participants
Seminar on Protection of Plant Varieties and Agricultural Biotechnology Inventions	Hotel Le Meridian, New Delhi	August 17-18, 2011	K H Singh
Agricultural Entomology for 21st Century: The Way Forward	NBAII, Bangalore	August 25-26, 2011	Y P Singh S P Singh
National Symposium on Advances in Biotechnological Research In Agri-Horticulture Crops For Sustaining Productivity, Quality Improvement and Food Security	SVPUA&T, Meerut	September 14-16, 2011	S S Rathore
Review meeting of ICAR Seed Project	New Delhi	September 19-20, 2011	J S Chauhan V V Singh
Interactive meeting of VCs, Directors/ Project Directors/ Project Coordinators to discuss issues of AICRPs	NASC, New Delhi	September 26, 2011	J S Chauhan K H Singh
International Conference on Issues for Change, Land use Diversification and Biotechnological Tools for Livelihood Security	SVPUA&T, Meerut	October 8-10, 2011	J S Chauhan P K Rai V V Singh A K Thakur
Consultation Meet on Genetically Modified Foods	NRCPB, New Delhi	October 14, 2011	A K Thakur
Annual Day Celebration and DUS Review Meeting of PPV& FRA	NBPGR, New Delhi	November 11, 2011	K H Singh
Meeting to Discuss the First Draft of National Network Project on Management and Use of PGR	NBPGR, New Delhi	November 17, 2011	V V Singh J Nanjundan
6th National Extension Education Congress-2011 on Emerging Models of Technology Application for Agri-rural Development	ICAR Research Complex for Goa, Goa	November 17-19, 2011	Vinod Kumar A K Sharma
XII plan EFC meeting	NASC, New Delhi	November 22, 2011	P K Rai K S Tanwar J L Sharma
Stakeholder Consultation on Regulation of Transgenic Crops having Stacked Events/Genes'	Department of Biotechnology, Ministry of Science & Technology, New Delhi	November 23, 2011	A K Thakur
Scientists Meet to Assess the Impact of International Training Organised by NAIP	NASC, New Delhi	November 28-30, 2011	K H Singh
Development of Protocol for GM Crops for AICRP Testing	NASC, New Delhi	November 29, 2011	J S Chauhan A K Thakur
Training Course on Cropping System Models	ICRISAT, Hyderabad	December 5-9, 2011	S S Rathore
National Seminar on Harnessing Seed Spices for Better Socio-economic Well being	NRCSS, Ajmer	January 6, 2012	J S Chauhan M Singh S S Rathore

Events	Venue	Period	Participants
3rd Global Conference of Indian Society of Mycology and Plant Pathology	MPUAT, Udaipur	January 10-13, 2012	Pankaj Sharma P D Meena A K Sharma
Interactive Meeting to Discuss Programme for Development of White Rust Resistant Varieties	ICAR, New Delhi	January 13, 2012	J S Chauhan V V Singh
Oilseed Sectional Committee Meeting of Food and Agriculture Division (FAD)	Bureau of Indian Standards (BIS), New Delhi	Februsry 8, 2012	J S Chauhan
Orientation Training Programme of Nodal Officers, RFD	ICAR, New Delhi	February 21, 2012	V V Singh Vinod Kumar
1st National Brassica Conference	CCS HAU, Hisar	March 2-3, 2012	Y P Singh B K Kandpal P K Rai V V Singh O P Premi P D Meena S P Singh Ashok Sharma Vinod Kumar
TSP Mini Workshop	Krishi Bhawan, New Delhi, DRMR, Bharatpur	March 19-20, 2012	J S Chauhan Y P Singh B K Kandpal P K Rai V V Singh S K Jha K H Singh Maharaj Singh
National Seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate	CCS HAU Hisar	March, 27-28, 2012	S P Singh
Annual breeder Seed review Meeting	NASC, New Delhi	March 29, 2012	K H Singh B Ram

12

Workshop, Seminar, Winter School and Farmers' Days Organized

Awareness Programme on Protection of Plant Varieties and Farmers Rights Act (PPV & FRA) Organized

DRMR organized one-day training–cum-awareness programme on PPV & FRA on March 24, 2012 for the benefit of farmers, researchers, development personnel and other stakeholders. On the occasion, Director, DRMR, Dr J S Chauhan said that the farmers should be aware of their rights, provided under PPV & FR Act, an effective system for protection of plant varieties and rights of both farmers as well as plant breeders. It also helps in recognizing contributions of the farmers/ community in conserving, improving and making available plant genetic resources for development of new plant varieties. On this occasion, Dr K H Singh, Course Director, Dr S S Rathore, Dr J Nanjundan, Mrs. Priyamedha- Scientists of the Directorate shared their knowledge with the farmers. More than 100 farmers, research and extension personnel participated in the programme.

Brain Storming and Review Meetings

Directorate of Rapeseed-Mustard Research, Bharatpur organized brain storming meeting on enhancement of productivity of rapeseed- mustard in zone II and III of India on May 17, 2011 at GBPUA&T, Pantnagar. Dr J S Chauhan, Director DRMR presented an overview of rapeseed- mustard crops in the country and future projected demand for the next 10 years. Dr B S Bisht, Hon'ble Vice Chancellor, GBPUAT, Pantnagar in his address presented significant achievements of the University in rapeseed-mustard research and showed concern about widening gap between demand and supply of oilseeds in the country resulting in to huge import of edible oils. Chief Guest Dr B B Singh, ADG (OP), ICAR, New Delhi called for genetic enhancement of yield in rapeseed-mustard utilizing wild and related species for introgression of resistance to biotic and abiotic stresses. He suggested changing the plant architecture of Indian mustard to improve harvest index.

Dr D P Singh, former Director Research, GBPUA&T, Pantnagar chaired the first technical session and highlighted the importance of oilseeds and the need for enhancing productivity. Dr K H Singh, Senior Scientist, DRMR, Bharatpur presented the constraints and issues to enhance rapeseed mustard productivity in zone II comprising parts of Rajasthan, Haryana, Punjab, Jammu & Kashmir and Delhi. Prof Ram Bhajan, GBPUA&T, Pantnagr highlighted issues and strategies for zone III comprising Uttar Pradesh, Uttaranchal and Madhya Pradesh. Climate change was perceived as the major issue in both the zones in the years to come. Chairman suggested wide hybridization to solve problems like frost, drought, diseases and insect pests. Dr S S Banga, National Professor, ICAR, PAU Ludhiana made a presentation on Breaking yield barriers in rapeseed- mustard and Dr D K Yadava talked about available technology and strategies to harness their potential. Prof Banga suggested three approaches *viz.*, adaptation breeding, re-synthesis of Brassica digenome through derived amphiploidy and alien introgression to enhance genetic diversity. Dr B B Singh, ADG (OP) suggested to work in project mode on different aspects and suggested that initially data on plant type should be generated on released varieties.

Following areas were identified for preparation of projects in network mode:

- Development of hybrids and enhancing level of heterosis in Indian mustard
- Utilization of wild and related crucifers for photo insensitivity, enhancing tolerance against biotic and abiotic stresses and broadening the genetic base of Indian mustard,
- Marker assisted selection for quality improvement

On May 18, 2011 status of plant physiology and biochemistry research under AICRP-RM during 1980 to 2010 was discussed. The following issues emerged for future research:

- Biochemical and molecular characterization of identified strains showing tolerance to salinity & /or high temperature during seedling/terminal stage.
- Germplasm should also be evaluated for tolerance to drought stress in addition to high temperature at terminal stage.
- Associated mapping for various stresses be carried out in the Biochemistry research under AICRP RM programme.
- Only those centres having basic infra structure should be strengthened further for biotechnological/ biochemical work during 12th plan
- The plant physiology research work should confine on different aspects of abiotic stresses to elucidate mechanism /basis of tolerance while biochemists should adequately address various aspects of biotic stresses tolerance.

Agronomists, Entomologists and Plant Pathologists, working at different centers under AICRP-RM met at DRMR during June 27-28, 2011 to discuss pertinent issues of regional and national importance addressing agronomical and plant protection perspectives of the coordinated programme. Principal Investigators of Agronomy, Plant Pathology and Entomology highlighted the progress made during the last 25 years in respective fields. The agronomists discussed the issues and strategies for each of the zone separately and recommended that the package of practices of only those genotypes should be generated which clears the stringent norm of AVT-II. The centers should take lead for the development of technologies for managing *Orobanche* root parasite, integrated weed management strategies for broad leaf and grassy weeds, intercropping, fertilizer use efficiency, abiotic stress management and resource conservation technologies. Crop protection scientists suggested dynamics of emerging pests and diseases under changing climate, epidemiological studies and development of forecasting model for major pests and diseases, bio-intensive integrated pests/ diseases management modules, standardization of host differential for major pathogens and techniques for long term maintenance of isolates, to be the areas for consideration during 12th five year plan.

Mini Workshop Under Tribal Sub Plan

Directorate of Rapeseed Mustard Research, Bharatpur organized a two-day Mini Workshop on **'Augmenting Rapeseed-Mustard Production for Sustainable Livelihood Security of Tribal Farmers'** under Tribal Sub-Plan at ICAR, New Delhi and DRMR, Bharatpur during March 19-20, 2012. Dr S N Puri, Hon'ble Vice Chancellor, Central Agricultural University, Imphal, Manipur chaired the inaugural session of the Workshop at ICAR, New Delhi on March 19, 2012. In all, 30 participants from three collaborating centres, AAU, Jorhat, CAU, Imphal and BAU, Ranchi and DRMR, Bharatpur attended the workshop at ICAR, New Delhi. Progress report was presented and future programme was also discussed. The participants later visited Division of Genetics, IARI, New Delhi and also the rapeseed-mustard experiments including seed production programme. On March 20, 2012, the participants held meeting at DRMR, Bharatpur and finalized the action-plan for the year 2012-13. DRMR has been implementing TSP project through 4 collaborative centres (AAU, Jorhat, CAU, Imphal and BAU, Ranchi and MPUA&T, Udaipur) with an outlay of over Rs. 93.0 lakhs.

Kisan Diwas

DRMR organized 7 *Kisan Diwas* during 2011-12 in different villages of Bharatpur and Agra districts in which 510 farmers and farm women were educated for rapeseed-mustard and other *rabi* crops production technologies.

13

Distinguished Visitors

Name	Designation & Address	Date
Dr R K Dixit	Ex-Professor & Head (Plant Breeding & Genetics) CSAUA&T, Kanpur	May 23, 2011
Dr Ajit Tyagi	DG, IMD, New Delhi	August 1, 2011
Dr P R Kumar	Ex- Director, NRCRM (DRMR), Bharatpur	August 26-27, 2011
Dr D P Singh	Ex- Director Research, GBPUA&T, Pantnagar	August 26-27, 2011
Dr D P Singh	Chairman, RAC and Member, Farmers' Commission Haryana	August 26-27, 2011
Dr N P S Sirohi	ADG (Engineering), ICAR, New Delhi	October 3, 2011
Dr Chakresh Kumar	Associate Director Research, ARS (SKRAU), Navgaon	October 3, 2011
Dr G N Mishra Dr P L Saroj	Principal Scientist(Commercial Crops), ICAR Krishi Bhavan, New DelhiPrincipal Scientist (Horticulture), Krishi Anushandhan Bhawan-2 New Delhi	October 3, 2011 and November 26, 2011
Dr S S Tomar	Senior Agronomist, ZARS, Morena	October 3, 2011 and November 26, 2011
Prof Deepak Pental	Director, CGMCP, Delhi University, South Campus	October 20, 2011
Dr S S Banga	National Professor, Punjab Agricultural University Ludhiana	October 20, 2011
Prof M M Anwar	Director, NRCSS, Tabiji, Ajmer	October 20, 2011
Dr J S Yadava	Ex-PC & In-charge Director, NRCRM, Bharatpur	October 20, 2011
Dr J S Sandhu	ADG (Seeds), ICAR, Krishi Bhavan, New Delhi	October 20, 2011
Dr T R Chauhan	Principal, Raja Balwant Singh (RBS) College, Agra	November 3, 2011
Dr R K Singh	Director, Nand Education Foundation for Rural Development, 1, Devlok colony, Church Road, Lucknow	November 11, 2012
Dr Brij Mohan	Principal Scientist (Agril. Extension), CIRG, Makdoom	November 11, 2011
Dr S K Dubey	Head, Central Soil Water Conservation Research & training Institute, Chhalesar, Agra	November 26, 2011
Sh N S Rathore	Ex-Director, Rajasthan State Seed Certification Agency, Rajasthan	December 07, 2011
Dr B Gangawar	Director, PDFSR, Modipuram	January 16, 2012
Dr A R G Ranganatha	Project Coordinator (Sesame & Niger) & Act. Director DWSR, Jabalpur	January 16, 2012
Dr D P Singh	Chairman, RAC and Member, Farmers' Commission Haryana	January 31-February 3, 2012
Dr T Mohapatra	Director, CRRI, Cuttack and Member, RAC	January 31, 2012

Name	Designation & Address	Date
Dr S E Pawar	Ex-Scientist, BARC and Member, RAC	January 31-February 1, 2012
Dr K P Singh	Professor, Plant Pathology and Mycology, BHU Varanasi and Member, RAC	January 31-February 1, 2012
Dr S N Upadhyay	Prof. & Head (Entomology), RVSKVV, Gwalior and Member, RAC	January 31-February 1, 2012
Padma Bhushan Dr. R B Singh	President, National Academy of Agricultural Sciences New Delhi	February 3, 2012
Dr B B Singh	ADG (Oilseeds & Pulses), ICAR, Krishi Bhavan New Delhi	February 3, 2012
Dr J S Heslop Harrisen Dr (Mrs) Trude Hcswarzache	Professors, Department of Biology, University of Leicester, UK	February 10, 2012
Dr G Kalloo	Vice-Chancellor, JNKVV, Jabalpur	February 26, 2012
Dr M P Sahoo	Dean (Agriculture), SKRAU, Bikaner	February 26, 2012
Dr H C Sharma	Ex-Director Research, CCS HAU, Hisar	February 26, 2012
Dr Rajendra Prasad	Head, Designing of Experiment, IASRI, New Delhi	February 26, 2012
Dr B K Garg	Principal Scientist (Farm Machinery and Power) CIAE, Bhopal	February 26, 2012
Prof S K Datta	Deputy Director General (CS), ICAR, New Delhi	March 18, 2012

14

Personnel

Director's Office

J S Chauhan	Director
Mrs Veena Sharma	P A
Govind Prasad[c]	Driver (T 4)
Lala Ram	SSG III

Scientific Staff

Crop Improvement

V V Singh[1*]	Pri Scientist (PBG) & I/c
K H Singh	Sr Scientist (PBG)
S S Meena[2*]	Sr Scientist (PBG)
Arun Kumar	Sr Scientist (PBG)
Bhagirath Ram	Sr Scientist (PBG)
J Nanjundan	Scientist (PBG)
Priya Medha	Scientist (PBG)
M L Meena	Technical Officer (T 7/8)
Karnal Singh[c]	Technical Officer (T 6)

Crop Production

B K Kandpal	Pri Scientist (Agronomy) & I/c
N S Bhogal	Sr Scientist (Soil Science)
O P Premi	Sr Scientist (Agronomy)
S S Rathore	Sr Scientist (Agronomy)
Kapila Shekhawat	Scientist Sr Scale (Agronomy)
P Kumararaja[a]	Scientist (Soil Science)
R N Singh[c]	Technical Officer (T 7/8)
Ram Narayan	Technical Officer (T 6)

Crop Protection

Y P Singh	Pri Scientist (Ag Ent) & I/c
P K Rai	Pri Scientist (Pl Pathology)
S P Singh	Sr Scientist (Ag Ent)
P D Meena	Sr Scientist (Pl Pathology)
Pankaj Sharma	Sr Scientist (Pl Pathology)
U S Rana	Technical Officer (T 7/8)
Ram Singh	Technical Assistant (T 3)

Plant Physiology& Biochemistry

Maharaj Singh	Sr Scientist (Pl Physiology) & I/c
Manjubala	Sr Scientist (Biochemistry)
R C Meena	Technical Assistant (T 3)

Biotechnology

P K Rai	Pri Scientist (Pl Pathology) & I/c
Ajay Kumar Thakur	Scientist (Pl Biotechnology)
Binay Kumar Singh	Scientist (Pl Biotechnology)
N K Gupta***	Sr Scientist (Pl Biotechnology)

Technology Assessment & Dissemination

S K Jha[b]	Sr Scientist (Ag Ext) & I/c
A K Sharma	Sr Scientist (Ag Ext)
Vinod Kumar	Sr Scientist (Comp Appl Ag)
Lijo Thomas[a]	Scientist (Ag Eco)
Rakesh Goyal	Technical Assistant (T 3)

AICRP (RM) Unit

K H Singh	Incharge
R C Sachan	Technical Officer (T 7/8)

Farm Section

S S Rathore	Incharge
H P Meena	Tech. Officer (T 6)
Radha Charan	Supporting Staff (SSG-II)

Research Priority Setting, Monitoring and Evaluation (PME)

V V Singh	Incharge
Sanjay Sharma	Tech. Officer (T 5)

Estate Management Unit

P K Rai	Incharge
Bachhu Singh[c]	Technical Assistant (T 3)
Kamal Singh	Supporting Staff (SSG-II)

Administrative Unit

J.L. Sharma	Assistant Administrative Officer
Kanta Prasad[3*]	Assistant
U C Sharma	Assistant
Mukesh Kumar	Assistant
Pankaj Pathak	Junior Clerk
G L Meena[c]	Senior Clerk
Sheetal Sharma	Supporting Staff (SSG-I)

Audit and Accounts Unit

Karan Singh Tanwar	Finance and Accounts Officer
Ram Sahay Meena	Assistant
Rajiv Kulshreshtha	Senior Clerk
Tara Singh	Supporting Staff (SSG-II)

[1*]Selected Principal Scientist, DRMR, Bharatpur
[2*]Selected Principal Scientist, IGFRI Regional Station, Avikanagar
[3*]Selected AF & AO, Zonal Project Directorate, Kanpur
***Joined during the year and subsequently resigned

[a] On study leave
[b] Transferred out during the year
[c] Promoted during the year

15 Panorama

Institute Bio-Safety Committee (IBSC) Meetings

DRMR organized 4th IBSC meeting under the Chairmanship of Director on April 18, 2011 which was attended by members, Dr S J Kolte, Ex- Professor, Plant Pathology, GBPUA&T, Pantnagar, Dr. Anil Kumar, Professor & Head, Deptt of Mol. Biology & Genetic Enigineering, GBPUA&T, Pantnagar, Dr S R Bhat, Principal Scientist, NRCPB, New Delhi, Dr Harish Sharma, Medical Officer, RBM Hospital, Bharatpur, Dr V V Singh, Principal Scientist, DRMR, Bharatpur and Dr Ajay Kumar Thakur, Scientist, DRMR, Bharatpur and member secretary. The members discussed the BRL-1 trial of transgenic mustard hybrid developed by DHARA/University of Delhi and conducted at ARSs Navgaon, Sriganganagar and KVK, Kumher under the overall coordination of Director, DRMR. The IBSC suggested constituting Coordination Committees at district and state level for carrying out any confined field trials for transgenic crops. Considering the facilities required for the proposed Basic Science Complex at the Directorate, the committee suggested to consult BARC before developing radio labeling facilities.

In the 5th IBSC meeting attended by Dr S J Kolte, Ex- Professor, Plant Pathology, GBPUA&T, Pantnagar, Dr. Harish Sharma, Medical Officer, RBM Hospital, Bharatpur, Dr V V Singh, Principal Scientist, DRMR, Bharatpur and Dr Ajay Kumar Thakur, Scientist, DRMR, Bharatpur and member secretary under the chairmanship of Dr J S Chauhan, Director on October 10, 2011 it was approved to carry out the BRL 1 trial for transgenic mustard hybrid DMH 11 during 2011-12 following the DBT guidelines and standard operating procedures. The committee monitored the bio-safety practices at the directorate and expressed satisfaction.

Anti-Terrorism Day

DRMR observed Anti-terrorism day on May 21, 2011. Dr J S Chauhan, Director DRMR, Bharatpur administered to the staff members oath of having abiding faith in non-violence, tolerance and to oppose all forms of terrorism and violence. He also urged to uphold and promote peace, social harmony and understanding among all fellow human beings and fight the forces of disruption threatening human lives and values. On this occasion, guest speaker Dr Daaudayal Gupta, Ex-Deputy Director (Education) said that suitable strategy should be devised to fight against the terrorism and stern punishment be given to terrorists. Dr Firoz Akhator, lecturer of Sociology, R D Girls College, Bharatpur opined that terrorist has no caste, creed and religion. The causes of terrorism be addressed suitably by the society as well as through the Govt policies. He said that terrorism may be countered by adopting the principles of truth and non-violence.

International Rapeseed Congress

The 13th International Rapeseed Congress (IRC) was organized by Groupe Consultatif International de Recherche Sur le Colza (GCIRC) at Prague Congress Centre, Prague, Czech Republic during June 5-9, 2011. The IRC is held every 4th year to review international trends in research, marketing and government policies. The IRC also aimed at identifying thrust areas; chalk out future strategies and action plan. Dr W Friedt of Germany chaired International Scientific Committee. Dr Andre Pouzet, General Secretary of GCIRC opened the congress on June 06, 2011. There were 831 participants from almost around the globe. 19 researchers from India participated in the Congress. Dr Gerhard F W Rakow, a leading plant breeder from Germany and Dr Emmer Sorenson of Denmark were awarded the prestigious GCIRC Eminent Scientist Award.

The Congress was spread over three plenary sessions comprising 11 lecturers on genetics and breeding, Brassica genomics, disease control in oilseed rape, integrated management of diseases, technology innovation for 3rd generation biodiesel production, etc. There were 09 concurrent sessions having more than 150 oral presentations covering wide-ranging areas of research, *viz.*, genetics and breeding, biotechnology, agronomy, plant protection, quality and nutrition, industrial materials and biodiesel. Seven workshops focusing on special topics like club root control, functional components of rapeseed oil, seed meal quality, SNP, genomic selection in rapeseed breeding, weed control and herbicide tolerance were also held during the congress. Presentation of over 500 poster papers covering a spectrum of diverse research areas was another significant highlight of the congress. Nine research papers were presented orally from India in different sessions. From ICAR Dr Arvind Kumar, DDG (Education), Dr J S Chauhan, Director and Dr V V Singh, Principal Scientist (Plant Breeding) from DRMR, Bharatpur participated in the Congress. Further, Dr Dhiraj Singh and Dr A S Rathi from CCSHAU, Hisar, Dr P B Kirti, University of Hyderabad, Drs P S Siddhu, Sharavan Kumar, Chhaya Atri, Pushap Sharma, Gurpreet Kaur from PAU, Ludhiana were other participants besides scientists and official from private organizations and seed companies from India.

The major thrust areas identified were use of exotic germplasm for new trait discovery, molecular dissection of the hybrid vigour, two line system for hybrid development, new Nsa CMS system for increasing heterosis, association genetics and genomic selection for disease resistance, QTL's for fibre content, use of unreduced gametes for inter sub-genomic hybrids, genome sequencing, development and construction of high density linkage maps, association mapping analysis for quality traits, dissection of complex trait loci, tilling for detection of mutations, use of SNP arrays, crop modeling and bio processing technology. Need was also felt to refine standards for bio fuels and concern was expressed for the lack of adequate papers dealing with trading, policies and economics. In the General body meeting of GCIRC, 14th IRC was announced to be held at Saskatoon, Canada during July 5-8, 2015.

Independence Day Celebration

DRMR celebrated the 65th Independence Day on August 15, 2011 with great fervour and gaiety. Dr J S Chauhan, Director hoisted the national flag on this historic day and reminded the staff about sacrifices of thousands of known and unknown martyrs in the long battle to achieve independence.

हिन्दी चेतना मास और कार्यशालाऐं

सरसों अनुसंधान निदेशालय ने सितम्बर 14 से अक्टूबर 13, 2011 तक हिन्दी चेतना मास मनाया। इसमें महारानी श्रीजया महाविद्यालय, भरतपुर के पूर्व प्रधानाचार्य डॉ. उमेश चन्द्र चतुर्वेदी ने अपने भाषण में ''भारतीय संविधान में राजभाषा हिन्दी के महत्व और स्थान पर प्रकाश डाला। रामेश्वरी देवी कन्या महाविद्यालय, भरतपुर के प्रवक्ता डॉ0 लाला शंकर गयावाल ने हिन्दी के बहुआयामी पहलुओं पर अपने विचार व्यक्त किये। 13 अक्टूबर को समापन समारोह के अवसर पर श्री मोहन वल्लभ शर्मा, सभापति हिन्दी साहित्य समिति, भरतपुर एवं श्री रामबाबू शुक्ला पूर्व सभापति हिन्दी साहित्य समिति, भरतपुर ने कृषि विज्ञान में हिन्दी की प्रमुख भूमिका के बारे में अवगत कराया। श्री रामबाबू शुक्ला ने इस अवसर पर सरसों अनुसंधान निदेशालय पर रचित अपनी काव्य रचना का सस्वर पाठ किया। इस अवसर पर विभिन्न प्रतियोगिताओं जैसे श्रुतिलेख, सुलेख, पत्र–लेखन, निबन्ध लेखन, शोध पत्र का हिन्दी अनुवाद आदि प्रतियोगिताओं में भाग लेने वाले प्रतिभागियों को पुरस्कृत किया गया। सरसों अनुसंधान निदेशालय के दो कर्मचारियों को उनके कार्यालयीन कार्यों में हिन्दी के अधिकतम प्रयोग के लिए भी पुरस्कृत किया गया। सरसों अनुसंधान निदेशालय के निदेशक डॉ0 जितेन्द्र सिंह चौहान ने सभी जीतने वाले प्रतिभागियों को बधाई दी और कहा कि निदेशालय में हिन्दी के प्रयोग पर और अधिक जोर देने की आवश्यकता है साथ में उन्होनें 2010–11 में किये गये कार्यों की सराहना भी की और कहा कि पिछले वर्ष के कार्य को परिषद द्वारा भी सराहा गया है।

सरसों अनुसंधान निदेशालय भरतपुर के राजभाषा प्रकोष्ठ द्वारा 3 एक दिवसीय हिन्दी कार्यशालाओं का आयोजन किया गया। निदेशालय के निदेशक डॉ. जितेन्द्र सिंह चौहान ने इनका उद्घाटन करते हुये सभी वैज्ञानिकों एवं कर्मचारियों को हिन्दी में अधिक से अधिक कार्य करने के लिए प्रोत्साहित किया। डॉ. इन्दुप्रकाश सिंह, व्याख्याता हिन्दी राजकीय महाविधालय धौलपुर ने कहा कि भाषा अभिव्यक्ति का महत्वपूर्ण माध्यम है तथा हिंदी भाषा इसमें प्रमुख भूमिका निभा रही है। श्री आलोक अहलुवालिया, वरिष्ठ प्रबन्धक, पंजाब नेशनल बैंक, भरतपुर ने अपने व्याख्यान 'नगर राजभाषा कार्यान्वयन समिति' की भूमिका और गतिविधियों पर प्रकाश डाला।

Foundation Day Celebrated

DRMR celebrated its 18th foundation day on October 20, 2011. The function started with the **'Cultural Evening'** on October 19, 2011. Prof Deepak Pental, Director, CGMCP, South Campus, Delhi University, Chief guest and other dignatries graced the beautiful occassion.

On October 20, 2011, Dr Pental hoisted the national flag at the Directorate and function started with the invocation of ICAR song. A film on the 18 years journey of DRMR was also screened. Dr J S Chauhan, Director, DRMR, presented the highlights of the progress made by DRMR during the last 18 years. Dr. J S Sandhu, ADG (Seeds) ICAR, New Delhi, Special guest, in his address, emphasized the need to increase the production of rapeseed-mustard crop in present situation of climate change and degraded resources, Dr. M.M. Anwar, Director, NRCSS, Ajmer stressed the need to provide good quality seeds to the farmers. Dr S S Banga, National Professor, Dr J S Yadava, Ex Project Coordinator, AICRP(RM), Dr Amar, Singh, Incharge, KVK, Kumher, Dr. Virupakshappa, Senior Mustard Breeder, Advanta Ltd India and Sh Harvir Singh, a progreesive farmer also adressed the participants. The dignatories released 3 DRMR's publications namely " Sidhartha- Sarson Sandesh(2nd issue), "Sarson se adhik utapadan ke liye unnatsheel krishi vidhiyan" and " Sarson Anusandhan Nidheshalaya: Ek drishiti mein". Prof. Deepak Pental, in his Foundation Day Lecture, presented an overview of Rapeseed-mustard Research in the world *vis-a-vis* India highlighting achievements of Delhi University, South Campus, during the last 20 years, such as transgenic hybrid and high oleic lines of mustard, marker assisted selection for fatty acid profile and glucosinolates. He also priortised the agenda for the next 20 years with a clear cut road map. He was of the opinion that development of mustard hybrid having resistance to major prevelant diseases, high oil content and canola quality needs emphasis. Besides, Chief guest also gave away prizes to the best performing personnel in scientific, administrative, technical and supporting staff categories. Further, Institute Purchase Committee, Raj Bhasha Committee, Farm Unit were also presented with appreciation letters for excellent work.

Vigilance Awarreness Week

Vigilance awarreness week was observed at the Directorate during October 31 to November 6, 2011 with the focus "Generation of Awareness and Publicity against Corruption". The observance of week commenced with pledge administered to the officials and staff members on October 31, 2011. On November 6, 2011 in the concluding session the DRMR staff reiterated the resolve for honesty, transperancy in the official work and continue efforts to keep the Institute corruption free.

Communal Harmoney Campaign Week

DRMR observed Communal Harmony Campaign and the Fund Raising Week during November 19 -25, 2011 and the Flag Day on November 25, 2011. Sh. Anoop K R, Director Keoladeo National Park, Bharatpur inaugrated the programme on November 19, 2011 and called for communal harmony to foster national integration keeping aside creed, caste, ethnicity and region which is vital for the development of the country. Such awareness should be inculcated among the children through primary education to strengthen the foundation. Natonal Foundation for Communal Harmony, an autonomous organization with the Ministry of Home Affairs, Govt. Of India, coordinated this campaign.

Annual Sports

Dr J S Chauhan, Director inaugurated Annual Sports Meet during January 18-22, 2012 at the Directorate. The staff and their family members participated in various games. A twelve members sports team headed by Chief-de-mission Dr. Maharaj Singh participated in the Zonal Sports tournament for western zone held at CAZRI, Jodhpur from Feb., 13-17, 2012. The Vollyball (Shooting) team reached in the semi final of the

tournament first time since the establishment of DRMR/ NRCRM.

Republic Day Celebration

DRMR celebrated 63rd Republic day on January 26, 2012 with great fervour and joy. Dr J S Chauhan, Director hoisted the national flag on this occasion. On this auspicious and historic day, he extended good wishes to the staff for their happiness, prosperity and success. He also gave away prizes to the winners of Annual Sports Meet.

National Science Day

Under the initiative of *Rashtriya Vigyan Evam Prodoyogiki Sanchar Parishad*, *National Council for Science & Technology Communication,* DRMR observed National Science Day on 28th February 2012 to mark the novel discovery of ***Raman Effect*** by the great Indian Physicist Sir C V Raman on 28th February, 1928. On the occasion, Dr. J S Chauhan, Director, DRMR said that National Science Day is a great day for Indian Science and scientific community. The day offers an opportunity to bring issues of science on to the centre stage. The basic objective of celebrating National Science Day is to spread the message of importance of science and its application among the people.

Dr L L Sharma, Vice-Principal, R D Girls' College, Bharatpur delivered a lecture on "*Science- A True Service to the Mankind:* The Passage Through Years & Challenges Ahead". He said that genetic Improvement in crops especially genetically modified crops, gene therapy, cloning, artificial organs and their transplantation, gene banks, alternative sources of energy, etc. will be the main tools for human welfare in current century.

Samaj Sadan

Dr P K Rai was unanimously elected as General Secretary of Samaj Sadan for the year 2011-13. Samaj Sadan organized *Deepawali Sneh Milan* on November 2, 2011, *Nav-Varsh Sneh* Milan on January 2, 2012 and *Holi* Milan on March 3, 2012. The entire DRMR family participated in these programmes. Children performed graceful cultural programmes on these occasions. Director, DRMR and President Samaj Sadan addressed the members and distributed prizes to the participants of cultural programmes.

Foundation Stone of Basic Science Complex Laid

Prof S K Datta, DDG (Crop Science), ICAR, New Delhi laid foundation stone of Basic Science Complex at DRMR, Bharatpur on 18th March 2012. The proposed basic science complex will have marker assisted breeding and transgenic laboratories besides physiology and bio chemistry laboratory. It will also have a committee hall and room for accommodating 5 scientists. The CPWD, Jaipur is constructing this building with the total outlay of Rs. 115 lakh.

The building will be constructed in 6 months, informed Sh N K Jain, Executive Engineer, CPWD, Jaipur. Besides, DRMR staff, collaborative scientists of AICRPRM centres at Kanpur, Jobner, Navgaon, Morena, KVK & Agriculture Research Sub Station, Kumher of SKRAU, Bikaner, officials of agriculture department, Govt. of Rajasthan and progressive farmers were present on the occasion.

Prof S K Datta, after laying the foundation stone also addressed the gathering, highlighting the perspective for future rapeseed-mustard research

stressing biotechnological approaches and development of transgenic plants especially' for resistant/ tolerance to aphid insect and Alternaria blight disease as the need of the hour for sustainable rapeseed-mustard production. He also called for developing definite road map for the future research and make all out efforts for enhancing the productivity of this important oilseed crop.

Dr J S Chauhan, Director, DRMR outlined the 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 up gradation as Directorate in 2009 by ICAR. He thanked all the guests and staff for attending the important event in the annals of DRMR.

ICAR Sanctioned KVK

ICAR sanctioned a KVK to DRMR, Bharatpur vide letter no. F. No. 13 (9)/2009-AE1 dated March 22, 2012. The proposed KVK is 612th in India and to be established at Gunta village of Tehshil Bansur, district Alwar under the administrative control of DRMR, Bharatpur. Dr K D Kokate, DDG (Ag. Ext), ICAR, New Delhi conveyed his good wishes to the DRMR staff and the Director on this occasion.

DRMR is on 2Mbps Internet Bandwidth

The internet band width has been upgraded from 512 Kbps to 2 Mbps lease line link through ERNET India which allows seamless access to the internet. It will also help in improving the efficiency of staff by speedily acquiring scientific and administrative knowledge. DRMR has also implemented in-house mail and messaging and web facility, a step forward for paperless office work.

Budget (₹ in lakhs)

	Plan		Non-plan	
	Sanctioned	Utilized	Sanctioned	Utilized
DRMR	250.00	249.99	519.85	519.38
AICRP (RM)	1190.00	1189.99	—	—

Resource generation

Head of account	Amount (₹)
Sale of farm produce	16,41,667.0
Sale tender forms	25,300.0
Sale of publication and advertisement	13,980.0
Licence fee	1,44,934.0
Analytical testing fee	1,11,399.0
Unspent balance of grants	5,307.0
Income generated from internal resource generation schemes	
(a) Training	1,82,000.0
(b) Guest house	2,22,355.0
(c) Transport charges	96,658.0
(d) DRMR	10,49,268.0
(e) RTI	140.0
Total	**34,93,008.0**

16

Meteorological Data

A total of 685.1 mm rainfall was received during the year at the DRMR. It was highest in July followed by September and June. Only 24.3 rains were received in a day in January during the cropping season.