वार्षिक प्रतिवेदन
ANNUAL REPORT
2009-2010

सरसों अनुसंधान निदेशालय

सेवर, भरतपुर-321 303 (राजस्थान), भारत

DIRECTORATE OF RAPESEED-MUSTARD RESEARCH

SEWAR, BHARATPUR – 321 303 (RAJASTHAN), INDIA

ISSN 0973- 5356

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The Indian Council of Agricultural Research (ICAR) established Directorate of Rapeseed – Mustard Research (earlier name, National Research Centre on Rapeseed-Mustard) 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, 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 multilocation 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, consultancies in this area.

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Printed: **July 2010**

Citation: Annual Report 2009-2010
Directorate of Rapeseed-Mustard Research
(Indian Council of Agricultural Research)
Sewar, Bharatpur–321 303 (Rajasthan), India

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Preface

I am pleased to place before you Annual Report of Directorate of Rapeseed-Mustard Research for the year 2009-10. Although decline in area and production of the crop continued consecutively for the second year, a worrying trend, but high crop productivity was sustained during the year due to technological advances especially release of hybrids/high yielding varieties and matching agro production technologies.

The significant achievements of the Directorate were release of NRCDR 601, an Indian mustard variety for cultivation under timely sown conditions of Rajasthan, Haryana, Punjab and Jammu, development of a CMS line "MCA 1" of *Brassica carinata* through introgression of mori cytoplasm, characterization of 276 exotic accessions for 14 agro-morphological traits and sharing of 131 accessions with other research organizations for strengthening breeding programme. In an endeavour to insulate the crop against white rust, 6 advanced breeding lines were found resistant under field screening at IARI regional station, Wellington. A high frequency plant regeneration protocol has been standardized for *Brassica juncea* using cotyledonary petiole explants. Studies on resource conservation technologies such as drip irrigation system, furrow irrigated raised beds and reduced/zero tillage were initiated. Molecular diversity in 17 *S. sclerotiorum* isolates was confirmed. Among the eco-friendly approaches for the management of mustard aphid, neem oil @ 2% was found most effective. A standardized scale was developed to measure the extent of adoption of recommended technologies of mustard cultivation by the farmers based on the data collected from 240 farmers and 30 experts. Directorate sponsored 6 weekly radio programmes from AIR Agra, Mathura, Najibabad and Rampur stations in Uttar Pradesh and Jaipur and Sawai Madhopur stations in Rajasthan with 114 episodes on the technological advances in rapeseed-mustard for the benefit of the farming community. An 8-day model training course on production technology of *rabi* oilseeds (rapeseed-mustard, safflower and linseed) and a 7-day farmers' training programme on seed production in agricultural crops were organized. 19 research papers, 6 technical bulletin/training manual, one book and 4 book chapters were published by the scientists.

I deem it privilege to express my heartfelt thanks and gratitude to Dr. S. Ayyappan, Secretary DARE, Government of India and Director General, ICAR; Dr. Mangala Rai, former Secretary, DARE, Government of India and Director General, ICAR; Prof. Swapan Kumar Datta, DDG (CS) and Dr. V.D. Patil, Assistant Director General (Oilseeds & Pulses) of the Council for their immense help, guidance, and support extended to the Directorate.

With immense pleasure, I congratulate all the research and service staff of the DRMR and AICRPRM, whose contributions formed the bases of this report. My sincere appreciation to the editors Drs. K. H. Singh, A. K. Sharma, Sandeep Kumar and Kapila Shekhawat for their painstaking efforts in bringing out the achievements of the Directorate in the present form. I extend my thanks to all the staff of the Directorate for their much-needed direct and indirect help in timely preparation and publication of this report.

DRMR, Bharatpur
July 28, 2010

(J.S. Chauhan)
Director

कार्य सारांश

- निदेशालय द्वारा विकसित लाहा की किस्म एन॰आर॰सी॰डी॰आर॰ 601 को फसल मानक, अधिसूचना एवं प्रजाति रिलीज की केन्द्रीय उप समिति द्वारा जोन 2 के क्षेत्रों (राजस्थान, पंजाब, हरियाणा एवं जम्मू आदि) हेतु अधिसूचित किया गया।
- तीन जननद्रव्यों (बी॰पी॰आर॰ 611–23–186–518, बी॰पी॰आर॰ 659–45–372–102 एवं बी॰पी॰आर॰ 650–50–319–89) नें भरतपुर एवं जोबनेर के असिंचित क्षेत्रों में मानक किस्म वरुणा से बेहतर प्रदर्शन किया। जोबनेर में बी॰पी॰आर॰ 611–23–186–23 (1266 किग्रा/हे.), बी॰पी॰आर॰ 565–40–60–13 (1288 किग्रा/है.) एवं बी॰पी॰आर॰ 605–13–53 (1259 किग्रा/है.) से मानक की तुलना में क्रमशः 11.0%, 12.9% एवं 10.3% बेहतर उपज प्राप्त की।
- करन राई में "एम॰सी॰ए॰ 1", नामक मोरिकेन्डिया साईटोप्लास्मिक मेल स्टेराइल प्रभेद का विकास किया गया है। 21 साईटोप्लास्मिक मेल स्टेराइल प्रभेदों (सिफोलिया–06, ट्रेकी–02, ऑक्सीरिना–06, ओगुरा–02 एवं टोर्नीफोर्टाइ–05) को उचित परागण विधि द्वारा बनाए रखा गया।
- प्रायोगिक संकर किस्मों के परीक्षण में डी॰आर॰एम॰आर॰एच॰जे॰ 3503 से पी॰ए॰सी॰ कोरल 432 संकर की तुलना में 21.4% अधिक उपज प्राप्त हुई। एम॰जे॰बी॰ 40 नामक प्रभेद से मानक किस्म क्रांति की तुलना में 12.9% अधिक उपज प्राप्त हुई। तीन क्रॉस, 39–3–2–3 X EC 597313, 78–1–1–2 X EC 597313 एवं 4–7–12–6 X EC 597313 में अधिक संकर ओज पाया गया।
- 267 विदेशी जननद्रव्यों का (लाहा 176, गोभी सरसों 51, तोरिया 10, करण राई 1 एवं तारामीरा 29) 14 शस्य आकारिकी गुणों के आधार पर वर्गीकरण किया गया।
- कर्नाटक राज्य से एकत्रित किए गए 42 जननद्रव्यों को वर्गीकृत किया गया। 131 जननद्रव्यों को विभिन्न शोध संस्थान एवं विद्यार्थियों को शोध कार्य के लिए वितरित किया गया। अधिक तेल मात्रा (> 44%) वाली 26 संततियों को भी चुना गया।
- भा॰कृ॰अ॰सं॰ के वैलिंगटन केन्द्र में 6 संततियाँ सफेद रतुआ के प्रति प्रतिरोधक पाई गई एवं सफेद रतुआ के प्रति न्यूनतम स्कोर एवं प्रतिरोधक प्रतिक्रया के आधार पर 38 संततियों का चयन किया गया।
- संतति संख्या ओ॰एच॰एस॰–28, ओ॰एच॰एस॰–55, ओ॰एच॰एस॰–124, ओ॰एच॰एस॰ –149, ओ॰एच॰एस॰–153 को अधिक तेल मात्रा (> 43%) के आधार पर अगले चक्र हेतु चयन किया गया।
- परिवर्तित प्रथम पीढी के बीजों को 20 ग्रा./ली. कैनामाईसिन युक्त अंकुरण माध्यम पर पृथ्थकरण हेतु रखा गया। कुल 64 बीजों में से 12 बीजों में कैनामाइसिन के प्रति प्रतिरोधकता पाई गई।
- बीज उत्पादन कार्यक्रम के अंतर्गत किसानों के सहयोग द्वारा कुल 164.67 क्वि॰ सत्य चिन्हित बीज का उत्पादन किया गया। इसके अतिरिक्त 77.06 क्वि॰ एन॰आर॰सी॰डी॰आर॰ 02 सत्य चिन्हित बीज

भी तैयार किया गया। राष्ट्रीय बीज निगम के बीज उत्पादन कार्यक्रम के अंर्तगत, 6.7 क्वि॰ गेहूँ का प्रमाणित बीज एवं 17 क्वि॰ ढेंचा का सत्य चिन्हित बीज तैयार किया गया।

- एस॰डी॰एस॰ पेज द्वारा, प्रोटीन प्रोफाईल के आधार पर पीली सरसों को मुख्यतः 2 समूह में बांटा गया। पहले समूह में झुमका एवं एन॰डी॰वाई॰एस॰–2 में 90% समानता पाई गई। अन्य सभी प्रजातियों को दूसरे समूह में सम्मिलित किया गया। इसमें जी एस 1 एवं पी॰एस॰ 66 में 100% समानता पाई गई।
- लाहा की प्रजाति एन॰आर॰सी॰डी॰आर॰–02 में कॉटीलिडिनरी पीटीऑल एक्सप्लांट द्वारा 'हाई फ्रीक्वैंसी प्लांट रीजनरेशन प्रोटोकोल का मानकीकरण किया गया।'
- स्केलोरोटिनिया हेतु प्रतिरोधकता जानने के लिए 126 लाईनों (56 स्वदेशी एवं 70 बाहरी) में गोभी सरसों की EC 597274, लाहा की EC 597329 एवं EC 597340 लाईन प्रतिरोधक पाई गई।
- पूर्णतः जैविक माध्यम की खेती में ढेंचा की हरी खाद देने से अधिकतम उपज प्राप्त हुई।
- बूंद–बूंद सिंचाई विधि में 120 किग्रा नाईट्रोजन प्रति है. उवर्रक डालने पर अधिक जल उपयोग क्षमता पाई गई जो कि सूक्ष्म फव्वारा विधि में 80 किग्रा प्रति है. नाईट्रोजन के समतुल्य पाई गई।
- विभिन्न संसाधन संरक्षण तकनीकों में चौडी बैड एवं नाली प्रणाली विधि में परम्परागत कृषण, न्यूनतम कृषण तथा शून्य कृषण विधि से बेहतर उपज देने वाले गुण एवं अधिकतम उपज (1954 किलोग्राम /हैक्टेयर) प्राप्त की गई।
- अधिक तापमान की स्थिति में बी॰पी॰आर॰ 543–2, सी॰एस॰ 52, पी॰सी.आर॰ 7, एन॰डी॰आर॰ 8501, जे॰एन॰ 03, जे॰एन॰ 031 बेहतर पाई गई।
- बी॰पी॰आर॰–541–4, बी॰पी॰आर॰, 139–8, बी॰पी॰आर॰ 543–2 एवं बी॰पी॰आर॰ 540–6 ने सिंचित एवं बरानी दोनो ही स्थितियों में अधिक जल उपयोग क्षमता दिखाई। बरानी स्थिति में, बी॰पी॰आर॰ 543–2 से प्रचलित किस्म आर॰एच॰ 819 की तुलना में 17% अधिक उपज प्राप्त हुई।
- 37.5 किलोग्राम जिंक सल्फेट/है. तथा 15 किलोग्राम बॉरेक्स द्वारा जिंक एवं बोरोन देने से उपज में क्रमशः 34% एवं 19% की वृद्धि पाई गई।
- कार्बनडोजिम के बीज उपचार (2 ग्राम प्रति किलोग्राम बीज) एवं छिडकाव (0.1%)से तना गलन रोग में अन्य 10 उपचारों की अपेक्षा 93% तक कमी पाई गई।
- स्कलेरोटीनिया स्केलोरीशियम के 17 विभेदों को एम्पलिफाइड प्रोडक्ट की उपस्थिति या अनुपस्थिति के आधार पर 4 समूहो में रखा गया जो कि स्कलेरोटीनिया विभेदों में विविधता दर्शाते है।
- काला धब्बा की रोकथाम हेतु, 40 दिन उपरान्त नीचे की तीन पत्तियाँ हटाने तथा रीडोमिल एम॰जेड–72 का 0.25% का छिडकाव करने से 19% तथा केवल पत्तियाँ हटाने से 18.9% तक बीमारी से बचाव पाया गया।
- सफेद रतुआ के कारक कवक के ऊस्पोरिक अंकुरण के लिए भूमिगत ऊस्पोरिक पदार्थ के बीज से इनोक्युलेशन की अपेक्षा आंत के एन्जाइम लेकर स्पोरेन्जिमा से पौधे को इनोक्युलेट करना श्रेष्ठ विधि पाई गई।

- सफेद रतुआ के नियंत्रण हेतु, मल्टीनीम के छिडकाव के साथ रिडोमिल एवं डाइथेन एम–45 के 33.3% घोल से 51.7% तक नियंत्रण पाया गया।
- चैंपा नियंत्रण हेतु, *सी॰ सेपटमपंक्टेटा* के 5,000 कीडे प्रति है. श्रेष्ठ पाए गए। उसके बाद *सी॰ सेप्टमपंक्टेटा* के 3,000 कीडे प्रति है. तथा बी॰ लीकैनाई को 10^8 सी॰एस॰/मिली॰ उपयोगी पाया गया।
- डाइमिथोऐट (1 मिली/ली.) तथा *सी॰ सेप्टमपंक्टेटा* के 5,000 कीडे प्रति है. से 95.3% तक चैंपा का नियंत्रण पाया गया।
- तारामीरा के दो जननद्रव्यो आर॰टी॰एम॰ 1212 तथा आर॰टी॰एम॰ 2002 को चैंपा से प्रतिरोधक पाया गया।
- पर्यावरण सुरक्षित चैंपा नियंत्रण विधियों में 2% नीम के तेल का घोल सर्वश्रेष्ठ पाया गया। उसके बाद नीम के बीज का सत् (5%) उपयोगी पाया गया।
- चैंपा तथा चितकबरा कीट नियंत्रण हेतु डाइमिथिओट 30 ई॰सी॰ का 300 ग्रा. सक्रीय पदार्थ प्रति हे. के बाद ईमिडाक्लोपरिड 17.8 एस॰एल॰ 40 ग्रा सक्रिय पदार्थ प्रति हे. उपयोगी पाया गया।
- चैंपा के नियंत्रण हेतु, विभिन्न जैविक पदार्थों में नीम गार्ड (0.1%) के बाद हरी मिर्च का 5% सत तथा नीम के बीज का 5% सत् उपयोगी पाये गये।
- 240 किसानों एवं 30 विशेषज्ञों से प्राप्त जानकारी के आधार पर, सरसों उत्पादन की आधुनिक तकनीक अपनाने के बारे में एक मानकीकृत पैमाना तैयार किया गया।
- तेल मिलों का आदान खरीदने और उत्पादों की बिक्री के लिए बाजार पर अत्यधिक निर्भरता के कारण, तेल प्रसंस्करण ईकाईयों द्वारा सूचनाओं के स्त्रोतों में, व्यापारी सबसे अधिक उपयोग किए जाने वाले सूचना के स्त्रोत पाए गए।
- सरसों अनुसंधान निदेशालय ने किसानों के उपयोग हेतु राई–सरसों उत्पादन की आधुनिक तकनीको के बारे में 6 हफ्तों तक 114 अंकों की वार्ता का रेडियो प्रसारण उत्तरप्रदेश राज्य के आगरा, मथुरा, नजिबाबाद एवं रामपुर जिले तथा राजस्थान के जयपुर एवं सवाईमाधोपुर जिले में किया गया।
- एन॰आर॰सी॰एच॰बी॰ 506 एवं एन॰आर॰सी॰डी॰आर॰ 02 किस्मों के प्रदर्शन हेतु 20 अग्रिम पंक्ति प्रदर्शन भरतपुर के 3 गाँवों में किए गए।
- रबी तिलहन फसलों की उत्तम उत्पादन तकनीकों के बारे में एक 8 दिवसीय मॉडल ट्रेनिंग कोर्स का एवं भा॰कृ॰अ॰सं॰ के बीज कार्यक्रम के अंतर्गत किसानों के प्रशिक्षण हेतु 7 दिवसीय प्रशिक्षण का आयोजन किया गया।
- निदेशालय में 9 फरवरी 2010 को 16 वें सरसों विज्ञान मेला एवं प्रदर्शनी का आयोजन किया गया।

Executive Summary

- NRCDR 601, an Indian mustard variety was notified by the Central Sub-Committee on Crop Standards, Notification and Release of Variety for cultivation under timely sown conditions of zone II (parts of Rajasthan, Haryana, Punjab and Jammu).
- Three strains, BPR 611-23-186-518, BPR 659-45-372-102 and BPR 650-50-319-89, evaluated under rainfed conditions at Bharatpur and Jobner out performed the best check, Varuna at Bharatpur. At Jobner, BPR 611-23-186-23 (1266 kg/ha), BPR 565-40-60-13 (1288 kg/ha) and BPR 605-13-53 (1259 kg/ha) out yielded the check by 11.0%, 12.9% and 10.3%, respectively.
- A stable *Brassica carinata* CMS line (MCA 10) having *mori* cytoplasm has been developed. 21 CMS lines comprising *siifolia* (06), *trachy* (02), *oxyrrhina* (06), *ogura* (02 and *tournefortii* (05) system were maintained through crossing with respective maintainers.
- Experimental hybrid DRMRHJ 3503 out yielded the check hybrid PAC Coral 432 by a margin of 21.4%, in station trial. Inbred MJB 40 out yielded the check variety Kranti by 12.9 %. Three F_1 crosses (39-3-2-3 X EC597313, 78-1-1-2 X EC 597313 and 4-7-12-6 X EC 597313) were identified for high heterosis.
- 267 exotic lines were characterized for 14 agro-morphological traits. 131 accessions were distributed to various research organizations/students for use in research programme
- 26 progenies having high oil content (> 44%) were identified and progeny OHS-28, OHS-55, OHS-56, OHS-124, OHS-149, OHS-153 had > 43% oil content (1-1.5 % higher than the best check Rohini), hence selected for second cycle of random mating.
- 164.47 q truthful labelled seed of mustard was produced, in addition to 77.06 q produced under farmers participatory seed production programme. 130 q certified seeds (wheat), 6.7 and 11.19 q foundation and certified seed, respectively of cluster bean were also produced.
- Micro-sprinkler and drip irrigation systems resulted in significantly higher seed yield (1660 and 1680 kg/ha, respectively) but higher oil content was observed in check basin system . Maximum water use efficiency (43.7%) was recorded with drip irrigation along with 120 kg N/ha (36.36 kg/ha-cm).
- Among the various resource conservation technologies, the yield attributes and the yield produced was highest in furrow irrigated raised beds (1954 kg/ha) followed by reduced tillage (1582 kg/ha) and conventional tillage (1571 kg/ha).
- Zinc and boron application through 37.5 kg $ZnSO_4$/ha and 15 kg borax/ ha, respectively, increased the seed yield significantly up to 34 % and 19 %, respectively.
- Three exotic lines; EC 597274 of *Brassica napus*, EC 597329 and EC 597340 of *Brassica juncea having* tolerance to *Sclerotinia* and 6 lines were found resistant against white rust.
- Seed treatment (@ 2g/kg seed) and foliar spray of carbendazim (@ 0.1%) provided significant reduction (93.0%) in Sclerotinia rot disease and produced highest seed yield (2062 kg/ha) over control (1104 kg/ha) among the 10 treatment combinations studied.
- 17 isolates of *S. sclerotiorum* were placed in to 4 groups based on the presence and absence of the amplified product.

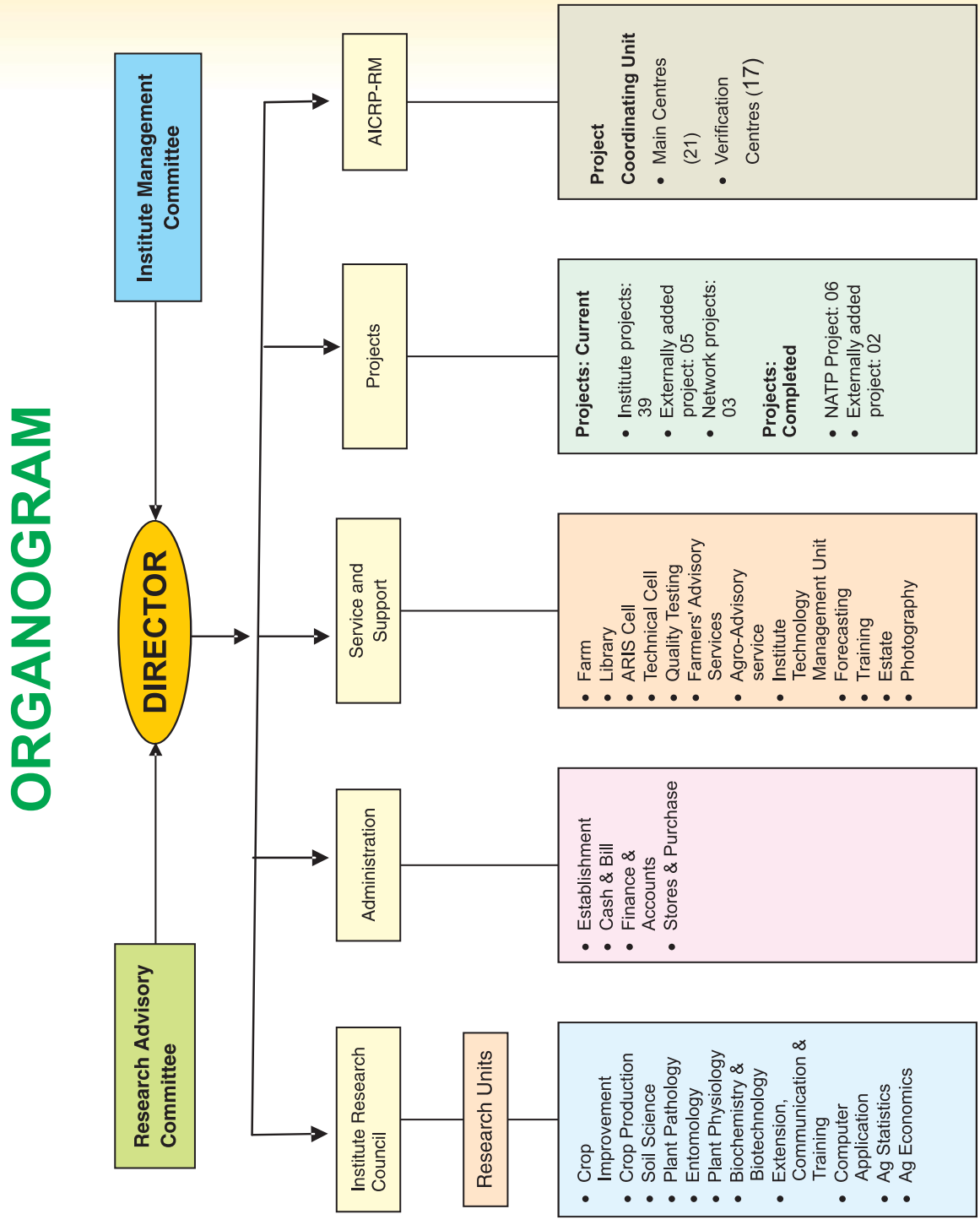
- Removal of 3 lower leaves at 40 days after sowing reduced the Alternaria blight disease by 19 % over control.
- Oosporic germination of *A. candida* using gut enzymes and subsequently inoculation with sporangia on host plant was better than direct inoculation of ground oosporic material with seed.
- Maximum (51.7%) white rust disease reduction on leaves was recorded in multineem sprayed crop.
- *C. septempunctata* @ 5,000 beetles/ha was found most effective followed by *C. septempunctata* @ 3,000 beetles/ha for the control of aphid.Among the eco-friendly approaches for the management of mustard aphid neem oil @ 2% was found most effective followed by NSKE @ 5%.
- Dimethoate 30 EC @ 300g *a.i.* / ha followed by imidacloprid 17.8 SL @ 40g *a.i.* / ha spray was found most economical for management of mustard aphid and painted bug.
- Accessions BPR 543-2, CS 54, PCR 7, NDR 8501, JN 03 and JN-031 were found promising under high temperature situation (When).
- The genotypes BPR 541-4, designation 139-8, BPR-543-2 and BPR-540-6 during seedling stage showed high WUE under both irrigated and rainfed conditions. Under rainfed conditions the genotype BPR 543-2 showed 17% higher yield than check RH 819.
- A high frequency plant regeneration protocol has been standardized for *Brassica juncea* var. NRCDR-02 using cotyledonary petiole explants.Of the 64 T_1 seeds of *Brassica juncea* inoculated, only 12 showed resistance to kenamycin (20 mg/l).
- Cross transferability and polymorphic potential of 67 STMS markers developed in different *Brassica* species were evaluated using 21wild species of *Brassica* and allied genera.
- Using partial least square regression, calibration for non-destructive estimation of erucic acid and glucosinolates in seeds of rapeseed-mustard by Fourier transform near infrared reflectance spectroscopy (FT-NIRS) was developed.
- On the basis of protein profile, 10 yellow sarson varieties were divided into two major clusters. Major cluster I was occupied by two varieties *i.e*. Jhumka and NDYS 2 which showed 90% similarity to each other. Cluster II was occupied by rest of the varieties. In this group, GS 1 and PS 66 showed 100% similarity to each other.
- 20 frontline demonstrations with NRCHB 506 (hybrid) and NRCDR 2 (variety) of Indian mustard were laid out in 3 villages of Bharatpur district of Rajasthan
- A standardized scale was developed to assess the extent of adoption of recommended practices of mustard cultivation by the farmers based on the data collected from 240 farmers and 30 experts
- DRMR sponsored 6 weekly radio programmes from AIR Agra, Mathura, Najibabad and Rampur stations in Uttar Pradesh; Jaipur and Swai Madhopur stations in Rajasthan with 114 episodes on the package of practices for rapeseed-mustard for the benefit of the farming community.
- An 8-day model training course on production technology of *rabi* oilseeds (rapeseed-mustard, safflower and linseed) and a 7-day farmers' training programme on seed production in agricultural crops and 16th Sarson Vigyan Mela-cum-Exhibition were organized.
- A total of 70 students were enrolled for training and dissertation work and 6 scientists received training in different areas.
- 19 research papers, 6 technical bulletin/training manual, 1 book and 4 book chapters, were published.

1 DRMR: An Overview

All India Coordinated Research Project on Oilseeds (AICRPO) was established in April 1967 for the improvement of oil seeds in the country. Setting up separate Project Coordinating Units in the V Plan further strengthened the research programme. The Unit of the Project Coordinator (Rapeseed-Mustard) was accordingly established on January 28, 1981 at the campus of the Haryana Agricultural University, Hisar. During VIII Plan the Indian Council of Agricultural Research (ICAR) established the National Research Centre on Rapeseed-Mustard (NRCRM) 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, Rajasthan at Sewar, Bharatpur on the recommendation of the Task Force constituted in 1990. The centre has been upgraded as Directorate of Rapeseed–Mustard Research (DRMR) in the XI plan vide letter no. F. No. 9(7)/2007-1A III dated February 24, 2009. Besides, generating basic knowledge and material, it also engages in developing ecologically sound and economically viable agro-production and protection technologies. The Directorate also has the responsibility to plan, coordinate and execute the research programme through wide network of 23 main and sub-centres across the country in addition to 22 verification centres to augment the production and productivity of rapeseed-mustard. The Directorate is 7 km away from the Bharatpur railway station and 3 km from the Rajasthan Roadways bus station 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. The campus of the Centre is spread over an area of 44.21 hectares, of which about 80% is experimental and the rest is covered by Administrative–cum-Laboratory building and residential quarters. It is situated at 77.27 ^{0}E longitude and 27.12 ^{0}N latitude and is about 160 meter above mean sea level. The DRMR functions as a fulcrum to support the production system research through different research, service, support units (see organogram) with basic technologies and breeding material for rapeseed (yellow sarson, toria, taramira, gobhi sarson) and mustard (Indian mustard and Ethiopian mustard) crops. The mandate of the DRMR is as follows:

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

ORGANOGRAM


Institute Management Committee
Research Advisory Committee
DIRECTOR
AICRP-RM
Project Coordinating Unit
• Main Centres (21)
• Verification Centres (17)
Projects
Projects: Current
• Institute projects: 39
• Externally added project: 05
• Network projects: 03
Projects: Completed
• NATP Project: 06
• Externally added project: 02
Service and Support
• Farm
• Library
• ARIS Cell
• Technical Cell
• Quality Testing
• Farmers' Advisory Services
• Agro-Advisory service
• Institute Technology Management Unit
• Forecasting
• Training
• Estate
• Photography
Administration
• Establishment
• Cash & Bill
• Finance & Accounts
• Stores & Purchase
Institute Research Council
Research Units
• Crop Improvement
• Crop Production
• Soil Science
• Plant Pathology
• Entomology
• Plant Physiology
• Biochemistry & Biotechnology
• Extension, Communication & Training
• Computer Application
• Ag Statistics
• Ag Economics

2 Research Achievements

2.1 CROP IMPROVEMENT

DRMR CI 2: Development of improved genotypes of Indian mustard with high yield and oil, good quality of oil and seed meal

Project Leader: J.S. Chauhan, Principal Scientist (Plant Breeding)

Associates: Maharaj Singh, Sr. Scientist (Plant Physiology), Satyanshu Kumar, Sr. Scientist (Organic Chemistry)

Improving genetic potential for seed yield, high oil content, drought and quality

Generation advance

18 $F_{1's}$ along with the parents were grown during the cropping season. M_3 generation of variety Urvashi (irradiated with gamma rays (0, 50, 100, 150, 200, 250 kR) was raised and 37 bulks were prepared on the basis of pod length, seeds/siliqua and plant height.

Generation of new breeding materials

5 new F_1 crosses along with BC_1 and BC_2 involving an early maturing line (NPJ 112) were made. Further, 6 multiple crosses were also made.

Evaluation and selection in segregating generations

The segregating and non-segregating generations [F_2: 25 crosses, F_4: 250 bulks (28 crosses), F_5: 109 lines (34 crosses), advanced breeding lines: 66(46 crosses)] were grown for evaluation and 1950 single plant selections from F_2, 84, 29 and 21 bulks from F_4, F_5 generations and advanced breeding lines on the basis of main shoot length, siliqua length and plant height were made under irrigated conditions.

50 and 109 promising advanced breeding lines (F_4) were evaluated at DRMR and SKN College Jobner under moisture stress conditions. 24 and 43 bulk selections were made at DRMR. Further, from 309 F_4 lines, 84 bulks were prepared at DRMR.

Evaluation of advanced breeding materials

One replicated yield trial comprising 15 strains and 3 checks (Varuna, Bio 902 and PCR 7) was conducted under rainfed condition at DRMR, Bharatpur and SKN College Jobner. The plot size was 5 x 1.8 m. The crop was grown at 40: 40: 20 (N: P_2O_5 : K_2O, kg/ha). Analysis of variance revealed significant differences among the strains for seed yield. Three strains BPR 611-23-186-518 (1832 kg/ha), BPR 659-45-372-102 (1788 kg/ha) and BPR 650-50-319-89 (1788 kg/ha) out performed the best check, Varuna (1655 kg/ha) at Bharatpur. At Jobner, BPR 611-23-186-23 (1266 kg/ha), BPR 565-40-60-13 (1288 kg/ha) and BPR 605-13-53 (1259 kg/ha) out yielded the check by 11.0%, 12.9% and 10.3%, respectively.

Genetic studies

Pooled analysis of variance indicated highly significant differences for genotypes (G), environment (E) and G x E interaction for oil, protein, glucosinolates, oleic, linoleic, linolenic, eicosenoic and erucic acid suggesting that quality characters should be evaluated under different environments. The environment (linear) was highly significant for all the characters, while the linear component of genotype x environment interaction was highly significant for protein content only. Pooled deviation differed significantly for linoleic; linolenic, erucic acid and glucosinolates suggesting the genotypes had varying level of stability over the cropping seasons for these characters. Stability parameters indicated that oil and protein content were fairly stable across environments in 14 and 11 varieties respectively. Only 3 varieties, 'CS 52' (protein content, oleic, linoleic, linolenic, eicosenoic and erucic acid); 'Saurab' (oil content, protein content, oleic,

linoleic, linolenic and erucic acid) and 'Sanjucta Asech' (oil content, protein content, saturated fatty acid, oleic, linoleic and erucic acid) were stable for maximum of 6 characters. Eight and 4 varieties exhibited stable performance for 5 and 4 of the nine characters studied, respectively. In the quality-breeding programme, appropriate selection strategy should be adopted to address an all-important G x E interaction in the expression of oil and seed meal quality traits.

Total phenols, glucosinolates, flavonoids content and *in vitro* antioxidant activity of Indian mustard leaves differed significantly among the varieties. Total phenols, total glucosinolates, crude fibres, flavonoids, ascorbic acid and ß-carotenes ranged from 4.3-8.3 ppm; 19.9-32.7 µ moles / g; 9.5-11.8 %; 0.8-2.3 ppm; 0.002- 0.31 mg / 100 g and 37.7-42.2 ppm, respectively. Variety Urvashi exhibited the highest *in vitro* antioxidant activity assessed as free radical scavenging activity of 1,1-diphenyl-2-picryl hydrazil radical (DPPH) by methanolic extract which varied from 44.4-59.2% and positively correlated with total phenols and flavonoids.

Changes in total glucosinolates in leaves, roots and stem at 3 developmental stages, pods and seeds of four advanced breeding lines BPR 897-4-11-8-4-91-2, BPR 897-4-11-8-4-91-5, BPR 897-4-11-8-6-93-10, BPR 897-4-11-8-6-93-11 and Varuna variety of Indian mustard with differing glucosinolates content (29.7-106.5 µ moles / g defatted seed meal) were investigated. Glucosinolates in leaves were, in general, higher than that of stem and roots except for roots at 45 days after sowing (DAS). Genotype BPR 897-4-11-8-91-2 accumulated more glucosinolates in stem as compared to leaves and genotype BPR 897-4-11-8-6-93-11 showed more glucosinolaes in leaves than roots at 45 DAS. Glucosinolates in stem and roots decreased at higher rate in comparison to that of leaves. Leaf glucosinolates at 45 DAS had positive relationship with that of 60 DAS (r =0.871). Total glucosinolates in pods and seeds were also positively correlated (r =0.814) and hence could be a good criterion for identifying low glucosinolates lines at early stage.

DRMR CI 5 : Development of hybrids in Indian mustard

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

Associate: J. Nanjundan, Scientist (Plant Breeding)

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

NRCHJ 1103 (hybrid) was promoted for advanced testing (AHT-1) during 2009-10 on the basis of its superiority over the best check during 2008-09. Three new hybrids NRCHJ 0403, NRCHJ 3603 and NRCHJ 3803 were inducted for evaluation in IHT. Similarly DRMRIJ 20 was inducted to IVT (Timely Sown) and DRMR 447 was inducted to IVT (Late Sown). One strain of Karan rai, NRCKR 0901 was inducted to IVT (Karan rai). NRCHB 04-6, NRCIJ 06-112, and MCB 1 were inducted to National Disease Nursury (NDN) for white rust and two entries NRCIJ 06-44 and NRCIJ 38 were inducted to Uniform Disease Nursery (UDN) for screening against major diseases.

Evaluation of hybrids/promising entries

Twenty hybrids and 08 promising strains were tested in station trials in randomized block design with three replications and 124 F_{1s} and 255 inbred lines were evaluated in augmented design with 3 check varieties. DRMRHJ 100 (1874 kg/ha) and DRMRHJ 0101 (1806 kg/ha) had more seed yield than the check variety Kranti (1788 kg/ha). Station trial 2 comprised of nine experimental hybrids of which DRMRHJ 3503 (1085 kg/ha) surpassed the check hybrid PAC 432 (966 kg/ha) by a margin of 21.4%. MJB 40 out yielded the check variety Kranti by 12.9 %. Three F_1 crosses *viz*., 39-3-2-3 X EC597313, 78-1-1-2 X EC 597313 and 4-7-12-6 X EC 597313 were identified for high seed yield heterosis. Among the inbred lines, DRMRIJ 118, DRMRIJ 161, DRMRIJ 279, DRMRIJ 300 and DRMRIJ 317 were identified for high seed yield (> 500 g/plot); DRMRIJ 16, DRMRIJ 314, DRMRIJ 332, DRMRIJ 334, DRMRIJ 340 and DRMRIJ 343 were found promising for early flowering (< 40 days); DRMRIJ

105, DRMRIJ 86, DRMRIJ 160 and DRMRIJ 408 had bold seeds (1000-seed weight > 6.5 g); DRMRIJ 138, DRMRIJ 82, DRMRIJ 153 and DRMRIJ 32 had more than 18 seeds/siliqua.

Conversion of A and R lines

12 mori CMS lines of Indian mustard were planted alongwith respective maintainer. Similarly 07 restorer lines were also planted for attempting backcrosses with recurrent parent.

Introgression of mori CMS into karan rai (*Brassica carinata*)

After 8 backcrosses a stable *Brassica carinata* genotype named as MCA 1having moricandia cytoplasm possessing male sterility has been developed. t-statistics used for making comparison between MCA 1 and its maintainer (MCB 1), revealed that both A and B lines were *at par* for days to flower initiation, days to maturity, primary branches, main shoot length, siliquae on main shoot and siliqua length (Fig 2.1a). Among the flower characteristics, petal length, petal width and style length were found at par between both MCA1 and its maintainer, however difference was significant for stamen length which were shorter in MCA1(Fig 2.1b). The developed CMS line MCA 1 will pave the way for hybrid development in *B. carinata*.

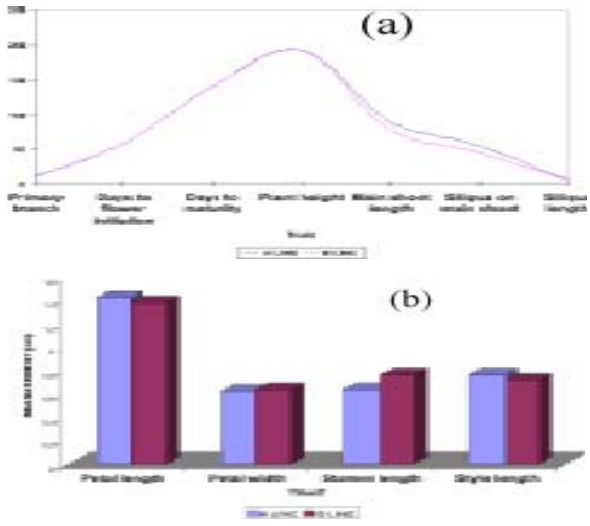


Fig 2.1. Comparison between cytoplasmic male sterile line MCA 1 of *Brassica carinata* and its maintainer MCB 1; (a) agronomic traits and (b) flower traits

Maintenance of inbred, CMS and maintainers

21 CMS lines comprising 06 siifolia, 02 trachy, 06 oxyrrhina, 02 ogura and 05 tournefortii system were maintained through crossing with respective maintainers. Likewise, 427 inbreds and 38 maintainers were maintained through selfing.

Selection from segregating generations Individual plants were selected from 06 F_2 (MJA 25 X HB 101-1), MJA 34 X SSR 1-8, (EC 597309 X NUDHYJ 3) X RL 1359, EC 597313 X MJR 9; 6 F_3 (HB 9918 X HB 9914, MJA 11 X SSR 1-9, ZEM 2 X BPR 6-166, MJA 26 X MJR 2 and of two other hybrids), 01 F_5 (HB 9917 X HB 9907-3) X (RH 30 X RH 8812) and 02 F_7 (VSL 5 X SEJ 2 and ZEM 2 X HB 9916-01) generations. Random bulks were also drawn.

Generation of F_1 crosses

Fifty F_1 crosses involving 10 lines (MJA 2, 04-09-2, 39-3-2-3, HB 9925, HB 202, MJA 11, MJA 25, MJA 34, MJA 27, MJA 38) and 05 testers (MJR 9, MJR 2, MJR 3, MJR 4, EC 597309) were attempted in line x tester design.

Multiplication of parental lines

Small quantity of 07 A lines was produced by growing them with their respective maintainers in small plots covered with nets. Seeds of 06 promising entries were also produced. Likewise, the seed of hybrid NRCHB 506 and MJA 5 was produced by growing respective A and R/B lines in two isolated plots.

DRMR CI 6 : Evaluation and characterization of rapeseed-mustard germplasm

Project Leader: J Nanjundan, Scientist (Plant Breeding)

Associates: K.H. Singh, Sr. Scientist (Plant Breeding) and Sandeep Kumar, Scientist (Plant Biochemistry)

Development of trait specific gene pool in Indian mustard

With an objective to develop trait specific gene pool for the important traits, 143 Indian mustard accessions

(51 accessions for days to flower initiation, 33 accessions for main shoot length, 21 accessions for seeds/siliqua, 5 accessions for 1000 seed weight, 3 accessions for seed yield/ plant, 30 accessions for oil content) were sown in augmented design along with the three checks (Kranti, Sej 2 and Pusa Bold). The observations were recorded on 14 agro-morphological traits *viz*., initiation of flowering (days), 50% flowering (days), maturity (days), plant height (cm), primary branches/plant, secondary branches/ plant, main shoot length (cm), siliquae on main shoot, seeds/siliqua, siliqua length (cm), siliqua beak length (cm), 1000-seed weight (g), seed yield/plant (g) and harvest index (%). Seeds/siliqua ranged from 8.6-28.4.

Characterization of exotic accessions

Two hundred and sixty seven exotic lines (176 of Indian mustard, 51 of gobhi sarson, 10 of toria, 1 of karan rai and 29 of taramira) were sown in augmented design along with checks namely Rohini, Maya, Kranti (Indian mustard), GSL 1, GSL 2, GSC 5 (gobhi sarson), PT 507(toria), RTM 314, T 27, TMLC 2 (taramira). The accessions were characterized for 14 agro-morphological traits.

Characterization of new Karnataka accessions

Forty two new accessions collected during 2008-09 in an exploration trip to Karnataka were characterized along with three checks (Rohini, Maya, and Kranti). Highest variability in term of coefficient of variation (%) was recorded for 1000-seed weight followed by harvest index and yield/plant (Fig. 2.2).

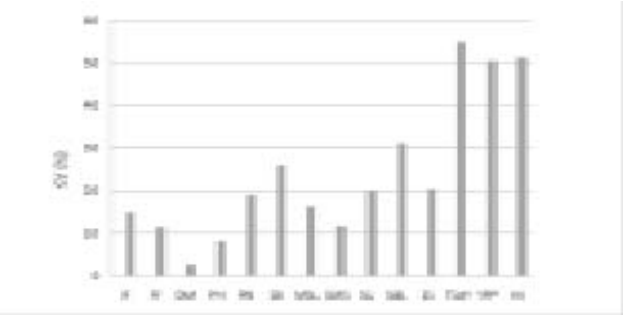


Fig 2.2. Variability for agromorphological traits in Brassica collection

DRMR CI 7 : Collection, maintenance, conservation and documentation of rapeseed-mustard germplasm

Project Leader: J Nanjundan, Scientist (Plant Breeding)

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

Acquisition of germplasm materials

A total of 115 accessions of rapeseed-mustard germplasm were obtained from AICRP (R & M) network centers and other institutions.

Maintenance of germplasm

Six hundred twenty five accessions were maintained by adopting proper pollination control during the crop season.

Distribution of germplasm materials

Total of 131 accessions were distributed to various research organizations/students for their use in research /varietal development.

Seed multiplication

Seed multiplication of three yellow sarson strains namely, NRCYS 05-02, DRMRYS 09-103, DRMRYS 9-99 was carried out.

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

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

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

NRCDR 601, an Indian mustard variety was notified by the Central Sub-committee on Crop Standards, Notification and Release of Variety for cultivation under timely sown conditions of zone II including Rajasthan, Haryana, Punjab and Jammu. This variety was developed through pedigree selection from the

cross NBPGR 272 X RK 9903. On the basis of 3 years multilocation testing (19 locations) under AICRP-RM, it gave seed yield of 2317 kg/ha, higher by 22.3%, 13.5% and 10.3% over the checks Varuna, RL 1359 and Kranti, respectively. It has inbuilt tolerance against high temperature at the time of sowing and salinity with high rate of imbibition (Fig. 2.3).

Fig. 2.3. NRCDR 601

Contribution of entries for multilocation testing under AICRP-RM

NRCM 802 and NRCM 812 were promoted to AVT-1 (late sown) and saline conditions, respectively under AICRP-RM trials. 5 strains have been included in IVT for multilocation testing during *rabi* 2009-10.

Observation nursery for component traits

One hundred forty five F_{5-6} progenies were planted in paired rows of 5 m length. 26 progenies having high oil content (> 44%) were selected.

Evaluation of F_1 and generation advancement

Eighteen F_1 crosses attempted for introgressing resistance/tolerance to biotic stress in Indian mustard from *B. carinata* and *B. napus* were planted in paired rows for evaluation and generation advancement. Five crosses *viz*, (PR 8903 X BEC 71) X NRCGS 1, (SEJ 2 X K 28) X NRC GS 1, (HC 2 X BEC 107) X NRC GS 1 were found promising for resistance to white rust disease.

Maintenance breeding

Varieties NRCDR 2 and NRCDR 601 were planted in isolation at ARS, Kumher for multiplication of pure seed stock. About 500 true to the type plants from each variety were selfed and harvested separately to have nucleus seed.

Breeding for white rust resistance

One hundred twenty five progenies of Indian mustard were planted during 2009 (May– September) at IARI regional station, Wellington for screening against white rust and 6 progenies were found resistant against the prevalent pathotype of white rust.

Evaluation of segregating generations

Two hundred thirty F_{4-7} lines were planted in paired row for screening against the white rust. Repeated irrigations and inoculum spray (collected from early sown crop) was done for enhancing disease pressure and about 1650 single plants form 38 progenies were selected on the basis of low score against the Bharatpur race of white rust. Two F_1 crosses (NRCDR 2 X NRC GS 1 and NRCDR 2 X NRCDR 515) for enhancing white rust resistance in high yielding background were attempted.

Evaluation of F_{5-6} generation for Alternaria blight tolerance

Thirty eight progenies of intra and inter specific multiple crosses were planted in paired rows of 4 m length. The plants were exposed to artificial inoculation for enhancing the disease development. The plants were scored for disease on the leaves as well as on stem and pods. Tolerant plants from the crosses MDOC 41 X NRC 59, BEC 107 X Hyola 401) X Varuna, (EC 399299 X EC 399301) X (PAB 9511 X PAB X 9534), (EC 399299 X EC 399301) X (EC 399313 X PHR 2) were selected.

DRMR CI 10: Population improvement in Indian mustard

Project leader: V.V. Singh, Sr. Scientist (Plant Breeding)

Associates: S.S. Meena, Sr. Scientist (Plant Breeding), Maharaj Singh, Sr. Scientist (Plant Physiology), Pankaj Sharma, Sr. Scientist (Plant Pathology) and Satyanshu Kumar, Sr. Scientist (Organic Chemistry)

Evaluation of half sib progenies for drought tolerance

One hundred five half-sib progenies and base population were sown on conserved moisture along with checks RH 819, Geeta, RB 50 and PBR 97 in augmented complete block design. Observations were recorded on 20 different morpho-physiological characters. On the basis of seed yield superiority over checks half-sib progenies HS 11, HS 14, HS 15, HS 19, HS 25, HS 26, HS 33, HS 35, HS 48, HS 51, HS 52, HS 54, HS 61, HS 67 were selected for initiating second cycle. The same set of half-sib progenies was also sown at SKN College of Agriculture, Jobner under severe moisture stress. Few half-sib progenies, HS 7, HS 17, HS 31, HS 52, and HS 53 were selected.

Evaluation of full-sib progenies for drought tolerance

One hundred full-sib progenies developed from F_2 population of Varuna X BPR 148 were sown on conserved moisture along with checks RH 819, Geeta, RB 50 and PBR 97 in augmented complete block design. Observations were recorded on 20 different morpho-physiological characters. On the basis of yield superiority over best check RB 50, full -sib progenies, FS 8, FS 11, FS 22, FS 34, FS 35, FS 45, FS 58, FS 63, FS 77, FS 85, FS 93 were selected for initiating second cycle of full-sib progeny selection.

Selection from early segregating generations (F_2, F_3) for drought tolerance

One hundred seventy five F_3 progenies derived from 5 crosses were sown on conserved moisture along with checks RH 819, Geeta, RB 50 and PBR 97 in augmented complete block design. Selection of 35 F_3 progenies on the basis of seed yield and 92 single plants on the basis of phenotype was made. 104 F_3 progenies were screened at SKN College of Agriculture, Jobner for drought tolerance. 13 F_3 progenies were found promising. 20 rows of each of 3 F_2 populations derived from BPR 141 X BPR 150, BPR 141 X BPR 582-36 and Rohini X BPR 141 were sown on conserved moisture and 84 single plants were selected on the basis of phenotype. 15 complex crosses were sown in paired rows of 4 m length. Crosses, (BPR141 X RH 819) X (BPR 148 X BPR 150) and (Varuna X BPR 585-37) X (Varuna X BPR 58-40) were good performers under moisture stress conditions.

Evaluation of half-sib progenies

Alternaria blight

One hundred half-sib progenies along with base population and checks (PHR 2, EC 399301, JMM 915 and PAB 9534) were sown in augmented complete block design along with infector rows of yellow sarson. The inoculum of isolates was sprayed regularly and crop was irrigated to create epiphytotic conditions. Disease intensity was recorded on leaves as well as on pods. The progenies numbered AHS 33, AHS 42, AHS 50, AHS 55, AHS 58, AHS 73, AHS 91, AHS 95, AHS 96, AHS 99, and AHS 100 had shown low disease incidence on leaves as well as on pods as compared to checks.

Oil content

One hundred sixty half-sib progenies along with base population and checks (06-1942, 06-1946, Rohini) were sown in augmented complete block design with 5 blocks. Progeny numbers OHS 28, OHS 55, OHS 56, OHS 124, OHS 149, OHS 153 had > 43% oil content (1-1.5 % higher than the best check Rohini), hence selected for next cycle.

Yield components

Progenies HYP 1, HYP 13, HYP 16, HYP 32 were found promising for seed yield, while progenies HYP 26, HYP 58, HYP 78, HYP 88, HYP 93, HYP 100

were selected for bold seed (> 6 g 1000-seed weight).

Performance of advanced lines

A trial consisting of 8 strains and 2 checks (Maya and Kranti) was conducted. Lines 08-513-15 and 08-538-41 recorded 13% and 13.5% more yield, respectively, over the best check Maya.

Population/progeny development

Base population derived from the second cycle of random mating for yield components was grown at ARSS, Kumher. 180 single plants on the basis of phenotype were selected and threshed separately. Similarly, 250 single plants were selected from the second cycle population for high oil content.

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

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

Associates: Satyanshu Kumar, Sr. Scientist (Organic Chemistry), J. Nanjundan, Scientist (Plant Breeding)

Twelve varieties of Indian mustard were grown in randomized complete block design with 3 replications in 6-row plots of 5 m length, keeping 45 cm row-to -row distance. 20 traits which include 3 observations (seed coat colour, leaf colour and flower colour) recorded as visual observation on group; 2 observations namely time of flowering and maturity period were recorded on group of plants; 11 observations, namely leaf lobes, leaf length and width, length and width of petals, main shoot length, plant height, siliqua length, siliqua beak length, siliquae on main shoot, siliqua density on main shoot, recorded on 20 plants or parts of 20 plants/replication; 5 traits (leaf hairiness, leaf lobes, dentation of margin, siliqua angle and siliqua surface texture) were recorded as visual observations.

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

Project leader: V.V. Singh, Sr. Scientist (Plant Breeding)

Associates: P.K. Rai, Principal Scientist (Plant Pathology), Y.P. Singh, Sr. Scientist (Entomology), Sandeep Kumar, Scientist (Plant Biochemistry) and Ajay Kumar, Scientist (Plant Biotechnology)

Development of putative transformants

Putative transformants were developed from *B. juncea* varieties Rohini and Pusa Bold using cotyledonary petioles explant. About 450 explants of each variety were co-cultivated with *Agrobacterium* suspension having chickpea lectin gene construct. The putative transformants were selected on the basis of green shoots developed on selection medium.

Segregation Pattern Analysis

T_1 seeds were placed on germination media containing 20 mg/l kanamycin for analysis of segregation pattern. Of the 64 seeds inoculated, only 12 showed resistance to kanamycin.

In vitro regeneration of T_1 seeds

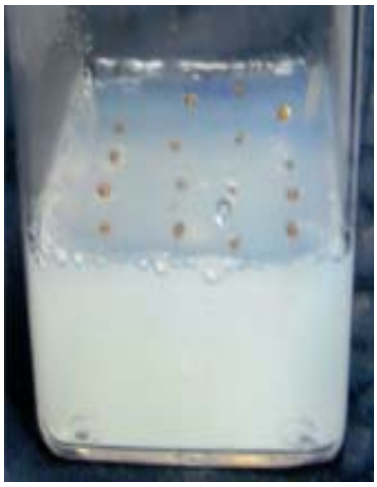


Fig. 2.4a. T_1 Seeds on selection medium

Fig. 2.4b. Regeneration of T_1 Seed

After germination, T_1 seeds were regenerated through MS medium containing 3.0 mg/l BAP and 0.2 mg/l IAA. All regenerated T_1 shoots and plants were maintained through tissue culture. Regenerated T_1 plants were kept on rooting medium for hardening (Fig.2.4 a,b.).

DRMR NP 4: ICAR seed project on seed production in agricultural crops and fisheries

Project leader: Dr. V.V. Singh, Sr. Scientist (Plant Breeding)

Associate: Dr. Y. P. Singh, Sr. Scientist (Entomolgy)

241.53 q (unprocessed) truthful labelled seed of mustard varieties was produced including 77.06 q seed of NRCDR 02, produced under farmers participatory seed production programme. 130 q certified seed of wheat was produced under seed production programme of National Seeds Corporation (NSC). Similarly, 6.7 q and 11.19 q foundation and certified seed, respectively, of cluster bean were produced in collaboration with NSC. 17 q truthful labelled seed of *Sesbania* was also produced.

2.2 BIOCHEMISTRY AND BIOTECHNOLOGY

DRMR B 3: Biochemical aspects of *Brassica* quality and development of analytical methods

Project leader: Satyanshu Kumar, Sr. Scientist (Organic Chemistry)

Calibration development for screening of erucic acid and glucosinolate content in rapeseed-mustard seeds using near infrared reflectance spectroscopy

Using partial least square regression, calibration for non-destructive estimation of erucic acid and glucosinolate content in seeds of rapeseed-mustard by Fourier transform near infrared reflectance spectroscopy (FT-NIRS) was developed. The calibration developed showed a very close relationship between the reference method for erucic acid (gas chromatography) and glucosinolate content (palladium complex formation) and NIR spectral data from 7502.1 to 5444.6 cm^{-1}. The coefficients of determinations were 97.1 % and 98.4 % for erucic acid and glucosinolate content, respectively.

DRMR B 4: Biomolecular characterization of rapeseed-mustard genotypes for genetic diversity and quality parameters

Project leader: Sandeep Kumar, Scientist (Biochemistry)

Associates: A.K. Thakur, Scientist (Plant Biotechnology), B.K. Singh, Scientist (Plant Biotechnology)

Characterization of yellow and brown sarson

Molecular characterization of 9 yellow and 3 brown sarson varieties was carried out using 15 RAPD markers.

Protein profile of yellow sarson

SDS-PAGE was used to study seed storage banding pattern of 10 yellow sarson varieties. Total 21 bands were observed having Rm value ranging from 0.290 to 0.956. Genetic diversity among yellow sarson varieties was based on the presence or absence as well as intensity of bands. Out of 21, 12 bands were found to be monomorphic and were present in all the10 varieties (Fig. 2.5).

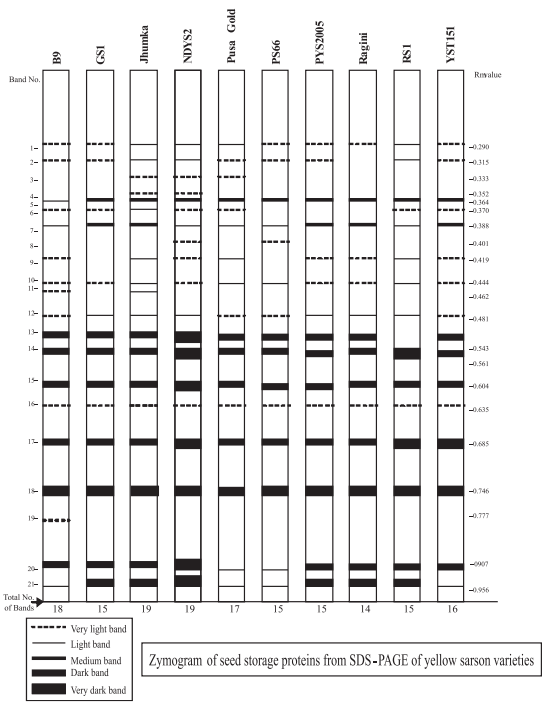


Fig. 2.5. Protein profile of yellow sarson varieties

The 0/1 binary matrix data was used to prepare the dendrogram revealing relationship among yellow sarson varieties using Jaccard similarity coefficient. The similarity matrices ranged from 0.76 to 1.0 showing high variability at protein level among the varieties. Maximum similarity between two varieties was 100 % between PS 66 and GS 1 and the minimum similarity was 76% between NDYS 2 and B 9, Ragini and Jhumka, Ragini and NDYS 2. The average similarity index value was 0.88. The varieties were divided into two major clusters at a similarity coefficient of 0.82. Cluster I was occupied by two varieties i.e. Jhumka and NDYS 2 which showed 90% similarity. Cluster II was occupied by rest of the varieties where B 9 separated from the other varieties at a similarity coefficient of 0.85. In this group, GS 1 and PS 66 showed 100% similarity (Fig. 2.6).

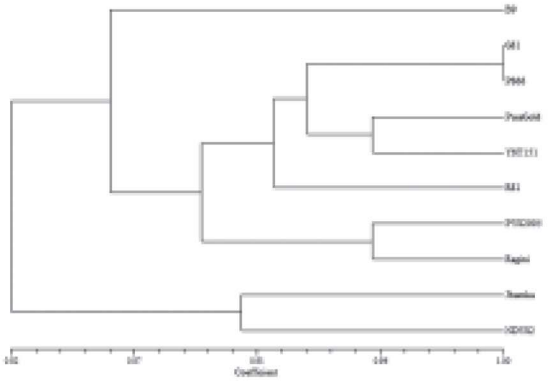


Fig. 2.6. Dendrogram showing clustering among yellow sarson varieties

Protein profile of brown sarson

SDS-PAGE was used to study seed storage banding pattern of 3 brown sarson varieties. Total 22 bands were observed having Rm value ranging from 0.148 to 0.742 (Fig.2.7). Out of 22, 12 bands were found to be monomorphic and were present in all varieties. The similarity matrices ranged from 0.54 to 0.91. Maximum similarity was 91% between KOS 1 and KBS 3 and the minimum was 54% between KS 101 and KOS 1. The average similarity index value was 0.73.

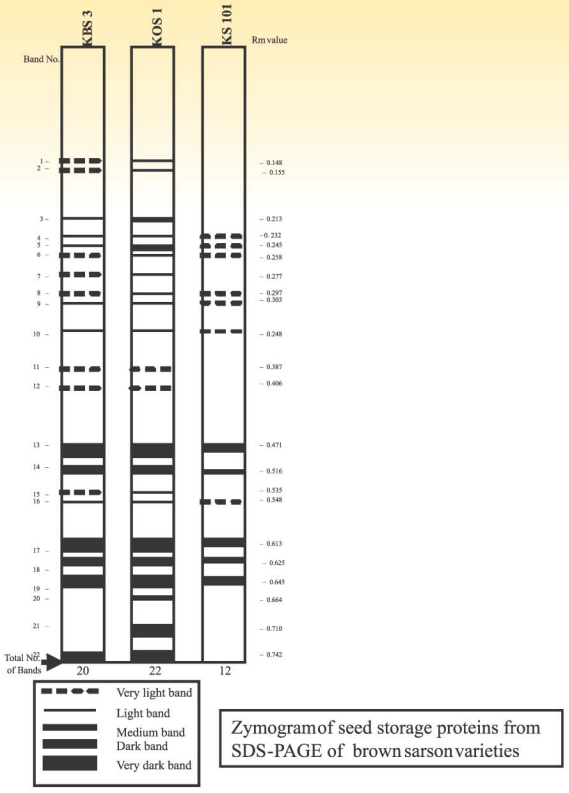


Fig. 2.7. Zymogram of seed storage proteins of brown sarson varieties

Dendrogram also showed that varieties KBS 3 and KOS 1 showed maximum (91%) similarity to each other, which occupied the same cluster and separated from KS 101 at a similarity coefficient of 0.59 (Fig 2.8).

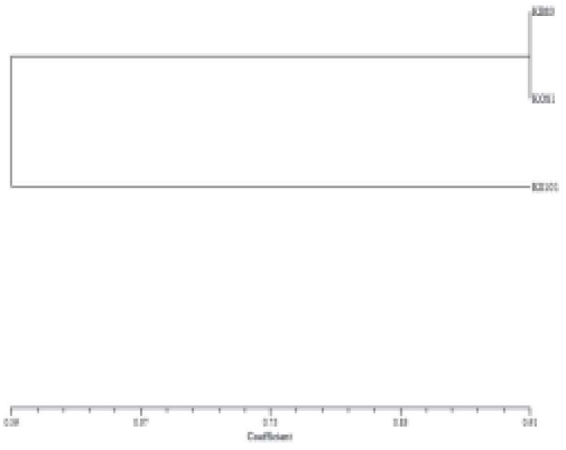


Fig. 2.8. Dendrogram showing clustering among brown sarson varieties based on seed storage protein profile

DRMR B 5: Phytonutraceuticals from *Brassica*

Project leader: Satyanshu Kumar, Sr. Scientist (Organic chemistry)

Phytochemical constituents (total phenol, flavonoids, phytic acid) of seed meal of 37 rapeseed-mustard varieties were quantified and in *vitro* antioxidant properties were evaluated using two different methods i.e. DPPH and ABTS assay. The range of phytochemical constituents have been summarized (Table1).Using high performance liquid chromatography (HPLC) glucosinolate profiling of the varieties indicated sinigrin as the major glucosinolate (Fig.2.9.).

Table 1. Phytochemical constituents of rapeseed-mustard seed meal

Constituent	Range
Total phenol (µg/g)	27.90-101
Total flavonoids (µg/g)	3.1-9.0
Phytic acid (mg/100g)	0.5-0.8
DPPH assay (% inhibition)	21.7-59.8
ABTS assay (% inhibition)	33.6-77

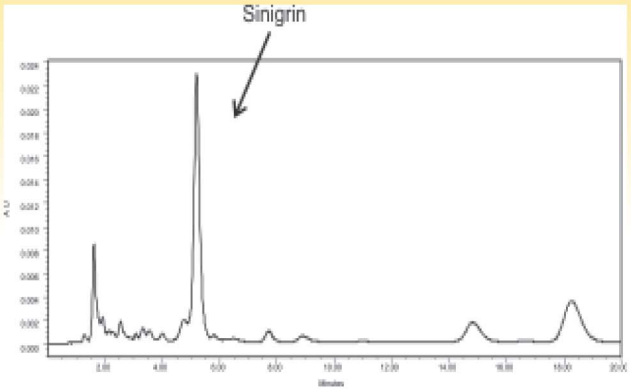


Fig.2.9. Glusinolate profile of seed meal of Indian mustard

Phytochemical characterization of Indian mustard hybrids and parental lines

Leaves of 10 Indian mustard hybrids and thirteen parental lines were collected at 13 different stages. Methanolic extract of the dried leaf samples were analyzed for total phenol, flavonoids, total glucosinolates and ascorbic acid content. Glucosinolate profiling was also carried out but no significant variation was observed in the pattern. Antioxidant assay of methanolic extract using DPPH and ABTS method showed high percentage inhibition of free radicals generated *in vitro* (Table 2).

Table 2. Phytochemical constituents of air dried leaves of Indian mustard hybrids and parental lines at three different stages

Parameter	Range					
	35 DAS		50 DAS		80 DAS	
	Hybrids	Parents	Hybrids	Parents	Hybrids	Parents
Total phenol (µg/g)	71.8-119.6	65.2-118.9	64.6-104.3	57.9-111.3	83.0-215.4	58.3-139.4
Total flavonoids (µg/g)	319.2-514.7	312.0-580.1	212.0-270.7	188.5-270.7	293.5-557	229.7-484.3
Vitamin C (%)	*	*	0.3-0.7	0.3-1.7	0.2-1.4	0.2-1.7
Glucosinolate (µ mole/g)	15.3- 22.7	17.1- 27.0	11.2- 30.3	13.1- 25.0	20.8- 38.4	22.6- 43.7
DPPH assay (% inhibition)	25.4- 31.3	26.7- 31.2	31.6- 35.7	31.1- 35.4	40.9- 60.7	38.6- 61.5
ABTS assay (% inhibition)	12.3- 15.3	11.7- 16.4	12.9- 18.4	12.4- 19.4	26.5- 37.1	23.1- 37.5

* not analysed, DAS= days after sowing

DRMR BT 01: *In vitro* plant regeneration and genetic transformation of *Brassica juncea* L. Czern. & Coss. with an antifungal defensin gene

Project leader: Ajay Kumar Thakur, Scientist (Plant Biotechnology)

Associates: B.K. Singh, Scientist (Plant Biotechnology), Sandeep Kumar, Scientist (Biochemistry) and P.D. Meena, Sr. Scientist (Plant Pathology)

A high frequency plant regeneration protocol has been standardized for *Brassica juncea* var. NRCDR 02 using cotyledonary petiole explants. The highest frequency of shoot regeneration (4.6 shoots/explant) was obtained on MS medium supplemented with 1.0 mg/l BAP and 0.1 mg/l NAA with 86.7% explant regeneration. The highest frequency of root regeneration was obtained on MS medium supplemented with 0.30 mg/l IAA (Fig. 2.10).

A B

Fig. 2.10 a. Shoot (from cotyledonary petiole explants) and b. root (from *in vitro* developed shoots) regeneration in Indian mustard (*Brassica juncea*) var. NRCDR-02

DRMR BT 2: Allele mining for stress tolerance genes in *Brassica* related species

Project leader: Binay Kumar Singh, Scientist (Plant Biotechnology)

Associates: Sandeep Kumar, Scientist (Biochemistry) and Ajay Kumar Thakur, Scientist (Plant Biotechnology)

21 wild species of *Brassica* and allied genera were multiplied in the crop season 2009-10 and seeds were harvested. High molecular weight genomic DNA was isolated and full length defensin gene was amplified from *Camelina sativa* through PCR.

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

Project leader: Binay Kumar Singh, Scientist (Plant Biotechnology)

Associates: K.H. Singh, Sr. Scientist (Plant Breeding) and Ajay Kumar Thakur, Scientist (Plant Biotechnology)

Cross transferability and polymorphic potential of 67 STMS markers developed in different *Brassica* species were evaluated using 21wild species of *Brassica* and allied genera.

2.3 CROP PRODUCTION

DRMR CP 6: Use of organic farming in rapeseed-mustard production

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

Integrated nutrient management

Two field experiments were conducted to identify sustainable mustard based land utilization for semi arid region of Rajasthan. The first experiment was conducted in split-plot design with 3 replications. The treatments consisted of 3 main plot, *viz*., (control, mustard straw @ 2.5t/ha + Sesbania (green manure), *Azotobactor* (100 g/kg seed) + *Sesbania* (green manure) and eight fertility levels (N 80, 40, P_2O_5 40, 20 and K_2O 0, 40 kg/ha) as sub-plots. The experimental soil was sandy loam, medium in organic carbon and phosphorus and low in available nitrogen. The green manure crop, *Sesbania* was sown in first week of July, with recommended doses of fertilizers (20:40:0) and was incorporated into the soil after 54 DAS. The mustard straw was incorporated into the soil in *kharif* season before sowing of *Sesbania*. In

rabi season, *Rohini* variety at Indian mustard was sown on Oct. 26, 2009 with a row spacing at 30 cm using 5 kg seed/ha. The plant-to-plant distance was maintained at 10 cm by thinning at three weeks stage. Half dose of N and whole dose of P_2O_5 were applied as basal, whereas the remaining N was applied after first irrigation. Incorporation of mustard straw + *Sesbania* green manure gave maximum seed yield (2406 kg/ha) followed by *Azotobactor* (seed treatment, 100g/kg seed) + *Sesbania* green manure (2016 kg/ha), which was 69% higher over fallow-mustard crop sequence. The higher yield in this treatments was mainly due to significantly higher number of siliquae / plant. Among fertility levels, application of 80 kg N + 40 kg P_2O_5 + 40 or 0 kg K_2O gave significantly higher mustard seed yield as compared to other levels. The interaction effect indicated that mustard straw + *Sesbania* recorded maximum seed yield (3093 kg/ha) at 80 kg N + 40 kg P_2O_5 + 40 kg K_2O but was at par with the same fertility level with out potassium application.

In another experiment, after 4 years of transitional phase the experiment was conducted with 4 main plots *viz.*, subsistence, conventional, organic and integrated farming practices and six treatment combinations (control, *Sesbania* green manure, cluster bean green manure, mustard straw @ 2.5t/ha, vermicompost @ 5.0t/ha and FYM @ 10.0 t/ha) with and with out inorganic nitrogen as sub-plots. The experimental soil was sandy loam, medium in organic carbon and phosphorus and low in available nitrogen. The green manure crops (*Sesbania and* cluster bean) sown in first week of July with recommended doses of fertilizers and were incorporated into the soil after 54 DAS. The mustard straw was incorporated into the soil during *kharif* season. Vermicompost and FYM were applied one month before mustard sowing. *Rohini* variety of Indian mustard was sown on Oct. 24, 2009 with row spacing of 30 cm using 5 kg *Azotobactor* treated seed/ha(100g/kg seed). The plant-to-plant distance was maintained at 10 cm by thinning at three weeks stage. Half dose of N (as per treatment), whole dose of P_2O_5 and 25 kg Biopower were applied as basal, whereas the remaining N was applied after first irrigation. Application of sole organics gave maximum seed yield (2755 kg/ha) of mustard after four years, which was 12% and 48% higher over conventional and subsistence farming, respectively. Among the fertility management practices growing of *Sesbania* during *kharif* followed by mustard recorded significantly higher seed yield of mustard over other practices. Addition of inorganic nitrogen further increased the seed yield of mustard in all the fertility management practices. The positive interaction effect between nutrient management system and fertility management practices indicated that growing of *S*esbania as green manure in the pure organic system gave significantly higher seed yield than any other combination.

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

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

Associates: Kapila Shekhawat, Scientist (Agronomy)

Influence of phosphate solubilizing bacteria and vesicular arbuscular mycorrhizae on mustard

A field experiment was conducted to study the effect of phosphate solubilizing bacteria (PSB) and vesicular arbuscular mycorrhizae (VAM) application in combination with chemical fertilizers on mustard productivity in complete randomized block design with 4 replications. The experiment consisted of twelve treatments *viz.*, control (T_1), PSB (T_2), VAM (T_3), PSB+VAM (T_4), 40 kg P_2O_5/ha as basal (T_5), 40 kg P_2O_5/ha as basal + PSB (T_6), 40 kg P_2O_5/ha as basal + VAM (T_7), 40 kg P_2O_5/ha as basal + PSB +VAM (T_8), 35 kg P_2O_5/ha as basal + 2% DAP spray at 50% flowering (T_9), 35 kg P_2O_5/ha as basal + 2% DAP spray at 50% flowering + PSB (T_{10}), 35 kg P_2O_5/ha as basal + 2% DAP spray + VAM (T_{11}), 35 kg P_2O_5/ha as basal + 2% DAP spray at 50% flowering+ PSB + VAM (T_{12}). The crop was fertilized

with 80 kg N (as per treatment), 40 kg P_2O_5 (as per treatment), 30 kg K_2O, 1.0 kg boron, 30 kg S, 5 kg Zinc through urea/ DAP, MOP, borax, gypsum, zinc sulphate, respectively. Application of 35 kg P_2O_5/ha as basal + 2% DAP spray at 50% flowering with or with out PSB/ VAM/ PSB+VAM inoculation significantly increased seed yield over control. This treatment was at par with 40 kg P_2O_5/ha as basal alone + 2% DAP spray at 50% flowering with PSB/ VAM/ PSB+VAM inoculation. Inoculation of PSB/ VAM with phosphorus showed positive effect on seed yield of mustard while PSB/VAM inoculation or phosphorus application alone did not improve the yield of mustard over control.

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

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

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

The experiment was conducted during *rabi* season 2009-10 in spilt - plot design with 3 replications. The treatments consisted of five irrigation methods in main-plots, *viz.,* micro-sprinkler system (MS), MS followed by check basin (MS+CB), drip irrigation system (DS), DS followed by CB (DS+CB) and only CB irrigation system and in sub - plot 4 treatments of N doses, *viz.,* control (0), 40 kg/ha 80 kg/ha and 120 kg/ha. The initial soil pH and EC were 8.5-9.5 and 15-25 dS/m. The initial soil was poor in available N (125 kg/ha), medium in P (20 kg/ha) and medium in available K (245 kg/ha). MS and DS resulted in significantly higher increase in test weight over CB method, same trend was recorded in biological and seed yield. Contrary to this trend higher oil content was observed in CB but reverse trend was recorded in protein content. However, significantly higher oil and protein yield was recorded in MS and DS due to higher seed yield over CB, which followed similar trend in case of MS along with the CB irrigation systems. Among fertigation treatments, 80 kg N /ha was found at par with 120 kg N /ha. in enhancing the test weight, biological, seed, oil and protein yield .The maximum water was applied in CB to meet the crop water requirement it was less in case of DS and MS, where 50 % water was saved (Fig. 2.11). The water use efficiency increased substantially from CB to DS and MS.

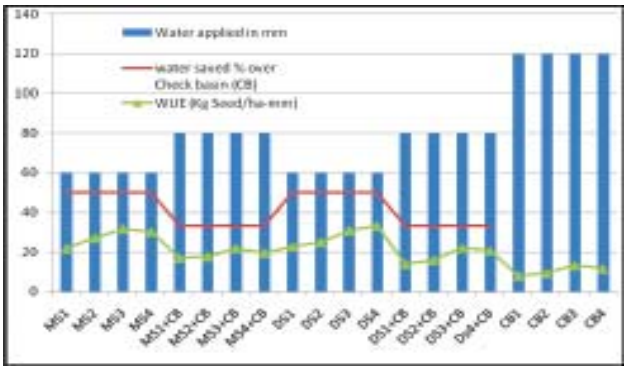


Fig. 2.11.Water applied (mm), water use efficiency (kg seed/ha-mm) and percentage water saved over check basin irrigation in mustard (cv Rohini).

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 (Agronomy)

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

To assess the impact of various RCTs on growth, yield attributes and yield, soil properties, soil moisture dynamics and economics of mustard based cropping systems, an experiment was conducted in the *rabi* season of 2009-2010. 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 beds (FIRB) in split-plot design. The initial soil pH and EC varied from 8.5-9.1 and 12-35 dS/m. The soil was poor in available

nitrogen (105-155 kg/ha), medium in available P_2O_5 (12-23 kg/ha) and medium in available K_2O (158-240 kg/ha).

Rohini variety of mustard was grown. It produced significantly higher seed, biological, oil and protein yields along with the highest water use efficiency under FIRB. The yield attributes and the yield (1954 kg/ha) produced was highest in FIRB as every alternate row of mustard took the advantage of border effect. Hence, the primary and secondary branches were also higher with FIRB. Oil and protein yields (844 and 377 kg/ha) under CT and RT were significantly higher than zero tillage, while protein content under CT was higher than RT and ZT. Hence, the yield obtained/unit of water applied (66.9 kg/ha-cm) was highest with FIRB. The residual moisture pattern indicated that the moisture depletion from the upper soil layer was maximum in FIRB followed by ZT, RT and CT (Fig.2.12). In FIRB, the water was applied in the furrows only while in CT the amount of water applied was maximum, therefore, the moisture retention was maximum in CT throughout the soil profile up to 1 metre.

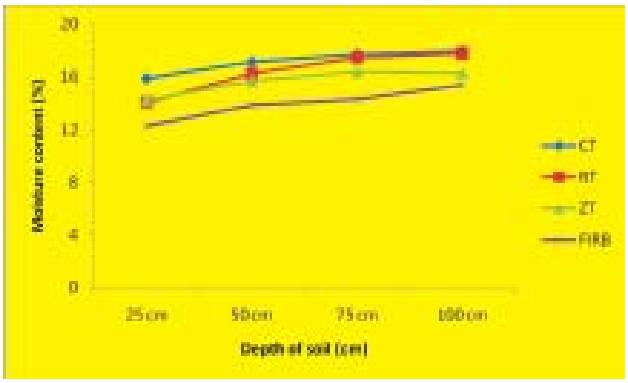


Fig.2.12. Soil moisture depletion pattern under various tillage methods.

2.4 SOIL SCIENCE

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

Project leader: N. S. Bhogal, Sr. Scientist (Soil Science)

Zinc and boron interaction in Indian mustard

NRCDR-2 was used to study the effect of zinc and boron interactions (zinc and boron deficient soil; 0.45 ppm zinc and 0.38 ppm boron) using a split-plot design. Four levels of zinc (0, 12.5, 25.0, 37.5 kg/ha Zinc sulphate) as the main-plots and 4 levels of boron (0, 5, 10, 15 kg borax /ha) as sub-plot were used in the plot size of 3.0 x 4.0 m with 4 replications. The sowing was done on October 24, 2010. Recommended dose of fertilizer (N: P_2O_5: K_2O 80:40:20) was added as the basal dose except for nitrogen, half of which was added as a basal dose and rest half after the first irrigation. Zinc and boron application increased the seed yield significantly up to 34 % and 19 % respectively. The highest seed yield (2200 kg/ha) was obtained when 37.5 kg zinc/ha was applied along with 15 kg B/ha. Secondary branches/plant were significantly affected by both Zn and B along with their interaction effects. Zinc contributed 7.1% and boron 13.8% to the secondary branches. Increasing levels of both Zn and B significantly increased the secondary branches. Siliquae/plant increased significantly by 20.2% and 22.9% with Zn and B application, respectively.

2.5 PLANT PHYSIOLOGY

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

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

Associate : J.S.Chauhan, Principal Scientist (Plant Breeding)

Twenty three indigenous and 37 exotic germplasm from Australia and China were screened for high temperature tolerance at seedling stage on the basis of germination imbibition and seedling mortality. The experiment was conducted in plastic trays filled with soil. The moisture level in soil was maintained by adding measured amount of water. 20 seed/genotypes were sown in rows. There were two sets of experiments, one set of tray was kept in BOD

incubator and allowed to germinate and grow at 25 ±1^{0}C. The other set of tray was exposed to 4 hours high temperature treatment (45 ±1^{0}C) and thereafter allowed to grow at 25 ±1^{0}C. The experiment was replicated thrice in complete randomized design. Seedling mortality due to high temperature was measured as per cent killed seedlings at 5th, 6th and 7th day after seed soaking. High temperature affected plumule growth more than that of the radicles (root). Germination and mortality was significantly influenced by available moisture and seed coat hardness. Genotypes with thinner seed coat imbibe more water and resulted in rapid germination rate. The exotic germplasm showed thinner seed coat and higher imbibition rate as compared to Indian germplasm. As far as the embryo weight is concerned, the Indian genotypes BPR 543-2 had highest embryo weight followed by PCR 7 and CS 54. JN 031 was the only exotic germplasm that showed higher embryo weight. Vigour index increases with advancement of growth and drastically reduced under high temperature condition. The Indian germplasm Pusa Mahak, Swarnjyoti, CS 54, JM 03, PCR 7, Bio 772, BPR 543-2, and NDR 8501 showed higher vigour index under high temperature. The vigour index has positive significant relationship with embryo weight (Fig 2.13). The genotypes with higher embryo weight showed higher vigour index hence better seedling growth. The mortality due to high temperature was measured with relation to soil moisture and it was found that the Indian genotypes BPR 543-2, CS 54, RH 8814, RB 50, Urvashi, NDYR 10 Bio 902 and Swarnajyoti showed < 10% mortality at 9.5% and 20% mortality at 6.5% soil moisture. Australian germplasm, JN 031 JM 016, JN 032, and JR 042 were rated as thermo tolerant genotypes as they showed less seedling mortality (< 10%) in soil. The study revealed that the germplasm with higher embryo seed weight and high vigour index showed low seedling mortality. On this basis BPR 543-2, CS 54, PCR 7 NDR 8501 and JN 031 were found as the promising accessions under high temperature.

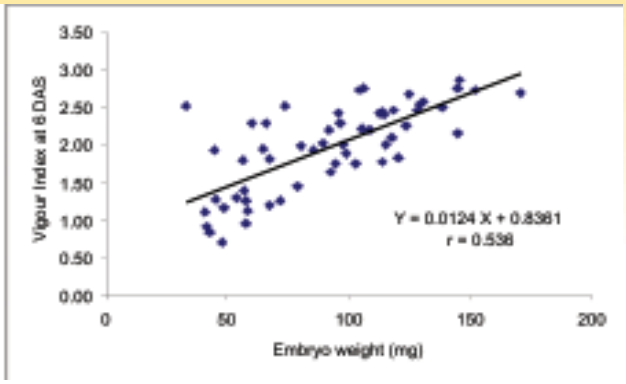


Fig.2.13. Relationship between embryo weight and vigour index in Indian mustard.

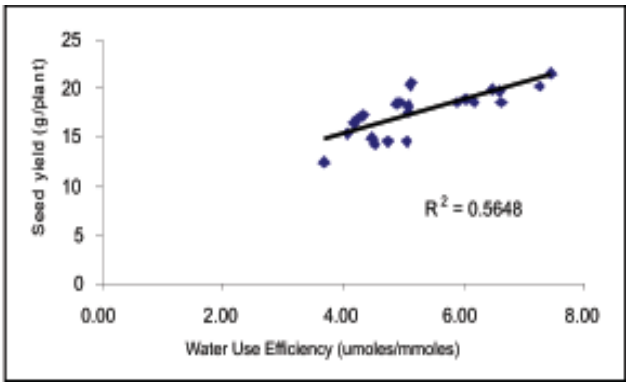
DRMR PHY 3: Morpho-physiological and biochemical basis of drought tolerance in Indian mustard

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

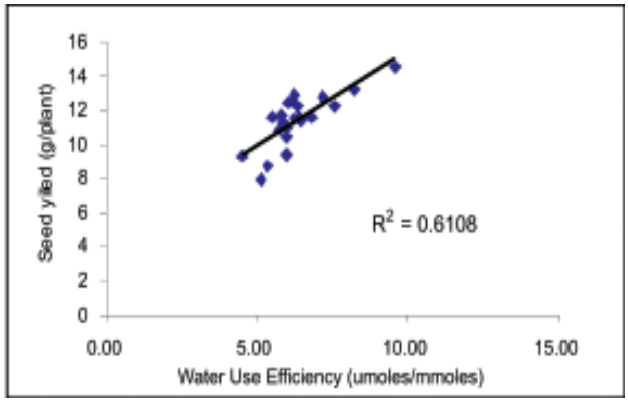
Associates : J.S.Chauhan, Principal Scientist (Plant Breeding), Satyanshu Kumar, Sr. Scientist (Organic Chemistry)

Experiment to study the water use efficiency and related characters i.e., photosynthesis, transpiration and stomatal conductance were carried out with 22 mustard genotypes in randomized complete block design. under irrigated and rainfed situation. There were 5 rows of 5 m length for each genotype. The spacing between rows and within plant genotype was kept at 30 cm and 15 cm respectively. The fertilizer dose of 40N: 20 P_2O_5 kg/ha. was applied just before sowing and remaining 40 kg N/ha was geiven just after the first irrigation, while in case of rainfed, the full recommended dose of fertilizer was given at the time of sowing. The need based plant protections measures were followed. Five competitive plants/ genotypes/replication were taken to record observations on yield and yield attributing characters. The leaf gas exchange was measured on a fully expanded welllit main stem leaflet. Gas exchange measurements (CO_2/H_2O) were carried out with a

climate-controlled cuvette system (CIRAS-2, PP System, Hitchin, UK). The gas exchange parameters were measured at bolting and full flowering stage during relatively clear days. For the characterization of photosynthesis, stomatal conductance g_s (mmol/m^2/S) and CO_2 assimilation A_{max} (µmol/m^2/S) were measured under near-optimal conditions. The leaf temperature was 20-25^{0}C and 60-70% RH. Water use efficiency (WUE) was cellular level is measured as the ratio of assimilation and the transpiration. The photosynthesis under irrigated condition varied from 18.2 (RH 819) to 27.2(BPR 541-4) at bolting stage while at flowering stage it varied from 13.2 to 21.4(BPR-349-9). The genotypes BPR-349-9, BPR-139-8, BPR-541-4 and BPR-543-2 showed higher photosynthesis than the others. The drastic reduction in photosynthesis rate was observed under rainfed situation and it varied from 14.5 (BPR-172-7) to 22.3 (Rohini and NRCDR-02) at bolting stage. While at flowering stage it showed variation from 10.3 to 17.1. The genotypes BPR 349-9, BPR 549-2, BPR 543-2 and NRCDR 02 showed higher photosynthesis rate under rainfed condition. The genotypes BPR-541-4, BPR 139-8, BPR-543-2 and BPR-540-6 showed high WUE under both irrigated and rainfed conditions. Under rainfed conditions the genotype BPR 543-2 showed 17% higher yield than check RH 819. BPR 537 and BPR 139-8 also harvested higher yield than RH 819. The study revealed that the genotypes BPR 541-4, BPR 543-2 were screened (Fig. 2.14).



(a)



(b)

Fig. 2.14. Relationship between seed yield and water use efficiency at flowering under (a) irrigated and (b) rainfed condition

2.6 ENTOMOLOGY

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

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

Evaluation of bio-agents

Three bio-agents *i.e. Coccinella septempunctata* @ 3,000 beetles/ha and 5,000 beetles/ha, *Chrysoperla carnea* @ 40,000 larvae/ha and 50,000 larvae/ha and *Verticillium lecanii* @ 10^7 CS/ml and 10^8 CS/ml were evaluated for their efficacy in net covered plots of 2 X 2 m size in 3 replications along with control. *Brassica juncea* var. PCR 7 was grown under late sown conditions. All 3 bio-agents were found effective in reducing mustard aphid population however, *C. septempunctata* @ 5,000 beetles/ha (seed yield 2229 kg/ha) was found most effective followed by *C. septempunctata* @ 3,000 beetles/ha (seed yield 2063 kg/ha) and *V. lecanii* @ 10^8 CS/ml (seed yield 1958 kg/ha).

Evaluation of biological control agents against mustard aphid under field condition

The experiment was conducted on three *Brassicas i.e. B. juncea* cv. PCR 7, *B. rapa* var yellow sarson cv. YST 151 and *B. rapa* brown sarson cv. BSH 1. The crop was planted in plot size of 4.2 x 3 m and

replicated thrice. The efficacy of *Verticillium lecanii, Coccinella septempunctata* and *Chrysoperla carnea* was evaluated against mustard aphid in two dosages. All the 3 bio-agents were found effective in reducing mustard aphid population (53-72%) over control. The yield in all the varieties was significantly superior in the treatments of *C. septempunctata* @ 3,000 beetles/ha (2063 kg/ha), *C. septempunctata* @ 5,000 beetles/ha (2229 kg/ha), and *V. lecanii* @ 10^8 over control (1958 kg/ha),

Integration of bio-agents along with plant products and insecticide for the management of mustard aphid

Sixteen treatments *viz*., T_1= *Verticillium lecanii* @ 10^8 CS/ml followed by *Coccinella septempunctata* @ 5,000 beetles/ha, T_2= *V. lecanii* @ 10^8 CS/ml followed by *Chrysoperla carnea* @ 50,000 larvae/ha, T_3= NSKE @ 5% followed by *C. septempunctata* @ 5,000 beetles/ha, T_4= NSKE @ 5% followed by *C. carnea* @ 50,000 larvae/ha, T_5= NSKE @ 5% followed by *V. lecanii* @ 10^8 CS/ml, T_6= *V. lecanii* @10^8 CS/ml followed by NSKE @ 5%, T_7= Dimethoate @ 1ml/litre followed by *V. lecanii* @ 10^8 CS/ml, T_8= Dimethoate @ 1ml/litre followed by *C. septempunctata* @ 5,000 beetles/ha, T_9= *V. lecanii* @10^8 CS/ml followed by Dimethoate @ 1ml/litre, T_{10}= Neem oil @ 2% followed by *C. septempunctata* @ 5,000 beetles/ha, T_{11}= Neem oil @ 2% followed by *C. carnea* @ 50,000 larvae/ha, T_{12}= NSKE @ 10% followed by *C. septempunctata* @ 5,000 beetles/ha, T_{13}= NSKE @ 10% followed by *V. lecanii* @ 10^8 CS/ml, T_{14}= Neem oil @ 4% followed by *C. septempunctata* @ 5,000 beetles/ha, T_{15}= Neem oil @ 4% followed by *V. lecanii* @10^8 CS/ml and T_{16}= control were applied in *Brassica juncea* var. PCR 7 keeping plot size of 4.2 X 3.0 m in 3 replications. The crop was sown under late sown condition to find out the efficacy of bio-agents along with plant products and insecticides. All the bio-agents/treatments were applied one by one after twelve days of previous application. The highest reduction (95.3 %) of aphid population after two application of bio-agent/insecticide/plant product was recorded in the treatment "Dimethoate @ 1ml/litre followed by *C. septempunctata* @ 5,000 beetles/ha (T_8)" and gave the highest seed yield (2585 kg/ha).

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 around 5°C) was evaluated for their feeding potential under controlled conditions in Environmental Chamber. Ten adults of each from laboratory reared and field collected cold tolerant *C. septempunctata* were kept separately in petri dishes in Environmental Chamber. Each petri dish was provided with 50 mustard aphids as food which was counted after 24 hours and replaced again. Such observations were made for three days at a temperature (15-20 ^{0}c) and fixed humidity of 70%. It was found that the feeding potential of field collected cold tolerant *C. septempunctata* was higher than the normal laboratory reared *C. septempunctata*.

Demonstration of best package of bio-control based integrated pest management at farmer's field

Best package of bio-control based integrated pest management was demonstrated at the farmer's field in village Paharsar (Nadbai), Bharatpur. The farmer's field was divided in to two parts, one part was kept for the treatment with insecticide dimethoate @ 1ml/litre followed by the release of *Coccinella septempunctata* @ 5,000 beetles/ha and other was kept as untreated control. It was found that treated block provided higher yield (2844 kg/ha) than the untreated control (2370 kg/ha) establishing the effectiveness of the bio-control based package.

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

Project Leader : Y. P. Singh, Sr. Scientist (Agrilcultural Entomology)

Associates: S. P. Singh, Sr. Scientist (Agrilcultural Entomology), Maharaj Singh, Sr. Scientist (Plant Physiology), J.S. Chauhan, Principal Scientist (Plant Breeding)

Screening of advanced breeding germplasm against mustard aphid

Sixty advanced breeding lines were evaluated to find out the resistance/tolerance against mustard aphid. Each accession was sown in paired rows of 3 m length in three replications. The aphid infestation was moderate in late stage and on the basis of Average Aphid Infestation Index (AAII) at full flowering and full pod formation stage, two accessions of taramira namely, RTM 1212 and RTM 2002 (AAII < 1.0) were rated as highly resistant. Forty three and 14 accessions were grouped as resistant (AAII 1.1-2.0) and moderately resistant (AAII 2.1 - 3.0), respectively.

Population dynamics of insect pests in rapeseed-mustard

The population of insect pests was observed on four species of rapeseed-mustard *i.e.* PCR 7 (Indian mustard), GSC 6 (gobhi sarson), BSH 1 (brown sarson) and YST 151 (yellow sarson). The maximum population of mustard aphid was in 8th standard week (19th to 25th February) and of leaf miner was during 10th standard week (5th to 11th March). Painted bug population was found maximum during 50th standard week (10th to 16th December) at early stage and during 14th standard week (2nd to 8th April) at later stage (Fig 2.15 a,b).

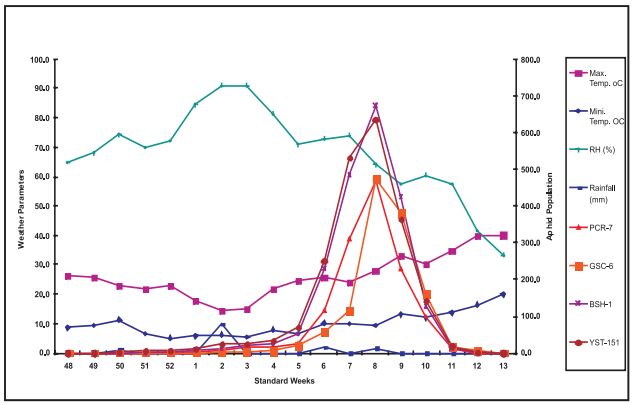


Fig 2.15 a. Population dynamics of mustard aphid

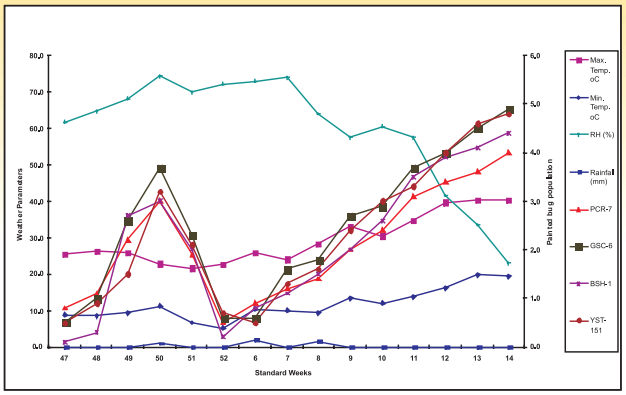


Fig 2.15 b. Population dynamics of painted bug

Eco-friendly approaches for the management of mustard aphid

The experiment was laid out in plot size of 4.2 x 3 m in three replications with *B. juncea* cv. PCR 7. Eight treatments *i.e.* NSKE @ 5% (T_1), neem oil @ 2% (T_2), azadirachtin 1500ppm @ 4 ml/litre of water (T_3), *Verticillium lecanii* @ 10^8 CS/ml (T_4), *V. lecanii* @ 10^8 CS/ml followed by NSKE @ 5% (T_5), *V. lecanii* @ 10^8 CS/ml followed by neem oil @ 2% (T_6), *V. lecanii* @ 10^8 CS/ml followed by azadirachtin 1500ppm @ 4 ml/litre of water (T_7) and control (T_8) were taken and the crop was sprayed twice. The pre and post spray population of mustard aphid (after 1, 3, 5, 7 and 10 days of each spray) was recorded. The highest mean reduction (76.3%) in aphid population and maximum yield (2251 kg/ha) were obtained in the T_2 followed by T_1.

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 alate aphid was first appeared during 48th standard week and attained the peak during the 7th standard week. The aphid was found to increase from 3rd standard week and reached to th peak in 7th standard week. Aphid population declined sharply from 10th standard week and no alate aphid population were observed after 13th standard week.

Contract Research: Testing of HP Mustard Spray oil

Bio-Efficacy of HP mustard spray oil against mustard aphid

The experiment was sown on November 5, 2010 in plot size of 4.2 x 3 m with three replications having *Brassica juncea* variety NRCDR-2. Eight treatments *i.e*. HP Mustard Spray Oil @ 0.50%, 0.75%, 1.00%, 1.25%, 1.50% and 1.75%, dimethoate 30 EC @ 1 litre/ha and control were taken and the crop was sprayed twice. The pre and post spray population of mustard aphid (after 1, 3, 5, 7 and 10 days of each spray) was recorded. The highest mean reduction (98%) in aphid population and maximum seed yield (2730 kg/ha) was obtained in the treatment of dimethoate @ 1 litre/ha. Significant higher yield 2489 kg/ha, 2525 kg/ha and 2560 kg/ha was obtained with the spray of HP Mustard Spray Oil @ 1.25, 1.50 and 1.75%, respectively, over the control (2228 kg/ha).

Efficacy of HP mustard spray oil against mustard aphid at farmers fields

HP Mustard Spray Oil @ 1.00%, dimethoate 30 EC @ 1 litre/ha and control were evaluated against mustard aphid at two farmer's fields of village Paharsar, Bharatpur. The late sown fields of these farmers were selected and divided in to three parts for above treatments and the crop was sprayed twice. At harvest the yield was recorded and converted into kg/ha. It was found that dimethoate 30 EC @ 1 litre/ha had the highest average yield of 2922 kg/ha. HP Mustard Spray Oil @ 1% provided the average yield of 2565 kg/ha and the control 2369 kg/ha. Application of HP mustard spray oil @ 1% at farmer's field increased seed yield by 8.3 % over the control (2365 kg/ha), however application of dimethoate 30 EC @ 1 l/ha gave 23% higher yield over the control.

Toxicity of HP mustard spray oil to honey bee and natural enemies

No mortality was recorded in the larvae of syrphid fly and grub of *Coccinella septempunctata* with the treatments of HP Mustard Spray Oil @ 0.50%, 0.75%, 1.00% and control. However, HP Mustard Spray Oil @ 1.25%, 1.50% & 1.75% and dimethoate 30 EC @ 1 litre/ha resulted in 6.6%, 16.6%, 20% and 100% mortality, respectively, of the grub of *Coccinella septempunctata* and 13.3%, 20%, 30% and 100% mortality, respectively, of the larvae of syrphid fly.

DRMR ENT 4: Management of insect-pests of Brassicas through environment friendly approach

Project Leader : Dr. S.P. Singh, Sr. Scientist (Agricultural Entomology)

Project Associate: Dr. Y.P. Singh, Sr. Scientist (Agricultural Entomology)

Role of different pesticidal formulations in the management of mustard aphid and Painted bug through seed treatment vis-à-vis spray

The experiment was conducted on mustard variety Pusa Jai Kisan in complete randomized block design with 3 replications in the plots of 4.2m x 3m size. The crop was sown on November 6, 2009. There were 10 treatments including control. Significantly low population of aphid (47-55 aphid/plant) was observed under the seed treatments done with imidacloprid 17.8 SL @ 7 ml/kg seed, imidacloprid 70 WS @ 7 g/kg seed, thiamethoxam 25WG @ 7 g/kg seed and fipronil 5 SC @ 7 ml/kg seed when compared with control (131 aphid/plant). Similarly, the spray of imidacloprid 17.8 SL @ 40g a.i./ha, thiamethoxam 25WG @ 50 g a.i./ha, fipronil 5 SC @ 75g a.i./ha and dimethoate 30 EC @ 300g a.i./ha caused significant reduction to the mustard aphid population (20-27 aphid/plant) when compared with control (131 aphid/plant). Water spray alone did not provide any effect on mustard aphid population (128 aphid/plant) when compared with control treatment. All the treatments except seed treatment with fipronil 5 SC @ 7 ml/kg seed have provided significantly higher yield (2110-2490 kg/ha) when compared with control (1560 kg/ha). Most favourable incremental cost-

benefit ratio was obtained under the treatment i.e. dimethoate 30 EC @ 300g a.i./ha followed by imidacloprid 17.8 SL @ 40g a.i./ha spray and imidacloprid 17.8 SL @ 7 ml/kg seed. Therefore, dimethoate 30 EC @ 300g a.i./ha proved to be the best treatment. High mortality of natural enemies and pollinators was observed under imidacloprid 17.8 SL @ 40g a.i./ha while other treatments were more or less safe to the natural enemies and pollinators.

Bio-efficacy and phytotoxicity studies of botanicals and detergent against mustard aphid

The experiment was conducted on mustard variety Pusa Jai Kisan in complete randomized block design with 3 replications in the plots of 4.2m x 3m size. The crop was sown on November 6, 2009. There were 10 treatments namely, green chilly extract 5%, red chilly extract 5%, neem seed kernel extract 5%, neem oil 1%, neem oil 2%, neem guard 0.1% , karanj oil, detergent 0.1%, water spray and control. Significantly low population of aphid was observed under all the treatments (23-35 aphid/plant) when compared with control (129 aphid/plant) and water spray (121 aphid/plant). However, among the treatments poor aphid control was observed under the treatment i.e. detergent 0.1% and red chilly extract 5% when compared with other treatments. Water spray did not play any role in controlling the aphid. No phytotoxicity symptom were observed on the crop under any treatment. Significantly higher yield was observed under all the treatments (2060-2240 kg/ha) except red chilly extract 5% and detergent 0.1% over the control (1490 kg/ha). Most favourable incremental cost-benefit ratio was obtained under the treatments i.e. Neem Guard(0.1%) followed by green chilly extract 5% and neem seed kernel extract 5%. All treatments were found safer to the natural enemies and pollinators.

Long term study on pest scenario, status of natural enemies and pollinators under recommended and farmers practice

The experiment was conducted on mustard variety was Rohini in three block of 40m x 20m size. The crop was sown on November 6th , 2009. There were 3 treatments viz., recommended practice, farmers practice and control. Under the recommended practice fertilizers like DAP, urea, potash, zypsum, boron and zink sulphate were applied in recommended doses while endosulfan dust was applied to control the soil insects during early stages of crop. Folior spray of dimethoate 30 EC @ 300g a.i./ha was done twice to keep the aphid population under check. Under the farmers practice only DAP, urea and zypsum was applied while folior spray of dimethoate 30 EC @ 300g a.i./ha was done twice to control the aphid population. Aphid infestation was significantly low under both the recommended practice (21 aphid/plant) and the farmers practice (23 aphid/plant) over the control (134 aphid/plant). It was interesting to note that the population of weed namely, *Asphodelus* spp. was quite high in the control treatment. Significantly higher yield (2480 kg/ha) was obtained under the recommended practice when compared with the farmers practice (1820 kg/ha) and control (820 kg/ha).

DRMR ENT 5: Pesticide residue studies in Rapeseed-Mustard

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

Associates : Y.P.Singh, Sr. Scientist (Agricultural Entomology), N.S. Bhogal, Sr. Scientist (Soil science)

Thirty soil samples were collected from the experiment namely "Role of different pesticidal formulations in the management of mustard and painted bug through seed treatment vis-à-vis spray" to evaluate the residue of different insecticides in soil samples after harvesting of mustard crop. Analysis of insecticides i.e. imidacloprid 17.8 SL, imidacloprid 70 WS and thiamethoxam 25WG was carried out using HPLC while fipronil 5 SC and dimethoate 30 EC were analyzed by GC. Analysis of residue indicates that the residue of insecticides was below detectable level (ppm) in soil samples of respective insecticides. However, no residue was detected in water spray and control. The detection limit for HPLC was 0.02ppm while for GC it was 0.05ppm.

2.7 PLANT PATHOLOGY

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

Project Leader: Pankaj Sharma, Sr. Scientist (Plant Pathology)

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

Epidemiology

Epidemiological studies of Sclerotinia rot were done using 3 dates of sowing from October 8, 2009 at three-weeks intervals with four replications in plot size of 4.8 x 5 m using cultivar Rohini of Indian mustard. Soil moisture at weekly interval, soil pH at 3 week intervals and disease incidence were recorded apart from petal infection and weather data. Incidence of Sclerotinia rot was positively correlated with soil moisture, pH and weather parameters including temperature, relative humidity and rainfall (R^2:0.44, 0.38 and 0.59, respectively). Combination of clear sky with low temperature, high soil moisture and low soil pH during the critical stage of 60-70 days after sowing, favoured higher Sclerotinia rot incidence. Based on Sclerotinia rot incidence (%) and 10 independent variables, a multiple linear regression model has been desceibed : Sclerotinia rot incidence(%) = 11.2351 + 0.9529*BSSH + 4.93924* eva + 3.83308* pH + 0.60885* RF (mm) - 0.406458* RH 720 + 0.524095* RH1420 + 0.17386* soil moisture (%) - 0.30461*T max - 0.677744*T min - 2.19556* WS. Soil pH sloped down in all plots till the middle of crop season and then almost evened to pre-sowing figure, particularly in the plots where the rot incidence was higher. Under petal infection study, some petals were found infected with ascospore of *S. sclerotiorum* in October 29 sowing during the critical stage (flowering). Rainfall also played an important role during the early flowering stage which increased carpogenic infection of *S. sclerotiorum*. Maximum incidence of Sclerotinia rot was observed in October 29 sown as compared to November 8 and 19 sown crop.

Germplasm Screening

One hundred twenty six (56 indigenous and 70 exotic) germplasm lines of *Brassica juncea, B. carinata* and *B. napus* were screened in *Sclerotinia* infested plot, sown on October 27, 2009 in single row of 3 m length with 30 x 10 cm spacing maintaining two test rows / plot along with border rows of cv. Rohini (susceptible check) in randomized block design with two replications. Pathogen inoculum was multiplied in laboratory on autoclaved *Sesbania* leaves and sorghum grain in glass jars and mixed with soil prior to sowing. The test lines were sprayed at 45 days after sowing with mycelial suspension of the pathogen after growing them in the laboratory on potato dextrose broth. Further, the plants were inoculated with the pathogen growing on potato dextrose agar and tied to stem with parafilm. All the test lines were found susceptible except EC 597274 (*B. napus*), EC 597329 *(B. juncea)* and EC 597340 (*B. juncea*) which showed tolerance.

Management

A trial on management of Sclerotinia rot was laid out in randomized complete block design with 10 treatments (including control) in 4 replications on Sclerotinia infested plots. The crop was sown on October 27, 2009 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). Seed treatment with garlic bulb extract (1% w/v) and carbendazim @ 2g/kg seed. At 65 days after sowing a foliar spray of boron, garlic bulb extract and carbendazim was applied. Seed treatment and foliar spray of carbendazim provided significant (P= 0.05) disease reduction (93.0%) and highest seed yield among the treatments over control. Both myceliogenic and carpogenic infections were minimum in carbendazim treatment. However, application of mustard cake gave significantly higher yield (1695 kg/ha) and oil content (43.2%) as compared to control (1104 kg/ha and 40.7%).

Molecular variability among isolates

Purified DNA was amplified with 50 primers of 10-mer arbitrary sequences *viz*., OPA01 to OPA20, OPB01 to OPB20, OPS06 to OPS10 and OPZ11 to OPZ15. The amplified products were fractionated on 1.8% agrose gel electrophoresis. The fingerprints generated by presence ('1') or absence ('0') of a band of a particular molecular weight was scored as allele at a single locus. The dendrogram (Fig 2.16) was constructed by the Unweighted Paired Group Method of Arithmetic Average (UPGMA) based on Jaccard's similarity coefficient with SHAN program of NT-sys. 45 Primers produced 692 scorable amplicons ranging in size from 190 to 3600 bp. Out of these, 385 fractionated fragments were reported polymorphic. The polymorphism was detected for 1.3 to 2.7 kb amplified product. On an average, 13-14 unambiguous and reproducible amplified products were generated by single primer (minimum of 4 and maximum of 23 fragments). The present investigation confirmed the diversity in *S. sclerotiorum* isolates determined on the basis of molecular criteria (Fig. 2.17). All the 17 geographical isolates of *S. sclerotiorum* were placed in to four groups based on the presence and absence of the amplified products. These major clusters were further divided into sub cluster.

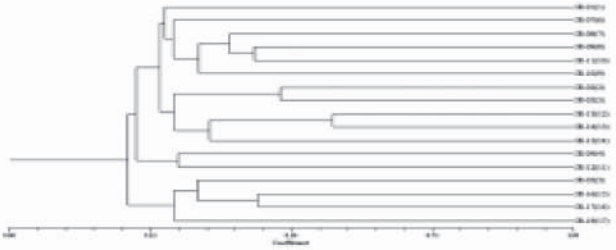


Fig 2.16. Phylogenetic tree generated through 45 RAPD primers

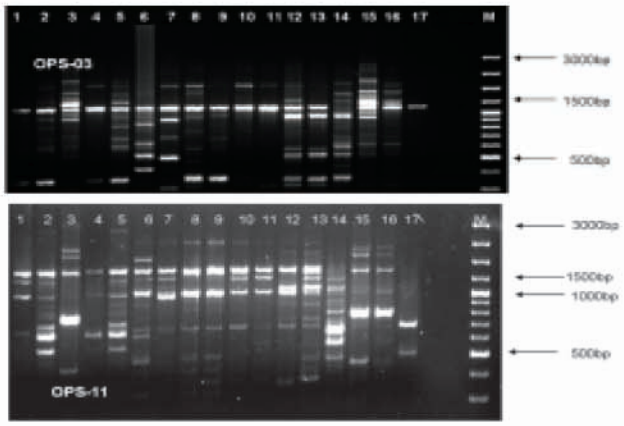


Fig 2.17. RAPD Fingerprints of 17 *Sclerotinia sclerotiorum* isolates

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

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

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

Germplasm Screening

Sixty one germplasm lines alongwith cultivar Varuna (susceptible check) of oilseed Brassica were sown in single row plot of 3 m length at 30 x 10 cm spacing in randomised complete block design with 2 replications for screening against Alternaria blight disease. Plants were inoculated by spraying the inoculum from local isolate of *Alternaria brassicae*. Disease severity (%) was recorded using Conn *et al* 1990 scale. Genotypes, Diviya 22 (12.7%), ELM 134 (14.3%), PHR 2 (15.2%), RK 08-2 (15.7%), LET 14-1 (15.9%), NRCHJ 1103 (17.5%) and NPJ 24 (17.8%) showed tolerance over check variety Varuna (30.3%).

Integrated disease management

Integration of cultural, chemical, biological and physiological components was tested to reduce the Alternaria blight disease severity. Maximum Alternaria blight disease reduction (26%) was observed using soil application of potash @ 40 kg/ha + zinc sulphate @ 25 kg/ha + copper sulphate @ 40 kg/ha + sulphur @ 10 kg/ha + ridomil MZ-72 as foliar spray @ 0.25% followed by their foliar spray (21%). However, removal of three lower leaves at 40 days after sowing and foliar spray of Ridomil MZ-72 @ 0.25% reduced the disease by 19% followed by leaf removal alone (18.9%) over control.

Variability among isolates

Eighteen isolates of *Alternaria brassicae* collected from different locations of the country were tested

for variability at different pH levels using Radish Root Mannitol Agar medium at 25 °C and 100% relative humidity. Isolates SS-7, SS-5, SS-13, and SS-18 showed poor mycelial growth at pH 8 while, SS 12, SS 6, and SS 17 grew well. Isolates SS 5, SS 3 and SS 1 showed less growth while, SS 11, SS 2 and SS 12 had more growth at pH 7 (Fig. 2.18).

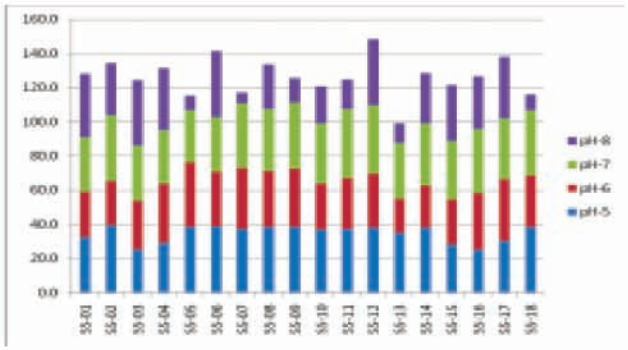


Fig 2.18. Mycelial growth of *A. brassicae* isolates at different pH levels

Conservation of cultures

Out of 30 pure single spored cultures available in the repository at DRMR, 5 isolates (BAB 01 to BAB 05) have been deposited at NBAIM, Mau during September 2009 to develop the national repository.

DRMR PP 4: Development of simple technique for germination of oospore in *Albugo candida*

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

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

Oospore germination

Universal tubes were filled with 9 ml of distilled water and autoclaved to sterilise. A 1% mixture of ß-glucuronidase and arylsulfatase was prepared by making a 1/50 dilution of the stock 20μl enzyme in 0.980 ml [1 ml] sterile distilled water (SDW) in sterile glass vial to prepare 1 ml aliquot or 1 ml enzyme in 49 ml SDW in sterile bottle. Then 1 ml quantity was added to 9 ml of SDW. The 10 ml vials were then stored in the refrigerator. Germination of oospores was recognized by the formation of germ tubes or sessile vesicles and the disappearance of the central reserve globule and granular contents. Plants were then drop inoculated using a micropipette and incubated in a growth chamber. All the work pertaining to preparation of inoculum and inoculation was carried out in a sterile environment inside a laminar flow cabinet. The suitable method for oosporic germination of *A. candida* was through revival using gut enzymes and subsequently inoculation with sporangia on host plant instead of direct inoculation of ground oosporic material with seed.

Host–pathogen interaction

The host genotype, inoculum concentration, and incubation temperature had significant effects on white rust infection. The day/ night temperature of 17°C to 22°C was more favourable to fungal growth on host. Infection levels increased with the concentration of inoculum on cultivar at both the 2 leaf and 5 leaf growth stages of *B. juncea*. White rust pustules increased at a faster rate when the mean temperature was 11.5-12.5°C, mean RH > 75%, cloudy weather coupled with precipitation. Delay in sowing until after October 25 increased the disease intensity. Late planting (October 3rd week or November Ist week) caused high incidence (43%) and severity (32%) of stag heads in mustard.

DRMR PP 5: Epidemiology and management of white rust

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

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

Epidemiology

The experiment was laid out under randomised complete block design in plots of 5 x 4.8 m size, at 30 x 10 cm spacing on 3 dates of sowing at 2 weeks intervals, starting from October 24, 2009 with 4 replications using cv. Rohini. Soil moisture was recorded at weekly interval apart from weather data

and was correlated with the severity of the disease. A sharp increase in disease intensity was observed during the last week of January under foggy and moist weather conditions in early as well as late sown crop. The lowest disease severity on leaves was observed on October 27 sown crop whereas, maximum severity was observed on late sown *i.e.* November 10 and 24, sown crop. Similarly, average stag head formation was maximum in late sown crop. The disease severity on pods was maximum on November 10 sown crop followed by November 24 sown crop.

Management

The experiment was laid out in randomised complete block design using 08 treatment combinations including control. The sowing was done on October 27, 2009 in plots of 5 x 3 m size at 30 x 10 cm spacing. The seed treatment with Apron SD @ 6g/kg seed was done at the time of sowing whereas, other chemicals *viz*., dithane M-45 (0.2%), ridomil (0.2%) and multineem (0.1%) were applied twice as foliar spray on January 12 and 27, 2010. The maximum disease reduction on leaves (51.7%) was recorded in multineem sprayed crop followed by ridomil and dithane M-45 (33.3% each). However, the maximum reduction in disease on pods was recorded with foliar spray of ridomil. Seed treatment with apron SD alone recorded minimum disease reduction, both on leaves and pods, as compared to combined treatments of apron SD and other chemicals.

Screening

Fourteen promising genotypes of rapeseed-mustard including cv Rohini, susceptible check, were screened under artificial inoculation. The experiment was laid out in 3 rows of 3 m length with 30 x 10 cm spacings. The sowing was done on October 28, 2009. Artificial inoculcation was done twice, on January 16 and February 1, 2010 using sporangial suspension of *A. candida*. Disease severity was recorded before the first inoculation on January 14, 2010 and after I and II inoculation on January 25 and February 18, 2010, respectively. None of the *B. juncea* lines, including exotic, showed resistance to the disease. However, *B. napus* and *B. carinata* lines showed resistance.

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

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

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

Development of recombinant inbred lines (RIL) population

F_1 seeds from the crosses between 6 selected parental lines of *Brassica juncea* were harvested. Crosses were Rohini X PHR 2, Rohini X PBR 97, Rohini X EC 399301 (for mapping QTLs for *Altrenaria* tolerance), Rohini X RH 819 and Rohini X NRCDR 2 (for mapping QTLs for drought and heat tolerance). 25 F_1 seeds from each of the 10 crosses were raised during summer season of 2009 at IARI, Regional Station, Wellington. *Alternaria* blight spots were observed and number of lesions and lesion size were recorded on third lower leaves at vegetative and reproductive stage. Number of lesions in Rohini (susceptible parent) ranged from 42 to 50 whereas, 10 to18 in other parents (tolerant). In F_1 population, the number of lesions ranged from 6 to 20 in all the crosses. The lesion size in F_1 was smaller as compared to susceptible parent. Spot colour was light brown and concentric rings were not observed. Further, pollen fertility test for some of the F_1 plants of each of the 10 combinations was performed. F_1s has been initially characterized morphologically in the cross PHR 2 X Rohini and its reciprocal. Violet colour stain present on leaf (midrib along with veins) of PHR 2 was introgressed into offspring developed in the cross PHR 2 X Rohini and its reciprocal. One male fertile and disease free plant was selected for selfing. Matured F_2 seeds were harvested separately from

each selected $F_{1s.}$ Harvested F_2 seeds of 8 combinations out of 10 crosses were sown during crop season 2009-10 for generation advancement.

Polymorphic survey

60 RAPD and 67 SSR (derived from *Brassica nigra* and *B rapa*) primers were used for characterizing F_{1s}. Total 271 RAPD bands were scored across the six parental lines. Out of these, 169 were polymorphic. Primers generated between 5-22 bands with an average of 13.5 bands/primer. Size of scorable bands ranged from 400-2700 bp. Male specific bands were observed in F_{1s} (Fig.2.19, 2.20).

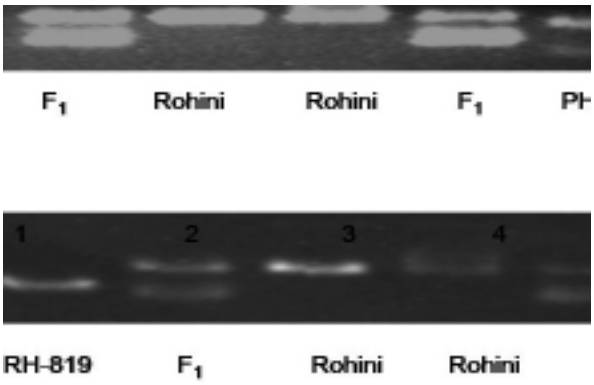


Fig 2.19. Confirmation of F1s using STMS markers derived from B.nigra and B.rapa

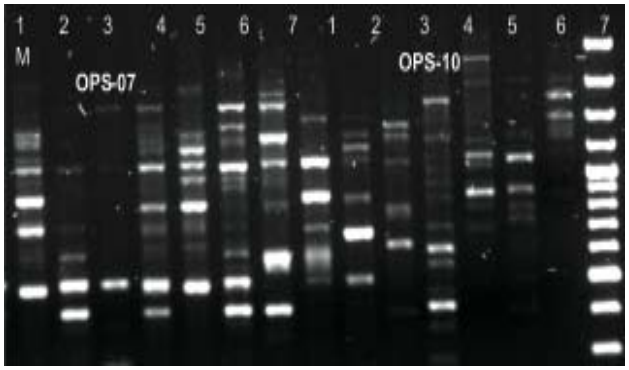


Fig 2.20. RAPD profile (1. Rohini; 2. PHR-2; 3. PBR-7; 4. EC.399301; 5. RH-819; 6. NRCDR-2; 7. RTM-314 and M- 100 bp DNA ladder)

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

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

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

Variability among *Alternaria brassicae* isolates

Alternaria isolates were obtained from various rapeseed-mustard tissues collected from different locations in India. In addition to morphology, 20 isolates of *Alternaria brassicae* were tested for variability at different pH levels using Radish Root Mannitol Agar medium at 25 °C and 100% relative humidity. Results indicated the existence of variability among the isolates. However, few isolates were found virulent and some were less virulent. Based on characteristics of single-spored colonies, all *Alternaria* isolates could be grouped into four colony types. Group 1 consisted of colonies that were lettuce green to olive green and usually had a prominent (2 to 5 mm) white margin. Colony texture was effuse to cottony. Isolates typically produced colonies over 70 mm in diameter after 7 to 10 days. These characteristics were most similar to those of the *A. brassicicola* representative culture. Host differential study of *Brassica* spp. was under taken using detached leaf technique for 15 *Alternaria brassicae* isolates. Preliminary results indicated the variability exist towards virulence among the isolates.

2.8 AGRICULTURAL EXTENSION

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

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

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

The investigation studied the prioritized technological needs of the farmers with regard to important pests and diseases of rapeseed-mustard in 3 districts with high productivity (Alwar, Agra and Morena) and 3 with low productivity (Dausa, Jhansi and Datia) spread across Rajasthan, Uttar Pradesh and Madhya

Pradesh states. The important pests and diseases were mustard aphid, painted bug, sawfly, termites, Alternaria blight, white rust, Sclerotinia rot and powdery mildew. Thirty farmers of large, medium and small-marginal categories from each of the districts indicated their prioritized technological needs by ranking the 8 important pests and diseases problems they faced, in order of importance, giving details of the extent of damage due to each problem. A 2 way frequency table was prepared keeping problems in rows and ranks in the columns and Rank Based Quotient (RBQ) was computed for each problem. The estimated average loss from these problems was also ascertained to know the magnitude value (MV) and to determine the priority ranking of the problems. The district wise RBQ and MV for the 8 problems indicated mustard aphid as the most prioritized problem in all the six districts followed by white rust disease in Jhansi, Dausa, Agra and Morena districts, Alternaria blight in Datia district and Sclerotinia rot in Alwar district. In the districts with low productivity, mustard aphid (MV: 2930), Alternaria blight (MV: 1608), white rust (MV: 1588), Sclerotinia rot (MV: 1051) and saw fly (MV: 650) were the 5 top problems and in the districts with higher productivity, mustard aphid (MV: 2880), white rust (MV: 2178), Sclerotinia rot (MV: 1855), painted bug (MV: 1210) and Alternaria blight (MV: 911) were the five prioritized problems. Based on the summated scores (number of farmers x importance of problem), RBQ and MV, the 5 prioritized pests and diseases problems across the 6 districts were mustard aphid (MV: 2905), white rust (MV: 1900), Sclerotinia rot (MV: 1416), Alternaria blight (MV: 1228) and painted bug (MV: 928).

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

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

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

A standardized scale was developed to measure the extent of adoption of recommended practices of mustard cultivation by the farmers based on the data collected from 240 farmers and 30 experts. The 12 major practices of mustard cultivation were included in the scale. The weightage adoption scores of major and sub-practices were assigned based on importance of each practice as perceived by farmers and experts. The relevancy per centage, relevancy weightage and mean relevancy score of the practices along with the validity and reliability was also ascertained for standardization of the scale. The level of adoption was rated on the basis of total score as low (< 40%), medium (40-60%), high (60-80%), and very high (> 80%).This standardized scale can be used to study the level of adoption of recommended practices to devise a suitable extension strategy.

Scale to measure the level of adoption of technology of mustard cultivation

Adoption practices	Adoption score
Improved variety	**5**
Certified seed of recommended variety	5
Own seed of recommended variety (first year)	3
Seed of recognized private firm	4
Uncertified seed from fellow farmers	2
Field preparation	**6**
One plough with Mould Board plough	1
Recommended ploughing (4-5 ploughing and planking after every ploughing)	2
Well pulverized, drained and leveled field	3
Less or more than recommended ploughing	1
Soil treatment (Application of endosulphan 4% or quinalphos dust)	**2**
Less than 20 kg/ha	1
20-25 kg/ha	2
More than 25 kg/ha	1

Seed treatment	**3**
Treatment with metalaxyl (apron 35 SD) @ 6 g/ kg seed or carbandazim @ 2-2.5 g/ kg seed.	2
Treatment with 2 % garlic bulb extract	2
Treatment with phosphate solubilizing bacteria (PSB)/ Azotobactor	1
Time of sowing	**6**
Last week of September	5
First fortnight of October	6
Second fortnight of October	4
First fortnight of November	3
Seed rate and spacing	**10**
Recommended seed rate (kg/ha)	4
3-4	3
4-5	4
5-6	3
Recommended row to row distance (cm)	2
25	1
30	2
35	1
Recommended plant to plant distance (cm)	2
5	1
10	2
15	1
Recommended depth of sowing (cm)	2
3	1
4-5	2
6	1
Fertilizer management	**20**
Application of nitrogen	8
Dose of nitrogen (kg/ha)	5
40-60	3
75-80	5
> 80	4
Method of nitrogen application	3
Full dose at the time of sowing	1
Half dose at the time of sowing by drilling and half dose at the time of first irrigation by top dressing	3
Full dose at the time of first irrigation	1
Application of phosphorus (kg/ha)	6
Dose of phosphorus (kg/ha)	4
25-30	2
30-40	4
> 40	1
Method of phosphorus application	2
Full dose at sowing time by placement method	2
Any other method	1
Application of sulphur (kg/ha)	3
25-30	2
40	3
> 40	1
Application of Zinc (kg/ha)	2
10-15	1
25	2
> 25	1
Application of other required micronutrient	1
Recommended dose	1
Irrigation management	**10**
One irrigation only at pre-bloom stage of 35-40 days after sowing	7
Two irrigation (35-40 and 60-65 days after sowing)	10
Any other	6
Weed management	**4**
Hoeing (15-25 days after sowing)	4
Weedicide	2

Harvesting and threshing		**4**
Harvesting of the crop early in the morning when 75-80% siliquae have turned golden yellow and seed moisture about 30-35 %		2
Threshing by thresher when seed moisture is about 15-20 %		1
Storage of the seed when moisture content is about 8 %		1
Any other		1
Plant protection measures (1 mark for right insecticide/fungicide and 1 mark for right dose)		**20**
Pest management		10
Name of pest	Control	
Painted bug	Endosulphan 4% or quinalphos 1.5% dust @ 20-25 kg/ha or Malathion 50 EC @ 500 ml/ha or Endosulphan 35 EC @ 625 ml/ha	1+1
Aphid	Dimethioate 35 EC 1000 ml/ha	1+1
Mustard sawfly	Malathion 50 EC @ 500 ml/ha or endosulphan 35 EC @ 625 ml/ha	1+1
Bihar hairy Caterpillar	Endosulphan 4% dust @ 20-25 kg/ha or malathion 50 EC or endosulphan 35 EC @ 1000 ml/ha	1+1
Pest control	Insecticides recommended by Govt. agency (specify)	1+1
Disease management		10
White rust	Mancozeb (dithane M 45) @ 2 kg/ha	1+1
Alternaria blight	Mancozeb (dithane M-45) @ 2 kg/ha	1+1
Sclerotinia rot	Spray of 2% garlic bulb extract solution or Spray of 0.1 % carbandazim	1+1
Downy mildew	Mancozeb (dithane M-45) @ 2 kg/ha	1+1
Disease control	Fungicides recommended by Govt. agency (specify)	1+1
Other recommendations		**10**
Frost management		1
Spray of dimethyl sulphoxide (0.5 ml/1 lit.), difolatan (0.2%) and dithane (M-45 0.3%)		1
Burning of waste material, dung or straw to produce smoke		1
Irrigate the field at 10-15 days interval when the temperature is low		1
Spray of thio-urea @ 0.1 % at the time of 50% flowering		1
Removal of surplus leaves after 40 days of sowing		1
De-topping		1
Sowing in north-east direction		1
Sowing of pure seed without mixing of fertilizers		1
Application of gypsum for soil reclamation		1
Addition of FYM in the field		1
Green manuring		1
Any other (Specify)		1

DRMR ECT 3: Participatory validation and transfer of the DRMR's technology package for Indian mustard

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

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

Twenty demonstrations on DRMR's mustard package were conducted in one acre area each in Paharsar, Andhiyari, Aau and Hathaini villages of Bharatpur district during the *rabi* 2009-10. The package for one acre included improved variety/ hybrid seed (NRCHB-506 and NRCDR-2), soil treatment with 4% endosulfan dust (10 kg basal), urea (35 kg basal and 35 kg top dressing), SSP (100 kg basal), MOP (25 kg basal), elemental sulphur (4 kg basal), zinc sulphate (10 kg basal), borax (4 kg basal) and need based plant protection measures under irrigated condition. NRCHB-506 hybrid had an average yield of 2510 kg/ha, the yield improvement of 20.1% over the farmers' package and the average additional net monetary return of Rs 7,500/ha. While, the package with NRCDR 2 variety of Indian mustard had an average yield of 2625 kg/ha, the yield improvement of 24.4% over the farmers' package and the average additional net monetary return of Rs 10,125/ha.

2.9 COMPUTER APPLICATION/ARIS CELL

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

Project Leader: Vinod Kumar, Scientist, SS (Computer application in agriculture)

Associates: A. K. Sharma, Sr. Scientist (Agricultural Extension), P.D. Meena, Sr. Scientist (Plant Pathology)

In the digital photo library software some additional feature such as connoisseur annotated metadata based image retrieval for searching accurate image was developed. Images were annotated by the subject matter specialists before image submitted in the image database. The images were critically analyzed and described using agriculture research scientific vocabulary. Improvement in functionality of software updating and adding of more photos in database is continuing.

The website of DRMR developed and regularly updated as per guidelines of ICAR. The new URL of website is www.drmr.res.in

DRMR CA 2: Rapeseed-mustard genetic diversity information management system

Project Leader: Vinod Kumar, Scientist, SS (Computer application in agriculture)

Associate: Dr. K. H. Singh, Sr. Scientist (Plant Breeding)

Rapeseed-mustard plant germplasm information system (RMpgis) includes notified varieties, advance breeding lines and germplasm accessions and presently developed for retrieval of notified rapeseed-mustard varieties characterized on the basis of DUS guidelines. The system enables searches to the identity, origin, DUS characters. System interface is very user friendly, user can make the query simply by selecting options in general such as crop name (Indian mustard, karan rai, brown sarson, yellow sarson, taramira, toria and gobhi sarson) genotype (notified varieties, advance lines, germplasm accessions, etc.) and descriptors (passport, leaf, flower, plant, siliqua, maturity, seed, etc). For making error free data input the system provides drop down combo of range of character values.

Services

- Scientists were facilitated data analysis, report preparation and presentation
- Terminal (PC) trainings were given to the staff of DRMR to enhance their computer skill and improve work efficiency.

2.10 AGRICULTURAL ECONOMICS

DRMR AE 1*:* Techno-economic assessment of production and processing of rapeseed mustard in Rajasthan.

Project Leader: Lijo Thomas, Scientist (Agriculture Economics)

Associates: Ashok Kumar Sharma, Sr. Scientist (Agricultural Extension) and R. C. Sachan, Technical Officer

Data with respect to use of information sources, its pattern and other relevant information were collected from 60 oil processing units from Bharatpur and Alwar districts of Rajasthan to study. Relevance of the source of information for the oil mills was calculated based on relevancy coefficient.

Number of Information sources used

It was found that the modal class of respondents used 4 sources and the number of sources ranged from 2 to 8. The most of the oil mills used multiple channels for sourcing information. Out of the selected respondents, 76.7% used more than 3 information sources. The remaining oil mills used ≤ 3 sources of information. This showed the tendency of the firms to triangulate the information from different sources. The use of multiple information sources might have arised due to the difference in the message content provided by different sources. Information sources like 'traders' provided micro level information whereas, sources like 'national newspapers' provided a wider perspective to the mill owners. This led to the dependency on multiple sources to get comprehensive information. The modal class represented by the usage of four communication channels denoted the most common level of usage of information sources (41.7%).

Penetration of information sources

The number of respondents using a particular source among the sample indicated the penetration and coverage of each source. The results indicated that 'traders' were the most widely used source of information due to high market dependency of the oil mills to procure inputs and for the sale of their outputs at the most profitable rates. The market price for the raw material (rapeseed-mustard) fluctuates widely both intra-seasonally and on a day-to-day basis. 'Newspaper', as a traditional source of information got good credibility among the oil mills and this role of newspapers is now being supplemented and shared by television. The increase in the number of local TV channels with relevant information on markets and the increase in the number of programmes dealing with markets and commodities were factors leading to its wide usage. The peer held information is used by 60% of the respondents. A noteworthy feature was the use of internet by 40% of the respondents. The 'technical publications' and the 'government departments' were the least used sources.

Relevance of sources

The relevancy of the source of information determines the impact on the decision making of the firm. Higher the relevancy coefficient, higher will be the chances that information from that particular source will be used in decision making. The relevancy rating revealed that sources like 'Traders', 'Internet', 'Govt. Departments' and 'Television' carried information with high relevance to the oil mills. The sources like 'Radio', 'Other oil mills' and 'Technical publications' were perceived to have message content with low relevance to the oil mills. Traders, as a source of information had the highest relevancy coefficient of 0.84 followed by internet with a relevancy coefficient of 0.83. A two way classification matrix based on the relevance and level of penetration of different sources of information provides inputs for the policy to be followed to promote the information availability and spread among the stakeholders. Sources with high relevance and low penetration (Internet, Government Department) need further popularization. The reasons for the low relevance perceived for 'technical bulletin' needs further study to reform the message content in suitable forms.

3 Transfer of Technology

Beej phakwada organized

12th *Beej Phakwada,* Directorate's popular endeavor to reach out to the mustard growing farmers through the sale of quality seeds and counselling for situation specific varietal selection along with advice on improved package of practices was organized during September 7-21, 2009. About 400 mustard farmers, mainly from Rajasthan and Uttar Pradesh took advantage of this out reach programme conducted annually and appreciated efforts in providing quality seeds at affordable prices and technical guidance.

Radio programmes from DRMR

Recognizing the vast potential of radio programmes and reaching out to large farming community, DRMR has been sponsoring technology delivery modules through radio talks. For the *rabi* season 2009-10, it sponsored 6 weekly radio programmes from Agra, Mathura, Najibabad and Rampur stations (Uttar Pradesh) and Jaipur and Swai Madhopur stations (Rajasthan) with 114 episodes on the package of practices for rapeseed-mustard.

Video stories for *Krishi Darshan* programme

Shootings of four short video stories (agronomic management, disease management, pest management and beekeeping) were completed at DRMR farm and in the villages of Bharatpur district on Dec 9, 2009 by a team of Doordarshan Kendra, New Delhi in which three scientists from DRMR and an expert from a local NGO worked as resource persons. These stories were telecasted from the Rashtriya *Krishi Darshan* programme from the second fortnight of Dec 2009.

Frontline demonstrations on Indian mustard

Twenty frontline demonstrations (FLDs) on varietal component with NRCHB 506 (hybrid) and NRCDR 2 variety of Indian mustard were laid out under the umbrella of AICRP-RM at Paharsar, Andhiyari and Hathaini villages of Bharatpur district, Rajasthan during *rabi* season 2009-10. These FLDs were conducted in plots of one acre each to show the production potential of improved varieties/hybrid of mustard. On the basis of 8 locations, the hybrid

NRCHB 506 had an average yield of 2350 kg/ha against the average yield of 2110 kg/ha from Rohini with a yield improvement of 11.4%, while the improved variety NRCDR 2 had an average yield of

2460 kg/ha against the average yield of 2190 kg/ha from Rohini with a yield improvement of 12.3%. The additional net monetary return (ANMR) from the hybrid NRCHB 506 ranged from Rs 4,625/ha to Rs 6,625 /ha with an average of Rs 5,750 /ha. The ANMR from the improved variety NRCDR 2 ranged from Rs 5,000/ha to Rs 8,750/ha with an average of Rs 6,750 /ha.

Model training course

An 8-day Model training course (MTC) on production technology of rabi oilseeds (rapeseed-mustard, safflower and linseed) was organized during November 23-30, 2009. A total of 16 senior

agriculture research and extension officers from Rajasthan, West Bengal, Chhattisgarh, Haryana, Gujarat, Andhra Pradesh and Uttar Pradesh participated in this training course.

The objective was to refresh and upgrade the knowledge and skill of extension personnel through lectures-cum-discussion sessions covering various aspects of recent and improved production, protection, seed production and post-harvest technologies. Screening of video films and interaction with the farmers in the nearby villages helped the participants in enhancing their skill and knowledge.

Farmers training on seed production

A 7-day farmers' training programme under ICAR Seed project "Seed Production in Agricultural Crops" was organized at the Directorate during December 18-24, 2009. Inaugurating the training, Acting

Director Dr. J. S. Chauhan 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, wheat, guar and daincha and motivate them for participatory seed production programme.

A total of 18 progressive farmers participated in the training. Dr. R. K. Choudhary, chief guest at valedictory function encouraged farmers to take up the participatory seed production programme so that

quality seed can be produced in large quantity and accelerate adoption of quality seeds.

Sarson vigyan mela-cum-exhibition

Chief guest Sh. Subodh Agrawal, IAS, Divisional Commissioner, Bharatpur inaugurated 16th Sarson vigyan mela-cum-Exhibition at DRMR, Bharatpur on Feb. 09, 2010. In his inaugural address, he advised the farmers to adopt low input technologies for reducing the cost of cultivation, identify farming

problems and make collective efforts to address them. Further, they should have positive attitude about emerging global agriculture scenario and emphasized the importance of proper marketing of agriculture produce. Ms. Suman Koli, Chairperson Nagar Parisad, Bharatpur presided over the function and called the farmers to be more pro-active and get the benefit of the scientists of the Directorate as well as various government schemes especially for empowerment for women.

Dr. J.S. Chauhan, Acting Director, DRMR in his address requested the farmers to adopt scientific technologies to increase production and productivity of rapeseed-mustard. Four technical bulletins namely "Seed production programme", "Integrated disease management", "Integrated pest management", "DRMR Developed varieties of rapeseed-mustard" were also released by the guests on the occasion. Dr. K. A. Singh, Director, IGFRI, Jhansi was the guest of honour.

Further progressive farmers were honoured for raising excellent mustard crop by applying scientific recommendations and winning quiz programme of Radio Krishi Shiksha Programme of DRMR broadcasted though AIR, Mathura during 2008-09.

The mela had many exhibition stalls representing industries, NGOs, banks, fertilizers/ pesticides agencies and been visited by more than 600 participants.

Integrated agro-met advisory services

About 102 suitable agro-advisories on real time basis based on analysis of weather data received from IMD were prepared and disseminated through various channels like telephone, FAX, email and SMS to farmers, extension workers, scientists, administrators, policy makers and media persons on regular basis for timely guidance to them.

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

Under the National Extension Programme for technology assessment and transfer initiated by IARI, New Delhi, a collaborative varietal interventions on pearl millet (cv PC-383), Sorghum chari (cv PC-9), Maize (cv Pioneer Swarna) and Green gram (cv Pusa Vishal) were made in 5.5 ha area of Aau village of Bharatpur district of Rajasthan in which 23 farmers participated during Kharif 2009-10. The trials were badly affected due to moisture stress and therefore

the true potential of these improved varieties could not be assessed, however, the farmers appreciated the superiority of these varieties vis-à-vis their own. During Rabi 2009-10, varietal interventions on wheat (HD 2851, HD 2733, DBW-17, PBW-550), lentil (L-4076), carrot (Pusa Rudhira) and onion (Pusa Red) were made in 6.2 ha area of Aau, Paharsar and Andhiyari villages of Bharatpur district in which 27 farmers participated. All the demonstrated wheat varieties had higher yield, uniform maturity and longer spike than the prevailing local varieties like Raj 3765, Lok-1, HD 2329, Raj 3077, etc. In terms of productivity, PBW-550 was the best yielder (av. 50 q/ha) followed by HD 2851 (av 48 q/ha), DBW-17 (av 45 q/ha) and HD 2733 (av 42 q/ha). The bold seeded lentil variety L-4076 had the average yield in the range of 12-15 q/ha. Pusa Rudhira variety of carrot was appreciated by the farmers for its colour, uniform size and sweet taste. Farmers appreciated all the demonstrated varieties and saved the seed for wider dissemination in and around their villages.

Study tour of Bharatpur farmers to Pusa *krishi vigyan mela*, New Delhi

DRMR mobilized 30 farmers from Bharatpur district to take part in 3- days Pusa Krishi Vigyan Mela at IARI, New Delhi during March 4-6, 2010. ATMA, Bharatpur sponsored the transportation and boarding

expenses of these farmers for their participation. A progressive farmer from the group Sh Harbhan Singh of Daurda village was felicitated at the Mela based on the recommendation of DRMR due to his enormous contributions in the field of transfer of technology.

4 Education and Training

Training imparted

A total of 70 students were enrolled for training and dissertation work during 2009-2010. Of these, 11 carried out research work for the fulfilment of Master's degree and remaining for project reports of 3-6 months duration.

Training attended

Name	Training Programme	Duration	Institute
Sandeep Kumar	21-days Summer School on Quality enhancement: Conventional and molecular approaches	July 15 – August 04, 2009	Division of Genetics, IARI, New Delhi
Vinod Kumar	Winter School on Bioinformatics and its applications in Agriculture	December 1-21, 2009	Bioinformatic Centre, KAU, Thrissur
J. Nanjunadan	Winter school on Application of Molecular Tools for Crop Improvement	December 2-15, 2009	SBI, Coimbatore
B. K. Kandpal	Management Development Programme on "Leadership for Innovation in Agriculture"	January 18-22, 2010	IIM, Lucknow, NOIDA Campus
P. K. Rai A. K. Sharma	Management Development Programme on PME of Agricultural Research and Development Projects	March 8-12, 2010	NIRD, Hyderabad

5 Awards / Recognition

Dr. Ashok Kumar Sharma, Sr. Scientist (Ag. Extension) was elected as Zonal Editor for Indian Journal of Extension Education published by Indian Society of Extension Education, IARI, New Delhi for 3 year duration.

Dr. P.K. Rai, Principal Scientist (Plant Pathology) was conferred fellowship by 'Hi-Tech Horticultural Society' on the occasion of National symposium on *Technological innovations for enhancing agricultural production*, CCS University, Meerut, October 3-4, 2009.

Sh. Karnal Singh, Technical Officer completed M.Sc. (Genetics and Plant Breeding) degree from Bulendkhand University, Jhansi under supervision of Dr. A.K. Misra, former Senior Scientist, DRMR, Bharatpur.

DRMR family extends hearty congratulations and wishes them a rewarding future.

6 Linkages and Collaboration

Mustard production forecasting

Ministry of Agriculture sponsored FASAL (Forecasting Agriculture output using Space, Agro-meteorology and Land based observations) programme to provide timely and precise estimates of acreage and production for policy decisions. Under this, Space Application Centre, Ahmadabad and DRMR ventured into a collaborative project for mustard forecasting. A multiple estimation of acreage and production at national/state level using multi-date AWiFS data and weather data is being done in the project. Ground Truth (GT) observations form 37 districts of UP, Rajasthan, Haryana and Madhya Pradesh were recorded during Nov.-Dec. 2009 and again in January 2010. The GT data and AWiFS data for identical period were analysed for acreage estimation. Dynamic crop growth simulation model "WOFOST" was used for yield and production forecasts.

Based on the data analysis and modelling about 6.25 mt mustard production from 5.80 m ha area was forecasted. At national level, an overall decrease in mustard acreage and production by 7.6% and 5.9%, respectively, was observed. At state level, Rajasthan and UP showed significant decrease in acreage 11.0% and 7.5%, respectively, and production 10.3% and 8.3%, respectively.

National level monitoring team for Andhra Pradesh

A national level monitoring team (NALMOT) constituted for monitoring and implementation of production programme of oilseeds, pulses and maize in Andhra Pradesh under Integrated Scheme for Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) programme of Govt of India, visited several villages in the Mahaboobnagar, Kurnool and Medak districts of the state during February 4-6, 2010. The team included the Director, Directorate of Oilseeds

Development (DOD), Hyderabad as convener and Dr. S. K. Jha, Senior Scientist, DRMR, Bharatpur, Dr. Manish Dagla, Scientist, DGR, Junagadh, Dr. G. Suresh, Senior Scientist, DOR, Hyderabad and Shri Adhikeshavalu, JDA (ISOPOM), Commissionerate of Agriculture, Govt. of Andhra Pradesh as members. Shri. S. S. Kagi, Senior Technical Assistant, DOD accompanied the team. The team had detailed interaction with the farmers and concerned officials and observed that farmers have been greatly benefited by water pipes, sprinklers, Taiwan sprayers, gypsum, etc supplied under the subsidy programme and there was more demand for them. It suggested the department to come out with publishing the success stories of "Higher yields of groundnut under sprinkler irrigation" (Mahaboobnagar) and the "Feasibility of red-gram cultivation in *rabi* (Medak district)" and to distribute widely for the benefit of large farming community.

Integrated agro-met advisory services

Indian Meteorology Department, Ministry of Earth Sciences, New Delhi sponsored Integrated Agro-met Advisory Services (IAAS) Project has been running at this Directorate since 2005. IAAS Unit is releasing medium range weather forecast for eastern flood plain zone of Rajasthan (Alwar, Bharatpur, Karauli, Swai Madhopur and Dholpur) in collaboration with National Centre for medium Range Forecasting, Noida. The advisory includes forecast for next 5 day

and contingency crop/farm planning. The information is communicated through Telephone, FAX, e-mail and SMS to farmers, extension workers, scientists, administrators, policy makers and media personnel on regular basis. One-day roving seminar on weather, climate and farmers was organised on March 27, 2010 at the Directorate to make farmers aware about the availability of weather related information and its impact on farming through IAAS. More than 110 farmers from the nearby villages attended the seminar.

Final meeting of ACIAR/GRDC project and 16th Australian research assembly on *Brassicas* held in Australia

Final meeting of ACIAR/GRDC project "Oilseed *Brassica* improvement in China, India and Australia" was held at University of Melbourne, Victoria on September 9-11, 2009. Drs. Arvind Kumar, Director, J.S. Chauhan, Principal Scientist, Maharaj Singh and Pankaj Sharma, Senior Scientist attended the meeting and 16th Australian Research Assembly on *Brassicas* at Ballarat, Victoria September 14-16, 2009.

The meeting was inaugurated on 9th September 2009 by Professor John Dewar, Deputy Vice Chancellor (Global Relations), University of Melbourne. Dr. Arvind Kumar presented key note address *Canola cultivation in India: scenario and future strategy*, Dr. J.S. Chauhan presented research paper on *Heat stress effects on morpho-physiological characters of Indian mustard (B. juncea L.)* and Dr. Maharaj Singh presented paper on *Drought induced changes in water use efficiency and other morpho-physiological characters in Indian mustard (B. juncea L.)*. Pankaj Sharma presented research paper on *Search for resistance to Sclerotinia sclerotiorum in exotic and indigenous Brassica germplasm*. He also presented a poster, *Eco friendly management of Sclerotinia rot in Indian mustard (B. juncea).*

Bio-efficacy studies of *Penicillium bilaii*

Novozymes Biological Limited, a biotech based multinational company and DRMR signed an agreement to test the bio-efficacy of two strains of *Penicillium bilaii* (Jumpstart 1 and Jumpstart 2) on soil phosphorous solubilisation, phosphorous use efficiency and mustard yield. The experiments were conducted at four locations (Sriganganagar, Hisar, Bharatpur and SK Nagar). The mean mustard seed yield over the centres ranged between 1.57 t/h in Bharatpur to 3.08 t/ha in Sriganganagar. At all the locations, application of P fertilizer significantly increased mustard seed yield. However, seed treatment with various *Penicillium bilaii* strains was found significantly effective at Bharatpur and SK Nagar centres only.

7 All India Coordinated Research Project on Rapeseed-Mustard

The 16th Annual Group Meeting of AICRP on Rapeseed-Mustard, organised by DRMR, Bharatpur was held at College of Agriculture, Nagpur (Maharastra) during August 6-8, 2009. The meeting was inaugurated by Professor Swapan K. Datta, Deputy Director General (Crop Science), ICAR. Dr S. V. Sarode, Director of Research, PDKV, Akola welcomed the Chairman, dignitaries and other participants.

Professor Swapan K. Datta, DDG (CS), ICAR in his inaugural address emphasized that rapeseed-mustard is the major source of income especially to the marginal and small farmers in rainfed areas, offer higher return with low cost of production and low water requirement. He stressed for development of better varieties suitable for various agro-climatic conditions. Research on crop management practices focusing on mitigating the adverse climate change need to be given a place of priority while formulating research strategies. The use of innovative agro-techniques, resource conservation technologies, precision farming, contingency crop planning, etc are some of the indicative areas of frontier research, emphasized Dr. Datta. Development of suitable machinery, studies on residue management, development and agronomic testing of varieties suitable for zero tillage, advantages and impact of land leveling on crop production , productivity and input use efficiency, etc are some other areas where research gaps exist which needs to be addressed suitably.

Professor Datta mentioned about the future action plan and thrust areas for rapeseed mustard crop such as, genetic enhancement for seed and oil yields, development of hybrids, varieties with heat and drought tolerance, developing surveillance mechanisms in view of changing climate, integrated management and optimization of scarce natural resources like rain water, surface and ground water, capacity building in emerging areas like bio-processing, bio-prospecting, bio-informatics, ICT and IPR management in view of the emerging global trends, post harvest technology, value addition, strengthening market surveillance and market intelligence.

Dr V.D. Patil, ADG (O&P), ICAR, in his address, highlighted the importance of rapeseed-mustard and key areas for enhancing the crop productivity.

Dr. Arvind Kumar, Director, DRMR Bharatpur, in his presentation, informed the house that thirty eight strains consisting 1 of toria, 36 of Indian mustard and 1 of taramira have been promoted for advance testing. Mustard hybrids NRCHJ 1103, 45S45 and PCJ 04-405 tested under initial hybrid trial have shown superiority. Against the indents, 132.2 q breeder seed of 63 rapeseed-mustard varieties was produced. He also reported that 26 cooperating centres conducted 612 FLDs in 67 districts across 17 states of the country. Under the normal sown irrigated conditions, the highest yield gap was 90.1%, 24.3%, 20.2% and 114.2% in case of mustard, *toria*, *yellow sarson* and *gobhi sarson*, respectively, in the whole package demonstrations.

During the meeting, 12 different sessions were organized and about 150 personnel from ICAR, SAUs, NGOs, personnel of state govt. and private seed companies attended the meeting. Two varieties viz. NRCDR 601and NPJ 112 of Indian mustard, one hybrid of Indian mustard namely PAC 432 and one variety of yellow *sarson* namely RYSK 05-02 were identified for release in this group meeting

8 Publications

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RAC members light the lamp and interacting with scientists

9 Research Programmes and Projects

SN	Institute Projects	Principal Investigator
1.	DRMR CI 2: Development of improved genotypes of Indian mustard with high yield, good quality of oil and seed meal.	J.S. Chauhan
2.	DRMR CI 5: Development of hybrids in Indian mustard.	K.H. Singh
3.	DRMR CI 6: Germplasm characterization and evaluation of rapeseed-mustard	J. Nanjundan
4.	DRMR CI 7: Collection, maintenance, conservation and documentation of rapeseed – mustard germplasm	J. Nanjundan
5.	DRMR CI 9: Genetic enhancement of Indian mustard by characterizing and introgressing the novel traits from the related species	S.S. Meena
6.	DRMR CI 10: Population improvement in Indian mustard	V.V. Singh
7.	DRMR CP 6: Use of organic farming in rapeseed - mustard production	O.P. Premi
8.	DRMR CP 7: *Orobanche* management in rapeseed-mustard	O.P. Premi
9.	DRMR CP 8: Studies on nutrient dynamics in Indian mustard	O.P. Premi
10.	DRMR CP 9: Enhancement of nutrient use efficiency in Indian mustard under limited moisture regime	O.P. Premi
11.	DRMR CP 10: Standardization of micro-irrigation and fertigation methods for mustard crop under semiarid conditions	S.S. Rathore
12.	DRMR CP 11: Evaluation and standardization of resource conservation technologies for mustard based cropping systems in semi arid conditions of Rajasthan	Kapila Shekhawat
13.	DRMR B 3: Biochemical aspects of *Brassica* quality and composition	Satyanshu Kumar
14.	DRMR B 4: Biomolecular characterization of rapeseed-mustard genotypes for genetic diversity and quality parameters	Sandeep Kumar
15.	DRMR B 5: Phytonutraceuticals from *Brassica*	Satyanshu Kumar
16.	DRMR BT 1: *In vitro* plant regeneration and genetic transformation of *Brassica juncea* L. Czern. & Coss. With an antifungal defensin gene	Ajay Kumar
17.	DRMR BT 2: Allele mining for stress tolerance genes in *Brassic*a related species	Binay Kumar Singh
18.	DRMR BT 3: Assessment of cross-transferability and polymorphic potential of genomic STMS markers of *Brassica* species.	Binay Kumar Singh

19.	DRMR PP 1: Management of Sclerotinia rot in rapeseed-mustard crop	Pankaj Sharma
20.	DRMR PP 3: Management of Alternaria blight in rapeseed-mustard crop	P.D. Meena
21.	DRMR PP 4: Development of simple technique for germination of oospore in *Albugo candida*	P.D. Meena
22.	DRMR PP 5: Epidemiology and management of white rust	P.K. Rai
23.	DRMR SS 1: Nutrient use efficiency under saline and alkali condition of soil and water in mustard crop.	N.S. Bhogal
24.	DRMR SS 5: Effect of the effluent water of oil refinery on germplasm of Indian mustard	N.S. Bhogal
25.	DRMR SS 6: Screening of germplasm of *Brassica juncea* for salinity tolerance	N.S. Bhogal
26.	DRMR SS 7: Boron nutrition of rapeseed-mustard	P. Kumararaja*
27.	DRMR SS 8: Evaluation of rapeseed-mustard germplasm for boron use efficiency	P. Kumararaja*
28.	DRMR ENT 2: Biological control of major pests of *Brassicas* with special reference to mustard aphid	Y.P. Singh
29.	DRMR ENT 3: Plant-pest interaction of major pests of *Brassica* with special reference to mustard aphid.	Y.P. Singh
30.	DRMR ENT 4: Management of insect-pests of *Brassica* through environment friendly approach	S.P. Singh
31.	NRC: P DRMR ENT 5: Pesticide residue studies in rapeseed-mustard	S.P. Singh
32.	DRMR PHY 1: Screening of mustard genotypes for high temperature tolerance at seedling stage	Maharaj Singh
33.	DRMR PHY 3: Morpho-physiological and biochemical basis of drought tolerance in Indian mustard	Maharaj Singh
34.	DRMR CA 1: Development of application software for rapeseed-mustard information management	Vinod Kumar
35.	DRMR CA 2: Rapeseed-mustard genetic diversity information management	Vinod Kumar
36.	DRMR AS2: To develop forecasting model for production of rapeseed-mustard.	A.P. Mishra**
37.	DRMR AS 3: Methodological advancement for effective and sustainable promotion of strains under AICRP on oilseed crops	A.P. Mishra**
38.	DRMR ECT 1: Study the pattern of rapeseed-mustard production problems, indigenous technical knowledge (ITK) and impact assessment of technology transfer programme	S.K. Jha

39.	DRMR ECT 2: Study the adoption pattern and farmers' perception of technological advances	A.K. Sharma
40.	DRMR ECT 3: Participatory validation and transfer of NRCRM's technology package for Indian mustard in Bharatpur district of Rajasthan	S.K. Jha
41.	DRMR AE 1: Techno-economic assessment of production and processing of rapeseed-mustard in Rajasthan	Lijo Thomas*
42.	DRMR AE 2: Development of trade statistics database for rapeseed-mustard	Lijo Thomas*
Externally aided projects		
43.	DRMR EA 2: Characterization of rapeseed-mustard varieties for distinctness, uniformity and stability	K.H. Singh
44.	DRMR EA 5: Oilseed Brassica improvement in China, India and Australia	J.S. Chauhan
45.	DRMR EA 6: Mustard production forecast using remote sensing data at national level {Under forecasting agricultural output using space agricultural meteorology and land based observations (FASAL) programme}	B.K. Kandpal
46.	DRMR EA 7: IP Management and transfer /commercialization of agricultural technology scheme	K.H Singh
47.	DRMR EA 8: Integrated agro-met advisory services	B.K. Kandpal
48.	DRMR NP 2a: ICAR NPTC: Development of aphid resistance transgenic *Brassica*	V.V. Singh
49.	DRMR NP 2b: ICAR NPTC: *Brassica* functional genomics for *Alternaria blight* and drought/heat tolerance	P.K. Rai
50.	DRMR NP 4: Seed production in agricultural crops and fisheries	V.V. Singh
51.	DRMR NP 5: Diagnosis and management of leaf spot diseases of field and horticultural crops	P.D. Meena

*On study leave, **Transferred out

10 IRC, RAC IMC and QRT Meetings

Institute Research Council

The 15th Institute Research Council (IRC) meeting was held during September 29-30 and October 1, 2009 under the Chairmanship of Dr. Arvind Kumar, Director, DRMR. The progress of research work done during 2008-2009 by respective sections was critically reviewed. The scientists presented the significant findings of their respective projects and set targets to be accomplished during the 2009-10. Dr. P. R. Kumar, Ex-Director, DRMR, an external expert appreciated the on-going research work and provided valuable inputs in shaping up the technical programme for the year 2009-10.

Institute Management Committee

The 12th Institute Management Committee (IMC) was held on November 27, 2009 under the Chairmanship of Dr. Arvind Kumar, Director, DRMR, Bharatpur. Joint Director of Agriculture, Department of Agriculture, Government of Rajasthan, Bharatpur, Dr. R. A. Singhania, Dr. R.K. Jain, Dr. C. Chattopadhyay, Sh. Harveer Singh, Sh. Mohan Singh and Sh. J. L. Sharma were the members present during meeting. The IMC approved the equipment and the civil work to be carried out at the Directorate and recommended installation of an ATM in the premises. The IMC members expressed satisfaction over the on-going research programme and also suggested to hold the IJSC meeting regularly.

Research Advisory Committee

DRMR held its 13th meeting of Research Advisory Committee (RAC) during February 13-14, 2010. Dr. J. B. Chowdhury (Ex-VC GBPUAT, Pantnagar), Chairman, Dr. A. S. Tiwari (Ex-Actg. VC, JNKVV, Jabalpur), Dr. S. N. Sharma (Ex-Prof & Head, Dept. of Agronomy, BHU, Varanasi), Dr. P.B. Kirti (Professor, Botany, Department of Plant Sciences, University of Hyderabad), Sh. Harveer Singh and Sh Mohan Singh, members attended the meeting.

Dr. J.S. Chauhan, Acting Director welcomed the Hon'ble Chairman and members. In his introductory remarks, Dr. J. B. Chowdhury advised the scientists to integrate modern tools of biotechnology with conventional approaches and also stressed the need of developing suitable mechanism for transgenic evaluation. He reminded the scientists that in the era of globalization, multi-disciplinary and multi-institutional national / international collaboration is imperative for the effective research programme. Dr. J.S. Chauhan presented research and development programme of the Directorate and AICRP-RM Research highlights for the year 2008-09. The scientists presented project-wise achievements. The RAC advised for more focused efforts in some of the areas especially creation of epiphytotic condition for screening germplasm against diseases under controlled environmental conditions, organic farming, resource conservation techniques and their effects on oil quality and soil micro-flora. In view of the climate change, development of high temperature tolerant varieties with high productivity per day is another area of priority, according to RAC. Acting Director assured the RAC for considering the suggestions during the programme formulation in the coming years. Dr. Y. P. Singh, member secretary thanked Chairman and members for sparing their valuable time and providing useful suggestions.

On February 14, 2010, the RAC members had in-depth interaction with the scientists and attended a "*kisan diwas*" at village Paharshar, Bhartpur and also visited front-line-demonstrations being in progress with mustard varieties and hybrids.

Quinquennial Review Team (QRT) for DRMR, Bharatpur and AICRP-R&M for the period 2004-2009.

The QRT team with Dr. B. Mishra, Vice Chancellor, Sher-e-Kashmir University of Agriculture Sciences and Technology, Jammu, Chairman, Dr. S.S. Banga, National Professor (ICAR), PAU Ludhiana; Dr. B.L. Sharma, Ex-Dean, Rajasthan Agricultural University, Bikaner; Dr. S.J. Kolte, Ex-Professor (Plant Pathology), GBPUAT, Pantnagar; Dr. O.P. Dubey, Ex-ADG (PP), ICAR, New Delhi, members and Dr. B.K. Kandpal, Principal Scientist, DRMR,

RRS, Bawal (CCS HAU, Hisar); ARS, Navgaon (RAU, Bikaner); ZARS, Morena (RVRS KVV, Gwalior); SKD Agril. University, SK Nagar and DRMR, Bharatpur during February 20-24, 2010; BHU, Varanasi and CSAUA&T, Kanpur during March 10-12, 2010

Bharatpur, Membeer Secretary held its first meeting with Dr. S.K. Datta, DDG (CS) at ICAR, Krishi Bhawan on February 4, 2010. Dr. Datta suggested the team to critically review the work done during the period and give constructive suggestions. The QRT also visited experiments being in progress at Division of Genetics, IARI, New Delhi. The team visited various experiments, laboratory facilities and interacted with concerned scientists as well as held discussion with policy planners and administrators at

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

Events	Venue	Period	Participants
Executive committee meeting of state food security mission	Secretariat, Jaipur	April 20, 2009	S. K. Jha
Review meeting of Indo-Australian project	ICAR, New Delhi	May 04, 2009	Arvind Kumar J.S. Chauhan
9th Agricultural science congress on technological and institutional innovations for enhancing agricultural income	Sher-e-Kashmir University of Agricultural Sciences & Technology, Kashmir, Srinagar	June 22-24, 2009	J.S. Chauhan
Scientific advisory committee meeting of KVK, Kumher (Rajasthan)	Krishi Vigyan Kendra, Kumher	July 16, 2009	S. K. Jha
Scientific Advisory Committee Meeting of KVK, Dholpur (Rajasthan)	Krishi Vigyan Kendra, Dholpur	July 17, 2009	B. K. Kandpal S. K. Jha
ICAR foundation day and Director's meet	New Delhi	July 16-17, 2009	Arvind Kumar
XVI annual group meeting of rapeseed-mustard research workers	PDKV, Nagpur (Maharashtra)	August 06-08, 2009	13 Scientists from DRMR
Breeder seed review meeting Review meeting of ICAR seed project	New Delhi New Delhi	August 19, 2009 August 24-25, 2009	Arvind Kumar Arvind Kumar V.V. Singh
ZREAC meeting of Zone III B (Flood prone eastern plain zone of Rajasthan)	Agriculture Research, Station, Navgaon	August 27, 2009	S. K. Jha
Workshop on "new technological innovations in oilseeds and pulses cultivation"	BAMETI, Patna	September 7-9, 2009	S. K. Jha
Final meeting of ACIAR-GRDC collaborative project on oilseed *Brassica* improvement in China, India and Australia	University of Melbourne, Melbourne	September 09-11, 2009	Arvind Kumar J.S. Chauhan Maharaj Singh Pankaj Sharma

16th Australian Research Assembly on Brassicas on Changing foods, changing climate and changing canola	Ballarat, Australia	September 14-16, 2009	Arvind Kumar J.S. Chauhan Maharaj Singh Pankaj Sharma
Fundamentals of GCMS, GCMS solution software and maintenance	Shimadzu Analytical Pvt. Ltd., Mumbai	September 22-23, 2009	N.S. Bhogal
Ist Indian agricultural scientists and farmers congress on technological innovations for enhancing agriculture production	Chaudhary Charan Singh University, Meerut	October 03-04, 2009	P.K. Rai
Indo-US sponsored international congress-cum-workshop on IPR	Amity Institute of Microbial Biotechnology, Amity University, U.P.	October 05-07, 2009	Arvind Kumar J.S. Chauhan
National seminar on designing crops for the changing climate	BAU, Ranchi	October 30-31, 2009	V.V. Singh K.H. Singh
Meeting of PGR export facilitation committee	NBPGR, New Delhi	November 06, 2009	Arvind Kumar
National seminar on information technology application in agricultural for livelihood security of farmers	RCA, MPUAT, Udaipur, Raj.	November 10-12, 2009	A.K. Sharma Vinod Kumar R.C. Sachan
5th International conference of Indian phytopathological society on plant pathology in the globalized era	IARI, New Delhi	November 10-13, 2009	P.D. Meena Pankaj Sharma
Ist meeting of state pest, surveillance and advisory unit	Pant Krishi Bhawan, Jaipur	December 04, 2009	Y.P. Singh P.K. Rai Pankaj Sharma
3rd annual review meeting of integrated agro-met advisory services	IIT Roorkee, Uttarakhand	December 10-12, 2009	B.K. Kandpal Pankaj Sharma
ISOPOM meeting to discuss the strategies for oilseeds and palm development programme	Krishi Bhavan, New Delhi	December 17, 2009	J.S. Chauhan B.K. Kandpal S.K. Jha
National symposium on recent global developments in the management of plant genetic resources	NBPGR, New Delhi	December 17-18, 2009	K.H. Singh V.V. Singh Maharaj Singh M. L. Meena
XX Indian convention of food scientists and technologist	NIMHANS Bangalore,	December 20-24, 2009	Satyanshu Kumar

Discussion on agro biodiversity hotspots, farmer's rights and international legislations and notification of DUS test guidelines of oilseed crops.	PPV& FR Authority, NASC Complex, New Delhi,	December 21, 2009	J.S.Chauhan K.H. Singh
74th annual convention of Indian society of soil science	IARI, New Delhi	December 22-25, 2009	N.S. Bhogal
National seminar on enhancing efficiency of extension for sustainable agriculture and live stock production	Indian Veterinary Research Institute, Izatnagar (U.P.)	December 29-30, 2009	A.K. Sharma R.C. Sachan
Second meeting of state pest, surveillance and advisory unit	Pant Krishi Bhawan, Jaipur	January 04, 2010	Y.P. Singh P.K. Rai
Meeting of Directors of crop science division	Krishi Bhawan, New Delhi	January 19-20, 2010	J.S. Chauhan S.K. Jha
QRT meeting with DDG (CS)	ICAR, New Delhi	February 04, 2010	J.S. Chauhan B.K. Kandpal
ICAR Director's conference and Vice Chancellor's meeting	NASC Complex, New Delhi	February 15-17, 2010	J.S. Chauhan
International symposium on current status and oppertunities in aromatic and medicinal Plants	CIMAP, Lucknow	February 21-24, 2010	Satyanshu Kumar
Indo-US bilateral workshop on plant genomics in crop improvement with reference to biotic and abiotic stresses	CCS HAU, Hisar in collaboration with Michigan State University East Lansing, USA	February 25-27, 2010	Sandeep Kumar
Workshop on Flyash in Agriculture	TERI, Delhi	March 09, 2010	N.S. Bhogal
Workshop organized by state department of agriculture, Government of Rajasthan on bridging the gap in mustard productivity in Rajasthan	Pant Bhawan, Jaipur	March 12, 2010	K.H. Singh S.S. Rathore
31st All India Rabi Oilseeds Seminar	Air Force Auditorium, New Delhi	March 12, 2010	S. K. Jha
National stakeholders workshop on Establishment of the Information Sharing Mechanism for Monitoring the Implementation of Global Plan of Action (GPA)	NBPGR, New Delhi	March 17, 2010	J. Nanjundan

Workshop on ICT Initiatives of the NAIP with special reference to the Uniformity Guidelines for ICAR websites	NBPGR, New Delhi	March 19, 2010	Vinod Kumar
Meeting-cum-workshop of ICAR Zonal Technology Management and Business Planning and Development, North Zone-1	IARI, New Delhi	March 19-20, 2010	K.H. Singh S.S. Rathore Sandeep Kumar
Germplasm Field Day	NBPGR, New Delhi	March 20, 2010	J.S. Chauhan S.S. Meena

Extended Forms:

BAMETI	- Bihar Agricultural Management and Extension Training Institute
BAU	- Birsa Agricultural University
CCS HAU	- Chaudhary Charan Singh Haryana Agricultural University
CIMAP	- Central Institute of Medicinal and Aromatic Plants
IARI	- Indian Agriculture Research Institute
ICAR	- Indian Council of Agricultural Research
IIT	- Indian Institute of Technology
MPUAT	- Maharana Pratap University of Agriculture and Technology
NASC	- National Agricultural Science Complex
NBPGR	- National Bureau of Plant Genetic Resources
NIMHANS	- National Institute of Mental Health and Neuro Sciences
PPV&FRA	- Protection of Plant Variety and Farmers Rights Authority
RCA	- Rajasthan College of Agriculture
TERI	- The Energy Resources Institute

QRT Chairman Dr. B. Mishra visiting field experiments and interacting with scientists

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

Visitors advisory services

Under visitors' advisory services, farmers-scientists interactions and counseling sessions on rapeseed-mustard cultivation were organized for 26 groups comprising 871 farmers and farmwomen and 64 students from Ajmer, Baran, Barmer, Bhilwara, Bharatpur Jhalawar and Jaipur districts of Rajasthan;Sitapur, Meerut, Mathura, Mainpuri, Mahoba, Mahamayanagar, Kansi Ram Nagar and Lucknow districts of Uttar Pradesh; Jhabua and Morena districts of Madhya Pradesh and Godhra district of Gujarat.

National workshop on remote sensing applications for rapeseed-mustard

A 2-day National workshop on 'Remote sensing applications for rapeseed-mustard' in collaboration with Space Applications Centre (ISRO), Ahmedabad under FASAL project was organized at DRMR, Bharatpur during September 23-24, 2009. A total of 27 personnel from State Remote Sensing Agencies of different states, AICRP-RM centres and DRMR participated in the workshop. Dr. N.K. Patel, Head and Dr. Ram Rajak, Sr. Scientist, Crop Models Division, Space Applications Centre, Ahmadabad, presented lead papers in the workshop. Various issues related to remote sensing applications for effective and accurate production forecast were discussed.

Kisan diwas at Paharshar

On February 14, 2010, Research Advisory Committee consisting of Dr. J. B. Chowdhury, Chairman, Dr. A. S. Tiwari, Dr. S. N. Sharma, Dr. P.B. Kirti, Sh. Harveer Singh and Sh Mohan Singh, members attended the

*kisan diwas*at at village Paharshar, Bhartpur organized by DRMR. About 150 farmers participated in this programme and visited frontline demonstrations laid out with mustard varieties and hybrids in the village. The RAC appreciated the efforts of the Directorate in establishing strong linkages with all the stakeholders which would essentially help in the speedy dissemination of generated technology.

Farmers awareness programme under integrated agro-met advisory sercives

Integrated Agro Advisory Sercives (IAAS), DRMR, Bharatpur organized one day Farmers Awareness Programme about weather and climate of the farming region, climate change and farming risks on March 27, 2010 in collaboration with Indian Meteorological Department (Ministry of Earth Sciences)**.** The programme was inaugurated by Dr. J. S. Chauhan, Acting Director, DRMR. The objective of the programme was to secure farmer self reliance, through helping them about effective weather and climate risk management by sustainable use of natural resources for agricultural production and also to increase overall preparedness better outcomes under adverse weather conditions. About 150 progressive farmers participated in the programme. Sh. R. C. Gupta, Director, IMD, Jaipur, Sh. B. K. Singh, Joint Director, (Oilseeds), Department of Agriculture, Bharatpur Division, Dr. Amar Singh, Programme Coordinator, KVK Kumher, Dr. Udaibhan Singh ,In-charge, ARSS, RAU, Kumher, Dr. Pankaj Sharma,Sr. Scientist, DRMR, Bharatpur, Sh. Deshraj Singh, Deputy Director, (Ag. Extension), Department of Agriculture, Bharatpur delivered lectures.

13 Distinguished Visitors

Name	Designation and address	Date
Prakash Goyal and Shyam Bhattad	K.S.Oils Ltd., Morena	April 24, 2009
Dr. P. R. Kumar	Ex-Director, DRMR, Bharatpur	September 29-30, -October 1, 2009
Prof. Dr. Ajit Verma	DG & Vice Chairman, Amity University, Noida	October 19, 2009
Dr. S.K.Datta	DDG (CS), ICAR, New Delhi	November 15, 2009
Dr V.D. Patil	ADG (O&P), ICAR, New Delhi	November 15, 2009
Dr. B. K. Singh	Joint Director, Deptt. Of Agriculture, Govt. of Raj.	November 27, 2009
Dr. R. A. Singhania	Dean (Ag.), RAU, Bikaner	
Dr. R.K. Jain	Head, Plant Pathology, IARI, New Delhi	
Dr. C. Chattopadhyay	Head, Plant Pathology, IIPR Kanpur	
Sh. Harveer Singh	Progressive Farmer, Bharatpur	
Sh. Mohan Singh and	Progressive Farmer, Bharatpur	
Dr. J. B. Chowdhury	Chairman, RAC	February 13-14, 2010
Dr. A. S. Tiwari	Member, RAC	
Dr. S. N. Sharma	Member, RAC	
Dr. P.B. Kirti	Member, RAC	
Sh. Harveer Singh	Member, RAC	
Sh Mohan Singh,	Member, RAC	
Dr. B. Mishra	Vice Chancellor, SK Univ. of Ag. Sci. & Tech., Chatha , Jammu (As chairman QRT)	February 21, 2010
Dr. S.S. Banga	National Professor (ICAR), PAU Ludhiana	
Dr. O.P. Dubey	Ex-ADG (PP), ICAR, New Delhi	
Dr. B.L. Sharma,	Ex-Dean, COA, Rajasthan Agriculture University, Bikaner;	
Dr. S.J. Kolte,	Ex-Professor (Plant Pathology), GBPUAT, Pantnagar;	
Dr. S.K.Datta	DDG (CS), ICAR, New Delhi	February 28, 2010

ICAR Deputy Director-General (Crop Science) Dr. Swapan Kumar Datta visits Directorate of Rapeseed-Mustard Research, Bharatpur

Dr. Swapan Kumar Datta, Deputy Director General (Crop Science) accompanied by Dr. V. D. Patil, ADG (OP),ICAR, New Delhi visited DRMR, Bharatpur on Nov 15, 2009.

Dr. S. K. Datta inaugurated the Seed processing plant and Green house. Addressing the staff, he said that rapeseed-mustard research programme will be speeded up with the help of green house by growing the crop under the control condition and hoped that by establishing seed processing plant, now Directorate will be able to make available good quality seeds to the farmers. He urged the scientists to work in a national perspective, keep regular contact with other research institutes to take advantage of their research programmes / outputs. Dr. Arvind Kumar, Director welcomed Dr. S. K. Datta and presented the research highlights of the Directorate.

Dr. S. K. Datta and V. D. Patil inspecting the research activities specially hybrid development programme, germplasm maintenance, management of *Alternaria blight*, development of quality seed, management of aphid, etc. and offered valuable suggestions and comments to the concerned scientists. Expressing satisfaction over the progress made towards the development of hybrids, he said that hybrids and biotechnology will play key role in future and efforts should be made to develop the disease resistance and drought tolerant varieties through biotechnology.

He also called for developing a definite road map for future and make all out efforts for enhancing the production and productivity of this important oilseed crop. On the ocassion, Dr. Patil also addressed the staff.

Dr. Swapan Kumar Datta also visited DRMR, Bharatpur on Feb 28, 2010. He visited rapeseed-mustard experiments, interacted with the scientists and offered valuable suggestions and comments for better and effective research output. He reiterated the importance of bio technology in the present era and expressed need for speedy development of a new basic science complex to suitably address this issue.

Development of low cost technology for resource poor farmers should be the ultimate goal of research, opined Dr. Datta. He also emphasised the need of multidisciplinary team efforts and establishing multi-institutional linkages for enhancing the efficiency of the rapeseed-mustard research and development programme. He also released a bulletin entitled "DRMR at a glance".

14 Personnel

Director's Office

Arvind Kumar	Director (Dec. 13, 2009)
J.S. Chauhan	Acting Director (Dec. 14, 2009)
Mrs. Veena Sharma	Jr. Stenographer
Lala Ram	Supporting staff (SSG III)

Scientific staff

Crop Improvement

J. S. Chauhan	Pr. Scientist (Plant Breeding) upto December 13, 2009
K.H. Singh	Sr. Scientist (Plant Breeding)
A.K. Misra*	Sr. Scientist (Economic Botany)
V.V. Singh	Sr. Scientist (Plant Breeding)
S.S. Meena	Sr. Scientist (Plant Breeding)
Arun Kumar**	Sr. Scientist (Genetics and Cytogenetics)
J. Nanjundan**	Scientist (Plant Breeding)

Agronomy

B.K. Kandpal**	Pr. Scientist
O.P. Premi	Sr. Scientist
S.S. Rathore	Sr. Scientist
Kapila Shekhawat	Scientist

Soil Science

N.S. Bhogal	Sr. Scientist
P. Kumararaja[a]	Scientist

Plant Pathology

P.K. Rai**	Pr. Scientist
P.D. Meena	Sr. Scientist
Pankaj Sharma	Sr. Scientist

Agricultural Entomology

Y.P. Singh	Sr. Scientist
S.P. Singh	Sr. Scientist

Plant Physiology

Maharaj Singh	Sr. Scientist

Biochemistry and Biotechnology

Satyanshu Kumar	Sr. Scientist (Organic Chemistry)
Manju Bala**	Sr. Scientist (Bio chemistry)
Sandeep Kumar	Scientist (Bio chemistry)
Ajay Kumar Thakur	Scientist (Plant Biotechnology)
Binay Kumar Singh	Scientist (Plant Biotechnology)

Extension, Communication & Training

S.K. Jha	Sr. Scientist (Agricultural Extension)
A.K. Sharma	Sr. Scientist (Agricultural Extension)

Agricultural Statistics

A.P. Mishra[b]	Sr. Scientist

Agricultural Economics

Lijo Thomas[a]	Scientist

ARIS Cell

Vinod Kumar	Scientist SS (Computer Application in Agriculture)

Technical Staff

U.S. Rana	Technical Officer (T-7/8)
R.C. Sachan	Technical Officer (T-7/8)
R.N. Singh	Tech. Officer (T-6)
M.L. Meena	Tech. Officer (T-6)
H.P. Meena	Tech. Officer (T-6)
Ram Narayan	Tech. Officer (T-6)
Karnal Singh	Tech. Officer (T-5)
Sanjay Sharma	Tech. Officer (T-5)
R.C. Meena	Tech. Asstt. (T-3)
Govind Prasad	Driver (T-3)
Ram Singh	Tech. Asstt. (T-3)
Rakesh Goyal	Tech. Asstt. (T-3)
Bachhu Singh	Tech. Asstt. (T-2)

Administrative Unit

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

Audit and Accounts Unit

M.M. Lal	Asstt. Finance and Accounts Officer
Pawan Kumar Pandey	Junior Accounts Officer
Ram Sahay Meena	Sr. Clerk

Supporting

Tara Singh	Supporting Staff (SSG-II)
Radha Charan	Supporting Staff (SSG-II)
Kamal Singh	Supporting Staff (SSG-II)

*Selected principal scientist, NBPGR, Regional Station, Umiam, Shillong, Meghalaya
**Joined during the year
[a]On study leave
[b]Transferred out during the year

DDG (CS), ICAR, Dr. S. K. Datta visiting museum and interacting with scientists

15 Panorama

Earth day

On the occasion of Earth Day on April 22, 2009 Weather Based Integrated Agro Advisory Services (IAAS) Unit of DRMR organized a painting competition at DPS, Bharatpur. About 500 students from 15 different schools participated in the competition. Dr. Arvind Kumar, Director, DRMR emphasised the need for conservation of land, water and environment in present scenario. He along with Sh. Anup K.R., Director, Keoladev National Bird Sanctuary, Bharatpur distributed the prizes and certificates to the winners of the competition.

Independence day

DRMR celebrated Independence Day on August 15, 2009 in a befitting manner. Dr. Arvind Kumar, Director, hoisted the national flag. In his address, he stressed the need to work as a unified team to achieve the objectives/mandate of the Directorate. He also reminded the gathering of the sacrifices made by the freedom fighters in achieving independence, prosperity and harmony.

हिन्दी चेतना मास का आयोजन

निदेशालय में 14 सितम्बर से 13 अक्टूबर 2009 तक हिन्दी चेतना मास का आयोजन किया गया। कार्यक्रम का उद्घाटन करते हुए निदेशालय के निदेशक डॉ. अरविन्द कुमार ने निदेशालय में हो रहे हिन्दी में काम काज की प्रगति पर प्रकाश डाला तथा और अधिक कार्य राजभाषा में करने का आह्वान किया।

प्रभारी राजभाषा डॉ. पंकज शर्मा ने इस अवसर पर होने वाली प्रतियोगिताओं के बारे में विस्तार से बताया तथा अधिक से अधिक लोगों को भाग लेने के लिए प्रोत्साहित किया। इस दौरान सुलेख, श्रुतिलेख, पत्रलेखन, निबन्ध, शोध पत्र हिन्दी अनुवाद एवं सामान्य ज्ञान प्रतियोगिता का आयोजन किया गया। विभिन्न अधिकारियों एवं कर्मचारियों ने इसमें भाग लिया। विभिन्न प्रतियोगिताओं हेतु प्रथम, द्वितीय, तृतीय एवं प्रोत्साहन पुरूस्कार स्वरूप नकद राशि प्रदान की गई। समापन

समारोह में निदेशालय के निदेशक ने विभिन्न वर्गों में सफल प्रतिभागियों को पुरूस्कार एवं प्रमाण पत्र प्रदान किये। इन प्रतियोगिताओं के निर्णायक मण्डल में डॉ. प्रमोद कुमार राय, डॉ. संजीव कुमार झा एवं डॉ. पंकज शर्मा थे।

Observance of vigilance awareness week

November 3-9, 2009 was commemorated Vigilance Awareness Week. The staff members took oath in the presence of Director, for being vigilant against corruption and affirmed the commitment to prevent corruption. The messages from Hon'ble President and Vice President of India as well as posters supplied by ICAR were displayed to mark the occasion.

Campaign for communal harmony

Directorate actively participated in Communal Harmony Campaign and the Fund Raising Week during November 19-25, 2009 and the Flag Day on November 25, 2009 organized by National Foundation of Communal Harmony, New Delhi. The financial contributions from the staff members collected during the campaign were sent to the foundation.

Dr. Arvind kumar joined as Deputy Director General (Education), ICAR, New Delhi

Dr. Arvind Kumar, an eminent scientist and Director, DRMR took the charge of Deputy Director General (Education) ICAR on Nov 30, 2009.

He has more than 34 years experience of teaching, research and extension activities extensively in the area of oilseeds. He left a distinct mark in the portfolio he handled. As an outstanding Agronomist, his pioneering research contribution was oriented towards assessment of quality parameters in relation to resource management in rapeseed-mustard and developing improved production technologies. He has published more then 130 research papers in Indian and foreign journals, 85 popular articles, 57 books/ booklets/chapters and presented more then 195 papers in various national and international conferences. He has also guided 32 postgraduate theses including 9 for Ph. D research. He has been awarded Dr. Rajendra Prasad Puraskar for the triennium 1991-93, by ICAR for the book on Crop Geography of India in Hindi. He is Fellow of the Indian Society of Agronomy, New Delhi (1996), Indian Society of Oilseed Research, Hyderabad and Society of Extension Education, Agra (2009). The centre has been upgraded as Directorate due to his significant contributions.

DRMR family congratulate and wish him a rewarding future

Dr. J. S. Chauhan was appointed as acting Director of the Directorate of Rapeseed-Mustard Research by Indian Council of Agricultural Research on December 14, 2009.

Annual sports

Dr. J.S.Chauhan, Acting Director, inaugurated Annual Sports Meet during January 21-24, 2010 at the Directorate. The staff and their family members participated in various games/sports. A thirteen member sports team of the Directorate also participated in the ICAR Zonal Sports Meet at Central Sheep and Wool Research Institute, Avikanagar held during February 10-14, 2010.

Republic day celebrated

DRMR celebrated the 61st Republic day on January 26, 2010 with great fervour and gaiety. Dr. J. S. Chauhan, Acting Director hoisted the national flag. He reminded the gathering about the importance of the day on which the Constitution of India came into force. On this auspicious and historic day, he extended good wishes to all for their happiness, prosperity and success. He also gave away the prizes to the winners of Annual Sports Meet.

Samaj Sadan activities

General body meeting of Samaj sadan was held for constituting the new executive committee for the year 2010-2011 on March 4, 2010. The members of the new executive committee are as under:

President	Dr. J.S. Chauhan
Vice-president	Dr. B. K. Kandpal
General Secretary	Dr. V. V. Singh
Joint Secretary	Dr. S. S. Rathore
Joint Secretary (Women)	Dr. Kapila Shekhawat
Cultural Secretary	Sh. M. L. Meena
Sports and Health Secretary:	Sh. Karnal Singh
Literary Secretary:	Mrs. Veena Sharma
Treasurer:	Mr. P.K. Pandey

Deepawali and New Year celebrated

Samaj Sadan organized Deepawali Sneh Milan on October 21, 2009 and Navvarsh Sneh Milan on January 1, 2010. All the *Sarson* family participated in these programmes. On the occasion children performed graceful cultural programmes. The President, Samaj Sadan addressed the members and distributed prizes to the participants of cultural programmes.

DDG (CS), ICAR, Dr. S. K. Datta celebrating colourful Holi with staff members

Library services

Particulars	No	Detailed descriptions
Journals subscribed	49	*Agricultural review, Annals of Agricultural Research, Annals of Agri. Bio-Research, Annals of Biology, Brassica, Chip, Current Science, Dataquest, Indian Farming, Indian Journal of Biotechnology, Indian Journal of Traditional Knowledge, Indian Journal of Agronomy, Indian Journal of Genetics and Plant Breeding, Indian Journal of Plant Genetic Resources, Indian Journal of Extension Education, Indian Journal of Plant Physiology, Indian Science Abstracts, Journal Asian Agri. History, Indian Journal of Ephidology, Journal of Biological Control, Journal of Bio-Science, Journal of Communication Studies, Journal of Genetics, Journal of Intellectual Property Rights, Journal of Interacademia, Journal of Mycology and Plant Pathology, Journal of Oilseeds Research, Science and Culture, Science Reporter, The Indian Journal of Agricultural Science, Indian Journal of Entomology, The Indian Journal of Cytology and Genetics, Agronomy Journal, Plant Breeding Abstracts, Review of Plant Pathology, Review of Agricl Entomology, भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका, खेती, फल–फूल एवं कृषि–चयनिका*
Journals received as gratis	15	*California Agriculture, Fertilizer News, Intensive Agriculture, IPR Bulletin, Oryza, Pestology, PGR Newsletter, Research Observer, Span, The Economist, The World Bank Economic Review, World Grain, Khad Patrika (Hindi), Krishi Vigyan (Hindi), Krishi Vistar Samichha (Hindi)*
Newsletters received	129	From various government, ICAR, SAU and other institutes/centres
Annual reports received	55	From various government, ICAR, SAU and other institutes/centres
Other reference material	124	From various government, ICAR, SAU and other institutes/ centres
Books purchased	25	Latest books, encyclopedia, dictionaries, Hindi books, etc.

Budget 2009-2010 (Rs.in lakhs)

	Sanctioned	Expenditure
DRMR (Plan)	150.00	149.49
AICRP (Rapeseed-mustard)	450.00	450.00
Non-plan	397.69	387.35
Pension	14.13	14.13
Loan and advances	7.86	7.74

Resource generation

During the year 2009-2010, the DRMR generated Rs. 32,26,883.

16 Meteorological Data

Mean monthly weather data at DRMR, Bharatpur (2009-2010) .

Month	Temperature (^{0}C)		Relative humidity (%)		Evaporation (mm)	Rainfall (mm)	Wind speed (km/h)	Sunshine (hrs)
	Max.	Min.	0720 hrs	1420 hrs				
April 09	38.9	19.8	43.2	21.3	9.9	5.9	6.70	8.7
May 09	42.0	25.3	52.5	22.0	10.0	38.1	4.61	8.0
June 09	42.9	27.9	42.8	19.3	12.0	56.1	7.03	7.1
July 09	35.4	26.8	84	32.1	5.7	203.4	2.31	5.7
August 09	34.9	26.3	81.9	64.2	5.7	209.3	1.69	6.0
September 09	35.1	24.3	83.9	52.0	4.5	83.1	3.55	7.2
October 09	34.3	18.2	75.2	32.0	2.5	6.1	2.94	6.7
November 09	27.7	13.1	87.8	43.0	1.6	29.1	2.02	5.9
December 09	23.3	8.0	94	47.9	1.0	3.0	0.42	5.7
January 10	18	6.4	98	74.0	0.8	10	0.51	4.0
February 10	26.4	9.4	94	43.0	1.6	3.5	1.83	7.3
Mar-10	35.8	15.1	77	23.0	3.8	0	2.94	8.0