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Project Coordinator's Report
(2019-20)

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All India Coordinated Research Project on Rapeseed-Mustard: Research Highlights (2019-20)

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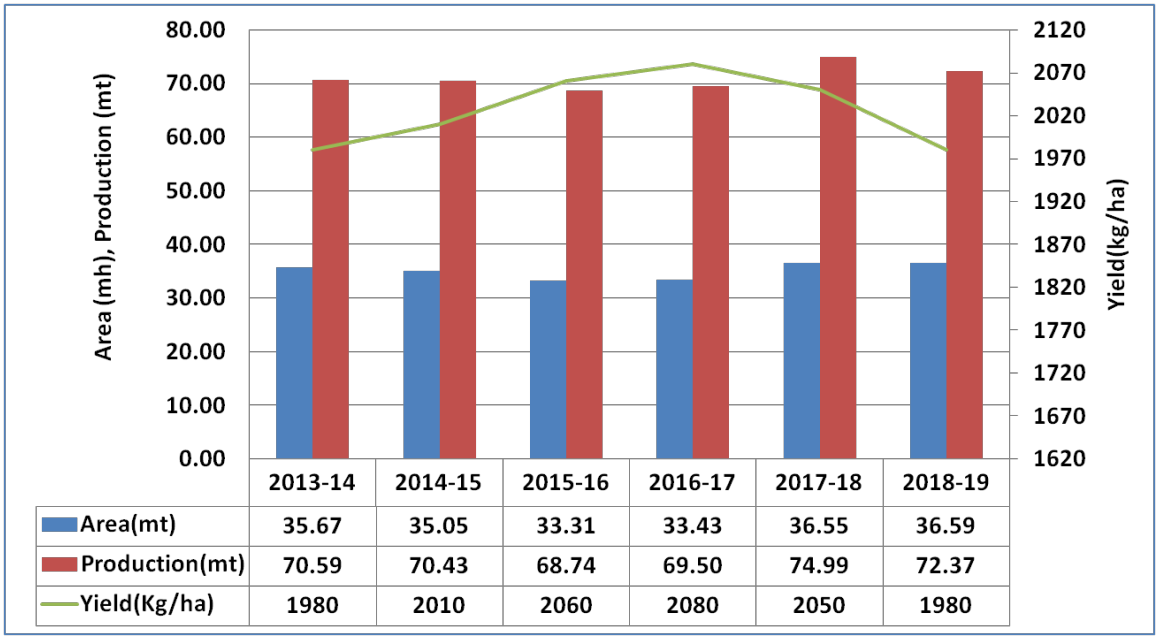
Hon'ble Secretary DARE and DG, ICAR, Deputy Director General (CS), ICAR, esteemed subject experts Dr H C Sharma, Prof. S. S. Banga, Dr K R Kaundal, Dr S R Bhatt, Prof. G S Sahran, Dr B S Mahapatra, my colleagues from Council Dr D K Yadava, ADG (Seed), Dr S K Jha, ADG (OP), esteemed distinguished scientist from this Directorate and from AICRP-RM coordinating centres, representatives from private seed companies, ladies and gentlemen!

I take this opportunity to express my sincere gratitude to Dr. T. Mohapatra, Secretary, DARE, Government of India and Director General, ICAR for his constant encouragement, guidance and help to improve rapeseed-mustard research and development programme in the country. Thank you sir for accepting our request to be the Chief Guest of Inaugural session of this very group meeting of AICRP-RM workers. Your guidance will certainly improve our program. I am thankful to Deputy Director General (Crop Science) Dr T R Sharma for according permission to hold this Group meeting in virtual mode and also chairing the inaugural session of this 27th AICRP-RM Group meeting. I am also thankful to Assistant Director General (O & P) Dr. S. K. Jha, Assistant Director General (Seeds) Dr. D.K. Yadava and other ADGs of the Council for their guidance and support extended for the planning and implementation of All India Coordinated Research Project on Rapeseed-Mustard. With the permission of chair, I would like to present the crop status and research highlights of the programme during 2019-20 for discussion of the esteemed subject experts, colleagues in the rapeseed-mustard fraternity, policy planners and administrators and look forward for their critical comments and suggestions for further strengthening and revitalizing the programme.

Crop scenario

Total area, production and yield of rapeseed-mustard in world during 2018-19 was 36.59 million hectares (mha), 72.37 million tonnes (mt) and 1980 kg/ha, respectively (Fig. 1). There has been a considerable increase in production and productivity from 2013-14 to 2018-19. However, there was slight decrease in production and productivity from 2017-18 onward.

Backed by good monsoon, India has attained a record food grain production of 281.37 million tonnes during 2018-19. The total oilseeds production has been hovering around 30-31 million tonnes during last few years. The rapeseed-mustard acreage increased from 5.98 m ha (2017-18) to 6.12 m ha (2018-19) and production got increased from 8.43 mt (2017-18) to 9.26 mt (2018-19). The rapeseed-mustard yield has also shown an increment during 2018-19 as compared to the previous years (Fig. 2). The inconsistency in the rapeseed-mustard production system over the years is a cause of concern for all of us.



	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Area(mt)	35.67	35.05	33.31	33.43	36.55	36.59
Production(mt)	70.59	70.43	68.74	69.50	74.99	72.37
Yield(Kg/ha)	1980	2010	2060	2080	2050	1980

Fig. 1Global trend of area, production and productivity of rapeseed-mustard

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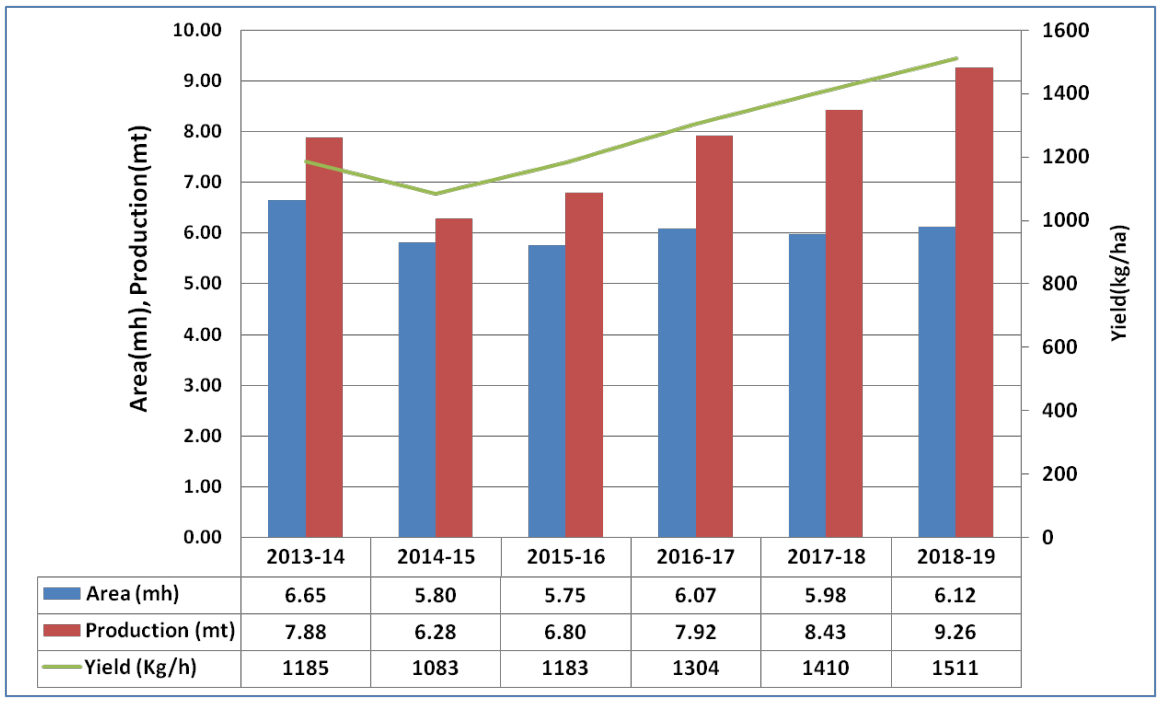
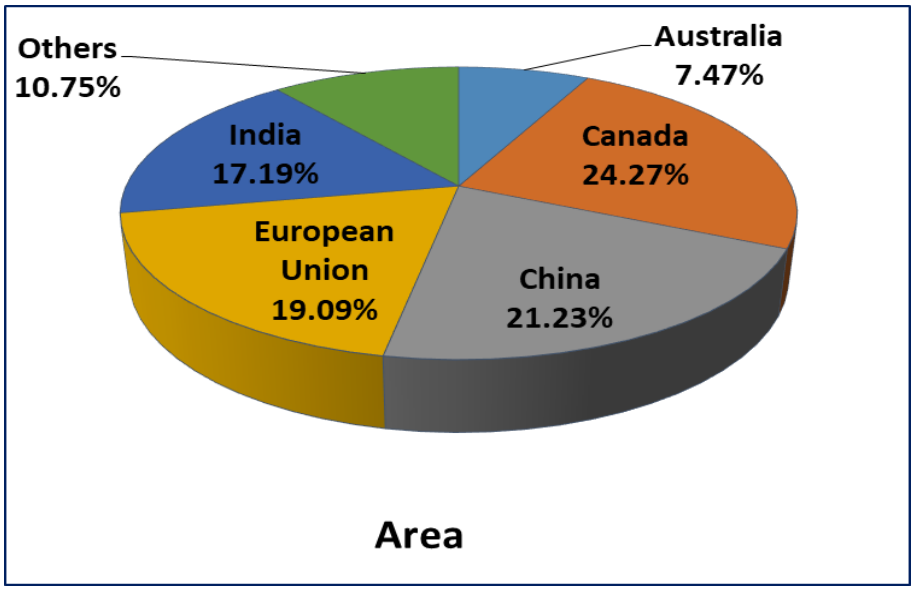


	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Area (mh)	6.65	5.80	5.75	6.07	5.98	6.12
Production (mt)	7.88	6.28	6.80	7.92	8.43	9.26
Yield (Kg/h)	1185	1083	1183	1304	1410	1511

Fig. 2 Trends in area, production and yield of rapeseed-mustard in India

Globally, India continues to be at rank 4th after Canada, China and European Union in acreage (17.19%) (Fig. 3a) and after European Union, Canada and China in production (8.54%) (Fig. 3b).

(a)



(b)

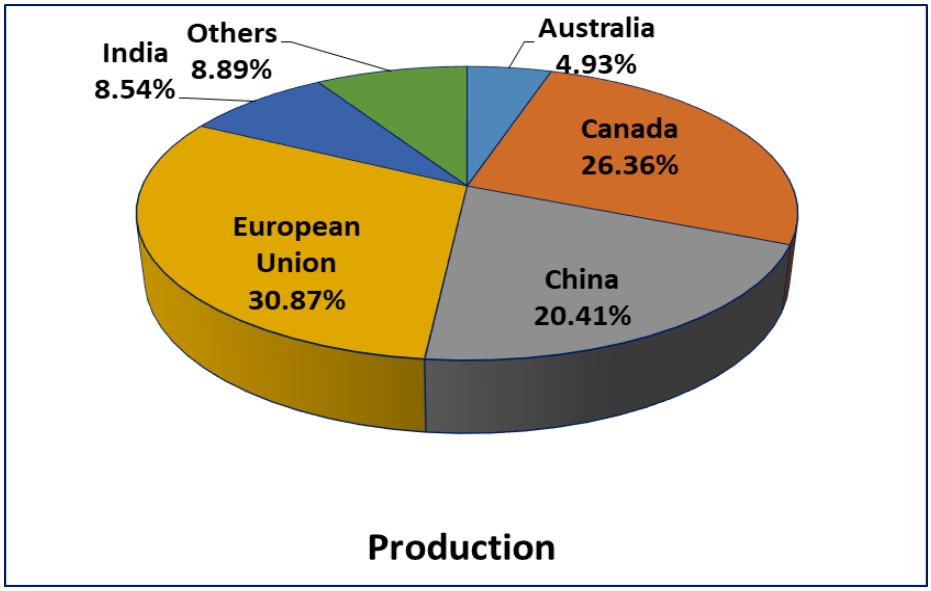


Fig. 3 Contribution of major rapeseed-mustard producing contries in a) Area and b) Production (Average of 2013-14 to 2017-18)

Rapeseed-mustard crops in India are grown in diverse agro climatic conditions. If we see the trends from 2014-15 to 2018-19, their contribution to the total acreage was 23.33% (Fig. 4a) and oilseed production was 26.24%, (Fig. 4b).

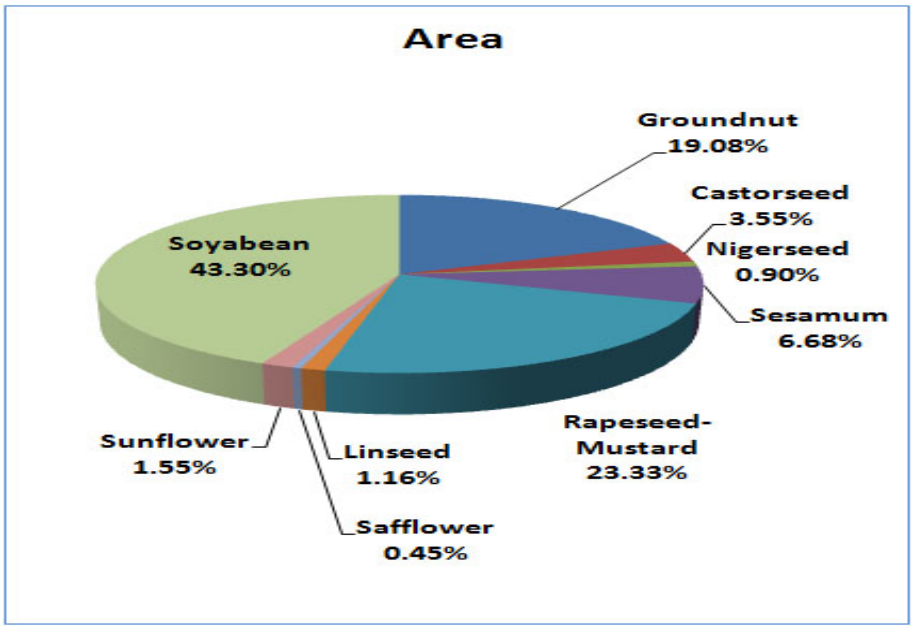


Fig. 4a Contribution of major oilseed crops in total oilseed acreage (Average of 2014-15 to 2018-19)

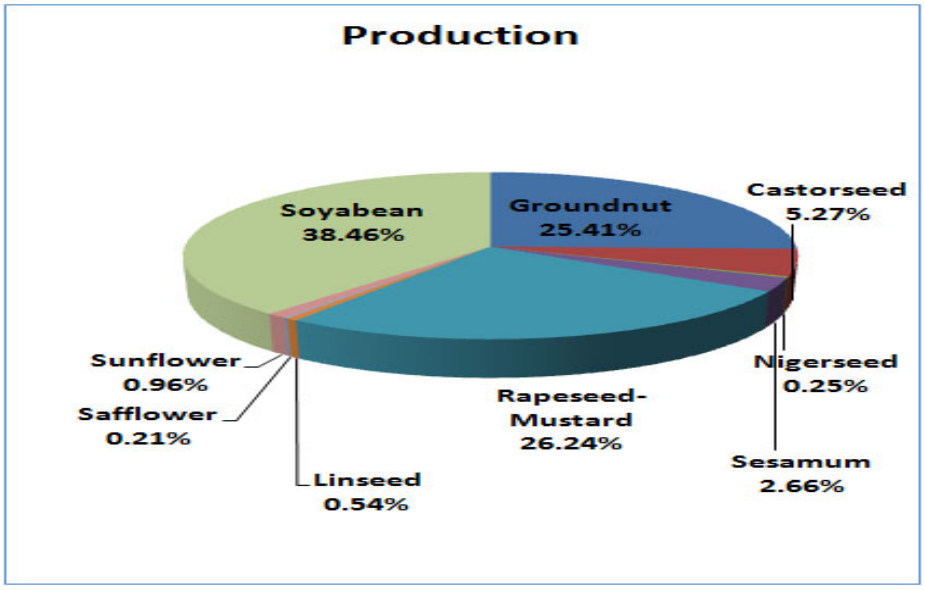


Fig. 4b Contribution of major oilseed crops in total oilseed production (Average of 2014-15 to 2018-19)

Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, West Bengal, and Assam states accounted for 86.29% of area and 88.46% of production in the country. Rajasthan alone contributed 40.74% to the total area (Fig. 5a) and 44.97% to the production (Fig. 5b).

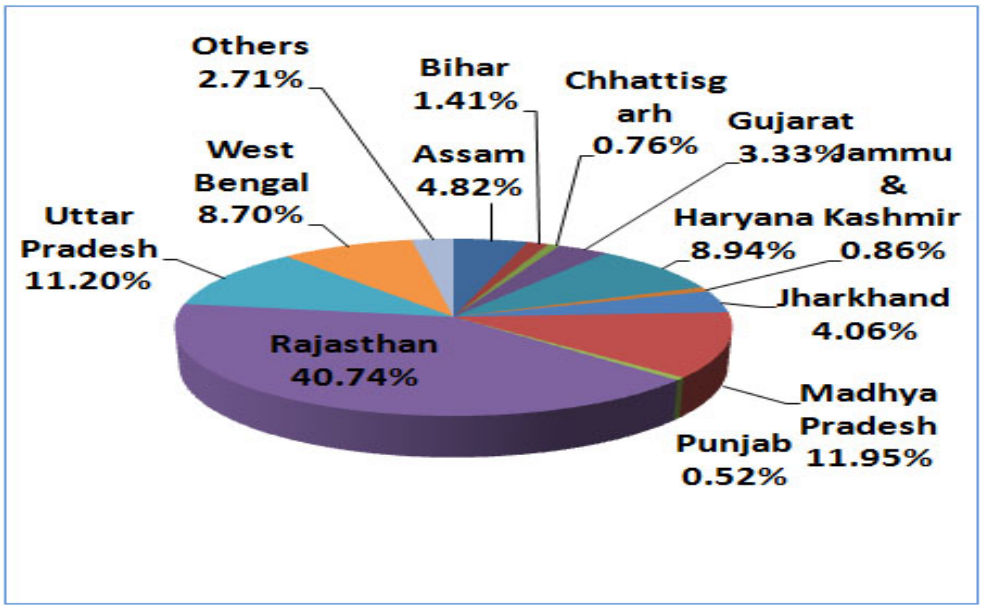


Fig. 5a Contribution of major states to acreage (Average of 2014-15 to 2018-19)

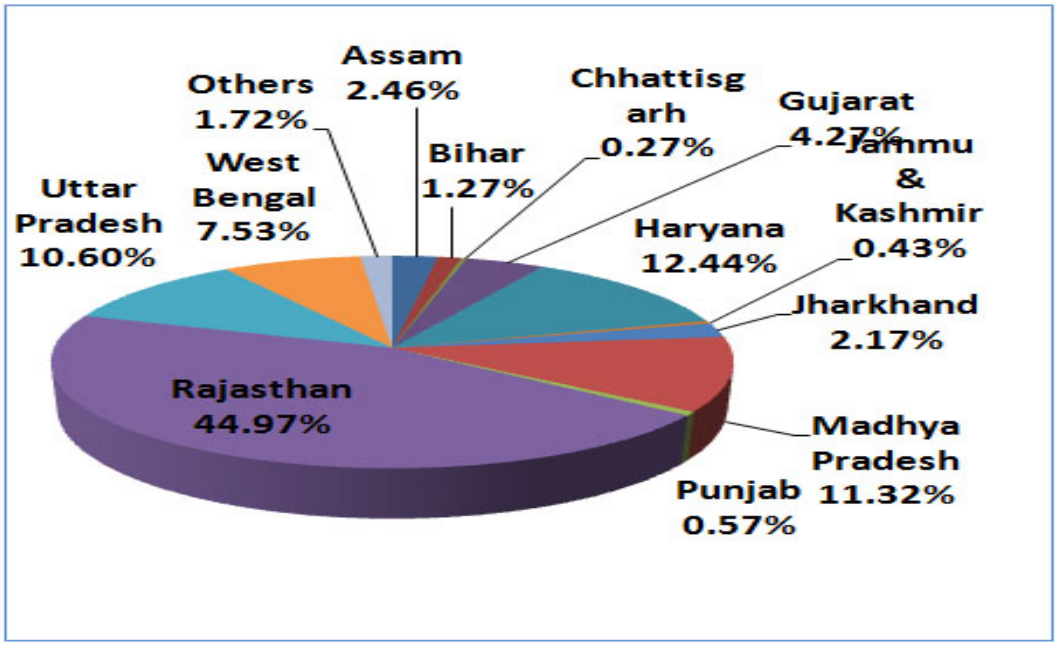


Fig. 5b Contribution of major states to production (Average of 2014-15 to 2018-19)

It has been found that in 2017-18, at country level, the acreage of rapeseed-mustard increased by 6.6%, yield by 18.1% and production by 25.9% by keeping 2009-10 as the base year (Fig. 6). Some of the RM cultivating states including Rajasthan, Madhya Pradesh and Bihar showed decrease in RM acreage, which a growing concern for RM community.

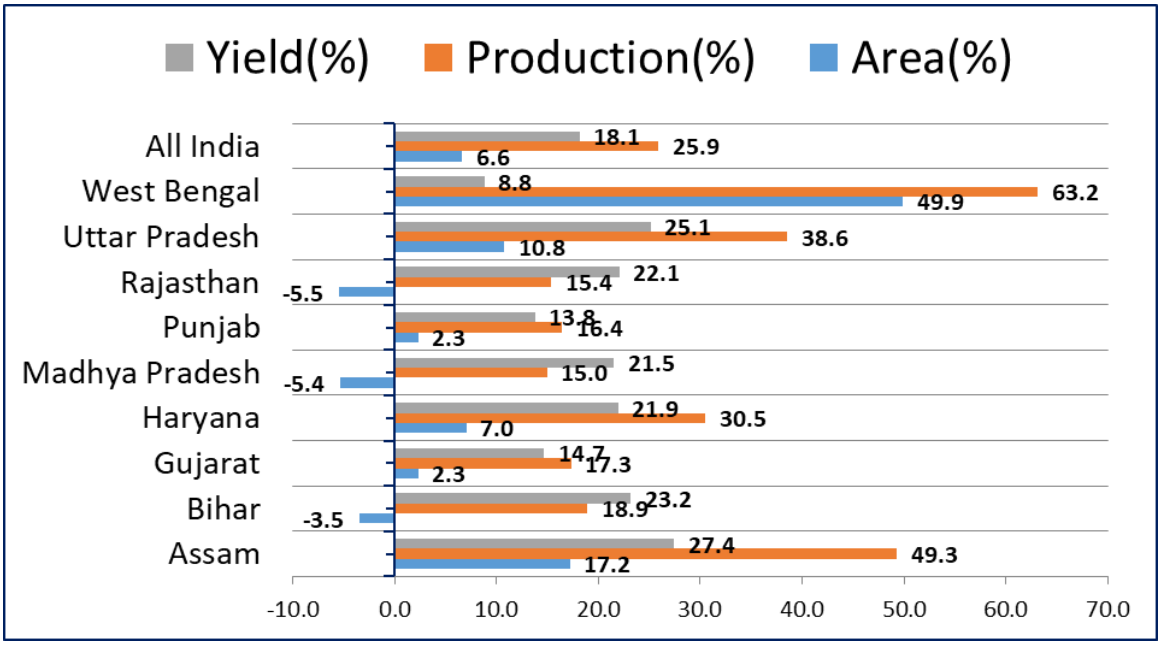


Fig. 6 Per cent Change in Area, Production and Productivity in Rapeseed - Mustard in 2017-18 (base year: 2009-10)

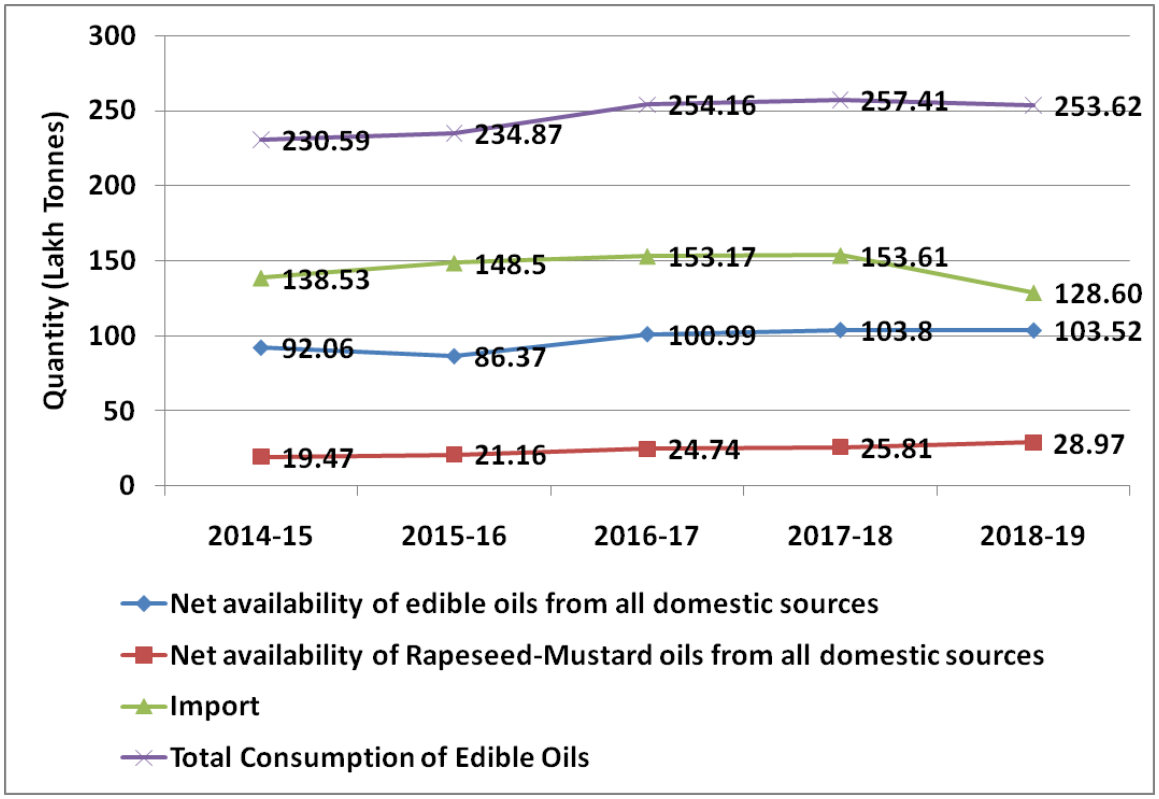


Fig. 7 Edible oil availability, share of Rapeseed-Mustard oil, import and consumption during 2014-15 to 2018-19

However, despite all efforts, the import of edible oil has increased up to 128.60 lakh ton during 2018-19. The total availability of edible oil has also increased from 230.59 lakh ton (2014-15) to 253.62 lakh ton (2018-19) (Fig. 7).

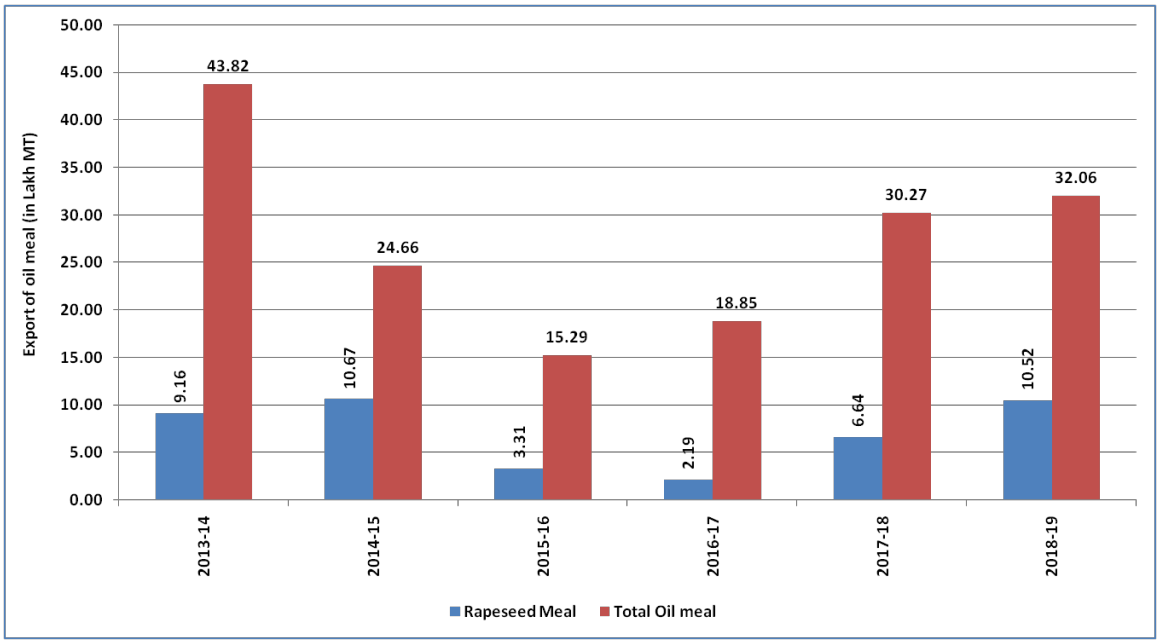


Fig. 8 Status of export of Rapeseed-Mustard seed meal

The export of rapeseed-mustard seed meal during 2017-18 has increased to 32.06 lakh tons as compared to that of 2013-14 (9.16 lakh tons) (Fig. 8).

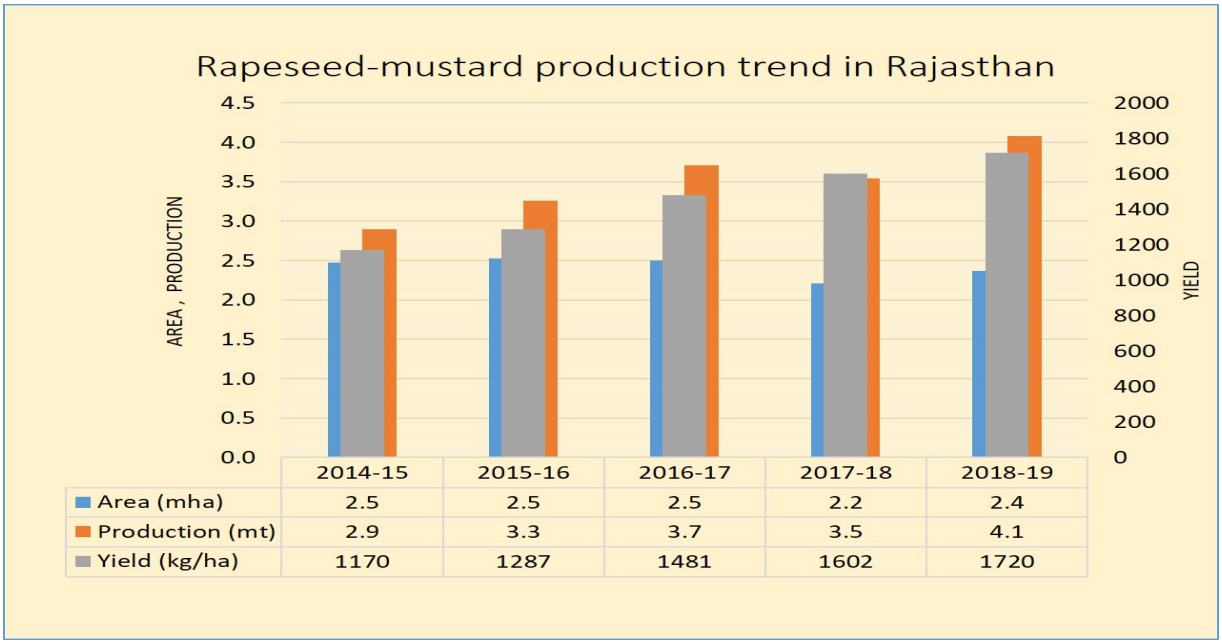


Fig. 9 Rapeseed-Mustard production trends in Rajasthan

Among various states cultivating RM crops, Rajasthan is showing increment in area, production and productivity in the year 2018-19 as compared to the previous crop season. In addition, yield of the RM crops in Rajasthan has showed perpendicular increment from 2014-15 to 2018-19 (Fig. 9).

Seasonal Conditions

Weather was favourable for the mustard crop during the crop season 2019-20. Good precipitation was received during monsoon in the month of September at almost all the centres. The extremely low temperature -1.1^{0}c and 0.7^{0}c was reported of Bajaura centre in the month of December & January 2019-20 respectively. Incidence of diseases and pest was very low then resulted high productivity (More than 14 qtl/ha).

Genetics and Plant Breeding

Varietal Improvement

Fourteen centres spread over 11 states carried out the varietal development activities as per the approved technical programme. The salient achievements during the year 2019-20 in toria (Brassica rapa var toria), yellow sarson (B. rapa var yellow sarson), gobhi sarson (B. napus), Indian mustard (B. juncea), karan rai (B. carinata) and taramira (Eruca sativa) are discussed below:

Genetic Resource Management

A total of 7029 accessions comprising toria (508), Indian mustard (4,600), yellow sarson (548), gobhi sarson (146), brown sarson (108), karan rai (232), taramira (67), *B. caudatus* (04), *R. caudatus* (01), *B. rugosa* (30), *B. nigra* (22) S. Alba (01), Crambe sp (02), and Lapidium sp (02) were maintained through appropriate mating system at Bhubneshawar, Dholi, Hisar, Pantnagar, Ludhiana, Kanpur, Sriganganagar, IARI, New Delhi, Jobner, Morena, Pannagar, Chatha-Jammu and SK Nagar (Table 2.1.1). In addition, 30 new accessions comprising Indian mustard (22), toria (03), and taramira (05) were collected. Further, 790 accessions consisting of 438 Indian mustard, 84 toria, 174 yellow sarson, 17 gobhi sarson, 41 brown sarson, 06 Karan rai, and 30 taramira accessions were evaluated. On the basis of germplasm evaluation, promising accessions were identified for seed yield, earliness, yield components, thermo-tolerant (early and terminal stages), resistance/tolerance to diseases/pests and quality traits in toria at Dholi and Chatha-Jammu.

Creation of genetic variability through hybridization/ mutagenesis and selection

Creation of variability is the essence and backbone of the breeding programme. To cater the need of diverse agro-climatic conditions of the country, 99 crosses were attempted in toria, 26 in yellow sarson at Pantnagar and Kanpur and 933 in Indian mustard at Chatha, Hisar, IARI New Delhi, Ludhiana, Kanpur, Pantanagar, SK Nagar, Morena, Sriganganagar, Jhansi and Varanasi to improve seed yield, earliness, seed size, component traits, disease/pest resistance, heat tolerance suitable for late sown condition, drought tolerance, “0” and “00” quality characters and high oil content (Table 2.1.2). Selection of superior plants/bulks at different centres was practised in toria, yellow sarson and Indian mustard. In toria, development of composites population after the selection was the main objective. In yellow sarson, hybridization and selection from segregating generations were attempted at Kanpur and Pantnagar. However, few of the centres reported that due to spread of COVID 19 in an across the region, the single plant selection could not perform. In Indian mustard, 3581 single plants were selected at New Delhi, Jhansi, Pantnagar, Ludhiana, SK Nagar and Morena. In Indian mustard, about 887 bulks were selected from segregating and advanced generations.

Evaluation of advanced breeding lines

The advanced breeding lines evaluated under different station/state /preliminary yield trials at various centres have been presented in Table 2.1.3. 56 strains of toria were tested at Kanpur, Chatha, Ludhiana and Dholi. The yield superiority in toria was up to 17.18 % over the check (Tapeshwari) at Kanpur. In yellow sarson, 45 strains were tested at Kanpur and Dholi. The yield superiority up to 16.66 % over the check Pitambari was recorded at Kanpur. In Indian mustard, 467 strains were evaluated at 07 centres; Chatha, Hisar, Ludhiana, Kanpur, Dholi, Varanasi, and Sriganganagar in 24 trials. Seed yield superiority up to 14.67 % over the check Kranti was recorded at Kanpur. Ten strains at Hisar, 32 strains at Ludhiana and 09 strains at Chatha of gobhi sarson were evaluated for seed yield and its component characters. In addition, 26 strains of Karanrai were also evalauted at Ludhiana for Seed yield and oil content under irrigated condition.

Hybrid/ Mapping Populations' Development/Quality Improvement

Efforts for hybrid development continued under "Consortia Research Platform on Hybrids", at four centres including ICAR-DRMR Bharatpur, ICAR-IARI New Delhi, PAU Ludhiana and CCS HAU Hisar. A total of thirty six experimental hybrids including each 8 from DRMR, 12 from IARI, 9 from PAU PAU Ludhiana and 07 from Hisar were evaluated in three multilocation trials; early maturity group and medium to late maturity group, conducted at each of four centres. Under early maturity trial (MLT 1), 9 early maturing hybrids were tested against three checks. All experimental hybrids were late in maturity than earliest maturing check Keshri but matured at par with NRCHB 101, hence, these were compared with NRCHB 101 for seed yield. Fifteen experimental hybrids were evaluated under timely sown normal maturity (CRPMLT 2) group against three checks. In MLT 2, Three hybrids, RHH1903, RHH 1904 and RHH 1905 out yielded the best check Pioneer 45S46 (2445 kg/ha) by a margin of 9.1, 8.6 and 8.5 percent, respectively. In MLT 3, one hybrid PHR 3328 out yielded the best check Pioneer 45S46 by a margin of 5.3% only. Seventy-six F_1 crosses comprising 22, 20, 19 and 15 from DRMR, PAU, HAU and IARI, respectively were evaluated at all four centres in MLT 4. Five crosses DRMREH 19-10, RHH 1915, DRMREH 19-3, RHH 1927, DRMREH 19-7 expressed >15% seed yield heterosis over best check Giriraj. Eight hybrids were inducted to All India Coordinated Research Project for multilocation evaluation. Out of eight 2 were evaluated in early mustard trial and remaining 6 hybrids in initial hybrid trial

Breeder seed production

Indents of 76.02 q breeder seed of 54 rapeseed-mustard varieties were received from Department of Agriculture and Cooperation (DAC), Ministry of Agriculture and Farmer Welfare, Govt. of India for production during 2019-20. The allocation was made to 18 centres for the production of **76.00** q breeder seed of 54 varieties during the 26th annual group meeting held at BAU, Ranchi (Jharkhand). Against the indent of 76.02 q, 258.64 q breeder seed was produced, indicating a surplus availability of 164.20 q. Breeder seed of yellow sarson variety Benoy (B 9) of could not be produced . Further, less quantity of Sushree of toria; DRMR 601 of Indian mustard and Tapeshwari of Toria was produced. In addition, 116.19 q breeder seed of 24 varieties was also reported from different centres.

Coordinated Trials

Performance of 163 strains including 16 of toria, 129 of Indian mustard, 15 of gobhi sarson and 03 of taramira was tested in thirty two performance evaluation trials consisting of toria (03), gobhi sarson (02), taramira (01) and Indian mustard (26) at 45 locations across the 6 agro-climatic zones of the country. On the basis of superiority for seed/ yield/ earliness/quality over the best check, 25 strains comprising taramira (01), gobhi sarson (05) and Indian mustard (19) were promoted for advanced stage evaluation.

Rapeseed-Mustard strains promoted for advance stage testing on the basis of higher seed/oil yield/quality (2018-19)

Zone I	Zone II	Zone III	Zone IV	Zone V
Early Mustard, IVT, Irrigated				
	RH 1999-42 2436(17.8)	KMR (E) 19-2 (2005,28.1 NPJ 229 (1886, 20.5) RH 1999-42 (1975, 26.2) PRE 17.5 (1917, 22.5) PRE 17.2 (1846, 17.9) DRMRCI 116 (1953, 24.8) NPJ 230 (1955, 24.9) KMR (E) 19.1 (2001, 27.9) PHR 8022 (Hybrid 19.6, 21.8)		
Mustard, Timely Sown, Irrigated, IVT				
AKM 5-19-2 (1202, 15.8)			NPJ 231 (2543, 10.8)	
Mustard, Quality, IVT				
	LES 60 (2912, 3.8) 9IJ5001 (2606, -7.09, 12.0)	LES 60 (2159, 1.4)		
Mustard, Quality, AVT I + II				
	PDZ 12 (2765, ≈) PDZ 11 (2703, ≈) RCH 1 (2765, ≈)			
Saline/ Alkaline IVT				
		CS 2005-143 (2054, 9.4)		
Gobhi Sarson IVT				
GSH 2196 (1874, 15.0) AKGS 19-8 (1788, 9.8) HNS 0702 (1807, 10.9) GSH 2180 (1876, 15.2)				
Gobhi Sarson AVT I				
GSH 1699 (1728, 9.2)				
Taramira AVT I				
RTM 1624 (999, 19.8)				

Figures in parenthesis indicate seed yield (Kg/ha), percent superiority over best check
** promoted on te basis of oil yield; # double low strain.

Crop Production

Six experiments on various crop production aspects of rapeseed-mustard were conducted at 23 cooperating centres across the 5 zones.

3.1 Long-term fertility experiment on cropping systems involving rapeseed-mustard

The results highlighted the long term effect of fertility levels on seed yield of mustard. Significantly higher seed yield was recorded with the application of 150% NPK at all the locations except at PNT, and increased by 107, 197, 278, 172, 59, 556, 83, 157, 54, 78, 175%

at KDW, KNG, LDH, HSR, SGN, DOL, KOT, MOR, SKN, BHU and SHL over control, respectively. At PNT, integrated use of 100% NPK+FYM 2.5 t/ha recorded highest seed yield.

3.2 Data generation for herbicide label claim registration in rapeseed-mustard.

The results revealed that pre-emergence application of pendimethalin @ 1.0/0.5 kg a.i./ha recorded highest seed yield at BTE and PNT. Whereas, pre-emergence spray of oxadiargyl @ 0.09 kg a.i./ha recorded higher seed yield at HSR and LDH.

3.3 Agronomic evaluation of promising rapeseed-mustard entries.

The toria entry TS 38 produced 8.2% and 21.7% higher seed yield than the best check at KLY and IMP. Under late sown condition, DRMRIC 16-38 recorded 7.4% more seed yield over the nearest check at CHT only. *Brassica napus* entry AKMS 8141 gave significantly higher seed yield than best check by 41.0% at BJR and 85.0% at LDH.

3.4 Developing resource efficient and resilient rapeseed- mustard based cropping systems under current and future climates.

The location-wise most productive cropping systems reported are; green gram-mustard at CHT and PNT, black gram-mustard at KPR and maize-mustard at MOR. Raised bed planting method recorded maximum mustard seed yield at all the locations except at MOR.

3.5 Studies on system of mustard intensification (SMI) in rapeseed-mustard through transplanting.

Among different species suitability, *B. carinata* at IARI, SKN and LDH; *B. juncea* at NAG and MOR; and *B. napus* at PNT recorded more seed yield. Among planting methods, transplanting found more suitable and recorded higher seed yield at IARI and PNT. However, it was not found suitable at NAG, MOR, SKN and LDH.

3.6 Enhancing of water use efficiency in rapeseed-mustard under rainfed conditions.

Application of hydrogel 5 kg/ha at sowing time followed by foliar spray of salicylic acid 200 ppm at flowering and silique formation stages recorded highest seed yield at KDW, HSR, BAW, SGN, JOB, NAG, KNG, CHT, BND, KPR, KOT, VAR, SHL, BHU. Whereas, hydrogel 2.5 kg/ha and foliar spray of salicylic acid 100 ppm at flowering and silique formation stage recorded higher seed yield at LDH, JHS and IMP.

Plant Pathology

Disease Scenario

During 2019-20, moderate to severe occurrence of Alternaria blight was recorded at all locations. However, low to the medium severity of Alternaria blight was recorded from JAG and MOR. White rust appeared in moderate to severe form at all locations except JAG. Medium to severe prevalence of DM was observed at the cotyledonary stage at JHS and PNT. Powdery mildew severity was moderate to high at JHS, SKN, MOR and low at JAG and BPR. Low to moderate incidence of Sclerotinia rot was observed at MOR, HSR, SGN, and PNT.

Screening of *Brassica* germplasm and breeding materials

Under natural condition, PDZ 11, PDZ 12 (Bj) and AKMS 8141, AKGS 8146, AKGS 8217, GSH 1717, GSH 1699 (Bn) were found resistant to WR at all eight locations. Under artificial condition, PDZ 12, PDZ 11 (Bj), and AKGS 8217, HNS 1102, GSH 1699, AKMS 1841, AKGS 8146, GSH 1717, (Bn) were found resistant to WR at all locations except JHS. Genotype, RH (OE) 1706 of *B. juncea* and GSH 1717 of *B. napus* showed resistance to DM at PNT and JHS.

Uniform Disease Nursery for major diseases

DRMRSJ 1, DRMRSJ 7, DRMR 2018-37, and PAB 14-5 of *B. juncea* showed resistance reaction to WR under natural conditions with mean disease severity below 10%, whereas highest WR severity was on check Rohini was 31.5%.

DRMRSJ 25 at MOR and PNT while, RMM-10-1-1, DRMRSJ 26 and DRMR 2018-41 were found tolerant at MOR and SGN to SR under natural condition.

National Disease Nursery (NDN) for Alternaria blight

None of the entries were tolerant to AB. Whereas, PMW 8, DRMR-2018-37, DRMR 2018-41, DRMRSJ 7, PAB 14-5, DRMRSJ 1, DRMRSJ 4, DRMRDJ 3, DRMRDJ 1, and DRMRSJ 19 of *B. juncea* showed resistant reaction to WR.

National Disease Nursery (NDN) for white rust

PRD 17-1, PRD 17-2, DRMRIJ 12-40, DRMRIJ-16-7-1, RH 1400, RH 1400-1, entries of *B. juncea* showed immune reaction to WR at MOR, PNT, HSR locations. Some of the promising strains sowed resistance to WR viz., DRMRIJ 12-27, DRMRIJ 12-37, DRMR-5206, PDZ 5, DRMRSJ 1, DRMRSJ 4, DRMR 2018-41, DRMRDJ 1, DRMR 2018-37 and DRMRIJ 12-37 (3 locations).

PB (A4A5)-842, PJK (A4A5)-21, Varuna (A4A5)-936-279 were showed immune reaction to WR at 5 locations and also at cotyledonary stage under artificial conditions. Although, PB(A4A5) 491 showed resistant reaction to WR at 3 locations.

DRMRIJ 12-26, and DRMRMJA 35 were found consistently resistant to WR during 2014-15, 2015-16, 2016-17, 2017-18, 2018-19 and 2019-20.

National Disease Nursery (NDN) for Sclerotinia rot

Comparatively less incidence (<50%) of SR was recorded on *B.juncea* strains DRMRSJ 21, DRMRSJ 22 and DRMR 5206 under artificial condition.

Screening of IVT entries of Brassica against different diseases

MCB 1-2-3-2-4, PDZ 13, 91J5001 (Q), 7J157C (H) of *B. juncea* were found resistant to WR at five locations. Whereas, almost all the entries of *B. rapa* var. Toria and *B. rapa* var. Yellow Sarson*, B. napus* escaped WR infection.

Standardization of differential hosts for identification of races in *A. candida*

The reaction of 10 rapeseed-mustard genotypes was recorded against 5 isolates of *Albugo candida* (AcPNT, AcHSR, AcBPR, AcNDH, AcLDH) at LDH, HSR, PNT and NDH. None of the genotype gave WR resistant reaction against all 5 isolates. Genotype DRMRAB 753 gave susceptible reaction to all isolates at all five locations. Whereas, genotypes DRMR 2035 and Basanti gave resistant reaction against Ac-BPR, and Ac-HSR, and variable reaction to other isolates of *A. candida* at 3 locations.

Epidemiology of Alternaria blight, white rust, powdery and downy mildew

Experiments on the epidemiology of foliar diseases of rapeseed-mustard were laid out using cv. Varuna and local cultivar. The experiment was sown on eight different dates at weekly interval starting from October 1 to November 19 without adopting any protection measures against pest and diseases.

At PNT, Two genotypes Varuna and Kranti were sown at eight different sowing dates. Downy mildew disease first appeared 10 DAS on Nov 05, Nov 12, and 11 DAS on Oct 29 and Nov 19 sown Varuna and Kranti cultivars. Whereas, on Oct 01 to Oct 22 sown crop, the DM appeared between 35 to 42 DAS and on Oct 29 to Nov 19 sown crop disease appeared between 56 to 70 DAS on both the cultivars. White rust disease first appeared 38 DAS on Nov 12 and Nov 19 sown crop while 50 DAS on Oct 1, and Oct 08, continued up to 97 DAS on late sown crop (Table 4.8.1). Alternaria blight disease was first noticed 39 DAS on Oct 08 and 46 DAS on Oct 01, and Nov 05 on both the cultivars. While, on Oct 22 sown crop, the disease appeared late i.e. 56 DAS. The Alternaria blight on pods first appeared 88 DAS on late (Nov 12) sown crop which is 7 days early in comparison to last year. On early (Oct 01) sown crop, the symptoms on pod appeared late after 120 days of sowing (Table 4.8.2).

At SHL, Epidemiological experiment was laid out with cv. Varuna and TM 2. The crop was sown with 6 dates of sowing started from Oct 15 to Nov. 19 at weekly intervals. AB was first observed at 41 DAS in Nov 05 sown crop. While AB appeared at 66 DAS in Oct 08 seeded crop during 2018-19, while, it was appeared in 39 DAS in Nov 19 sown crop during 2017-18. AB on silique first appeared at 85 DAS in Nov 19 sown crop which was appeared at 110 DAS in early sown crop on Oct 15 in both the cultivars. Maximum disease severity was at 100 DAS (39.2%) in Nov 19 on cv TM 2 (Table 4.8). Maximum yield was recorded in Oct 29 sown cv Varuna (17.2 q/ha) while in TM 2 it was 12.9 q/ha (Oct 29). Yield data revealed that the best sowing time of crop in the region is last week of October (Table 4.8.3).

At SKN, Experiment was laid out with cv. Varuna and GM 2 sown on 8 dates of sowing started from Oct 01 to Nov 19 at weekly intervals. Powdery mildew disease first appeared at 78 DAS instead of 83 DAS, 76 DAS during 2018-19, 2017-18 respectively, on Nov 19 sown crop of Varuna and 79 DAS instead of 88 DAS last year in Nov 19 sown GM 2. The maximum disease severity was observed 99% in Nov 19 sown crop cv Varuna followed 97% in Nov 12 sown GM 2. The maximum seed yield reduction was observed in late sown crop. Although, highest yield was observed in Oct 01 sown crop (Table 4.8.4).

At MOR, Trial on epidemiology of foliar diseases of Indian mustard was laid out with cv. Varuna and Rohini. The crop was sown with 8 dates of sowing started from Oct 01 to Nov 19 at weekly intervals using recommended agronomic practices. Alternaria blight on leaf first appeared 70 DAS in Nov 12, and Nov 19 sown crop of both cultivars Varuna and Rohini. Whereas, AB on silique appeared at 80 DAS on same plots (4.8.5). PM was observed first 80 DAS and was maximum 63.1 % reported in cv Varuna (130 DAS) in Nov 19 sown crop.

WR appeared first on 48 DAS in Nov 19 sown crop and continued till 110 DAS in Oct 01 sown crop. WR disease severity was maximum upto 44.0% in Nov 05 sown crop both cv Varuna and Rohini. Maximum staghead was observed 44.4% in Nov 19 sown cv Rohini followed by Nov 05 sown both cultivars. Maximum yield (26.5 q/ha) was recorded in both cultivars on Oct 08 sown.

At JAG, Experiment on epidemiological studies of PM and WR was laid out with cvs Varua and DRMRIJ 31 with 8 dates of sowing started from 01 Oct to Nov 19 at weekly interval using recommended agronomic practices. PM appeared first at 66 DAS on cv Varuna whereas 70 DAS on cv DRMRIJ 31 in Nov 19 sown. WR first appeared 48 DAS on cv DRMRIJ 31 sown on Nov 19. Optimum date of sowing for maximum seed yield seems between Oct 08 to Oct 15 sown crop.

At DOL, Experiment was laid out with cvs. Varuna and Rajendra Suflam sown with 8 dates of sowing starting from Oct 01 to Nov 19 at weekly intervals. AB first observed 41 DAS in Nov 19 sown cv Varuna and 50 DAS on cv Rajendra Suflam, while, it appeared late in early sown (Oct 01) crop (90 DAS). The disease continued to progress on leaves up to 140 DAS on both the cultivars.

Testing of IDM module for major rapeseed-mustard diseases

AB, WR, DM, PM, SR diseases were observed in integrated disease management practices and farmer's practices to standardise the best integrated disease management module. Module included seed treatment with *Trichoderma harzianum* @10g/ kg seed, soil application of *Trichoderma* (1 kg/ 50 kg FYM), basal application of zince sulphate @ 15 kg/ h + S (dose as per location recommendation) + boron (10 kg borax/ ha), line sowing 45 x 20 cm spacing, no irrigation during 25th to 15th Jan. AB severity recorded from 18.2 % at MOR to 40.2% at PNT in module while in farmer's practices AB severity ranged from minimum 21.2% at JAG to highest at PNT (46.9%). Similarly, WR severity was recorded minimum 6.3 % at DOL and maximum 36.2 % at PNT in module while minimum at DOL (10.0%) and maximum 60.0% at BPR in farmer's practices. PM severity was observed in module between 19.3 % at Jag to

73.0% at SKN while in farmer's practices 15.9% at Jag to 75.5% at SKN. Mean SR disease was reduced from 23.3% in farmer's practices to 12.2% in module. Results showed that the significant increase in yield upto 2034 kg/ha by using IDM module over 1650kg/ha in farmer's practices

Entomology

Summary Entomology 2019

The 2019-20 crop season witnessed low to moderate population development of mustard aphid on different Brassica species.

NPJ-231, BAUM 08-18, NPJ-234, SVJH 85, DRMRHJ-1518, RMT-1726, RE(OE)-1710, DRMRC1116, JT-13-8, RH1999-18, TM-52, AKMS-19-2, PBR-15-2, HUJM-18-7, CAN 184/CAN-184, RGN 462, SVJH 85, HNS 0901, AKGC 19-19, GSLI (ZC), RMT-314, PBG 385, RH 1676, 7IJ0003, RGN 73 (LR), RH -1424, DRMR-IC-1638, Raj Vijay Mustard-2, RH1599-41, kranti (NC), SVJH 108, NRCHB-506(HC), PM-29(LC), RMM 10-1-1, RGNB (LR), DRMR16161-31, AKGS-8217, GSLI (ZC), GSH-1707, GSH-1717, GSH-1619 were found promising since these recorded AAII ≤2

The highest yield loss was observed in PM31 (60.22%) followed by RH725 (58.94%) and BSH-1 (55.44.2%) at Kanpur. In general, PM31 suffered high yield loss at Kanpur (60.22%), Dholi (32.68%), Hisar (27.2%), New Delhi (21.6 %%), Pantnagar (20.25%) and 9.37% at Bharatpur (9.37)

Moderate to high population of mustard aphid was reported at most of the centers from 3rd to 12th with peak during 7th to 11th . Low to moderate population of painted bug was observed from 11th to13th std week. The activity of coccinellid predators was moderate to high during 7th and 11th std week. However, low population of leaf miner was observed which remained active from 3rd to 11th std week. In addition to this, low to moderate population of sawfly was observed on early sown crop from 46th to 49th std week. Very low activity of cabbage caterpillar was recorded both under late sown conditions. Cabbage caterpillar appeared as early as on 9th std week under timely sown conditions and remained active till 12th std week, while under late sown conditions.

The alate aphid population was recorded by eight centres. First appearance was recorded during 1st std week from Morena. It started increasing at most of the centers from 51st – 1ststd. Week and reached its peak from 8th – 11th std. week. The highest peak (1523.6 aphids/ trap) was recorded SKN during 7th std week. After 11th std. week at general trend of decline in alate aphid population was observed which disappeared from most of centers after 13rd standard week.

Among bio-intensive IPM module treatments, treatment with Dimethoate 30 EC@2 ml/l followed by its second application after 10 days was found effective at most of the centers *i.e* NDH, DOL, HSR, KAN, LDH ,MOR,SHIL, SKN and BPR with IBCR 7.86,12.8, 44.35,40.87, 3.0 2.0,4.28,41.67 respectively. PTN treatment T5 was found effective with yield with IBCR ratio of 5.74

Survey and surveillance of insect-pests was conducted at SKN, PTN, KPR, LDH and SHL Mustard aphid, painted bug, sawfly, flea beetle and coccinellid predators were reported from fields with moderate to low activity.

Plant Physiology

Five experiments were conducted to evaluate mustard genotypes from different agro-climatic zones to abiotic stresses while sixth experiment was conducted at two locations to test the efficacy of PGR's under rainfed conditions. Thirty genotypes of Indian mustard (*B.juncea*) were tested for high temperature tolerance at seedling stage both under laboratory and field conditions. Seedling mortality ≤20% and DW/10 seedlings ≥ 40mg rated genotypes tolerant under controlled conditions.PM 25 (NC) and DRMR2018-27 at Hisar while PM25 (NC), RGN229 and DRMR 4009 at Kanpur showed thermo tolerance. Three genotypes namely

JD6(ZC), PM25(NC) , DRMRHT13-22-10 at Kanpur and Ludhiana, DRMR-2018-27 at Hisar and Ludhiana, DRMRHT13-22-10 at Kanpur and Ludhiana while RMM10-17,PM25 (NC),PM27 (NC),RGN229, DRMR2017-27 at 3 locations showed seedling mortality ≤30% indicating moderate thermo tolerance under controlled condition. In the field sown trial, DRMR2059, PM 25(NC), DRMR-2017-8 and DRMR2275 at Dholi and Ludhiana had seedling mortality ≤30% and dry matter per 10 seedlings ≥4.0g. Conclusively, only PM 25 (NC) was highly tolerant at Hisar and Kanpur while RMM10-17, PM27 (NC), RGN229, DRMR2017-27 moderately tolerant at Hisar, Kanpur and Ludhiana. JD-6(ZC) was moderately tolerant at Kanpur and Ludhiana under controlled condition. PM 25(NC) and JD-6 (ZC) showed tolerance to high temperature at seedling stage both under laboratory and field conditions with seedling thermo tolerance index (STI) ≥50%. Light stress due to shading for 30 days impaired physiological and yield traits to variable extent within the genotypes and also at two locations. Lesser reduction in the physiological traits and seed yield (≤20%) identified RMM10-1-1, RH1676 and SVJH-108 at Hisar and Ludhiana as promising genotypes under low light stress Moisture stress imposed by withholding irrigations at 35 and 65 DAS significantly affected the performance of thirty one genotypes tested at 3 locations. NPJ214, LES54, NPJ210, NPJ225, DRMR2017-15 and DRMR1222 at Dholi, Hisar and Ludhiana were tolerant to moisture stress. Only one genotype LES54 was rated highly tolerant at Hisar and Ludhiana whereas DRMRCI114 moderately tolerant at 3 locations (Dholi, Hisar and Ludhiana) to moisture stress. Tolerance to moisture deficit in these genotypes was attributed to higher chlorophyll content, RWC, SPAD values and lesser decline in seeds per siliqua siliqua, seed weight with DSI ≤1.0 and YSI ≥0.82. Genotype RH0725 (check) suffered decline in seed yield ≤30% and was rated moderately drought tolerant at Dholi and Hisar but highly tolerant at Ludhiana with yield reduction ≤20%. RGN229 (check) was highly tolerant with yield reduction ≤20% at Dholi and Hisar and moderately drought tolerant at Ludhiana with ≤30% decline in seed yield .Out of thirty four mustard genotypes only Raj Vijay Mustard 2 (LR) was rated highly tolerant to terminal heat stress with seed yield reduction ≤20% and high stability indices (HIS ≥0.75 and YSI ≥0.82).Three genotypes (DRMR2059, Raj Vijay Mustard, DRMRHT13-28-8) showed yield reduction ≤30% with HSI ≥0.48 and YSI ≥0.70 at Hisar and Ludhiana and were considered moderately tolerant to terminal high temperature with relatively lesser depression in membrane stability, seed weight, seeds per siliqua and cooler canopies. PDZ4 seems promising at 3 locations for salinity tolerance (Hisar, Kanpur and Ludhiana) with relatively lesser decline in germination percentage, seedling length, dry matter accumulation at 3 locations and decrease of 19.4% in vigor index II at Hisar only. Foliar spray of brassinolide @ 20ppm and salicylic acid @ 200ppm at 2 locations (Hisar and Ludhiana) improved seed yield under rainfed conditions.

Biochemistry

Entries of IVT/AVT quality trials were evaluated at Bharatpur, Kangra, Pantnagar, Hisar and Ludhiana. Oil stability index which is the ratio of MUFA: PUFA ranged from 0.40 in PR-2016-4 to 1.57 in GSH-16-99. The SFA: MUFA: PUFA ratio ranged between 1:07:09 (GSH-21-80) to 1:24:10 (PT-2015-6). RCH-1, GSH-16-99, LEC-61, PDZ-13, RH(OE)-1705, JC-21, GSH-1707, RH(OE)-1710, RH(OE)-1711, PDZ-1, PM29, PM-30, LES-60, LES-59 and LES-54 had < 2 % erucic acid content. Palmitic acid mean values ranged from 2.71% (PT-2015-6) to 4.27 % (GSH-17-17); Stearic acid mean value raged from 0.76 % (PT-2015-6) to 2.08% (PDZ-1). Oleic acid from 9.71 % (PRE-2017-5) to 43.62 % (GSH-1707); Linoleic acid from 15.04 % (PR-2016-8) to 40.05 % (LEC-61). Linolenic acid: 11.39 % (PT-2015-7) to 25.84 % (RH (OE)-1711); Eicosanoic acid: 4.76 % (RH (OE)-1711) to 11.50 % (GSH-21-80).ω6:ω3 ratio ranged from 1.05 (PRE-2017-5) to 3.06 (LES-59).Total Protein ranged from 28.42 (JC-21) to 35.53% (RH (OE)-1706); Methionine ranged from 1.28 (JC-33) to 2.08 (LEC-61, RH(OE)-1711) g/100g protein. Tryptophan: 0.81 (LES-54) to 1.25 (PR-2017-7) g/100g protein. Total antioxidant capacity ranged from 15.04 (PDZ-1) to 26.01 (JC-21) mg/g AAE; β-carotene ranges from 2.80 (PDZ-13) to 5.22 (PRC-2017-5). Variations in glucosinolate content were observed from 10.89 to 99.42 μmole/g defatted meal. Less then 30

µmol/g glucosinolate was observed in GSH-21-80, GSH-17-17, RCH-1, GSH-16-99, PDZ-13, JC-21, GSH-1707 and JC-33 genotypes. Phytic acid content was reported less then 2% in LEC-61, JC-21,RH(OE)-1706, RH(OE)-1711, PRE-2017-5 and PRL-2017-5.

Frontline demonstrations 2019-20

Under the scheme "Frontline demonstrations and other related activities of Oilseeds", 26 cooperating centres of AICRP-RM/ ICAR institutes/ Ag. Universities conducted 1405 frontline demonstrations (FLDs) on rapeseed-mustard during 2019-20 in 57 districts across 15 states. Rajasthan had maximum FLDs (467) followed by Manipur (240), Uttar Pradesh (183), Assam (135), and Jharkhand (78). Two hundred thirty six FLDs were conducted on rapeseed and 1169 on mustard. All the demonstrations were conducted under whole package demonstrations in two different situations viz., irrigated (870) and rainfed (535).

The maximum average yield of 2,497 kg/ha from the IP under irrigated conditions was in Haryana followed by 2,211 kg/ha in Rajasthan; 2,157 kg/ha in Gujarat; 2,022 kg/ha in Punjab, 1,923 kg/ha in Uttar Pradesh; 1,675 kg/ha in Madhya Pradesh; 1,383 kg/ha in Uttarakhand; 1,225 kg/ha in Jharkhand and 1,143 kg/ha in Telangana. The maximum yield gap of 61.0% was recorded in Odisha followed by 54.1% in Jammu & Kashmir; 49.2% in Telangana; 33.4% Himachal Pradesh; 26.7% in Uttar Pradesh; 21.3% in Maharashtra; 19.2% in Haryana, 17.6% in Madhya Pradesh and 15.3% in Gujarat. The maximum ANMR/ha were Rs 19,027; Rs 14,602; Rs. 13,794; Rs. 12,933; Rs. 11,875, Rs. 10,681; Rs. 9,848; Rs. 7,075 and Rs. 6,670 in Jammu & Kashmir, Haryana, Uttar Pradesh, Telangana, Gujarat, Rajasthan, Odisha, Punjab and Himachal Pradesh, respectively. The cost of cultivation ranged from Rs. 14,520/ha in Maharashtra to Rs. 34,514 /ha in Haryana in IP under irrigated Whole package demonstrations.

The maximum average yield of 1,720 kg/ha from the IP of WP under rainfed conditions was in Rajasthan followed by 1,388 kg/ha in Uttar Pradesh; 1,306 kg/ha in Uttarakhand; 1,141 kg/ha in Assam; 1,076 in Jharkhand; 1,020 in Manipur and 916 in Himachal Pradesh. The maximum yield gap of 45.0% was recorded in Jharkhand followed by 36.6% in Assam; 33.9% in Himachal Pradesh; 28.8% in Manipur; 26.1% in Uttar Pradesh; 20.6% in Uttarakhand and 14.0% in Rajasthan. The maximum ANMR/ha were Rs 12,478; Rs 8,780; Rs 8,221; Rs 7,429; Rs. 6,699; Rs 6,220 and Rs. 5,250 in Uttar Pradesh, Manipur, Uttarakhand, Rajasthan, Assam, Himachal Pradesh and Jharkhand, respectively. The cost of cultivation ranged from Rs. 13,060/ha in Manipur to Rs. 29,702/ha in Uttar Pradesh in IP under rainfed Whole package demonstrations.

A total of 10 improved varieties of Indian mustard, 2 each of yellow sarson and toria and one of gobhi sarson were used in WP covering 12 states under irrigated condition. Under irrigated condition, improved variety RH 725 of Indian mustard demonstrated in 29 FLDs in Haryana recorded highest average yield of 2,525 kg/ha with a yield improvement of 18.1% over local (FP) followed by Giriraj demonstrated in 6 FLDs in Haryana with average seed yield of 2,358 kg/ha with yield improvement 25.1%. The minimum yield improvement of 8.5% was reported from CS 60 variety from 9 FLDs in Rajasthan, while minimum average seed yield of 826 kg/ha was reported from TAM 108-1 variety from 30 FLDs in Maharashtra. However, the variety RH 749 in Jammu & Kashmir under irrigated condition recorded highest yield improvement of 62.6% with average seed yield of 1,190 kg/ha.

The maximum yield improvement of 12.8% from Pant Sweta variety of yellow sarson in Uttarakhand, 33.4 % from GSC 7 variety of gobhi sarson in Himachal Pradesh, 9.1% from PT 508 in Uttarakhand were recorded under irrigated condition.

Under rainfed condition, the demonstrations with RGN 298 recorded the highest average seed yield of 2,160 kg/ha with yield improvement of 11.1% in Rajasthan under rainfed

situation. In Manipur, 85 demonstrations with NRCHB 101 recorded lowest average seed yield of 1,008 kg/ha with yield improvement of 28.2% over FP. However, The variety PM 27 in Assam under rainfed condition recorded highest yield improvement of 84.0% with average seed yield of 1,325 kg/ha.

The maximum yield improvement of 53.8% from YSH 401 variety of yellow sarson in Assam, 33.4 % from GSC 7 variety of gobhi sarson in Himachal Pradesh, 61.0% from TS 38 variety of toria in Assam and 23.1% from RTM 1351 of taramira in Rajasthan were recorded under rainfed condition.

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Thank You! Jai Hind!

ACTION TAKEN REPORT 2020

S. No.	Recommendation	Action Taken
Plant Breeding		
1	Centres working on yellow sarson improvement, namely Pantnagar, Kanpur and DRMR Bharatpur shall share germplasm and segregating material of yellow sarson with other centres of zone V, particularly, Jagdalpur, Shillongani, Kalyani and CAU Imphal to strengthen their breeding programme	germplasms and segregating breeding materials shared with Kalyani and CAU Imphal
2	Looking the less number of entries inducted in yellow sarson trial, it was decided to conduct yellow sarson trial in alternate years as already being practiced in salinity mustard and taramira trials	Implemented as suggested.
3	A new trial shall be constituted to evaluate the performance of introgressed White Rust Resistant lines developed by Delhi University South Campus, keeping IVT format	A new trial for evaluation of introgressed white rust resistant lines was constituted during 2019-20, however, due to less quantity of seed available, it could not be conducted. The trial shall be conducted this year (2020-21) subject to availability of required qauantity of seed.
4	In hybrid trial, microscopic observations on fertility/sterility status of pollen grains may be recorded at some centres	Microscopic observations on fertility/sterility of inducted hybrids initiated at ICAR-IARI, New Delhi
5	In double zero lines, promotion shall be on the basis of 10% superiority for seed/oil yield over quality check as well as at least -10 % seed/oil yield of the best non quality check	Recommendation has been included in the promotion criteria and implemented from 2019-20.
6	It was decided that those entries of AVT I trial, yielded (seed/oil yield) more than 5% but less than 10 % over the best check shall be repeated for one more year in same trial, however in this case data of 1st year AVT 1 trial shall not be the part of the proposal	Recommendation has been included in promotion criteria and is implemented from 2019-20.
7	In AVT-I Taramira trial, data of Morena centre shall be excluded and entry shall be repeated in AVT - I trial	Recommendation implemented as suggested

8	Under early and late sown mustard trials, row to row spacing shall be kept 30 cm instead of 45 cm	Recommendation implemented as suggested
9	In zone V, cutoff date for sowing shall be 15th November for toria and yellow sarson trials	Recommendation implemented as suggested
10	In taramira, general mean of the trial should be at least 50 % of state average for its acceptance	Recommendation implemented as suggested
11	Facilities for DNA Finger Printing of rapeseed-mustard varieties/advanced lines may be developed at ICAR-DRMR, Bharatpur and fund for this purpose may be demanded from DAC & FW	Proposed for funding of DAC& FW under NMEO.
12	A proposal on development of infrastructure for hybrid seed production may be submitted to DAC&FW by ICAR-DRMR, Bharatpur	Proposal shall be submitted to DAC&FW, for funding.
Biochemistry		
13	All the centers should conduct the experiments according to the technical programme and submit the report.	All the centers have performed the experiments according to the technical programme and submitted report timely.
14	Maximum 30 genotypes shell be considered for each experiments and minimum 50 g of seed of each genotype will be required for the study.	31 genotypes were provided for experiments and the amount supplied was more than 50 g
15	Those centers which do not have sufficient facilities for GC, can analyze their samples at DRMR, Bharatpur.	Hisar and Pantnagar send their samples for GC analysis.
16	All the centers should follow the same protocols with similar standards for all the experiments.	All the centers followed the same protocol and standards.
17	All the centers should send the replicated data of each experiment in biochemistry for statistical analysis.	All centres have given the replicated data.

Annexure 1

Rapeseed – Mustard hybrids/varieties released during 2011-2019

Year of notification	Number	Variety/Hybrid
Brassica juncea		
2011	02	Pusa Mustard 26 (NPJ 113), Pusa Mustard 27,
2012	04	Pusa Mustard 28 (NPJ 118), ELM 123 (RLC 2), Coral PAC 437, and PR 2006-1,
2013	09	Giriraj (DRMRIJ 31), RH 0749, Divya 33, Pusa Mustard 29, RH 0406, Pusa Mustard 30, RajVijay Mustard 2, RGN-229, RGN 236
2015	07	Albeli 1, RGN 298, GDM-4*, PBR 357, Pant Rai 20* DRMR-150-35**, SKM 518**
2016	05	Gujarat Mustard 5*, JK Pukhraj*, JK Samridhi Gold*, RLC 2*, RVM 1*
2017	04	PRB-2008-5*, CS 58**, NRCHB 101**, RH 749**
2018	05	CS 2800-1-2-3-5-1**, RH 0725**, PDZ-1**, DRMR 1165-40**, Hybrid (PRO5111) Keshri**
Toria (*Brassica rapa*)		
2016	01	TL 17*
Yellow sarson (*Brassica rapa*)		
2016	01	JK Pukhraj (JKYS 2)*
Taramira (*Eruca sativa*)		
2011	02	Vallabh, Taramira 1* and VallabhTaramira 2*
2014	01	RTM 1355**
2017	01	RTM-1351**
Brown Sarson		
2012	01	Shalimar Sarson-1*
Gobhi Sarson		
2015	02	RSPN-25, GSC-7
Karan rai (*Brassica carinata*)		
2016	01	BJC 1 (PC6)*
Grand Total	**46**	

** State release (14)*

** Identified (12)

Annexure 2

Zone-wise research centre's for multi-location testing

Zone I		
Jammu & Kashmir	:	Khudwani, Srinagar*
Himachal Pradesh	:	Kangra, DhaulaKuan*, Bajaura*, Una*
Zone II		
Jammu &Kashmir	:	Chatha
Punjab	:	Ludhiana, Bathinda*
Haryana	:	Hisar, Bawal, Karnal*, Gurgaon*, Panipat*
Rajasthan	:	Navgaon, Sriganganagar, Alwar*
Delhi	:	IARI*, Jaunti*, Modipuram*
Zone III		
Uttar Pradesh	:	Kanpur, Faizabad /(Jhansi), Varanasi, Lucknow*, Agra*, Mauranipur*, CSSRI* (Agra)
Uttarakhand	:	Pantnagar
Madhya Pradesh	:	Morena, Tikamgarh*
Rajasthan	:	Kota*, Bharatpur
Zone IV		
Rajasthan	:	Jobner
Gujarat	:	Junagadh*, S.K. Nagar, Anand*
Maharashtra	:	Jalgaon*, Nagpur
Zone V		
Chhattisgarh	:	Jagdalpur
Bihar	:	Dholi
Jharkhand	:	Kanke
West Bengal	:	Berhampore /(Kalyani)
Orissa	:	Bhubaneswar
Assam	:	Shillongani
N.E.Hill State	:	Imphal, Shillong*

*Voluntary Centre

Abbreviations used in the report

Zone I		**Zone III**		**Zone V**	
KHD	Khudwani	AGR	Agra	BER	Berhampore
KNG	Kangra	BPR	Bharatpur	BHU	Bhubaneswar
DLK	Dhaula Kuan	KOT	Kota	DOL	Dholi
UNA	Una	KPR	Kanpur	JAG	Jagdalpur
SRN	Srinagar	FZB	Faizabad	KNK	Kanke
Zone II		VAR	Varanasi	IMP	Imphal
CHT	Chatha	LKW	Lucknow	SHG	Shillong
LDH	Ludhiana	MRP	Mauranipur	SHL	Shillongani
BTH	Bathinda	PNT	Pantnagar		
HSR	Hisar	MOR	Morena		
BAW	Bawal	TKM	Tikamgarh		
KAR	Karnal				
NAV	Navgaon	**Zone IV**			
PNP	Panipat	AND	Anand		
SGN	Sriganganagar	JUG	Junagadh		
MOD	Modipuram	SKN	S.K. Nagar		
NDH	New Delhi	BKR	Bikaner		
JNT	Jaunti	JAL	Jalgaon		
ALW	Alwar	NGP	Nagpur		
GUR	Gurgaon				

26th Annual Group Meeting

All India Coordinated Research Project on Rapeseed-Mustard
Birsa Agricultural University, Ranchi
(August 03-05, 2019)