Annual Report: Glimpses 2019-20

AICRP
"National Seed Project (Crops)"

ICAR- Indian Institute of Seed Science

(Formerly ICAR-Directorate of Seed Research)

(Indian Council of Agricultural Research)

Kushmaur, Mau 275103 (UP)

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Preface

Quality seed is the decisive input for sustained agriculture production and is paramount for realizing the potential of all other inputs without which the investment on inputs such as fertilizer, water and pesticide will not pay desired dividends to the farmers. The pace of progress in food production is largely dependent upon the progress of seed programme with which a country is able to multiply and market good quality seed of high yielding varieties with superior genetics. Role of quality seed is documented and acknowledged across farming systems and ICAR duly acknowledged this fact by the launch of mile stone project *viz*. AICRP- NSP (Crops) during 1979-80. To effectively operationalize quality seed programme, it is essential to produce sufficient quantity of breeder seed. Similarly, to organize well orchestered seed production programmes, research back up on various aspects of seed production technology, quality maintenance and its fine tuning, storage, seed health care and seed processing *etc*. are vital and found to be indispensable. In order to address issues such as Seed Replacement Rate (SRR) and Varietal Replacement Rate (VRR) and to develop need based technological interventions in seed domain, launching of network project viz. AICRP-NSP (Crops) has been a significant stride under ICAR. AICRP-NSP (Crops) under aegis of ICAR is guiding, coordinating and promoting seed technology research and breeder seed production very systematically with an appropriate research backdrop.

Annual Report 2019-20 is a compilation of progress made by varied co-operating centers under AICRP-National Seed Project (crops) under its two components *viz*., Breeder Seed Production and Seed Technology Research. It is my immense pleasure to gratefully acknowledge the dynamic leadership and path illuminating guidance received from Dr. T. Mohapatra, Hon'ble Secretary, DARE & Director General, ICAR and I hope that under his able stewardship, Indian seed production and research fraternity would excel in the arena of quality seed production and research. I acknowledge gratefully Dr. T.R. Sharma, DDG (CS), who is the mission leader of this project, for his kind support, guidance and encouragement. I thank Dr. D.K. Yadava, ADG (Seed) for his tireless help and active co-operation rendered. I also thank Seed Section, DAC&FW, MoA&FW for their cooperation in implementation of BSP programme. I also place on record my sincere thanks to all nodal officers and scientists from various co-operating centers, who did commendable job in successful implementation of the project. I gratefully acknowledge the immense support of Principal Investigators; Dr. Sandeep K. Lal, Dr. S.K. Yadav, Dr. Atul Kumar, Dr. Amit Bera and Dr. Ashwani Kumar, who have done meticulous compilation of various reports, technical programme and for providing technical guidance to scientists. I also take this opportunity to acknowledge all scientists and staff of IISS primarily Dr. Vijayakumar H.P. and Dr. Sripathy K.V. for their efforts in successful co-ordination of this massive project across the country. I firmly believe that this project, down the line would tread us towards attaining seed sufficiency with adept technological backup for quality seed driven agricultural growth.

(Dinesh K. Agarwal)
Director (Acting), ICAR-IISS, Mau

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Introduction

Seed provides foundation to productive agriculture, be it crop husbandry, horticulture or fisheries. It is cheapest input among all and plays seminal role in enhancing agricultural productivity. To operate quality seed production programme, it is essential to produce sufficient quantity of breeder seed. Similarly, to organize well orchestered successful seed production programmes, research back up on various aspects of seed production technology, quality maintenance and its fine tuning, storage, seed health care and seed processing *etc*. are vital and found to be indispensable. The development of high yielding varieties/ hybrids of wheat, rice, maize, pearlmillet and sorghum in early sixties were the landmark beginning for development of the seed programme in the country. The World Bank assisted considerably for strengthening of Indian seed programme by launching NSP I in 1977-78 and subsequently NSP II in the following year. The ICAR along with its partner *i.e.* SAUs shouldered the responsibility of producing the breeder seed through launch of All India Coordinated Research Project on seed called 'National Seed Project (Crops)' in 1979-80 with two components *viz*. Breeder Seed Production (BSP) and Seed Technology Research (STR). The seed programme of the country was further strengthened with NSP III through World Bank assistance in 1989-90, which not only supported the ICAR and SAUs but also Department of Agriculture Corporation and Farmers Welfare (DAC&FW), Seeds Corporations, Seed Certification Agencies and Private Seed Industry to a great extent in production, processing and in providing quality seeds to the farmers.

The AICRP-NSP (Crops) is mandated to produce breeder seed of various field crops as per national requirement and to develop region specific seed technologies as per the contemporary needs of seed industry under five broad theme areas of seed science *viz*. seed production and certification; seed physiology, storage and testing; seed pathology, seed entomology and seed processing. The project has been strengthened over the years to develop state of art seed infrastructure facilities for carrying out breeder seed production and seed technology research at varied cooperating centres and during XII plan the horizons of the project were extended to NEH states. During 2019-20, Breeder Seed Production and Seed Technology Research components were operational at 41 centres and 24 centres respectively, under AICRP-NSP (Crops) at various SAUs and ICAR institutes across the country.

Mission of AICRP-NSP (Crops)

To ameliorate Seed Replacement Rate (SRR) and Varietal Replacement Rate (VRR) through production of adequate quantity of breeder seed and to develop region specific seed technologies for improved yield and production.

Mandates of AICRP-NSP (Crops)

1. To produce adequate quantity of nucleus and breeder seed as per national requirements.
2. To conduct, coordinate and monitor research on different aspects of seed science and technology.
3. To generate basic information on seed certification standards including seed health.
4. To disseminate information and impart training on seed production, processing, storage & packaging, quality control and seed health.
5. To make linkages with crop improvement projects, seed industries, seed certification agencies, NGOs / KGK / KVK *etc*.

Cooperating centres & location

As per EFC (2017-20), 41 breeder seed production and 24 seed technology research centres are in existence under AICRP-NSP (Crops).

S. No.	Breeder Seed Production (BSP)	S. No.	Seed Technology Research (STR)
	State Agricultural University (SAUs)		**State Agricultural University (SAUs)**
1	AU, Kota	1	AAU, Anand
2	BAU, Ranchi	2	CCSHAU, Hisar
3	BCKV, Nadia	3	CSAUAT, Kanpur
4	BSKKV, Dapoli	4	GBPUAT, Pantnagar
5	CCSHAU, Hisar	5	CSKHPAU, Palampur
6	CSAUAT, Kanpur	6	JAU, Jamnagar
7	GBPUAT, Pantnagar	7	JNKVV, Jabalpur
8	CSKHPAU, Palampur	8	MPKV, Rahuri
9	IGKV, Raipur	9	NDUAT, Faizabad
10	JNKVV, Jabalpur	10	OUAT, Bhubaneswar
11	KAU, Thrissur	11	PAJANCOARI, Karaikal
12	MPKV, Rahuri	12	PAU, Ludhiana
13	NDUAT, Faizabad	13	PDKV, Akola
14	OUAT, Bhubaneswar	14	PJTSAU, Hyderabad
15	PAU, Ludhiana	15	SKNAU, Jobner
16	PDKV, Akola	16	SKUAST, Srinagar
17	PJTSAU, Hyderabad	17	TNAU, Coimbatore
18	SDAU, S.K. Nagar	18	UAS, Bangalore

19	SKRAU, Bikaner	19	UAS, Dharwad
20	SKUAST, Srinagar	20	VNMKV, Parbhani
21	TNAU, Coimbatore		**SAUs – NEH Region**
22	UAS, Bangalore	21	AAU, Jorhat
23	UAS, Dharwad		**Central Agricultural University (CAUs)**
24	UAS, Raichur	22	RPCAU, Pusa
25	VNMKV, Parbhani		**ICAR Institutes**
	SAUs – NEH Region	23	ICAR-CAZRI, Jodhpur
26	AAU, Jorhat	24	ICAR-IARI, New Delhi
	Central Agricultural University (CAUs)		
27	BHU, Varanasi		
28	RPCAU, Pusa		
	ICAR Institutes		
29	ICAR-CAZRI, Jodhpur		
30	ICAR-CICR, Nagpur		
31	ICAR-CRIJAF, Barrackpore		
32	ICAR-IARI, RS, Karnal		
33	ICAR-IGFRI, Jhansi		
34	ICAR-IIMR, Hyderabad		
35	ICAR-IIPR, Kanpur		
36	ICAR-IIRR, Hyderabad		
37	ICAR-NRRI, Cuttack		
38	ICAR-VPKAS, Almora		
	ICAR Institutes – NEH Region		
39	ICAR RC for NEH, Manipur		
40	ICAR RC NEH, Meghalaya		
41	ICAR RC NEH, Tripura		

Thrust areas in Breeder Seed Production

- Production of adequate quantities of breeder seed as per national requirement.
- Quality maintenance of nucleus and breeder seeds by employing dynamic maintenance breeding and rapid genetic purity testing tools.
- Identification of suitable provenance for offseason seed production to compensate the effects of changing climate.
- Networking for development of national database of DNA profiles for varietal identification.
- Effectively ensure and monitor generation system of seed multiplication at national level through bar code and QR coding module.
- Identification of suitable seed provenance for institution of 'National Seed Reserves', with special emphasis on pulses & oilseeds in states of Maharashtra, Madhya Pradesh, Rajasthan, Karnataka, Andhra Pradesh and Telangana.

Thrust areas in Seed Technology Research

a. Seed production and certification

- Identification of suitable alternative areas/ provenances for seed production in a bid to counter the effects of climate change.
- Development and optimization of climate resilient seed production technology.
- Harmonization of seed standards in tune to the needs of global seed certification standards.
- Optimization of micro-nutrients and growth regulators in relation to reproductive behaviour to augment the seed yield.
- Developing alternative methods (self-incompatibility & apomixes systems) for hybrid seed production in a bid to exploit heterosis.
- Development of seed production packages and seed certification standards for underutilized crops.
- To explore upon new planting methodologies/ geometries in a bid to optimize seed rate in tune to realization of higher seed yields (revisiting SMRs).

b. Seed physiology, testing and storage

- Validation/up-gradation of field and seed standards/protocols, isolation distance, sample size, physical purity and ODV's in varied crops.
- Standardization of seed testing procedures in field, vegetable, medicinal and green manure crops.
- Standardization of DNA finger printing/molecular markers tools to supplement GOT.
- Use of second and third generation tools for seed quality enhancement.
- Identification of seed vigour traits as a sensitive measure of seed quality in major crops.
- Identification of suitable seed treatments / materials / methods for safe storage of seed.

c. Seed pathology

- Identification of disease free zones for quality seed production.
- Development of rapid and reliable techniques for detection, identification and screening of seed materials for different seed borne diseases.
- Development of integrated strategies for management of seed borne diseases.
- Development of field and seed standards for seed borne diseases and strengthening of work on biological control of seed borne diseases.
- Revisiting of field and seed standards for seed-borne diseases.
- Monitoring, detection, and management of new seed borne diseases.

d. Seed entomology

- Pest risk analysis for efficient management of insect pests under seed storage.
- Evaluation of new insecticide molecules for management of storage insects.
- Development of integrated management strategies for management of storage insects.

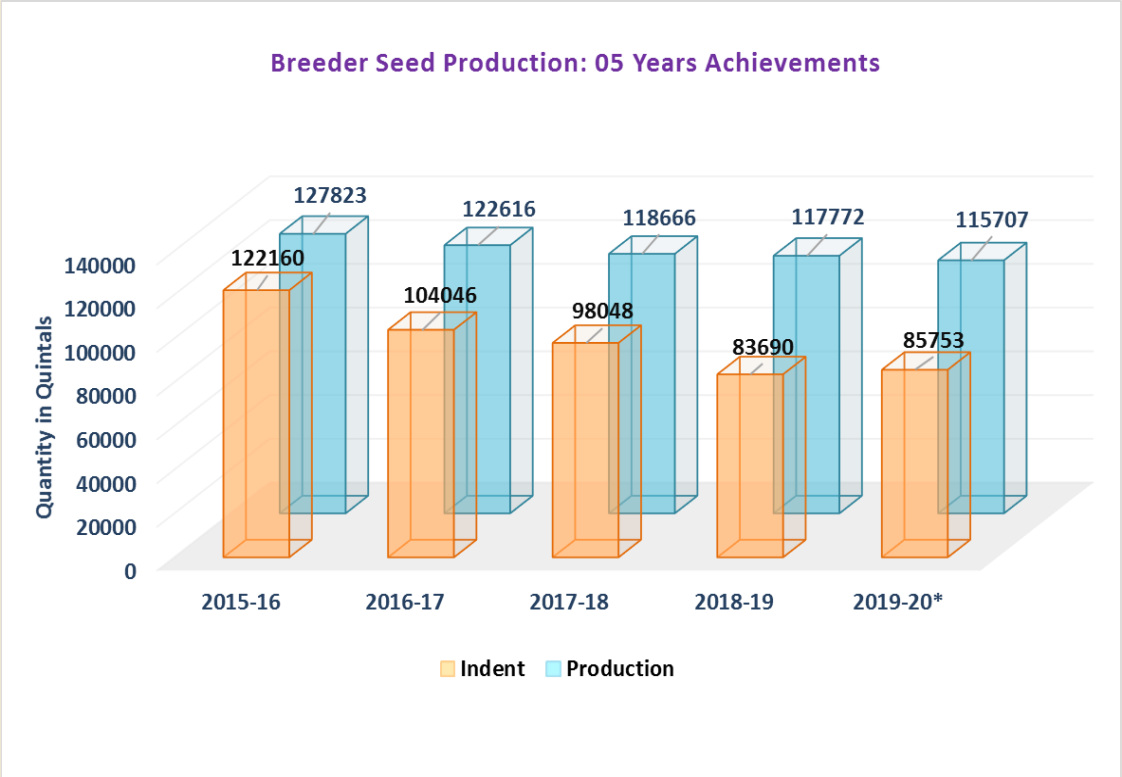
- Management of insect pollinators for increasing pollination efficiency and seed set.
- Determining the efficacy of novel packaging material with new chemistry for management of storage insects.

e. Seed processing

- Standardization of grading sieve sizes (top & bottom sieves) and processing methodologies for new crop varieties/ parental lines.
- Bringing mechanization in seed production to march towards precision farming.

Breeder seed production achievements during 2019-20

During the year 2019-20, total breeder seed production in various field crops was 115706.95q against the indent of 85752.76q. Production comprises of 80337.66q against the GoI indent of 60833.10q, 23549.24q against the state indent of 21454.43q and 11820.05q under ICAR Seed Project (additional) against the target of 3465.31q, apart from marginal shortfall in few varieties due to climate vagaries the major requirement has been met as per indents in varied crops. Whereas, with respect to *Rabi* 2019-20, expected breeder seed production figures were used for aforementioned compilation. Perusal of statistics clearly suggests that the present level of breeder seed production is surpassing the national requirement and is sufficient to produce required amount of certified seed for realizing the targeted SRR in varied crops.



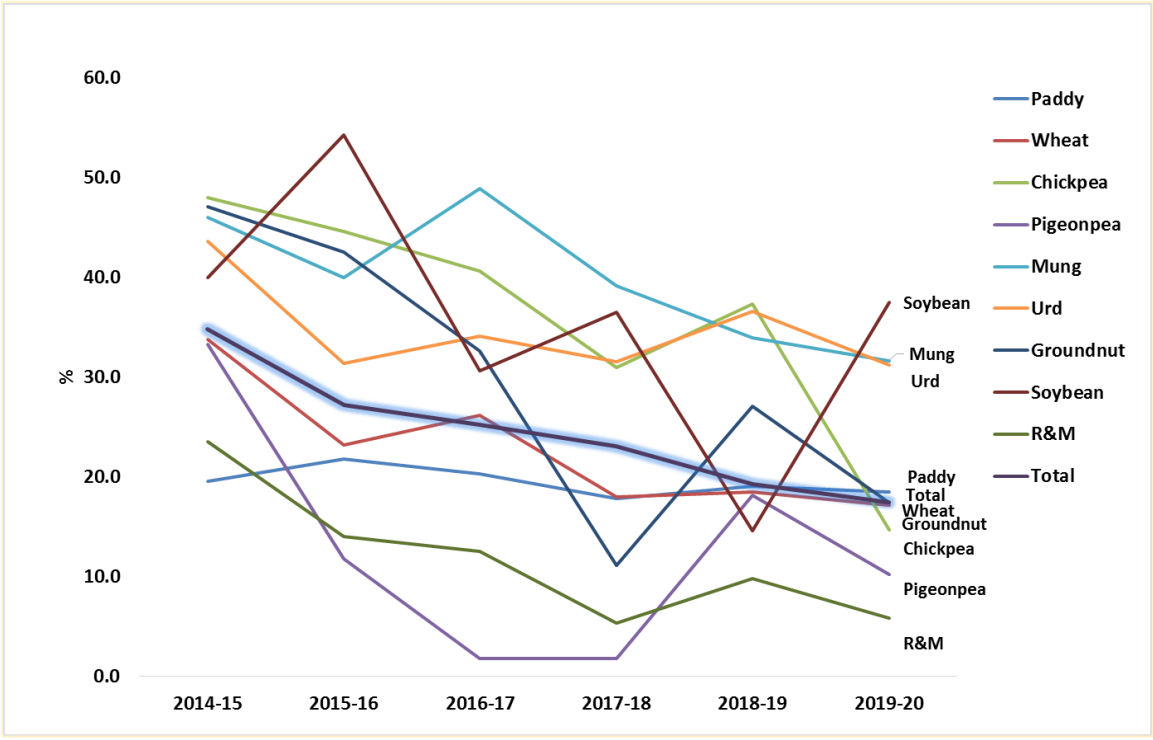
*Includes expected figures of *Rabi* 2019-20

Crop-wise breeder seed production during 2019-20

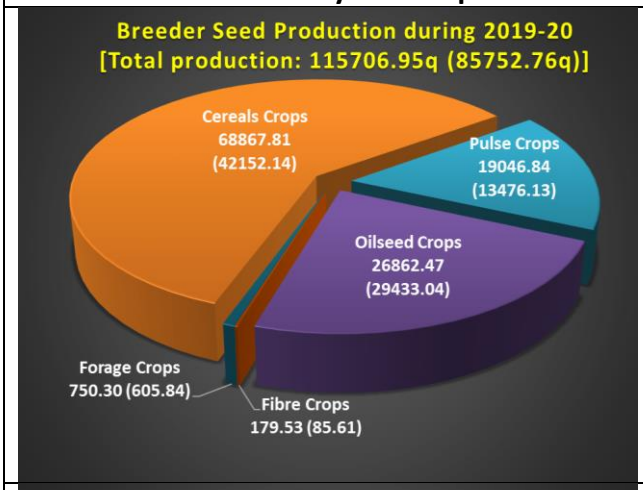
Out of the total breeder seed produced, the major share belongs to cereal crops i.e., 68867.81q in which maximum breeder seed was produced for wheat (48090.84q) followed by paddy (19112.23q). Under pulse crops a total of 19046.84q breeder seed was produced out of which 14419.88q was alone contributed by chickpea followed by lentil (989.83q), pigeonpea (954.23q), mung (935.62q), and fieldpea (832.39q). In oilseeds, total breeder seed production was 26862.47q; soybean and groundnut together have contributed to 25984.51q out of total breeder seed produced in oilseeds. Breeder seed produced in case of fiber crops was 179.53q against the indent of 85.61q in which, cotton had the major share of 158.27q. In case of forage crops, breeder seed production was 750.30q against the indent of 605.84q, out of which 467.00q alone was contributed from forage oats followed by fodder maize (84.00q) and berseem (53.89q) (Table 1).

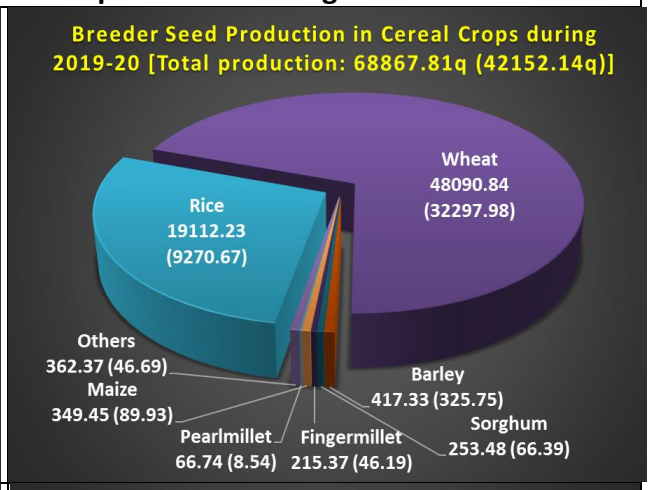
Varietal mis-match in breeder seed production

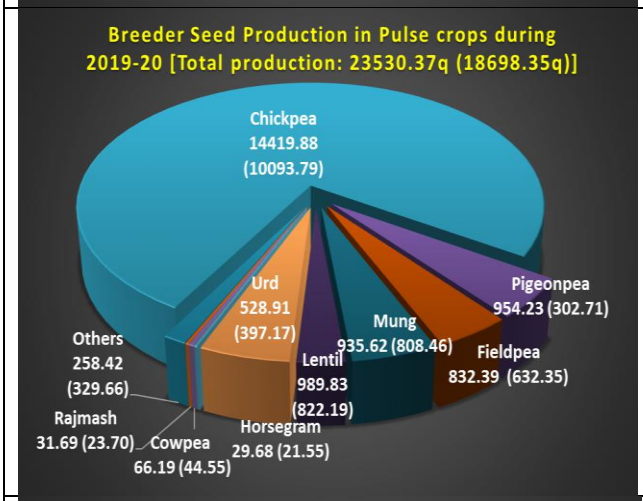
Quantum of breeder seed production always surpassed the indents reflects successful progression of AICRP-NSP (Crops). Imperceptible varietal mis-matches in breeder seed production were observed during past years, below referred illustration clearly depicts that, there is a discernible decrease in mis-matches observed in all major field crops. For example, during the year 2014-15; among 1172 varieties in seed chain, mis-match was reflected in 408 varieties (34.8%). In comparison, during 2015-16, 2016-17, 2017-18, 2018-19 and 2019-20; among 1154, 1169, 1205, 1302 and 1296 varieties in seed chain, mis-matches were reflected in 314 (27.2%), 295 (25.2%), 278 (23.1%), 251 (19.3%) and 226 (17.4%) varieties, respectively.

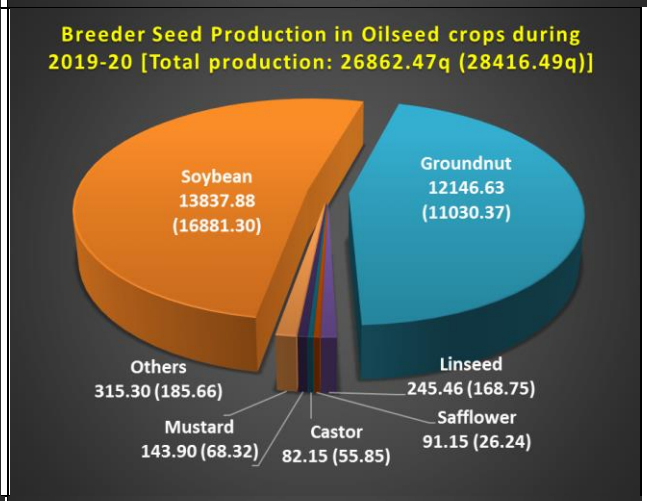


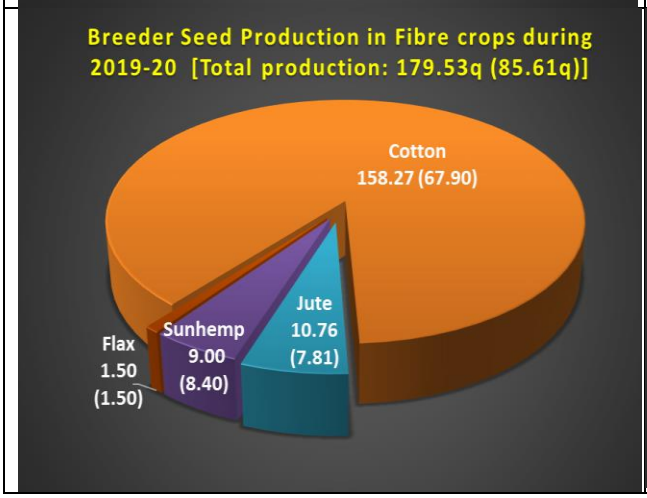
Commodity and Crop-wise breeder seed production during 2019-20

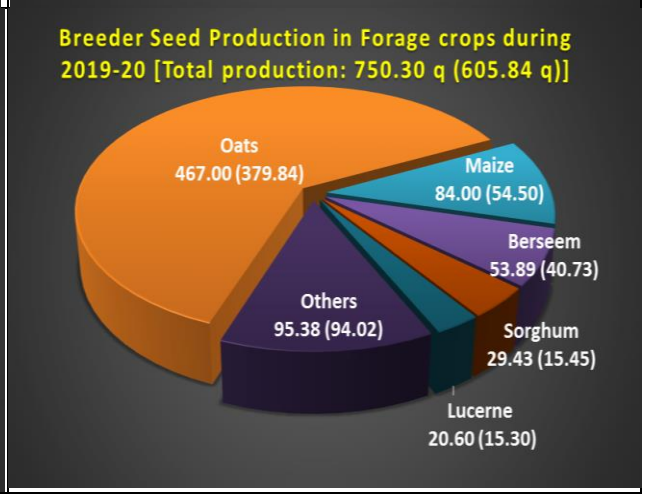












Note: Figures in parentheses indicate indent (q); for *Rabi* 2019-20, expected figures were used in compilation.

Varietal Replacement Rate (VRR) in major field crops

Varietal Replacement Rate (VRR) is one of the important factor in realizing higher crop productivity. The pace of progress in food production is largely depend upon the progress of seed programme that could able to supply quality seed of high yielding varieties with superior genetics. Perusal of statistics suggest that, across the crops, the pace of VRR was being highest in wheat followed by mungbean, chickpea, soybean, rapeseed & mustard, pigeonpea and rice. In wheat, the average (3 years, 2018-19 to 2020-21) share of varieties, notified during last five years and ten years in total breeder seed indent were 50.7 % and 77.0 %, respectively. Among pulses, mungbean has the share of 31.8 % and 73.2 % w.r.t. varieties, notified during last five years and ten years to total breeder seed indent, respectively. While in chickpea, share of varieties, notified during last five years was 42.1%, indicating better VRR. In general, pace of VRR among wheat, chickpea and soybean was being found to be satisfactory.

Varietal Replacement Rate (VRR) among major field crops

Crops	No. of varieties in seed chain	Total indent (q)	Varieties < 5 years old			Varieties < 10 years old		
			No's	Indent (q)	% share in total indent	No's	Indent (q)	% share in total indent
Rice	292	4616.5	67	845.1	18.1	122	2026.0	43.9
Wheat	145	19378.5	51	9575.6	50.7	91	14943.8	77.7
Pigeonpea	55	292.0	10	26.6	10.0	19	127.5	44.7
Chickpea	75	10231.7	21	4326.2	42.1	39	7056.4	68.8
Mungbean	59	756.2	11	222.2	31.8	24	545.4	73.2
Urdbean	47	444.7	7	46.3	10.8	17	174.2	39.6
Soybean	38	17796.9	15	9301.4	52.9	22	10240.2	57.9
Groundnut	48	9893.5	8	1132.2	11.6	26	3778.3	38.3
R&M	40	62.9	11	10.2	16.4	24	42.4	67.4

Table 1: Summary of crop- wise breeder seed production during 2019-20

(in quintals)

Crop	GOI		State		Additional (ISP & others)		Grand Total	
	Indent	Production	Indent	Production	Indent	Production	Indent	Production
Cereals								
Rice	4328.33	11983.61	3763.65	4123.22	1178.69	3005.40	9270.67	19112.23
Wheat	17760.99	27775.96	14028.99	14568.28	508.00	5746.60	32297.98	48090.84
Barley	286.15	373.33	32.60	36.40	7.00	7.60	325.75	417.33
Maize	70.78	246.80	15.25	94.85	3.90	7.80	89.93	349.45
Pearlmillet	6.54	64.59	2.00	2.15	-	-	8.54	66.74
Sorghum	49.11	224.95	5.53	6.33	11.75	22.20	66.39	253.48
Fingermillet	24.39	188.67	4.60	5.60	17.20	21.10	46.19	215.37
Foxtailmillet	1.30	171.58	-	-	-	-	1.30	171.58
Barnyardmillet	2.50	54.70	-	-	-	-	2.50	54.70
Kodomillet	14.29	49.28	12.10	12.55	-	-	26.39	61.83
Prosomillet	0.80	30.30	0.00	0.00	-	-	0.80	30.30
Littlemillet	1.20	40.00	2.15	2.33	12.00	1.05	15.35	43.38
Buckwheat	-	-	0.25	0.40	-	-	0.25	0.40
Grain Amaranth	0.10	0.18	-	-	-	-	0.10	0.18
Total Cereals	**22546.48**	**41203.95**	**17867.12**	**18852.11**	**1738.54**	**8811.75**	**42152.14**	**68867.81**
Pulses								
Pigeonpea	242.26	847.40	19.60	9.50	40.85	97.33	302.71	954.23
Chickpea	8670.49	12128.63	609.10	540.95	814.20	1750.30	10093.79	14419.88
Lentil	446.50	577.40	102.69	114.45	273.00	297.98	822.19	989.83
Fieldpea	351.45	512.90	176.90	180.86	104.00	138.63	632.35	832.39
Mungbean	524.01	566.88	219.06	288.14	65.39	80.60	808.46	935.62
Urdbean	329.55	430.53	26.55	35.58	41.07	62.80	397.17	528.91
Rajmash	6.00	4.50	3.70	5.99	14.00	21.20	23.70	31.69

Crop	GOI		State		Additional (ISP & others)		Grand Total	
	Indent	Production	Indent	Production	Indent	Production	Indent	Production
Horse Gram	9.50	17.36	10.50	10.50	1.55	1.82	21.55	29.68
Lablab Bean	1.00	0.50	3.00	3.85	1.00	1.00	5.00	5.35
Cowpea	20.05	29.17	15.95	19.47	8.55	17.55	44.55	66.19
Moth Bean	15.50	20.23	0.70	0.70	0.25	1.34	16.45	22.27
Guar	120.21	156.80	-	-	-	-	120.21	156.80
Lathyrus	188.00	74.00	-	-	-	-	188.00	74.00
Total Pulses	**10924.52**	**15366.30**	**1187.75**	**1209.99**	**1363.86**	**2470.55**	**13476.13**	**19046.84**
Oilseeds								
Soybean	17854.35	13686.53	23.50	21.35	20.00	130.00	17897.85	13837.88
Sunflower	2.01	43.72	1.50	1.50	-	-	3.51	45.22
Groundnut	8747.75	8845.93	2038.35	3097.20	244.27	203.50	11030.37	12146.63
Sesame	26.29	50.90	3.70	3.89	6.35	3.10	36.34	57.89
Niger	13.80	11.99	3.20	3.75	-	-	17.00	15.74
Castor	1.65	19.25	53.70	62.40	0.50	0.50	55.85	82.15
Linseed	56.90	128.68	106.85	109.78	5.00	7.00	168.75	245.46
Safflower	21.94	40.75	0.30	0.30	4.00	50.10	26.24	91.15
Indian Mustard	52.05	125.15	15.10	17.50	1.25	1.25	68.32	143.90
Toria	10.58	31.86	5.64	5.64	5.00	13.00	21.22	50.50
Rai/Sarson	4.04	28.97	74.03	79.23	0.00	2.50	78.07	110.70
Raya	5.87	7.25	0.30	0.40	0.10	1.00	6.27	8.65
G. Sarson	1.55	4.00	0.10	0.10	18.00	18.50	19.65	22.60
B. Sarson	-	-	1.60	1.80	1.50	1.70	3.10	3.50
Karan Rai	-	-	-	-	0.50	0.50	0.50	0.50
Total Oilseeds	**26798.78**	**23024.98**	**2327.87**	**3404.84**	**306.47**	**432.65**	**29433.04**	**26862.47**
Fibers								
Cotton	16.57	63.99	46.59	55.96	4.74	38.32	67.90	158.27

Crop	GOI		State		Additional (ISP & others)		Grand Total	
	Indent	Production	Indent	Production	Indent	Production	Indent	Production
Jute	7.81	10.08	-	-	0.00	0.68	7.81	10.76
Sunhemp	8.40	9.00	-	-	-	-	8.40	9.00
Flax	-	-	-	-	1.50	1.50	1.50	1.50
Total Fibers	**32.78**	**83.07**	**46.59**	**55.96**	**6.24**	**40.50**	**85.61**	**179.53**
Forages								
Maize	51.50	81.40	3.00	2.60	-	-	54.50	84.00
Sorghum	15.45	29.43	-	-	-	-	15.45	29.43
Pearlmillet	1.15	1.75	0.10	0.20	0.50	0.50	1.75	2.45
Cowpea	9.15	7.92	1.00	1.50	1.50	1.50	11.65	10.92
G. Grass	-	0.00	-	-	0.50	0.50	0.50	0.50
Styloxanthes	-	0.05	-	-	-	-	0.00	0.05
Dhaincha	25.00	5.00	-	-	-	-	25.00	5.00
Berseem	37.73	50.35	3.00	3.04	-	0.50	40.73	53.89
Fodder Guar	57.92	72.84	-	-	-	-	57.92	72.84
Lucerne	4.20	5.50	1.10	1.30	10.00	13.80	15.30	20.60
Oats	327.94	404.50	16.90	17.70	35.00	44.80	379.84	467.00
Metha	-	-	-	-	1.00	1.20	1.00	1.20
Rye Grass	-	-	-	-	1.40	1.40	1.40	1.40
Fescue Grass	-	-	-	-	0.30	0.40	0.30	0.40
Rice Bean	0.50	0.62	-	-	-	-	0.50	0.62
Total Forages	**530.54**	**659.36**	**25.10**	**26.34**	**50.20**	**64.60**	**605.84**	**750.30**
Grand Total	**60833.10**	**80337.66**	**21454.43**	**23549.24**	**3465.31**	**11820.05**	**85752.76**	**115706.95**

Note: For *Rabi* 2019-20, expected breeder seed production figures were used in compilation.

Table 2: Summary of centre-wise breeder seed production during 2019-20

(in quintals)

S. No.	Center	GOI		State		Additional (ISP & others)		Grand Total	
		Indent	Production	Indent	Production	Indent	Production	Indent	Production
A	**State Agriculture Universities**								
1	NAU, Navsari	95.97	116.80	29.15	27.30	-	14.67	125.12	158.77
2	UAHS, Shivamogga	206.25	151.00	127.00	104.00	-	-	333.25	255.00
3	IGKV, Raipur	1872.92	1949.19	345.55	441.55	-	-	2218.47	2390.74
4	AAU, Anand	39.55	40.05	740.05	939.72	94.30	125.70	873.90	1105.47
5	UAS. Raichur	323.92	478.89	-	-	0.00	32.40	323.92	511.29
6	OUAT, Bhubaneswar	460.43	465.47	-	-	44.00	40.60	504.43	506.07
7	CSKHPKV, Palampur	186.90	277.20	75.80	82.96	483.05	524.53	745.75	884.69
8	PJTSAU, Hyderabad	674.45	697.60	817.78	849.20	118.77	342.22	1611.00	1889.02
9	TNAU, Coimbatore	112.61	220.18	509.14	509.46	851.12	851.12	1472.87	1580.76
10	DRPCAU, Pusa	700.58	745.15	721.50	779.40	191.00	195.00	1613.08	1719.55
11	AU, Kota	2787.80	4241.53	-	-	180.00	191.15	2967.80	4432.68
12	CRIJAF, Barrackpore	15.71	17.50	-	-	1.50	1.50	17.21	19.00
13	SVPUA&T, Meerut	259.50	214.00	-	-	-	-	259.50	214.00
14	BCKV, West Bengal	67.75	69.30	10.00	10.00	-	30.13	77.75	109.43
15	SKUAST (K), Srinagar	62.94	99.50	26.98	64.26	-	-	89.92	163.76
16	NDUAT, Faizabad	69.29	285.50	0.00	274.58	-	228.70	69.29	788.78
17	SDAU, SK Nagar	629.42	732.03	1349.55	1475.20	-	11.10	1978.97	2218.33
18	VNMKV, Parbhani	1718.84	1826.93	-	-	65.00	137.00	1783.84	1963.93
19	GBPUAT, Pantnagar	239.27	1048.79	-	-		5579.15	239.27	6627.94
20	RVSKVV, Gwalior	8341.95	13563.01	-	-	10.00	27.10	8351.87	13590.11
21	SKRAU, Bikaner	1097.52	1132.98	-	-	0.75	0.75	1098.27	1133.73
22	UAS, Dharwad	3650.00	4418.97	558.80	390.45	53.40	45.50	4262.20	4854.92
23	CCS HAU, HISAR	1179.28	1319.40	290.80	309.10	-	25.00	1470.08	1653.50
24	KAU, Thrissur	34.35	49.00	1.82	8.30	6.00	17.50	42.17	74.80

25	BAU Sabour	377.95	806.90	-	-	-	454.36	377.95	1261.26
26	CSAUAT, Kanpur	549.53	774.27	1382.01	1439.31	-	-	1931.54	2213.58
27	JNKVV, Jabalpur	5696.66	10706.47	12137.10	12336.60	160.00	135.11	17993.76	23178.18
28	UAS , Bangalore	903.79	798.20	22.40	26.85	47.17	33.87	973.36	858.92
29	AAU, Jorhat	155.60	421.60	-	-	-	425.20	155.60	846.80
30	PAU, Ludhiana	2846.97	3410.53	-	-	20.00	27.70	2866.97	3438.23
31	JAU, Junagadh	418.83	429.35	1651.15	2678.90	8.80	8.80	2078.78	3117.05
32	BHU, Varanasi	68.70	187.85	107.00	124.55	-	-	175.70	312.40
33	MPKV, Rahuri	1446.93	2210.41	-	-	719.00	1179.13	2165.93	3389.54
34	MPUAT, Udaipur	613.25	296.90	3.00	2.60	-	-	616.25	299.50
35	PDKV, Akola	1178.99	1111.51	11.50	22.20	-	659.10	1190.49	1792.81
36	BAU, Ranchi	66.60	41.98	67.90	81.95	-	0.00	134.50	123.93
37	DBSKKV, Dapoli	11.31	181.30	1.10	17.34	47.60	62.29	60.01	260.93
38	SKUAST, Jammu	90.65	76.65	15.00	17.90	-	-	105.65	94.55
39	ANGRAU, Guntur	6891.35	8292.45	415.85	483.35	3.78	0.43	7310.98	8776.23
40	PAJANCOA & RI, Karaikal	-	-	9.30	21.45	-	-	9.30	21.45
41	SKNAU, Jobner	205.35	307.39	-	-	-	-	205.35	307.39
42	AU, Jodhpur	4.23	10.17	-	-	-	-	4.23	10.17
	Total SAUs	**46353.89**	**64223.90**	**21427.23**	**23518.48**	**3105.24**	**11406.81**	**70886.28**	**99149.19**
B	**ICAR Institute**								
43	ICAR-CAZRI, Jodhpur	-	-	-	-	0.25	0.94	0.25	0.94
44	ICAR-DGR, Junagadh	-	-	-	-	117.57	98.00	117.57	98.00
45	ICAR-IARI, New Delhi	1973.71	2086.29	-	-	20.00	20.00	1993.71	2106.29
46	ICAR-IARI, RS, Karnal	1774.32	1846.88	-	-	1.60	1.60	1775.92	1848.48
47	ICAR-IISR, Indore	165.00	131.00	-	-	-	-	165.00	131.00
48	ICAR-IIOR, Hyderabad	8.26	11.90	-	-	-	5.00	8.26	16.90
49	ICAR-IIPR, Kanpur	451.45	500.52	-	-	-	-	451.45	500.52
50	ICAR-IGFRI, Jhansi	104.50	127.00	-	-	-	-	104.50	127.00
51	ICAR-CCARI, Goa	-	-	25.00	27.00	-	-	25.00	27.00
52	CAU, Imphal	-	-	-	-	11.00	11.98	11.00	11.98

53	ICAR-IIMR, Hyderabad	31.08	94.40	-	-	-	-	31.08	94.40
54	ICAR-IIMR, Ludhiana	2.80	25.30	-	-	-	-	2.80	25.30
55	ICAR-NRRI, Cuttack	794.67	774.02	-	-	-	-	794.67	774.02
56	ICAR-IIRR, Hyderabad	328.50	121.50	-	-	-	-	328.50	121.50
57	ICAR -CICR Nagpur	0.12	0.15	-	-	0.02	21.90	0.14	22.05
58	ICAR-IARI, RS, Pusa, Bihar	1088.34	1057.80	-	-	-	-	1088.34	1057.80
59	ICAR-IARI, RS, Indore	1193.20	2265.00	-	-	20.00	20.00	1213.20	2285.00
60	ICAR-RCER, Patna	16.50	23.00	-	-	-	-	16.50	23.00
61	ICAR-CSSRI, Karnal	16.52	36.05	-	-	-	-	16.52	36.05
62	ICAR-DRMR, Bharatpur	12.43	26.30	-	-	-	-	12.43	26.30
63	ICAR-VPKAS, Almora	98.52	123.05	1.20	1.76	37.00	37.00	136.72	161.81
64	ICAR-IIWBR, Karnal	4948.00	5422.00	-	-	-	-	4948.00	5422.00
65	ICAR-RC, NEH, Tripura	2.55	4.10	1.00	2.00	101.00	142.20	104.55	148.30
66	ICAR-RC NEH, Manipur	-	-	-	-	19.50	19.50	19.50	19.50
67	ICAR-RC NEH, Meghalaya	-	-	-	-	30.50	34.00	30.50	34.00
68	ICAR-CIARI, Port Blair	-	-	-	-	1.63	1.12	1.63	1.12
	Total ICAR Institutes	**13010.47**	**14676.26**	**27.20**	**30.76**	**360.07**	**413.24**	**13397.74**	**15120.26**
C	**Others**								
69	Lokbharti	200.00	175.00	-	-	-	-	200.00	175.00
70	ARI, Pune	95.00	37.00	-	-	-	-	95.00	37.00
71	NSC, New Delhi	244.43	84.61	-	-	-	-	244.43	84.61
72	ICRISAT, Patencheru	5.81	27.39	-	-	-	-	5.81	27.39
73	HIL, Hyderabad	740.00	930.00	-	-	-	-	740.00	930.00
74	BARC, Mumbai	183.50	183.50	-	-	-	-	183.50	183.50
	Total Others	**1468.74**	**1437.50**	**-**	**-**	**-**	**-**	**1468.74**	**1437.50**
	Grand Total	**60833.10**	**80337.66**	**21454.43**	**23549.24**	**3465.31**	**11820.05**	**85752.76**	**115706.95**

Note: For *Rabi* 2019-20, expected breeder seed production figures were used in compilation.

Seed Technology Research highlights 2019-20

Research Highlights of experiments conducted in disciplines of Seed Production & Certification; Seed Physiology, Storage and Testing; Seed Pathology; Seed Entomology and Seed Processing under AICRP-NSP (Crops) STR component during 2019-20 at varied cooperating centres are given below:

A. Seed Production and Certification

❖ Experiment on Integrated approach for enhancing seed yield and quality in millets

Year of start: 2015-16

Treatment details
I. Main-Plot treatments (Nutrient management)
N1 – No fertilizer
N2 – 125 kg Neem + 1250 kg Vermi compost per ha or 12.5 tons FYM/ha
N3 – 50 kg Urea + 50 kg Super phosphate and 50 kg Muriate of potash per ha + Top dressing urea at 3-4 weeks after transplanting + 2% Borax spray at flowering
N4 – 125 kg Neem + 1250 kg Vermicompost (or) 12.5 tons FYM/ha + 50 kg Urea + 50 kg super phosphate and 50 kg Muriate of potash per ha + Top dressing urea at 3-4 weeks after transplanting/ DS + 2% Borax spray at flowering
N5- State recommended dose of fertilizer
II. Sub-plot treatments (Priming)
P1 – Control - No priming
P2 - Hydropriming for 6 h (Finger millet, Kodo millet), 8 h (Foxtail millet, Proso millet, and Little millet) by adopting seed to solution ratio of 1:1 and then mixing with Carbendazim (Bavistin) @ 2.5 -3.0 gram/kg seeds and leaving the mixture for 24 hours for drying before sowing
P3 – Seed priming with 2 % KH_2PO_4 for 6 h (Finger millet and Kodo millet), 8 h (Foxtail millet, Proso millet and Little millet) by adopting seed to solution ratio of 1:1 and then mixing with Carbendazim (Bavistin) @ 2.5-3.0gm/kg seeds, and leaving the mixture for 24 hours before sowing
P4 – Seed priming with 20 % liquid *Pseudomonas fluorescens*

Salient findings

1. **Finger millet (*Elusine coracana*):** This experiment was conducted during *kharif* 2019 at three locations *viz.,* IGKV, Raipur, UAS, Bangalore and CSKHPKV, Palampur. Mean data over locations revealed that Seed Priming with 20% liquid *P. fluorescens* in combination of nutrient management with 125 kg Neem + 1250 kg Vermicompost per ha or 12.5 tons FYM per ha + 50 kg Urea + 50 kg SSP and 50 kg MOP per ha + Top dressing urea at 3-4 weeks after transplanting + 2% Borax spray at flowering) (N_4P_4) was found to be superior and lead to a

significant increase in field emergence 93.83% (15%), seed yield/ha 33.66q/ha (41%) and net monetary returns Rs. 67925 (24.8%) over state recommended dose of fertilizer (without any priming) (81.17%; 23.88q/ha; Rs. 54392, respectively) (Fig. 1.1 &1.2).

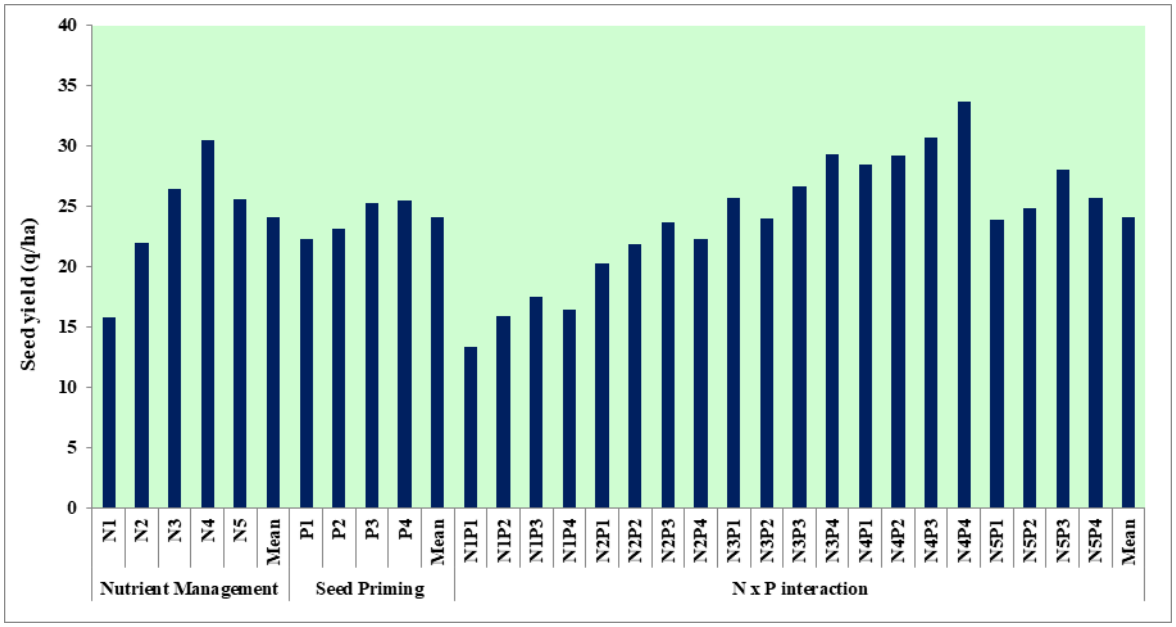


Fig. 1.1: Effect of nutrient management and seed priming treatments on seed yield in Finger millet (Mean over locations)

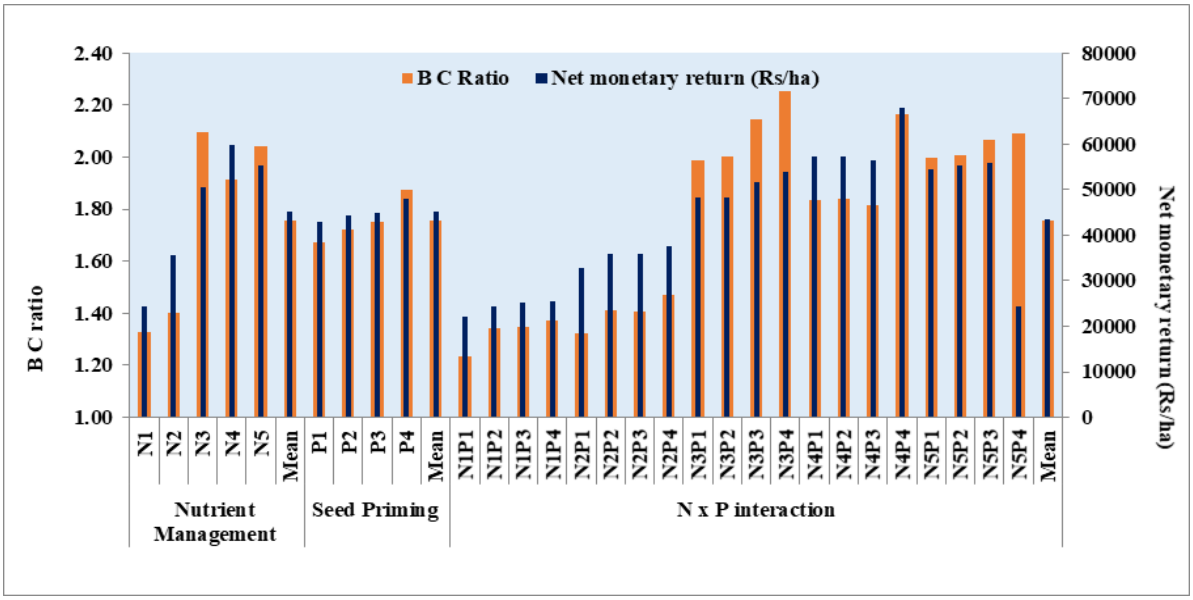


Fig. 1.2: Effect of nutrient management and seed priming treatments on economic indicators in Finger millet (Mean over locations)

2. **Foxtail millet *(Setaria italica):*** This experiment was conducted during *kharif* 2019 only at one centre i.e. TNAU, Coimbatore. Hence, no unified observations could be derived. At TNAU,

Coimbatore, nutrient management treatment with 125 kg neem + 1250 kg Vermicompost per ha + 50 kg urea + 50 kg SSP + 50 kg Muriate of potash + Top dressing urea + 2 % Borax spray at flowering along with seed priming treatment 20 % liquid *Pseudomonas fluorescens* (N_4P_4) significantly enhanced field emergence 95 % (8%), seed yield per hectare 22.4 q/ha (19.7%) and benefit cost ratio 1.86 (151%) over N_5P_1 i.e. state recommended dose of fertilizer (application of 87 kg urea + 125 kg SSP/ha) (without seed priming) (88%; 18.7 q/ha; 0.74, respectively) (Fig. 1.3 & 1.4).

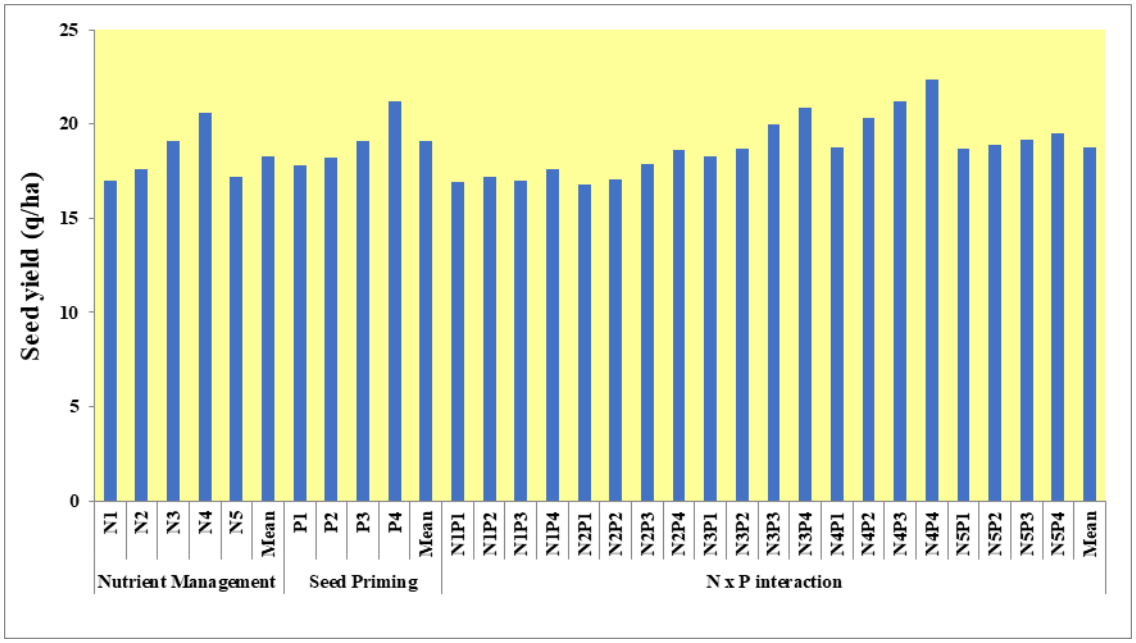


Fig. 1.3: Effect of nutrient management and seed priming treatments on seed yield in Foxtail millet (TNAU, Coimbatore)

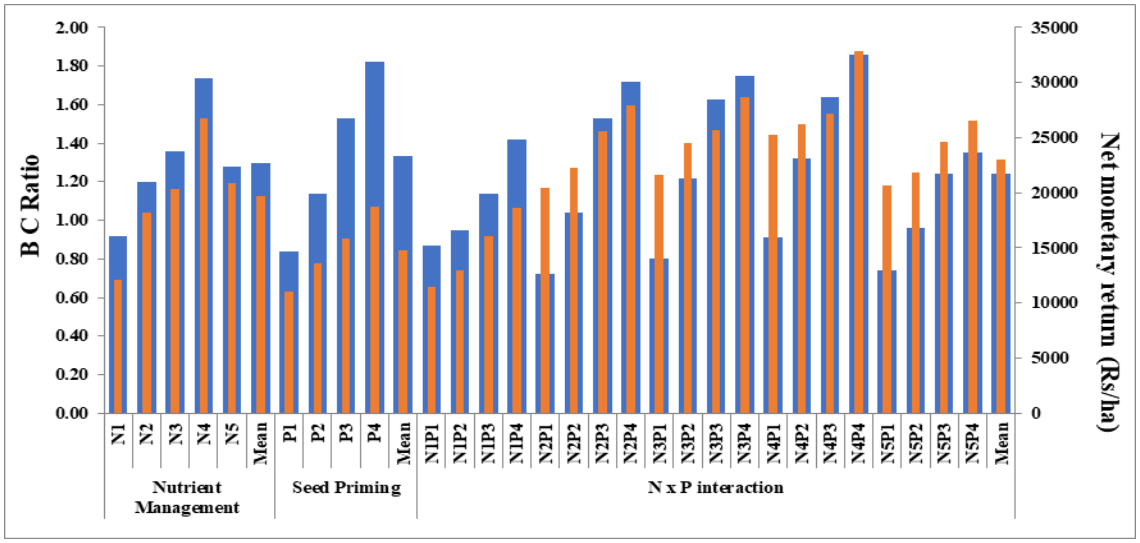


Fig. 1.4: Effect of nutrient management and seed priming treatments on economic indicators in Foxtail millet (TNAU, Coimbatore)

3. **Kodo millet (*Paspalum scrobiculatum*):** This experiment was conducted during *kharif* 2019 at two locations *viz.,* JNKVV, Jabalpur and TNAU, Coimbatore**.** Mean data over locations revealed that treatment combination N_4P_4 (Seed Priming with 20% liquid *P. fluorescens* in combination of nutrient management with 125 kg Neem + 1250 kg Vermicompost per ha or 12.5 tons FYM per ha + 50 kg Urea + 50 kg SSP and 50 kg MOP per ha + Top dressing urea at 3-4 weeks after transplanting + 2% Borax spray at flowering) lead to a significant increase in field emergence 92.43% (12.3%), seed yield/ha 17.54 q/ha (21.8%) and net monetary returns Rs.34014 /ha (37%) in comparison to State Recommended Fertilizer (without seed priming) (82.25%; 14.4q/ha and Rs. 24761) (Fig.1.5 & 1.6).

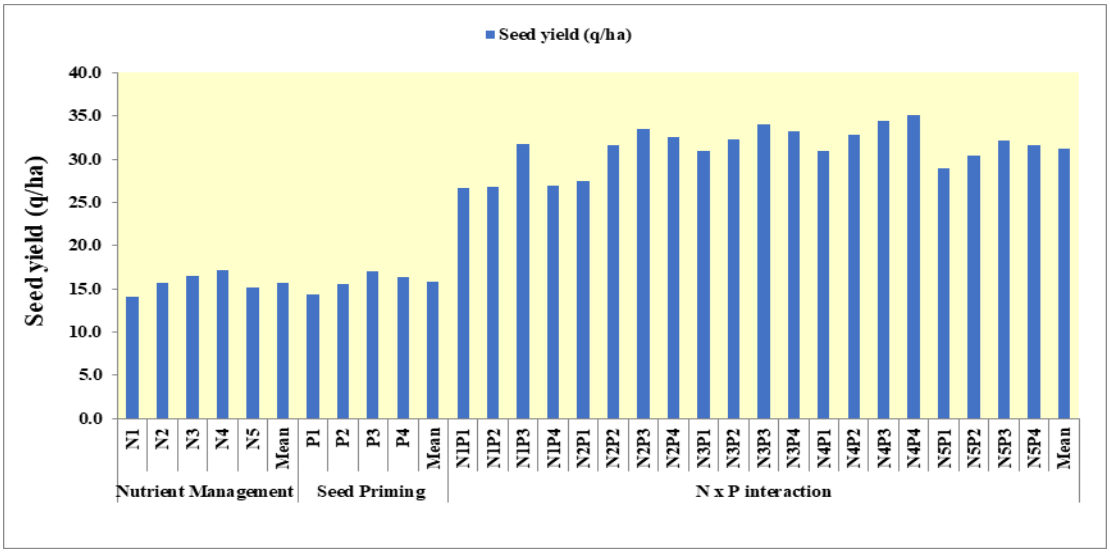


Fig. 1.5: Effect of nutrient management and seed priming treatments on seed yield in Kodo millet (Mean over locations)

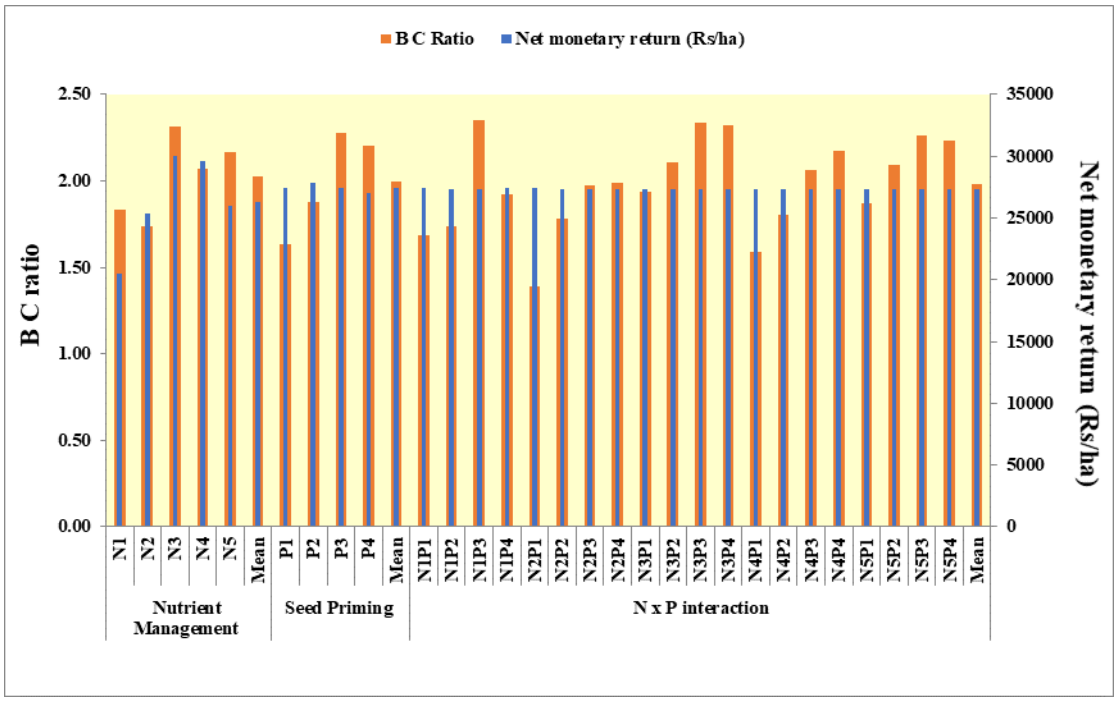


Fig. 1.6: Effect of nutrient management and seed priming treatments on economic indicators in Kodo millet (Mean over locations)

4. **Proso millet (*Panicum miliaceum*):** This experiment was conducted during *kharif* 2019 at two locations *viz.,* UAS, Bangalore and RPCAU, Pusa. Mean data over locations revealed that treatment combination N_4P_4 (Seed Priming with 20% liquid *P. fluorescens* in combination of nutrient management with 125 kg Neem + 1250 kg Vermicompost per ha or 12.5 tons FYM per ha + 50 kg Urea + 50 kg SSP and 50 kg MOP per ha + Top dressing urea at 3-4 weeks after

transplanting + 2% Borax spray) resulted in significant increase in field emergence, seed yield/ha. Since, there was a wide variation in the values reported by the two centers and non-uniformity in data recording; there is a need to conduct the experiment across different locations to derive logical conclusions with respect to enhancing seed yield in Proso millet.

5. **Little Millet (*Panicum sumatrense*):** This experiment was conducted during *kharif* 2019 at JNKVV Jabalpur, TNAU, Coimbatore and IGKVV, Raipur. Mean data over locations revealed that the treatment combination, N_4P_4 (Seed Priming with 20% liquid *P. fluorescens* in combination of nutrient management with 125 kg Neem + 1250 kg Vermicompost per ha or 12.5 tons FYM per ha + 50 kg Urea + 50 kg SSP and 50 kg MOP per ha + Top dressing urea at 3-4 weeks after transplanting + 2% Borax spray at flowering) lead to a significant increase in field emergence 90.3% (8.53%), seed yield 13.06 q/ha (45.4%) and net monetary returns Rs. 19,045 (72%) in comparison to state recommended dose of fertilizer without seed priming (83.2%; 8.98 q/ha) and Rs. 11051 (Fig.1.8 & 1.9).

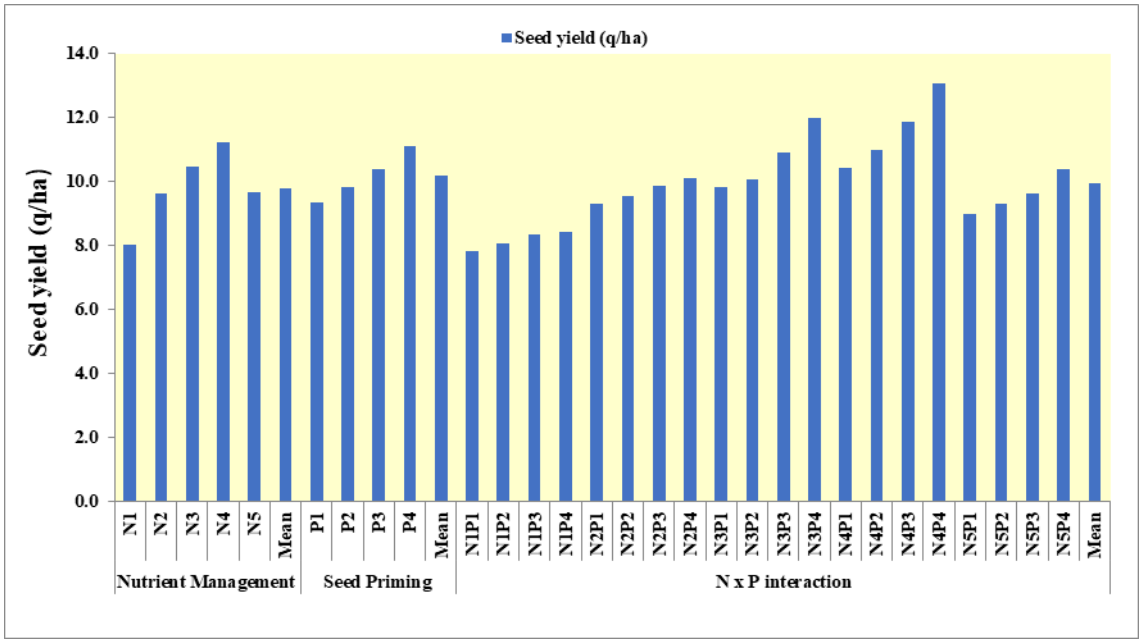


Fig. 1.8: Effect of nutrient management and seed priming treatments on seed yield in Little Millet (Mean over locations)

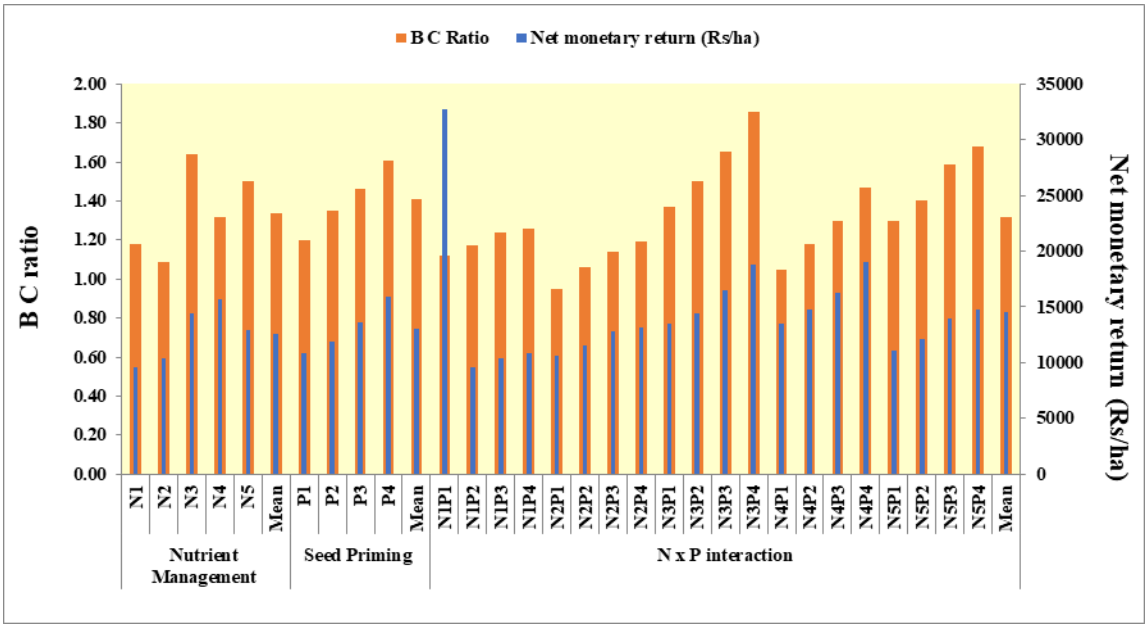


Fig. 1.9: Effect of nutrient management and seed priming treatments on economic indicators in Little millet (Mean over locations)

Fig. 1.10: Field view of different treatments in Little millet at TNAU, Coimbatore

❖ **Experiment on optimization of seed rate in Soybean (*Glycine max* L.)**

Year of start: 2018-19

Soybean crop is highly sensitive to climatic factors and supply of quality seeds is becoming a critical problem due to climatic uncertainties. With this rational, study on reduction of seed requirement was conducted with following objectives

- To increase the productivity with reduced seed rate
- To study the effect of less plant population on control of insect and disease infestation
- To find out economic viability of low seed rate and production

Treatment details

I. Main-Plot treatments

- T_0 - Recommended seed rate @ 70 kg/ha
- T_1 - Reduced seed rate @ 60kg/ha
- T_2 - Reduced seed rate @ 50kg/ha

II. Sub-plot treatments (Sowing method)

S1-Ridge & furrow

S2-Flat bed

Centers	Variety	
	Medium Maturity	**Early Maturity**
JNKVV, Jabalpur	JS 20-29	JS 20-34
RVSKVV, Gwalior	JS 20-29	JS 20-34
VNMKV, Parbhani	MAUS 162	JS 20-34
UAS, Dharwad	DSB 21	JS 93-05
MPKV, Rahuri	KDS 344	JS 93-05
AU, Kota	RKS 45	JS 20-34
IISR, Indore	NRC 86	JS 20-34
PDKV, Akola	NRC 86	JS 20-34
PJTSAU, Hyderabad	Any suitable variety	Any suitable variety
UAS, Bengaluru	Any suitable variety	Any suitable variety

Salient findings:

➢ The experiment was conducted at ten locations (JNKVV, Jabalpur; RVSKVV, Gwalior; VNMKV, Parbhani; UAS, Dharwad; MPKV, Rahuri; AU, Kota; IISR, Indore; PDKV, Akola; PJTSAU, Hyderabad and UAS, Bengaluru) to optimize seed rate in soybean. The results revealed that highest seed yield was observed for hand dibbling with ridge and furrow (20.28 q/ha) as compared to flat-bed method (18.65 q/ha), amongst the sowing methods. With respect to seed rates, highest seed yield was observed for 70 kg/ha (20.91 q/ha),

followed by reduced seed rate 60 kg/ha (19.09 q/ha) and 50 kg/ha (18.40 q/ha). Due to reduced seed rates, yield loss in the seed rate @ 60 kg/ha and 50 kg/ha over control (70 kg/ha) was about 8.70% and 12.00% respectively. The loss in monetary terms was to the tune of 12% (Rs. 6825 /ha) and 16.65% (Rs. 9413 /ha) over control due to reduced seed rate of 60 kg/ha and 50 kg/ha, respectively. With respect to interaction, $V_1S_1T_0$ (medium duration variety with ridge and furrow sowing and seed rate @ 70 kg/ha) recorded highest seed yield (22.56 q/ha), which was at par with $V_1S_1T_1$ (medium duration with ridge and furrow sowing and seed rate at 60 kg/ha: seed yield 21.71 q/ha) with minimal yield loss i.e., to the tune of 3.91% over recommended seed rate.

- Irrespective of the sowing methods, seed yield in medium maturity duration varieties with reduced seed rate of 60 kg/ha (21.38) was at par with the recommended seed rate of 70 kg/ha (21.53 q/ha), with a negligible reduction of 0.7% over recommended seed rate. There was a decrease in plant population due to reduced seed rate of 60 kg/ha, however the number of pods per plant were at par. The net monetary loss due to reduced seed rate of 60 kg/ha over recommended seed rate was to the tune of about 1.0 % (Rs. 570 /ha) but highest B:C ratio (3.74), in comparison to recommended seed rate (3.68). The seed quality was enhanced with the reduction in seed rate; due to reduced seed rate of 60 kg/ha, enhancement in seed quality attributes was also observed viz. germination percentage, Vigour index I (3.94%) and II (4.8%) over recommended seed rate. In case of early maturing variety, seed yield due to reduced seed rate of 60 kg/ha was 16.8 q/ha, which is quite less as compared to recommended seed rate (20.28 q/ha), resulting in reduction of about 17% over control. The net monetary loss due to reduced seed rate (60 kg/ha) over recommended seed rate (70 kg/ha) was calculated to be about 24%, i.e. Rs. 13042 /ha.

Table 1.1: Effect of sowing method and seed rate on the seed yield (q/ha) of medium and early maturing varieties of soybean over the locations

Varieties	Sowing Method	Seed Rate			Mean (Sowing method)	Mean (Varieties)
		70 Kg/ha	60 kg/ha	50 kg/ha		
MM varieties	**R & F**	22.56	21.71	21.00	**21.76 (R & F)**	**20.92**
	FB	20.50	21.04	18.73	**20.09 (FB)**	**(MM)**
Mean (Seed Rate)		**21.53**	**21.38**	**19.87**		
EM varieties	**R & F**	20.90	17.60	17.90	**18.80 (R & F)**	**18.01**
	FB	19.66	16.00	15.97	**17.21 (FB)**	**(EM)**
Mean (Seed Rate)		**20.28**	**16.80**	**16.94**		

- **Varieties-** MM: Medium maturity variety; EM: Early maturity variety
- **Seed rates**-T_0: Recommended seed rate @70 kg/ha; T_1: Reduced seed rate @60 kg/ha; T_2: Reduced seed rate@50 kg/ha;
- **Sowing methods-** R & F: Hand dibbling with ridge & furrow sowing method; FB: Flat bed sowing method

50kg/ha 60 kg/ha 70 kg/ha

Fig. 1.11: Field view of experiment on optimization of seed rate in soybean at JNKVV, Jabalpur

❖ **Experiment on redefining isolation distance of IMSCS 2013 in Pigeon pea, Cotton, Maize, Mustard and Rice**

Year of start: 2018-19

Salient findings

1. **Pigeonpea**

   The experiment was allotted to three centers to test nine isolation distances from 100 to 500m with an interval of 50m. Seed set was not observed at 200m onwards in GBPUAT, Pantnagar, at 300m in PJTSAU, Hyderabad and at 400 m onwards at MPKV, Rahuri.

2. **Cotton**

   The experiment was allotted to five centers to test four isolation distances from 25 to 100m with an interval of 25m. Three centers viz., PDKV Akola, UAS Dharwad and JAU Jamnagar reported boll/ seed setting upto 25, 100, 100m respectively. However, ICAR-CICR Nagpur observed seed setting upto 75m but they didn't remove the fertile plants/flowers/bolls from the A line parent. The boll set was also observed in case of greater isolation distance (75 m and 100m), which may be due to the presence of fertile plants in respective GMS lines. Hence, the experiment may be repeated with isolation of 50 to 150m with 50 m intervals. Therefore, it is suggested that centre (PDKV Akola) should supply pure seed of stable CMS line.

3. **Maize**

   The experiment was allotted to six centres to test seven isolation distances from 400 to 700m with an interval of 50m. Three centers viz., ICAR-IARI, New Delhi, PAU, Ludhiana and GBPUAT, Pantnagar reported no seed setting with an isolation of 400, 600, and 450m respectively. However, the experiment was not conducted at UAS Dharwad because of unavailability of

proper isolation and at CSKHPKV, Palampur because they did not have desired site and area to conduct this type of experiment. At OUAT, Bhubaneshwar, the experiment has been taken up in summer 2020 and seed set is yet to be recorded.

4. Rice Hybrid

The experiment was allotted to five centers to test five isolation distances from 50 to 150m with an interval of 25m. Three centers viz., TNAU Coimbatore, PJTSAU, Hyderabad and ICAR-IISS, Mau reported seed setting upto 150m and up to 100m isolation at UAS, Bengaluru. The experiment is being carried out during rabi 2019-20 at KKV, Dapoli. Hence, the experiment may be repeated with an isolation of 100 to 200m keeping a 25m interval.

5. Mustard

The experiment was allotted to seven centers to test eleven isolation distances from 100 to 550m with the first interval of 25m and subsequent intervals of 50m each. Three centers viz., PAU Ludhiana, GBPUAT, Pantnagar and JNKVV, Jabalpur reported seed setting upto 400 (max.) 550 and 400m, respectively. However, PAU Ludhiana and GBPUAT, Pantnagar observed male fertile plants in A line. The experiment is being carried out in rabi 2019-20 at NDUAT, Faizabad, and ICAR-IISS, Mau, whereas SKNAU, Durgapura did not conduct the experiment. Hence, the experiment may be repeated with pure seed of stable female parent.

Fig.1.12 : Field view of experimental plot of redefining isolation distance in rice at IISS, Mau

(Male sterile line was planted at different distance from R line)

❖ **Experiment on redefining IMSCS 2013 for seed standard (ODV) in rice**

- The experiment was conducted at 10 centres. At six out of nine centres, number of ODV seeds observed in the certified lot was above the maximum permissible limit of 20/kg seed; rather it fell in the range of 25+ tolerance (10%). Therefore, it can be reasonably concluded that there is a need to increase the maximum permissible limit to 30/kg seed for certified seed lots so that most of the lots can qualify for seed certification, without compromising on seed quality. The seed standards for maximum permissible limit of ODVs for foundation seed class can be retained at the present level of 10/kg seed.
- It is also to be noted that a uniform standard of 10/kg seed in case of FS and 30/kg seed in case of CS can be applied to fine (small), medium and coarse (long) varieties of paddy.

Table 1.2: Average number of observed ODVs in foundation and certified seed classes across the locations

Class of seed/ Variety type	PJTSAU, Hyderabad	TNAU, Coimbatore	PAU, Ludhiana	OUAT, Bhubaneswar	IISS, Mau	NDUAT, Faizabad	UAS, Bangalore	KKV, Dapoli	SKUAST, Srinagar	Mean
Foundation										
Small	13.67	8.3	-	6.7	8.0	10	10.3	10	10	**9.04**
Medium	11.0	6.3	1.7	5.0	7.3	8.0	8.0	11.67	5.83	**6.0**
Large	9.33	9.3	3.33	5.8	10	8.3	8.3	10	10.67	**8.3**
Mean	**11.3**	**7.8**	**2.5**	**5.8**	**8.4**	**8.76**	**8.8**	**10.2**	**9.2**	**7.76**
Certified										
Small	41.0	27.0	-	17.3	23.0	29.0	25.0	40.83	15.83	**27.38**
Medium	37.67	29.0	6.67	18.33	32.6	24	26.0	49.17	12.5	**25.98**
Large	32.0	28.6	8.33	19.2	23.3	26.33	25.0	44.17	19.10	**25.59**
Mean	**37.74**	**28.2**	**7.5**	**18.3**	**25.3**	**26.44**	**25.3**	**44.9**	**15.9**	**26.32**

*ANGRAU, Maruteru and RARI, Durgapura did not conduct the experiment

**The values reported by ICAR-IARI, New Delhi centre is not in congruence within the range exhibited by other centres over last two years of experimentation. Therefore, the results of ICAR-IARI, New Delhi has not been considered for calculating the overall means.

❖ **Experiment on development of Seed Production Technology for *Chenopodium quinoa* crop**

TREATMENT DETAILS

No of treatments **Main plots** (Nutrient management): **04**

Sub-plots (Seed Priming): **03**

Treatment details

I. Main-Plot treatments (Nutrient management)

N1- Recommended dose of NPK in the ratio of 60:40:20 or state recommendation dose of fertilizer.

N2-80 kg Urea + 50 kg Super phosphate and 50 kg Muriate of potash per ha+ 2% Ferrous sulphate

spray at flowering

N3- 80 kg Urea + 50 kg Super phosphate and 50 kg Muriate of potash per ha + 2% DAP spray at pre-flowering

N4-125 kg Neem + 1250 kg Vermicompost + 10kg PSB per ha+10kg KSB per ha+ 10 kg Azospirillum per ha.

II. Sub-plot treatments (Priming)

P1- Control - No priming

P2- Seed priming with *Trichoderma harzianum* (1.5%)

P3-Seed priming with 20 % liquid *Pseudomonas fluorescence*

Salient findings:

- This experiment was conducted during *rabi* 2018-19 at three locations *viz.,* CSKHPKV, Palampur; JAU, Jamnagar and RARI, Durgapura to standardize the nutrient management & seed quality enhancement techniques to increase the production potential of *Chenopodium quinoa*. SKRAU, Bikaner did not conduct the experiment.
- Mean results over locations revealed that nutrient management treatments had a significant effect on plant growth and seed yield attributes in *Chenopodium quinoa*. Among the nutrient management treatments, N_2 (80 kg Urea + 50 kg Single Super Phosphate and 50 kg Muriate of Potash per ha + 2% Ferrous Sulphate spray at flowering) was found superior with respect to seed yield (18.85 g/plant and 22.46 q/ha) and 1000 seed weight (2.39g).
- Among the priming treatments, seed priming with *T. harzianum* @ 1.5% (P_2) was superior as compared to control and other treatments in terms of plant height at maturity (125.6 cm), days to 50% flowering (74 days), number of branches per plant (16.69), biological yield per plant (54.83), seed yield/plant (17.95 gm) and seed yield (21.47 q/ha), followed by P_3 (Seed priming with 20 % liquid *Pseudomonas fluorescens*) in case of most of the parameters studied.
- Among interactions of seed priming with nutrient management treatments, N_3P_3 (80 kg Urea + 50 kg Single Super Phosphate and 50 kg Muriate of Potash per ha + 2% DAP spray at pre-flowering along with seed priming with 20 % liquid *Pseudomonas fluorescens*) recorded highest values for parameters *viz.,* plant height at maturity (130.7 cm) and harvest index (29.73).
- Since it was the first year of the experiment with only 3 centres and non-uniformity among the observations recorded at the centers, no concrete conclusions can be derived on the basis of the experimental results. However, N_2 (80 kg Urea + 50 kg Single Super Phosphate and 50 kg Muriate of Potash per ha + 2% Ferrous Sulphate spray at flowering) and N_3 (80 kg Urea + 50 kg Single Super Phosphate and 50 kg Muriate of Potash per ha + 2% DAP spray at pre-flowering) in combination with P_2- seed priming with *T. harziannum* @ 1.5%) can be taken up as the potential treatments for further studies.

❖ **Experiment on development of organic seed production technology for important crops**

TREATMENT DETAILS	
No. of treatments	**05**
Treatment details (Common to rice, maize, wheat and ragi))	
T_1 – Control **(**No Fertilizer & Manure)	
T_2- State Recommended Dose of NPK Fertilizer (Inorganic)	
T_3-10% of RDN through Neem Cake+70% of RDN through FYM+20% of RDN through *Azospirillum* + 10kg PSB per ha+10kg KSB per ha	
T_4-10% of RDN through Neem cake+ 70% of RDN through Vermicompost+ 20% of RDN through *Azospirillum* +10kg PSB per ha+10kgKSB per ha	
T_5- 10% of RDN through Neem cake + 30% of RDN through Vermicompost+ 40% of RDN through FYM+ 20% of RDN through *Azospirillum* +10kg PSB per ha+10kgKSB per ha	
Note: *The doses of organic sources have to be calculated as per the N requirement of respective crop prescribed as per state package of practices.****(RDN – Recommended dose of Nitrogen)***	
Treatment details (for blackgram)	
T_1 – Control **(**No Fertilizer & Manure)	
T_2- State Recommended Dose of NPK Fertilizer (Inorganic)	
T_3-10% of RDN through Neem Cake+70% of RDN through FYM+20% of RDN through *Azospirillum* + 10kg PSB per ha+ Remaining Phosphorus through rock phosphate+10kg KSB per ha	
T_4-10% of RDN through Neem cake+ 70% of RDN through Vermicompost+ 20% of RDN through *Azospirillum* +10kg PSB per ha+ Remaining Phosphorus through rock phosphate + 10kgKSB per ha	
T_5- 10% of RDN through Neem cake + 30% of RDN through Vermicompost+ 40% of RDN through FYM+ 20% of RDN through *Azospirillum* +10kg PSB per ha+ Remaining Phosphorus through rock phosphate + 10kgKSB per ha	
Note: *Through application of Neem cake and FYM/vermicompost, some quantity of Phosphorus also will be supplied in addition to 'N' but remaining phosphorus needs to be supplied through Rock phosphate.*	

- The experiment was conducted at six locations *viz.,* AAU, Jorhat; IGKV, Raipur; IISS, Mau; PJTSAU, Hyderabad; UAS, Bangalore and ICAR RC NEHR, Manipur (Black Rice) to standardize organic seed production technology in rice. However, the data of ICAR RC NEHR, Manipur and UAS, Bangalore was not included for calculating the mean, as the treatments were not in line with the approved technical programme and the fertilizer treatments were also superimposed with seed priming treatments. The results revealed that State Recommended Dose of Fertilizer (T_2) recorded highest seed yield (32.06 g/plant and 47.636 q/ha), 1000 - seed weight (16.83), B C ratio (2.85) as well as better seed quality in terms of vigour indices (1122 and 9.04) and seed germination (84.91%). The treatment T_4 (10% of RDN through Neem cake+ 70% of RDN through Vermicompost+ 20% of RDN through *Azospirillum* +10kg PSB/ha+10 kg KSB/ha) was performing better in comparison to other organic treatments.

Since this is the first year of the experiment, no valid conclusion can be drawn. Hence. it needs to be repeated for another 3-4 years to generate useful data and to make suitable recommendations thereon. Some suggestions were made by AAU, Jorhat to use the varieties with a common plant type, preferably tall to medium tall in height. Such varieties are deep rooted and hence, they can absorb nutrients yet available in the deeper soil strata. Varieties are suited for organic farming situations and may be resistant to major insect-pests and diseases of the concerned state may be used.

Fig.1.13: Field view of experimental plot of rice at IISS, Mau

Fig.1.14: Effect of different nutrient management treatments on organic seed production of Rice

B. Seed Physiology, Storage and Testing

Under seed physiology, storage and testing, several experiments including Confirmation of validity periods of certified seeds of field crops (as per the IMSC regulations); Hybrid purity testing using molecular markers in public sector hybrids of field crops; Physiological studies and development of priming technologies for enhancing planting value of seed in field crops under optimal and sub-optimal conditions; Use of nano-particles in enhancing seed quality and storability of seeds and Influence of terminal heat stress on seed set, seed yield and quality in field crops were conducted at different cooperating centres during 2019-20 and highlights of results are given below:

❖ **Experiment on ascertaining the validity periods of certified seeds of field crops (as per the IMSCS regulations)**

The experiment was conducted in 9 crops *viz.,* wheat, paddy, maize, sorghum, cotton, soybean, chickpea, castor and groundnut.

Salient findings

Wheat: Germination percentage (mini.) as per IMSCS, 2013 is 85%

Date of harvesting: April, 2019 Date of first test: 25.05.2019

Varieties: WH 1105 and WH 1124

Centre	Compliance of germination with IMSCS	Remarks
ICAR-IARI, New Delhi	Germination% was above IMSCS at 8th month of storage.	Mean germination recorded was 88.5% and 90.0% after 8 months of storage of WH 1105 and WH 1124, respectively.
GBPUAT, Pantnagar	Germination% was above IMSCS at 8th month of storage.	Mean germination recorded was 89.7% and 91.7 % after 8 months of storage of WH 1105 and WH 1124, respectively.
ICAR-IISS, Mau	Seed germination was above IMSCS at 8 months after harvest (7 months after initial testing) (>90% in both the varieties in gunny as well as HDPE bag)	In gunny bag, WH1124 has 95.5%; WH 1105 has 90% germination. While in HDPE bag, WH1124 has 96.5% and WH 1105 has 95% germination after 8 months of harvest.

VNMKV, Parbhani	Germination% is above IMSCS at 8th month of storage	Mean germination recorded was 86.12% and 95.25% after 8 months of storage of WH 1105 and WH 1124, respectively.
MPKV, Rahuri	Germination% is above IMSCS at 8th month of storage	Mean germination recorded was 87.00% and 88.50% after 8 months of storage of WH 1105 and WH 1124, respectively.
	Comply up to 27 months of storage under Rahuri conditions	Mean germination recorded was 85.66, 85.83, 85.50% and 84.66% after 28 months of storage of cvs.; Panchvati, Godavari, Tapovan and Trimbak, respectively.
HAU, Hisar	Germination% is above IMSCS at 8th month of storage	Mean germination recorded was 91.67% and 93.00% after 8 months of storage of WH 1105 and WH 1124, respectively.
NDUAT, Faizabad	Germination% is above IMSCS at 8th month of storage	Mean germination recorded was 88.50% and 89.00% after 8 months of storage of WH 1105 and WH 1124, respectively.
CSAUAT, Kanpur	Comply up to 6 months of storage	Mean germination recorded was 86.66% and 86.33% after 5 months of storage of WH 1105 and WH 1124, respectively.
CSKHPKV, Palampur	Germination% is above IMSCS at 6th month of storage	Mean germination recorded was 92.77% and 94.89% after 6 months of storage of WH 1105 and WH 1124, respectively.

Paddy: Germination percentage (mini.) as per IMSCS, 2013 is 80%

Date of harvesting (North): Nov., 2018 Date of first test (North): Jan/Feb., 2019

Date of harvesting (South): Jan., 2019 Date of first test (South): May, 2019

Varieties: Pusa 1121, Pusa 44, ADT (R) 46

Centre	Compliance of germination with IMSCS	Remarks
ICAR-IARI, New Delhi	Comply up to 15 months in Pusa 1121; 13 months in Pusa 44 from the date of harvest. While, 9 months and 7 months	Seed germination was 78.5% (HDPE bag) & 77% (gunny bag) in Improved white ponni; 83.5% (HDPE bag) and

	in ADT (R) 46 and Improved White Ponni, respectively from the date of initial testing in both the packaging materials. However, ADT (R) 46 and Improved white ponni maintained germination above IMSCS up to 13 and 11 months from the date of harvest. (4 months delay in initial testing from the date of harvest)	81.5% (gunny bag) in ADT (R) 46 after 9 months of testing/13 months of harvesting; and 82% (HDPE bag) & 77% (gunny bag) in Pusa 44; 86.25% (HDPE bag) and 81% (gunny bag) in Pusa 1121 after 13 months of testing/15 months of harvesting.
PAU, Ludhiana	Comply up to 9 months of storage in gunny bag and continued to comply till 10 months of storage in HDPE bag in Improved white Ponni. While in variety ADT(R) 46, seed germination was higher than IMSCS even after 10 months of storage.	Seed germination was 60% (gunny bag) and 83.7% (HDPE bag) at 10 months of storage in I. W. Ponni; Seed germination was 82% (gunny bag) & 84% (HDPE bag) in ADT (R) 46 at 10 months of storage.
	Seed germination was higher than IMSCS even after 13 months of storage in Pusa 44 in both packaging materials. While it was comply upto 12 months in Pusa 1121 in gunny bag and continued to comply after 13 months of storage in HDPE bag	Seed germination was 93% (gunny bag) and 92.7% (HDPE bag) after 13 months of storage in variety Pusa 44; Seed germination was 64.3% (gunny bag) and 86% (HDPE bag) after 13 months of storage in Pusa 1121 respectively.
IISS, Mau	Seed germination in I.W. Ponni and ADT (R) 46 was more than IMSCS at 11 months after harvest (7 months after initial testing) (around 85%) in both gunny as well as HDPE bag. While, in Pusa 44 and 1121, germination was more than IMSCS at 13 months after harvest (11 months after initial testing) (90%)	-
PJTSAU, Hyderabad	Seed germination continued to be higher than IMSCS even after 12 months of	Seed germination was 90%, 91%, 91% 92%, 90% and 90% after 12 months of storage in PB 1121, Pusa 44, IW Ponni,

	storage.	ADT (R) 46, BPT 5204 and RNR 15048, respectively.
TNAU, Coimbatore	Variety Pusa 1121 continued to comply with IMSCS even after 12 months of initial testing in both the packaging materials. Pusa 44 complied up to 12 months after initial testing in HDPE bag & up to 10 months in gunny bag. I.W. Ponni and ADT (R) 46 complied IMSCS up to 6 months after initial testing (10 months from the date of harvest) in HDPE bag. While complied up to 5 months of initial testing/9 months of harvest in gunny bag.	Only variety Pusa 1121 maintained the higher germination of 88 % in HDPE bag and 82 % in gunny bag even after 12 months of initial testing.
UAS, Bengaluru	Seed germination fell below IMSCS in I.W. Ponni and ADT (R) 46 after 2 months of initial testing/6 months of harvesting. Pusa 1121 and Pusa 44 complied up to 4 months after initial testing/8 months of harvest.	Packaging material used is cloth bag and gunny bag
PAJANCOA & RI, Karaikal	ADT (R) 46, PUSA 44 and PB1121 had maintained the minimum germination required as per IMSCS after 6 months of storage in polylined gunny bag only (i.e.10 months after harvest & 7 months after processing).	None of the variety stored in gunny bag had retained the 80 per cent germination after 6 months of storage due to moisture pervious nature of the container. Hence, it is suggested that, the period of validity of certification tag needs to be reconsidered according to the place of production, place of seed storage (storage region) and type of containers (packaging materials) used for storage.
KAU, RARS, Pattambi	Varieties I. W. Ponni and ADT (R) 46 complied for 2 months after testing/6 months after harvest in both HDPE and	Very high humidity in Kerala during the period of study caused faster

	gunny bag. Whereas Pusa 44 and Pusa 1121complied up to 3 months from the date of initial testing(7 months after harvest)	deterioration of seed quality.
AAU, Jorhat	ADT (R) 46 complied up to 5 months after initial testing/9 months of harvesting in both the packaging material; I.W. Ponni complied up to 7 months from initial testing; Pusa 44 complied for 9 months from initial testing; Pusa 1121 comply up to 11 months from initial testing.	-
SKUAST, Kashmir	Seed germination of I.W. Ponni and ADT (R) 46 was higher than IMSCS at 7 months of testing/11 months after harvest in both HDPE and gunny bags.	Mean germination recorded was 88.25%, 87.50%, 87.50% and 86.00% after 15 months of storage of SR-2, SR-4, I. W. Ponni (TL) and ADT (R) 46 (TL), respectively.
OUAT, Bhubaneswar	In HDPE bag storage, varieties Pusa 44 and PB 1121 maintained germination above IMSCS even after 11 months after initial testing, whereas, I. W. Ponni and ADT (R) 46 maintained germination above IMSCS up to 7 months after initial testing. In gunny bag storage, varieties Pusa 44 and PB 1121 maintained germination above IMSCS even after 8 months after initial testing, whereas, I. W. Ponni and ADT (R) 46 maintained germination above IMSCS up to 4 months of initial testing.	-

Maize: Germination percentage (mini.) as per IMSCS, 2013 is 90%
Date of harvesting: October, 2018 Date of first test: May, 2019
Variety: J-1006

Centre	Compliance of germination with IMSCS)	Remarks
ICAR-IARI, New Delhi	Maintained germination per cent above IMSCS (90%) up to 9 months after initial testing (16 months after harvest) when stored in HDPE bag; and comply up to 8 months after testing (15 months after harvest) when stored in gunny bags.	-
ICAR-IISS, Mau	Germination was higher than IMSCS even after 14 months of harvest (97%) in both gunny as well as HDPE bags.	-
TNAU, Coimbatore	Complied up to 9 months after initial testing (16 months after harvest) in HDPE bags and 5 months after testing (12 months after harvest) in gunny bag	-
PAU, Ludhiana	Complied up to 14 months after harvest, when stored in gunny as well as HDPE bag.	-

Sorghum: Germination percentage (mini.) as per IMSCS, 2013 is 75%

Date of harvesting: November 2018 Date of first test: Jan, 2019

Variety: AKSV-181 & CSV 34

Centre	Compliance of germination with IMSCS)	Remarks
ICAR-IIMR, Hyderabad	In HDPE bag, complied up to 12 and 11 months after harvest in AKSV-181 and CSV-34, respectively. While in gunny bag, comply up to 11 and 10 months after harvest in AKSV-181 and CSV-34, respectively.	Mean germination recorded was 80.75% and 80.75% after 12 and 11 months of storage of AKSV-181 and CSV-34, respectively.
PDKV, Akola	Seed germination was above IMSCS even after 14 months after harvest both in seed stored in gunny as well as HDPE bag. In both the varieties, seed germination was above 85% after 14 months of storage. (Min	Mean germination recorded was 89.50% and 85.25% after 14 months of storage of AKSV-181 and CSV-34, respectively.

	IMSCS is 75%)	
VNMKV, Parbhani	In HDPE bag storage, seed germination was above IMSCS at 12 months of storage in both the varieties. While, in gunny bag storage, comply upto 11 months in CSV-34 and continued to comply after 12 months in AKSV-181.	Mean germination recorded was 92.37% and 75.00% after 12 months of storage of AKSV-181 and CSV-34, respectively.
MPKV, Rahuri	Complied up to 28 months of storage (Varieties: Phule Vasudha and Phule Rohini)	Mean germination recorded was 84.50% and 83.33% after 28 months of storage of Phule vasudha and Phule Rohini, respectively.
	Seed germination was higher than IMSCS after 13 months of storage (85% in CSV-34 & 94% in AKSV-181)	Mean germination recorded was 94.00% and 85.50% after 8 months of storage of AKSV-181 and CSV-34, respectively.
UAS, Dharwad	Complied up to 14 months after harvest in CSV-34 and 12 months after harvest in AKSV-181	-

Cotton: Germination percentage (mini.) as per IMSCS, 2013 is 65% for varieties and 75% for hybrids

Date of harvesting: February, 2019 Date of first test: March/April, 2019

Varieties: NH 615 (*G. hirsutum*) and Roja [CNA1003 (*G. arboreum*)]

Centre	Compliance of germination with IMSCS	Remarks
ICAR-CICR, Nagpur	Seed germination in both the varieties was maintained higher than IMSCS at 9 months after harvesting (in both gunny as well as polythene 700 guage bag)	Germination was more than 85% in all the cases at 9 months after harvesting.

PDKV, Akola	Complied up to 10 months of storage only in both the varieties in gunny as well as polythene bag.	-
PJTSAU, Hyderabad	Seed germination was maintained more than IMSCS even after 12 months of storage.	Mean germination recorded was 92%, 91 and 93% after 12 months of storage of NH 615, Roja (CNA1003) and ADB-542, respectively.
UAS, Dharwad	Complied up to 12 and 9 months of storage in NH 615 and Roja (CNA1003), respectively.	-

Soybean: Germination percentage (mini.) as per IMSCS, 2013 is 70%
Date of harvesting: October, 2018 Date of first test: 25 Feb-2019
Varieties: JS-335 and Phule Sangam

Centre	Compliance of germination with IMSCS	Remarks
ICAR-IARI, New Delhi	Seed germination was higher than IMSCS after 12 months of initial testing (16 months after harvest) in both the varieties.	In JS 335, after 12 months of testing, germination was 78.5% and 83.5% in HDPE and gunny bags, respectively. In Phule Sangam, after 12 months of testing, germination was 70.5 and 75.5% in HDPE and gunny bag, respectively.
GBPUAT, Pantnagar	Complied up to 11 months after initial testing (15 months after harvest) in var. JS 335. Complied up to 10 months after initial testing (14 months after harvest) in Phule Sangam.	-

JNKVV, Jabalpur	Seed germination was higher than IMSCS at 10 months after initial testing (14 months after harvest) in both the varieties in gunny bag as well as HDPE bag.	In JS335, germination was 86 and 88% in gunny and HDPE bag, respectively at 10 months after testing. While, in Phule Sangam, it was 81 and 83% in gunny and HDPE bag, respectively.
VNMKV, Parbhani	Seed germination was higher than IMSCS at 14 months after harvest in both the varieties in gunny bag as well as HDPE bag.	JS 335 maintained 91 and 87% germination after 14 months of harvest in HDPE and gunny bag, respectively. Phule Sangam maintained 90 and 81 % germination in HDPE and gunny bag, respectively
MPKV, Rahuri	Seed germination was higher than IMSCS at 10 months after initial testing (14 months after harvest) in both the varieties in HDPE bag.	Both the varieties have maintained above 80% germination after 10 months of initial testing.
UAS, Dharwad	Complied up to 11 months after initial testing (15 months of harvest) in JS335 and comply up to 10 months after harvest (14 months of harvest) in Phule Sangam.	-

Chickpea: Germination percentage (mini.) as per IMSCS, 2013 is 85%
Date of harvesting: April, 2019 Date of first test: May, 2019
Varieties: RSG- 963 and CSJD- 884

Centre	**Compliance of germination with IMSCS**	**Remarks**
ICAR-IARI, New Delhi	Complied up to 10 months after harvest in both var. RSG – 963 and CSJD – 884 when stored in HDPE bag.	-

	While, in case of gunny bag, complied up to 6 months and 9 months after harvest in RSG-963 and CSJD-884, respectively.	
ICAR-IISS, Mau	Seed germination in both the varieties was more than IMSCS in gunny as well as HDPE bag after 8 months after harvest (7 months after initial testing) (around 95%)	-
JNKVV, Jabalpur	Complied up to Revalidation 2nd time in varieties JG 16 and JG 63.	Mean germination recorded was 88.85% and 91.82% after 12 months of storage of JG16 and JG63, respectively.
VNMKV, Parbhani	Seed germination was more than IMSCS after 6 months of initial testing (7 months after harvest) in both the varieties in gunny as well as HDPE bags.	In both the varieties, germination was more than 95% after 6 months of initial testing.
CSAUAT, Kanpur	Complied up to 6 months after initial testing (7 months from the harvest) in both the varieties.	-

Castor: Germination percentage (mini.) as per IMSCS, 2013 is 70%

Varieties: PCH 111, DCH 519 and Haritha

Centre	Compliance of germination with IMSCS	Remarks
PJTSAU, Hyderabad	Seed germination was more than IMSCS at 12 months of storage.	Mean germination recorded was 91%, 92% and 90% after 12 months of storage in PCH 111, DCH 519 and Haritha, respectively.

JAU, Jamnagar	Complied up to 27 months of storage (Variety: GCH-7)	Mean germination recorded was 75.75% after 27 months of storage of GCH-7.
AAU, Anand	No indication for months of storage	Germination data reported is below IMSCS

Groundnut: Germination percentage (mini.) as per IMSCS, 2013 is 70%
Date of harvesting (GPBD-4 & G2-52): kharif crop harvest: October/Nov., 2018 Date of first test: March, 2019
Date of harvesting (TAG-24 & TG 37-A): Rabi crop harvest: May, 2019 Date of first test: May/June, 2019

Centre	Compliance of germination with IMSCS	Remarks
AAU, Anand	GPBD-4 & G2-52 maintained higher germination than IMSCS at 9 months after harvest. TAG-24 & TG 37-A had around 80% germination at 3 months after harvest.	-
OUAT, Bhubaneswar	Complied up to 11 months after harvest in cloth bag and higher than IMSCS at 13 months of harvest in HDPE bag (around 75%) in GPBD-4 & G2-52. While, in TAG-24 and TG 37-A, maintained higher germination after 8 months of harvest 75% in gunny bag and around 85% in HDPE bag.	-
JAU, Jamnagar	Complied up to 7 months of storage. (Variety: GG-5)	-
MPKV, Rahuri	Seed germination was higher than IMSCS at 13 months after harvest in GPBD-4 (74%) and G2-52 (72%). While, TAG-24 (80.5%) and TG 37A (86%) maintained higher germination than IMSCS at 7 months after harvest.	-

UAS, Bengaluru	Due to infection, final germination count could not be taken even from two months of storage	-
UAS, Dharwad	Complied up to 14 months after harvest in both GPBD-4 & G2-52. While TAG-24 (82%) & TG 37A (87%) maintained higher germination than IMSCS at 9 months after harvest (under progress)	-
RARI, Durgapura	Complied up to 9 months of storage. Varieties: RG 425 and RG 510	-

❖ **Experiment on hybrid purity testing using molecular markers in public sector hybrids of field crops**

Year of Start: 2011- 2012

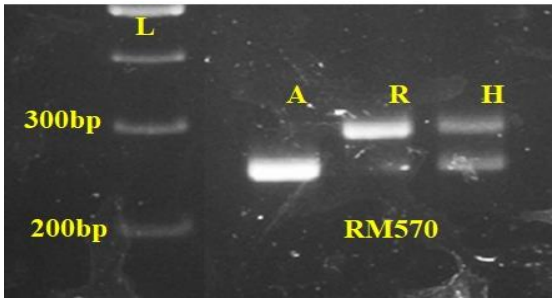
Salient findings

- For hybridity determination in rice, RM-570 and RM-276 SSR markers showed differentiating banding pattern of parental lines with hybrids JRH-5 and CO-4, respectively.
- For hybridity determination in sunflower, ORS-513 and ORS-509 are able to differentiate NSH-10 and KBSH-78 hybrids along with parental lines.
- In assessment of genetic purity in rice, RM-452 SSR marker showed different amplification pattern in varieties cultivated in U.P.

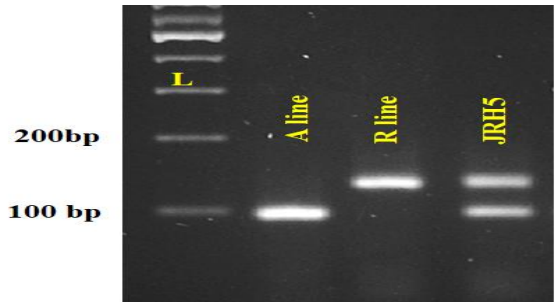
Hybridity and genetic purity determination using various SSR markers in different crops across STR centres.

Crop	Centre	SSR marker	Hybrid /Variety	Parental lines
Paddy	PJTSAU, Hyderabad	RM-206	JGLH-1	CMS-64A, JBR-7
Paddy	JNKVV, Jabalpur	RM 276	JRH5	A line (P1) and R line (P2)
Paddy	TNAU, Coimbatore	RM 570	CO4	TNAU CMS 23 A, CB 174 R
Paddy	IISS, Mau	RM-452	16 varieties cultivated in U.P.	
Maize	CSKHPKV, Palampur	umc1066, bnlg1520, umc1066	Palam Sankar Makka-2	Bajim-08-26 (female parental line), Bajim-08-27(male parental line)
Maize	CSKHPKV, Palampur PAU, Ludhiana	bnlg 238, umc 1227 and umc 1798	PMH 1	LM 13 and LM 14

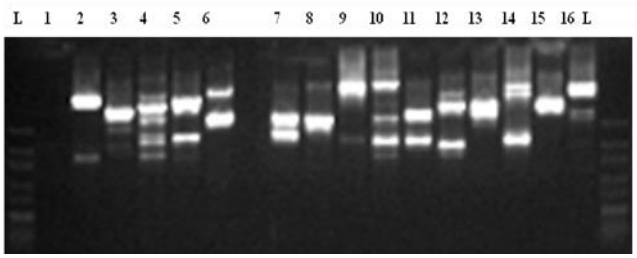
Maize	UAS, Bengaluru	Phi053 Bnlg 1520 umc 1627	Hema MAH-14-5 PMH 10	NAI-137 (female parental line), MAI-105 (male parental line) CAL 1443 (female parental line), CML 451 (male parental line) LM 23 and LM 24
Sunflower	UAS, Bengaluru	ORS-57 and ORS-170; ORS-610; ORS-513 and ORS-613; ORS-716; ORS-621 and ORS-811; and ORS-513, ORS-605 and ORS-337	KBSH-78; KBSH-79; KBSH-41; KBSH-44; KBSH-53; and NSH-10	
Castor	AAU, Anand	RcDES55 RcDES45	DCH-177 DCH-519	DPC-9 and DCS-9 M-514 and DCS-78



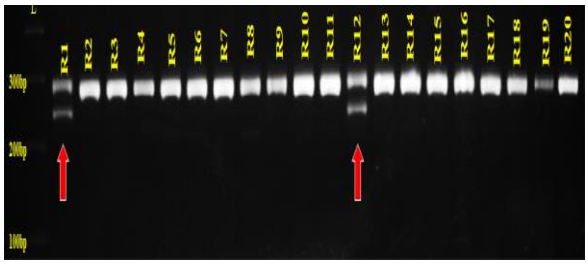
Hybridity determination of CO-4 rice hybrid along with parental lines using RM-570 SSR marker (TNAU, Coimbatore)



Hybridity determination of JRH5 along with A, R parental lines using RM-276 SSR marker (JNKVV, Jabalpur)



SSR marker RM 452 showing polymorphic



Identification of off-type using SSR marker

banding pattern among 16 rice cultivars (IISS, Mau)

RM 570 in CO-4 rice hybrid production (TNAU, Coimbatore)

❖ Experiment on use of nano-particles in enhancing seed quality and storability of seeds

Materials:

Crops and Varieties: Use any two recommended local varieties e.g.

Pigeonpea: BRG 2 and BRG4

Soybean: Pusa 9712 and Pusa 9814

Onion: Pusa Madhvi, Pusa Riddhi and Pusa Red

Paddy: Only in Basmati varieties; Pusa Basmati 1509 and Pusa 1121

Treatments:

Nano-particles: Zinc oxide, Silver, Silicon dioxide (both bulk and nano form).

Dosage: Control (no treatment); 100 ppm, 250 ppm, 500 ppm, 750 ppm and 1000 ppm

Formulation: Dry form

Salient findings:

Pigeon pea:

Study in referred crop was conducted at two cooperating centres *viz.* TNAU, Coimbatore and UAS, Bengaluru.

- Pigeon pea seeds treated with nano formulation of ZnO @ 500ppm and also SiO_2 @ 500 ppm maintained the maximum germination of 82 % in comparison to control (68 %) after 13 months of storage (TNAU, Coimbatore).
- During the storage, silicon dioxide in nano form @ 100 ppm recorded highest seed quality parameters germination (72.13%), mean seedling length (22.38 cm), seedling dry weight (25.36 mg), seedling vigour index I (1589) and vigour index II (1829), lower electrical conductivity (45.73 µS/cm/g) followed by silicon dioxide at 50 ppm in nano form (UAS, Bengaluru).
- Among the packaging material seeds stored in super grain bag recorded higher quality parameters as compared to cloth bag (UAS, Bengaluru).

Onion:

Study in referred crop was conducted at two cooperating centres *viz.* IARI, New Delhi and TNAU, Coimbatore.

- Nano formulations of Zinc oxide @ 100/ 250 ppm, Titanium oxide @ 250/ 500 ppm and Silicon dioxide @ 100/ 250 ppm proved to be effective for enhancing the seed quality in onion (IARI, New Delhi). An increment of 7.3 % was observed w.r.t germination over control.

- Nano particle seed treatments with Titanium oxide 250 ppm recorded maximum values for all seed quality parameters (13 % increment w.r.t germination) than control. Bulk formulation of 250 ppm Titanium oxide also recorded similar results but the effect was lesser than the nano treatment (TNAU, Coimbatore).

Soybean:

Study in referred crop was conducted at cooperating centres *viz.* TNAU, Coimbatore; IARI, New Delhi; VNMKV, Parbhani and PDKV, Akola.

Nano particle seed treatment with Zinc Oxide @ 500 ppm recorded maximum values for seed quality parameters among varied soybean varieties across cooperating centres. Zinc Oxide @ 500 ppm registered an increment of 11 to 17 % w.r.t germination per cent and an increment of around 14 % w.r.t field emergence in comparison to control among cooperating centres.

- Soybean varieties *viz.* DS 2614 and Pusa 9712 responded to nano formulations of zinc oxide @ 500-750 ppm followed by silicon dioxide @500-750 ppm. Similarly, for bulk formulations too, treatments with zinc oxide @ 500-750 ppm followed by silicon dioxide @ 500-750ppm were found to be the most effective treatments for enhancing the seed quality (IARI, New Delhi).
- Nano particle seed treatments with zinc oxide 500 ppm recorded maximum values for all seed quality parameters which were on a par with Silicon dioxide than control irrespective of varieties. Bulk formulation of 500 ppm zinc oxide also recorded similar results but the effect was lesser than the nano treatment (TNAU, Coimbatore; PDKV, Akola).
- Among the different concentrations, 500 ppm in all nano chemicals (Zn, Ti and Si) recorded significantly higher values of vigour index I and vigour index II for both the soybean varieties (VNMKV, Parbhani).

Paddy:

Study in referred crop was conducted at cooperating centres *viz.* PAU, Ludhiana and IARI, New Delhi.

- Seed priming with silver Nano conjugate-B + Seedling root dip treatment before transplanting for 6 hours (T9) with B (B=1, 2, 4-triazolodithiocarbamate conjugated Silver nanoparticles aqua emulsions) and Seed priming with silver nano conjugate-B (T2) resulted in maximum disease control and also gave maximum seed yield. As the results obtained from Seed priming with silver nano conjugate (T3) and T2+ Seedling root dip treatment before transplanting for 6 hours with B (T9) were statistically at par with each other, the need of seedling root dip for the management of seed borne inoculum of *Fusarium fujikuroi* may not be required.

❖ **Experiment on influence of terminal heat stress on seed set, seed yield and quality in field crops**

Materials:

Three most popular varieties; one recommended for normal dates of sowing and others recommended for late and very late dates of sowings, in each crop have taken for the study.

Methodology:

1. Set 1: The experiment in open field conditions (where growth chamber facilities for elevated temperature are not available) is conducted by sowing each crop thrice; normal, late and very late sowing dates. The dates differed depending upon the location of centre with respect to a particular crop. Hence, the sowing dates were adjusted accordingly (experiment was conducted with normal date of sowing and two more sowings at 15-20 days intervals, thereafter).
2. Set 2: Where growth chamber facilities for elevated temperature are available, the experiment has conducted at normal temperature requirements of that crop and 5°C elevated temperature conditions to be maintained from anthesis onwards.

Mitigation treatments:

1. Control
2. Salicylic acid (800 ppm)
3. Salicylic acid (400 ppm)
4. Ascorbic acid (10 ppm)
5. KCl (1%)
6. Thiourea (400ppm)
7. Cycocel (please ensure that *a.i.* concentration should not to exceed 1250ppm)

Spray Schedule:

1. Control (Without spray)
2. Vegetative stage (35-40 days after sowing or transplanting)
3. Anthesis stage (Vary from crop to crop and location to location)
4. Vegetative + Anthesis stage

Salient findings:

Crop: Wheat

Centre	Varieties	Most effective treatment	% increase over control	Remarks

PDKV, Akola	-	Salicylic acid @ 800 ppm	Yield increased by 12 % (11.23 q/ha) over control (10.04 q/ha) under late sowing and 11 % (11.55 q/ha) over control (10.41 q/ha) under very late condition	Salicylic acid @ 400 ppm- second best treatment
JNKVV, Jabalpur	LOK-1, JW3211, JW 3382	Salicylic acid @ 400 ppm	Yield increased by 23 % (577 g/ plot) over control (470 g/ plot) using Salicylic acid @ 400 ppm under late sowing; and 14.6 % (477 g/ plot) over control (416 g/ plot) using KCl @ 1 % under very late sowing.	Seed set increased by 8 % (69.91 %) over control (64.66 %) and 7.5 % (61.59 %) over control (57.27 %) under late and very late sown conditions, respectively using Salicylic acid @ 400 ppm.
UAS, Dharwad	DWR 162, UAS 304, Mass 6222	KCl @1%	16 % (26 q/ha) increment over control (22.28 q/ha) for yield	Result inconsistent for late and very late sown conditions
TCA, Dholi	HD 2733, HI 1563, WR 544	Salicylic acid @ 800 ppm	Yield improved was 8.86 % (0.86 kg/ plot) over control (0.79 kg/ plot)	-
GBPUAT, Pantnagar	UP 2565, UP 2554, DBW16	Cycocel @ 1000 ppm and Thiourea @ 400 ppm at par	Yield increased by 9.42 % (44.2 q/ha) over control (40.3 q/ha) and 10 % (36.5 q/ha) over control (33 q/ha) under late and very late sown conditions, respectively	Salicylic acid @ 800 ppm- second best treatment

CCSHAU, Hisar	WH 1124, WH 1105	Salicylic acid @ 800 ppm	Yield increased up to 25.3 % (55.25 q/ha) over control (44.1 q/ha) and 27.3 % (48.95 q/ha) over control (38.45 q/ha) under late and very late sown conditions, respectively	1000 seed weight increased up to 12.24 % (41.7 g) over control (37.15 g) and 12.65 % (40.95 g) over control (36.35 g) under late and very late sown conditions, respectively
VNMKV, Parbhani	NIAW-301	Ascorbic acid @ 10 ppm and KCl @ 1 % at par	Grain weight increased 22 % (1.93 g) over control (1.58 g)	-
NDUAT, Faizabad	NW-5054	Cycocel @ 1000 ppm at par with Salicylic acid @ 800 ppm	Overall increment in yield up to 27 % (4.6 kg/ plot) over control (3.6 kg/ plot), seed set up to 9.9 % (92.77 %) over control (84.39 %)	Salicylic acid @ 400 ppm- second best treatment
CSAUAT, Kanpur	K-1006	Salicylic acid @ 400 ppm and	Increment in yield up to 16 % (50.98 q/ha) over control (43.74 q/ha) and 1000 seed weight up to 12 % (38 g) over control (33.99 g)	Ascorbic acid @ 10 ppm –second best treatment

Inference- Salicylic acid @ 800 ppm has been identified as best treatment in most of the centres followed by Salicylic acid @ 400 ppm across centers.

Crop: Rice

Centre	**Varieties**	**Most effective treatment**	**% increase over control**	**Remarks**
PJTSAU, Hyderabad	JGL 18047, Tellahamsa and RNR 15048	Salicylic acid @ 400 ppm	Superiority for yield up to 11.74 % (6884 kg/ha) over control (6161 kg/ha) and seed set up to 8.58 % (88.93	Salicylic acid @ 400 ppm was followed by Ascorbic acid @10 ppm

			%) over control (81.90 %)	
TNAU, Coimbatore	CO 52	Salicylic acid @ 400 ppm	Increment in yield up to 12 % (5838 kg/ha) over control (5215 kg/ha), seed set up to 8 % (89 %) over control (82.4 %) under open field condition whereas increment in yield up to 13 % (5270 kg/ha) over control (4660 kg/ha), seed set up to 14 % (83.1 %) over control (72.6 %) in growth chamber (5ºC elevated temperature)	Salicylic acid @ 800 ppm is the second best treatment under growth chamber
ICAR RC NEHR, Manipur	RC Maniphou-13, RC Maniphou-10 and RC Maniphou-7	Salicylic acid @ 800 ppm	Yield increased up to 27 % (1394 kg/ha) over control (1094 kg/ha) under stress condition	Second best treatment was Salicylic acid @ 400 ppm for yield
OUAT, Bhubaneswar	Mandakini, Naveen, Hiranmayee	Salicylic acid @ 800 ppm	Yield increased up to 16 % (45.73 q/ha) over control (39.35 q/ha) and 24 % (44.92 q/ha) over control (36.28 q/ha) under late and very late sown conditions, respectively	Salicylic acid @ 400 ppm- second best treatment
BSKKV, Dapoli	Karjat-184, Karjat-3, Karjat-2	Salicylic acid @ 800 ppm	Improvement in yield up to 26 % (1.58 kg/ plot) over control (1.25 kg/ plot), seed set up to 7 % (90.38 %) over control (84.42 %) .	Salicylic acid @ 400 ppm- second best treatment

Inference: Salicylic acid @ 800 ppm has been identified as best treatment in most of the centres followed by Salicylic acid @ 400 ppm across centers.

Crop: Sorghum

Centre	Varieties	Most effective treatment	% increase over control	Remarks
MPKV, Rahuri	Swati and Phule Revati	Salicylic acid @ 800 ppm	Increment in yield up to 17 % (35.25 q/ha) over control (30.12 q/ha), 1000 seed weight up to 10 % (33.67 g) over control (30.58 g)	Second best treatment was Salicylic acid @ 400 ppm
VNMKV, Parbhani	SPV-1411	Salicylic acid @ 800 ppm at par with Salicylic acid @ 400 ppm	1000 seed weight improved by 24 % (29.72 g) over control (23.95 g) and grain filling by 1.75 % (99.75 %) over control (98.03 %)	-

Inference: Salicylic acid @ 800 ppm has been identified as best treatment followed by Salicylic acid @ 400 ppm across centers.

Crop: Mustard

Centre	Varieties	Most effective treatment	% increase over control	Remarks
CAZRI, Jodhpur	Laxmi	NS	-	None of the treatments could be advocated for mitigating the effect of elevated temperature in mustard
NDUAT, Faizabad	Pitambari	Cycocel @ 1000 ppm and Salicylic acid @ 800 ppm at par	Yield improved by 40 % (2.10 g/ plot) over control (1.50 g/ plot) and 67 % (1.87 g/ plot) over control (1.12 g/ plot) under late and very late sown conditions, respectively	Single variety used under timely, late and very late sowing dates

CSAUAT, Kanpur	Rohini	Thiourea @ 400 ppm	Yield increased by 41.6 % (2.55 kg/ plot) over control (1.80 kg/ plot) for timely sown and 44 % (2.46 kg/ plot) over control (1.70 kg/ plot) for late sown conditions	Single variety used under timely and heat phase

C. Seed Pathology

Under seed pathology, various experiments on monitoring and detection of various diseases, survey and evaluation of seed health status of farmers' own saved seed; development of rapid and reliable techniques for detection of seed borne pathogens; development of integrated strategies for management of seed borne diseases; biological control of seed borne diseases have been taken up during 2019-20and the highlights of achievements have been summarized for a quick inference from various experiments.

❖ **Experiment on monitoring and detection of rice bunt, false smut, bacterial leaf blight (BLB) and bacterial panicle blight in processed, unprocessed and farmer's seed samples were conducted at 16 centres.**

- The highest paddy bunt infection was observed in unprocessed seed samples from PAU, Ludhiana (3.5%) where 95.0% samples were carrying bunt infection. At PJTSAU, Hyderabad, 87.6% samples from farmer's field were found to be infected with bunt with maximum infection up to 1.4%. It was also evident from the results that, there was a drastic increase in number of samples affected by bunt in 2019-20 (59.66%) in comparison to 2018-19 (14.18%). Similarly, there was an exponential increase in bunt incidence during 2019-20 in all the paddy growing areas of the state. This could be attribute to the rainfall pattern prevailed during crop growth period especially from last week of July to third week of October 2019 which is something different from the regular rainfall pattern of previous years. Across the samples tested, the percent increase in bunt incidence ranged between 75.91 to 99.40%. Though the incidence of bunt was found to be relatively high, it was surprised to notice that, all the samples recorded the germination above IMSCS.
- At MPKV, Rahuri, 8.3% samples in unprocessed seed were found to be infected with bunt with maximum infection up to 0.35%. At CCSHAU Hisar, 37.31%samples were carrying bunt infection and there was rejection of eight seed samples due to bunt because infection was above prescribed limit of certification. In JNKVV Jabalpur, highest number of bunt infected samples was reported from Dindori (13.3%), a tribal dominant belt. At AAU, Anand, bunt incidence has been reported but it's below IMCSS. At IISS, Mau, 13% samples were found

to be infected with rice bunt in the range of 1-3%. At CSKHPKV, Palampur, 37 rice seed sample out of 178 samples showed the presence of rice bunt with an incidence of 0.2-1.0 percent, maximum being in Sambuwala location of district Kinnaur. Bunt incidence was not observed in samples collected from both seed processing plants and farmers field in Sher-e-Kashmir University, Srinagar; CSKHPKV, Palampur; VNMKV, Parbhani; RPCAU, Dholi; PAJANCOA & RI, Karaikal; IARI, New Delhi and AAU, Jorhat.

- During the year 2019-20, incidence of BLB in all major paddy growing areas of Telangana state was at very low levels and recorded rating scale 1 while it was very severe last year. At MPKV Rahuri, the incidence of bacterial blight on farmer's field ranged from 1.67 to 9.67 per cent. Highest incidence of BLB was noticed on Phule Samrudhi (9.67%) in Maval tehsil of Pune districts. BLB incidence was very low in seed production plots of DRPCAU, Pusa, Bihar as compared to last year. The bacterial leaf blight incidence in Krishnagiri, Erode, Tiruppur and Cuddalore districts of Tamil Nadu ranged from 2.00 to 19.50%. IARI, New Delhi has reported that both in farmers field in different villages of Baraut, Noida, Gurgaon, Ghaziabad and Meerut as well as in seed production plots of IARI, BLB was observed in moderate severity in Pusa 1121 only. Incidence of BLB was observed in farmers' fields only in Khatima and Sitarganj, U S Nagar and exhibited highest upto 20% disease incidence. However, seed production fields were free of blight infection at Pantnagar. In JNKVV, Jabalpur, BLB incidence was severe at famers fields in Jabalpaur, Dindori and Mandla districts of Madhya Pradesh. No BLB has been reported from Himachal Pradesh this year however, grain discoloration incidence was recorded in many locations which ranged between 0.8-8.6 per cent. BLB has been reported in very low severity at Ludhiana, Mau, Hisar and Jorhat. No report from Parbhani, Anand and Srinagar. No panicle blight was found at any of the locations except in farmers' fields as reported by IISS, Mau and GBPUA&T, Pantnagar. Pusa sugandh-5 showed incidence of False smut in farmers field in different villages of Noida only while, PB 1509 and Pusa 6 showed incidence of False smut in farmers field in different villages of Meerut only and this disease was not observed in any other variety and in any other locations. False smut was not observed in PS-5 in seed production plots of IARI and the probable reason would have been the prophylactic spray of fungicide in these plots. False smut has been reported by Palampur, IISS Mau and Hyderabad centre too.

❖ **Experiment on 'monitoring of emerging new diseases of seed borne nature'**

- Sheath rot in Paddy has been reported from IARI New Delhi and AAU, Assam. Bacterial Panicle Blight of Paddy *Burkholderia glumae* and Fruit rot of Chilli has been reported at GBPUA&T, Pantnagar. Potato Virus Y (PVY) and Corm rot of Saffron are reported at Sher-e-Kashmir University, Srinagar as emerging seed- borne diseases affecting seed quality.

Fig 1. Symptom of rice sheath rot and its morphological and microscopic view

Fig 2. Symptoms of panicle blight in paddy (*Burkholderia glumae*)

Fig 3. Fruit rot of Chilli caused by *Alternaria alternata*

Fig 4. Symptoms of saffron corm rot

Fusarium oxysporum

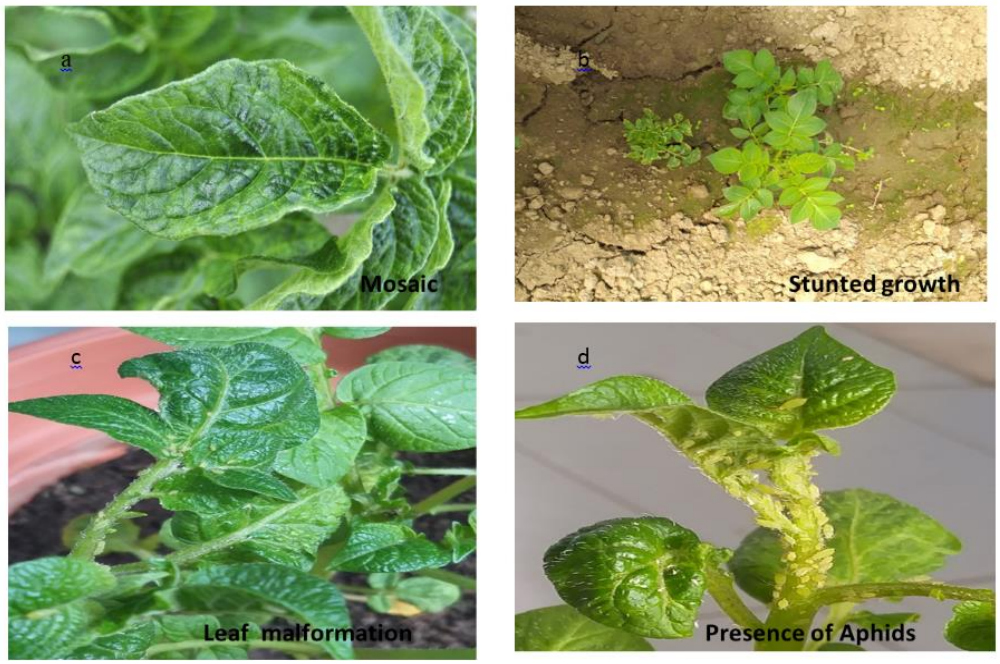


Fig 5. Symptoms of PVY observed during the field survey:
a: Mosaic; b: Stunted growth; c: Leaf malformation and d: Presence of main vector (Aphids)

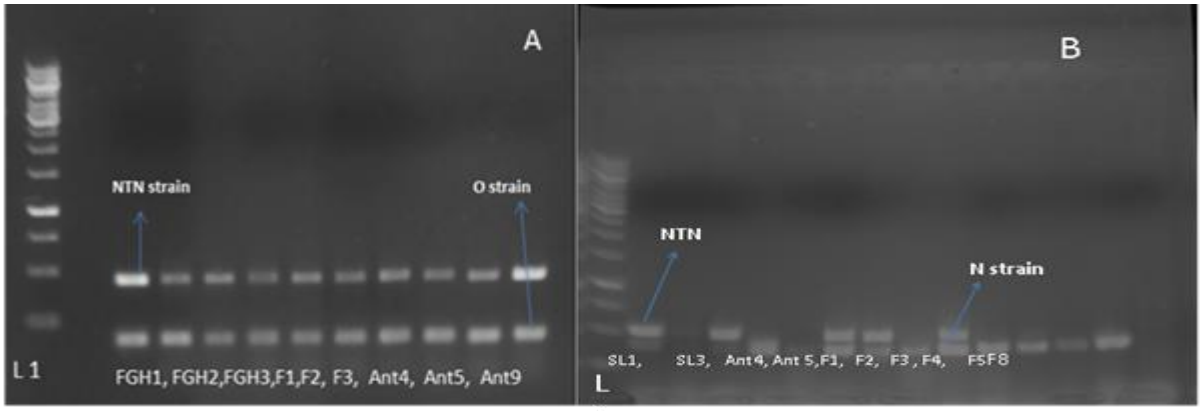


Fig 6: Multiplex PCR Product separated on 1% Agarose gel, Lane 1: 1kb ladder, A)NTN& O strain (452bp & 267bp respectively). B) NTN & N strain (452bp & 398bp respectively)

- False smut is an important rice disease emerging in Uttar Pradesh region and the disease shown to be prevalent especially after flowering stage in all four districts studied (IISS, Mau). In addition, CSKHPKV, Palampur, and PJTSAU, Hyderabad centres have also reported it.

Fig 7. False smut infected panicles from farmers field showing golden yellow smut balls in florets of rice cv. Sampurna

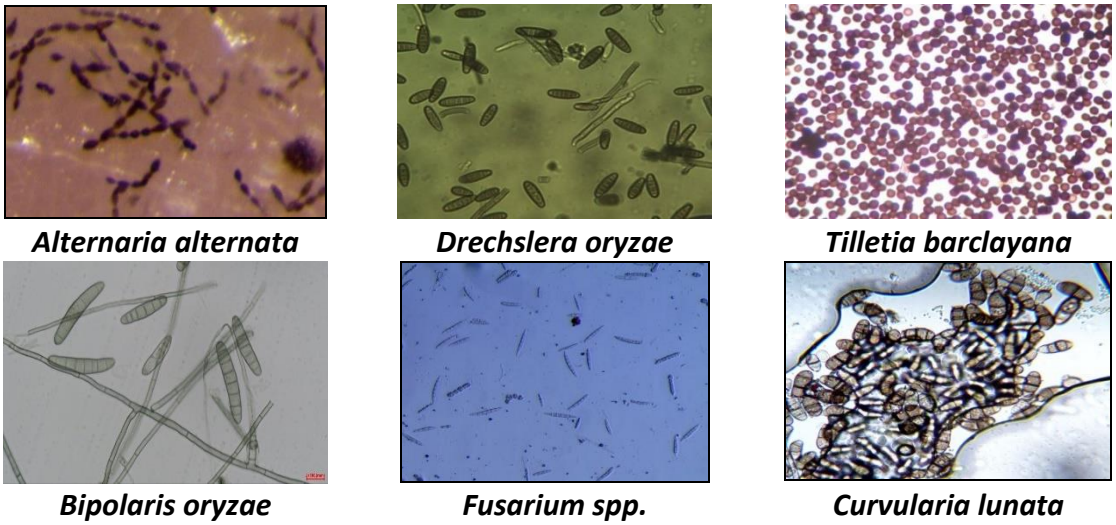
- PAU center along with IARI, New Delhi has reported association of *Albifimbria terrestris* with rice seeds. The pathogen produced symptoms resembling sheath rot and caused sterility of panicles on artificial inoculation at boot stage of rice.

Fig 8.a. Culture of *Albifimbria terrestris*

b. Sheath rot symptoms produced by inoculation of *Albifimbria terrestris*

❖ **Experiment on studies on seed health status of farmers saved seeds**

- Most of the farmers in the country use seeds stored by them in previous season and therefore it is very important to know the health status of farmers' saved seed across the country. Study revealed that seed health status of farmers' saved seed samples was comparatively poor.
- In paddy, majority of seed samples at certain locations were having very poor germination *viz.,* study at PAU Ludhiana exposed that discoloration of rice seeds caused severe reduction in germination and vigour of seedlings. Seed germination was below Indian Minimum Seed Certification Standard in severely discolored seed samples. Discolored seeds resulted in seed rot, produced stunted and blighted seedlings. Mycoflora responsible for seed discoloration was *C. lunata*, *Alternaria alternata, Drechslera oryzae, Aspergillus flavus, Chaetomium globosum, A. niger r*and *Penicillium* sp. to varying percentage at different locations. *Myrothecium leucotrichum* was isolated from more than 40% of the discolored rice grains. It was identified as *Albifimbria terrestris* based on sequence information from NCBI at IARI, New Delhi. The appearance of *Myrothecium* infected seeds was confused with the association of kernel smut of rice in many samples. 66.6% of samples collected at PAJANCOA&RI, Karaikal exhibited germination below IMSCS in Paddy. At AAU, Jorhat, out of 104 seed samples from 31 different varieties, 34 samples showed germination below IMSCS in Paddy which is 32.6% of total. At DRPCAU, Dholi (Bihar), 115 samples were collected from 33 varieties and 20.86% samples of farmer's saved samples exhibited germination below IMSCS.



Alternaria alternata ***Drechslera oryzae*** ***Tilletia barclayana***

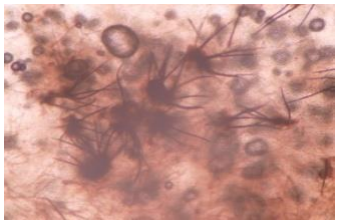
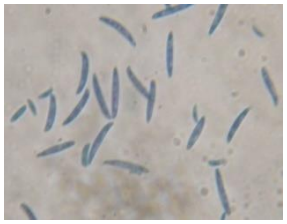
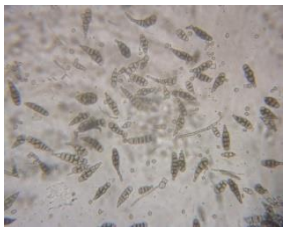
Bipolaris oryzae ***Fusarium spp.*** ***Curvularia lunata***

Fig. 9 View of conidia of different fungal species in paddy seeds

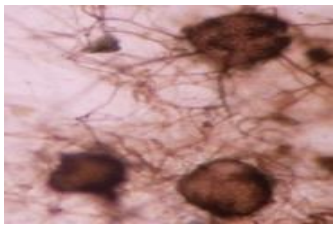
- Seed health status of farmers' saved seed in wheat was studied at PAU Ludhiana in 1155 wheat seed samples collected from 18 districts of the state. Seed sample of variety HD 2967 from Tarantaran district exhibited maximum karnal bunt infection (12.7%) and Ear cockle

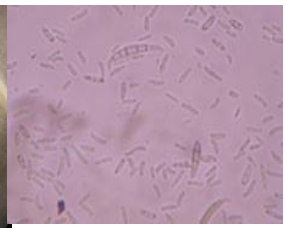
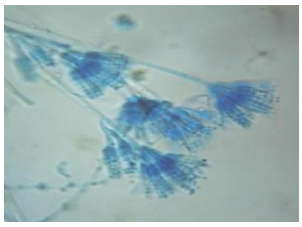
was not present in any of the samples. The average incidence of Karnal bunt varied from 0.003 to 0.821 % in wheat samples. High incidence of Karnal bunt (ranging from 2.6 to 12.6 %) was recorded from Hoshiarpur (5.4%), Jalandhar (6.3%), Sangrur (2.6%) and Tarantaran (12.7%) districts of the state. At CSKHPKV, Palampur, 300 wheat seed samples were collected from eight district of Himachal Pradesh to assess the prevalence of karnal bunt disease in farmer's unprocessed seed samples. It was found that Karnal bunt was noticed in 245 seed samples with an incidence ranging from 0.05 to 3.85 percent with a maximum incidence of 3.85 % in Jihan area of district hamirpur and 178 samples were found to have infection above seed certification standard. 217 farmers own saved seed samples collected from different districts of Himachal Pradesh were tested by GOT to see the prevalence of loose smut disease under field conditions during *rabi* season of 2018-19. Out of 217 seed samples, loose smut was observed only in 8 samples with an incidence of 0.1-0.2 percent in local varieties grown by the farmers. At DRPCAU, Dholi (Bihar), out of 102 samples from 18 varieties of wheat, 11.6% of farmer's saved samples were exhibited germination below IMSCS. At rest of the centers, farmer's saved samples recorded with germination above IMSCS.

- Seed health status of farmers' saved seed in soybean was studied at MPKV, Rahuri; JNKVV, Jabalpur; PJTSAU, Hyderabad and VNMKV Parbhani. Seed samples from 13 districts were analyzed for the association of mycoflora at Jabalpur. Range of association of *Macrophomina phaseolina*was 01-17% in seeds from Seoni while it was 01-21% for *Colletotrichum dematium* in seeds from Chhindwara and 02-23% for *Fusarium oxysporum* in seeds from Jabalpur. Based upon naked eye observations supported by observations under Diaphanoscope, the association of Purple stained seed disease was 02-18% in seeds from Chhindwara district. At MPKV, Rahuri, 12.54 % of farmer's saved samples exhibited germination below IMSCS. At VNMKV, Parbhani, 2.31 % of farmer's saved samples exhibited germination below IMSCS. At PJTSAU, Hyderabad, the most predominantly occurring fungus was found to be the genus *Fusarium* spp. (10.10%) followed by *Colletotrichum* sp. (3.88%) with a significantly lowest percent seed infection by purple stain (0.25%) and *Phomopsis* spp. (0.54%). There was no incidence of SMV in soybean belt of Telangana state. Major fungi associated with soybean seed in farmers' saved samples as evaluated by different centres are *Macrophomina phaseolina, Colletotrichum sp., Phomopsis* spp. along with other fungi *viz., F. moniliforme* and *F. oxysporum.*


Colletotrichum truncatum ***Fusarium oxysporum*** ***Alternaria alternata*** ***Phomopsis spp.***

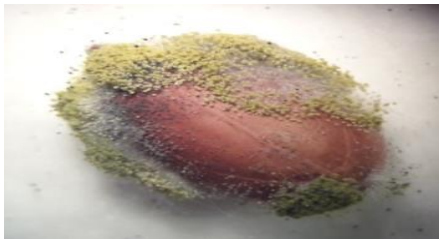


Macrophomina phaseolina ***Aspergillus* spp.** ***Fusarium moniliforme*** ***Penicillium* spp.**

Fig 10: Fungi on farmers' saved seed of soybean

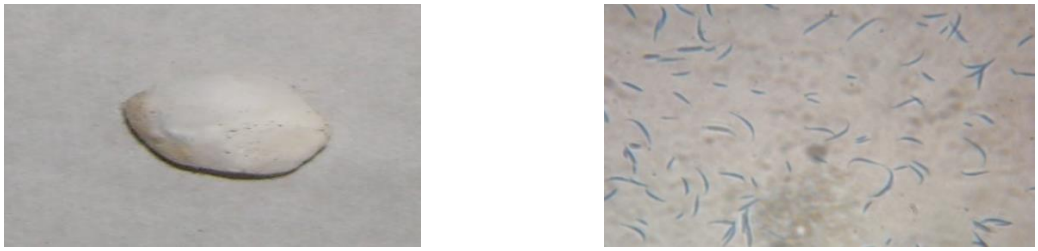
- Seed health status of 234 samples of groundnut collected from Ahmednagar, Nasik, Pune, Sangali, Solapur and Jalgaon districts was tested at MPKV, Rahuri. Seed germination ranged from 56 to 88 per cent while the seed mycoflora associated with the seed ranged from 1.2-17.9 per cent. Twenty-three samples showed seed germination below IMSCS i.e. 70 %. Almost all the samples were infected with *A. niger* and *A. flavus*. Seed health status of groundnut was also studied at TNAU, Coimbatore; JNKVV, Jabalpur; AAU, Anand and RARI Durgapura. Both *A. niger* and *A. flavus* were observed at all the places except RARI, Durgapur which has noticed only *Aspergillus niger*.

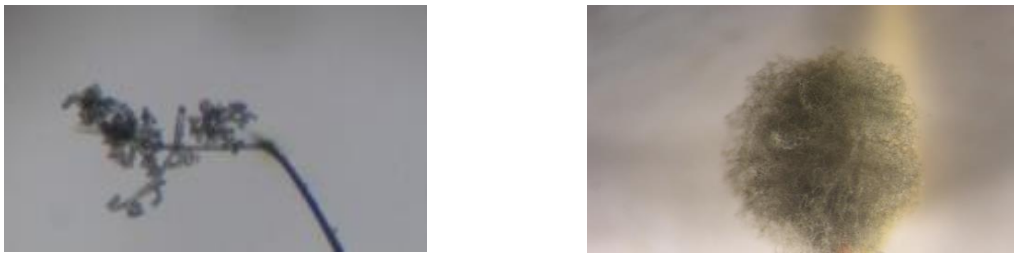
A. niger ***A. flavus***

Fig 11. Detection of seed mycoflora by blotter test in farmers' saved groundnut seed

- Seed health status of 356 samples of chickpea collected from Ahmednagar, Nasik, Dhule, Jalgaon, Pune, Satara, Sangli, Solapur, Kolhapur, Washim and Wardha districts were tested at MPKV, Rahuri. Seed germination ranged from 77 to 98 per cent while seed mycoflora associated with seeds ranged from 1.1 to 7.7 per cent. Twenty-four samples showed seed germination below IMSCS i.e. 85.00 per cent. At RARI Durgapura, only *Fusarium* spp. was observed.



Fusarium oxysporum



Botrytis cinerea

Fig. 12 View of conidia of different fungal species in chickpea seeds

- Seed health status of farmers' saved seed in saffron was studied at SKUAS&T, Srinagar. Saffron corms were dug in affected fields from two saffron growing areas of Ladoo, Pulwama district and Budgam. The samples were observed in relation to corm health and disease/ pathogen associated. Most commonly encountered pathogens were *Fusarium sp., Rizoctonia spp, Aspergillus sp.* and *Penicillum spp.* The most prominent among them was *Fusarium oxysporum,* which was studied further by establishing association of this pathogen with corm rot disease using pathogenicity test.

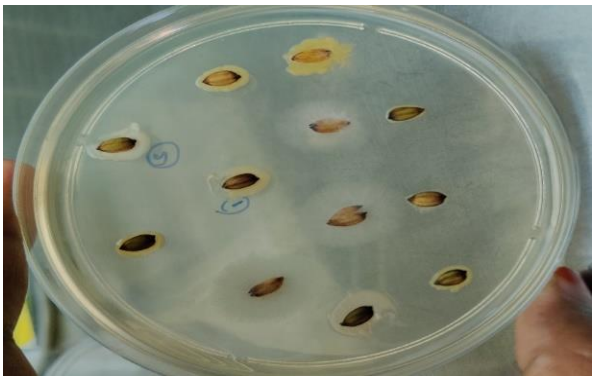
Fig. 13 Saffron infected by *Aspergillus sp.* and *Penicillum*

❖ **Experiment on standardization of detection methods for seed borne pathogens of significance**

➢ For detection of seed-borne infection of important pathogens of significance, the methods standardized, protocols developed and validated at different centers are mentioned below. Some of these methods were tried during last year too and needs validation by different centers so that some conclusive evidence could be documented.

Centre	Method	Pathogen	Crop	Protocol standardized
TNAU, Coimbatore	Standard blotter method	*Fusarium* spp.	Blackgram	Modified as Blotter sheets soaked in NaOH 0.4% and incubated at 25^{0}C at 12h alternate light and dark period
		Macrophomina spp.		Modified as Blotter sheets soaked in KOH 0.2% and incubated at 25^{0}C at 12h alternate light and dark period (needs revalidation)
PJTSAU, Hyderabad, IARI New Delhi	Standard blotter method	*Fusarium, Alternaria*	Blackgram	NaOH Blotter soaked method better than SBM
		Macrophomina		2, 4 D blotter method better than SBM
SKUAS&T, Srinagar	Molecular diagnosis	*Potato Virus Y* *Potato Virus X* *Potato Virus S*	Potato	Universal Primers and strain specific primers have been designed for detection of all the strains of PVY. In addition to this, primers for other viruses of potato viz. PVX, PVS, PLRV and PVA were also designed and used for detection of these viruses
	Agar Plate Method	*Corm rot (Fusarium sp.)*	Saffron	Corms plated on PDA and incubated for 5-7 days at 22± 1^{o}C under alternate cycles of 12 hour light and 12 hour darkness
MPKV, Rahuri	Standard deep freeze	*Fusarium oxysporum*	Soybean	Better recovery but needs validation.

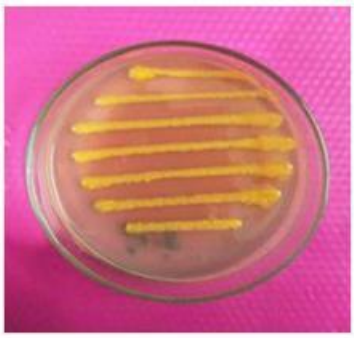
	blotter method			
GBPUA&T, Pantnagar	Molecular diagnosis	*Burkholderia glumae*	Paddy	The bacterium has been detected by 16s ribosomal DNA sequencing by universal primer pair 27F (5' AGTTTGATCCTGGCTCAG 3') and 1492R (5' ACCTTGTTACGACTT3').
	Standard blotter method	*Alternaria alternata*	Chilli	Deviation from the SBM is not clear and so needs validation after discussion.
JNKVV, Jabalpur	Standard blotter method	*Colletotrichum dematium*	Soybean	Soybean seed were treated with 1% NaOCl and placed on top of the blotters, incubated for 7 days with 12 hr light and 12hr dark periods at 25^0C.
		Colletotrichum dematium	Mungbean	seeds were placed without any treatment on top of the paper and pretreated with streptopenicillin (200ppm), needs validation.
PAU, Ludhiana, IARI New Delhi	Washing test	*Albifimbria terrestris*	Paddy	Needs validation using molecular diagnostics
IISS, Mau	Standard blotter method	*Burkholderia glumae, Burkholderia cepacia*	Paddy	Seed surface sterilization and plating of 6 seeds was done instead of 10 and 12 and 100% bacterial growth observed in all the seeds plated.
CSKHPKV, Palampur	Molecular diagnosis	*Pepper mild mottle virus* (PMMoV)	Capsicum	The RT- PCR based protocol designed to detect the PMMoV was validated for its authenticity and robustness using coat protein (CP) gene specific primer pair (CPF: CCAATGGCTGACAGATTACG, CPR:CAACGACAACCCTTCGATTT.



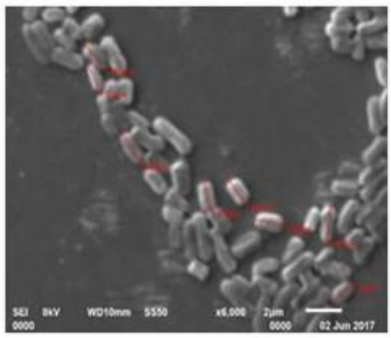
Seed surface unsterilized plating method showing external fungal growth along with bacterial growth (12 seeds per 90mm petri plate)

Surface sterilized seed plating method showing only bacterial growth with no fungal contamination (6 seeds per 90mm petri plate)

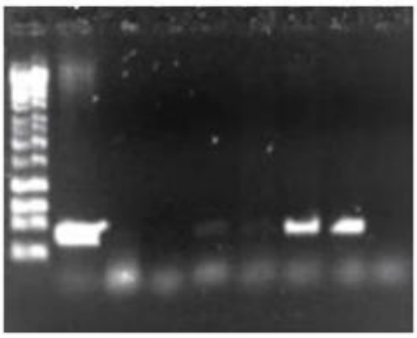
Fig14. Standard blotter test method standardized at IISS, Mau



Isolation of bacterium



Rod shaped with round ends Bacterium under SEM with average size 0.45-0.65x1.41 to 1.65 µm



PCR amplification of 530 - bp product for *B. glumae*

Fig 15. Molecular characterization of *Burkholderia glumae* from paddy seed at GBPUA&T, Pantnagar

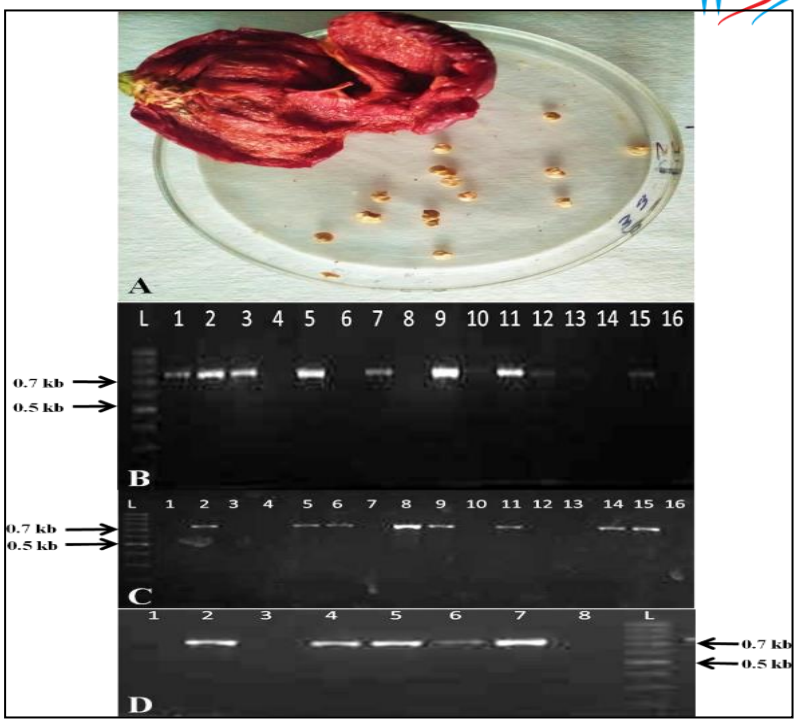
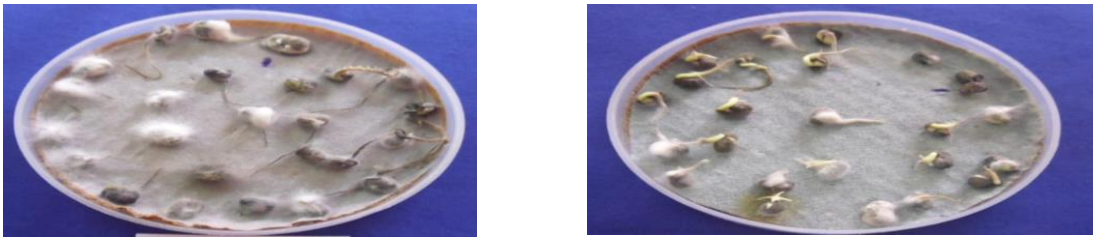
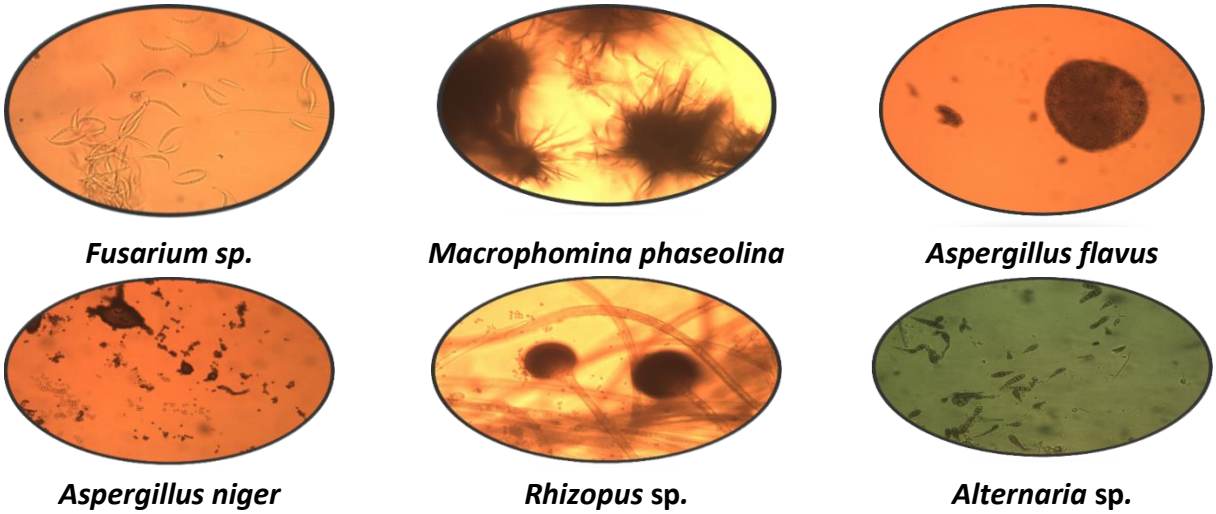


Fig.16. RT-PCR based amplification of PMMoV from seeds of diseased fruit using CP-gene specific primer CSKHPKV, Palampur. A: Seeds harvested from infected fruit; B and C: PCR amplification using individual seed (L: 100bp DNA ladder, Lane 1-14: represents ampilcons of ~730bp in single infected seed; Lane 15: positive control; Lane 16: Negative control); D: PCR amplification using individual seed (L: 100bp DNA ladder, Lane 1-: represents ampilcons of ~730bp in single infected seed; Lane 7: positive control; Lane 8: Negative control)



NaOH (0.4%) **KOH (0.2%)**

Fig. 17 Detection of seed borne pathogens in blackgram by alkali method



Fusarium sp. *Macrophomina phaseolina* *Aspergillus flavus*

Aspergillus niger ***Rhizopus* sp.** ***Alternaria* sp.**

Fig. 18 Seed borne pathogens from blackgram seeds under various methods of detection at TNAU, Coimbatore

❖ **Experiment on non-chemical management of seed borne infection of bean anthracnose**

- Non-chemical management of seed borne infection of bean anthracnose was investigated at SKUAST, Srinagar; RARI, Durgapura and CSKHPKV, Palampur. There was significant increase in percent germination, seedling vigour and reduction in percent disease incidence in non-chemical treatments of Panchgavya + *T.viridae,* Panchgavya + *T. harzianum* and Panchgavya + *P. flourescens* over biocontrol agents when used alone. Though it was lesser than the carbendazim treatment but taking into consideration of environmental issues, we need to look into alternatives for chemical fungicides. The experiment needs to be done at few more centers where bean anthracnose is a common disease for getting better understanding of the non-chemical means of management. The highest germination percentage and lowest disease incidence was recorded in infected seeds treated with Carbendazim followed by Panchgavaya in combination with *T.viride*.

❖ **Experiment on management of *Alternaria solani* in tomato through seed treatment and foliar application of newer chemicals**:

- Experiment was carried out at 7 centers namely AAU, Anand; PAU, Ludhiana; SKUAST, Srinagar; MPKV, Rahuri, GBPUAT, Pantnagar, RARI, Durgapur and ICAR-IISS, Mau. Two centers namely PAU and SKUAST have indicated that foliar spray of Azoxystrobin (18.2 %) + Difenconazole (11.4 %) @ 0.03% as most effective treatment for reducing the diseases and improving fruit and seed yield. MPKV, Rahuri and GBPUAT, Pantnagar are differing in their

results. Hence, the experiment needs to be repeated again in order to come to a consensus conclusion.

❖ **Experiment on monitoring of seed borne viruses in soybean & pulses**

- Experiment was undertaken in various villages by AAU, Anand and none of the samples collected showed the presence of SMV although it was reported last year in varying severity by the same center. At IARI New Delhi, Soybean leaf samples showing mosaic and crinkling symptoms were subjected to direct antigen coating enzyme linked immunosorbent assay (DAC-ELISA) using SMV polyclonal antibodies. Detection of SMV through DAC-ELISA is inconsistent as the absorbance values are very low**.** Detection of SMV through reverse transcription polymerase chain reaction (RT-PCR) using the specific primers gave non-specific amplification. The seed material showing hilum bleeding symptoms received from Marathwada agricultural university, Maharashtra was also checked for the presence of SMV. RNA was isolated from the infected seed material and tested with 5 sets of SMV specific primers. But there is no specific amplification indicating the absence of SMV from the soybean seed material.

❖ **Experiment om impact of different storage conditions and longevity of seed associated mycoflora of greengram / blackgram**

- Experiment was conducted at MPKV, Rahuri; TNAU, Coimbatore; PAJANCOA&RI, Karaikal; AAU, Jorhat and ICAR-IISS, Mau. The effect of seed treatment was significant on seed germination, shoot and root length and seedling vigor in terms of dry weight of the seedlings and seed infection. The influence of containers was significant on all seed quality parameters. Nearly 7 per cent higher germination was observed in treated seeds than untreated probably due to lesser seed moisture content during storage. Similar effect was also noticed in seed vigor index. Significant reduction in associated mycoflora (*Macrophomina*: 0%; *Aspergillus* sp.: 3.3%) observed in Thiram treated seeds stored in polylined gunny bag. Untreated seeds exhibited almost >70% infection after 6 months of storage period. Field emergence also recorded very low in case of untreated seeds (5-15%). After 6 months of storage, samples exhibited very poor germination (8-38%) which is below the IMSCS for germination (75%).

❖ **Experiment on detection, location and transmission of seed borne *Macrophomina phaseolina* in sesame**

- Experiment was carried out at two centers namely MPKV, Rahuri and PJTSAU, Hyderabad. Out of three methods employed, Agar plate method was the most suitable for detection of *Macrophomina phaseolina* in which 14.5 per cent infection was observed in variety VRI 2, followed by Standard blotter method (9.5 % infection). The variety TMV 7 was found free from *Macrophomina phaseolina* pathogen**.** The experiment needs to be validated again as PJTSAU, Hyderabad centre could not get recovery of test pathogen by any methods. Infact

this is a validation experiment of TNAU center developed protocol which needs to be validated before coming to any conclusion.

❖ **Experiment on management of purple blotch and stemphylium blight of onion by fungicides and plant-based products**

➢ Experiment was conducted by MPKV, Rahuri; SKUAST, Srinagar; PAU, Ludhiana; RARI, Durgapur and IARI New Delhi. All the centers have reported different results. At MPKV Rahuri, the treatment tebuconazole @ 0.10% was found to be most effective in reducing the disease severity by 59.07% followed by difenoconazole @0.10 %, with 53.67 per cent reduction of blight as compared to 69.07 per cent disease severity in untreated control. Among the three plant-based products, Crude leaf extract of *Pongamia pinnata* @ 5 %was found to be superior over other plant based products in reducing disease severity (30.51%) and increasing the yield by 6.55% over control. However, at SKUAST, Srinagar, Difenconazole @0.1%+0.1% Triton was best treatment with highest germination (88%) and least disease incidence (9.33%). At PAU, Ludhiana, four prophylactic spray of Zineb @ 0.2% at 10 days interval or 2 sprays of Difenconazole @ 0.1% at 10 days interval gave minimum percent disease incidence (PDI) of purple blotch and stemphylium blight of onion. At IARI, New Delhi and RARI, Durgapura, it was first year of the experiment and it is in progress. The experiment would continue for one year more before any conclusive recommendation is achieved across all centers.

❖ **Experiment on effect of pre-harvest fungicidal sprays on seed health and quality of soybean**

➢ Experiment was carried out at three centers *viz.,* PJTSAU, Hyderabad; GBPUA&T, Pantnagar and JNKVV Jabalpur. Irrespective of pre harvest treatments imposed in field, there was gradual decline in germination during storage from zero months to ten months after storage both in treated and untreated seeds. Across the treatments evaluated, it was also observed that, the data is not giving any indication for effect of pre harvest treatments on germination of soybean seeds during storage. However, there is a clear indication for effect of seed treatment on improvement of germination of treated soybean seed when compared to untreated. Soybean seeds treated with vitavax power @3g/kg found to be effective in reducing per cent seed infection in comparison to untreated control. The data also indicates that this effectiveness is because of seed treatment and not due to pre-harvest sprays.

D. Seed Entomology

Under seed entomology, six experiments *viz.* Survey and evaluation of seed health status of farmers' saved seed with respect to insect infestation; evaluation of solarization on bruchids (pulse beetle) infestation and quality of pulse seeds; survey and monitoring of insecticide resistance in storage insect pests infesting seeds in storage godowns; evaluation of

commercially available neem products on storage pest management during storage under ambient condition; management of pulse beetle (*Callosobruchus sp.*) through pre-harvest spraying of insecticides & botanical and evaluation of new insecticide molecules for management of storage insects of seed were taken up during 2019-20.

❖ **Experiment on survey and evaluation of seed health status of farmers' saved seed**

- Study was carried out by 13 cooperating centres in eight states and one union territory across the country and about 2067 nos. of farmers' saved seed samples have been collected and analysed for seed quality. The survey revealed that about 38.7% seed samples had germination bellow IMSCS and about 61.8% seed samples were infested with various storage pests. About 53.5% samples had insect damage beyond permissible limit. The intensity of damaged seed usually varied from 0.25-5.0%. Therefore, there is ample scope of improvement of seed health status of farmers' saved seed.

Table 4.1: Seed health status of farmer's saved seed with respect to storage insects

Name of centre	No. of sample	Crops	Storage period (months)	Per cent infested sample	Insect recorded	Intensity of insect damage (%)	Samples with insect damage beyond permissible limit (%)	Seed germination (%)	Samples having Germination above IMSCS (%)
PDKV, Akola	135	Wheat, soybean, chickpea,	7-8	83.7	Cc, Rd	0.1-6.0	74.1	61-97	81.5
IISS, Mau	100	Wheat	*6*	18.0	Rd, Sc, So	0.25-25.0	13.0	61-88	52.0
TNAU, Coimbatore	103	Indian bean, Finger millet, Pearl millet, Groundnut	*3-12*	31.1	Cm, Tc, So, Cs	1.0-25.0	26.2	16-100	49.5
NDUA&T, Faizabad	166	Paddy, Wheat	*5-7*	82.5	Rd, So, Sc, Tg	0.33-20.0	78.3	10-99	53.0
MPKV, Rahuri	295	Soybean, Wheat, Chickpea, Sorghum, Pearlmillet	*8-9*	16.3	C, Rd, So,Tc	0.10-16.0	16.3	65-94	78.3
OUAT, Bhubaneswar	294	Paddy	*5-6*	69.0	Rd, Sc	0.5-11.5	58.8	44-95	74.8
AAU, Jorhat	101	Paddy	*7-8*	42.6	Rd, So, Sc	0.25-16.5	21.8	30-93	65.3
PJTSAU, Hyderabad	175	Paddy, Greengram, redgram	*6-18*	89.7	Rd, So, Sc, Tc, Cc	0.21-59.6	88.6	40-100	74.3
UAS, Dharwad	139	Chickpea, Soybean	*2-8*	30.2	Cc	0.5-15.0	27.3	52-88	28.8
JAU, Jamnagar	106	Groundnut	*7-8*	64.2	*Cs*	1.0-65.0	34.0	42-90	95.3
UAS, Bangalore	178	Cowpea, Fieldbean, chickpea, paddy, Groundnut	*2-12*	100.0	So, Rd, Tc, Cm, Cs	0.80—6.7	97.8	54-85	20.2
PAJANCOA, Karaikal	63	Paddy	*3*	100.0	Rd	1.78-6.22	100.0	0.0-100	33.3
CSAUAT, Kanpur	212	Paddy, Wheat	*6-8*	83.0	Rd, So, Os	0.25-9.0	59.4	45-97	57.5

Rd – *Rhyzopertha dominica* (Lesser grain borer); So – *Sitophilus oryzae* (Rice weevil); Cc– *C. chinensis* (Pulse beetle); Sc – *Sitotroga cerealella* (Angoumois grain moth);Tc - *Tribolium castaneum* (Red flour beetle); *Cs-Corcyra cephalonica* (Rice moth); *Os-Oryzaephilus surinamensis* (Saw toothed grain beetle) *Cm-C. maculatus*

❖ **Experiment for evaluating effect of solarization treatments on bruchids (pulse beetle) infestation and quality of pulse seeds**

➢ Experiment was conducted in nine centres. Solarization of seeds was carried out in clear polythene (700 gauge) packet (5cm thick seed layer) for different duration. Present study revealed that solarization of seeds for 6 days (3 h on each day) was highly effective treatment for reducing insect damage in most of the centres and maintained higher seed germination compared to control during storage. Solarization can be used for management of insect infestation and maintenance of seed germination in chickpea, cowpea, greengram, pigeonpea and blackgram seeds.

Table 4.2: Effective solarization schedule for different crops at various centres

Crop	Centre	Solarization schedule	Remarks
Chickpea	JAU, Jamnagar	Solarization of seeds in clear polythene (700 gauge) packet for 2 days (3 h on each day)	No adult emergence in both fresh seeds and inoculated seeds up to 12 months of storage.
	MPKV,Rahuri	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	No adult emergence in fresh seeds and least insect damage in inoculated seeds up to 9 months of storage.
	UAS, Dharwad	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	No adult emergence in fresh seeds and least insect damage in inoculated seeds up to 6 months of storage.
Green gram	OUAT, Bhubaneswar	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	Lowest insect damage in both fresh seeds and inoculated seeds up to 9 months of storage.
	PJTSAU, Hyderabad	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	Lowest insect damage in both fresh seeds and inoculated seeds up to 6 months of storage.
Black gram	TNAU, Coimbatore	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	No adult emergence in fresh seeds and least insect damage in inoculated seeds up to 12 months of storage.
	AAU, Assam	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	No adult emergence in fresh seeds and least insect damage in inoculated seeds up to 9 months of storage.
	PAJANCOA, Karaikal	All solarization treatments of seeds in clear polythene (700 gauge)	No adult emergence in fresh seeds and inoculated seeds up to 12 months of

		packet	storage.
Cowpea	UAS, Bangalore	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	Lowest insect damage in both fresh seeds and inoculated seeds up to 6 months of storage.
Pigeon pea	PDKV, Akola	Solarization of seeds in clear polythene (700 gauge) packet for 6 days (3 h on each day)	Lowest insect damage in both fresh seeds and inoculated seeds up to 12 months of storage.

❖ **Experiment on survey and monitoring of insecticide resistance in storage insect pests infesting seeds in storage godowns**

➢ Study was conducted to estimate level of resistance to commonly used insecticides in storage godowns at various centres. Five insects' *viz. Rhyzopertha dominica, Sitophilus oryzae, Tribolium castaneum, Callosobruchus maculatus* and *Callosobruchus analis* were collected and multiplied in laboratory to determine relative susceptibility (LC_{50} values) of these insects through bioassay technique. Results obtained at various centres indicated that degree of resistance varied from insect to insect and strain to strain. Degree of resistance ranged from x1.02 to x1095.6 compared to susceptible strains. Highest degree of resistance was observed towards deltamethrin in *Tribolium castaneum* strain collected by TNAU from Department of millets (x1095.6) followed by *Tribolium castaneum* strain collected by TNAU from private seed godown (x960.9). *C. analis* strains collected by PDKV also showed x500 resistance towards deltamethrin. *C. maculatus* strain collected by TNAU from Department of pulses showed highest degree of resistance (x183.3) towards malathion. In majority of strains, resistance level ranged between x4 to x50, which is a matter of great concern.

❖ **Experiment on efficacy of commercially available neem products on storage pest management during storage under ambient condition**

➢ Different concentrations of two neem formulations (neemazal T/S and neemoz gold) having 10000ppm azadiractin were tested along with deltamethrin. Although there were variations in results from centre to centre, in most of the crops, neemazal T/S @7.5ml/kg seed recorded least insect damage and at par with deltamethrin in some of the centres. Thus, preliminary results revealed that neemazal T/S @ 7.5ml/kg seed can be used for management of storage insects up to 3-6 months in paddy, wheat and cowpea seeds without affecting seed germination.

Table 4.3: Effective seed treatment botanicals and storage periods for different crops at various centres

Crop	Centre	*Safe period of	Effective botanicals

		storage (months)	
Wheat	MPKV, Rahuri;	6	Neemazal T/S@ 5ml/kg and neemazal T/S @7.5ml/kg
	CSAUAT, Kanpur	6	Neemoz Gold @7.5ml/kg
	NDUAT, Faizabad	6	Neemazal T/S @7.5ml/kg
Paddy	AAU, Jorhat	3	All neem formulations
	PJTSAU, Hyderabad	6	Neemazal T/S@ 5ml/kgand neemazal T/S @7.5ml/kg
	PAJANCOA,Karaikal	6	All neem formulations
	OUA&T, Bhubaneswar	3	Neemazal T/S @7.5ml/kg
Cowpea	TNAU, Coimbatore	3	Neemazal T/S@ 5ml/kgand neemazal T/S @7.5ml/kg

* Insect damage below the prescribed limits and seed germination above IMSCS

❖ **Experiment on evaluation of pre-harvest spraying of insecticides and botanical for management of pulse beetle.**

➢ Investigation to identify suitable insecticide for pre-harvest spraying for management of pulse beetle among pulses revealed that spraying of emamectin benzoate (5 SG)@ 0.3ml/L/neemazal T/S @6ml/L at 50% pod maturity and maturity were effective in management of insect population build up during storage of pulses (pigeonpea, greengram, blackgram, chickpea and cowpea.

Table 4.4: Effective pre-harvest spraying schedule of insecticides/ botanicals for different crops

Crop	*Centre*	*Insecticide/ Botanical*	*Spraying schedule*	*Remarks*
Pigeonpea	UAS, Bangalore	Emamectin benzoate, Neemazal T/S @ 6ml/L	Spraying at 50% pod maturity and maturity (S3)	Insect damage within permissible limit
	PJTSAU, Hyderabad	Emamectin benzoate, Neemazal T/S @ 6ml/L	Spraying at 50% pod maturity and maturity (S3)	Lowest adult emergence
	PDKV, Akola	Emamectin benzoate, Neemazal T/S @ 6ml/L	Spraying at 50% pod maturity and maturity (S3)	Lowest insect damage
Green gram	JAU, Jamnagar	Emamectin benzoate, Neemazal T/S @6ml/L	Spraying at 50% pod maturity and maturity (S3)	Insect damage within permissible limit
Black gram	AAU, Assam	Emamectin benzoate Neemazal T/S @ 6ml/L Neemazal T/ S @4ml/L	Emamectin benzoate at maturity (S2)/ Neemazal T/S @ 6ml/L at maturity (S2)/Neemazal T/S @4ml/L spraying at 50% pod maturity and maturity (S3)	No adult emergence
	TNAU,	Emamectin benzoate	Neemazal T/S @6ml/L spraying at	Insect damage at

	Coimbatore	Neemazal T/S @ 6ml/L	50% pod maturity and maturity (S3)	par with emamectin benzoate
	PAJANCOA, Karaikal	Emamectin benzoate Neemazal T/S @ 6ml/L	Neemazal T/S @6ml/L spraying at 50% pod maturity and maturity (S3)	Lowest insect damage
Chickpea	NDUAT, Faizabad	Emamectin benzoate Neemazal T/S @ 6ml/L	Spraying at 50% pod maturity and maturity (S3)	Insect damage at par with emamectin benzoate
Cowpea	IISS, Mau	Neemazal T/S @ 6ml/L Emamectin benzoate	Spraying at 50% pod maturity and maturity (S3)	Lowest insect damage at par with emamectin benzoate

❖ **Experiment on effect of insecticidal seed treatment on seed viability during storage under ambient condition.**

➢ Efficacy of newer insecticides like spinetorum and flupyradifurone were tested along with emamectin benzoate and deltamethrin for management of storage pests. The results revealed that among various concentrations of newer insecticides spinetorum@4ppm and flupyradifurone @8ppm provided control of storage insects infesting wheat, paddy, green gram, pigeonpea, cowpea and chickpea under different agro-climatic conditions up to three to six months without impairing the seed viability. However, in some of the centres, lower concentrations had also shown promising results which might be ascertained after one season of storage. Newer insecticides were found at par with deltamethrin (Decis 2.8 EC) @1.0ppm and emamectin benzoate @2ppm or even better in some of the centres.

Table 4.5: Effective seed treatment insecticide molecules and storage periods for different crops and at various centres

Crop	Centre	*Safe period of storage (months)	Effective treatments
Wheat	CSAUA&T, Kanpur	6	Spinetorum @ 4ppm, flupyradifurone @8ppm, deltamethrin
Paddy	PJTSAU, Hyderabad	6	All concentrations (1ppm, 2ppm & 4ppm) of spinetorum
	AAU, Jorhat	3	All insecticidal treatments
	Karaikal, (Pondicherry)	6	Spinetorum @2ppm, emamectin benzoate @2ppm, deltamethrin@1ppm
Pigeon pea	NDUA&T, Faizabad	6	All concentrations of flupyradifurone, spinetorum @4ppm, emamectin benzoate @2ppm, deltamethrin@1ppm
	PDKV, Akola	3	Spinetorum @ 4ppm Flupyradifurone @8ppm

Cow pea	UAS, Bangalore	-	None (spinetorum@4ppm, emamectin benzoate @2ppm, deltamethrin@1ppm were at par)
	TNAU, Coimbatore	3	flupyradifurone @4ppm and 8ppm, spinetorum @4ppm
Mung bean	OUA&T, Bhubaneswar	6	Spinetorum (@2&4ppm), flupyradifurone (@ 4&8ppm), emamectin benzoate @2ppm, deltamethrin@1ppm
Chick pea	MPKV, Rahuri	6	All treatment
	JAU, Jamnagar	6	All treatment

* Insect damage below the prescribed limits and seed germination above IMSCS

E. Seed Processing

❖ **Experiment on optimum sieve size and type of screen for grading seeds of different crop varieties and hybrids including their parents**

- Optimum sieve size for thickness grading in three paddy varieties *viz.*, Pusa 44 (Coarse bold), Pusa Basmati 1718, Pusa Basmati 1509 (Medium slender) was found to be 1.9mm (s) and while it was 1.8mm for Pusa Basmati 1121 (Medium slender), against recommended 1.85mm (s) for coarse grain/ bold type, 1.80mm (s) for medium slender and 1.7mm (s) for fine/ superfine varieties with maximum seed recovery of 90.2, 88.9, 92.9 and 89.9%, respectively. For another two coarse paddy varieties MDU 6 and Sakoli 6 optimum sieve size for thickness grading was 2.00mm. Whereas, 1.6mm may be recommended as grading screen for medium slender paddy varieties like ADT(R) 46 & ADT 43; and small seeded Akola non-basmati varieties *viz.*, PKV Tilak, PKV Kisan, PKV HMT.

- Optimum sieve size for thickness grading in three newly released wheat varieties *viz.*, HI 1620, HD CSW 18 was found to be 2.4mm (s) against recommended 2.3 mm (s) while it was 2.2mm (s) for HS 562 against recommended 2.1mm (s) as per IMSCS.

- For small seeded chickpea varieties viz., Radhey, KWR 108, Udai, optimum grading sieve size was found to be 4.75mm (r) against recommended size of 5.0mm (r). While, 6.50mm (r) was found to be suitable for medium seeded variety Vijay and bold seeded varieties viz., PKV Kabuli-2, Phule Vikram, Phule Vikrant against recommended sizes of 5.5 and 6.00mm (r).

- Optimum grading sieve size was found to be 3.75mm (s) for soybean varieties viz., DSb-21, JS 335, JS 9305, DS 228, KDS 726 and KDS 753against recommended size of 4.0mm (s). This optimum grading sieve size has exhibited higher seed recovery and better in seed quality.

- Optimum grading sieve size was 8.0mm (r) for maize hybrid COH (M) 6 and its female parent (UMI 1200) against recommended size of 7.0mm (r) as it exhibited higher seed recovery and better in seed quality.

- Optimum sieve size for grading of bold seeded pigeonpea cultivar BRG 3 was found to be 5.00 mm (r) against recommended size of 4.75mm (r), whereas 3.75mm (r) is the best size for grading small seeded cultivar GRG 811 against recommended size of 4.00mm (r).
- Optimum grading sieve size was found to be 2.70mm (s) for blackgram varieties viz., VBN 4 and ADT 3 against recommended size of 2.80mm (s).
- Sieve aperture size of 2.0mm (Slotted) is found to be ideal grading screen for size grading of dhaincha seeds for which no IMSCS recommendation is given.

Table 5.1: Crop & variety wise screen size optimized for grading of seeds

Crop / Seed Size (categories)	Variety	Recommended Sieve Size (mm)	Standardized Sieve Size (mm)	Seed Recovery (%)
Paddy				
Coarse/ Bold	Pusa 44	1.85 s	1.90 s	90.2
Medium slender	PB 1718	1.80 s	1.90 s	88.9
Medium slender	PB 1509	1.80 s	1.90 s	92.9
Medium slender	PB 1121	1.80 s	1.80 s	89.9
Medium Slender	CO-51	1.80 s	1.85 s	92.4
Long slender/ Bold	MDU-6	1.85 s	2.00 s	92.6
Medium slender	ADT (R) 46	1.80 s	1.60 s	87.3
Medium slender	ADT 43	1.80 s	1.60 s	81.1
Coarse/ Bold	ADT 37	1.85 s	1.85 s	92.6
Small seeded	PKV Tilak	1.70 s	1.60 s	89.3
Small seeded	PKV Kisan	1.70 s	1.60 s	90.3
Small seeded	PKV HMT	1.70 s	1.60 s	90.7
Medium seeded	Sakoli– 6	1.80 s	2.00 s	89.0
Wheat				
Bold seeded	HI 1620	2.30 s	2.40 s	95.8
Bold seeded	HD CSW 18	2.30 s	2.40 s	95.3
Medium seeded	HS 562	2.10 s	2.20 s	91.3
Bold seeded	K 9423	2.30 s	2.30s	87.0
Medium seeded	K 1317	2.10 s	2.10 s	93.8
Medium seeded	PBW 343	2.10 s	2.10 s	96.5
Chickpea				
Bold seeded	NBeG 49	6.00 r	6.00 r	93.4
Medium seeded	NBeG 47	5.50 r	5.50 r	98.6
Bold seeded	JG11	6.00 r	6.00 r	89.7
Small Seeded	Radhey	5.00 r	4.75 r	95.4
Small Seeded	KWR 108	5.00 r	4.75 r	94.2
Small Seeded	Udai	5.00 r	4.75 r	93.0
Medium seeded	Caffa	5.50 r	5.50 r	86.0

Medium seeded	PDKV Kanchan	5.50 r	5.50 r	89.0
Medium seeded	Jaki 9218	5.50 r	5.50 r	89.3
Bold seeded	PKV Kabuli-2	6.00 r	6.50 r	89.0
Medium seeded	Vijay	5.50 r	6.50 r	73.1
Bold seeded	Phule Vikram	6.00 r	6.50 r	79.1
Bold seeded	Phule Vikrant	6.00 r	6.50 r	87.1
Soybean				
Medium seeded	DSb21	3.75 s	4.00 s/ 3.75 s	90.6/ 81.6
Medium seeded	JS 335	3.75 s	3.75 s	97.5
Medium seeded	JS 9305	3.75 s	3.75 s	
Medium seeded	DS 228	3.75 s	3.75 s	
Medium seeded	KDS 726	3.75 s	3.75 s	
Medium seeded	KDS 753	3.75 s	3.75 s	
Maize				
Small seeded	MAH 14-5	6.40/ 7.00 r	6.40 r	94.3
Medium seeded	UMI 1230	6.40/ 7.00 r	7.00 r	90.3
Bold seeded	UMI 1200	6.40/ 7.00 r	8.00 r	90.2
Bold seeded	COH(M) 6	6.40/ 7.00 r	8.00 r	86.2
Medium seeded	RCRMH 2	6.40/ 7.00 r	6.00 r	99.3
Pigeonpea				
Bold seeded	BRG 3	4.75 r	5.00 r	94.5
Medium seeded	PKV Tara	4.00 r	4.00 r	87.7
Small seeded	BSMR 736	4.00 r	4.00 r	88.0
Small seeded	GRG 811	4.00 r	3.75 r	91.8
Mustard				
Medium seeded	Maya	1.40 r	1.30 r	90.5
Medium seeded	Rohini	1.40 r	1.30 r	95.5
Medium seeded	Urvashi	1.40 r	1.30 r	94.5
Blackgram				
Medium seeded	VBN 4	2.80 s	2.70 s	98.4
Medium seeded	ADT 3	2.80 s	2.70 s	97.3
Dhaincha				
	---	---	2.00 s	81.9
Fieldbean				
Medium seeded	HA 4	6.50 r	6.50 r	92.9
Fingermillet				
Medium seeded	KMR 630	1.40 s	1.20 r	91.4
Sunflower				
	KBSH 78	2.40 s	2.40 s	89.3

❖ **Experiment on management of karnal bunt through mechanical seed processing**

- 2°slope of deck of the gravity separator and 15kg per minute rate of feed, for one tonnes per hour processing unit, is recommended for processing of wheat seed for management of Karnal bunt.

Capacity Building, Extension Activities, Publications and Recognitions

AICRP-NSP (Crops) with the mandate of human resources development in seed domain, various training modules were implemented by cooperating centres during 2019-20 to cater the needs of varied stakeholders of seed industry *viz*. seed production personnel from SSCs, NSC, state Department of Agriculture and private sector; farmers, trainers, seed certification agency officials *etc*. Trainings were mainly focused on seed production technology, processing, safe seed storage, quality enhancement, quality assurance, seed health management and seed entrepreneurship development. Apart from training programmes, several extension activities like *exhibition, kisan mela, kisan goshti, field day & demonstration* have been conducted by several cooperating centres. Several scientific staffs of AICRP-NSP (Crops) were also conferred with awards and other recognitions during 2019-20 in various international/ national seminars, conferences and workshops. The efforts made by cooperating centres in capacity building will certainly boost the quality and quantity of the seed and would help in amelioration of Seed Replacement Rate (SRR) in different crops.

During 2019-20, *in toto* 56 training programmes were organized for varied stakeholders of seed industry. Similarly, 14 exhibitions/ *kisan melas*, 03 seed day/ field day/ demonstration were organized on diverse themes related to seed by different cooperating centres. Scientific staffs of AICRP-NSP (Crops) published 79 research papers in the varied journals of national and international repute and also received 11 awards for contributions made in seed domain.

Training on varietal characterization & seed production technology in castor at JAU, Jamnagar

Field day organized on new variety of bengalgram and their cultivation practices at UAS, Raichur

Summary of capacity building programmes, extension activities, research publications and recognitions under AICRP-NSP (Crops) during 2019-20

S. No.	Centre	Training (No's)	Exhibition/ *kisan mela* (No's)	Seed day/ Field day/ FLD's (No's)	Research paper (No's)	Awards (No's)
1	AAU, Anand	2	1	-	4	-
2	CSKHPKV, Palampur	13	-	-	4	3
3	SKRAU, Bikaner	-	1	-	-	-
4	ICAR-CICR, Nagpur	11	2	1	-	-
5	BCKV, Nadia	7	3	1	-	-
6	RPCAU, Pusa	-	2	1	3	-
7	JNKVV, Jabalpur	4	1	-	15	6
8	NDUAT, Faizabad	-	-	-	11	-
9	PDKV, Akola	10	2	-	13	1
10	PAU, Ludhiana	-	-	-	1	-
11	SKNAU, Jobner	-	-	-	4	-
12	PJTSAU, Hyderabad	-	-	-	2	-
13	JAU, Jamnagar	2	1	-	2	-
14	UAS, Raichur	-	1	-	5	-
15	TNAU, Coimbatore	-	-	-	4	-
16	MPKV, Rahuri	7	-	-	11	1
	Total	**56**	**14**	**3**	**79**	**11**

AICRP-NSP (Crops) - Revolving Fund

Indian Council of Agricultural Research (ICAR) took firm steps as early as 1979-80 by launching AICRP–National Seed Project (Crops) and created as many as 41 Breeder Seed Production (BSP) units in almost all State Agricultural Universities and crop based ICAR institutes to cater to the requirement of breeder seeds in different crops. To support and strengthen breeder seed production programme, ICAR during VIII Plan has made provision of revolving fund with a policy of single window system for stringent compliance to avoid operational problem of recurring fund in the BSP centres. To make the system more efficient, vibrant, accountable and sustainable, fund provided under various heads of revolving funds were clubbed together and the centres were directed to make single account. Centres were instructed to operate single account of the fund and the Nodal Officers were entrusted with the responsibility of fund operation. The centres are instructed to undertake breeder seed production of the field crops. It is mentionable that profits earned by the centres were ploughed back in the system for creation of infrastructure facilities to enhance the capability of BSP units.

Highlights

1. Revolving fund has made significant impact in enhancing breeder seed production in the country as a whole and subsequently strengthened the infrastructure facilities for breeder seed production.
2. JNKVV, Jabalpur; MPKV, Rahuri; GBPUAT, Pantnagar; IGKV, Raipur; CSKHPKV, Palampur; VNMKV, Parbhani; UAS, Bengaluru and ICAR-NRRI, Cuttack were rated as very good performing centres.
3. All the centres have refunded the revolving fund amount. Centres have invested the profit obtained through the operation of revolving funds for infrastructure development in their respective centres.

Table: Utilization of revolving fund under AICRP-NSP (Crops) upto February 2020

(Rs. in lakhs)

S. No.	Centre	Amount sanctioned	Revenue generated in 2019-20 (upto Feb., 2020)	Profit utilized in 2019-20 (upto Feb., 2020)	Remarks (profit utilized for)
1	SKUAT, Srinagar	4.00	0.83 (12.71)	0.53	Seed production activity
2	CSKHPKV, Palampur	6.00	35.65 (421.23)	0.55	Repair of implements, Fencing etc.
3	PAU, Ludhiana	15.00	7.65 (127.37)	7.65	Purchase of inputs
4	CCSHAU, Hisar	15.00	51.40	28.60	-

5	GBPUAT, Pantnagar	18.00	387.56	-	-
6	NDUAT, Faizabad	10.00	50.33 (78.33)	10.50	Maintenance of farm equipments
7	BHU, Varanasi	10.00	25.13	12.13	Profit used for BSP
8	CSAUAT, Kanpur	17.00	0.41 (5.99)	0.29	Profits transferred to University RF
9	AAU, Jorhat	5.00	1.72 (23.01)	4.07	Strengthening of BSP
10	BAU, Ranchi	9.00	-	-	-
11	RPCAU, Dholi	10.00	68.06 (111.70)	35.36	Profit utilized for seed programme
12	OUAT, Bhubaneswar	13.00	14.26	Nil	-
13	SKRAU, Bikaner	40.00	85.76	40.77	-
14	SDAU, S K Nagar	20.00	74.49 (91.27)	48.35	Profit utilized for seed production & farm development
15	IGKV, Raipur	8.50	50.30 (321.36)	2.33	Utilized for farm development
16	PDKV, Akola	13.75	Nil	Nil	RF money credited to university RF account
17	JNKVV, Jabalpur	16.00	275.50	66.08	Remittance to University
18	MPKV, Rahuri	14.00	377.64	-	-
19	VNMKV, Parbhani	55.00	312.27	196.71	Farm development and seed production activity
20	UAS, Bengaluru	13.00	4.65 (350.79)	10.25	Purchase of farm equipments
21	UAS, Dharwad	18.00	19.17 (433.13)	32.92	Farm development, electrification, borewell etc.
22	PJTSAU, Hyderabad	18.00	38.94 (68.21)	-	RF merged with ISP RF
23	TNAU, Coimbatore	15.00	52.33 (157.80)	35.18	Farm developmental activities

24	KAU, Thrissur	4.00	48.89	44.40	Development of seed infrastructure
25	BSKKV, Dapoli	4.00	10.25 (148.91)	12.92	Seed production activity
26	VPKAS, Almora	4.50	5.41	4.16	Strengthening of seed production activity
27	IIPR, Kanpur	5.00	18.08 (37.54)	13.68	-
28	IGFRI, Jhansi	3.00	4.04 (3.93)	6.08	-
29	CRIJAF, Barrackpore	2.00	1.91 (13.64)	2.08	Breeder seed production activity
30	CAZRI, Jodhpur	3.00	23.30	18.38	-
31	NRRI, Cuttack	15.00	115.00 (359.58)	98.02	-
32	IIRR, Hyderabad	4.82	15.15 (77.18)	59.89	-
33	IIMR, Hyderabad	10.5	12.70 (32.00)	5.00	Seed production activity, farm machinery purchase, monitoring etc.
	Total	**419.07**	**1200.07 (3864.40)**	**796.88**	

Note:

1. The values given in parenthesis represent cumulative profit made over the years.
2. All centres have returned the sanctioned amount to council
3. All centres are using single window system

Tribal Sub Plan (TSP) Programme under AICRP-NSP (Crops)

Balanced growth and economic development is the ultimate aim of every country. During fifth five year plan, it was realized that the Scheduled Tribes were still way behind the mainstream development process. Agro-technologies generated during the past were still out of reach of the tribal farmers. In spite of significant strides made in agriculture, development is yet to take place in remote areas, which have not received any assistance for their upliftment and the farmers of these areas were still dependent upon the old varieties and landraces in different crops. Hence, Tribal Sub Plan (TSP) was initiated for socio-economic amelioration of the tribal communities with the objectives of organizing seed production in farmers' participatory mode to cater the local demands of quality seed, imparting training on quality seed production, enhancing quality of farm saved seeds, supply of quality seeds, storage structures and other farm inputs (physical assets).

During 2019-20, under AICRP-NSP (Crops), Rs. 100.00 lakhs was released to 12 cooperating centres across the country for organizing mandated activities in tribal areas for the benefit of farmers. Special training programmes on quality seed production in various crops; farmers' participatory seed production activities; distribution of quality seed, seed storage structures, crop protection equipments & small farm equipments; demonstrations, exhibitions and exposure visits were instituted by varied cooperating centres benefiting 5620 tribal farmers. *In toto*, 22986 kg of quality seed; 519 Nos of seed storage structures, crop protection equipments & small farm equipments were distributed. Similarly, 41 training programmes on various aspects of seed production, storage and quality enhancement, 02 demonstrations and 02 exposure visit were also organized for the benefit of tribal farmers. **ICAR-CICR, Nagpur organized seed production in tribal villages under farmers' participatory mode**. Seven tribal farmers were involved in participatory seed production programme of non-Bt cotton varieties viz. Suraj, LRK 516, Nh 615, AKH 081 and AKA 7 under ICAR-CICR, Nagpur.

Summary of physical achievements under TSP of AICRP-NSP (Crops) during 2019-20

Centres	Seed distributed (kg.)	Seed storage bins; sprayers, small farm implements (No's)	Training (No's)	FLDs (No's)	Exposure visit (No's)	Beneficiary (No's)
SKUA&T, Srinagar	10361	-	10	01	-	1262
CSHPKV, Palampur	2000	75	02	-	-	250
AAU, Anand	-	-	02	-	-	100
UAS, Bengaluru	7170	-	02	-	-	361
TNAU, Coimbatore	200	-	01	-	-	100

PDKV, Akola	1000	-	05	-	-	103
AU, Kota	-	444	06	-	-	444
IIMR, Hyderabad	2058	-	02	-	01	1243
CICR, Nagpur	197	-	11	01	01	1384
Total	**22986**	**519**	**41**	**02**	**02**	**5247**

Note:

- In addition to above, 300 bags vermi-compost (50 kg each) and 100 bottles of *Rhizobium* consortia was distributed by AAU, Anand to tribal farmers.
- A 'Modern Millet Value Addition Unit' was established at Karumanthurai, Salem district by TNAU, Coimbatore.

Training & distribution of quality seed under Tribal Sub Plan by UAS, Bengaluru

Training & inauguration of Millet Processing Unit under TSP by TNAU, Coimbatore

Training & distribution of quality seed under Tribal Sub Plan by PDKV, Akola

Farmers participatory seed production in tribal areas organized by ICAR-CICR, Nagpur

Joint AGM of AICRP-NSP (Crops) and ICAR Seed Project held at CCSHAU, Hisar during 07-09 April, 2019

हर कदम, हर डगर
किसानों का हमसफर
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